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ITB Research Center on ICT

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Proceedings of International Conference on Rural Information and Communication Technology 2009

Institut Teknologi Bandung
17-18 June 2009

General Chair's Message

This conference addresses rural information and communication technology (R-ICT) issues with digital culture objectives. We believe that everybody must have a chance to benefit from digital technology. The gap between the haves and the have nots to benefit from digital technology has been known as digital divide. There are approximately 3.6 billion people without benefits from ICT. We need to find solutions to allow digital inclusions for everybody.

On key issue is broadband infrastructure for rural areas. This requires innovations at many levels, from technology, products, applications, operations, and investments. In particular, we are looking at rural next generation network (R-NGN), next generation computing (NCG), next generation application platforms, as well as cultural contents. This conference gathers researchers to report their results pertaining those issues. But more importantly, this conference should consolidate research community to actively dedicate research efforts toward solving digital divide issues.

This conference is inspired by the idea that ICT empowers its users to be productive in creating values despite of their shortcomings. Without clear concept of how the users benefit from ICT, rural ICT will not be sustainable. We strongly believe, in additions to the usual education, health, trade, farming, and information applications, it is the cultural potentials that will eventually make rural ICT sustainable. It is the unleashing of the creative excitement embedded in each culture that will drive the value creation by rural communities. That is the creative entrepreneurial knowledge society that we are visioning.

This year's conference in particular is held within The Golden Anniversary of the Institute Technology Bandung. In conjunction to this conference, ITB holds 4 more international conferences with a common theme “Energy and The Environment: Reinvention for Developing Countries”. All these conferences focuses on the issues related to the developing countries. In addition to the technical sessions within these conferences we also hold Millennium Research Agenda (MRA) meeting.

We hope that through these conferences and MRA meeting, we could be able to join our focus in issues of helping the bottom pyramid of the society.

Bandung, 15 June 2009

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Intelligent Computation in Multi-Robotic Systems

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Warsaw University of Technology,
Institute of Mathematical Machines,
Research Institute for Automation and Measurements,
Warsaw, Poland

***Abstract*—Following paper is focused on the computational intelligence applied in cognitive supervision of the web connected multi-robotic system. The cognitive model of the human operator is described. The concept of the implementation of the cognitive model of human – operator is shown. The computational intelligence algorithms' usage in cognitive supervision is described, therefore the implementation of the classification and regression methods are presented. The development of the system components using Compute Unified Device Architecture (CUDA) is shown, therefore the increased performance is proven.**

I. INTRODUCTION

This paper describes the Cognitive Theory – Based Approach of multi mobile robot control with focus on artificial intelligence application. The main goal of the approach lays on the implementation of the self reasoning which is provided by the model of human supervisor. The interfaces are implemented in server – client scheme, because the mobile platforms are prepared to cooperate in distributed control system. All the cooperation shown above requires a kind of complex architecture which can be derived from CORBA. This paper as well, has shown how the architecture is applied and in general inducing an idea of multi-robot supervision.

In managing the complexity of the attributes of the system as been described above, then the behavioral conceptual adoption should be applied. This application succeed it's intelligence system by perpetuating the decision selection system which grounding its operation by the fuzzyARTMAP algorithm system. This skill is a prominent achievement which leads into the perceptual associative memory, as another essential attribute of the systematic cognitive system that this research borrowed it's concept.

The perceptual associative memory in this system particularly rendered by an ability to interpret the incoming stimuli by recognizing individuals or objects, categorizing them and noting the relationships between the objects and categories. These attributes mentioned above are showing the pertinent robot action which are always consistent with the categories and their relations. So far, the study has able to provide the new approach of the robot's cooperation system

In the application, the autonomous mobile robot is accompanying the teleoperated one. Meanwhile, the main goal for the mobile robot itself is to acquire data from the environment and delivers into Command Operation Center through the wireless communication system. The concept of building geometrical map using MK-SVM Multi Kernel Support Vector Machine is presented. COC is functioned by the existing system of the cognitive modeled of human supervision which perceptually and behaviorally are able to recognize and execute the procedures needed in the case of some risky events, particularly the collision problems given by supervision of autonomous navigation module. In contrary the PSO (Particle Swarm Optimization) algorithm as an improvement of Support Vector machine is shown. Therefore the two substantial components from the perception and association actions by mapping and localizing tasks are achieved by the system.

II. WEB CONNECTED ROBOTICS SYSTEM

The industry standard CORBA has been chosen for the implementation of the distributed robotic control system. CORBA is language and platform independent. Using such a standard simplifies the development and improves the interoperability with existing software. CORBA is actually a specification of the Object Management Group and the TAO (The ACE ORB) implementation has been chosen among others because it is an open source, efficient and standards-compliant real-time implementation of CORBA. Each system component provides CORBA server with its functionality, therefore each sensor can be read by CORBA clients.

III. COGNITIVE SUPERVISION

Following scheme (Figure 1) shows an idea of cognitive model of human operator of the multi robotic system. Cognitive layer is a virtual space, where set of procedures is responsible for self reasoning based on input data given by robot sensors[2]. The 3D map arrow represents the geometrical map building using Hough transform and MK-SVM algorithm for convex figures. Cognitive map is solving supervision of autonomous navigation task.

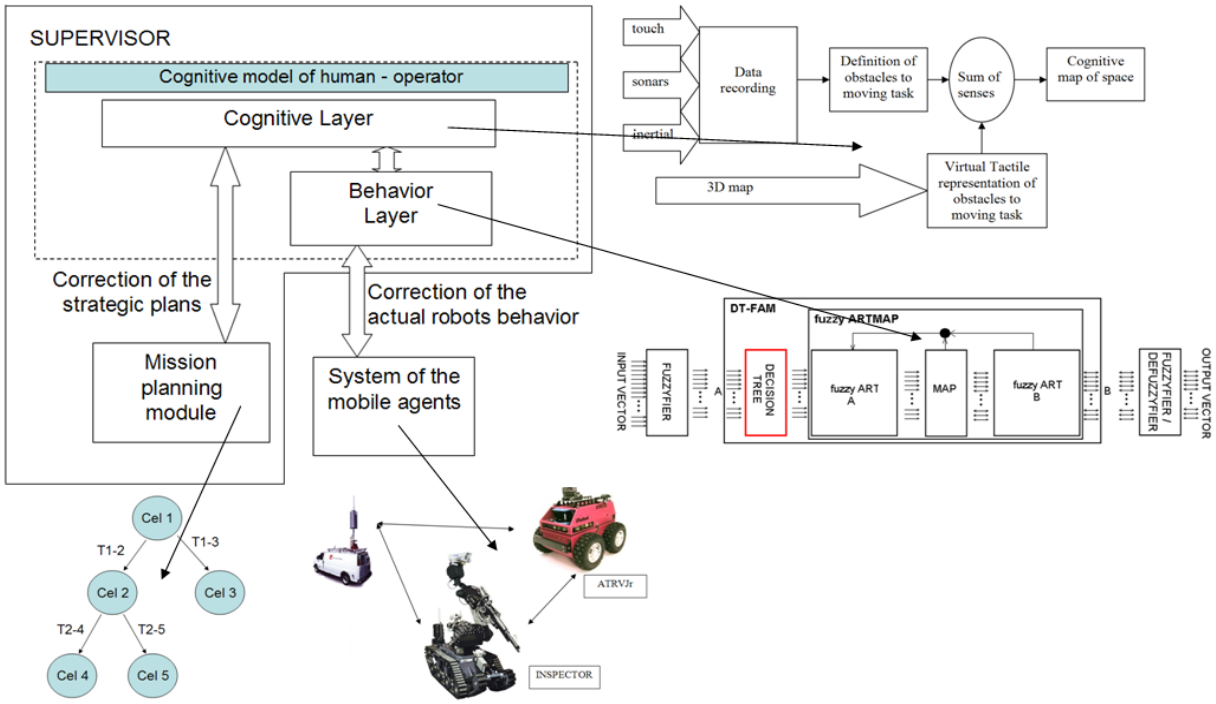

Figure 1. Cognitive model of the human – operator

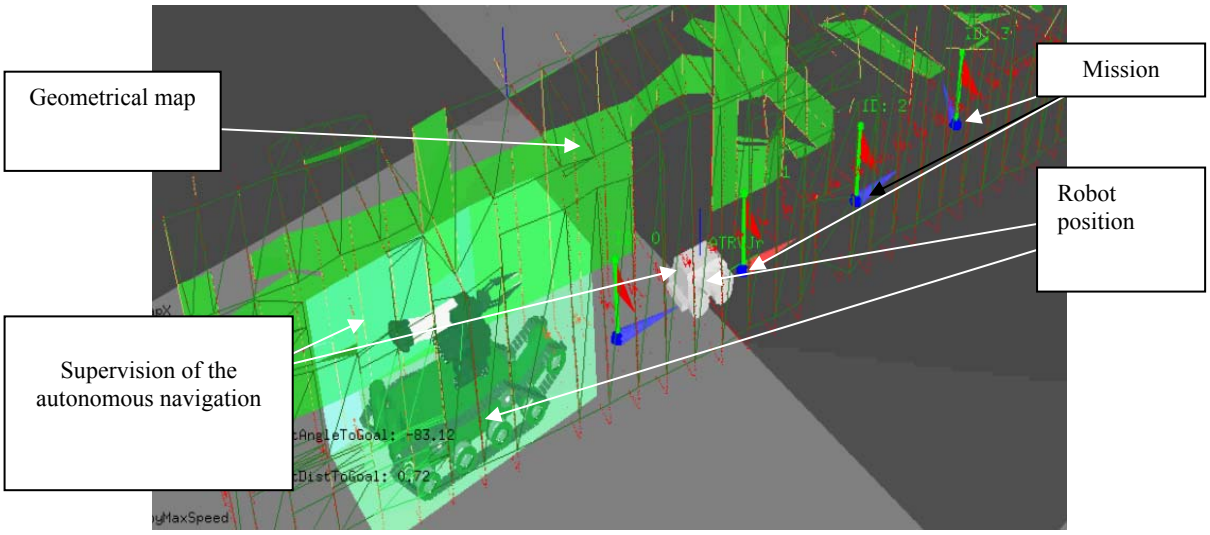

Figure 2. Visualization of the Cognitive map of space

Behavior Layer solves the autonomous navigation task. We consider using VFH+ algorithm or alternatively fuzzyARTMAP neural network for obstacle avoidance. System of the mobile agents is built from mobile platforms connected by Ethernet operating in CORBA distributed control system. Mission planning module stores mission plans, therefore cognitive model can supervise the mission execution using graph similarity methods.

Cognitive model of human – operator is able to learn by developing geometrical map, set of mission plans, and learning fuzzyARTMAP.

IV. Human Machine Interface / Cognitive Model – Machine Interface

We introduce the new concept of Cognitive Model – Machine Interface (CMMI). Following Figure 2 shows the visualization of the Cognitive map of space. We assume that our approach provides useful mechanism for Cognitive map of space understanding, in the same time the visualization of the mentioned cognitive map can be used as the Human Machine Interface. Presented idea is showing cognitive nature of the cognitive model human – operator. We can assure that, model has imagination

about robots position, it is visualized by robot models rendered on the global map. Model has imagination about mission and its execution, therefore the mission is represented by set of flags correspond to local goals. The model has knowledge about geometrical representation of the environment, therefore it can execute supervision if the autonomous navigation task. The geometrical map is given by rendered triangles, supervision of the autonomous navigation corresponds to the color of the rectangular prism surrounding mobile robot. If red color occurs, it denotes a problem.

V. GEOMETRICAL MAP

We assume that at least one mobile robot is equipped with sensor available to build geometrical 3D map. For the experimental purpose we equipped mobile platform with 3D Laser Range Finder. Therefore the 3D range data can be acquired during the robot executing task. Following figure shows a scheme for 3D map representation on the flat area as the set of nodes stores local 3D maps.

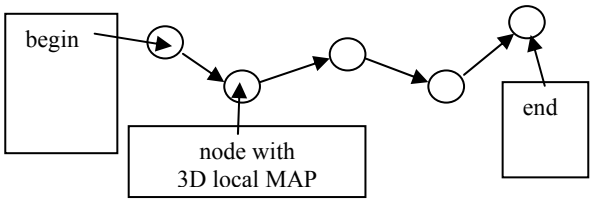

Figure 3. The robot path with nodes stored 3d local MAP

The geometrical map is a basic input for the supervision of the autonomous navigation. 3D local map is built from triangles. To compute the set of triangle we are using Hough transform for line extraction and for rest points the SVM – Support Vector Machine for convex figure approximation. The support vector machine approximation is based on introducing the ε-insensitive loss-function:

$$|S_L - f(\mathbf{x})|_\varepsilon = \max\{0, |S_L - f(\mathbf{x})| - \varepsilon\}$$

where S_L represents the data of the 2D RLF measurement, $f(\mathbf{x})$ is the smooth approximation function of S_L and the vector $\mathbf{x}$ represents the index of the measured point.

The function $f(\mathbf{x})$ can be obtained with precision ε by solving the constraint optimization problem [4]

$$\max\left[-\frac{1}{2}\sum_{i=1}^{l}(\alpha_i-\alpha_i^*)(\alpha_j-\alpha_j^*)k(\mathbf{x}_i,\mathbf{x}_j)-\varepsilon\sum_{i=1}^{l}(\alpha_i+\alpha_i^*)+\sum_{i=1}^{l}S_{Li}(\alpha_i-\alpha_i^*)\right]$$

subject to

$$\sum_{i=1}^{l}(\alpha_i-\alpha_i^*)=0$$
$$\alpha_i,\alpha_i^*\in[0,C]$$

where α, α^* are the Lagrange multipliers of each data point, l is the total number of datum points, C is the maximum value of Lagrange multipliers for points lying outside of the tube and $k(\mathbf{x}_i, \mathbf{x}_j)$ is the kernel function satisfying Mercer's theorem.

The support vector approximation is equal:

$$f(\mathbf{x}) = \sum_{i=1}^{l}(\alpha_i - \alpha_i^*)k(\mathbf{x}_i, \mathbf{x}) + b$$

The support vector machine approximation can be solved by using decomposition methods. We applied the Sequential Minimal Optimization (SMO) - extreme decomposition of the QP problem that involves two Lagrange multipliers at one step, the smallest possible optimization problem, because they must obey a linear equality constraint. The basic operations at every step of the SMO procedure are: heuristic choice two Lagrange multipliers to jointly optimize, analytical method to optimize values for these multipliers, a method for computing b, updates the SVM to reflect the new optimal values.

The SMO procedure is computationally efficient. It solves two Lagrange multipliers which can be done analytically with no requirement for large matrix storage.

The support vector approximation has some advantageous properties. The points inside the insensitive tube have Lagrange multipliers α, α^*=0, hence they have no influence on the function approximation. The support vectors are points lying on the border of the tube (their Lagrange multipliers α, $\alpha^* > 0$) and the points lying out of the tube (their Lagrange multipliers α, $\alpha^* = C$).

The quality of SVM approximation strongly depends on the proper choice of the parameters ε and C and on the kernel function and its parameters. The best selection gives the sparse function approximation of high accuracy represented by the least number of support vectors giving rise to the simplest function representation. In our approach, the number of support vectors varies from 12% to 55% of the total number of points of the dataset.

We introduce an imprudent of the SVM algorithm [1] – MK-SVM. The multi kernel support vector (MK-SVM) approximation is given:

$$f(\mathbf{x}) = \sum_{j=1}^{m}\sum_{i=1}^{l}(\alpha_i - \alpha_i^*)k_j(\mathbf{x}_i, \mathbf{x}) + \sum_{j=1}^{m}b$$

The algorithm of the multi kernel support vector machine training is given:

```
for j = 1:m
   set k(j)        //set different kernel for
each SVM
   setSVMparams(j) //set proper input
                   //parameters for each SVM
end

trainingset = inputdata       //input data are
                              //given by
                              //laser system
                              //measurement
oldresult = trainSVM(j=1)
newresult = inputdata;

for j = 2:m
   tempresult = resultSVM(j-1)
   trainingset = newresult – tempresult
   newresult = trainSVM(j)
end
```

The crucial point for our cognitive decision computation is the 3d map reconstruction. To obtain the virtual laser beam measurement the reconstruction of the local 3d map of the node (Figure 3) has to be done in real time mode to keep the safety of the mobile platform movement. It is important to realize, that presented idea allows to operate the platform without sensors in 3d space. The 3d map and localization problem have to be solved to achieve the manipulation safety of the "blind" robot. We applied the Common Unified Device Architecture (CUDA) to solve the highly computational complexity of the problem.

The following Figure 4 shows the idea of the 3d map reconstruction for convex figures.

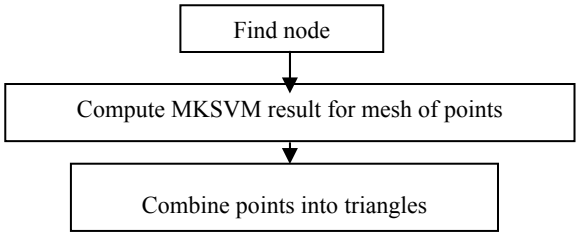

Figure 4. Algorithm for 3D map reconstruction

The *Find node* block represents the algorithm of robot path searching (the robot paths is shown on Figure 3) to obtain the node which stores the 3d local MAP. The *Compute MKSVM result for mesh of points* block represents the algorithm of the 3d local map points computation using equation 5 (MKSVM approximation). The input is defined as matrix of points I[i, j] (x, y, α_i ,β_j), where x, y are the node positions in global map, α_i and β_j are the vertical and horizontal angles of the laser beam. The *Combine points into triangles* block represents the algorithm of the obtaining the set of rendered triangles from mesh of computed 3d points.

To compute mesh of points of the 3D map we are using Compute Unified Architecture (NVIDIA CUDA). Therefore the computation is executed in highly parallel way. The result of the map 3D reconstruction algorithm is the set of the vertexes of the 3D robot environment. The reconstruction algorithm is based on the kernel execution in the Grid of Thread Blocks. There is a limited maximum number of threads that a block can contain. The implementation uses 256 threads (16 x 16). Blocks of the same dimensionality and size that execute the same kernel are batched together into a grid of blocks, therefore the number of threads that can be launched in a single kernel invocation is much larger:

$$NTh = Dx\_Th * Dy\_Th * Dx\_B * Dy\_B$$

where:

NTh – number of threads, Dx_Th – number of rows in thread table, Dy_Th – number of columns in thread table, Dx_B – number of rows in grid table, Dy_B – number of columns in grid table.

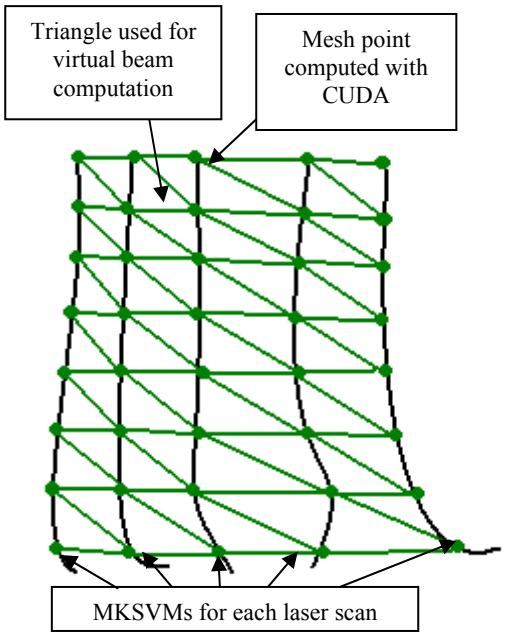

Figure 5. The idea of 3D map reconstruction.

Each thread is identified by its thread ID, which is the thread number within the block ID_Th(x, y) = x+y*Dx_Th. Each block is identified by it's block ID, which is the block number within the grid ID_B(x, y) = x+y*Dx_B [9]. Each thread executes the kernel function for one triangle of the scene, therefore the maximum number of triangles are limited by number of threads - NTh. The following picture shows the thread organization as a grid of thread blocks.

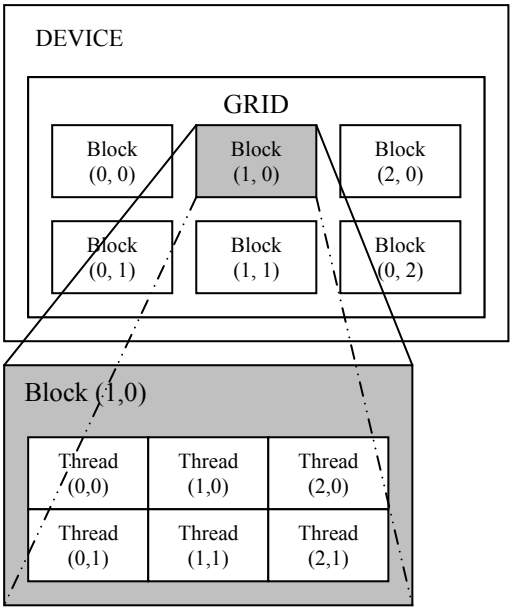

Figure 6. The thread organization as a grid of thread blocks

The thread realizes the kernel function for the input data assign by its block id. For the 3D reconstruction kernel's function realizes the equation (5). Further, the reconstructed map is used for virtual laser beam computation for cognitive supervision. Therefore the collision detection between robot chassis and the complex environment is obtained. The virtual laser beam measurement is coded into the tactile representation of the 3D scene as an input of the classifier.

VI. Particle Swarm Optimization for SVM

The goal for particles [5] is to find locations of the local maximum of the regression function and cover the area round this locations. The result is decomposed training set, that represents points potentially giving the highest impact into SVM SMO regression computation. We are proposing the method for the omitting flat region regression computation, that can potentially decrease the computational complexity.

The particle is defined as a data structure contains

- Central point $Cp\left(x_1, x_2, ..., \ x_n\right)$
- Range R
- Set of points P_i from training set that satisfy the equation
- $d_e\left(Cp, P_i\right) < R$, where $d_e(\mathbf{x},\mathbf{y}) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$, $\mathbf{x} = [x_1, x_2, ..., x_n], \mathbf{y} = [y_1, y_2, ..., y_n] \in \Re^n$
- local SVM based on training set P_i
- status – KINEMATIC (particle can change position) or STATIC (particle is located in local maximum of the regression function local SVM)
- Range of broadcast Rb
- Potential barrier Pb

Particles have social abilities to share information. We defined two types of behavior, kinematic and static. Ones, particle finds local maximum of the local regression function (local SVM), it changes behavior from kinematic into static and starts broadcasting this information in the neighborhood defined by Rb. This broadcast has high impact into the velocities of the particles in the range of Rb. We assume that static particle attracts all kinematic particles from neighborhood if the distance satisfies the potential barrier Pb condition, otherwise kinematic particles are pushed away form the local maximum. The following figure shows an idea of the potential field used for broadcasting the information by static particles.

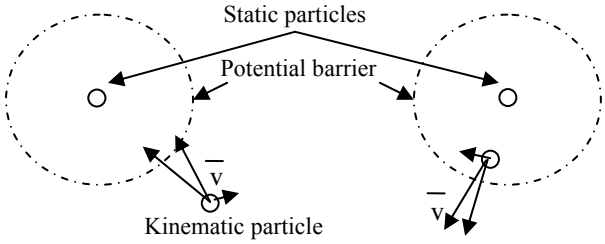

Figure 7. The visualization of the potential field used for broadcasting the information from static particles.

The algorithm PSO-SVM is given:

1. Initialize a population array of kinematic particles with random positions and velocities on *D* dimensions in the search space.
2. **loop**
3. For each particle $par(Cp, R, P_i, SVM, status, Rb, Pb)$, evaluate the SVM local regression function in *D* variables.
4. If current location is the local maximum of the local SVM regression function than fitness evaluation parameter equals local maximum. Compare particle's fitness evaluation with its *pbesti* (> local maximum). If current value is better than *pbesti*, then set *pbesti* equal to the current value, and $\vec{p}_i$ equal to the current location $\vec{x}_i$ in *D*-dimensional space.
5. If local maximum found, change particle status to *static* and start broadcasting this information to kinematic particles from neighborhood.
6. For all kinematic particles change the velocity vector assuming static particle broadcast using physical conditions of the simulated potential field.
7. If a criterion is met (usually a sufficiently good fitness or a maximum number of iterations), exit loop.
8. **end loop**
9. Compute SVM SMO using training set composed by points that satisfie the range of particles.

VII. Supervision of Autonomous Navigation

Robot navigation means its ability to determine its own position in its frame of reference and then to plan a path towards some goal location. In order to navigate, the mobile robot requires representation of its environment i.e. a map of the environment and the ability to interpret that representation. The art of navigation consists of smaller robot competences like:

- ability to self-localizing in the environment, which requires
- map-Building and Map-Interpretation
- ability to path plan
- local obstacle avoidance

Localization denotes the robot's ability to establish its own position and orientation within the frame of reference. Path planning is effectively an extension of localization, in that it requires the determination of the robot's current position and a position of a goal location, both within the same frame of reference or coordinates. Map building can be in the shape of a metric map or any notation describing locations in the robot frame of reference. In this study we will present the most popular approaches to global path planning using A* and Dijkstra's algorithms and two approaches to local obstacle avoidance using VFH (Vector Field Histogram) and Fuzzy ARTMAP. It is worth to mention main advantages of two algorithms to global path planning. A* algorithm is preferred when searching the shortest path from the position point of the robot to the target point. It is experimentally proved to get the shortest path in reasonably short time using this algorithm. On the other hand Dijkstra's algorithm is preferred when the robot needs to search shortest paths to many targets and choose one on this basis.

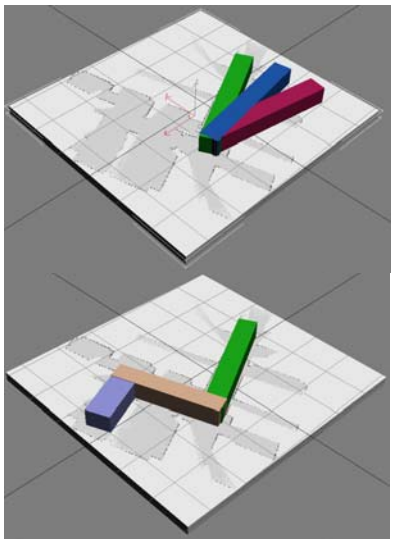

Figure 8. Supervision of the autonomous navigation.

The idea of robot navigation in 3D virtual world built from 3D LRF data is based on the verification of the hypothesis of the motion without collision. Multi hypothesis verification is high computational task, therefore CUDA capabilities are used for solving real time navigation. The basic object of the algorithm is the rectangular prism. Scene is represented as set of triangles and cloud of points. The fundamental procedure of 3D navigation is based on verification if there is an intersection of the triangle from the scene with current rectangular prism. If intersection appears the probability of safety navigation in current direction is low and decreases when another intersection is detected.

VIII. Experiments

The PSO-SVM regression decomposition algorithm was tested during 2-dimentional experimental surface approximation. The approximated function is composed by five Gaussian functions located in different separated areas. The SVM SMO algorithm was taken into the consideration with following parameters: Gaussian Kernel (sigma = 0.05), Tol = 1e-3, C = 1, Epsilon = 0.05. The 30 particles:

$$par_i \begin{pmatrix} Cp = rand(-1,1;-1,1), \\ R = 0.2, \\ P_i, \\ SVM, \\ status_i = kinematic, \\ Rb = 0.4, \\ Pb = 0.2 \end{pmatrix}$$

was generated to solve the decomposition problem of the following set of points.

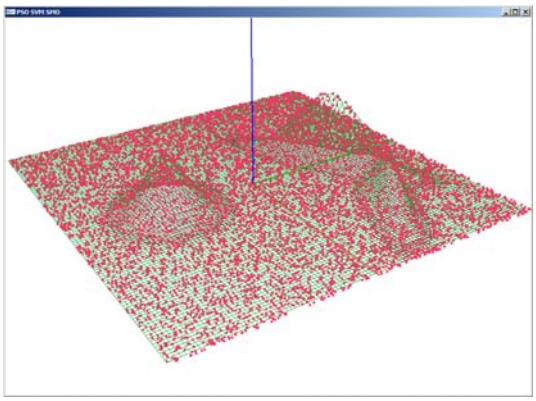

Figure 9: 2-dimentional experimental set of 10000 point.

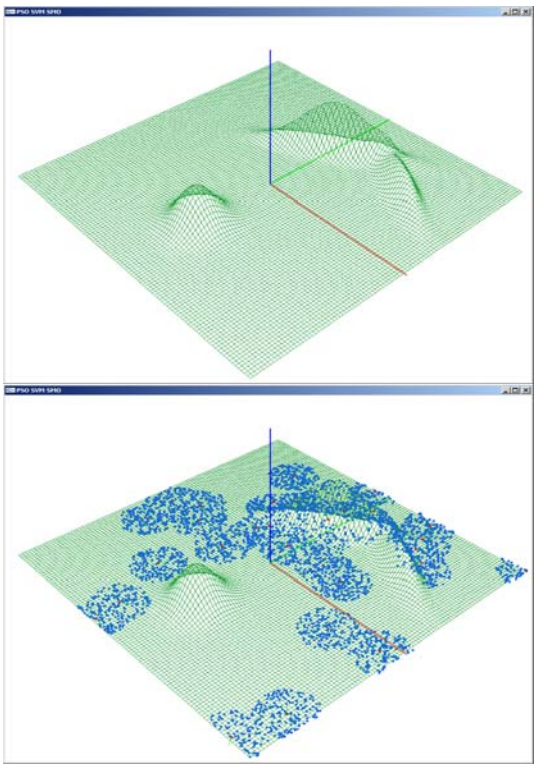

Figure 10: 2-dimentional experimental function (top), particles (bottom).

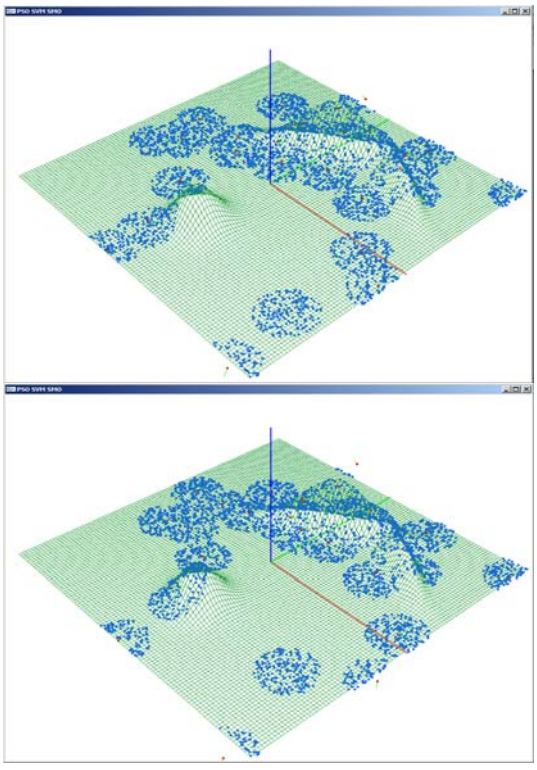

Figure 11: Result of PSO-SVM after 6th (top) and 12th (bottom) iteration

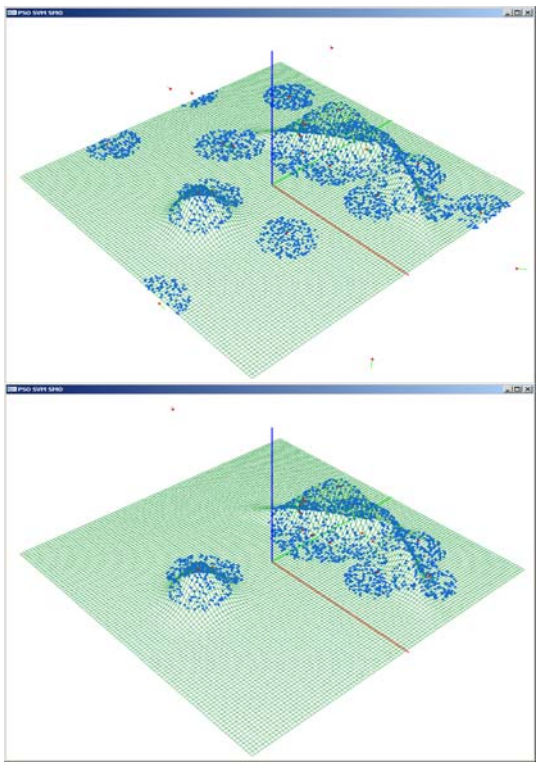

Figure 12: Result of PSO-SVM after 32th (top) and 100th (bottom) iteration

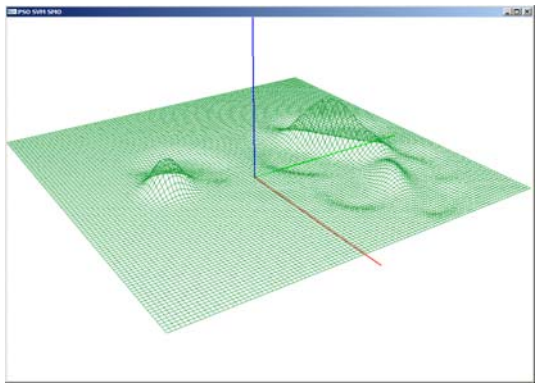

Figure13: Result of PSO-SVM approximation.

IX. Conclusion

The following paper has described the Cognitive Theory – Based Approach of multi mobile robot control. The main goal of the approach lays on the implementation of the computational intelligence applied to decision selection which is provided by the model of human supervisor. The usage of the Multi Kernel Support Vector Machine in the robotic system with cognitive supervision is investigated. The goal is achieved. Multi Kernel Support Vector Machine solves the problem of approximation efficiently. The concept of Cognitive Model – Machine Interface (CMMI) is presented, therefore useful mechanism for Cognitive map of space

understanding, in the same time the visualization of the mentioned cognitive map can be used as the Human Machine Interface. The idea of robot navigation in 3D virtual world built from 3D LRF data based on the verification of the hypothesis of the motion without collision is shown. The advantage of Compute Unified Device Architecture usage in cognitive supervision is shown.

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Random Search Codes and Implementation Model for Optical-CDMA-Based Local Area Networks

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***Abstract*—Optical code division multiple access (OCDMA) has the potential to provide flexibility and scalability for future local area networks (LANs) due to its simplicity in network control and management. OCDMA also provides low access delay that is suited well for bursty LAN traffic. Furthermore, optical coding allows users to share the same optical bandwidth and to operate asynchronously. In this paper, we present new random strict optical orthogonal codes (RS-OOCs), where a code set of RS-OOC is randomly generated and tested by a computer. The RS-OOC can achieve the minimum correlation value of one for the least multiple access interference in incoherent OCDMA computer networks. Moreover, implementation model is a crucial factor for OCDMA network architectures, without requiring synchronization among individual users. To realization of the RS-OOC, an implementation model of OCDMA-based LAN by using MATLAB simulink is investigated for four-pair users in the network. Then, we discuss the simulation results that are obtained from representative OCDMA-based LAN. The results show that the implementation model is straightforward and easy to implement LAN by using the OCDMA technique as the MATLAB simulink model.**

I. INTRODUCTION

Rapid growth of network and Internet traffic has placed high demand on the existing infrastructure. Recently, the demand for high speed and high capacity communication networks has received much attention to local area. In the future, local area network (LAN) should provide the requirements and a complete random asynchronous access. Since traffic in LAN is characterized by its burst in nature, conventional multi-access schemes; time division multiplexing (TDM) and wavelength division multiplexing (WDM), do not fulfil the above requirements, because the TDM or WDM is synchronous access system. Therefore, asynchronous multiplexing schemes are important to maximize the utilization of network resources.

Optical CDMA (OCDMA) system has been shown as a promising technology for future high speed LANs [1], [2]. It allows a large number of users to share the entire channel bandwidth of an optical fiber and offers asynchronous access, re-configurability of multi-user, on-demand capacity, and potential inherent security [3]. It has also the potential to provide flexibility and scalability for future LANs due to its simplicity in network control and management. In OCDMA systems, each user (node) is assigned to a specific codeword as his code address. Therefore, coding scheme is a prerequisite for designing the OCDMA system. The number of users that can be supported depends on length, weight, and efficiency of the coding scheme with which signals are coded for transmission. In most incoherent OCDMA systems, only unipolar (0, 1) codes can be used. A class of unipolar codes called optical orthogonal code (OOC) has been applied for OCDMA [4]–[7]. However, most of OOCs were constructed based on algebraic structures, where the codes that can be designed will be limited to specific code parameters. Therefore, flexible code designs are important. Furthermore, implementation models of OOCs are also crucial towards practical LAN based on OCDMA.

This paper proposes new random strict optical orthogonal codes (RS-OOCs), where a code set of RS-OOC is randomly generated and tested by a computer. The proposed RS-OOCs can find the codes for any code parameter with the minimum correlation value of one for the least multiple access interference (MAI) in OCDMA-based LANs. Moreover, bit error probability of the proposed RS-OOCs is evaluated numerically. To realization of the proposed codes, this paper will also investigate an implementation model of OCDMA-based LAN by using MATLAB simulink for four-pair users in the network. Simulation results of the implementation model are demonstrated that include spectrum outputs of transmitted signals, combined signals, received signals, and eye-diagram. From the results, the implementation model is straightforward and easy to implement LAN by using the OCDMA technique as the MATLAB simulink model. Therefore, an OCDMA-based LAN is practically evaluated in this paper.

The rest of the paper is organized as follows. OCDMA-based LAN architecture is presented in Section II. In Section III, random strict optical orthogonal codes are designed. Implementation model and simulation parameters of OCDMA-based LAN are demonstrated in Section IV. Simulation results and discussions are discussed in Section V. Finally, we conclude with a brief summary of results.

II. OCDMA-BASED LAN ARCHITECTURE

LANs need to connect a large number of users within a local area with high speed transmission. A LAN offers the advantage of a random access of the user to the network. The use of OCDMA technology in a LAN, it makes efficient use of channel by providing asynchronous access to each user. Figure 1 shows a typical OCDMA-based LAN architecture that consists of several nodes (i.e., eight users) connected by optical fibers to a passive star coupler. Each user will assign a codeword of a RS-OOC. The star coupler combines the optical signals from all nodes. Each node is connected to one input and one output port by an optical fiber. Then, the nodes and the star coupler form a shared medium network. The input and output ports are called transmitter and receiver, respectively. A node that is transmitting data to the other nodes on the LAN encodes the individual "1" bits into "chips" according to the RS-OOC. Every node in the network is assigned to a specific codeword. Transmitted signals on the inputs enter the coupler on several transmitters, where the optical power from all transmitters is merged. The power is then split equally among receivers. The same signal emerges on all the receivers of the coupler and is transmitted to all nodes. Furthermore, OCDMA technology enables an access platform, which provides interconnections between end-nodes and the wide area Internet through routers.

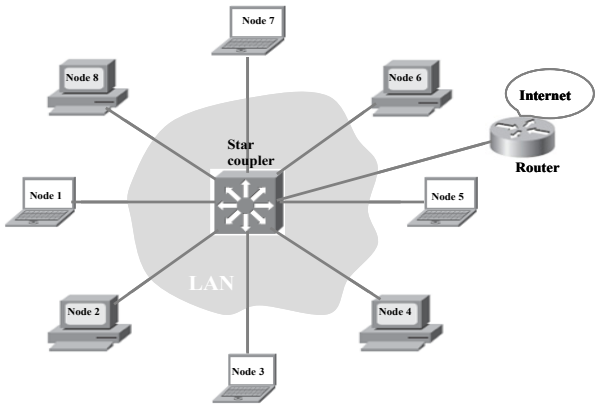

Fig. 1. OCDMA-Based LAN architecture.

III. RANDOM STRICT OPTICAL ORTHOGONAL CODES

A new approach for the design of OOCs is presented here, based on a random method, where the code set is randomly generated by computer search and their correlation value is strictly bounded by one. Then we call them random strict OOCs (RS-OOCs). A RS-OOC, *C*, is a family of (0, 1) sequences with the maximum auto-correlation (λ_a) and cross-correlation (λ_c) values of one, $\lambda_a = \lambda_c = 1$, respectively. It is represented by a set of parameters (*n*, *w*, 1) RS-OOC, where *n* is code length and *w* denotes the code weight which determines the total number of "1s" in each codeword. The number of codewords or *cardinality* of a RS-OOC is denoted by $|C|$ and is bounded [4]

$$|C| \le \frac{n-1}{w(w-1)}. \tag{1}$$

To obtain the correlation value of a RS-OOC, the relative delay elements between two "1s" in a codeword, and among codewords, must be distinct. Let $x \in C$ be a codeword and its relative delay elements are $D \in \{1,\cdots,n-1\}$. Suppose $x_{l0} = x_{l1} = \cdots = x_{lw-1} = 1$ of *x*, then the set of delay elements between "1s" positions associated with *x* is denoted by $D_x = \{\tau_0, \tau_1, \cdots, \tau_{w-1}\}$ and is defined as

$$\tau_j = \begin{cases} l_{j+1} - l_j & \text{for} \quad j = 0,1,\cdots,w-2 \\ n + l_0 - l_{w-1}, & \text{for} \quad j = w-1 \end{cases} \tag{2}$$

Now, let $R_x[r_x(j,l)]$ denote the (w-1) × w array of integers of which the (j, l)th interval is given by

$$r_x(j,l) = \sum_{k=0}^{j} \tau(l+k) \bmod w. \tag{3}$$

Using Eqs. (2) and (3), if there is no repeated delay element between two "1s" positions within a codeword, and among codewords, in *C*, it gives the best correlation property of $\lambda_a = \lambda_c = \lambda = 1$. A novel RS-OOC algorithm can be described as follows:

1. Select positive integers of *w* and $|C|$.
2. The code length *n* must satisfied
$$n \ge |C| w(w-1) + 1. \tag{4}$$
3. Set "0" for the first chip position in each codeword. Then assign a random integer of $\{1,2,\cdots,n-1\}$ to $b_{1,t}$, $b_{2,t,\ldots}$, $b_{w\text{-}1,t}$ by computer search, where t=1,…,$|C|$. The *w*-set of "1s" positions for *t*-th codeword can be represented by
$$(0, b_{1,t}, b_{2,t}, \cdots, b_{w-1,t}) \bmod n \tag{5}$$
Sort all possible *w*-set codewords and store them in look-up tables.
4. Check the used intervals in the codewords as
$$\tau_{jk,t} = b_{k,t} - b_{j,t} \text{ and } \tau_{jk,t} \ne \tau_{j'k',t'}, \tag{6}$$
for $\tau_{jk,t} \in D$ and $\tau_{j'k',t'} \in D$, where t=t'=1,2,…,$|C|$, j=0,1,..,k-1, j'=0,1,..,k'-1, k=k'=1,2,…,w-1. After the intervals in each codeword are computed, they are compared with their own used intervals and intervals among the others. If they cannot satisfy the correlation properties of a RS-OOC, return to the previous step and continue.
5. If all constraint parameters are found, stop searching. Otherwise go back to step 3.

We have simulated the algorithm by using a computer. An example of the corresponding (125, 4, 1) RS-OOC is found by computer search, where its codewords is shown in Table I.

TABLE I
CODEWORDS OF A (125, 4, 1) RS-OOC

No	"1s" Positions	No	"1s" Positions
1	(0, 3, 30, 61)	6	(0,10, 22, 48)
2	(0, 8, 17, 33)	7	(0, 4, 15, 60)
3	(0, 1, 7, 47)	8	(0, 13, 37, 72)
4	(0, 5, 34, 75)	9	(0, 14, 32, 68)
5	(0, 2, 23, 51)	10	(0, 19, 39, 81)

We have also simulated the used relative delay intervals in the code set and the result is shown in Figure 2. As we can see, there is no repeated use of delay intervals in the code. Hence, the correlation value of the RS-OOC can be guarantee at the minimum value of one in an incoherent OCDMA system.

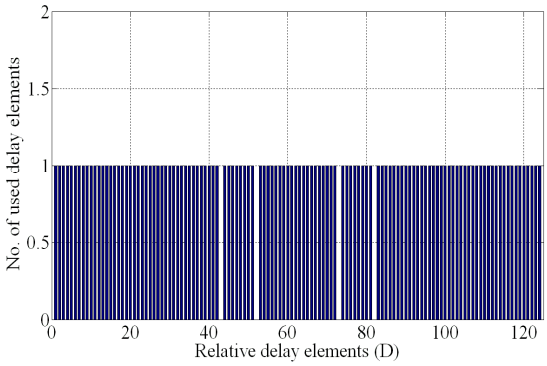

Fig. 2. Relative delay elements used in a (125, 4, 1) RS-OOC in Table I.

In General, bit error probability (P_e) of an OCDMA system is primarily affected by MAI from the other users. Using the proposed RS-OOC, each interfering user may contribute *only* to one chip overlap (hit) with the intended receiver. Then, the probability that one of "1s" positions of a user codeword with weight w will overlap with one of "1s" positions of the desired codeword, is given by

$$p = \frac{w^2}{2n}. \tag{7}$$

Without any other noise, P_e of an OCDMA–based system using the proposed RS-OOC can be modified from [8]

$$P_e = \frac{1}{2}\sum_{g=TH}^{M-1}\binom{M-1}{g}p^g(1-p)^{M-1-g}, \tag{8}$$

where M is the number of users in the network, g is the number of interferers with codewords of weight w and TH is threshold.

Figure 3 shows bit error probability versus number of simultaneous (active) users. Employing code length = 10000, 100 active users can be accommodated in a network with Pe=10-7 and 10-9 for the weight 5 and 7, respectively. The performance worsens as the number of active users increase. Moreover, when large code weight is employed in the network, the performance is improved.

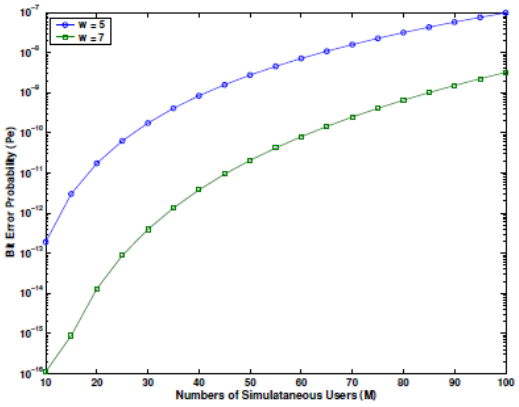

Fig. 3. Bit error probability versus number of simultaneous (active) users with code length = 10000.

IV. IMPLEMENTATION MODEL AND SIMULATION PARAMETERS

In this Section, we present an OCDMA-based LAN model which is similar to but simpler than the system it represents. One of purpose of a MATLAB/simulink model for OCDMA-based LAN is to enable the engineer to implement the optical coding and the visualization of the physical principal working of the network. A simulink implementation model for an OCDMA-based LAN is implemented as shown in Fig. 4. Simulation parameters for the model are listed in Table II. Using the simulation parameters, practical working of OCDMA-based LAN is evaluated.

In Fig. 4, there are four-pair users requiring four different (0, 1) codewords from a code set of (87, 5, 1) RS-OOC as their addresses. However, in large capacity networks, other users can easily be accommodated by using the large number of RS-OOC codewords. At transmitter side, information data for every user is generated by Bernoulli binary generator. Data at active transmitters are encoded with the desired codeword using an ON-OFF keying (OOK) modulation. An OOK modulation is performed by sum function of information data and user's codeword in the simulink. After encoding and modulating processes, the active transmitters superimpose their outputs over optical fiber using a star coupler (sum function in simulink) and are then distributed to each receiver. At receiver side, decoding is matched to the desired codeword by using XCORR function. If any pair of transmitter and receiver codeword matches exactly, the output of correlator has an auto-correlation peak which recognizes that the transmitter has transmitted a "1" data bit. Otherwise, the correlator output has no peak but sum of cross-correlation between other codeword users.

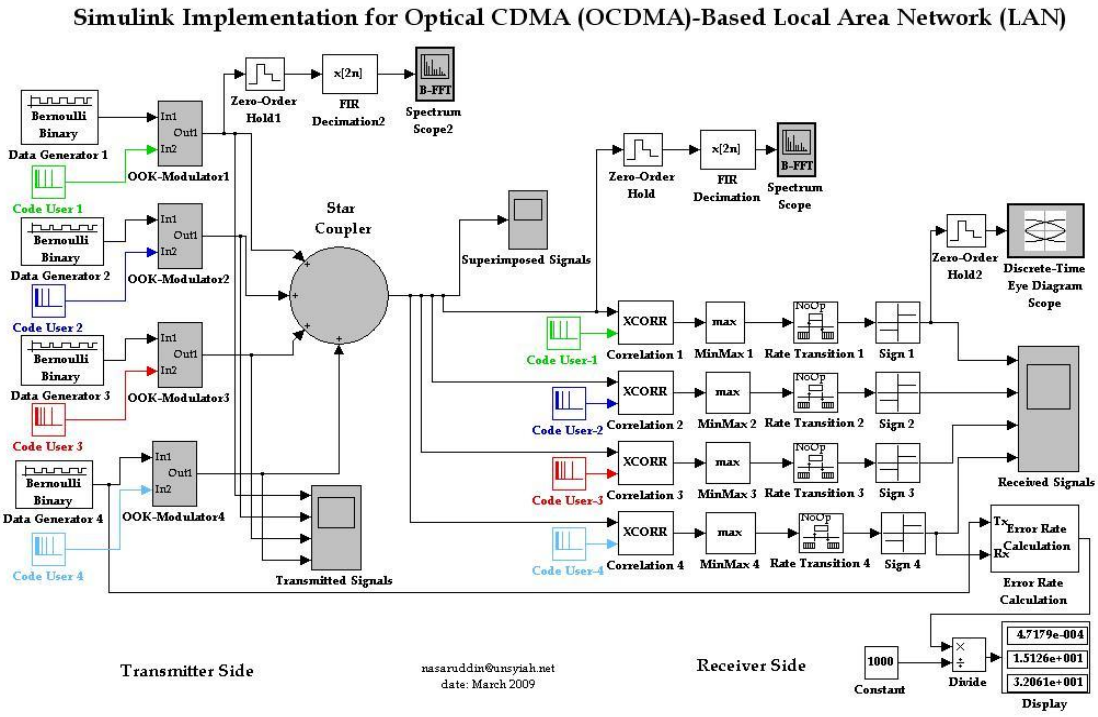

Fig. 4. A simulink implementation of an OCDMA-based LAN.

TABLE III
SIMULATION PARAMETERS

Parameter	Constraint
Coding Scheme	(87, 5, 1) RS-OOC: Codeword 1: (0,1,9,31,55) Codeword 2: (0,2,5,19,44) Codeword 3: (0,6,16,27,53) Codeword 4: (0,7,20,35,58)
Number pairs of users	4
Discrete step	100 ps
Chip duration	1 ns
Bit duration	87 ns
Data rate	11.5 Mbps

V. RESULTS AND DISCUSSIONS

We have investigated the OCDMA-based LAN using the implementation model and simulation parameters as described in the previous Section. The simulated results of the OCDMA-based LAN model for four-user are as follows.

Let user 1 is assigned "1s" positions of (0,1,9,31,55) codeword. Every information bit is encoded into n = 87 optical chips. Assume information bit is 1. Optical pulses are sent exactly at the 0^{th}, 1^{st}, 9^{th}, 31^{st} and 55^{th} chips. On the other hand, no pulse is sent if information bit is 0. Signal spectrum of user 1 after encoding process is shown in Fig. 5 that is monitored after modulation process of user 1's codeword with generated data output of OOK-Modulator1. It can be used to evaluate system performance by observing its optical spectrum.

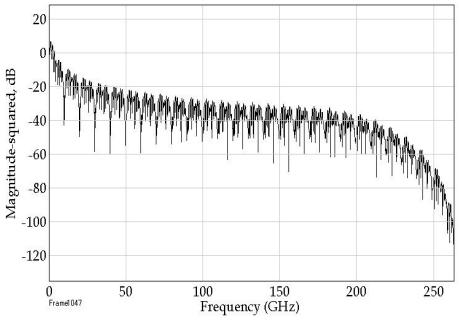

Fig. 5. Signal spectrum of user 1 after encoding process.

Figure 6 shows signal spectrum of user 1 that is monitored before decoding process or after transmission through star coupler input of correlation 1. The spectrum is quite increased and different from the encoded spectrum due to the effect of interference from the other users.

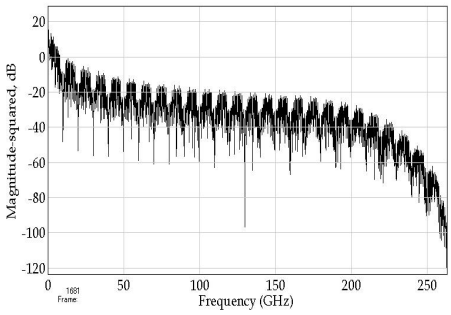

Fig. 6. Signal spectrum of user 1 before decoding process.

Figure 7 shows the transmitted signals of the four-user in the network in time domain. These output signals are passed through star coupler. Then, active users superimpose their information signals through the star coupler. The superimposed signals of the four-user are shown in Fig. 8. They are then distributed to each receiver. To properly decoding the data, decoder is matched to the desired codeword.

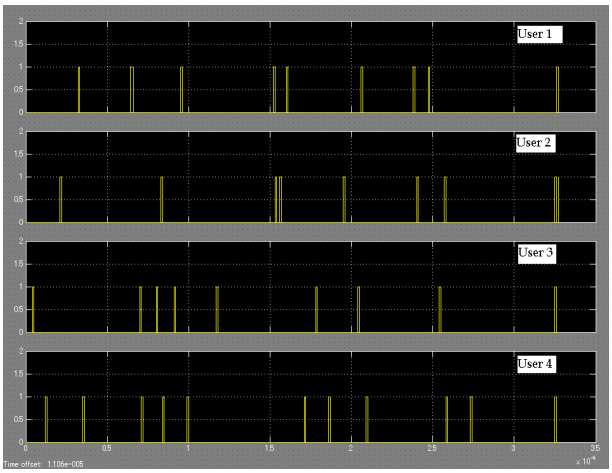

Fig. 7. Transmitted signals of four users in the network.

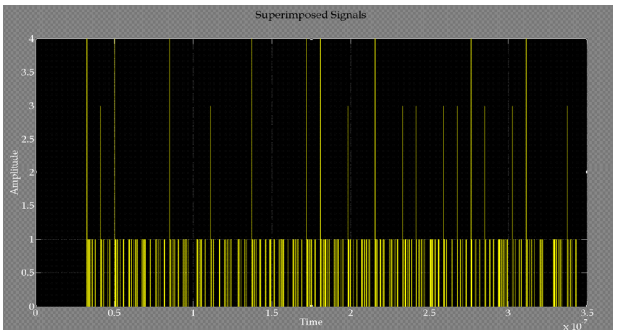

Fig. 8. Superimposed signals of four users in the network.

The decoded signals finally arrive at optical receivers. The received signals for the four-user are shown in Fig. 9. In the figure, the received signals are different from the transmitted signal because of different frame of the signals.

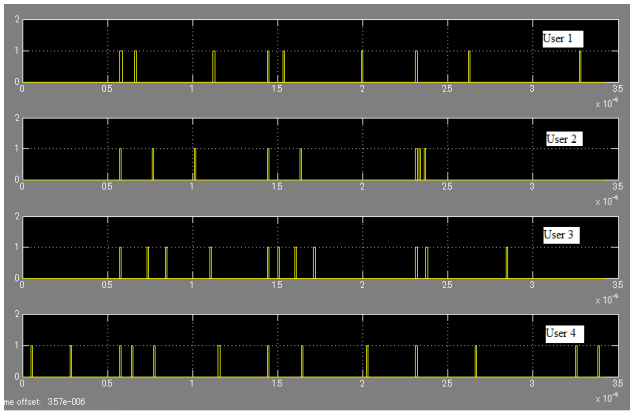

Fig. 9. Received signals of four users in the network.

Figure 10 shows binary eye diagrams of the received signal for user 1 and corresponding binary detected signals. Eye diagram is a very successful way of assessing the quality of a digital signal [9]. Therefore, as shown in the eye diagram, it is successfully transmitted the data with OOK modulation in the condition of four-pair users and the (87,5,1) RS-OOC.

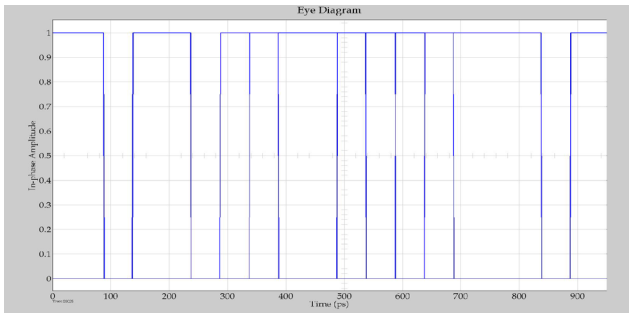

Fig. 10. Received eye-diagram for user 1.

VI. Conclusions

The random search codes and the implementation model for OCDMA-based LAN have been proposed in this paper. Random algorithm for generating the proposed RS-OOCs has been presented. Some examples and bit error probability of the proposed RS-OOCs are evaluated. A simulation model for OCDMA-based LAN by using Matlab/Simulink tools has been discussed by addressing the use of the proposed RS-OOCs. We have demonstrated various output of spectrum signals and eye diagrams of the proposed implementation model for OCDMA-based LANs. The results show that the implementation model is straightforward and easy to implement LAN by using the OCDMA technique as the MATLAB simulink model. Furthermore, an OCDMA-based LAN is practically investigated as a future candidate technology to faster communication and more efficient use of channel.

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Propagation Model Verification using Elementary Environment Specific Method for Analyzing 802.16e System Coverage in Bandung City

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***Abstract*—Mobile WiMAX or 802.16e is one of wireless access technologies that can provide users with high-speed data connection, mobility and relatively wide coverage. The interoperability effort under WiMAX Forum initiative makes this technology can be interoperable across multi-vendor infrastructures. By considering its very wide coverage range, in a relatively open area or less obstacles, Mobile WiMAX can be used in rural area. In order to predict the coverage more accurately, propagation model is the key issue to be verified first. The use of empirical propagation model, despite its superiority of fast execution and limited reliance for detail knowledge of the terrain, still needs a validation. Therefore we present analysis of Mobile WiMAX coverage using empirical propagation model namely SUI and COST-231 HATA. For both models, cell range estimation is made by a theoretical calculation. The result is then compared with the measurement data. Elementary Environment Specific (EES) is used as a method for gathering the measurement data. The result shows that SUI model appears to be more suitable for Bandung typical terrain than COST 231-HATA despite both model seems to over-predict the path loss.**

***Index Terms*—Coverage Measurement, Mobile WiMAX, Propagation Model.**

I. INTRODUCTION

Mobile WiMAX is a variance of Wireless Interoperability Microwave Access (WiMAX) which bears the standard name of IEEE 802.16e. In Mobile WiMAX, improvements were made to increase the capacity and coverage through several means. The use of Scalable OFDMA, MIMO system and smart antenna are introduced to achieve wider coverage while reducing interference to gain more capacity [3]. Propagation verification employs MIMO and smart antenna introduces more complex measurement methodology and analysis. The initial verification of the SISO antenna system and its propagation characteristics are required as the basis of more complex MIMO propagation verification. The study presented in this paper will be based on SISO antenna system.

Coverage of wireless system mainly depends on the path loss that is defined by propagation model and other system parameters including the transmit power, operating frequency, antenna gain and antenna tilting [4]. Among the existence of the empirical models, SUI and COST-231 HATA were selected to model radio wave propagation in Bandung City. Either SUI or COST-231 HATA is appropriate for Mobile WiMAX system, since they comply with mobility aspect and operating frequency.

The purpose of this study is to find the appropriate propagation model for Mobile WiMAX in Bandung City and introduce some correction factor if needed. We use EES [5] approach to do measurement in order to validate the Mobile WiMAX coverage and compare the result with ones based on the empirical models.

II. MOBILE WiMAX COVERAGE

This section describes Mobile WiMAX system capabilities related to the coverage issues.

A. Link Budget Designing

The main purpose of link budget is to estimate the cell range [3]. An example of link budget is provided in [3] which becomes a basic model. In link budget, there are some important parameters need to be carefully analyzed including receiver sensitivity and system margin.

The main issue that makes receiver sensitivity becomes important aspect in link budget calculation is because Mobile WiMAX employs adaptive modulation and coding (AMC) schemes. One common means to discover the differences in each AMC performance is to conduct link level simulation as in [6].

Link level simulation provides necessary information to observe the system performance measured in Bit Error Rate (BER) against its Signal to Noise Ratio (SNR). Link level simulation parameter settings should refer to 802.16e standard as stated in [6]. Then, to explore the system performance on different channel condition, SUI channel model is used in the simulation. SUI channel provides several channel category classified by its delay profile property. Thus, once the simulation is executed, the results will discover the system BER against SNR for

every AMC in different channel condition. The simulation value that will be used as basic assumption for designing link budget is SUI channel with medium delay profile or known as SUI-3.

The formula to characterize receiver sensitivity in dB is given below [2]:

$$RX\_Sensitivity = BW\_NOISE + SNR + ... \\ ... + Noise\_Figure \quad (1)$$

Where *BW_NOISE* is the white noise perceived by the receiver. *SNR* is the SNR threshold value for each modulation and coding. *Noise_Figure* is the equipment noise figure.

The second issue of link budget calculation is how to assume the system margin that is used to estimate the obstacle penetration losses. The common method for assuming the margin values is to appraise the typical propagation scenario in the measurement places. Since the research uses empirical propagation model, the system margin for each terrain models will likely be different.

B. The Empirical Propagation Models

There are several widely-accepted empirical path loss models for Mobile WiMAX namely SUI, COST-231 HATA and ECC [1]. The study use of the first-two models due to their simplicity and applicability within WiMAX Forum System Evaluation Methodology [6]. Both of them specifically characterized the types of terrain that have been designed for.

Propagation models formula is used in determining the cell range. Here is SUI path loss model formula as written in [1]:

$$PL = A + 10\gamma \log_{10}\left(\frac{d}{d_o}\right) + X_f + X_h + s \quad (2)$$

Where PL is the path loss estimation value in dB, d and d_0 is respectively the range and reference range which is 100 m; s is the shadowing factor which has typical values between 8.2 dB and 10.6 dB. A is the free-space path loss component, X_f and X_h is the frequency and height correction factor respectively. γ is the path loss exponent which value is obtained by using equation [1]:

$$\gamma = a - bh_b + \frac{c}{h_b} \quad (3)$$

Where a, b and c are the propagation constants which values are defined in Table 1 and h_b is the base station (BS) antenna height in meter. Notice that SUI specifies its model into three different terrains namely SUI A, B and C and each one representing dense-obstacles, light-obstacle and open-area environment respectively.

Table 1. SUI Model's propagation constants [1]

Parameter	***Terrain* A**	***Terrain* B**	***Terrain* C**
a	4,6	4,0	3,6
b (m^{-1})	0,0075	0,0065	0,0050
c (m)	12,6	17,1	20,0

Unlike SUI model, COST-231 HATA model only specifies two different propagations scenario namely urban and suburban or rural. The COST-231 HATA path loss formula is shown in equation below [1]:

$$PL = 46.3 + 33.9\log_{10} f - 13.82\log_{10} h_b + C_F + ... \\ ... + \left(44.9 - 6.55\log_{10} h_b\right)\log_{10} d - a\left(h_m\right) \quad (4)$$

Where f is the operating frequency in MHz, h_b is the BS antenna height in m; d is the range in km; C_F is the urban correction factor which is 3 dB for urban type environment and 0 dB for suburban or rural. $a(h_m)$ is the correction factor for user antenna height.

C. Theoretical Cell Range Estimation

As explained earlier, the theoretical cell range estimation for each AMC scheme is used as reference for measuring the system coverage. The cell range generated by link budget calculation will be considered as theoretical bounds. However, the actual cell range may be different from the theoretical value due to certain factor such as; cluttering environment, heterogeneous terrain morphology and unpredictable reflection points that affect signal condition. Therefore to minimize the difference between actual system coverage and estimation, some necessary adjustment in link budget should be done by referring to the measurement activities result.

The measurement activities are conducted in effect to verify that the model is applicable within the area of measurement. Thus, by using the configured system profile and the path loss formula, the radius for each modulation can be obtained. The example cell range estimation for both models is shown in Table 2.

Table 2. Urban cell range estimation

	Modulation / **Prop. Model**	**QPSK ½**	**QPSK ¾**	**16-QAM ½**	**16-QAM ¾**	**64-QAM ½**	**64-QAM ¾**
Downlink	SUI A (km)	1,79	1,63	1,26	1,15	0,91	0,84
	COST-231 (km)	1,71	1,52	1,07	0,95	0,70	0,62
Uplink	SUI A (km)	1,89	1,42	1,31	0,98	-	-
	COST-231 (km)	1,84	1,26	1,13	0,76	-	-

Table 2 shows the cell range estimations for every modulation in urban environment. It is understandable that highest modulation which is 64-QAM ¾ has the shortest range while the lowest modulation level which is QPSK ½ has the longest range. The estimation value from the other category will likely have greater range than those listed in Table 2. Thus, every modulation range

from each category will be taken as reference in measurement campaign.

III. MEASUREMENT METHODOLOGY

As stated in [5] that in essence, the empirical models are mainly suitable only for specific scenario in which the measurement campaigns were conducted. The simplicity of empirical propagation model takes its toll by inaccurately estimate the path loss if it is applied in different propagation scenario.

The objective of measurement campaign based on EES method is to explore the nature of shadowing in each terrain model. As explained in [5], the first step to use EES method is slicing the area within the estimated-coverage into smaller region which is called as a 50 x 50 meter cluster. See the fig. below.

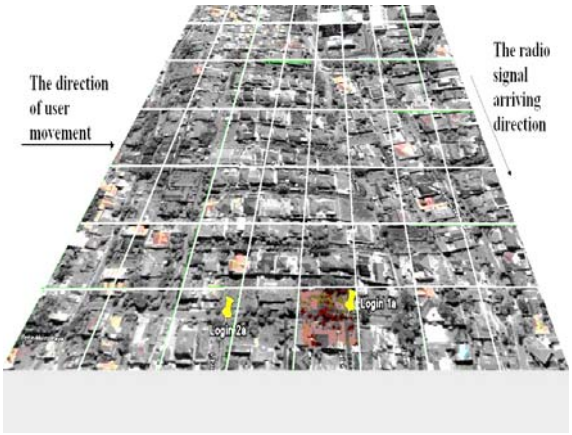

Fig. 1. The EES clustering processes.

As shown in Fig. 1, each cluster will be categorized into certain category such as; dense-obstacles, light-obstacles and open-area. In determining the cluster category there are two considerations; the cluster environment condition and arriving direction of radio wave relative to the base station position. The measurement will be conducted in several clusters according to the theoretical range of each modulation schemes.

In order to find the actual cell range, while the connection between the terminal and BS is maintained, the terminal is moved gradually toward the cell edge. Therefore the system range can be obtained.

IV. MEASUREMENT RESULT

The measurement is taken to obtain the Received Signal Level (RSL) and Carrier to Interference-Noise Ratio (CINR) values as well as throughput against its modulation-coding scheme. The system parameters used for measurement are listed in Table 3.

Table 3. 802.16e system parameter configuration

Parameters	BS	CPE
Transmit Power	40 dBm	26 dBm
Antenna Gain	18 dB	13 dB
Antenna System	SISO	SISO
Antenna Type	Dual Polarization 65°	Omni directional
Adaptive Modulation and Coding Schemes	QPSK ½, QPSK ¾ , 16QAM ½, 16QAM ¾, 64QAM ½, 64QAM ¾	QPSK ½, QPSK ¾, 16QAM ½, 16QAM ¾

Fig. 2 shows the measurement result.

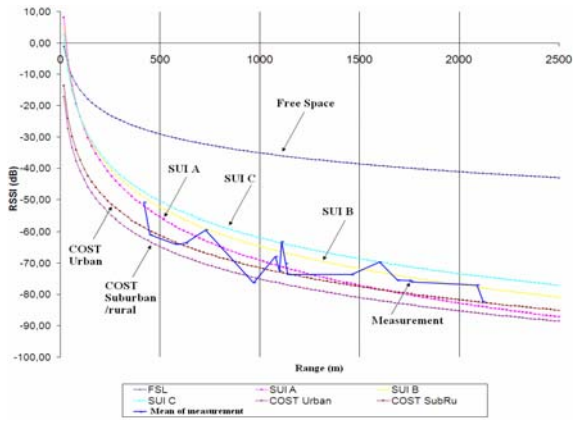

Fig. 2. RSSI vs. measurement ranges.

Fig. 2 shows that the measured-RSL values are situated among the other theoretical curves. It means that the model more or less fit the measurement result. The measurement data can be classified according to the terrain category. Fig. 3 until Fig. 5 show the comparison between the theoretical RSL bounds obtained from link budget and the measurement result for each cluster category.

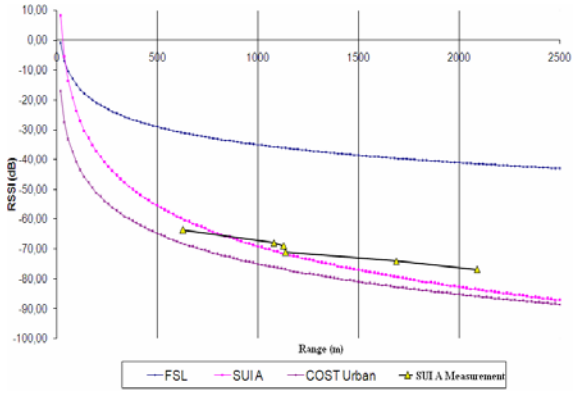

Fig. 3. RSSI vs. measurement ranges in dense-obstacles environment.

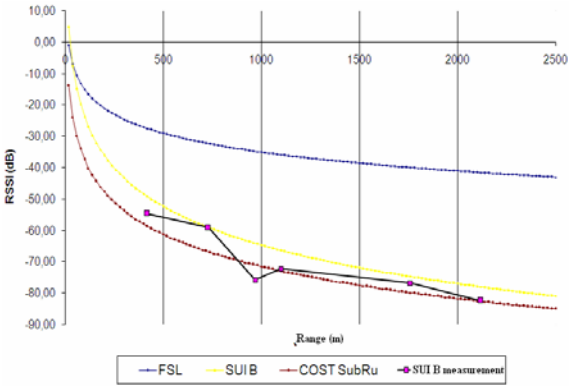

Fig. 4. RSSI vs. measurement ranges in light-obstacles environment.

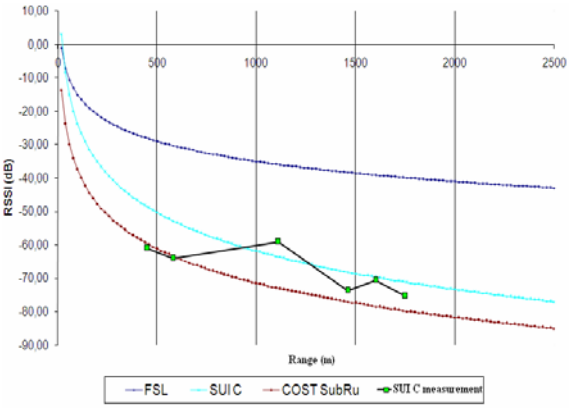

Fig. 5. RSSI vs. measurement ranges in open-area environment.

From the observation, it is known that SUI A and COST urban tend to overestimate the path loss in the measurement points where the relative distance is greater than 1200 m. The theoretical RSL and measured-RSL beyond that point is incomparable. In Fig. 4, the theoretical result agrees with measurement data. The measurement curve is situated mostly between SUI B and COST suburban curves.

In Fig. 5, the measured-RSL in measurement points where the relative distance is around 500 m is comparable to theoretical COST rural. However, in relative distance between 1000 m and 1300 m, the RSL value is incomparable to COST rural but SUI C. In the relative distance around 1400 m and 2000 m, the measured RSL are situated between SUI C and COST. These results give information that theoretical curve from SUI C is tend to overestimate the path loss while COST rural is too optimistic.

From this point, it is cleared that the propagation conditions in the measurement places are mostly fall in suburban-like environment category. According to the observation, the empirical path loss specifically modeled for suburban environment should appropriate to model the propagation in the measurement places. Thus the proposed empirical model namely SUI C and COST rural will be further analyzed.

However, in elaborating the measured data presented in Fig. 2, statistical approach, namely curve-fitting analysis, is used in order to obtain the data trend. Regression analysis is employed using cubic polynomial equation. Then, interpolation is calculated to predict the RSL value in unexplored data points. The cubic polynomial is selected because of its fitting property has the lowest Sum Square due to Error (SSE) value and R-square value close to '1' in comparison with the other polynomial equation.. See fig. 6 below

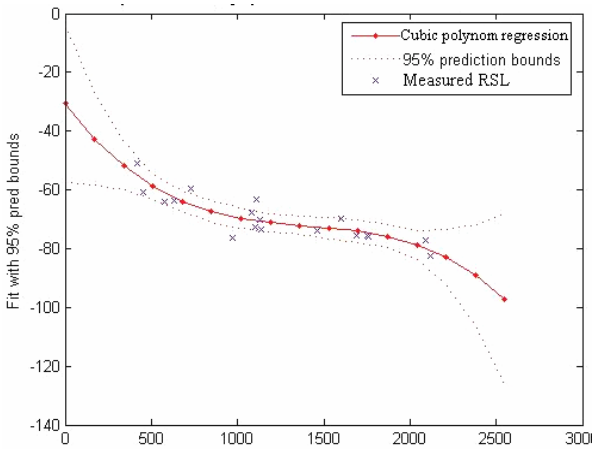

Fig. 6. The regressions curve of measurement data.

In Fig. 6, prediction bounds or confidence bounds which are drawn with dashed-line, define the lower and upper bounds of the associated regression curve. The width of the interval between regression curve and prediction bounds define the variation interval of predicted data.

In order to predict the actual cell range, the lowest achievable modulation receiver sensitivity value, that is QPSK ½, should be mapped onto the regression graphic. From the measurement campaign, the minimum RSL for QPSK ½ is -84 dBm. Thus, based on the regression, the actual QPSK ½ range predictions is 2250 meter away from base station antenna.

The existence of shadowing makes the signal fluctuation cannot simply be ignored. Then, to account shadowing factor, the lower prediction bounds is used to predict the shortest range of QPSK ½ and that is 2060 meter. The upper prediction bounds are not used because the curve does not agree with the fact that the cell range has limitation. The upper bound curve gradient beyond 2300 meter has positive value which means the RSL will become better as the range increase. Thus, the QPSK ½ range is approximately between 2060 and 2300 meter. These values are considered as prediction. Since the morphology of the terrain plays important role, the actual range varies between those points.

The EES model which is obtained from measurement campaign will be compared with the theoretical bounds. Fig. 7 shows the comparison among those curves.

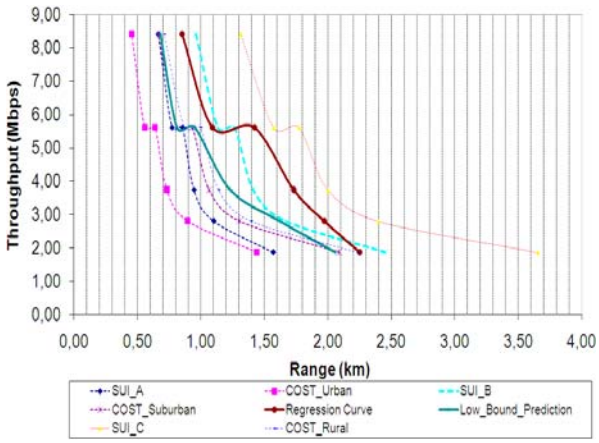

Fig. 7. Throughput vs. measurement range.

For the sake of simplification, the throughput fluctuation is omitted. The system throughput shown in Fig. 7 is assumed as ideal maximum throughput in 5 MHz system. The highest throughput is achieved using 64-QAM $^{5}/_{6}$ while the lowest is achieved using QPSK ½.

From here on, it is cleared that SUI B curve which is situated between regression and lower bound curve is the most suitable model in determining the coverage range for each modulation. The existences of the other curves are too optimistic or too pessimistic. Some corrections factor might be added in some interval of the coverage range so that empirical model can fit to the EES model.

V. CONCLUSION

Bandung is a typical urban city but based on the measurement results, it is understandable that most of the area within the coverage is fall in light-obstacles or suburban-like environment category. According to the measurement result, the scenario to be applied in link budget calculation should be based on light-obstacles environment and SUI path loss model, especially SUI B.

The EES concept enables the radio engineers to convincingly adjust the basic assumption such as system margin in link budget designing. The measurement campaign based on EES method is powerful and effective enough to verify the appropriate propagation model in a relatively clutter area such as Bandung.

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Implementation of Array Antenna for Footprint Adjusment on SFCW GPR Application

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***Abstract*—Antenna footprint is an important parameter for good detection result in ground penetrating radar (GPR) surveys and applications. The various condition of soil under which a target is buried may change the footprint of an antenna. An antenna with a capability to adapt with different soil condition is therefore needed. This type of antenna is capable to adjust the footprint due to the problem of varying soil condition. The footprint of an antenna is related to the antenna dimension. In this paper, an UWB array antenna of 5-element for footprint adjustment was investigated and implemented using FR4 substrate materials. The antenna of five UWB elements with different dimension is proposed to provide different footprint areas and the resistive loading is applied at each end of all antenna elements to reduce coupling between antenna element. Numerical simulation was conducted and measurements were carried out to validate the result. Simulation and measurement show that the footprint of the proposed antenna is directly proportional to the antenna dimension.**

***Index Terms*— Antenna array, footprint, GPR, SFCW.**

I. INTRODUCTION

Ground Penetrating Radar (GPR) systems are used for subsurface investigations. They are used in the detection of objects buried beneath the earth surface such as landmines, cables, pipes, and hidden tunnels. One important component in any GPR systems is the transmitter/receiver antenna [1]. Antennas are usually situated very close to the ground surface in order to couple electromagnetic energy into the ground more effectively. The characteristic of an antenna is strongly influenced by the type of the soil. GPR surveys show that there is a probability that a target object is buried different soil condition. Different soil condition may cause different results. An antenna with stable footprint and input impedance is therefore needed to achieve a good detection result [2],[8].

The footprint of an antenna is the effective area illuminated by the antenna on ground surface or subsurface. An optimal footprint is usually closely related to the size of the object. If the footprint is too large, it can increase the surface clutters in proportion to the area that is illuminated. Too small a footprint makes it difficult to distinguish the objects [2].

Adaptive antenna for GPR application for compensating the varying soil characteristic is one of the most challenging areas of research in GPR [3]. The previous research described that adaptation capability of wire bow-tie is achieved by varying the flare angle [2]. Varying the flare angle of wire-bowtie antenna will vary the antenna's footprint. Performance of antenna with multiple elements has been investigated by calculating the near field [4]. Every element in this antenna produced different near field area. This research was continued by calculating the footprint in sandy soil. Footprint simulation result also shown that footprint is proportional to the dimension of the active element [5].

The array antenna system that is proposed consists of five modified dipole antennas with relatively the same characteristic and different size. The resistive loading is applied for coupling reduction method. The footprint of antenna becomes large if the dimension of antenna is large, and vise-versa. In this research, switching between elements is performed manually. The PC controlled switch circuit will investigate in future research.

This research focuses on a GPR system within a frequency range of 100-1000 MHz. UWB antennas with different dimensions which are investigated should meet the requirement of 100-1000 MHz GPR system. Simulation is performed both in frequency and time domains. The Method of Moment (MoM) is chosen for the numerical method. Measurements are carried out to verify the simulation results.

The rest of the paper is organised as follows. Section II describes the antena design and fabrication. Section III shows the antenna measurement procedure and results. Finaly section IV conclude the works.

II. ANTENNA DESIGN AND FABRICATION

In this research, array of modified microstrip dipole antenna is used as proposed array UWB. The design of modified dipole has been discussed in [6]. The geometry of the array UWB antenna is depicted in Figure 1.

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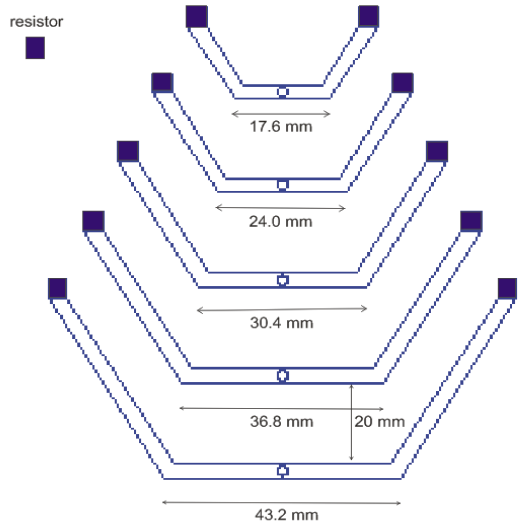
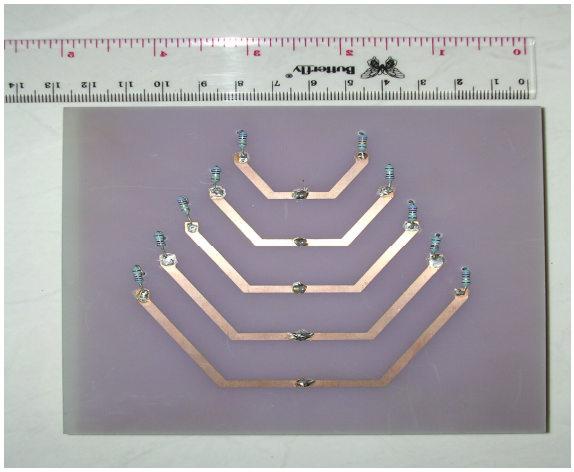
Antennas are printed on FR-4 epoxy dielectric substrate. The dielectric substrate has thickness of 3.2 mm and a relative dielectric constant of 4.4. Resistive loads 60 Ohm are added at the end of modified microstrip dipole and the Via input port is connected to SMA connector. The optimum value of the resistor is obtained by performing a parametric study. The complete dimensions of the array UWB antennas are identified in Figure 1. Every element of array UWB antenna is designed to meet the requirement of 100-1000 MHz GPR system. The S_{11} characteristic of every element on array UWB antenna can be seen in Figure 2. The simulation and the measurement result in Figure 2 show that every element of the array antenna meets the bandwidth requirement.



(a) design lay out of the antenna



(b) Fotograph of the fabricated antenna

Figure 1. Geometry of modified 5-element dipole antenna array.

The S_{11} characteristic of every element on array UWB antenna can be seen in Figure 2. The simulation results in Figure 2 show that every element of the array antenna meets the bandwidth requirement.

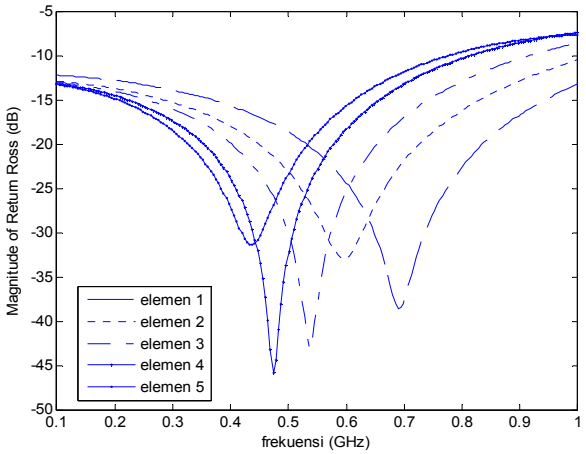


Figure 2. S_{11} characteristics of every element on array Antenna.

Scattering matrix and Impedances matrix can be calculated by combining of MoM and two-port Network equation [7]. Coupling between elements in the array become a very important consideration. If coupling between elements in array is significant, the feeding scheme for footprint adjustment that above mentioned will fail. The coupling level between nearest element should be below -30 dB. The measurement result in Figure 3 shows that coupling level between nearest element can be pushed to below -32 dB by applying resistive loading.

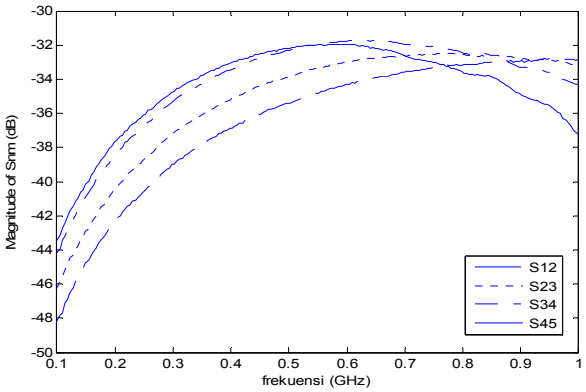


Figure 3. Coupling level between nearest elements in array.

Array antenna with different element dimension as shown in Figure 1 is constructed for giving possibility to adjust the effective aperture of the antenna. The effective aperture of the antenna is adjusted by selecting the array's element that will be fed. The antenna is excited by 5 ns monocycle pulse and the transmit waveforms of every element of the array antenna at a depth of d = 300 mm in dry sand. The monocycle pulse is shown in Figure 4.

The classical characterization of antennas by its far field radiation pattern is of little use in GPR antennas because of several reasons. First, objects can be located in the near- or intermediate region of the antenna. For processing of this data, the far-field pattern cannot be used. Second, in most cases the ground will have a layered structure. Due to the layers, the actual far-field of

the antenna is depending on electrical properties, structure and thickness of the layers.

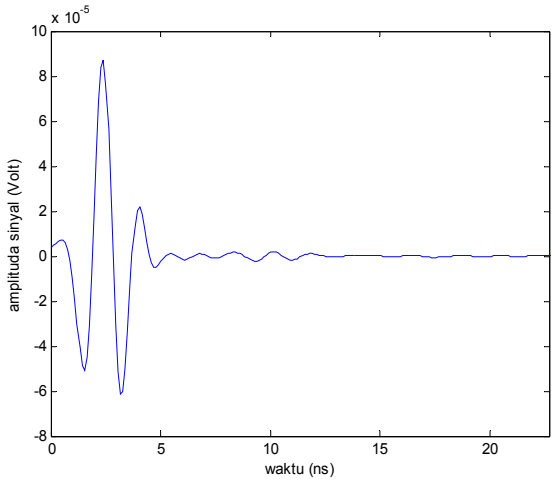
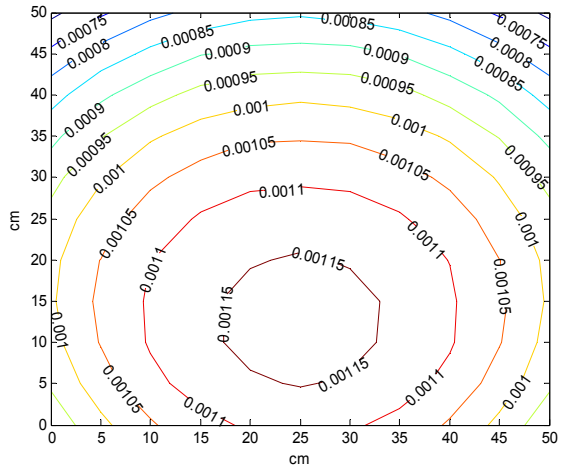
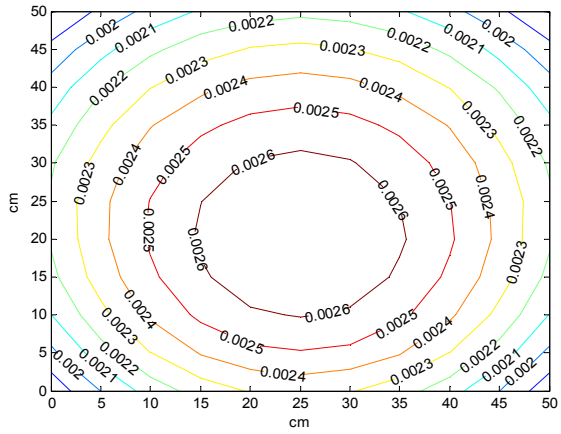


Figure 4.The measured transmit waveform of the antenna at a depth of d=300 mm in dry sand.



(a) Element-1



(b) Element-5

Figure 5. Some examples of footprint obtained from simulation (ε_r = 5, μ_r =1), ground depth = 300 mm.

An antenna footprint is defined as a distribution of the normalized peak values of transmit waveforms within a horizontal plane on the ground surface or subsurface, which indicates the shape and size of the spot illuminated by the antenna. The antenna footprint can be determined by observing the peak of transmit waveform at the discrete coordinate distributed in *xy* plane. We consider ground types of "soft" ground, i.e., dry sand (ε_r = 5.1, σ= 0.004 S/m, μ_r ranging from 1 to 3).

We also vary the depth of the ground (soil) from 200 mm to 500 mm. In this research, footprints of array UWB antenna have been investigated by simulation and measurement. In Figure 5, we present the computed antenna footprint from array UWB antennas with different active element, at a depth of 300 mm in dry sand. Figure 5 shows that size of the antenna footprint related with dimension of the antenna. Footprint of the antenna becomes large if the dimension of the antenna is large, and vise-versa.

III. Antenna Measurement and Results

Antenna is placed above the ground surface with elevation of 50 mm. The measurement setting is shown in Figure 6.

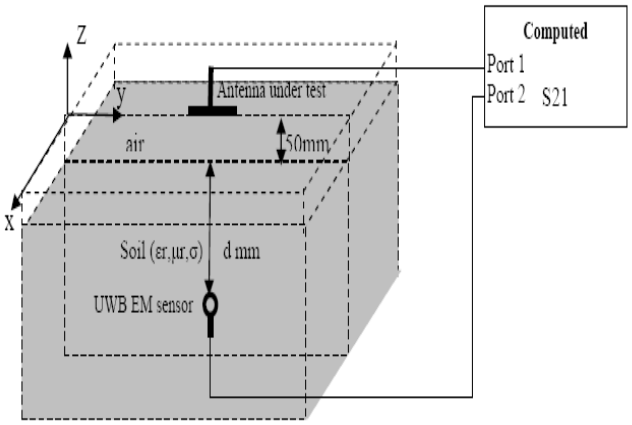


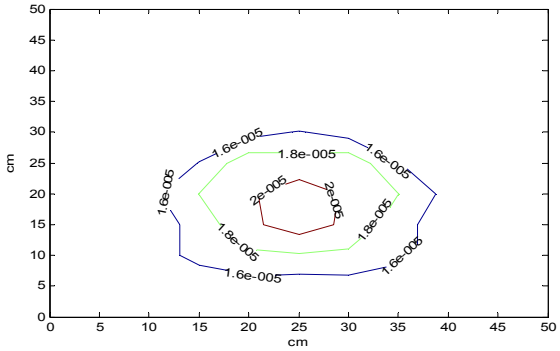
Figure 6. Antenna measurement procedure

For GPR it is important to examine the amplitude of the transmit waveforms since it indicates the amount of the energy transmitted by the antenna into the ground. The antenna system can be modeled as a linear time invariant system. Therefore the transmitted signal (E_t) can be obtained as a product of the computed S_{21} and the spectrum of the exciting pulse (S_f) followed by inverse FFT operation [8]. Antenna under test (AUT) and electromagnetic sensor (EM Sensor) may be considered as a two-port network.

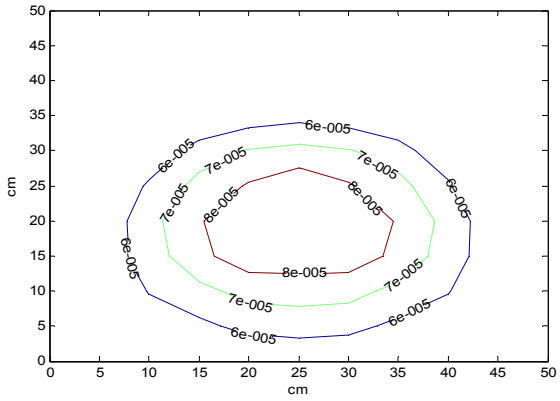
In this research, the footprint of UWB antenna is simulated for dry sand soil type at a depth of 300 mm and grid size of 50 mm (in x and y direction). The simulation

results show that the size of an antenna footprint is smaller in the presence of a "harder" ground. As the antenna footprint varies with changes of soil type, a problem to achieve a good post processing result arises. In dealing with the problem of varying soil conditions, an antenna with capability to control its footprint is required in GPR application. Measurements were carried out to validate the simulations result. The model of the UWB antenna shown in Figure1 has been constructed for experimental investigations. The measurement setup in our test facilities is shown in Figure 6. Our test facilities consists of a GPR test range, PC controlled scanner, a UWB sensor, and network analyzer as measuring equipment. The test range was constructed by a wooden sandbox with dimension 3 m x 3 m x 1.6 m and filled up with dry sand [9].

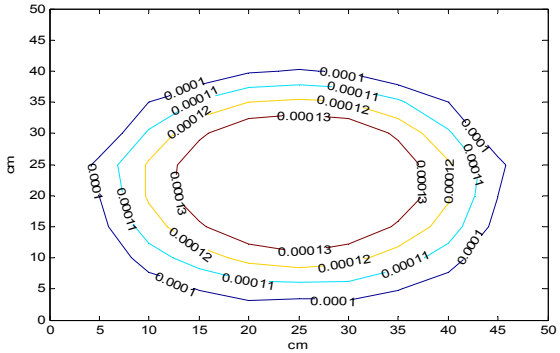
Figure 7 shows footprint measurement result of array UWB antenna when one of the five elements is fed.



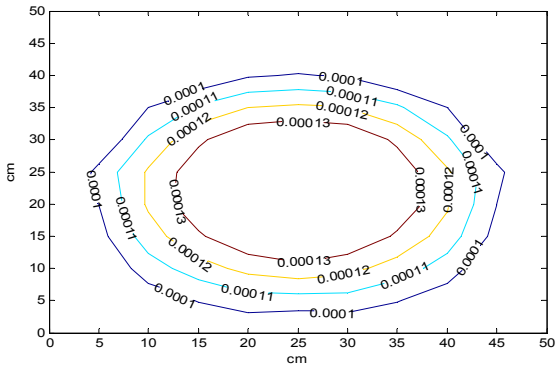
(a) element-1



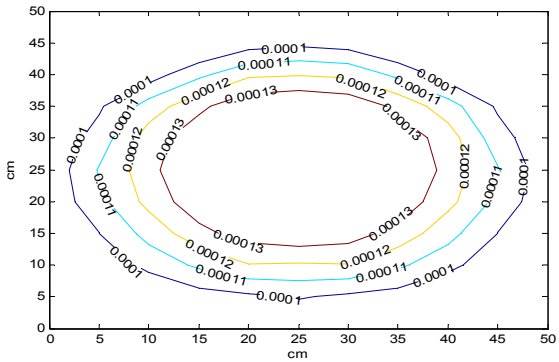
(b) element-2



(c) element-3



(d) element-4



(e) element-5

Figure 7. Footprint measurement with different active element at a depth of 400 mm in dry sand.

We can see from Figure 7 that the size of the antenna footprint related with dimension of the antenna element that is fed. Footprint of the antenna becomes larger for larger antenna dimension, and vise-versa. The measurement result has the same conclusion with the simulation result. According to simulation and measurement result, size of antenna footprint is possible to be adjusted by varying the effective aperture of the antenna. The effective aperture of the array depends on the element of array that is fed.

CONCLUSION

The implementation of array antenna for footprint adjustment on SFCW GPR 100-1000MHz has been investigated both in numerical simulation and experimental laboratory measurement. The numerical simulation and the measurement results are in agreement. The antenna footprint is proportional to the dimension of the element being fed. The simulation results of footprint also show that footprint area is proportional to the dimension of the active element. Footprint adjustment can be achieved by choosing suitable antenna element in the array system. The result of this research has paved the way towards an adaptive footprint adjustment in which the antenna will automatically adjust its footprint when the antenna input impedance changes due to changes in soil characteristics.

ACKNOWLEDGMENT

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A Comparative Study of Interpolation Methods On Channel Estimation for Downlink OFDMA IEEE 802.16e Standard

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***Abstract*—Mobile WiMAX system is expected to be a base for wireless ubiquity products all over the world. This high mobility communication systems need eficient channel estimation to cope high frequency selectivity and time variation channel effect. There are two types of channel estimation based on the symbol used for pilot data, preamble symbol or data symbol. For the data symbol based Channel Estimation, we compare several interpolation methods (linear, 2nd order polynomial, Lagrange, lowpass and wiener filter interpolation) for derive channel response at all subcarrier and then conclude an efficient and suitable scheme for the considered system. The performance of all methodes are showed by measuring bit error rate with 64 QAM and QPSK as modulation scheme and ITU A and ITU B vehicular channel as channel models.**

***Index Terms*—mobile WiMAX, channel estimation, OFDMA., interpolation.**

I. INTRODUCTION

Mobile WiMAX system is expected to be a base for wireless ubiquity products all over the world. This high mobility communication systems need eficient channel estimation to cope high frequency selectivity and time variation channel effect

There are three main aspect in designing channel estimators for wireless OFDM systems. The first is the arrangement and/or position of pilot information. The pilot is the aided known reference data that is used to obtain channel estimates. Based on the position of pilot, channel estimation method can be divided to preamble based channel estimation [3, 5].This approach, usually is done for initial channel estimation, the updating channel estimation proces for the following symbols after the preamble was out of the scope of this methods. This preamble pilot based channel estimation is appropriate for relatively low to medium mobility communication system, but for more high mobility environment, the data pilot based channel estimation is more suitable since channel estimation is carried out at every symbol to cope time domain channel response variation instead of once at preamble symbol .

The second aspect is the algorithms of a channel estimator for pilot subcarriers that can estimate actual response of channel by considering hardware/software implementation. Based on this aspect, the channel estimation at the pilot subcarrier can use several algorithms like LS [2]/MMSE [3,4,5,10] . In this paper we only use LS due to its lowest computational complexity.

The third, for the comb or scattering (not fully inserted in one OFDM symbol) it is necessary to do interpolation after the channel estimation process. Several interpolation methods for frequency dimension like Linear [2], Second Order Polynomial, Low Pass[4,5], Spline Cubic[4], Phase Compensated [6] and Raised Cosine Interpolation[1] were discussed. Although there are many interpolation methods for obtain channel response function reported in references, it is important to have specifically design for special pilot arrangement like downlink OFDMA WiMAX system, which is not uniformly distributed within each OFDM block like those on the above references.

In this paper, we investigate data pilot based channel estimation with various interpolation methods i.e Linear, Second Order Polynomial, Lagrange quadratic, Low Pass and MMSE interpolation.

Based on our simulation, it can be shown that the linear interpolation have equal performance compare to the 2nd poly, lagrange and lowpass interpolation with the low complexity advantage. On the other hand, MMSE interpolation achieve best performance among all interpolation methods especially for highly frequency selectivity and dispersive channel. The Symbol Error Rate for QPSK and 64 QAM system is presented by means of simulation.

The paper is organized as follows. In section II we explain System Description, section III discuss the two type of channel estimation based on the position of pilot. Interpolation methods are presented at section IV. Section V presents the simulation results, which indicate BER performance. Section VI conclude the paper.

II. SYSTEM DESCRIPTION

The IEEE 802.16e wireless MAN –OFDMA physical layer (PHY), based on OFDM modulation, is designed for NLOS operation in the frequency bands below 11 GHz. The OFDM system with pilot based on channel estimation is given in figure 1.

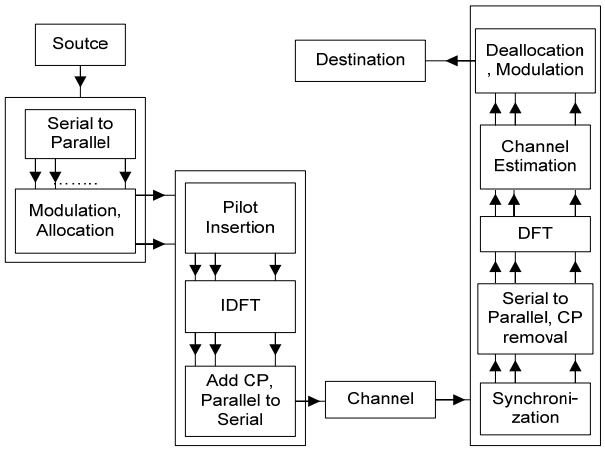

Fig. 1. Blog Diagram of The Pilot Based OFDM System

The data bits provided from the source are converted from serial to parralel to form parallel data of some subchannels[7]. Each parallel subchannel modulated to complex QAM symbols of N_u active subcarriers. The modulated data with other null carrier as guardband and DC form N subcarriers. This data sequence of length N $\{X_k\}$ are then fed into IDFT block symbol by symbol to transform them into time domain and generate an OFDM signal $\{x_n\}$ with the following equation :

$$x_n = IDFT\{X_k\} = \sum_{k=0}^{N-1} X_k\, e^{j2\pi kn/N}, \quad n = 0,1,\ldots, N-1 \tag{1}$$

Where N is the DFT length or the number of subcarriers. To prevent inter-symbol interference (ISI), a cyclic prefix of N_g samples is inserted at the beginning of every symbol. After D/A conversion, the signal is transmitted through the frequency selective time varying fading channel with additive noise.

Assumed that the impulse response of the multipath fading channel is given by [1]:

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$$y(\tau) = \sum_r h_r(t).x(\tau - \tau_r) + w(\tau), \tag{3}$$

Where $x(\tau)$ is the continuous-time representation of the transmitted discrete-time signal, x_n. The received continuous-time signal then convert back to a discrete – time signal y_n, the receiver do synchronization, downsampling, and removes the cyclic prefix. The simplified baseband model of the received samples takes the form of :

$$y_n = \sum_{l=0}^{L-1} h(l)x(n-l) + w(n) \tag{4}$$

Where L is the number of sample-spaced channel taps, w(n) is additive white Gaussian noise (AWGN) sample with zero mean and variance of σ^2_w, and h(l) is the time domain channel impulse response (CIR) for the current OFDM symbol. It is assumed that time and frequency synchronization is perfect.

FFT transforms y_n to the frequency domain received base band data :

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Following FFT block, the pilot signals are extracted and the Channel Estimation is carried out to obtain estimated channel response $\hat{H}_k$ for the data sub-channels. Then the transmitted data is estimated by equalization process :

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OFDMA is based on OFDM modulation. It support subchannelization in both UL and DL. The OFDMA frame structure is similar to the OFDM structure, except the subchannelization. At OFDMA system, broadcast message can be transmitted at the same time (on different subchannels) as data. The frame is divided into a number of zones that each use a different subchannelization scheme[6].

An 802.16e frame in TDD mode is built up by one downlink (DL) subframe and one uplink (UL) subframe. Based on the OFDM principle, the pilot both in time domain and in frequency domain is assigned for channel estimation calculation process. [2]

The OFDMA downlink PUSC IEEE 802.16e symbol structure is using pilots, data, and zero subcarriers. The symbol is first divided into basic clusters and zero carriers are allocated. Pilots and data carriers are allocated within each cluster. Figure 2 below depicts the cluster structure

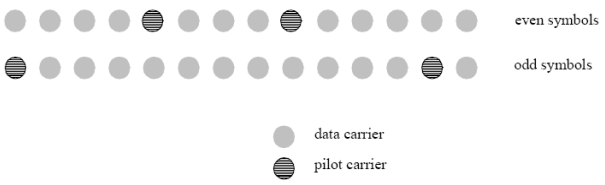

Fig. 2. Downlink OFDMA 802.16e cluster/tile structure

III. Channel Estimation Based on Symbol Source of Pilot /Pilot Source

There are two types of Channel Estimation for OFDMA /OFDMA system based on the symbol source of pilot used for estimation. The first kind of Channel Estimation type is Preamble based Channel Estimation [3, 5] and Data Symbol based Channel Estimation [2, 4, 6]. Both type of channel estimation can employ the usual Channel Estimation algorithms, for example, Least Square (LS) Method, Minimum Mean Square Error (MMSE) method to estimate channel response at the pilot position. Then using this channel function estimate, interpolation in time dimension is done. Next step is interpolation in frequency dimension.

Preamble Pilot based channel estimation exploit the first symbol of each downlink subframe dedicated as a preamble in OFDMA mode of 802.16e standard. This preamble is used for initial estimation of time varying channel. The LS estimation at non zero position at every third subcarrier in the preamble is done after FFT block at receiver. More processing (interpolation) is required to estimate complete channel response. In [3] the performances of mobile station initial channel estimation methods using such a preamble is analyse. The next paragraph explain about data pilot based channel estimation.

In general, the fading channel response of the OFDM/OFDMA system can be viewed as a two dimensional (2D) lattice in time-frequency plane [2]. For Downlink mobile WiMAX system, inside a tile/cluster, the fading channel responses are sampled at 4 pilot subcarriers as shown at figure 3. The channel responses at the rest of data subcarrier are estimated by interpolation.

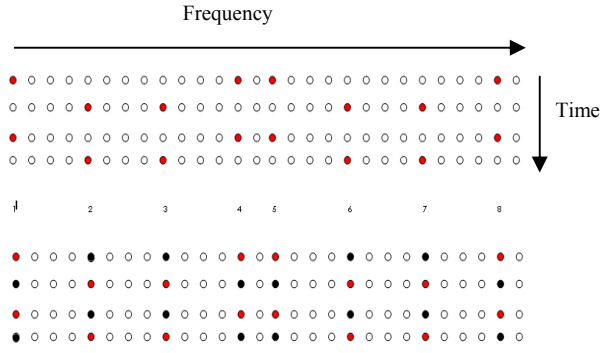

Fig. 3. Pilot Position before Interpolation (above) and after time interpolation (below)

First is interpolation at time dimension which has 2 symbols time spacing. In this paper we use linear interpolation for time dimension interpolation because it is sufficient for small time spacing. The time dimension interpolation steps are shown in figure 4. Next is frequency dimension interpolation. The subcarrier spacing after time interpolation is 4 subcarriers and 1 subcarrier.

In this paper, we compare this two different approach for downlink 802.16e OFDMA to calculate channel estimation employing LS estimator at the pilot subcarriers. The channel response of pilot subcarrier is then frequency dimension interpolated with linear, 2nd order polynomial, lowpass, lagrange and MMSE interpolation.

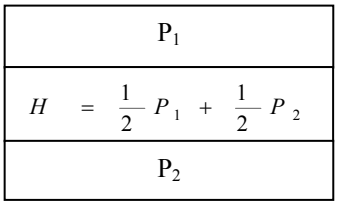

Fig. 4. Linear Interpolation for time domain interpolation

In the simplest case, the channel estimates, are found by straightforward multiplying the received pilot by the inverse of the known transmitted pilot. This method is called least square (LS) estimator, given by[8] :

$$\hat{H}_{P,LS} = X_P^{-1} Y_P = \left[\frac{Y_P(1)}{X_P(1)} \frac{Y_P(2)}{X_P(2)} \cdots \frac{Y_P(N_P)}{X_P(N_P)} \right]^T \quad (7)$$

Without using any knowledge of the statictics of the channels, The LS Estimator has very low complexity , but they suffer from a high mean-square error[2] so we can apply interpolation methods that use channel knowledge like MMSE interpolation to improve performance.

IV. Frequency Domain Interpolation

After the estimation of channel transfer responses of pilot subcarriers, the channel responses of the rest data sub carrier are obtained by interpolation process using the channel information at pilot subcarriers [6].

In this paper we consider a piecewise linear, and a MMSE interpolation. First interpolation methode have inherent low complexity and easy to implement. Other interpolation, MMSE interpolation, has better performance at highly frequency-dispersive environments [3]. The linear interpolation method obtains the channel response at the k-th subcarrier, as[1]

$$\hat{H}(k) = \hat{H}(mL+1) = \hat{H}_P(m) + \frac{l}{L}\left(\hat{H}_P(m+1) - \hat{H}_P(m)\right), 0 \le l < L \quad (8)$$

where $m = 0, 1, \ldots N_P\text{-}1$, N_P= number of pilot, $mL \le k < (m+1)L$ and $L = N/NP$, where N = total number of subcarriers.

Second order polynomial interpolator is given by

$$\hat{H}(k) = \hat{H}(mL+l) = C_{-1}\hat{H}_p(m-1) + C_0\hat{H}_p(m) + C_1\hat{H}_p(m+1) \quad (9)$$

where

$$\begin{cases} C_{-1} = \dfrac{\alpha(\alpha-1)}{2} \\ C_0 = -(\alpha-1)(\alpha+1) \\ C_1 = \dfrac{\alpha(\alpha+1)}{2} \end{cases}$$

and $\alpha = l/L$.

Lagrange quadratic interpolation [11] is interpolation of given (x_0, f_0), (x_1, f_1), (x_2, f_2) by a second degree polynomial $p_2(x)$, which by Lagrange's idea is

$$p_2(x) = L_0(x)f_0 + L_1(x)f_1 + L_2(x)f_2 \quad (10)$$

where

$$L_0(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)}$$

$$L_1(x) = \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)}$$

$$L_2(x) = \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)}$$

Low Pass interpolation [4, 5] is performed by inserting zeros between the original data values and then applying a lowpass FIR filter that allows the original data to pass through unchanged and interpolates between such that the MSE between the interpolated pointsand their ideal values are minimized. For interpolation (upsampling)rate of v and u original data's either side of interpolation point, a lowpass filter with length $2*u*v+1$ and cutoff frequency π/v is designed.

MMSE/Wiener filter interpolation can be perform by this equation[3] :

$$\hat{H}_{MMSE} = R_{HH_P}\left(R_{HH_P} + \sigma_n^2\left(X_P X_P^H\right)^{-1}\right)^{-1}\hat{H}_{P,LS} \quad (11)$$

Where $H_{P,LS}$ is the LS estimate of channel condition at pilot position, σ_n^2 is the variance of noise W_K , X_P is a matrix containing the transmitted pilot on its diagonal, $R_{H_PH_P}$ and R_{HH_P} is the channel response at pilot subcarrier autocorrelation matrix and crosscorrelation matrix of channel response at all subcarrier and pilot subcarrier respectively.

For this case, the correlation function between the channel frequency response value is given by[5] :

$$E\left\{H_m H_n^*\right\} = \begin{cases} 1, & m = n \\ \dfrac{1 - e^{-j2\pi\left(N_g(m-n)/N\right)}}{j2\pi\left(N_g(m-n)/N\right)}, & m \ne n \end{cases} \quad (12)$$

From equation (12) we can get $R_{H_PH_P}$.

In this paper we compare those five interpolation methods Linear, 2nd polynomial, lowpass, lagrange and MMSE interpolation .

V. SIMULATION

In this section, we report computer simulation carried out to evaluate and compare performance of the considered channel estimation. We used downlink OFDMA system of IEEE 802.16e. The OFDMA system parameters used in the simulation are indicated in Table I.

TABLE I. PARAMETER USED IN THE PAPER

Parameter	Value	Note
N	1024	FFT Size
N_u	840	Number of used subcarrier
N_g	256	CP Size
N_P	120	Number of pilot subcarrier
$N_{PPREAMBLE}$	280	Number of used/pilot subcarriers in preamble

The channel models used in the simulation is same as [3], the ITU-R A and ITU-R B channel for vehicular environment. We set the vehicle speed of user to 60 km/h.

Five interpolation method, linear, second order, low pass, lagrange quadratic and MMSE method are simulated and compared. All interpolation methode use LS estimator and data pilot based channel estimation algorithm. The result are shown in figure 5-8. The horizontal variable is signal to noise ratio and the vertical variable is Bit Error Rate.

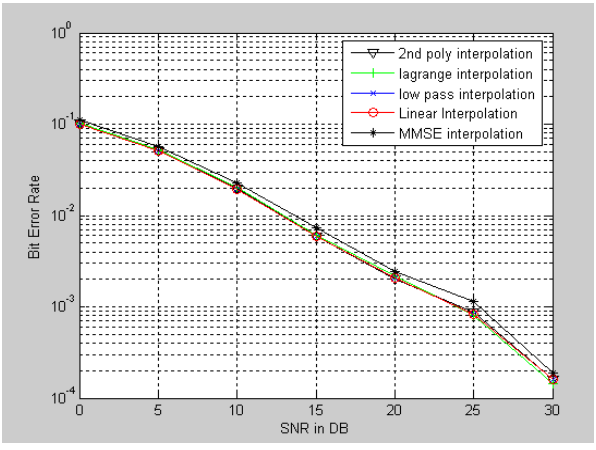

Fig. 5. BER performance of Symbol Data Based LS Estimate with different interpolator for QPSK under ITU A vehicular channel model.

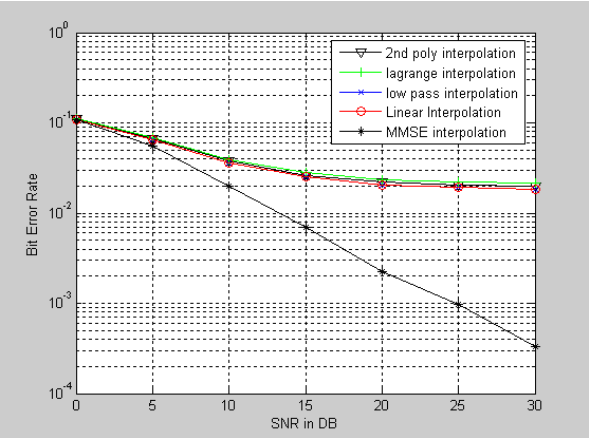

Fig. 6. BER performance of Symbol Data Based LS Estimate with different interpolator for QPSK under ITU B vehicular channel model.

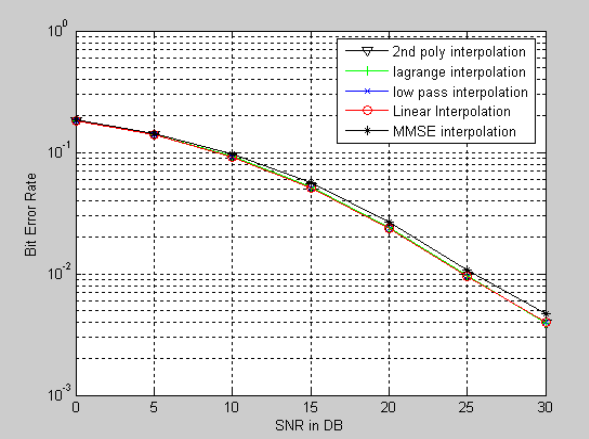

Fig. 7. BER performance of Symbol Data Based LS Estimate with different interpolator for 64QAM under ITU A vehicular channel model.

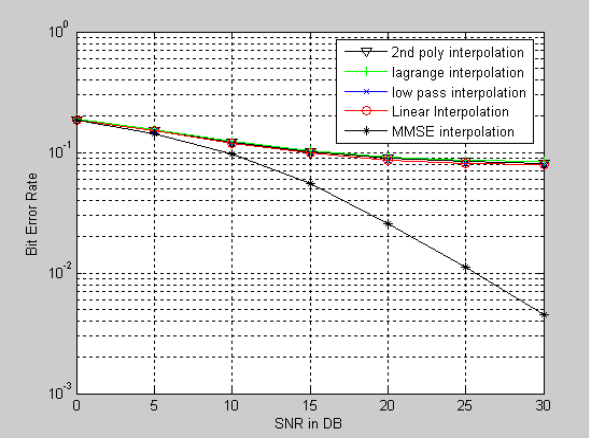

Fig. 8. BER performance of Symbol Data Based LS Estimate with different interpolator for 64QAM under ITU B vehicular channel model.

From figure 5 and 7 BER performance of Linear and MMSE interpolation at ITU A vehicular channel is approximately equal. This is due to the medium frequency selectivity condition can be coped well by linear interpolation. However, at high frequency selectivity (fig.6,10) the performances decrease due to unlinearity channel response between pilots occurred. [3].

From figure 6 and 8 we see that performance is improve significantly when MMSE interpolation is applied under ITU B channel condition. We also notice that the linear interpolation, 2nd order interpolation, low pass interpolation and Lagrange Quadratic nterpolation have approximately equal performanc e. 2nd order polynomial interpolation can not improve the performance due to large delay spread condition at ITU A and ITU B vehicular channel model[5] and ununiform pilot space condition.

The performance of low pass interpolation also limited by ununiform pilot space that make the length of filter is restricted to maximum of 3. The shorter the length of filter, the less MSE between the interpolations and their ideal values is minimized. The channel estimation based on Lagrange quadratic interpolation also out of expectation to achieve better performance. It is suspectable that Lagrange interpolation, same with 2nd order polynomial interpolation, Lagrange interpolation can not achieve higher performance at large delay spread condition with relatively long pilot space (4) because both methods employ three channel response at three subsequent pilot subcarrier that maybe too dispersive for obtaining the precise interpolation at such dispersive channel condition.

VI. CONCLUSION

In this paper five interpolation method at the data pilot based channel estimation method are analysed and compare . We conclude that the data pilot based channel estimation with linear interpolation LS estimator achieve good trade off due to its lowest complexity and has acceptabble performance compare to 2nd poly, lagrange and lowpass interpolation. The linear interpolation scheme with LS channel estimation is suitable for practical application of downlink IEEE 802.16e OFDMA systems for medium selectivity channel and high mobility condition. But MMSE interpolation is more suitable to cope highly frequency dispersive and selectivity environments with the consequence of higher complexity.

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High Mobility Data Pilot Based Channel Estimation for Downlink OFDMA System Based on IEEE 802.16e Standard

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***Abstract*—High mobility communication systems need suitable channel estimation to cope high frequency selectivity channel effect. In this paper we propose data pilot based channel estimation in downlink OFDMA for IEEE 802.16e standard (Mobile WiMAX). The Mobile WiMAX channel estimation can be done by exploiting pilot from preamble, in this paper we obtain channel transfer function by exploiting pilot at symbol data with two dimensial interpolation scheme. Based on our simulation, it can be shown that the second method have better performance compare with preamble based channel estimation method. The Bit Error Rate and equalized signal scatter plot for 64 QAM system with ITU A and ITU B vehicular channel as channel models are presented by means of simulation..**

***Index Terms*—mobile WiMAX, OFDMA, channel estimation**

I. INTRODUCTION

Channel estimation play an important role in a telecommunication receiver, especially for high mobility communication. Channel Estimation provides information about distortion of the transmission signal when it propagates through the channel. In order to mitigate hostile channel effect on the received signal, precise channel estimation is required, especially for mobile telecomunnication with highly dispersive channel.[1]

The channel estimation at receiver, however, requires knowledge of the channel over which the signal is transmitted. To facilitate the estimation of the channel in OFDMA mobile WiMAX system, known signals or pilots were inserted in the transmitted OFDM symbol. Different methods can then be applied to estimate the channel using these known pilots. Based on pilot position, the channel function for OFDM/OFDMA system can be obtain from the used/nonzero subcarriers in the preamble symbol (preamble based channel estimation) or from pilot subcarriers in each data symbols (Data pilot based channel estimation) of one OFDM/OFDMA data frame. For OFDMA system for IEEE 802.16e recent work was done by preamble based methods[3]. This approach only done for initial channel estimation, the updating channel estimation proces for the next symbol was not mentioned[3]. Data pilot based methode, has been presented by Shen [2] for other system, i.e uplink 802.16e OFDMA, which has relatively uniform pilot arrangement compare to the downlink system we use for this research. For downlink OFDMA mobile WiMAX system, clustered data pilot based channel estimation method was discused by Zhang et al [terakhir]. This method has limitation on finding channel taps coeficient that used for filtering or smoothing process due to the small number of pilot subcarrier in one cluster. Although there are many methods for obtain channel response function, it is important to have specifically design for special pilot arrangement like downlink OFDMA WiMAX system, which is not uniformly distributed within each OFDM block like those on the above reference [2].

In this paper we proposed data pilot based channel estimation instead of preamble pilot based channel estimation in downlink OFDMA for IEEE 802.16e standard (Mobile WiMAX). This proposed channel estimation method perform channel estimation symbol by symbol to compensate highly time variation channel effect. An 802.16e frame in TDD mode is built up by one downlink (DL) subframe and one uplink (UL) subframe. In this paper only the downlink subframe structures will considered.

The paper is organized as follows. In section II we explain System Description, section III discuss the proposed channel estimation method, with preamble based channel estimation method. Section IV presents the simulation results, which indicate BER performance. Section V conclude the paper.

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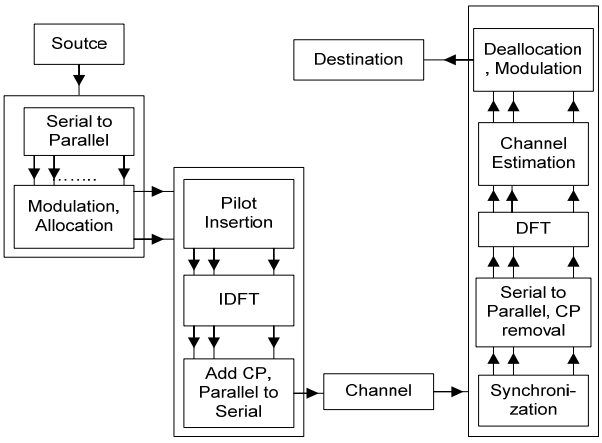

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$$y_n = \sum_{l=0}^{L-1} h(l)x(n-l) + w(n) \tag{4}$$

Where L is the number of sample-spaced channel taps, $w(n)$ is additive white Gaussian noise (AWGN) sample with zero mean and variance of σ^2_w, and $h(l)$ is the time domain channel impulse response (CIR) for the current OFDM symbol. It is assumed that time and frequency synchronization is perfect.

FFT transforms y_n to the frequency domain received base band data :

$$\begin{aligned} Y_k &= FFT(y_n) \\ &= X_k H_k + W_k \end{aligned} \tag{5}$$

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After signal demapping, the source binary information data are re-constructed at the receiver output.

OFDMA is based on OFDM modulation. It support subchannelization in both UL and DL. The OFDMA frame structure is similar to the OFDM structure, except the subchannelization. At OFDMA system, broadcast message can be transmitted at the same time (on different subchannels) as data. The frame is divided into a number of zones that each use a different subchannelization scheme[6].

An 802.16e frame in TDD mode is built up by one downlink (DL) subframe and one uplink (UL) subframe. Based on the OFDM principle, the pilot both in time domain and in frequency domain is assigned for channel estimation calculation process. [2]

The OFDMA downlink PUSC IEEE 802.16e symbol structure is using pilots, data, and zero subcarriers. The symbol is first divided into basic clusters and zero carriers are allocated. Pilots and data carriers are allocated within each cluster. Figure 2 below depicts the cluster structure

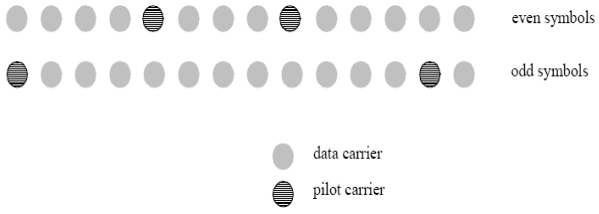

Fig. 2 Downlink OFDMA 802.16e cluster/tile structure

III. CHANNEL ESTIMATION

Previous work on downlink 802.16e OFDMA channel estimation has been proposed by Yucek [3]. In this reference, non zero data/ pilot from preamble symbol is used to calculate initial channel estimation. This preamble based channel estimation is appropriate for relatively medium mobility communication system, but for more high mobility environment channel estimation must be carried out at every symbol instead of once at preamble symbol to cope time domain channel response variation.

Other approach for channel estimation was presented by Shen [2] for uplink 802.16e OFDMA, which exploit pilot from data symbol to obtain channel response at pilot subcarrier position and carry out 2D linear interpolation method to get complete channel response.

In this paper, we present a different approach for downlink 802.16e OFDMA, which use pilot from data symbol to calculate channel estimation. The channel response of pilot subcarrier is then interpolated by Linear interpolation method as Shen[2].

A. 2D Linear Interpolation Method

In general, the fading channel response of the OFDM/OFDMA system can be viewed as a two dimensional (2D) lattice in time-frequency plane [2]. For Downlink mobile WiMAX system, inside a tile/cluster, the fading channel responses are sampled at 4 pilot subcarriers as shown at figure 2.

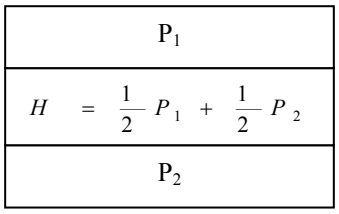

Fig. 3 Linear Interpolation for time domain interpolation

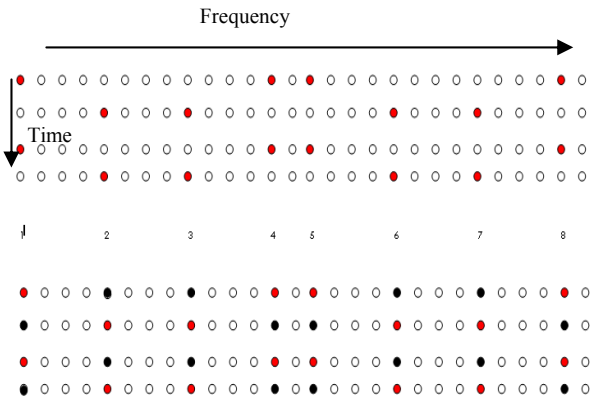

Fig. 4 Pilot Position before Interpolation (above) and after time interpolation (below)

The channel responses at the rest of data subcarrier are estimated by interpolation. First is interpolation at time domain which has 2 symbols time spacing. In this paper we use linear interpolation for time domain interpolation because it is sufficient for small time spacing. The time domain interpolation steps are shown in figure 3. P1 and P2 is two subsequent channel response at pilot subcarriers in one symbol. H is .. After time interpolation, tile structure is described at figure 4.

Next step is frequency domain interpolation. The subcarrier spacing after time interpolation is 4 subcarriers and 1 subcarrier. Linear Interpolation is used for frequency domain interpolation as time dimain interpolation.

B. Channel Estimation Algorithm

In the simplest case, the channel estimates, are found by straightforward multiplying the received pilot by the inverse of the known transmitted pilot. This method is called least square (LS) estimator, given by[8] :

$$\hat{H}_{P,LS} = X_P^{-1} Y_P = \left[\frac{Y_P(1)}{X_P(1)} \frac{Y_P(2)}{X_P(2)} \cdots \frac{Y_P(N_P)}{X_P(N_P)} \right]^T \quad (7)$$

Without using any knowledge of the statictics of the channels, The LS Estimator has very low complexity , but they suffer from a high mean-square error[2].

After the estimation of channel transfer responses of pilot subcarriers, the channel responses of the rest data sub carrier are obtained by interpolation process using the channel information at pilot subcarriers [6]. In this paper we consider a piecewise linear, which have inherent low complexity and easy to implement.

IV. SIMULATIONS

In this section, we report computer simulation carried out to evaluate and compare performance of the considered channel estimation. We used downlink OFDMA system of IEEE 802.16e and the parameters used in the simulation are indicated in Table I.

The channel models used in the simulation is the ITU-R A and ITU-R B channel for vehicular environment which represent the channel condition for mobile WiMAX system. We set the vehicle speed of user to 60 km/h.

Two channel estimation method, preamble pilot based channel estimation [3] and proposed data pilot based channel estimation, are simulated and compare. Both methode used LS estimator and linear interpolation and the result are shown in Fig. 5 - 6.The horizontal variable is signal to noise ratio and the vertical variable is Bit Error Rate. From Fig . 5-6 we see that the performance is improved significantly when the data pilot based channel estimation is applied.

Performance improvement at the data pilot based (2D linear interpolation) channel estimation in view of the fact

TABLE I. PARAMETER USED IN THE PAPER

Parameter	Value	Note
N	1024	FFT Size
N_u	840	Number of used subcarrier
N_g	256	CP Size
N_P	120	Number of pilot subcarrier
$N_{PPREAMBLE}$	280	Number of used/pilot subcarriers in preamble

that this method obtains channel response function every symbol periode. On the contrary, preamble pilot based channel estimation only take once at the initial of the frame. This condition make the data pilot based channel estimation can follow time domain channel response variation due to high mobility condition better than preamble based channel estimation.

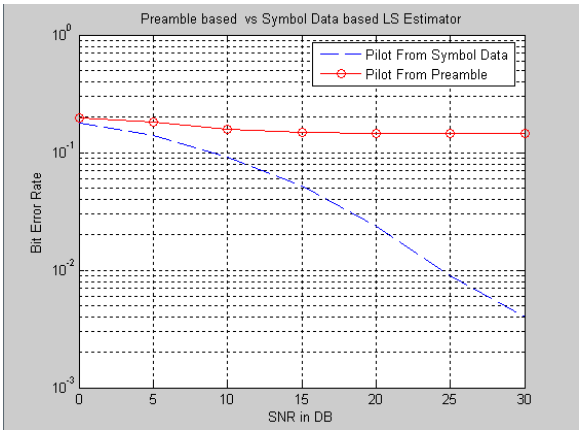

Fig.5. BER performance of the different pilot position based estimation methods for 64 QAM under ITU A vehicular channel model.

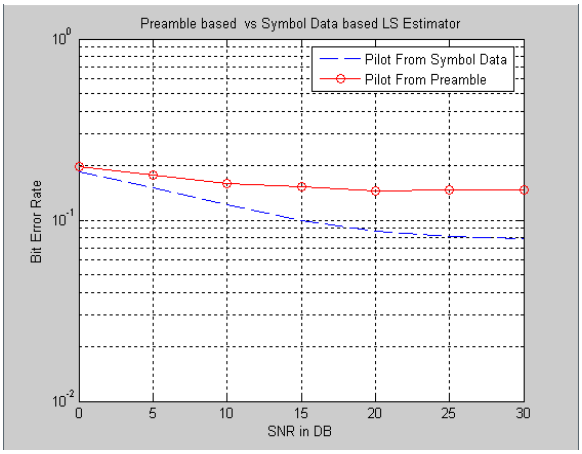

Fig.6. BER performance of the different pilot position based estimation methods for 64 QAM under ITU B vehicular channel model.

Fig. 7 – 10 show the scatter plot of received signal and equalized signal for the two algorithms with 64 QAM modulation. It is shown that the Data pilot based channel estimation (2D linear interpolation) method has closer equalized signal to the ideal signal constellation than the preamble based channel estimation method.

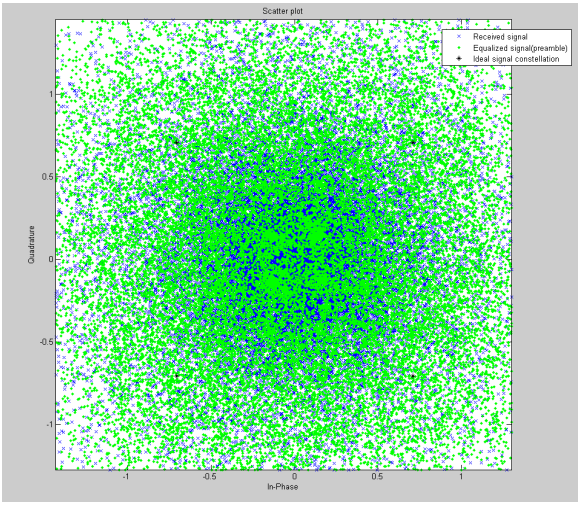

Fig.7. Scatter Plot of received signal (blue) and equalized signal (green) for preamble based channel estimation with 64 QAM modulation under ITU A vehicular channel model

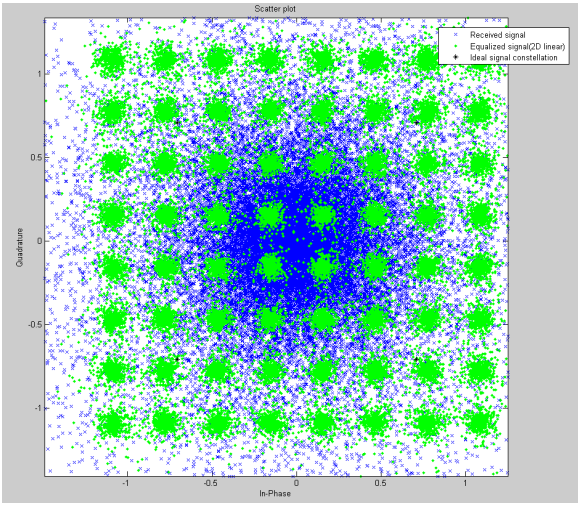

Fig.8. Scatter Plot of received signal (blue) and equalized signal (green) for data pilot based based channel estimation with QPSK modulation under ITU A vehicular channel model

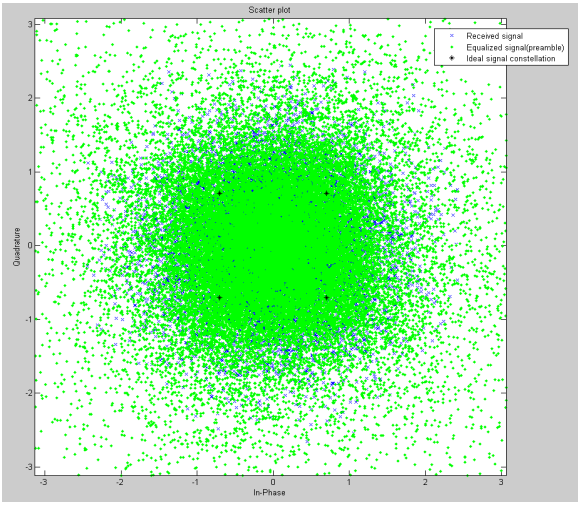

Fig.9. Scatter Plot of received signal (blue) and equalized signal (green) for preamble based channel estimation with 64 QAM modulation under ITU B vehicular channel model

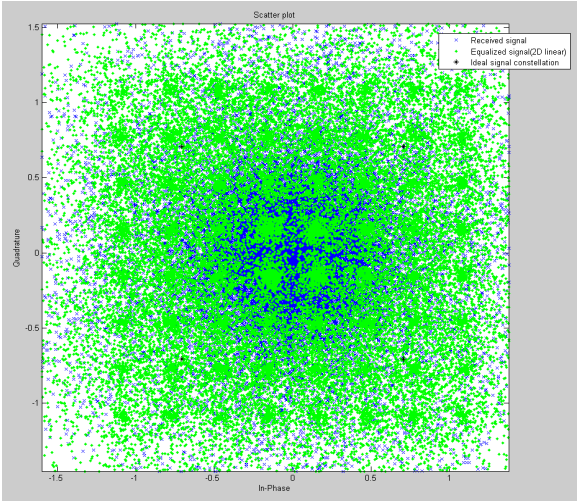

Fig.10. Scatter Plot of received signal (blue) and equalized signal (green) for data pilot based channel estimation with 64 QAM modulation under ITU B vehicular channel model

V. CONCLUSION

In this paper an OFDMA system based on IEEE 802.16e standard has been discussed with focus to downlink channel estimation at receiver. Two channel estimation method base on pilot source position, preamble based channel estimation [3] and the proposed data pilot based channel estimation for the system are compared . We conclude that the data pilot based channel estimation with linear interpolation LS estimator achieve good trade off and has acceptabble performance for high mobility condition (60 km/h) and for medium frequency selective channel (ITU A vehicular channel). The proposed channel estimation scheme with LS channel estimation is suitable for practical application of downlink IEEE 802.16e OFDMA systems

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Predictive Power Control of CDMA Systems in Rayleigh Fading Channels

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***Abstract*— In this paper a prediction-based power control is proposed for code division multiple access (CDMA) systems in Rayleigh fading environments. One of the most serious problems which degrades the performance of power control algorithm is the effect of feedback delay. To overcome the effect of feedback delay, power control algorithm relies on channel prediction techniques, which utilize the correlation property of the past channel measurements. In CDMA power control, however, the correlation property of channel measurements is destroyed because the transmit power is continuously updated for each power control interval. The prediction algorithm in this paper is proposed using the least mean square (LMS) technique. The result shows that the performance of predictive power control in terms of bit error rate (BER) as a function of bit energy-to-interference power density ratio Eb/Io provides a significant improvement from that of the conventional predictor.**

***Index Terms*—CDMA, least mean square, power control, prediction, Rayleigh fading.**

I. INTRODUCTION

Power contril in Direct Sequence Code Division Multiple Access (DS-CDMA) system is required in order to overcome the near-far problem and to mitigate the effect of multiple access interference among CDMA users in cellular and mobile radio environments. The eefect of fading channel significantly degrades the performance of CDMA systems because communication over fading channels require higher power levels, and thus producing higher unwanted multiple access interference among CDMA users. The near-far problem can be obercome by an open loop power control algorithm, while the effect of multiple access interference due to multipath fading requires a closed-loop algorithm when the uplink and downlink frequencies are not the same in a frequency duplexing (FDD) scheme [1].

Power control in CDMA systems is more important on the uplink direction compared to that on the downlink because uplink signals consist of all users from different locations (different path losses), while the downlink signals originate from the same base station and arrive at mobile stations with the same power level. Our previous study [2] shows that practical power control is imperfect in that it is affected by many factors; such as power updating rates and step size, channel estimation error, feedback transmission error, and feedback delay. Prediction-based algorithm proposed in this paper is employed to eliminate the effect of feedback delay. In a prediction-based algorithm, the channel state is predicted either through the measurement of signal strength or the signal-to-interference ratio (SIR) as the control parameter for power control algorithms. In this paper SIR is chosen as the parameter control to give better results.

In CDMA power control, however, the correlation property of the channel measurement is destroyed by power control updating, because the received signal strength or the SIR is continuously updated for each power control interval. Prediction algorithms utilize the correlation property of the past input samples or past measurements in order to predict the future channel conditions. Therefore, the convenrtional prediction-based algorithms may not work satisfactorily. In this paper the author proposes an improved prediction-based power control algorithm in that the past input samples to the predictor are compensated for by the same factors that were given by power updating for each power control interval in order to restore the correlation property of the channel.

The rest of the paper is organized as follows. Section 2 presents the closed loop power control algorithm in CDMA systems and explains the feedback delay problem. This section also briefly describes prediction techniques. Section 3 proposes an improved prediction technique for CDMA predictive closed loop power control algorithms. The computer simulation of the proposed algorithm and the results which show the improved performance of the proposed technique are discussed in Section 4. Finally, Section 5 draws the conclusion.

II. POWER CONTROL IN CDMA SYSTEMS

In the uplink of CDMA, signals from different mobile users are subject to different propagation mechanisms, resulting in different propagation path losses and independent fading that lead to unequal received power levels at the base station. When non-orthogonal spreading sequence of unequal received power levels arrive at the base station, multiple access interference becomes a

serious problem [3].

At the base station, the user recovers the transmitted symbol by correlating the received signal with the user spreading sequence. Due to non-zero crosscorrelation between spreading sequences of different users, the user will observe multiple access interference from the other users. If the received power levels at the base station are not equal, the correlating receiver may not be able to detect the weak user's signal due to high interference from other users with higher power levels. Clearly, if a user is received with a weak power, it will suffer from the interference generated by

stronger users' signals. Therefore power control in the uplink is indispensable to keep the interference acceptable to all users and to obtain a considerable channel-capacity [4]. In this paper power control is considered for the uplink CDMA channel based on SIR measurement as shown in Fig. 1.

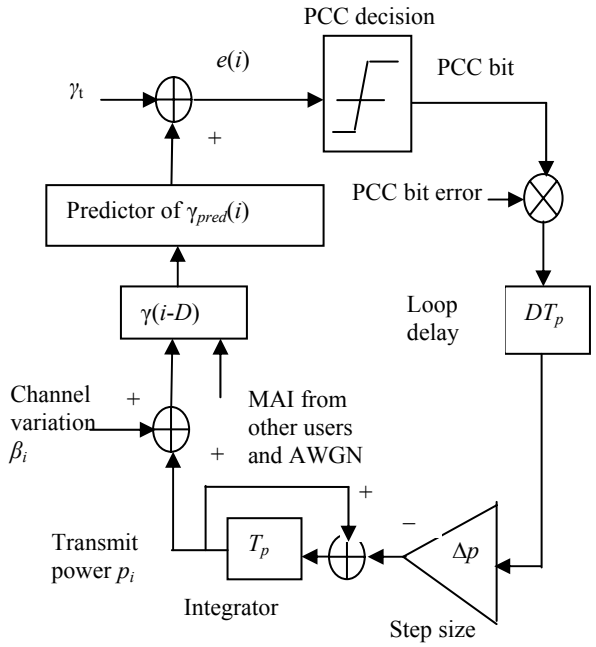


Figure 1: Predictive power control algorithm

For uplink power control, the mechanism of predictive power control algorithm proceeds as follows. First, the SIR for each user, $\gamma(i)$ is measured at the base station for the ith time slot. Due to the feedback delay introduced in the power control loop, the SIR for the ith time slot needs to be predicted D step ahead, where D is the total feedback delay introduced in the loop. Here the feedback loop delay is introduced in the power control algorithm due to measurement time, processing and propagation time of the command bits [5]. Therefore in Fig. 1, $\gamma(i)$ is predicted using the past SIR measurements to obtained the predicted value of SIR for the ith time slot, $\gamma_{pred}(i)$. We skip at this point the mechanism of SIR predictor to obtain $\gamma_{pred}(i)$ using the past input samples because this part will be explained in more detail in a section that follow.

The predicted SIR for the ith time slot $\gamma_{pred}(i)$ is then compared with the target SIR γ_t to produce the error signal $e(i)$. The error signal $e(i)$ is then quantized using a binary representation, so it can be transmitted via the downlink channel to instruct the mobile stations to increase or decrease their transmit power. The quantized form of error signal is called the power control command (PCC) bits, which can be implemented using a pulse code modulation (PCM) realization of mode q, where q is the number of PCC bits required in each power control interval.

The PCC bits for the ith time slot can be expressed as [6].

$$e(i)_q = \begin{cases} 2^{q-1}-1, & \text{index} < -2^{q-1}+1/2 \\ 2^{q-1}-2, & -2^{q-1}+1/2 \le \text{index} < -2^{q-1}+3/2 \\ \quad . & \quad . \\ \quad . & \quad . \\ 0, & -1/2 \le \text{index} < 1/2 \\ \quad . & \quad . \\ \quad . & \quad . \\ -(2^{q-1}-2), & 2^{q-1}-3/2 \le \text{index} < 2^{q-1}-1/2 \\ -(2^{q-1}-1), & \text{index} \ge 2^{q-1}-1/2 \end{cases} \quad (1)$$

where index is the difference between the predicted *SIR* (γ_{pred}) and the desired *SIR* (γ_t).

The PCC bits are also subject to high bit error rates because they are sent in the downlink channel without using error control coding or interleaving in order to minimize the signaling bandwidth of the downlink channel. Therefore, transmission of the PCC bits on the downlink channel suffers from two major impairments: PCC bit errors and feedback delay. The PCC bits error is represented as a multiplicative disturbance on the PCC bits, while feedback delay is represented by a delay operator of DT_p, which represents a multiple integer D of power control interval T_p as shown on the right hand side of Fig. 1. After the PCC bits are received by a mobile station, the mobile station computes the required power adjustment, Δp x PCC. The step size Δp is preset at 1 or 2 dB [7], while the PCC is either {+1, -1} in a fixed-step algorithm (q=1) or any integer between $-q$ and $+q$ in a variable-step algorithm.

The difference between the predicted and the desired *SIR* after quantization $e(i)_q$ is sent to the mobile to adjust the mobile's transmit power by Δp. $e(i)_q$ dB. Assuming the PCC bits are error free, in the absence of channel predictor, the transmit power at the next interval is

$$p(i+1) = p(i) - \Delta p \,.\, e(i-D)q \quad (2)$$

For the fixed step algorithm (q=1) the PCC bit can be expressed as

$$\text{PCC bit} = sign[e(i-D)_{q=1}] = \begin{cases} +1 & e(i-D) < 0 \\ -1 & e(\text{i - D}) \ge 0 \end{cases}, \quad (3)$$

where $e(i\text{-}D)$ is the power control error at the $(i\text{-}D)$th power control interval designating DT_p loop delay from the ith control interval.

It has been shown in [8] that the performance of power control in an actual system is limited due to non-ideal parameters of the real system, i.e. loop delay, feedback-channel error, and SIR estimation error. In this paper, feedback channel and SIR measurement are assumed to be error free, so the paper will focus on the effect of feedback delay and propose to use the improved predictor to overcome the effect of feedback delay.

Feedback delay is defined as the total time from which the channel is estimated at the receiver until the power control command is received at the transmitter and power adjustment is made. Note that in the uplink power control scheme, the channel condition is measured at the base station. Then the mobile user adjusts its transmit power according to the power-control command received from the base station to compensate for the channel. Due to the feedback delay, this power adjustment may no longer correspond to the channel condition when measurements were taken because the channel condition can change rapidly, particularly when Doppler frequency increases. Therefore, the power adjustment at the mobile user is outdated and does not compensate for the current channel condition.

The following processes contribute to the loop delay in a SIR-based power control. First, the SIR measurement is performed. It contributes a measurement delay, which is done during a period of one time slot. After the measurement of SIR is completed and then compared with the target SIR to produce the power control command bit, the command bit is inserted into the downlink data stream but may not be transmitted immediately because the downlink and uplink transmissions are not synchronized in an FDD system. This may contribute to another delay. The other delays are the propagation time of the command bit between the base station and mobile station and the corresponding processing time. Therefore, the total delay depends on SIR measurement time, synchronization between uplink and downlink transmission, processing time, and the propagation delay of the command bits transmission. Since the power control interval is standardized, the feedback delay can be expressed in multiples, D, of power control interval, T_p. A feedback delay of $D = 2T_p$ or $D = 3T_p$ is usually assumed to model a real system. Fig. 2 illustrates the condition of a real system from which the feedback delay can be determined.

Consider that a mobile begins transmitting data in the time slot 1 at time t_0. This time slot (slot 1) will arrive at the base station at time t_1, which takes $(t_1 - t_0)$ for this slot to propagate in the uplink. Then the base station estimates the SIR using data in the slot 1 of uplink transmission. The SIR measurement is completed at time t_2. In this case, SIR measurement is performed over one time slot duration. At this time, the base station compares the estimated SIR with the target SIR to produce the command bit.

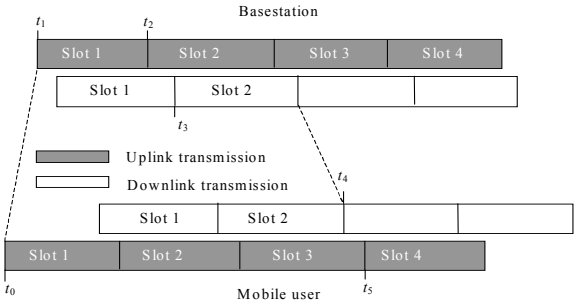


Figure 2: Illustration of feedback delay on uplink power control algorithm

As we can see from Fig. 2, the command bit should wait until time t_3 when the downlink begins transmission the slot 2. After propagating in the downlink, the command bit is received by the mobile user at time t_4, in which slot 2 of the downlink has been received by the mobile station. This mobile station then adjusts its power at time t_5 (the beginning of slot 4 transmission in the uplink). This situation leads to a total feedback delay $D = 3T_p$.

In a D-step linear prediction of order V, the predicted fading-factor is expressed as a linear combination of the previous samples $\{\beta(i - D), \beta(i - D - 1), \ldots, \beta(i - D - V+1)\}$ as

$$\beta_{pred}(i) = \sum_{v=0}^{V-1} a_v(i)\beta(i - D - v) \tag{4}$$

where $a_v(i)$, v = 0, 1, …, V-1 are the linear prediction coefficients for the i^{th} slot, $\beta(i)$ is the channel gain or the received signal strength which represents the fading factor, and D is the prediction range to reflect up to how many step ahead the prediction is conducted.

By using the orthogonal principle, the vector $\mathbf{a}(i) = [a_0(i)\ a_1(i)\ \ldots\ a_{V-1}(i)]^T$ under the minimum mean square error (MMSE) criterion can be computed as follow

$$\boldsymbol{a}(i) = \boldsymbol{R}^{-1}(i)\boldsymbol{r}(i) \tag{5}$$

Here $\mathbf{R}(i)$ is the V x V autocorrelation matrix of the input samples, whose elements are $r(i)_{v,u} = E[\beta(i - D - v)\ \beta^*(i - D - u)]$, v, u = 0, 1, …, V-1. The vector $\mathbf{r}(i)$ is the cross-correlation between the tap-input samples and the desired response. Elements of vector $\mathbf{r}(i)$ are $r(i)_v = E[\beta(i)\ \beta^*(i - D - v)]$, v = 0, 1, …, V-1. $E[.]$ is the expectation operator.

In practice, however, the analytical solution to compute the predictor coefficients $\mathbf{a}(i)$ is not recommended because it is computationally intensive due to the complexity of $\mathbf{R}$ matrix inversion and also numerically sensitive due to the fact that the matrix $\mathbf{R}$ can be ill-conditioned. In addition, the maximum Doppler spread f_D can be time varying during a call duration that is not easy to be estimated. Therefore a recursive algorithm is

preferable and in this study a recursive least square (RLS) method is used to update the predictor coefficients.

III. IMPROVED CHANNEL PREDICTION

In this section an improved power control scheme using a predictive algorithm is described. Predictive algorithm aims at predicting the future sample values using the correlation property of the past sample values. In the predictive power control algorithm, however, the correlation of past sample values is destroyed by power control updating factors.

In this study, the number of CDMA users is assumed to be large and therefore using the central limit theorem the multiple access interference is Gaussian distributed. As a result the SIR measured at the base station corresponds with the received signal strength which reflects the channel gain. However, since the received signal level or SIR has been updated by power control updating, in this paper the past power-controlled fading factor or the past SIR values, $\gamma(i - D - v)$, $v = 0, 1, \ldots, V - 1$ need to be compensated for by the same factors that were given by power control updating. The restored SIR values as input samples to the predictor can be expressed as

$$\gamma'(i-D-v) = \prod_{u=1}^{v} 10^{[e_q(i-D-u)]/10}\,\gamma(i-D-v) \qquad (6)$$

where $\gamma\,(i - D - v)$ is the power-controlled SIR, $\gamma'(i - D - v)$ is the restored SIR that can be used as the input samples to the channel predictor, and $e_q(i\text{-}D\text{-}u)$ is the control parameter to increase or decrease the transmit power reflecting the power increment step-size at the mobile station in decibel. The product term in the right-hand side of (6) indicates the total power-control gain accumulated during the v power-control interval. Therefore, the prediction algorithm can utilize the correlation property of the fading channel despite the power control updating factors.

IV. SIMULATION AND RESULTS

In the simulation, a single-cell CDMA system with the number of users $K = 10$ is considered. To reflect a practical situation, all users are considered in motion with different vehicle's speeds and thus have different maximum Doppler spreads. We model this situation by varying the users' vehicle speeds from 10 to 100 km/h at 10 km/h interval (i.e., the speed of the k^{th} user is $v_k = 10\,k$ km/h for $k = 1, 2, \ldots, 10$. Carrier frequency $f_c = 1.8$ GHz is used, so that the corresponding maximum Doppler spreads, f_D for the users are approximately ranging from 17 to 170 Hz at 17 Hz interval. The DS-CDMA processing gain is $M = 64$ and the modulation scheme is QPSK with a data rate $R_b = 120$ kbps (symbol rate $R_s = 60$ ksps in QPSK scheme). The power-update rate of 1.5 kHz is considered, which corresponds to the power control interval $T_p = 0.667$ ms. SIR measurement is performed during a period of one time slot that corresponds to one power control interval $T_p = 0.667$ ms. The chip rate $R_c = 3.84$ Mcps as given in the 3G specification for uplink data channel [9] is assumed in the simulation, resulting in each time slot to contain 2560 chips. Therefore, 40 binary symbols per time slot are available for SIR measurement. The simulation parameters is summarized in Tab. 1.

Table 1. Simulation parameters

Parameter	Notation and value
Number of users	$K = 10$
Carrier frequency	$f_c = 1.8$ GHz
Vehicle's speed of the k^{th} user	$v_k = 10.k$ km/h, $k = 1, 2, \ldots, K$
Maximum Doppler spread of the k^{th} user	$f_{D,k} = 1.67\,v_k$ Hz, $k = 1, 2, \ldots, K$
Processing gain	$M = 64$
Chip rate	$R_c = 3.84$ Mcps
Power control interval	$T_p = 0.667$ ms
Data rate	$R_b = 120$ kbps
Power update step size	$\Delta p = 1$ dB

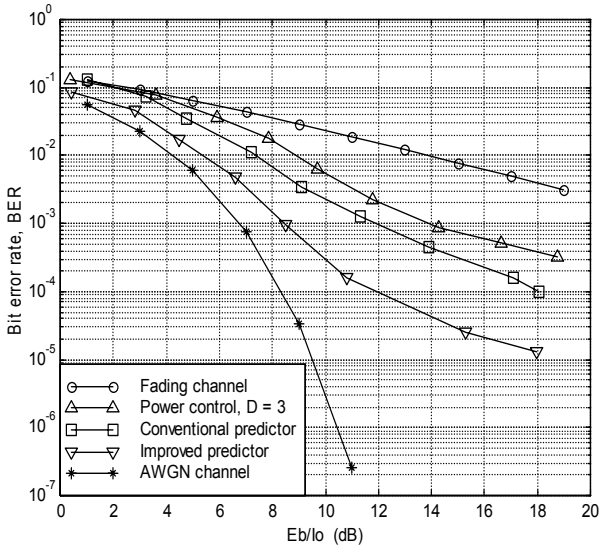
The simulation is conducted for $f_D T_p = 0.01$, and the performance is evaluated in terms of bit error rate (BER) as a function of bit energy-to-interference power density ratio (E_b/I_0). The simulation results for fixed step algorithm (q=1) and for variable step algorithm (with quantization level $q = 4$) are shown in Fig. 3 (a) and (b), respectively.

From Fig. 3 (a) and (b), we can see that for feedback delay $D = 3T_p$ the fixed step algorithm has a better performance than the variable-step algorithm. However when the channel predictor is used, the variable-step algorithm significantly outperforms the fixed-step algorithm. This can be explained that feedback delay causes the power adjustments become obsolete and irrelevant to the actual channel condition, and therefore resulting in large deviations of the SIR from the target SIR level. Since the incremental power step size in variable-step algorithm can be variable, the deviation or power control error can also be larger than that of the fixed-step algorithm. Thus, the performance of variable step algorithm degrades more significantly with feedback delay.

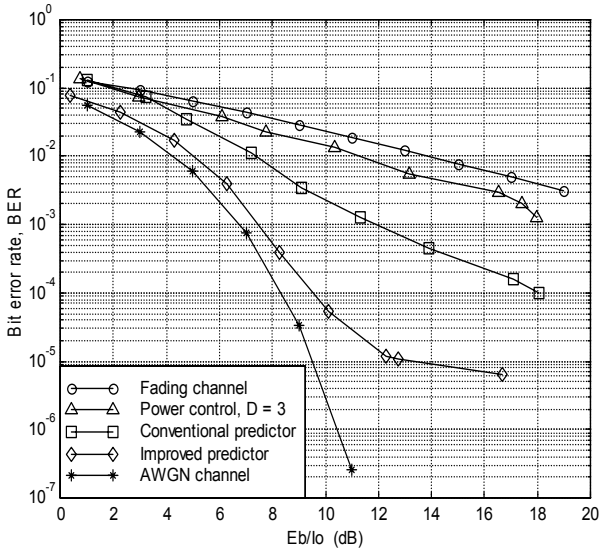
When channel predictor is used, however, the transmit power adjustments take place at the actual channel measurement time, and therefore become relevant with the current channel condition. Since the variable-step algorithm uses multiple PCC bits to convey various adjustment levels, it can better track the channel variation than that of the fixed step algorithm. Therefore, variable step algorithm outperforms the fixed step algorithm significantly when channel predictor is used.

We can also see from Fig. 3 (a) and (b) that for both the fixed-step and variable-step algorithms, the performance of channel predictor improves significantly

when the input samples to the predictor are compensated using the improved prediction method as outlined in Section 3. This is due to the fact that in the improved prediction method the channel correlation property is restored so the predictor can better predict the actual channel gain. The conventional predictor, on the other hand, uses the actual channel measurements whose correlation property has been altered or destroyed by power control adjustment factors.



(a). Fixed-step algorithm (q = 1)



(b). Variable-step algorithm (q = 4)

Figure 3. Performance of improved prediction-based power control algorithm

V. CONCLUSION

The need of power control to overcome multiple access interference of CDMA systems in fading channel environment has been presented. The performance of power control algorithm degrades significantly with feedback delay. The variable-step algorithm is shown to be more sensitive to feedback delay effect than that of the fixed-step algorithm. The effect of feedback delay in the power control algorithm needs to be overcome by using predictive algorithms. Since power control updating destroys the correlation property of the channel, the prediction algorithm needs to be compensated for by the power control updating factors in order to restore the correlation property of the input samples to the predictor.

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High Performance Time-and-Frequency Synchronization Design for DVB-T/H System

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***Abstract*—Time-and-frequency synchronization is critical point in OFDM based system such as DVB-T/H system. Synchronizer has a function to estimate and compensate for the carrier frequency and time offset of the received signal. False in time and frequency estimation will cause Inter Carrier Interference (ICI) and Inter Symbol Interference (ISI). This paper proposes high performance time-and-frequency synchronizer design, especially for DVB-T/H receiver. In order to achieve high precision of time and frequency synchronization. We employ 2 stages of synchronization. First stage is in time domain and then in frequency domain. Synchronization in time domain is performed by exploiting the Cyclic Prefix (CP) of DVB-T/H OFDM frame structure. Synchronization in frequency domain is performed by exploiting the continual and scattered pilot of DVB frame structure. Simulation results shows that proposed synchronizer can achieve carrier frequency estimation with an error smaller than 1% of subcarrier spacing. The timing estimation also avoids ISI in the receiver. The proposed design has also been verified in Gaussian, Rician, and Rayleigh Channel.**

Index terms–Symbol Timing Synchronization, Carrier Frequency Offset (CFO) recovery, DVB-T/H, C-OFDM

I. INTRODUCTION

Nowadays, Digital TV becomes a trend because it can provide more contents and better quality than analog systems. It can support more channels and provide much better quality and resolution. Many countries have already migrated from analog to digital TV system. There are several standards that have been established for digital TV, such as ATSC, ISDB-T, T-DMB, and DVB-T/H [1]. DVB-T/H is now the most popular video broadcasting technology for terrestrial and handheld devices. DVB-T is already used by over 100 countries in the world [2]. The Digital Video Broadcasting-Terresterial (DVB-T) standard has been released by ETSI (European Telecommunications Standards Institute) in 1997 . Later, ETSI released a new standard for handheld applications which is so called Digital Video Broadcasting-Handheld (DVB-H). DVB-T/H systems use Concanated-Orthogonal Frequency Division Multiplexing(COFDM) to provide a high data rate for video transmission.

In OFDM receiver, there is a problem to determine the starting point of OFDM symbols (symbol timing synchronization). It is caused by delay spread, which is produced by multipath fading condition. Symbol timing error will result in ISI. Another problem in OFDM system is the mismatch between transmitter and receiver oscillator. They don't use exactly the same frequencies which results in ICI. The demodulation of signal that contains the time and frequency offset will dramatically increase bit error rate.

This paper proposes high performance time-and-frequency synchronization design, especially for DVB-T/H system. Since DVB-T/H systems have no preamble data, we both utilize Pilots and CP for time-and-frequency synchronization. Two stages synchronization, that are in time and frequency domain, is employed to increase system performance. In time domain, synchronization is performed by exploiting the CP of OFDM frame structure. It consists of Coarse Symbol Timing Synchronization, Coarse Fractional Carrier Frequency Offset (CFO) recovery, FFT Window Selection Method, and Fine Fractional CFO Recovery. Synchronization in frequency domain is performed by exploiting the pilot of DVB frame structure. It consists only one part, i.e. integer CFO recovery.

II. SYMBOL TIMING SYNCHRONIZATION

When signals are transmitted through severe channel condition of multipath fading, pulse noise disturbance, and the Doppler Shift, it is important to solve symbol timing synchronization problem. Symbol timing error can disturb amplitude as well as the phase of received signal, which may introduce ISI. Symbol timing synchronization must be done to determine the starting point of OFDM symbol. There are two steps of symbol timing synchronization. The first is the coarse symbol timing which is executed in time domain and then FFT window selection method before FFT process.

A. Coarse Symbol Timing

Coarse symbol timing is performed by exploiting CP of OFDM frame. The synchronization algorithm is presented in [3]. The estimates are based on the simplified log likelihood function.

$$\Lambda(\theta,\varepsilon) = \left|re\{\gamma\}\right| + \left|im\{\gamma\}\right| \quad (1)$$

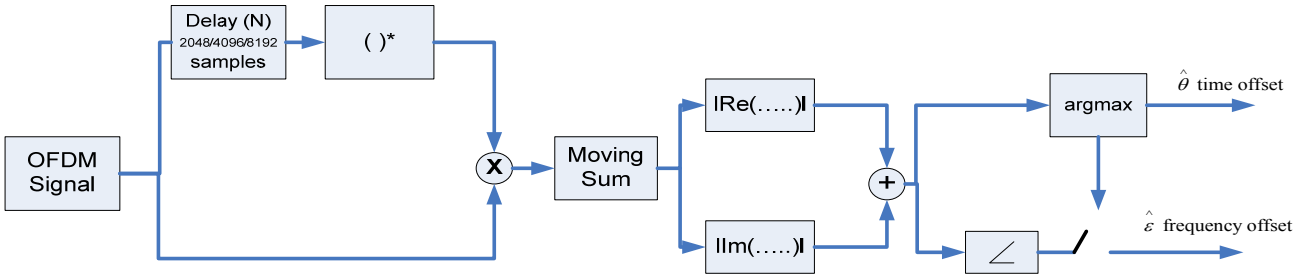

Fig.1. Simplified Maximum Likelihood Block Diagram

where

$$\gamma(m) = \sum_{k=m}^{m+M-1} r(k) r^*(k+N) \tag{2}$$

The m and N are sample index and number of subcarrier, respectively. The correlation equation above is about samples correlation per CP length fragment. It correlates samples in the first fragment of symbol with conjugate samples in the last fragment of symbol. It is performed in order to detect the starting point of symbol. The result of estimation is shown in Fig 2.

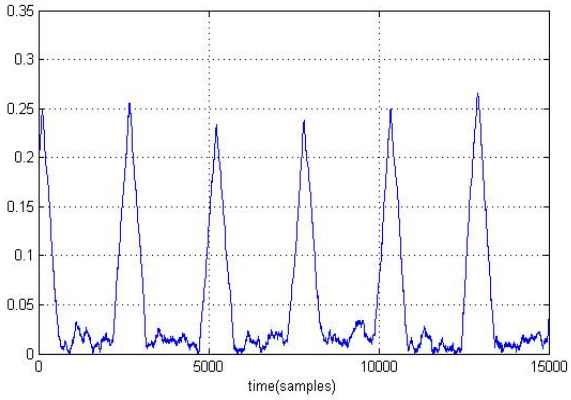

Fig.2. The result of correlation method

The timing estimation is given by log-likelihood function:

$$\hat{\theta} = \arg\max \{\Lambda(\theta, \varepsilon)\} \tag{3}$$

The complete process of coarse symbol timing with simplified Maximum Likelihood is shown in Fig 1.

This algorithm can be utilized for the joint estimation of time and frequency offset. It can be seen from Fig 1 that the phase of detected starting symbol can be used to estimate frequency offset. It is already analyzed in [8] that sufficient accuracy is obtained by using this algorithm which has also lowest hardware complexity.

In order to improve the accuracy of symbol timing estimation, we use averaging method. In system which transmit data continuously like DVB-T/H, averaging method can be used to improve the estimation accuracy because there is no stringent requirement on the acquisition time [4]. We do averaging over number of symbols that are weighted by their powers. As the averaging interval is extended, the acquired timing information is more robust. Fig 3 will show the averaging method result in three types of channel: Gaussian channel, Rician (F1) channel, and Rayleigh (P1) channel. Those two multipath channels (Rician and Rayleigh) were taken from the ETSI DVB-T standard [1]. It can be seen that in Rayleigh Channel there is a large constant error

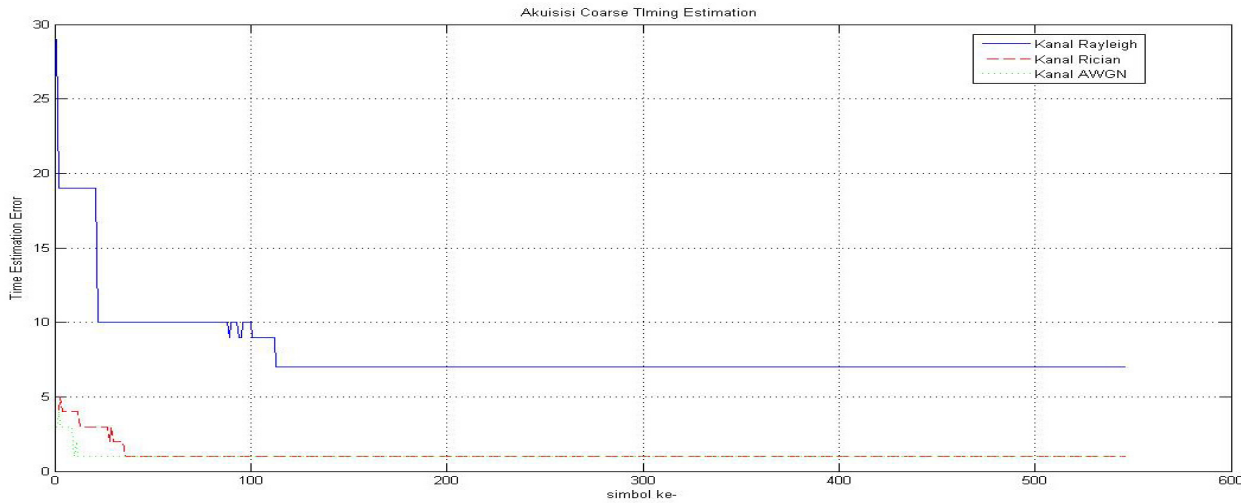

Fig.3. Coarse Timing Estimation Acquisition

about 7 samples. This large constant error in the estimation is due to the absence of a Line Of Sight (LOS) path in the Rayleigh Channel.

B. FFT Window Selection Method

From Coarse Symbol Timing estimation, there is still exist a small timing error as shown in Fig 3. Thereby, it results in the false detection of starting point in the FFT frame. This falsity causes an ISI. In order to solve this problem, FFT Window Selection Method [5] is performed after Coarse Symbol Timing estimation. The FFT window selection method is represented in Fig. 4. Some tail parts of a frame is replaced by signals before the starting point of the frame. Hence, the FFT frame is slightly modified without changing in in computations. *Tp* can be variable according to the channel delay profile. Using this method, ISI can be removed from FFT frame.

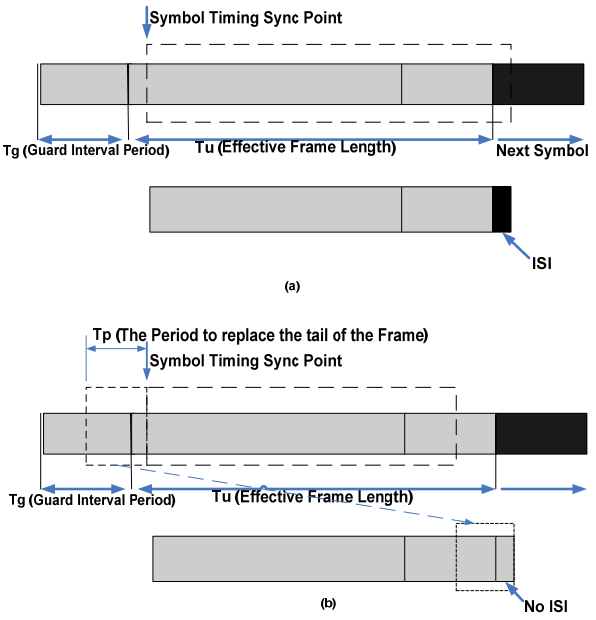

Fig.4. FFT Window Selection Method
(a) conventional (b) FFT window selection method

III. CFO RECOVERY

The CFO caused by the Doppler shift and local oscillator mismatch between the transmitter and receiver ends, may introduce ICI and destroy the orthogonality of OFDM subcarriers. As a result, large bit errors is generated. There are three steps of CFO Recovery: Coarse Fractional CFO recovery, Integer CFO recovery, and Fine Fractional CFO recovery. First, Coarse fractional CFO estimation and compensation is performed in time domain to minimize the ICI impact on the estimation in frequency domain. Afterward, Integer CFO recovery is performed in frequency domain to get the correct subcarrier index. Finally, the residual frequency offset is estimated by Fine Decimal CFO in time domain.

A. Coarse Fractional CFO Recovery

The estimation of Coarse Fractional CFO can be obtained simultaneously when the coarse symbol timing is acquired by simple maximum likelihood function (1). From the correlation result, we use phase of detected starting symbol to compute coarse frequency offset . The Coarse fractional CFO estimation is given by:

$$\varepsilon = \frac{1}{2\pi N T_s} \angle\left(\gamma(\hat{\theta})\right) \tag{5}$$

However, this algorithm has a limit. The limit is ±½ subcarrier spacing [6]. As ε →0.5 , the coarse fractional CFO estimate, may jump to -0.5 due to noise and the discontinuity of the arctangent. When this happens, the estimate is no longer unbiased and , in practice, it becomes useless.

B. Integer CFO Recovery

The Simplified Maximum Likelihood function can only detect CFO which is less than half of subcarrier spacing. However, during some operating modes, the CFO can exceed multiple subcarrier spacing. Therefore, both fractional and integer CFO need to be estimated and compensated. As the integer carrier frequency offset causes frequency shift of the receive frequency domain signals.

The following correlation function between the signal values on a set of subcarriers of consecutive symbols can be computed to detect continual pilot subcarriers[7]. It is given by:

$$\rho(k_0) = \frac{\left\langle R\left(j+1, k_p + k_0\right) R^*\left(j, k_p + k_0\right)\right\rangle}{\sqrt{\left\langle \left|R\left(j+1, k_p + k_0\right)\right|^2 \right\rangle \left\langle \left|R\left(j, k_p + k_0\right)\right|^2 \right\rangle}} \tag{6}$$

Where R(j,k) is the received subsymbol of the j-th OFDM symbol at the k-th subcarrier, <> denotes averaging over continual pilot subcarrier index kp. The integer CFO can be found by locating the subcarrier index offset K_0 with the largest $\rho(k_0)$

$$K_0 = \max_{k_0} \rho(k_0) \tag{7}$$

C. Fine Fractional CFO Recovery

After fractional and integer has been estimated and compensated, there is still exist residual fractional frequency offset. Therefore, (5) is evaluated again to recover the remaining frequency offset.

IV. TIME AND FREQUENCY SYNCHRONIZER DESIGN

It is the design of time-and-frequency synchronizer that proposed in this paper. It is shown in Fig 4. There are two stage of synchronization. First stage is in time domain and then in frequency domain. First, correlation

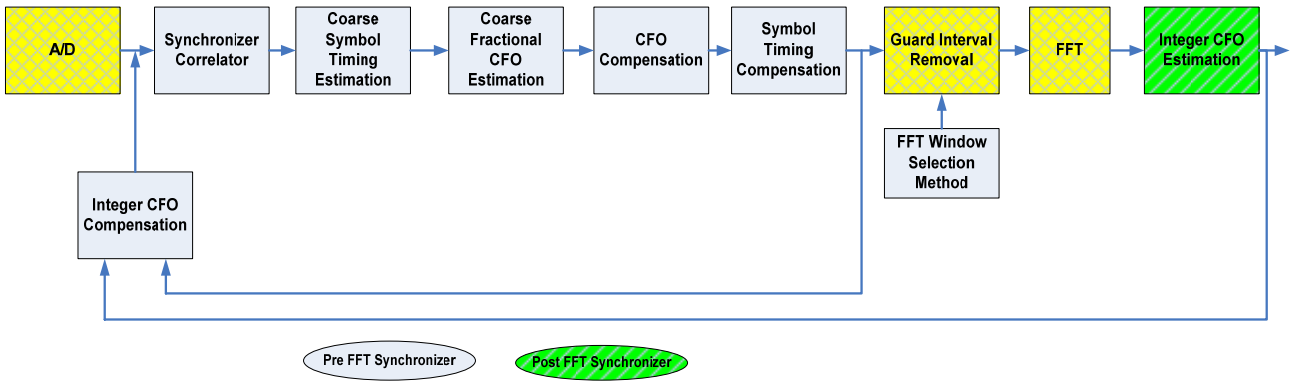

Fig.5. Time-and-Frequency Synchronizer Design

algorithm is performed and and the starting of symbol is detected from the correlation result using Simplified Maximum Likelihood function. To improve the estimation accuracy, averaging method is performed. Then, Coarse CFO is performed using the phase of detected starting symbol. After being estimated, CFO and coarse symbol timing is compensated. Before FFT processing, FFT window selection method is performed to remove ISI problem from FFT frame.

After FFT process, Integer CFO is estimated and then compensated. Finally, Fine Fractional CFO estimation is evaluated to recover residual CFO.

V. Simulation Result

In order to verify the performance of synchronizer design, baseband channel equivalent models have been established. It includes multipath fading, Doppler Effect, AWGN, CFO, and time offset. Performance Simulation is performed at three channel model. They are Rician(F1) channel for fixed reception [1], Rayleigh(P1) channel for portable reception [1], and TU6 channel model for mobile reception [9].

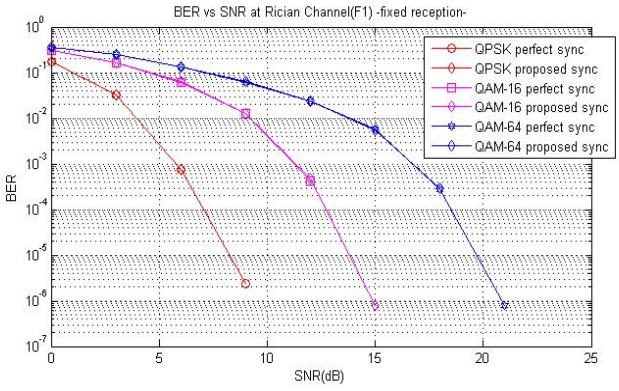

Fig.6. Performance Test of Proposed Synchonizer Design at Rician (P1) Channel

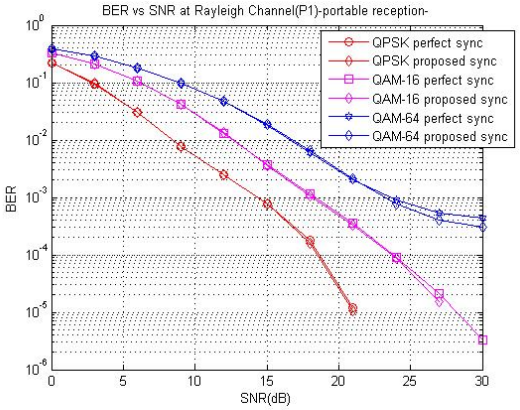

Fig.7. Performance Test of Proposed Synchronizer Design at Rayleigh (F1) Channel

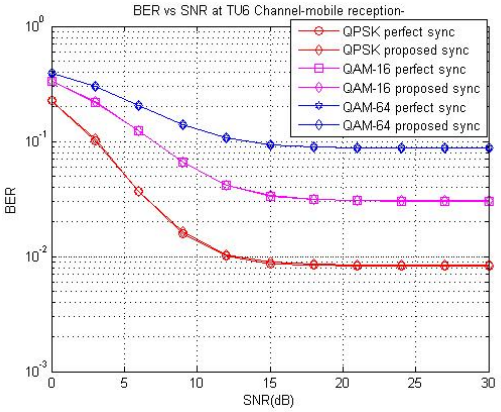

Fig.8. Performance Test of Proposed Synchronizer Design at TU6 Channel.

Table I. Simulation Condition

Transmission Mode	2K
CP ratio	1/4
Bandwidth	8 MHz
CFO	6 KHz
Doppler Frequency (TU6 Channel)	70 Hz

In this simulation, performance of proposed synchronizer design is compared with condition when perfect synchronization is achieved. The result shows that the proposed synchronizer design has a good performance in three kind of reception condition, i.e. fixed, portable, and mobile. In this simulation, mean CFO estimation error also has been calculated. It shows that proposed synchronizer design can achieve CFO estimate mean error smaller than requirement 1% of subcarrier spacing [8], i.e. 0.36%.

VI. CONCLUSION

Synchronization is critical point in OFDM based system. Synchronization error causes ICI and ISI, resulting in large bit errors. This paper proposes a high performance time-and-frequency synchronizer design, which has low complexity,but shows great performance. Coarse Symbol timing and fractional CFO recovery is performed using joint estimation algorithm which has lowest complexity[8]. The proposed design also shows great performance in fixed, portable, and mobile reception. It is already verified in AWGN channel, Rician Channel, Rayleigh Channel, and TU6 Channel Model. So, the proposed design is robust to be implemented in DVB-T/H system.

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Performance of RoF in P2P network using PSK and DPSK modulation format

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***Abstract*—Radio over fiber (RoF) systems is one of the technologies which carry microwave signals and distributed it using the optical fiber cable from the control station to the base station. The combining of wireless and optical networks is a potential solution for increasing capacity as well as decreasing costs in the network. The overall purpose of the project is to simulate the radio over fiber in point-to-point (P2P) network and compare the modulation performance of RF using Phase Shift Keying (PSK) and Differential Phase Shift Keying (DPSK). The performance of both modulation techniques are compared through simulation by using Optsim provided by RSoft. The performances are characterized through Bit Error Rate (BER) for eye opening and input power. For PSK modulation technique, the transmission power is -16 dBm, with bit rate at 1.25 Gbps and the frequency up to 1 GHz. It is found that the performance of PSK modulation is better than DPSK modulation technique in most of simulation results because it have a high sensitivity for detection and good tolerance to nonlinearity of transmission line.**

***Index Terms*—Radio-over-fiber, point-to-point, control station, base station.**

I. INTRODUCTION

Radio-over-Fiber (RoF) technology use of optical fibre links to distribute radio-frequency (RF) signals from a central station (CS) to base station (BS). In narrowband communication systems and (Wireless Local Area Network) WLANs, RF signal processing functions such as frequency up-conversion, carrier modulation, and multiplexing, are performed at the BS, and immediately fed into the antenna [1]. RoF makes it possible to centralise the RF signal processing functions in one shared CS, and then to use optical fibre, which offers low signal loss to distribute the RF signals to the BSs, as shown in Fig. 1. BSs are simplified significantly, as they only need to perform optoelectronic conversion and amplification functions. The centralization of RF signal processing functions enables equipment sharing, dynamic allocation of resources, and simplified system operation and maintenance. RoF technologies are of great interest for many potential applications such as broad-band wireless access networks, sensor networks, radar and satellite communication systems. The key function of a radio-over-fiber network is to distribute microwave and millimeter-wave signals over optical fiber to take the advantages of the low loss, low dispersion, and large bandwidth of optical fiber links [2].

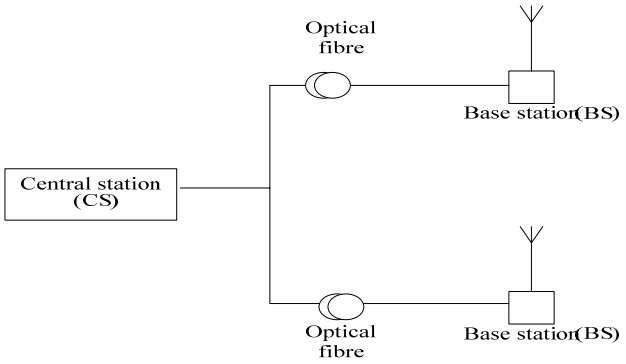


Figure 1: General radio over fibre system

In order to distribute these both RF signals (microwave and millimeter waves) there are different techniques to modulate these signals. The summarization of these techniques has been show in Fig. 2.

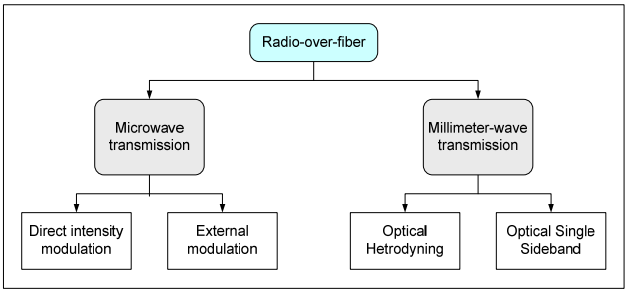


Figure 2: Microwave and millimeter-wave transmission techniques.

Under microwave transmission usually the frequency range is below 10 GHz. The frequency restriction is caused by either the electrical/optical transition or by dispersion in the fibre and the frequency limit is dependent on the length of the fibre. However for millimeter-wave the frequency range is above 10 GHz to

60 GHz. It has to meet two challenges which are frequency response of the optical to electrical (o/e) and electrical to optical (e/o) conversion functions and chromatic dispersion in the fibre. Usually from previous research in RoF, direct intensity modulation [3] and external modulation [4] are the famous modulation techniques have been applied in microwave transmission. While for millimeter-wave the modulation techniques are optical heterodyning [4] and optical single sideband (OSSB) [5].

So in this paper we presented PSK and DPSK as the modulation format in RoF systems. We use external modulation technique to compare both modulations format by using OptSim. In designing the system, the parameters such as eye opening and power transmit are been chosen against bit error rate (BER).

II. Simulation Setup

The model simulation setup for both modulation techniques are depicted in Figure 3. For DPSK modulation technique, the intermediate frequency (IF) is modulated by 2.5 GHz at 1.25 Gbps. It was generated by using CW laser source and electro absorption modulator. While for PSK modulation technique, the intermediate frequency (IF) is modulated by 1 GHz at 1.25 Gbps. The different between this simulation setup only at the demodulation input port for PSK which it require electrical carrier reference. This is because the PSK need a coherent reference signal at the receiver. While for DPSK does not require a coherent reference signal. The differential demodulator uses the previous symbol as the reference for demodulating the current symbol. The wavelength of the IF is 1550 nm. The output from optical modulator is amplified by erbium-doped fiber amplifiers (EDFA) in order to compensate the loss from the modulator modulation. The EDFA gain was fixed to 20 dB. The optical local oscillator (LO) signal is generated by using a laser diode with a wavelength of 1547 nm and CW power at 0 dBm. For DPSK, the LO frequency is set at 30-GHz and 1 GHz for PSK. After the following transmission over 50 km in fibre the signals are preamplified by SOA because as an optical signal propagates through an optical fibre, it gets attenuated and the optical power level decrease. The signal will filtered by a optical bandpass filter. The optical bandpass are designed to pass only a specific wavelength range. At the receiver, photodetector are used to converts the optical energy into an electrical current that is then processed to recover the information.

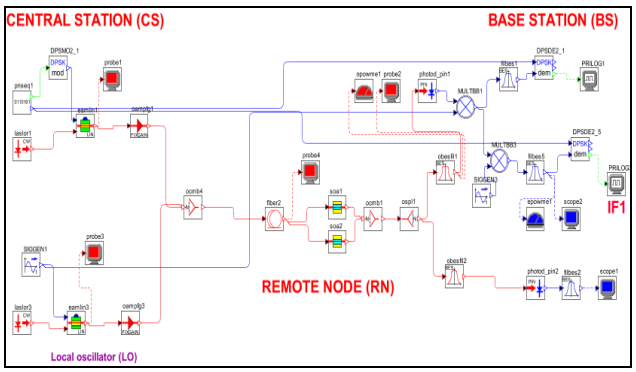


Figure 3: Basic simulation setup for RoF point to point network.

III. Results and Discussion

The simulation has been successfully simulated and the results are analyzed. In this section the results are divided into two parts to see the performance against BER

A. The Effect of power transmit on BER

The study on BER performance is carried out against the power transmits depicts in Fig.4. The power transmit range in this simulation is from -20dBm to -10dBm. At -20 dBm, the BER for PSK modulation is about 7.229×10^{-28}, while for DPSK modulation is 1.74146×10^{-17}. It shows that the patterns for both modulation techniques are the same. In practice a minimum requirement BER is from 10^{-9} to 10^{-12}. From the graph, the suitable power transmit is about -16dBm. This system is suitable in wavelength division multiplexing (WDM) technique. In WDM fibre radio networks have the potential to provide high bandwidth wireless access to a large number of users, using the high capacity offered by WDM optical networks. Other than that, this PSK modulation technique requires less power transmit which can reduce the optical power budget. However, for this study, the system only designs for single intermediate frequency (IF) to see the comparison between two different modulation formats.

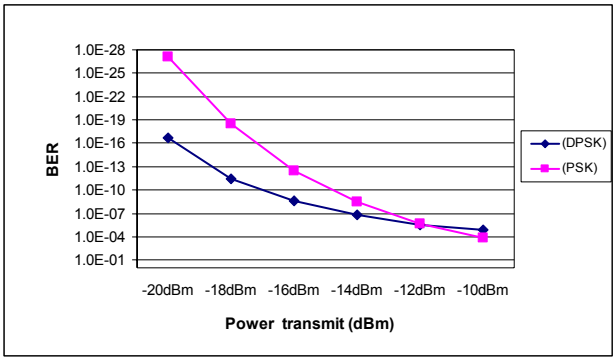
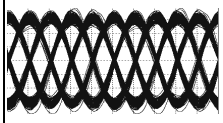
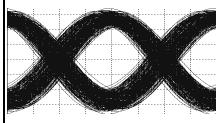
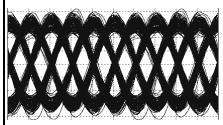
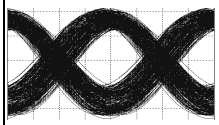
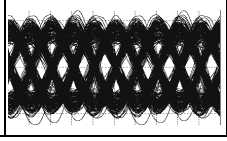
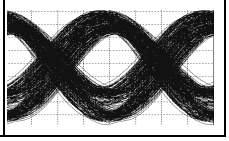


Figure 4: BER versus power transmit at 1.25 Gbps for DPSK and PSK modulation techniques

B. Eye opening

Table I shows the eye opening is taken from several samples in order to see the different effect on BER against the eye opening. For both modulations, as the BER increased the eye openings become closer. Other wise, when BER is low the wide opening can be seen in the results. It means that the percentages of bits that have errors in the transmission are less. Thus the decreased values of BER make the eye open very well.

Table I. Eye diagram at different BER for both modulation techniques.

BER	Eye opening for PSK modulation	BER	Eye opening for DPSK modulation
10^{-28}		10^{-17}	
10^{-13}		10^{-9}	
10^{-6}		10^{-6}	

IV. CONCLUSION

Recently RoF is becoming trend for many researches in today's optical wireless communication field. This is because this technology intended to provide broadband wireless communications for mobile users. From the finding it concludes that the modulation technique is playing a role to overcome the transportation problems in RoF system. By looking at both modulation format , it shows that the PSK format gives better performance because it have high sensitivity for detection and good tolerance to nonlinearity of transmission line. In contrast with DPSK, the information is encoded in differential phase shifts so it is more sensitive to the phase noise. Because of these negative aspects, DPSK has not been considered as a good transmission format. Future work need to be done at different kind of networks and other modulation format to see the system limitation and practical implementation of the RoF system.

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Located Bloom Filter

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***Abstract*—Even though the bloom filter has got a false positive, it is widely implemented because of its compactness and O(1) time complexity; However, if we want to save keys from the different location into the bloom filter, the bloom filter can not differentiate the location of keys that have been entered. To overcome this problem, researcher proposes to concatenate the key and its location identifier before saving it into the bloom filter. Meanwhile, this paper proposes to solve this problem by hashing the key and its location identifier separately, and then converting the hash code to the bit position of the bloom filter, after that merging the value of the bit position of the key and its location identifier. Based on the experiment, proposed bloom filter outperforms the previous research in term of the computation time while the false positive rate is not significantly different.**

***Index Terms*—Algorithms, Data structure, bloom filter, Experimentation.**

I. INTRODUCTION

Bloom filter is firstly introduced by Bloom [1] as a table look up. The bloom filter is widely used when the information is searched in a huge data collection in a short time O(1) and to save space for data storage, but the search process allows a false positive results[1]. However, Bloom filter was not popular with a number of researchers due to its false positive weakness. The implementation of the Bloom filter and its variance depends on the needs. Some implementation uses those advantages of the bloom filter to decrease the searching process and the bandwidth usage of the computer network [2,3,4,5] while others focused on how to reduce the false positive rate [6,7].

For other implementation that needs not only tell whether something is there but also where it comes from, the basic architecture of the bloom filter has to be modified. For example, previous researcher in [7] tried to concatenate the block of payload and its offset before entering into the Bloom filter, so that the block of payload and its location can be detected. This paper proposes to solve the same problem, but in the different area and using different architecture. For instant, if we want to implement a single bloom filter for the index of the informed P2P, it needs not only to know whether the keyword is there but also the peer where the keyword comes from. Other example, if we want to save term from different paragraphs and then we want to find in what paragraph a term comes from, the bloom filter has to be able to differentiate the paragraph where the term come from.

Instead of concatenating the keyword and its location identifier as the input of hashing process [7], this paper proposes to hash and convert the key and its location identifier to the bit position of the bloom filter separately; and then merge the value of the bit positions to be the final value of the bit position. This idea comes from the fact that the longest computation time of the bloom filter is in the hashing process [8]. Based on the experiment, proposed bloom filter outperforms the previous research in term of the computation time while the false positive rate is not significantly different.

This paper is organized as follows. Section 2 describes the proposed architecture of the Bloom filter while the result and discussion is presented Section 3. Finally, Conclusion and future work are given in Section 4.

II. PROPOSED BLOOM FILTER ARCHITECTURES

The characteristic of Bloom filters is the trade-off between size of bloom filter m and false positive rate f, for fixed number of keys n and hash functions k [3]. After insertion of n keys into a table with size m, the probability value of a bit still having 0 value is:

$$\left(1-\frac{1}{m}\right)^{kn} \tag{1}$$

So that the false positive for this condition is

$$f=\left(1-\left(1-\frac{1}{m}\right)^{kn}\right)^{k} \tag{2}$$

For large value of m, Eq.2 reduce to

$$f\approx\left(1-e^{\frac{-nk}{m}}\right)^{k} \tag{3}$$

value k in practice is integer, so that the k in above equation can be approached by the integer value that is the closest to the theoretical value. Based on Eq.3, it can be argued that the false positive rate is not depended on the kind of hash function and structure of the bloom filter

if the bit positions, results of hash and modulo function, are normally distributed. In other word, if it can be chosen hash functions that have normal distribution and each hash function is implemented in the bloom filter, it must be expected that those bloom filters will produce equal false positive rate. Based on this argument, it is possible to redesign the architecture of the bloom filter without affecting the value of the false positive.

The basic architecture of the bloom filter has two stages; first stage is to hash the input string to be numerical code, and second stage is to convert the numerical code using function of modulo *m* to bit positions of the bloom filter. Based on where the location identifier will be merged, it can be created three models. The first one is to concatenate the key and its location identifier before hashing process like in [7]. The first one is named as ORI (see Fig.1). The second one is to hash the key and its location identifier separately and then concatenating them. The second one is named as MODI-I (see Fig.2). The last one is to hash the key and its location identifier separately, and then each hash code is converted to be the bit position of the bloom filter, finally merge them. The last one is named as MODI-II (see Fig.3).

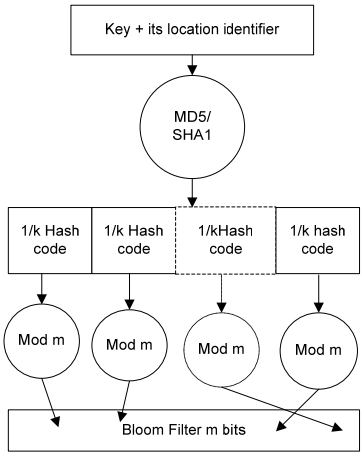

Figure 1. Architecture of ORI

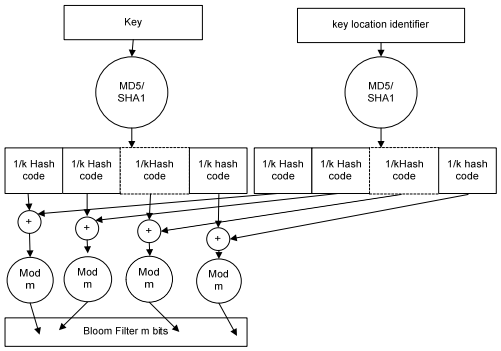

Figure 2. Architecture of MODI-I

The last two architectures are expected superior the first one in terms of computation time. This argument is based on the idea of omitting the redundancy of computation in the hashing process of the keys and its location identifier. For instance, if there are *q* keys that have to be searched in *p* locations, the hash function operation can be decreased from *q* x *p* times in ORI to *q* + *p* times in the MODI-I or MODI-II architectures. Moreover, if the location identifier is static it can be hashed offline, so that the hash function operation is *q* times.

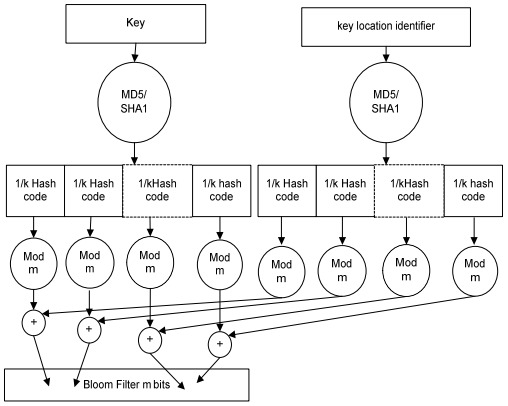

Figure 3. Architecture of MODI-II

III. EXPERIMENTAL RESULT AND PERFORMANCE EVALUATION

A. Evaluation Criteria

This paper uses metrics to evaluate the performance of the bloom filter architecture. Those metrics are false positive rate and computation time. This paper is not use space of storage as a metric because all bloom filters architectures have same space complexity. Therefore, the best architecture is the architecture that has the smallest false positive rate and computation time.

The false positive rate of a bloom filter is counted based on following equation

$$f = \frac{c}{n} x100\% \tag{4}$$

where *c* is the number of collision keys and *n* is number of keys entered into the bloom filter. The collision key is occurred if two or more unique keys are hashed and produce the same bit position of the bloom filter.

The computation time *T* is processing time started from the first key until the last key entered into the bloom filter. It can be expressed by following equation

$$T = \sum_{i=1}^{n} t_i \tag{5}$$

where *t* is time that is needed to convert a key to bit position of the bloom filter.

B. Experiment Design

To test the false positive rate of the bloom filter, a set of unique keys has to be prepared. The unique keys are created from the text document by using a word parsing technique.

To explore the characteristic of the bloom filter, it is needed to test the bloom filter in various values of *m*, *n*, and *k*. The size of a bloom filter *m* is chosen arbitrary while *n* is determined based on how much the density of keys or *n/m* that will be taken. This arrangement is taken in order to make a constant ratio between a number of keys and the length of the bloom filter for various values of *m*. The size of bloom filter is fit to memory size of computer system. Therefore, the range of the bloom filter length is 8192, 16384, 32768, 65536, 131072 bits and the range of keys is 5, 10, 15, and 20 percent of bloom filter length. Meanwhile, the range of the number bit position *k* of the bloom filter is between 2 and 10. Although the false positive rate of the bloom filter, theoretically, does not depend on the type of hash function (see Eq.3), in this paper, the bloom filter will be tested in two types of the hash function such as MD5 and SHA1. These hash functions are chosen based on the fact that SHA1 has the lowest computation time in SHA family [8]. In MD family, the MD5 has a hash code length nearest to a hash code size of SHA1 . Finally, the range value of the number of location is taken from one location until 100 locations incremented by 5 locations. The location identifier is orderly generated.

The experiment is conducted as follow:

1. The false positive rate testing
   for all bloom filter architectures do
      for all *k , m* do
         for all *n* do
            enter key and its location identifier into the bloom filter
            record every collided key
         Calculate the false positive rate
2. The computation time testing
   based on Fig.4 the value of *k* is 4,5,6
   for all bloom filter architectures do
      for all *m* do
         for all location identifier do
            for all *k* do
               start timer
               for all *n* do
                  enter key and its location identifier into the bloom filter
            stop timer
            calculate computation time

C. Experiment Result

The aim of this research is not to determine the best value of *f* and *T*, but to determine the best architecture in terms of *f* and *T*. Therefore, the comparison is conducted in the average value of *f* and *T*. Based on Fig.4, it can be concluded that all architectures have got nearly similar false positive rate if the value of *f* is minimum, except MODI-I-MD5. On the other word, there are not significantly different of *f* and *T* among the proposed bloom filter architectures, except MODI-I-MD5 (see Table. 1).

Table 1. Average false positive rate in % for k=4,5,6

Bloom Filter Architecture	k		
	4	5	6
ORI-MD5	0.71936	**0.674398**	0.738386
MODI-I-MD5	30.01483	**26.86226**	31.50124
MODI-II-MD5	0.691522	**0.657621**	0.689131
ORI-SHA1	**0.655978**	0.687554	0.709889
MODI-I-SHA2	0.675572	**0.666397**	0.708954
MODI-II-SHA3	0.728783	**0.684557**	0.710576

Based on Fig.5, it can be concluded that the MODI architectures outperform the ORI architecture either for MD5 or SHA1 hash function. Fig.6 is zooming of Fig.5 to show the different between MODI-I and MODI-II. Based on Fig.6 it can be concluded that MODI-II outperform MODI-I architecture. Finally, based on Fig.7 it can be concluded that the MODI-II-MD5 architecture outperform the MODI-II-SHA1 architecture.

For overall, it can be concluded that MODI-II-MD5 is the best architecture among the architectures under evaluation.

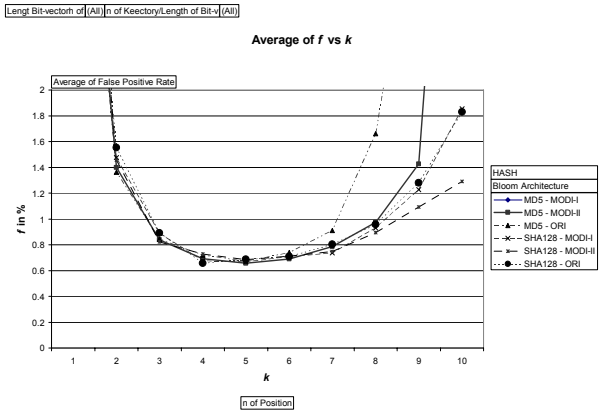

Figure 4. False positive rate characteristic of the bloom filter

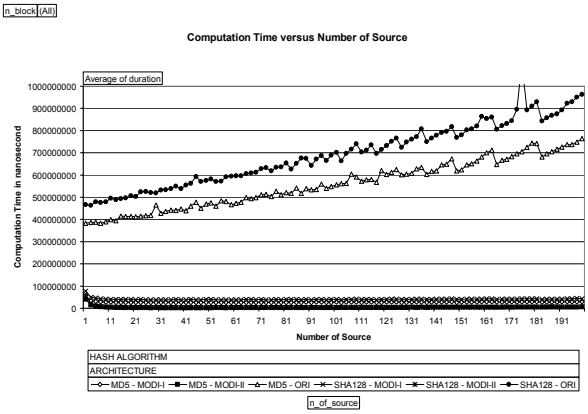

Figure 5. Computation time characteristic of the bloom filter

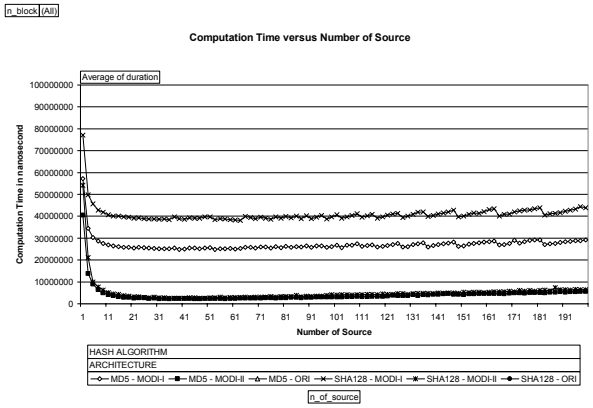

Figure 6. Zooming Figure 5

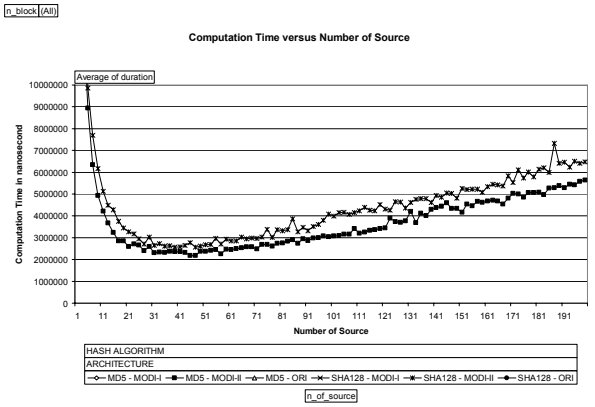

Figure 7. Zooming Figure 6

IV. CONCLUSION AND FUTURE WORK

A problem to know the location, owner, or origin of the key that is saved in the bloom filter can be solved by merging the key and its location/owner/origin identifier. To reduce the computation time, this paper proposes to omit the redundancy of computation in the hashing process of the key and its identifier. Based on the experiment result, it can be conclude that the proposed MODI-II-MD5 architecture outperforms the other architectures in terms of the computation time, while the false positive rate is not significantly different. The speed of computation can be increased more if the location identifier is static so that it can be hashed off line.

Based on the experiment it also can be concluded that the hashing process has significant impact on the computation time of the bloom filter. Therefore, there is still open research to decrease the speed of computation time by choosing another hash function with the false positive rate as a constraint.

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Cross-Selling's Product Determination in the Context of Analytical CRM Based on Association Rules

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***Abstract*—Cross-selling's product determination achieves through out an analysis of purchasing data by using business intelligence tools such as data mining. Data mining is part of Analytical CRM used to discover data pattern, while market basket analysis method with association rules technique are a data mining task used to discover the candidate of cross-selling's product combinations, based on frequent products in purchasing data.**

***Index Terms*—Cross-Selling, Customer Relationship Management (CRM), Association Rules.**

I. INTRODUCTION

Business competition has encouraged a trading company to be more selective on implementing their marketing strategy. Cross-selling's marketing strategy, as part of Customer Relationship Management (CRM) could be used as an alternative way. Sales transaction is possible to be increased by selling additional products from the main product that customer has purchased.

The determination of cross-selling product from sales transaction data as well as the techniques that will be used for Analytical CRM. Steps include source data identification, cross-selling modeling, choosing algorithm, correlation analysis, and result presentation through internal website.

II. TRANSACTION DATA

Identification is the first step in cross-selling product determination is to know business process that currently run in the company. As mention in previous chapter, PT XYZ is a trading company which has widely range products. Sales and distribution has supported by ERP (enterprise resource planning) which integrate all of company activities.

Implementation of cross-selling product determination will increase revenue in a row with selling of additional product that is derived from its base product. The final result of this research is cross-selling model through sales transaction data analysis by using association rule in order to support decision making process as well as determine best marketing strategy effectively and also enhance customer loyalty.

Data source identification must be performed in next step. Database is relatively uniform since has extracted from ERP's database server. In ERP system, there are many databases which also contain thousand tables and attributes. Each database handles divisions or business process in a organization, such as customer database, inventory, finance, sales and marketing, human resource, etc. Database that will be used is extracted from subject area sales.

Sales transaction data in 2007 is used to determine cross-selling strategy. One branch of PT XYZ is choosen. However, this branch have not implemented business intelligence tools such as data warehouse. Therefore, data mining task will directly mining database that came from OLTP (online transaction processing) (Tang and MacLennan, 2005).

The company's product offering are very diverse (selling more than 1000 different items) which is divided into five division. They are Industrial/Graphic Art, Telecomunication, Photography and Photofinishing, Ricoh, and Medical. Sales area covers South Sumatera, Bengkulu, Jambi, and Bangka Belitung. Their major customer include agent, sub-agent, and other business-to-business customer such as printing company, hospital, publishing company, and so on that in round numbers 400 customers. Some products are listed in the table below that are categorized by division.

For this study, not all sales transaction data will be involved in determining cross-selling product, however, only products that contained one of the top 50 products (how many times purchased, not how many quantity that have been sold). In 2007, the company had sold approximately 4674 different products to 400 customers. Sales transaction will be divided into two periods of time. Data in first semester (January-June) will be used as experiment and data in second semester will be used as evaluation. Top 50 product in first semester

III. ANALYSIS OF CROSS-SELLING'S PRODUCT DETERMINATION

After we choose the products that will be used, we try to determine possible combination of all products. The method of Market basket analysis and product affinity

analysis will be performed. Actually, association rule technique will be used in order to find product association or combination through transaction data (Bugher, 2000).

In association technique, there are three different indicators such as support score, confidence score, and improvement score. Support score specify frequent of two product appears in a transaction, confidence score indicate one product is dependent to other product, and improvement score specify customer to be more likely buy cross-selling's product from base product.

It is likely to produce the best cross-selling product from the total of transaction each customer in certain period is the item with high confidence score. As an example the first product is the combination of A and B with confidence score of x% mean that when product A is bought, possibilty product B is also bought equal to x% from the entire period of transaction. The second indicator that should be decided is support score which decides how many products of A and B appear in the entire of transactions simultaneously. As an example, the combination of Product C and D have support score y% indicate that product C and D appear simultaneously egual to y% from the entire of the total of transaction, whereas to combinate product E and F . It has an improvement score ≥1. indicate that product E and F is a positive correlated, means that if the customer buys product E, the customer also agrees to buy product F, whereas if improvement score<1, product E and F is a negative correlated. Product with negative correlated can not be concluded as a suggestion in determining cross-selling product although having support score and high confidence score.

IV. SQL Server 2005 Analysis Service

Tools which are used to analyze is SQL Server 2005. SQL Server 2005 Analysis Service has an ability in making data mining with knowledge discovery task such association rule and other tasks which have predictive character. First step in processing data mining in SQL Server 2005. It is used to compare tables data transaction result is copied into table format so easy to be known by SQL Server 2005. It only recognizes the concept of nested table to present a variable length where a group of attribute related to the same case. Kind of representation table concept is nested from SQL Server 2005 as follows:

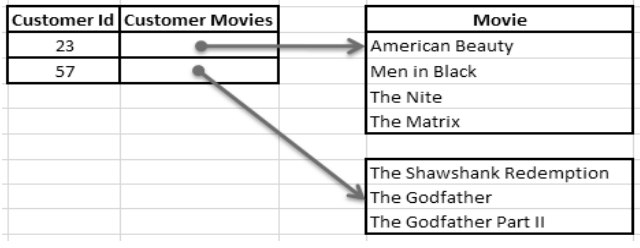

Figure 1: Example of nested table in SQL Server 2005 (Iyer and Jesper, 2004)

In this PT XYZ study case, selling data transaction on each customer is grouped into tables of owning three columns that is transaction column id, type of goods and type of good's name. this data is grouped on each customer transaction in making purchase at PT XYZ during range of time. Here is a represtation nested from purchasing transaction on each customer which is used in this study case

TRA_ID	TYPE_BARANG	NAMA_TYPE_BARANG
1	AA13161	CRYSTAL 80 5 X 610 G
1	AA13163	CRYSTAL 80 5 X 610 L
1	AA13165	CRYSTAL 80 5 X 610 M
1	AA13169	CRYSTAL 80 6 X 610 L
1	AA13173	CRYSTAL 80 8 X 295 L
1	AA3141	14834332 SUPER CONDITIONER 100 TABLET
1	AA3278	850086 CN16L/Q N4R 4X4 L
1	AA3284	CP49E REPL
1	AA70075	KAMERA AVEC
1	AA70116	KAMERA BONA ZOOM+2 NS 400/36+BATT
1	AA70122	KAMERA BENEV SILVER+2 NS 400/36+BATT+FB
1	AA7120	FILM WARNA NEW SUPERIA 200/36
1	AA7195	FILM WARNA NEW SUPERIA X-TRA 400/36
1	AA8024	SLING BAG
1	AA9171	AMPLOP FIS
1	AK4997	PAKET VATICA 3R (12 BUAH)
2	AA13161	CRYSTAL 80 5 X 610 G
2	AA13173	CRYSTAL 80 8 X 295 L
2	AA3015	850123 CN-16Q NQ1R 10LTX2
2	AA3016	850045 CN-16Q NQ2R 8LTX2
2	AA3284	CP49E REPL

Figure 2: Nested Table of Transaction Data of PT XYZ

V. Conclusion

Investigating in order to determine the cross-selling's product, in which explained in this paper, is valid for a trading company in the fields of medical, printing, telecommunication, photography, and photocopy. The Transaction data used is sales transaction data for 2007, in which extracted from their ERP system. Combinations of best cross-selling's products were chosen by order ranking of all possible products in descending order by their confidence score. Evaluation is discussed by comparing the cross-selling's product determination using January-June transaction data and validate each product combinations by comparing July-December data.

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Optimized Sampling with Clustering Approach for Large Intrusion Detection Data

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***Abstract*—Data mining is a process of discovering useful information from a data set. In data mining, there is a classification technique that depends on sampling accuracy to acquire a more accurate result in data classification or prediction. Therefore, a necessity in getting a good-quality sampling is required. The primary purpose of this research paper is to obtain the optimum sampling representing the original data set. Through sampling, we could minimize the total data that need to be processed. Because large amount of data requires longer processing time, reducing the amount of data with sampling will speed up the process of computing. In this study we introduced a new sampling algorithm with clustering approach applied to a network security data set. Preliminary results showed that proposed method offer fine result for large data set sampling.**

***Index Terms*—sampling algorithm, clustering, network security data set.**

I. INTRODUCTION

Nowadays, data mining is adequately popular in the information sciene area. The data culitivation is purposed to get the knowledge of data. Data mining is normally (but not limited to) dealing with large datasets and commonly employed in marketing, intrusion detection, surveillance, etc.For data that has many records, we may well use sampling in the data preprocessing step to lower the amount of data to be processed.

Sampling is a process of colleting several data which should represent the original data [1]. As the beginning of data exploration, sampling is also intended to gain maximum knowledge from the whole data set. Moreover, sampling also has immense influence to the final result of data analysis.

In recent years, a number of sampling algorithms have been introduced and proposed. The basic one is simple random sampling algorithms. According to Mc Call [2] "a **simple random** sample is one in which all elements of the population have an equal probability of being selected". Certainly, the sample will be selected in a random order. Sometimes simple random sample works acceptably for a certain types of data. Nevertheless, the problem of simple random sampling is when facing a large data set, it is often difficult or impossible to identify every element of the data, therefore extracted samples is usually not representing whole characteristics of the entire data set.

Another sampling algorithm is stratified random sampling [3]. In this method, data will be divided in to several strata such as ages, genders, and etc. The sample will be drawn in random order within each stratum, and each element must be assigned only into one group. In taking the random sample units, number of drawn samples has to be proportional to the size of the partition.Stratified sampling performs better than simple random sampling, since the sample will be represented all existing cases of the complete data set. On the other hand, this method would not be effective in non-homogeneous groups.

Currently, it is still difficult to find a proper way in getting a better sample from a large data set. Time consuming is a common problem that often shows up when we want to process a large data set. Yet, sampling is still required to diminish the processing time. Additionaly, accurate samples would influence final result of the data analysis. Therefore, it is critically important to have samples which represent the characteristics of the entire data set.

The aim of the study is to introduce a new sampling algorithm which obtains samples not in a random manner, but by considering similarity between data as well. The proposed algorithm will have capability in grouping data with similar characteristic and acquire the most representative data sample from every data collection as an output.

II. DESIGN AND IMPLEMENTATION

Our proposed method is an optimized sampling based on a clustering approach. Clustering approach is a technique to group data into some collections by taking

into account similarity of data described by its features. There are some examples of clustering algorithms which are known, i.e. K-Means clustering and ECM (Evolving Clustering Method). These methods are described in section 2.1 and 2.2 since it will be the foundation of the clustering process in our algorithm which will be elucidated in section 2.3

A. K-Means Clustering

K-Means clustering was introduced by J. McQueen [4]. K-Means is identified as one of the simplest and quietly efficient clustering technique. The prime principal of K-means is to define number of clusters to be created, *k* that appropriate for the data set. K-Means defined a model in terms of centroid, which is usually the mean of a group of points. The K-Means clustering algorithm works in three basic steps, as follow:

- **Step 1**: Determine the c or centroid coordinate .
- **Step 2**: Determine the distance of each object to the centroids, usually by using Euclidean distance.
- **Step 3**: Group the object by searching the minimum distance of centroid and the object.

First step of the algorithm is to decide how many clusters should be created to classify the data set. Next, the location of the centroid will be placed in randomly and certainly, the number of centroid will be matched (suited) with the sum of cluster that has been defined before. Then, distance between the centroid with each object is calculated, and the minimum distance will be determined. The new object then will be assigned to the centroid with the minimum distance. Basic approach to find distance between an object and each centroids is by implementing the Euclidean distance. After which, recalculate again distance between the centroid and all members inside the group and update the centroid position. Do the iteration until the object does not move group anymore.

Although K-Means clustering is quietly very simple and efficient, it also has some weaknesses in performing clustering which are; (1) the number of *k* must be determined by the user beforehand so the total cluster will depend on the user, and (2) it cannot handle data with different size.

B. Evolving Clustering Method - ECM

ECM (Evolving Clustering Method) is proposed by Song [5]. ECM is a dynamic clustering algorithm. An evolved node in an on-line form could represent a cluster centre of a distance based clustering method. Many clustering algorithms cannot update the cluster centre when a new data arrives. On contrary, ECM is able to renew the cluster centre and can as well create new clusters when new data come. It has been proven that ECM performs better compare to the other classic clustering methods (i.e. K-Means) and it can adapt to the changes of characteristic on the new data [5]. Steps of ECM algorithm are explained as follow:

- **Step 1**: Data point that comes first will be assigned as the first cluster with radius equal to zero.
- **Step 2**: The algorithm will be end when all data have presented. In case there is still incoming data, calculate the distance between the new point and all cluster centres.
- **Step 3**: If the distance between new point and a cluster centre is less than or equal with the cluster radius, the new point will be included into that cluster without changes the cluster centre or cluster radius. Then go to step 4
- **Step 4**: Calculate s distance which is the distance from new point to radius from each cluster. Find the minimum distance from every cluster (*Smin*).
- **Step 5**: If Smin > 2*threshold, the new point will be not entered to any cluster. Then, the new point will make a new cluster with radius = 0. Then go to step 2.
- **Step 6**: If Smin <= 2* threshold, the new point will be entered to that cluster, so the cluster centre and the radius will be updated. The new radius = *Smin*/2, and the new cluster will be located between the new data and the old cluster center where distance of new cluster center to new data = new radius.

ECM uses the Euclidean distance to calculate distance. ECM is a dynamic clustering method and has capability to apply a good optimization. Moreover, some clustering and classification problems can be solved by using ECM [5]. Hence, in our proposed algorithm we employ ECM as the core clustering algorithm.

C. Optimized Sampling Algorithm with ECM

In this part, the sampling algorithm that we propose based on clustering approach is described. The clustering method will be employed to a group of data with similar characteristic. Consequently, each cluster will have different interest to the other clusters. Therefore, the sampling procedures will be performed in each cluster. It aimed to acquire representative sampling as the sampling tasks has covered all data with different characteristics in which of those has been grouped into clusters. The sampling algorithms which is proposed in this study, is described as follow:

- **Step 1**: Partition the data into various groups based on the class label of each data records. Data partitioning can be done based on, for example, gender, age, etc. In this study, data will be partitioned based on intrusion types in KDD CUP 1999 data. There are 23 types of intrusion which are defined as class labels in the data set as listed in table 1.
- **Step 2**: Apply clustering process with ECM to each partition created in Step 1.
- **Step 3**: After clusters have been created as result of

the clustering process, sample is drawn from each cluster in every partition.A number of data which have the shortest distance to the centroid will be chosen as samples. These data are expected to represent the corresponding cluster.

- **Step 4**: Final step of the algorithm is to combine entire samples which have been drawn from each cluster in every partition.

Table 1. Variety intrusions in KDD CUP 1999 data

No	Label	total_conn
1	back	2,203
2	buffer_overflow	30
3	ftp_write	8
4	guess_passwd	53
5	imap	12
6	ipsweep	12,481
7	land	21
8	loadmodule	9
9	multihop	7
10	neptune	1,072,017
11	nmap	2316
12	normal	972,780
13	perl	3
14	phf	4
15	pod	264
16	portsweep	10,413
17	rootkit	10
18	satan	15,892
19	smurf	2,807,886
20	spy	2
21	teardrop	979
22	warezclient	1020
23	warezmaster	20

Figure 1 illustrates how the complete data set is partitioned and how samples are drawn from each cluster centre.

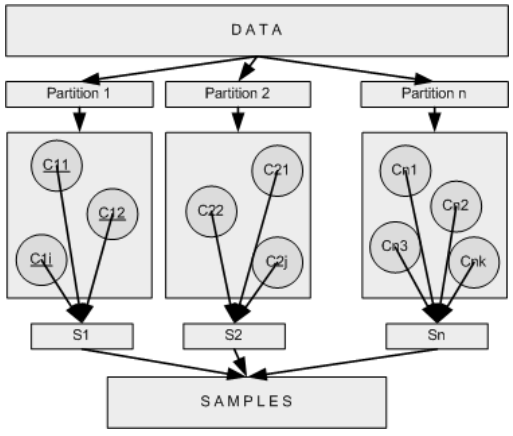

Fig 1. Illustration of how data set is partitioned, and how cluster centres are use as sample.

Validity of sampling results will be tested with statistical approach. The accuracy of the sampling will be measured from the data distribution of the samples compare to data distribution of the complete data set.

To calculate data distribution value, we employ standard deviation calculation as follow:

$$s = \left(\left(\frac{1}{n-1} \right) \sum_{i=1}^{n} (x_i - \bar{x}) \right) \quad (1)$$

where $$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \quad (2)$$

and n is number of elements in the sample. The sample is indicated to be closer with the mean when the standard deviation is low. If the standard deviation from the sample is closest with the entire data, we can assume that samples are representing the original data set.

III. Experiment and Discussion

In the experiment conducted to test the algorithm we have used KDD CUP 1999 data set [6]. KDD CUP 1999 data set is an intrusion data set which is used for The Third International Knowledge Discovery and Data Mining Tools Competition.This data is collected from raw TCP dump data. 42 attributes is mentioned in KDD CUP 1999. The data has a huge number of records which is around 4 million records. We aim to obtain samples with a size of 10-15% from the actual number of records. We believe with approximately 400,000 data samples, we could cover all data characteristics existing in the 4 million records

The KDD CUP 1999 data are not only formed in numerical ways, but also in form of combination of numeric and non numeric data (categorical data set). This categorical data should be labeled with a numeric values (regarding to distance calculation process in ECM). Therefore we labeled the categorical data with 1,2,3,4 and so on, for every object in categorical data. Another way to label categorical data is using 1-of-c coding [7] which we intend to implement in our future work.

As a first experiment, we took a sub-space of the KDD CUP 1999 data set as our real data and applied our proposed sampling algorithm on it. The first data we took was 729 data records. During the experiment data size will be increased step by step. Complete KDD CUP 1999 data set was not appropriate to be used because of resource and time limitation in conducting the experiment. This data as we have mentioned before, will be partitioned based on the intrusion type.

Some clustering algorithm works better with less but more significant attributes, therefore in this study we reduced number of attributes in the data set using a feature selection algorithm [8]. The main reason to this is

that we would like eliminate features that have less information in describing the data. The method of feature selection that we used is supervised filtered attributes with best first method. As the output of the feature selection algorithm, we got 9 attributes as the most informative attributes out of 42 attributes. Nevertheless, please note that there is a possibility the feature selection algorithm would give different output if the number of data is changed.

Our proposed algorithm uses ECM as its clustering method therefore it is required to define the minimum distance before the clustering process is started. In this experiment, we used 0.05 as a distance threshold. As a result the algorithm extracted 249 clusters from 729 data records which are divided into 23 partitions. Each cluster centre then taken as sample, thus number of drawn samples is approximately 34.15%.

Table 2. The results of attribute selection

No	Attributes name	Description
1	service	network service on the destination, e.g., http, telnet, etc.
2	flag	normal or error status of the connection
3	src_bytes	number of data bytes from source to destination
4	dst_bytes	number of data bytes from destination to source
5	land	1 if connection is from/to the same host/port; 0 otherwise
6	wrong_fragment	number of wrong fragments
7	num_root	number of root accesses
8	countx	number of connections to the same host as the current connection in the past two seconds
9	srv_count	number of connections to the same service as the current connection in the past two seconds
10	diff_srv_rate	% of connections to different services
11	dst_host_ srv_count	number of connections from the same host with same service to the destination host during a specified time window
12	dst_host_same_ src_port_rate	% of connections to same service ports from a destination host
13	dst_host_srv_ diff_host_rate	% of connections to the same service from different hosts to a destination host
14	dst_host_ rerror_rate	% of connections that have REJ errors from a destination host
15	label	attack types

note: to get complete description of KDD CUP 1990 data set attributes please refer to [9].

Next step we increased number of data to be sampled to 5,000 records. We re-applied the feature selection algorithm again and 15 attributes were chosen out of 42 attribute (shown in Table 2). In this second trial, we intended to have number of samples to be around 10.0-15.0% of the total records. We finally achieved 249 clusters from 5,000 records by setting the distance threshold value to 0.04. This gave us a number of samples approximately 9.2% of the whole data set. Additionally, we changed the distance threshold to 0.03 and received 620 clusters, which is around 12.4% out of the complete data set. Complete result of the experiment is shown in Table 3.

On the other hand, after the data is clustered in each partition, we found that there are several data that have different characteristic in every partition such as “smurf” since the standard deviation is still high (shown in Table 3). It shows that ECM can handle data with different interest and various characteristics are represented in the clusters formed by ECM.

Table 3. Cluster result in each partition, dthr = 0.03

No	Intrusion Type	Cluster	Std Dev.
1	back	36	4.5768
2	buffer_overflow	20	0.3999
3	ftp_write	7	2.5520
4	guess_passwd	18	11.0370
5	imap	12	5.1157
6	ipsweep	34	0.4318
7	land	12	1.5332
8	loadmodule	8	2.5453
9	multihop	7	2.5519
10	neptune	99	0.3190
11	nmap	38	0.3503
12	normal	113	0.3278
13	perl	3	11.1721
14	phf	3	2,116.8165
15	pod	33	2.5382
16	portsweep	34	0.3311
17	rootkit	9	2.5643
18	satan	43	0.3618
19	smurf	5	65.7723
20	spy	2	11.3022
21	teardrop	34	10.9822
22	warezclient	40	2.5539
23	warezmaster	10	2.5544
	Total Cluster	620	

Nonetheless, we recognize that the centroids of each cluster created by ECM are not a real data. The cluster center in ECM clustering is the result of mean calculations from all data samples which are belong to the cluster. Therefore, we believe that if we are able to find data samples in a cluster which have the shortest distance to the centroid, and use these data as drawn samples, we would be able to increase the sampling accuracy. In calculating the distance between data samples and their

centroid the Euclidean distance as describe in equation 3 can be employed.

$$d(x,y) = \sqrt{\sum_{k=1}^{n}(x_k - y_k)^2} \quad (3)$$

IV. Conclusion and Future Works

We have proposed a new algorithm that shows the ability to take a sample not in a random order, but by considering similar interest infatuated by data in the identical group. In this initial version of our proposed algorithm, samples are taken from the centroids of the clusters, which are the mean calculation of all data belong to the cluster. Yet, experiment results showed that the standard deviation of drawn samples can be considered to match the standard deviation of the complete data set in an acceptable degree, therefore we can conclude that the algorithm performs quite well for the KDD CUP 1999 data set.

As for future work, we would like to extend the algorithm to draw samples which are not the centroid of the cluster, but by taking into account those data in the cluster which are the closest ones to the centroid. Furthermore, we would like to investigate the possibility of using different method in labeling categorical data in order to observe if it would have any effect on the sampling results.

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Knowledge Extraction from the Semantic Web

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***Abstract*—Accessing and extracting knowledge from online documents is crucial for the realization of the Semantic Web and the provision of advanced knowledge services. The project is an ongoing investigation tackling these issues to facilitate the creation of tailored material course in the e-Learning management system from information harvested from the web. In this paper we will present the methods we currently use to model, consolidate and store knowledge extracted from the web so that it can be re-purposed as adaptive e-Learning content. We look at how Semantic Web technology could be used within this process and also how such techniques might be used to provide content to be published via the Semantic Web.**

***Index Terms*—Semantic Web, Knowledge, Course Learning**

I. INTRODUCTION

The growth of the World Wide Web and the corpus of documents that it covers has increased the demand for content to be annotated to facilitate systematic search, discovery of knowledge and intelligent information processing.

Accessing and extracting knowledge from online documents is crucial for the realization of the Semantic Web and the provision of advanced knowledge services. The collation of ontologically structured information from distributed web sites would pro- vide the needed infrastructure for a variety of new services including the reconstruction of the original source material in new ways.

The project seeks to create dynamic course in the e-Learning management system by harvesting material of learning from the web, using the information to automatically populate ontologies, and then reconstruct these annotated fragments based on user preferences using story schema [10].

Annotating existing Web documents forms one of the basic barriers towards realizing the Semantic Web [9, 15]. Manual annotation is impractical and unscalable, while automatic annotation tools are still in their infancy. Hence advanced knowledge services may require tools able to search and extract the required knowledge from the Web, guided by a domain conceptualization (ontology) that specifies what type of knowledge to harvest.

We believe that the tools we are developing to generate our internal knowledge structures for e-Learning management system could also be used to automatically annotate existing pages for the Semantic Web.

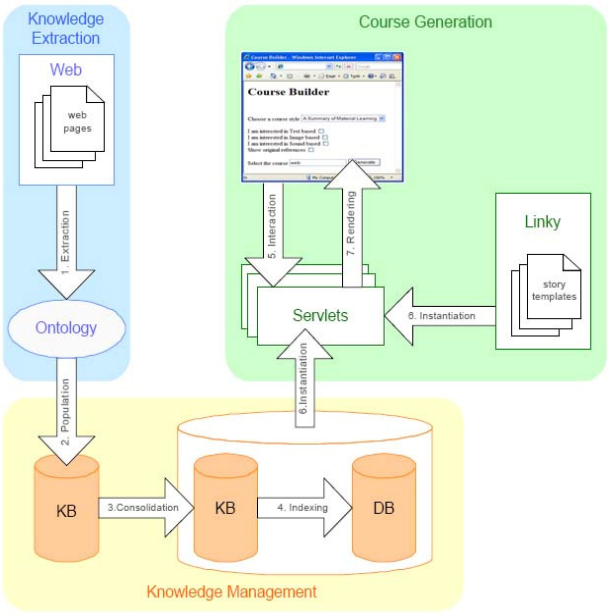

Figure 1. The Project Architecture

II. SYSTEM OVERVIEW

Figure 1 shows the key components of the project architecture. These can be broadly classified into three groups.

- Knowledge extraction tools: The knowledge extraction tools are used to extract factual information items together with sentences and paragraphs from web documents. This information is coded up in RDF.
- Knowledge management and storage: The RDF information is stored by the ontology server and consolidated into a structured knowledge base. Database indexes are used for speed of access to the original web-based content.
- Course generation: Course e-Learning templates are used to structure queries into the knowledge and data bases. On user request the templates are instantiated and adaptive web pages produced.

Figure 2 illustrates a typical user interaction with the project system. In the initial screen the user enters the

name of the course and selects a type of material e-Learning to generate, they also enter any preferences. If there is more than one course in the knowledge base that matches the search criteria, the course is presented with a choice, shown in the second screen shot. Finally, once the user has selected the generated material learning is displayed for them.

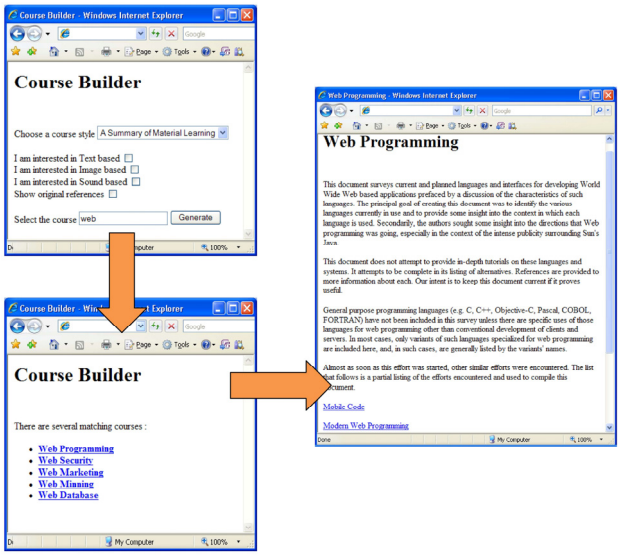

Figure 2. Course Builder Web Interface

III. KNOWLEDGE EXTRACTION AND MANAGEMENT

Ontologies play a significant role on the Semantic Web with respect to semantic enrichment and interpretation [2]. For Project the ontology represents the domain of course and material learning used to structure the extracted information. The main part of this ontology was constructed from selected sections of the Conceptual Reference Model (CRM) ontology [5]. Project uses Altova, a graphical ontology editing tool [7]. Altova provides an option to define ontology definitions in RDF Schema (RDFS) and has basic ontology reasoning capabilities. The extension of RDFS as a way of increasing ontological reasoning services for the full-fledged Semantic Web is exemplified in [3].

A. OWL

Part of the W3C's Semantic Web activity has been to define the Web Ontology Language (OWL). Defined using the Resource Definition Framework (RDF), OWL allows the formal definition of an ontology and provides the syntax for declaring instances of defined classes.

Eventually it is hoped that most information on the web will have an OWL representation (or similar structured metadata) and that the reliance on current extraction algorithms will be reduced. However, even if Semantic Web technology becomes pervasive, extraction tools will need to be employed to help people create OWL conformant documents and also to allow information extraction software to deal with the inevitable legacy information that is not marked up.

Original Sentences

Web Programming has 2 categories that is client side and server side. Client side need web browser like Internet Explorer, Opera or Mozila Firefox. Example languages programming for client side are HTML, CSS, and Javascript. Server side need web server like Internet Information Services (IIS) or Apache. Example languages programming for server side are ASP, JSP, PHP and CGI-Perl.

```
<kb:Course rdf:intro="&kb;Course_1" kb:name="Web Programming" rdfs:label="Course_1">
   <kb:has_categories rdf:resource="&kbCategory"/>
</kb:Course>
<kb:Course rdf:intro="&kb;Category" rdf:about="&kbCategory" rdfs:label="Category">
   <kb:category_1="&kb;Client_Side"/>
   <kb:category_2="&kb;Server_Side"/>
</kb:Course>
<kb:category_1 rdf:intro="&kb;Client_Side" kb:name_tools="Web Browser" kb:example="
Internet Explorer, Opera, Mozila Firefox" rdfs:label="Client_Side">
   <kb:has_client_programming_language rdf:resource"&kb;Client_Programming_Language"/>
</kb:category_1>
<kb:category_2 rdf:intro="&kb;Server_Side" kb:name_tools="Web Server" kb:example="
Internet Information Services (IIS), Apache" rdfs:label="Server_Side">
   <kb:has_server_programming_language rdf:resource"&kb;Server_Programming_Language"/>
</kb:category_2>
<kb:Client_Programming_Language rdf:intro="&kb;Client_Programming_Language"
kb:example="HTML, CSS, Javascript" rdfs:label="Client_Programming_Language">
</kb:Client_Programming_Language>
<kb:Server_Programming_Language rdf:intro="&kb;Server_Programming_Language"
kb:example="ASP, JSP, PHP, CGI-Perl" rdfs:label="Server_Programming_Language">
</kb:Server_Programming_Language>
```

Figure 3. RDF representation of a paragraph

B. Information Extraction

Information Extraction (IE) is one of a number of promising methods for enriching Web-based documents with semantics for the purpose of future semantic interpretation. However, the time and effort needed to manually annotate large numbers of pages and the prerequisite of templates that stipulate which types of information are extractable are major challenges of exploiting such extraction techniques [15].

It is well-known that information on Web pages use effectively limitless vocabularies, structures and composition styles for defining approximately the same content. This makes it hard for any IE technique to cover all variations of possible writing pat- terns. More importantly, traditional IE systems lack the domain knowledge required to pick out relationships between the extracted entities, which is essential for adding expressivity to the Semantic Web.

These observations lead us to the use of an ontology coupled with a general-purpose lexical database, WordNet [13] and an entity-recogniser, GATE (General Architecture for Text Engineering [6]) as guidance tools for identifying knowledge fragments consisting not just of entities, but also the relationships between them. Automatic term expansion based on WordNET is used to increase the scope of text analysis to cover syntactic patterns that imprecisely match our definitions.

When a user searches for course, if the given course is new to the KB, the Information Extraction process is run. A script submits the query to search engines (currently we use 'Google', 'Altavista' and 'Yahoo'). In order to select only related Web pages (as opposed to pages which may match the search criteria but are concerned with other topics) we use keywords extracted from trusted sites as a basis for measuring similarity between the query and the search results.

In order to construct semantically rich information, it is necessary to extract binary relationships between any identified pair of entities to gather structured collections of information [2]. Therefore, knowledge about the domain specific semantics is required, and can be inferred from the ontology. Project submits a query to the ontology server to obtain such knowledge. In addition, three lexical chains (synonyms, hypernyms, and hyponyms) from WordNet are used to reduce the problem of linguistic variation between syntactically different entities.

By providing the IE process with direct access to the concepts and relations in the ontology, our approach is applicable across more than one domain.

The output RDF representation (Figure 3) is submitted to the ontology server to be inserted into the KB. It would be possible to use this RDF to annotate the existing pages for the Semantic Web.

C. Automatic Ontology Population

Some semi-automatic approaches have investigated creating document annotations and storing the results as assertions in an ontology. For example, in Vargas-Vera [14], relationships were added automatically between instances only if these instances already exist in the KB, otherwise user intervention is needed. Handschuh et al [8] describe a framework for user-driven ontology-based annotations, enforced with an IE learning tool; Amilcare [4]. However, the framework lacks the capability of identifying relationships reliably.

In the project we investigate the possibility of moving towards a fully automatic approach of feeding the ontology with knowledge extracted from the Web. Information is extracted in the project with respect to a given ontology (e.g. the artist ontology described earlier), and provided as RDF files, one per document, using tags mapped directly from names of classes and relationships in that ontology (Figure 3).

One of the difficulties that arises when extracting similar or overlapping information from different sources is the consolidation of duplicate information. Tackling this problem is important to maintain the referential integrity and quality of results of any ontology-based knowledge service [1].

IV. COURSE GENERATION

While the Semantic Web promises to ease the problems of machine interaction, many of its applications will be attempting to sort, arrange and present information to people. Ontologies are appropriate vocabularies for machines, but human beings need a more natural interface.

Story telling provides this kind of intuitive mechanism. We can consider the structured information on the Semantic Web (consolidated by a system such as project into a knowledge base) as the underlying story, waiting to be told. The fragments of text in the knowledge base can be re-ordered and combined with generated sentences to produce an eventual discourse, personalized to a particular reader and drawing on the resources of many Semantic Web sites.

The system uses course learning templates to arrange the information in the knowledge base into a narrative. It then renders that into a DHTML page so that the personalized material learning can be displayed in a web browser.

Course Learning Templates

The structures we use to arrange the material for course learning templates that contain queries into the KB. The templates are written in the Fundamental Open Hypermedia Model (FOHM) [12] and stored as XML in the Linky contextual structure server [11]. As the templates are stored in a structure server they can be retrieved in different contexts and thus may vary according to the user's preferences and experience.

Each learning course is a tree of sub-structures and queries. The most common structure is a sequence, this represents a list of queries that should be instantiated and rendered in order. Each query uses the vocabulary of the project ontology to discover fragments of text concerned with a particular aspect of the artist's life. Other structures allow for more complex behavior. Concept structures are used to group alternative queries together, any of which may be successfully used at that particular point in the material learning. A Level of Detail (LoD) structure is similar, but orders the queries so that the most preferable is given the highest index.

The fact that fragments of text are associated with facts in the knowledge base is useful as it allows real text to be used in the final biography in preference to generated text. These fragments have been extracted from existing larger texts and so contain elements of discourse (focalization, tense information etc.). We are currently looking at how we might detect these attributes to ensure that the generated course is consistent.

As the attributes of existing text might preclude it from being used the project system also allows the knowledge base to be queried directly and basic natural language generation to be used to render them into the course. This might also be useful for facts in the knowledge base that have been inferred (and for which there is no corresponding text).

The story renderer uses the information in the knowledge base to keep track of which facts are being placed into the text during generation. In this way it can minimize repetition. It uses the structures of the template to chose which content to display by default but also uses Adaptive Hypermedia techniques to optionally reveal other content which may be relevant (using stretch text and dimming secondary fragments).

V. CONCLUSION

The system discussed here integrates a variety of tools in order to automate an ontology based knowledge acquisition process and maintain a knowledge base with which to generate customized course learning.

We believe that the automatic course learning generation approach presented here should be applicable to other domains with few changes.

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Frequent Episode Rules Using Compressed Frequent Pattern Data Tree Structure

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***Abstract*—In a swiftly grown network environment, network security is often a big concern in developing a system which is highly persistent against any attack attempts. One of the most severe attacks against network environment today is the distributed attacks. In counter-attacking against these threats, the current prevention technique is inadequate to mitigate the situation. Therefore we propose a new solution as an enhancement technique to counter security threats by using a technique called Frequent Episode Rules mining (FER). The reason we choose FER is because of its capability in analyzing patterns in inter-transactional records. FER also has the virtue of enabling real-time environment implementation which most other data mining techniques doesn't accommodate. In addition, this FER technique is best implemented using Compressed Frequent Pattern Tree Data Structure (CT-PRO). Since CT-PRO has the capability of providing efficient memory usage and swift mining process against any other association techniques, FER will be best suited to be implemented in this system. Therefore, this paper will mainly discussed on the reasons and proof of experiment on why Frequent Episode Rule (FER) data mining technique is efficient and effective in CT-PRO.**

***Index Terms*—Data mining, Frequent Episode Rules, Association Rule Mining, Data Structure, Network Security.**

I. INTRODUCTION

In a network traffic across the World Wide Web (WWW), we encounter a abundant data flow from one point to another point. Among these data, we encounter either normal data or malicious data that needs to be judged by a network security system[23].

The malicious data in a network system is hazardous to a server machine since it has the potential to bring the system into low performance and reliability. Hence, the Intrusion Detection System (IDS) has been introduced as a combat system against incoming malicious data into the network. In addition, many network security applications under Intrusion Detection System (IDS) have been purposed as alternative approach in judging whether the data is normal or attack [10], [11], [12].

One of these systems is the Anomaly Detection System (ADS) which role is to detect any anomalous sequence of data in reference to the normal profile that the Anomaly Detection System (ADS) has calculated from the previous normal data that occurred in a given time [10], [11], [12], [13], [14], [15], [16].

This system uses data mining approach to calculate normality profile behavior by using association rule mining to generate normality rule to be later compared with the incoming data across the network [18], [19]. Any incoming data that is out of the boundary of normality profile behavior will be considered as a intrusion attempt by the system.

One problem in this implementation, however, is the huge amount of normal data that occurs in a network traffic that creates hardware capacity and performance issue [18], [19]. There is a necessity to establish an optimal algorithm that will mine the normal data and create a summary of normal data called normal profile to be later used as a reference to detect any anomalous data that occurs in the network traffic.

Many algorithms can be used to optimize the system approach. Frequent Itemset Mining (FIMI) is a fundamental approach used in association rule mining (ARM). It calculates which item set is significant enough in a transaction data. It classified item set into frequent, closed, and maximal [1]. Any item set that is not in any of this classification will be pruned or in other words, not significant to the transaction. Frequent Itemset Mining (FIMI) has a virtue called the downward closure property [1]. This means that when an item set is considered infrequent, then for all subset of that particular item set must also be infrequent [1], [2], [3].

However, Frequent Itemset Mining (FIMI) doesn't have the capability of recognizing the order of sequence. In network traffic, it is very important to preserve the order of data sequence coming to the network. This order is important since we are interested in the sequence of data that makes a data pattern becoming an attack.

Apparently, Frequent Episode Rule (FER) does this job effectively. By preserving the order of data sequence, this algorithm can detect the data pattern that will be useful to determine normal profile behavior in the Anomaly Detection System (ADS) [18], [19]. Also, Frequent Episode Rule (FER) has a distinct feature over Frequent Sequential mining which rely on the attributes of an

event. In contrast of Frequent Episode Rule, Frequent Sequential mining finds every relationship in each event and between events, creating huge combinatorial explosion [21].

However, Frequent Episode Rule has one vital drawback. In previous research, Frequent Episode Rule (FER) is implemented using Apriori method. This method still resulted in overpopulated frequent item sets which are a waste of memory usage. There is a necessity to use an effective system to implement the Frequent Episode Rule algorithm.

Hence, a data structure algorithm called Compressed Tree is introduced as a non-recursive method in generating frequent item set. Called CT-PRO, this system is considered a lightweight system and can handle large item set efficiently [6]. CT-PRO has a great potential in memory usage handling and thus, a great system to be implemented by Frequent Episode Rule algorithm.

In conclusion, we propose the implementation of Frequent Episode Rule Mining (FER) using Compressed Tree (CT-PRO) data structure as an approach to optimize auditing the abundant data into a summary of relatively small data that can represent all the data without degrading its accuracy in respect to all the data analyzed. The idea behind this algorithm is finding the relationship between data in a sequence of data set.

II. Related Works

In the first proposal of assosiation rule mining [1], [2], [3], patterns are extracted from frequent associate item in individual transaction. This approach is the most widely used association method for discovering information from transaction data. The primary virtues in using this approach are its simplicity and easy to understand compared to the other approaches.

Many have proposed new techniques as well as its implementation variants in association rule area that are derived from this approach. Apriori, FP-Growth [20], CT-Pro [6], and Tree projection [22] are some noted variants association rule implementation that are derived from this technique.

However, this association rule mining itself has its drawback. It is incapable of mining patterns from inter-transaction record which is a crucial feature especially in analyzing real-time data such as in the network security aspect [20]. For example, discovery or acknowledgement the presence of Distributed Denial of Service (DDOS) attack from network log can only be extracted from finding patterns of more than one connection [18], [19]. There is a necessity of implementing an enhance association rule mining algorithm which can detect parallel connections which are attacking the network. In the research of this algorithm, some has proposed new techniques to extract rules from multi-transaction record. And the commonly known approaches of this technique are Sequential Mining and Frequent Episode Mining.

In this paper, we focus our interest in the implementation of association rule mining from multi-transaction data. We mainly focus on implementing Frequent Episode Rule (FER) technique using CT-Pro tree structure [6]. This reason why this approach is selected is because CT-Pro can efficiently mine rules from large data set with its compactness and efficient memory usage in comparison to other approaches.

III. Frequent Episode Rules & Compressed Tree Structure

A. Frequent Episode

Frequent Episode Rule (FER) mining is a concept of presenting and finding the relationship patterns in a transactional data. This concept offers inter-transaction support rule generation which mostly uncommon in standard Association Rule (AR) mining [20].

To generate rules in FER, the first thing to be done is determining the set of event sequence, window size and minimum support. Event sequence is a set of events occurs within a specific time range with each event is associated by the time of occurrences. Window size is the interval used to capture event sequence to detect inter-transaction property within transactions. In addition, minimum support is the minimum occurrence of an event that is allowed to be considered frequent. All frequent event sequences are considered significant to the rule extraction process [18], [19].

To better understand how Frequent Episode Rule works, let's first introduce the notion of inter-transaction and episode rules.

Definition 1. Given a set E of event types, an event is a pair of $(A; t)$, where $A \in E$ is an event type and t is and integer, the (occurrence) time of the event. An event sequence s on E is a triple $(s; T_s; T_e)$, where $s = \langle(A_1, t_1), ..., (A_n; t_n)\rangle$.

An event sequence s is a set of event in transactional data as a partial set to project event and its occurrences. Each event is in ordered sequence according to its timestamp such as $A_i \in E$ for all $i = 1, ..., n$, and $t_i \leq t_{i+1}$ for all $i = 1, ..., n - 1$. In addition, the time t_i of and event occurrences must not exceeding the interval of the event sequence, such as $T_s < t_i < T_e$ for all $i = 1, ..., n$. An event E also may consists of several attributes A_i, where $E = (\{A_1, ..., A_n\}; t)$.

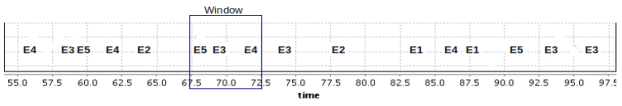

Figure 1. Event sequence T_{55} - T_{97} with window size 5s

Example 2. Given an event sequence, such as $s = (s; 56; 96)$ as in Figure 2.1, where

$s = \langle(E4, 56), (E3, 58), (E5, 60), ..., (E3, 93), (E3, 96)\rangle$

Event sequence s is a collection of event E, such as each event has an ordered timestamp and unique characteristic. In this example, we have five types of event which occurs at specific time t_i in given interval $T_{55} < t_i < T_{97}$. In addition, each event may occur in more than one time occurrences. For example, an event $E1$ occur in ‹(A, t_{83}); (A; t_{87})› such that $T_{55} < (t_{83}; t_{87}) < T_{97}$.

Definition 3. Let s be an event sequence as in example before, and given a window w of size win. A window is a partial event sequence in a full set of s, such as $w \subset s$. Each window has a form of triple (ω, t_s, t_e), where $t_s < T_e$ and $t_e > T_s$, and ω also consists pair of (A; t) from s such that $t_s < t < t_e$.

The timespan t_e - t_s is called the width of window, where it is denoted *width* (w). And the number of windows in given sequence s with window size win is a form of W (s, win) on such *width* (w) = win. The formulation can be calculated as follow.

$$W(s, win) = T_e - T_s + win - 1$$

A window w with width of win contains all event (A, t) in a given event sequence s where the occurrences t must not exceed the boundary interval, such as $t_s < t < t_e$. The interval of window is changing overtime, which it increment by sliding itself in event sequence from the first occurrence of the first event to the last occurrence of the last event. In each sliding process, a window only increment in one given time increment threshold to and each window is overlapping each other.

Example 4. Given a sequence s as in Figure 2.1, and window w with width win of 5s, such as

$$w(n) = (\omega_1, t_{52}, t_{57}), (\omega_2, t_{53}, t_{58}), \ldots, (\omega_n, t_{97}, t_{102})$$

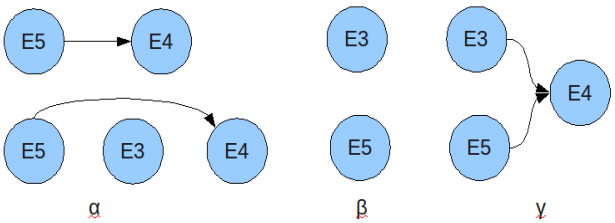

Figure 2. Three different episodes α, β, and γ

$$W(s; 5s) = T_{97} - T_{55} + 5 - 1 = 46$$

From the formulation above, it can be determined that, there are 46 overlapping windows in event sequence s in the form instance of $w(s, T_{55}, T_{97})$. And from each window, there are partial event sequences where each event E has a time occurrence in the respective window interval. For example, in window w of (w, t_{67}, t_{72}) as in Figure 2.1, we can extract sequence of events as following:

$$‹(E5, t_{67}), (E3, t_{69}), (E4, t_{72})›$$

Definition 5. An episode is an inter-association among event which extracted from event sequence s, where the episode is extracted from specific window w of given width win. Let α, β, and γ are instances of episode, where each instance may be in serial, parallel or combination respectively.

Serial episode α is an episode where occurrences of each event E must be in ordered according to its time of occurrence in window w. In the sequence, there can be another event that occurs between the serial events. As in figure 2.2, let $E5$ and $E4$ are an event in serial episode α, where $E5(t) < E4(t)$. The relation of $E5$ and $E4$ can be called as serial episode because event $E5$ must occur before event $E4$. In addition, there may be another event that occurs between event $E5$ and $E4$, such as event $E3$ in figure 2.2.

Parallel episode β is an episode where there is no constraint in the occurrence of its event. The episode β is simply inter-association between events in given window w. In figure 2.2, a parallel episode can be illustrated as association of events which occurs simultaneously in specific window w without having ordering constraint.

Combination episode is an episode which the occurrences of event in left-hand side L or right-hand side R may be in parallel and events in L must occur before the event in R, where $L(t) < R(t)$.

An episode can be defined formally as a form of (V, ≤, g) where V is a set of nodes, ≤ is a partial order on V , and $g : V \rightarrow E$ is a mapping association each node with its event type. This interpretation of episode is that each event in $g(V)$ must occur in order according to the partial order V of the episode.

An episode α is called parallel if the partial order of the events in $g(V)$ is trivial (*i.e.*, $x \not\leq y$ for all $x, y \in V$ such that $x \neq y$). Episode α is a serial episode if the partial order ≤ is a total order (*i.e.*, $x \leq y$ or $y \leq x$ for all $x, y \in V$). Episode α is called an injective episode if there is no events in V (g) occurs twice.

Timestamp	Event	Timestamp	Event
1	25	9	35
2	21	10	75
3	36	11	96
4	69	12	70
5	93	13	69
6	21	14	94
7	32	15	31
8	6	16	32

Table I. Event Sequence Database Timestamp t and Event Type E

B. Compressed FP-Tree Data Structure

In one of association rule mining method, CT-PRO uses the implementation of compressed FP-Tree for faster performance and memory consumption. Compressed FP-Tree (CFP-Tree) is another variant of FP-Tree in association rule mining which purpose is to define which item set is frequent at a given support count. Those item sets that are not frequent will be pruned to ensure the data from redundancy.

CFP-Tree enhancement included the descending order of the frequent item sets. This method ensure faster pattern matching rule which ensure that the item sets that will probably have the highest possibility of occurrence can be swiftly found.

Another distinct difference of CFP-Tree in compare of the normal FP-Tree is on the data structure aspect. While FP-Tree uses a tree to store the item which requires a recursive algorithm to recursively iterate all the members of the item, CFP-Tree implements an array of items as a storage which eliminate the requirement of recursion and thus, reduce a significant amount of computation cost.

Therefore, in regards of these advantageous virtues of fast performance and memory usage, CFP-Tree can be considered a relevant approach for the implementation of Frequent Episode Rule which will enable inter-transaction analysis to support further real-time data mining process.

V. ALGORITHM

In order to achieve frequent episode rule data mining in the CT-PRO program, there are a number of phases to change the frequent item set mining nature in the CT-PRO:

Phase 1: Transforming item set within the specified windows size. This phase is focus on how to generate new item set within the input data according to the windows size specified. The technique is based on a research on Extended Frequent Pattern Tree (EFP-Tree) algorithm [20]:

1. Given a set of event sequence with starting time Ts and end time Te and a fixed windows size φ, create a sliding window to capture the projection of the event sequence. This sliding window is define by:

   $$\varphi_n = \varphi_{n-1} + 1,$$

   where n is the event timestamp. The total of windows size (W) in a given event sequence is defined by:

   $$W(s, \varphi) = T_e - T_s + \varphi - 1$$

2. Write the projected event sequence into the projection event data. **Example 4.1.** From the set of projected event sequence:

   $$p\,(\varphi_n) = \langle(0,1),(0,2),(2,3),(3,2)\rangle$$

   refer the projected event sequence to single transaction according to windows size specified (in this case, we use 3 as the windows size). Hence, the single transaction event sequence is:

   $$p'(\varphi_n) = \langle(1, 2 , 3, 4)\rangle$$

3. Put an index according to the timestamp to each event according to when the event appears in the timestamp. This index is used to preserve the order of which the event appears in the original data set. **Example 4.2.** For the single transaction event sequence:

   $$p'(\varphi_n) = \langle(1, 2 , 3, 4)\rangle$$

   we transform the event sequence into:

   $$p'(\varphi_n) = \langle(1A, 2B , 3C, 4D)\rangle$$

   The whole event sequence that has been transform is similar to the example 4.2 and will be used for the next phase of frequent episode rule mining.

Phase 2: Mining the projected event sequence. This phase is done in the modified CT-PRO program which will process event sequence to discover frequent sequence set with the original order timestamp preserved.

1. Transform the projected event sequence into number sequence (unsigned short). This is done to optimize the mining process and post-mining process which involves an intensive sorting process. **Example 4.3.** For an event sequence:

   $$p'(\varphi_n) = \langle(1A, 2B , 3C, 4D)\rangle$$

   the transformed number sequence is:

   $$n(\varphi_n) = \langle(16641, 16897, 17153, 17409)\rangle$$

2. Mine the transformed number sequence using compressed FP-Tree association mining technique [2]. The result of this process is a set of unordered number event sequence with the support of each event sequence in the input data.

3. Sorting the result set orderly according to the original sequence of event's occurrence. This is done with a simple sort process which order the event based on the ascending number. **Example 4.4.** For a result sequence:

   $$n(\varphi_n) = \langle(16641, 17409\ 16897)\rangle$$

   sort the number to ascending order of result number sequence:

   $$n'(\varphi_n) = \langle(16641, 16897, 17409)\rangle$$

4. Revert back the result number sequence to the original input data format by using byte conversion to string. **Example 4.5.** For a result sequence:

   $$n'(\varphi_n) = \langle(16641, 16897, 17409)\rangle$$

   the converted result sequence is:

   $$p'(\varphi_n) = \langle(1A, 1B,1D)\rangle$$

5. Merge the similar result sequence set by ignoring the index. Each similar event sequence with different index will be treated as exactly one entity of sequence set which each support of similar event sequence summed up. **Example 4.6.** For a result sequence:

   $$p'(\varphi_n,s) = \langle([1A,3C], 2), ([2B,4D], 3), ([1E,3H], 2)\rangle$$

   the merge of result sequence is:

   $$p'(\varphi_n,s) = \langle([1,3], 4), ([2,4], 3)\rangle$$

VI. EXPERIMENTS

To test the efficiency and validity of the Frequent Episode Rule data mining technique in CT-PRO, we set up a test data set which is a synthetic data generated from IBM Quest Data Generator tool.

In addition, to set up a good dataset, a pre-processing method is used to reduce the number of unimportant attributes. The test data is pre-processed by using feature selection and discretization using entropy-based [4], [5].

The test data contains up to 100,000 rows with variety of timestamp. This test data was fed into our program, CTFER-PRO, and will be measured in various aspects. The measurement for this test data includes performance, memory usage, and numbers of episode generated in a given data set.

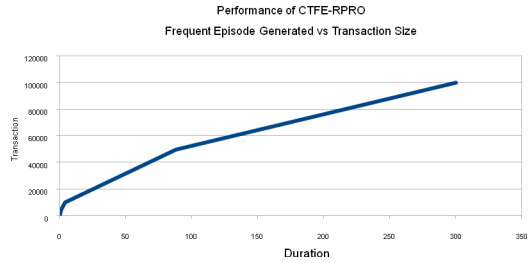

Figure 3. CTE-PRO Performance Transaction Size vs Duration

As can be seen in the chart, for window size of 5 and transaction support of 10, the computation cost is increase proportionally to the number of transaction generated by the test data. What can be noted is that there is a steep increase in computation cost duration when the transaction data is 50,000 rows or above from 10,000 rows. After it reaches 50,000 rows of transaction, the computation cost duration is increase linearly.

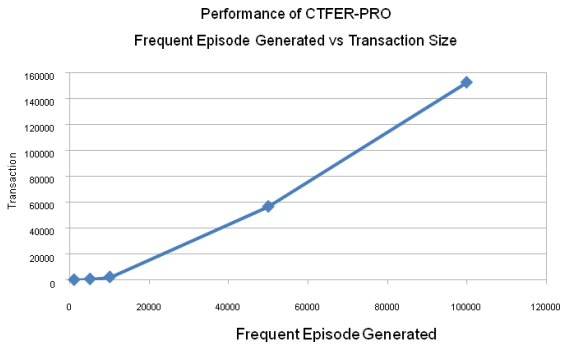

Figure 4. CTE-PRO Performance Transaction Size vs Frequent Episode Generated

As for the number of frequent episode generated in the CTE-PRO, there is a proportional increase of generated frequent episodes against the transaction size. The ratio of number of frequent episodes generated against the transaction size is reduced whenever there is an increase in transaction size. Thus, the CTE-PRO provides efficient memory usage against larger dataset.

VII. CONCLUSION

From the experiment section given above, we can conclude that CTFER-PRO provides significant efficiency in performance and memory usage. The numbers of episode generated are valid according to the algorithm of Frequent Episode data mining technique [20]. In addition, the algorithm presents an alternative technique to discover frequent episode from an event sequence which normally used the Apriori approach to do so.

VIII. FUTURE WORKS

This experiment was conducted using limited dataset since the research itself has limited hardware specification. Using a large dataset with millions of rows is quite an impossible task in an ordinary desktop computer.

However, an alternative approach can be used to mine a large dataset which ordinary association rule mining can't conduct. An item projection can be done by dividing each item into projected database containing specific item [7], [8]. Thus, this algorithm will reduce the frequent item set to an efficient number.

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Dynamic Average of Inter-reference Time as a Metric of Web Cache Replacement Policy

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***Abstract*—Caching objects in Internet environment is aimed to reduce bandwidth consumption and increase the response time of system in term of user perception. When the size of web cache is limited, it needs to manage the objects in web cache so that the hit ratio and byte hit ratio are optimal. For solving this problem, researcher proposes many web cache replacement policies such as LRU, LFU, GDS, GDSF, GD*, and IRT. In evicting object from web cache, each policy uses recency, frequency, size, size and frequency, or inter-reference time of object requested by user respectively. In web cache environment, the inter-reference time is rarely explored in previous research. Based on our research there is a correlation between average value of inter-reference time and the temporal locality, so it is reasonable to implement this value as a metric of web cache replacement policy. This research proposes to applied dynamic average of inter-reference time (DA-IRT) as a metric in evicting object from web cache. Based on the experiment using web trace log from three companies, it can be concluded that the performance of HR and BHR of DA-IRT is dependent on the behavior of the user requests.**

***Indext Terms*—inter-reference time, dynamic average of inter-reference time, web cache replacement**

I. INTRODUCTION

Caching objects in Internet environment is aimed to reduce bandwidth consumption and increase the response time of system in term of user perception. The performance of web cache is measured using the hit ratio (HR) and the byte hit ratio (BHR). HR is calculated from how many user requests that can hit the cache divided by the total requests. Mean while, BHR is calculated from how many bytes that can be hit in the cache divided by total bytes requested by user. In a web cache with limited cache size, the HR and BHR can be optimized by using cache replacement algorithms. Based on the research conducted by Lindemann & Waldhorst [1], it can be concluded that there is no cache replacement algorithm that can outperform at all workloads. The performance of the cache replacement policy is dependent on the behavior or characteristic of the web cache workload.

The research of workload of the web cache was conducted extensively [2][3][4]. Breaslau, et al. [2] concluded that the distribution of the web requests follow a Zipf-like distribution and this model can explain why the performance of the web cache is certain asymptotic properties. Then, Cohen&Kaplan [3] measured the regularity of the workload and use it to design the optimal cache replacement algorithm. Mean while, Benevenuto et al. [4] explores the impact of the first timer, included the one timer, on the performance of cache replacement schemes. From these studies, there are many properties of the workload such as the object size, the frequency of references, recency, one timer, first time, type of objects, and inter-reference time of object requests that can influent the performance of the web cache. Therefore, researcher proposes many web cache replacement policy such as Least Recency Used (LRU), Least Frequent Used (LFU), Greedy Dual Size (GDS), Greedy Dual Size and Frequency (GDSF), GD*, and IRT itself. The last property that is the inter-reference time of the object requested was discussed intensively in memory cache replacement [5],[6],[7] and outperforms the previous cache replacement schemes, but it was rarely discussed in web cache environment. Tanaka&Tatsukawa [8] uses the inter-reference interval called II-PO for manage the size of the web cache by using the modified 2Q, but they only use one trace log as a testbed.

Based on the IRT characteristic of eight web trace logs from three companies: GIA, Telkom, and Peti Kemas Co., it can be concluded that there is a correlation between average of IRT and the temporal popularity of the web object. Therefore instead of using IRT, this paper proposes to use average value of IRT. Because of the computation efficiency consideration, the average value of IRT for each cache object is approached using dynamic average of IRT. Therefore, this paper proposes to implement dynamic average of inter-reference time as a metric for web cache replacement policy. Based on the experiment result, it can be concluded that the performance of HR and BHR of DA-IRT is dependent on the behavior of the user requests.

The rest of this paper will be arranged as follows. Related work will be discussed in Section II. The DA-IRT is discussed in section III, and data preparation and simulation processes are presented in section IV. Experimental result and analysis is presented in section V, and then the conclusion and future work are presented

in section VI.

II. RELATED WORK

Inter-reference time of the successive object requests was extensively discussed and implemented in memory cache replacement [5][6][7]. Phalke&Gopinath [5] explored the behavior of inter-reference gap (IRG) that is the time interval between successive references to the same address. They concluded that the IRG has, in general, a repetitive behavior. Therefore, they applied a *k* order Markov chain to predict the next reference in the future. Based on the experiment, this method can improve the cache replacement until 37% over the Least Recently Usage (LRU). Jiang&Song [6] introduce the LIRS cache replacement based on Inter-reference Recency (IRR) Set. IRR uses the number of references of the other objects that is in the inter-reference time of certain object. On the other hand, they use spatial locality instead of temporal locality. They argue that the age of the object in the cache can be measured by counting the number of references of the other object after the object measured is entered into the cache. LIRS uses two blocks of cache: LIR for low inter reference and HIR for high inter reference. By using this approach that is not depending on the detectable pre-defined regularities in the reference of the workloads, LIRS can improve the LRU performance. Mean while, Takagi&Hiraki [7] argue that each memory address has own IRG distribution, so that they suggest to make individual probability distribution of each memory block and use the distribution to estimate the next reference in the future. This approach depends on the historical data so that it can introduce the complexity in both memory and computation.

Even though IRT has extensively discussed and implemented successfully in memory cache replacement, the research on the inter-reference time for web cache replacement was rarely conducted. Tanaka & Tatsukawa [8] adopted IRT to be a metric in web cache replacement algorithm. They modified the definition of IRT as an interval time between the time of purge object and time of the miss access of that object. For example, if an object *x* is referenced at time t_1, t_2, and t_3, and the reference at t_2 is not in the cache, then the original inter-reference interval for object *x* are t_2-t_1 and t_3-t_2. Instead of taking all inter-reference time, they take only t_2-t_1 as a metric called II-PO for cache replacement. A small II-PO implies that if the cache had additional it could have kept the object. They implemented the II-PO metric in the modified 2Q (2Q-Opt). 2Q-Opt uses two caching areas, Q1 and Q2. Q1 is a FIFO queue that keeps objects which are referenced for the first time, and Q2 is a LRU queue that keeps objects whose references counts are more than one. Caching management is conducted by decreasing or increasing the length of Q1 or Q2 vice versa based on the II-PO value so that the total cache size is not change. The drawbacks of this approach are requiring unlimited space for recording purged objects and testing only in one trace log. Therefore, it stills not confident whether is not the result also valid for the other web trace logs. This question is reasonable because based on research conducted by Lindemann & Waldhorst [1], it can be concluded that there are no cache replacement algorithm that can fit at all situations. The performance of the cache replacement policy is dependent on the behavior or characteristic of the web cache workload, especially the composition of the object type in the web cache.

III. DYNAMIC AVERAGE OF IRT

In this section it will be presented why the dynamic average of IRT can be used as a metric in evicting object in the web cache and how this metric will be implemented so that the computation time will be efficient.

A. Rationale

Based on the characteristic of IRT average, it can be shown that there is a strong correlation between IRT average and the temporal locality (see Table 2). Therefore, it is reasonable to implement the average of IRT as a metric for web cache replacement policy. However, if this metric is implemented in web cache replacement policy, it has to be calculated from previous set of log trace. If this approach will be taken, it is not only takes time to compute the average of IRT but also

Table 1. The properties of the web caches under investigation

	PT Garuda Indonesia Airways (1-18 Nov 2008)				PT Telkom (2-8 Nov 2008)			Peti Kemas (26 Juni - 31 July 2008)
	GIA #1	GIA #2	GIA #3	GIA #4	Telcom #1	Telcom #2	Telcom #3	
# of Request	3,544,156	8,269,922	4,717,459	3,137,920	5,014,879	4,560,189	8,219,840	7,558,496
# of Cachable Request	1,372,801	3,195,265	2,194,430	1,664,758	2,208,864	1,385,718	3,519,394	3,253,394
Request rate daily	**76,266**	**177,514**	**121,912**	**92,486**	**315,552**	**197,959**	**502,770**	**92,954**
% of Cachable Request	**38.73**	**38.64**	**46.52**	**53.05**	**44.05**	**30.39**	**42.82**	**43.04**
Total Size of Cachable Object (MB)	13,957.7	37,774.8	16,557.4	31,971.9	245,888. 8	99,323.9	245,888.8	66,548.2
One Timer	298,121	649,826	417,580	389,405	35,024	16,584	34,894	792,099
% of One Timer	**21.72**	**20.34**	**19.03**	**23.39**	**1.59**	**1.20**	**0.99**	**24.35**
# of Distinct Request	379,746	839,080	532,241	487,728	594,061	408,016	923,313	1,030,870

there is difficult to determine how long the previous log trace will be taken. Therefore, the IRT average will be approximated by the dynamic average of IRT (DA-IRT). In this approach, the average of IRT is calculated on every object in web cache by dividing the cumulative of the IRT by the frequency of reference (see Equation 1)

$$IRT_{ni} = \frac{IRT_{ni-1} + (t_{ni} - t_{ni-1})}{f_{ni}} \quad (1)$$

where IRT_{ni} is a dynamic average of inter-reference time of the reference n at time ith, $t_{ni} - t_{ni-1}$ is inter-reference time of reference n at time i, f_{ni} is frequency of reference n. Notable, for the first timer object, the average of IRT is assumed equal to the first reference time and placed into the web cache based on LRU policy among the first timer object.

Object with largest IRT average will be evicted first from the web cache. This approach assumes that object with smaller IRT average will be accessed sooner, so that it has to be kept in web cache in order to be hit.

Table 2. The correlation between the average of IRT and temporal locality

Web Cache	Correlation of Average of IRT	Linier regression (y=ax+b)		
		a	b	r^2
GIA#1	0.792747808	5.399	152.14	0.6284
GIA#2	0.612937861	**12.624**	**290.18**	**0.3757**
GIA#3	0.774937975	2.8128	65.35	0.6005
GIA#4	0.792337503	11.946	144.23	0.6278
Telkom#1	0.648806551	1.8602	261.43	0.4209
Telkom#2	**0.546831085**	**1.9141**	**519.91**	**0.2990**
Telkom#3	0.744491156	3.2217	100.42	0.5543
PetiKemas	0.731387095	15.49	1194.9	0.5349

B. Implementation

The DA-IRT is implemented using linked list data structure. The data attribute saved in the web cache are object size, lastly referred time, cumulative IRT, and frequency of reference. The cumulative IRT and frequency of reference of the object will be updated if the object is referred. Every updating the average of IRT, the linked list has to be sorted descendent by the value of average IRT. The algorithms of the DA-IRT as follows:

Input: X the object requested by user

Process:
If Object X is in Cache
    Add cumulative IRT by current IRT
    Increase the frequency by one
    Calculate the DA-IRT
    Sort descendent by DA-IRT value
    Calculate HR, BHR
Else
    While there is no the space of cache for X
        Evict the object with largest DA-IRT value
    Add object X into the cache using LRU policy among the first timer

Ouput: HR, BHR

IV. METHODOLOGY

The methodology used in this research is experimental-based methodology. The experiment is conducted by simulating the web cache replacement policy and using the web trace log as a input. This section describes and discusses about the evaluation criteria and the data preparation for the web cache simulation.

A. Evaluation Criteria

The criteria of evaluation is determined to asses the performance among web cache replacement policies. Based on the previous research, the criteria of evaluation for the web cache replacement are Hit Ration (HR) and Byte Hit Ratio (BHR). The HR is ratio between the number of references and number of requests. Meanwhile BHR is ratio between the number of byte of the references and the number of byte of the requests. The formulation of HR and BHR as follows:

$$HR = \frac{\sum hit}{\sum request} \quad (2)$$

$$HBR = \frac{\sum byte\_hit}{\sum byte\_requested} \quad (3)$$

B. Data Preparation

This section discusses about data testbed for simulation beginning from the raw data, data processing, and data properties.

The raw data for the experiment are collected from three companies: Garuda Indonesia Airways (GIA), PT Telkom (Telkom), and PT Peti Kemas (PetiKemas). The GIA web caches have been collected as long as three weeks from November, 1st till 18th 2008, and the Telcom web caches have been collected for one week from Nopember, 2nd till 8th 2008. Mean while, PetiKemas web cache have been collected for five weeks from June, 26th 2008 till July, 31th 2008.

Before the web caches workload is explored, the web caches are filtered so that only the cacheable object that will be explored. To filter the cacheable objects, this paper adopt the rule that was also used by [9]. The rule is the web request that contain the '?', 'cgi', or 'cgi-bin' will be discarded from the web cache log, and only those request with a cacheable response code, that is, 200 (OK), 203 (Partial), 206 (Partial Content), 300 (Multiple Choices), 301 (Move), 302 (Redirect), and 304 (Not Modified) will be used in the experiment.

The properties of the web caches workload are presented in Table 1. From the Table 1, it can be described that the cacheable requests are below 53 % of total web requests. The percentage of one timer is different among three companies, but for the cache in the same company the one timer is nearly equal. In all web caches, the object type is dominated by application, image, and text. More over, the composition of object type contained in the cache in the same company is nearly

equal. The important property that is related to IRT is the web request rate that shows the density of web request. From Table 1, It can be described that all web cache have different web request rate.

C. Simulation

The simulation is conducted using computer program in C# language. The web cache replacement policies that are compared in the experiment are LRU, LFU, GDS(1), and DA-IRT itself. The size of web cache is varied in range 20, 40, 60, 80 percent of the total size of distinct requests in testbed. These policies are implemented in same testbed and then HR and BHR of each web cache replacement policy and web cache size are calculated.

V. EXPERIMENT RESULT AND ANALYSIS

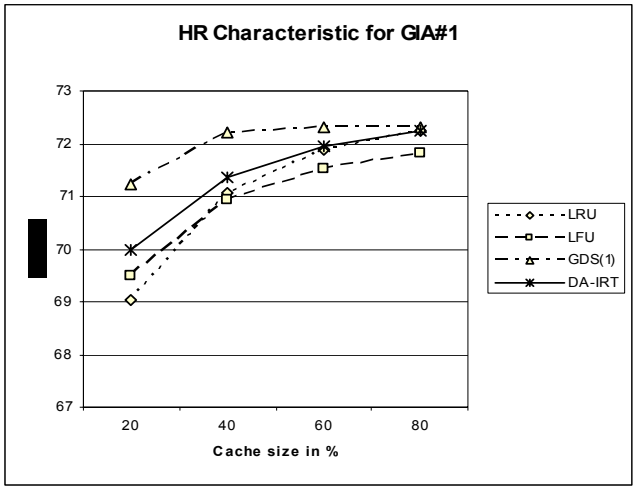
In general, increasing web cache size tends to increasing either hit ratio or byte hit ratio. This characteristic confirms to the previous research. GDS(1) outperforms all web cache replacement policies in terms of HR, but it has a poor performance in terms of BHR. This result is also conformity with previous research. The HR of DA-IRT outperforms LRU and LFU for Petikemas and GIA testbed, while for Telkom testbed DA-IRT don't outperform all of web replacement policies observed in this research. In general, it can be concluded that the performance of DA-IRT is dependent on the behavior of user request. In general, it can be concluded that the performance of DA-IRT is dependent on the behavior of user request. Based on this finding, it is important to explore the characteristic of web trace in order to determine the properties of workload so that the DA-IRT will be outperform the LFU. If this properties can be found, it could be decided whether or not DA-IRT will be implemented.

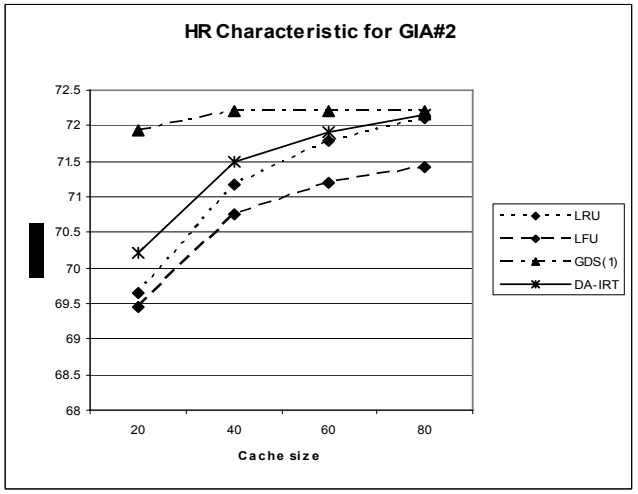
Based on the correlation between the average of IRT and temporal locality (see Table 2), the Telkom testbed have lesser correlation than the other testbeds. But, eventhough the correlation is weak for GIA#2, the DA-IRT of GIA#2 outperforms either LRU or LFU in terms of HR. Based on this fact, it can be concluded that it must be other parameters, beside the correlation value, that can be used to guarantee the DA-IRT will outperform. The other parameter could be the gradient value of the linier regression, the maintaining the value of average IRT after purging the object from web cache, the sequence of user request, or spatial locality parameter.

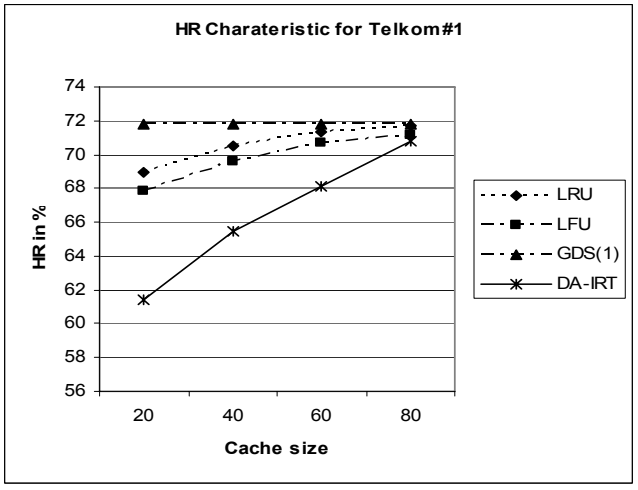
VI. CONCLUSION AND FUTURE WORK

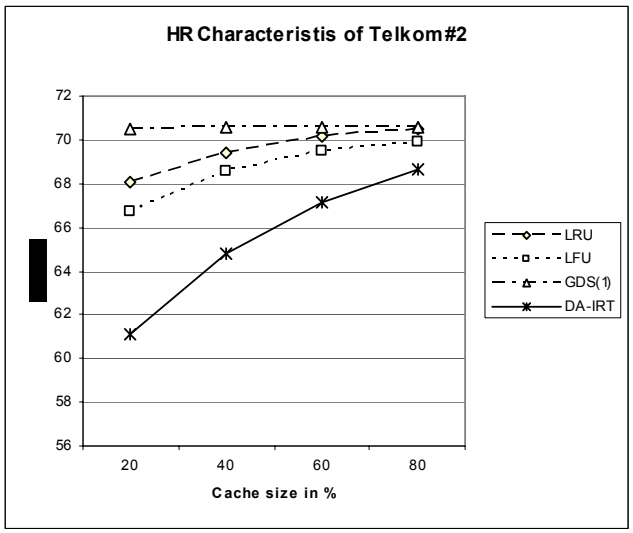
The performance of DA-IRT is dependent on the characteristic of workload. The strong correlation between average IRT and temporal locality can be used as one of parameter that can guarantee the DA-IRT will outperform, but it is not enough. Other parameter like gradient value of the linier regression, maintaining the value of average IRT after purging the object from web cache, the sequence of user request, or spatial locality parameter, have to be explore in depth to support the correlation value in order to recognize the other properties of workload that can be used to guarantee the DA-IRT better than other policies.

VII. APPENDIX








HR Characteristis of Telkom#2
72
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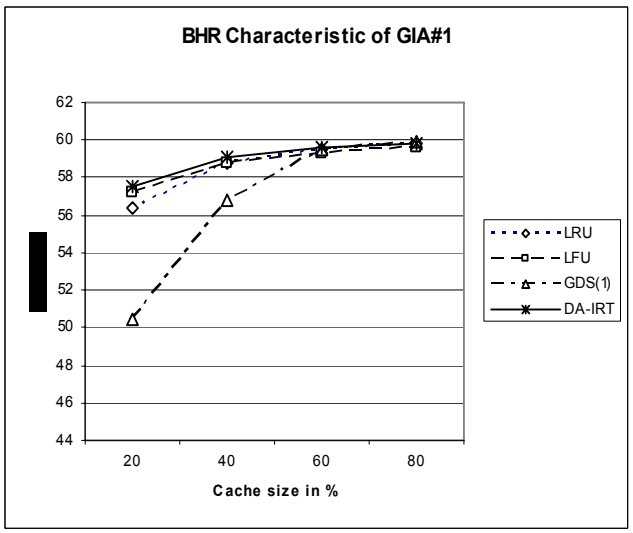
80
Cache size in %
LRU
LFU
GDS(1)
DA-IRT


BHR Characteristic of GIA#1
62
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52
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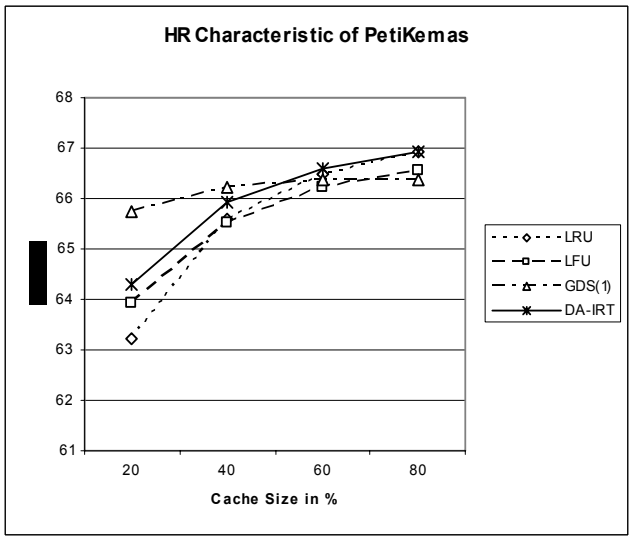
Cache size in %
LRU
LFU
GDS(1)
DA-IRT


HR Characteristic of PetiKemas
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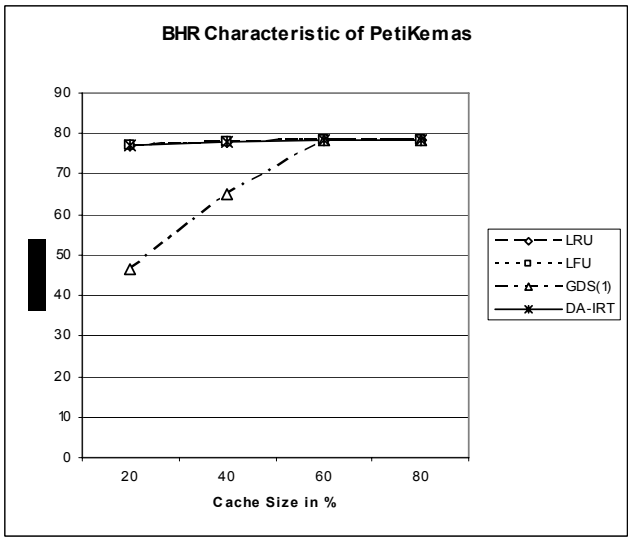
Cache Size in %
LRU
LFU
GDS(1)
DA-IRT


BHR Characteristic of PetiKemas
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Cache Size in %
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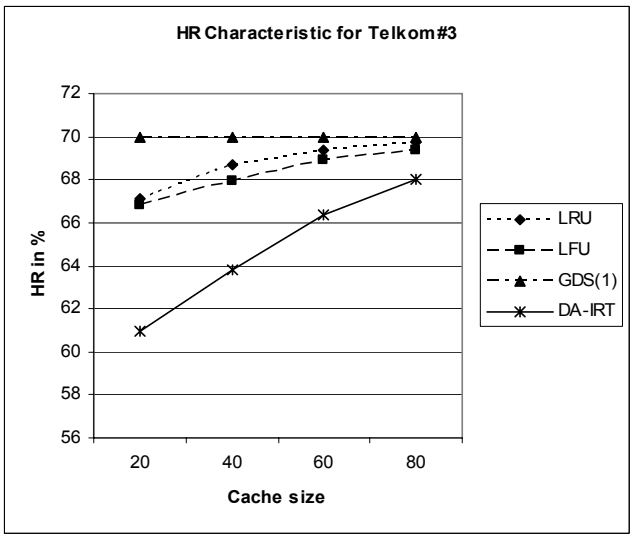
LFU
GDS(1)
DA-IRT


HR Characteristic for Telkom#3
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HR in %
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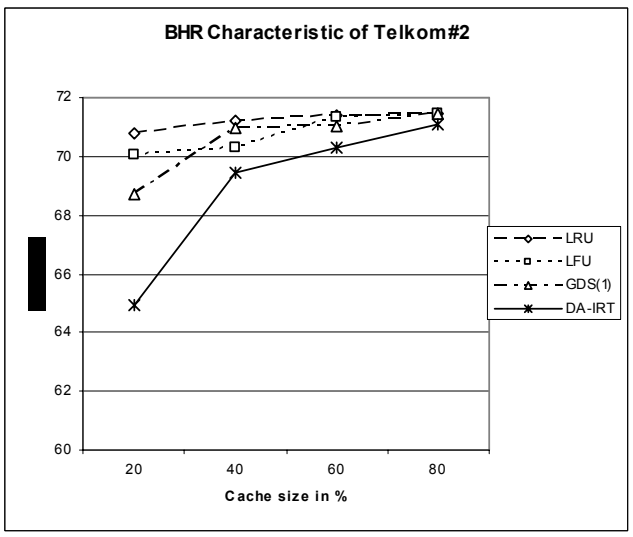
Cache size
LRU
LFU
GDS(1)
DA-IRT


BHR Characteristic of Telkom#2
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Cache size in %
LRU
LFU
GDS(1)
DA-IRT

VIII. ACKNOWLEDGMENT

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cAnt-WUM: Ant Colony Classification Algorithms Coping Continuous Attributes For Web Usage Mining

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***Abstract*— In a previous work we have proposed ant-miner algorithm based on ant colony optimization (ACO) to classify web users. Ant-miner algorithm copes only nominal/category attributes, then we can't know real value of the attributes. We must discretise continuous attributes in preprocessing step to support this algorithm running well. In this paper we propose enhancement of ACO algorithm to classify web users coping mix attributes (category and continues attributes), then we don't need discretization in preprocessing step. We propose to use three data source to classify web users for web usage mining: web access log, profile user, and transaction data form e-commerce web. Using these data combination facilitate to classify web users in potential web user class and not potential. In this paper we propose a new heuristic method for web user classification in web usage mining. This heuristic would be implemented in ACO classification algorithms that copes mix attributes (category and continuous attributes). And we use MDL (Minimum Description Length) Discretisation to handle continuous attributes. MDL allows a more flexible representation of continuous attributes intervals. in order to implement an improved pheromone updating method. In our research, we compared proposed heuristic and information theory heuristic (heuristic that used in origin Ant Miner). The results show that our heuristic method is very competitive in terms of accuracy and produces significantly simpler (smaller) rule sets, a desirable result in data mining.**

***Index Terms*—Ant colony optimization, web user classification, minimum description length.**

I. INTRODUCTION

The interaction between web user and website generates a huge web access data that stored in web access log. This data will provide valuable information for marketing activity of website and its products. In this context, web usage mining (WUM) has an important role to discover knowledge from web usage data. The web user interaction performs user profile and transaction data too. Our research uses three data for web user classification; web access log, user profile, and transaction data.

Business intelligence (BI) is one of WUM functions to provide an assistance to help marketing activity [4]. To perform BI function in WUM, we propose to classify web users into potential and non potential class by using three data. We use three parameters to classify web user [14]:

1. *Recency*: how long web users interact with our website since we saw at the last.
2. *Frequency*: how many times web users access our web site
3. *Intencity*: how much web users pay the transaction through our website.

Web user classification will assists us to perform marketing activities in [15]:

1. New customer acquisition
2. Existing customer retention
3. Existing customer penetration.

In the previous research, we have improved *Ant-Miner* algorithm with modification of heuristic function, and we named Ant-WUM [14]. We proposed closeness principal in Ant-WUM as heuristic function. Ant-WUM is an algorithm for web user classification in web usage mining domain. This algorithm is enhancement of *Ant-Miner algorithm based on Ant Colony Optimization* (ACO) [4]. In the context of WUM, for the web user classification, we have not found any researchers used this algorithm and other researches use ACO for web user clustering and web pages classification [15,16,17]. Ant-WUM only generates classification rules from category attributes. In this paper we propose Ant-WUM to generate classification rules copes category and continuous attributes using MDL (Minimum Description Length) discretisation, that we name cAnt-WUM. cAnt-WUM is extension of cAnt-Miner [18] and heuristic function modification using closeness principal.

For evaluation our algorithm, we performed performance comparison between Ant-WUM enhancement using information theory and principal closeness in the context of:

1. *Accuracy Rate*: algorithm capability to generate rules with minimum fault.
2. *Computational efficiency*: computation time that algorithm consumes to perform learning process of classification task form training set and test set.
3. *Interpretability*: algorithm capability to generate simple rules that facilitate users to understand and use them for decision making.

However, most Ant Colony Optimization (ACO) [2] classification algorithms have the limitation of being able to cope with only nominal attributes. Continuous attributes, if present, need to be transformed into

nominal attributes, by creating discrete intervals in a preprocessing step. There are potentially two drawbacks by not coping with continuous attributes directly. Firstly, there is a need for a discretisation procedure in a preprocessing step. Secondly, less information is available to the classification algorithm, since the discretisation procedure creates a fixed number of discrete intervals for each continuous attribute. In this paper, we focus on using the ideas of cAnt-Miner [3] in coping with continuous attributes and principal closeness as heuristic function. cAnt-Miner pioneered in coping with both types (nominal and continuous) attributes directly, taking full advantage of all continuous attributes' information and not requiring a discretisation procedure in a preprocessing step.

II . BACKGROUND

In this section, we would describe brief overview of web usage mining, Ant-Miner, and cAnt-Miner as extension of Ant-Miner to cope mix attributes between nominal and continuous attributes.

A. Web Usage Mining Overview

Web mining is a data mining technique to extract knowledge from web data (4). The are two approaches to define *web mining,* the first is *process-centric view* that defines web mining is sequence of tasks. And the second is *data-centric view* thet defines web mining is a terminology of data type that will be used by data mining process. In this paper, we will concern to data centric view as a reference. In this approach, web mining can be classified into three categories:

1. *Web content mining* (WCM): is information discovery of web content, such as text, image, audio, video, metadata, and hyperlinks.
2. *Web structure mining* (WSM): is information discovery model related with web structure relation such as intra-page structure and inter-page structure.
3. *Web Usage Mining* (WUM): as a topic of this paper ia a set of processes to apply data mining technique to discover usage pattern from web data (19).

WUM generates data from session and user behavior that resulted from user interation wirh web data. Web usage data consists of web access logs, browser logs, user profiles, registration data, user session and transaction, cookies, user queries, mouse clicks, and etc. The are three functions of WUM (19):

1. *Personalization*; web personalization depends on every web user behavior is ultimate goal for web provider. This function can be used for *one to one marketing* in e-Commerce.
2. *System improvement*; improvement of web performance is important goal to give a satisfaction for web user. WUM provides web user behavior traffic, this data can be used for *web caching,* network transmission, *load balancing* and data distribution.
3. *Site modification*; provides *feed back* of web access user behavior to web designer, as an information for web site reenginnering. This function contributes to make adaptive website with changie of website structure based on web usage pattern.
4. *Busines Intelligence*; provides information about web usage pattern marketing intelligence dari data web.
5. *Usage Characterization;* provides information of web usage to support decision of improvement scalability and load balancing.

In this paper, we will focus on business intelligence function.

B. Ant-Miner Overview

Ant-Miner aims at extracting IF-THEN classification rules of the form *IF* ($term_1$) *AND* ($term_2$) *AND ... AND* ($term_n$) *THEN* (class) from data. Each term in the rule is a triple (attribute, operator, value), where *operator* represents a relational operator and *value* represents a value of the domain of *attribute* (e.g. sex = male). The *IF* part corresponds to the rule's antecedent and the THEN part corresponds to the rule's consequent, which represents the class to be predicted by the rule. An example that satisfies the rule's antecedent will be assigned the class predicted by the rule. As Ant-Miner only works with nominal (categorical or discrete) attributes, the only valid relational operator is "=" (equality operator). Continuous attributes need to be discretised in a preprocessing step.

A high level pseudo-code of Ant-Miner is presented in Algorithm 1 [4]. In summary, Ant-Miner works as follows. It starts with an empty rule list and iteratively (*while* loop) adds one rule at a time to that list while the number of uncovered training examples is greater than a user-specified maximum value. In order to construct rules, ants start with an empty rule (no terms in its antecedent) and add one term at a time to their rule antecedent (repeat-until loop). Terms are probabilistically chosen to be added to current partial rules based on the values of the amount of pheromone (τ) and a problem-dependent heuristic information (η) associated with terms (vertices in the construction graph). A pheromone value and a heuristic value are associated with each possible term - i.e. each possible triple (attribute, operator, value). As usual in ACO, heuristic values are fixed (based on an information theoretical measure of the predictive power of the term), while pheromone values are iteratively updated based on the quality of the rules built by ants. Ants keep adding a term to their partial rule until any term added to their rule's antecedent would make their rule cover less training examples than a user-specified threshold (in order to avoid too specific and unreliable rules), or all attributes have already been used. The latter rule construction stopping criterion is necessary because an attribute can only occur once in the antecedent of a

rule, in order to avoid inconsistencies such as <sex = male AND sex = female>. Once the rule construction process has finished, the rule constructed by an ant is pruned to remove irrelevant terms from the rule antecedent. Then, the consequent of a rule is chosen to be the class value most frequent among the set of training examples covered by the rule in question. Finally, pheromone trails are updated using the best rule, based on a quality measure *Q*, created by ants. The process of constructing a rule is repeated until a user-specified number of iterations has been reached, or the best rule of the current iteration is exactly the same as the best rule constructed by a predefined number of previous iterations, which works as a rule convergence test. The best rule found along this iterative process is added to the rule list and the covered training examples (training examples that satisfy the antecedent of the best rule) are removed from the training set.

C. cAnt-Miner Overview

In order to overcome Ant-Miner's limitation of only cop-ing with nominal attributes, Otero et al. [3] have proposed an Ant-Miner extension — named cAnt-Miner (Ant-Miner coping with continuous attribute- which can dynamically create thresholds on continuous attributes' domain values during the rule construction process. Since cAnt-Miner has the ability of coping with continuous attributes "on the-fly", continuous attributes do not need to be discretised in a preprocessing step. cAnt-Miner extended Ant-Miner in several ways, as follows:

Algorithm 1: High level pseudo-code of Ant-Miner.

```
begin Ant-Miner
    tr set ← all training examples;
    rule list ← ∅;
    while |tr set| > MaxUncoveredExamples do
        τ ← initializes pheromones;
        rulebest ← ∅;
        repeat
            CreateRules();
            ComputeConsequents();
            P runeRules();
            currentbest ← BestRule();
            UpdateP heromones(τ , currentbest );
            if Q(currentbest ) > Q(rulebest ) then
                rulebest ← currentbest ;
            end
            i ← i + 1;
        until i ≥ MaxIterations OR Convergence() ;
        rule list ← rule list + rulebest ;
        tr set ← tr set \ CoveredExamples(rulebest );
    end
end
```

Firstly, cAnt-Miner includes vertices to represent continuous attributes in the construction graph. For each nominal attribute x_i and value v_{ij} (where x_i is the i-th nominal attribute and v_{ij} is the j-th value belonging to the domain of x_i), a vertex ($x_i = v_{ij}$) is added to the construction graph, as in Ant-Miner. Furthermore, for each continuous attribute y_i, a vertex (y_i) is added to the construction graph, unlike in Ant-Miner. Note that continuous attributes vertices do not represent a valid term, since they do not have a relational operator and value associated in the construction graph, in contrast to nominal attributes. The relational operator and a threshold value will be determined when an ant selects a continuous attribute vertex as the next term to be added to the rule (an example of continuous attribute term is: 'age > 21'). This makes the choice of a relational operator and value tailored to the current candidate rule being constructed, rather than chosen in a static preprocessing step.

Secondly, in order to compute the heuristic information for continuous attributes, cAnt-Miner incorporates a dynamic entropy-based discretisation procedure. In Ant-Miner, the heuristic value of each nominal vertex ($x_i = v_{ij}$) involves a measure of entropy associated with the partition of examples which have the specific v_{ij} value for the attribute x_i. The entropy measure, which is derived from information theory and is often used in data mining, quantifies the impurity of a collection of examples. Since continuous attribute vertices (y_i) do not represent a partition of examples as nominal attribute vertices, a threshold value v need to be selected in order to dynamically partition the set of examples into two intervals: $y_i < v$ and $y_i \geq v$. The best threshold value v is the value v that minimizes the entropy of the partition, computed as

$$entropy\ (yi, v) = \frac{|S_{yi}<v|}{|S|}\ .entropy\ (S_{yi} < v) + \frac{|S_{yi} \geq v|}{|S|}\ .entropy\ (S_{yi} \geq v) \quad (1)$$

where $|S_{yi} \geq v|$ is the total number of examples in the partition $y_i < v$ (partition of training examples where the attribute y_i has a value less than v), $|S_{yi} \geq v|$ is the total number of examples in the partition $y_i \geq v$ (partition of training examples where the attribute y_i has a value greater or equal to v) and $|S|$ is the total number of training examples. The values of entropy ($S_{yi} < v$) and entropy($S_{yi} \geq v$) are computed as

$$entropy\ (T) = \sum_{c=1}^{k} - p\ (c\ |T\ ).log_2\ p(c|T) \quad (2)$$

where p(c|T) is the proportion of examples in T that have class c and k is the number of classes. After selection of the best threshold value v using Equation (1), the measure of entropy used to calculate the heuristic value of the continuous attribute vertex (y_i) corresponds to the minimum entropy value between the two generated intervals ($y_i < v$) and ($y_i \geq v$), according to Equation (2).

Thirdly, when a continuous attribute vertex (y_i) is selected by an ant to be added to its current partial rule, a relational operator and a value is computed using a similar procedure as for the heuristic information. The best threshold value v is selected using Equation (1), subject to the restriction of considering only examples covered by the current partial rule in the evaluation of threshold values. Then, the relational operator ('<' or '≥')

associated with the interval with the lowest entropy value is selected and a term in the form (y_i, operator, v) added to the ant's current partial rule (e.g. age < 18). Fourthly, the pheromone updating procedure has been extended to cope with continuous attribute vertices. In the case of continuous attributes, pheromone values are associated with continuous attribute vertices not considering the operator and threshold value, that is, there is a single entry in the pheromone matrix for each continuous attribute, in contrast to multiple entry for nominal attributes have an entry for every (x_i,v_{ij}) pair.

III. PREPROCESSING PHASE

WUM has three main processes, these are *preprocessing, pattern discovery*, and *pattern analysis* [3]. These processes can be figured below:

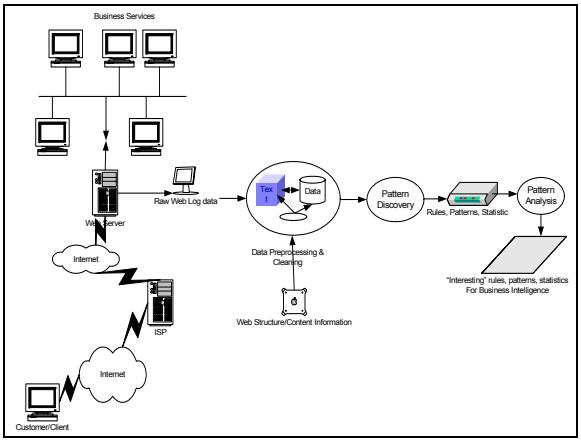

Figure 1. WUM Process

1. Preprocessing process consists of conversion process for web usage, *content*, and web *structure* that filled data sources to be processed in data abstraction level for *pattern discovery.*
2. Pattern discovery consists of methodes and algorithms that conducted form any disciplines such as statistics, machine learning, pattern recognition, and artificial intelligence. The method and algorithm for WUM has some similarites with method and algorithm application in non-web data, but it needs justification of data abstraction level. In this pattern analysis, it can apply tehnique that used in data mining tehniqus generally, such as statistical analysis, clustering, classification, association rule, dependency modeling, sequential patterns, etc.
3. Pattern analysis is the last process in WUM process, where the tasks is this process consists of filtering for irrelevant rules and patterns and pattern visualizing.

In preprocessing phase, we propose a method for preparation data supply for classification task. The proprocessing phase is figured below:

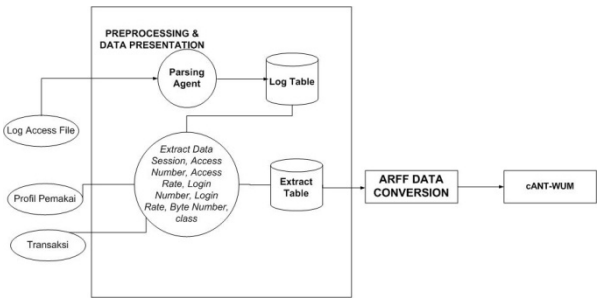

Figure 2. Preprocessing Process

The explanation of preprocessing process is below:

1. Web access log format is standard as figured in figure 4 and perform parsing form format **.log* to relation format. In parsing process, we perform data cleansing with rules below:
   a. URL pages is not consists of image extension (*.png,*.jpeg,*.gif, etc)
   b. We only use connection status with code 200 (access of page web is success) and 301 (indicates login or logout transaction)

#	IP Address	Userid	Time	Method/ URL/ Protocol	Status	Size	Referrer	Agent
1	123.456.78.9	-	[25/Apr/1998:03:04:41 -0500]	"GET A.html HTTP/1.0"	200	3290	-	Mozilla/3.04 (Win95, I)
2	123.456.78.9	-	[25/Apr/1998:03:05:34 -0500]	"GET B.html HTTP/1.0"	200	2050	A.html	Mozilla/3.04 (Win95, I)
3	123.456.78.9	-	[25/Apr/1998:03:05:39 -0500]	"GET L.html HTTP/1.0"	200	4130	-	Mozilla/3.04 (Win95, I)
4	123.456.78.9	-	[25/Apr/1998:03:06:02 -0500]	"GET F.html HTTP/1.0"	200	5096	B.html	Mozilla/3.04 (Win95, I)
5	123.456.78.9	-	[25/Apr/1998:03:06:58 -0500]	"GET A.html HTTP/1.0"	200	3290	-	Mozilla/3.01 (X11, I, IRIX6.2, IP22)
6	123.456.78.9	-	[25/Apr/1998:03:07:42 -0500]	"GET B.html HTTP/1.0"	200	2050	A.html	Mozilla/3.01 (X11, I, IRIX6.2, IP22)
7	123.456.78.9	-	[25/Apr/1998:03:07:55 -0500]	"GET R.html HTTP/1.0"	200	8140	L.html	Mozilla/3.04 (Win95, I)
8	123.456.78.9	-	[25/Apr/1998:03:09:50 -0500]	"GET C.html HTTP/1.0"	200	1820	A.html	Mozilla/3.01 (X11, I, IRIX6.2, IP22)
9	123.456.78.9	-	[25/Apr/1998:03:10:02 -0500]	"GET O.html HTTP/1.0"	200	2270	F.html	Mozilla/3.04 (Win95, I)
10	123.456.78.9	-	[25/Apr/1998:03:10:45 -0500]	"GET J.html HTTP/1.0"	200	9430	C.html	Mozilla/3.01 (X11, I, IRIX6.2, IP22)
11	123.456.78.9	-	[25/Apr/1998:03:12:23 -0500]	"GET G.html HTTP/1.0"	200	7220	B.html	Mozilla/3.04 (Win95, I)
12	209.456.78.2	-	[25/Apr/1998:05:05:22 -0500]	"GET A.html HTTP/1.0"	200	3290	-	Mozilla/3.04 (Win95, I)
13	209.456.78.3	-	[25/Apr/1998:05:06:03 -0500]	"GET D.html HTTP/1.0"	200	1680	A.html	Mozilla/3.04 (Win95, I)

Figure 3. Web Access Log Format

2. Perform data extraction from session table for providing attributes access number, login namber, access rate, login rate, transaction number, byte number, and class. This data is mix attributes between nominal attributes and continuos attributes.
   In data extraction consists of information:
   a. Access number generated by user interaction in time period (*A*), computed form access time accumulation per web page as long less than timeout that user defined (equation (1)).
   b. Access duration (*D*), computed from accumulation of access time sequence within time period that user defined (equation(2)).
   c. Access time arte ($\overline{D}$),computed from access duration divided by access time (equation(3)).
   d. Number of login time (*L*), computed from sequence of web page access until meet with *LOGIN* page and web page access is not equal with *time out* (equation(4)).
   e. Time login rate ($\overline{L}$), computed from total of login time (equation (5)) divided by login number (equation (6)).

   We use some equations to perform data extraction

as explained below:

$$A(t) = \sum_{p=1}^{p=n} t_p, t_p < t_{out} \quad (3)$$

$$D = A(t)_1 + A(t)_2 + A(t)_n \quad (4)$$

$$\overline{D} = \frac{D}{\sum A(t)} \quad (5)$$

$$L(t) = \sum_{p=1}^{p=n} t_p, t_p < t_{out}, p_n = "LOGIN" \quad (6)$$

$$TotL = L(t)_1 + L(t)_2 + L(t)_n \quad (7)$$

$$\overline{L} = \frac{TotL}{\sum L(t)} \quad (8)$$

where

- t_p is access time per page
- t_{out} is page time out
- p is web page

2. Perform relation webacceeslog with transaction and user profile data as figured below:

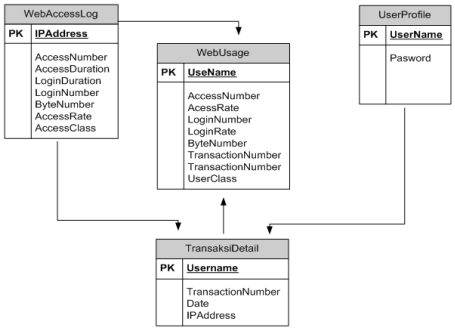

Figure 4. Data Relationship in WUM

The explanation of Figure 4 is:

a. Table *webacesslog* woul be used as data inputin c*Ant-WUM* to generate web user classification rules based on frequency access. We use any attributes as term candidates are access number, access duration, access rate, byte number, and acces class as predictor class. User data that represented as IP address in this table is web user list that not perform transaction in web e-commerce. And IP address that used by web user to perform login transaction would be managed in webusage table.

b. Table webusage as representation relation from *webaccesslog*, user profile, and transaction would be used as data input in cAnt-WUM to generate web user classification rule into category of potential and non potential. We will use any attributes as terms candidate are access number, access rate, login number, login rate, byte number, transaction number, transaction number, and user class as predictor class.

Data IP address in webusage table is part of IP address in webaccesslog table. Relationship between two kind of IP address is formulated below:

$$\sum_{i=1}^{n} I_a \in \sum_{i=1}^{n} I_u \quad (9)$$

where :

- i is IP address
- I_a is IP address list in webusage table
- I_u is IP address list in *webaccesslog* table

IV. MDL Discretisation for Handling Continuous Attributes

Fayyad and Irani [6] presented an MDL-based approach where multiple discrete intervals can be extracted by applying a binary discretisation procedure recursively, selecting the best threshold value at each iteration, and using the minimal description length principle as a stopping criterion to determine whether more threshold values should be introduced. The motivation for multiple interval discretisation lay in the fact that the 'interesting' value range may be an internal interval (e.g. 18 _ age < 21), which can not be easily generated by a binary-interval-at-a-time discretisation procedure. The MDL-based approach generally leads to coarse intervals in cases where the examples are homogeneously distributed (distributed in a few different class values) and to fine intervals in cases of more uniform distributions.

Following Fayyad and Irani, we have incorporated a MDLbased decision criterion to decide whether or not to split a given interval further in cAnt-Miner. The basic idea is to apply cAnt-Miner's entropy-based discretisation method recursively, relying on the MDL criterion to accept or reject a threshold value. In this way, instead of generating only intervals in the form $y_i < v$ and $y_i \_ v$, internal intervals in the form $v_{lower} \_ yi < v_{upper}$ can be created (where v, v_{lower} and v_{upper} are values in the domain of the continuous attribute y_i).

The MDL-based discretisation method is divided in two steps, as follows. In the first step, the best threshold value v for a continuous attribute vertex (y_i) is selected as in the original cAnt-Miner — Equation (1). In the second step, the MDL decision criterion for accepting or rejecting a threshold value v is computed as

$$Gain\ (yi, v; S) > \frac{log_2(|S|-1)}{|S|} + \frac{\Delta(yi,v;S)}{|S|} \quad (10)$$

$$Gain\ (yi, v; S) = entropy\ (S) - \frac{|S_{yi}<v|}{|S|} . entropy\ (S_{yi} < v) - \frac{|S_{yi}\geq v|}{|S|} . entropy\ (S_{yi} \geq v) \quad (11)$$

$$\Delta(yi, v; S) = log_2(3^k - 2) - [\, k . entropy\ (S) - k_{yi} < v . entropy\ (S_{yi} < v) - k_{yi} \geq v . entropy\ (S_{yi} \geq v)] \quad (12)$$

where k, $k_{yi} < v$ and $k_{yi} \geq v$ are the number of different class values in S, $S_{yi} < v$ and $S_{yi} \geq v$, respectively. If the MDL criterion defined in Equation (3) is satisfied, the threshold value v for the continuous attribute y_i is accepted; otherwise it is rejected. Note that the entropy measures of S, $S_{yi} < v$ and $S_{yi} \geq v$ required to evaluate the threshold value v against the MDL criterion are already computed by the first step (threshold selection). Therefore, there is no increase in computational time to compute the MDL criterion. Finally, if the threshold value v is accepted, the discretisation procedure is repeated individually for the partitions $S_{yi} < v$ and $S_{yi} \geq v$.

At the end of the MDL discretisation procedure, we can have potentially multiple threshold values. In order to select the best threshold value(s), the list of threshold values is sorted and the entropy value for each discrete interval is calculated. Then, the interval with the lowest entropy value is selected (based on the fact that lower entropy values represent more "pure" partitions where most of the examples belong to a single class). If an internal interval is selected (an interval between two threshold values), a term in the form $v_j - y_i < v_j + 1$ is generated; otherwise, a term in the form $y_i < v_j$ or $y_i - v_j$ is generated (where j is the j-th threshold value selected). Fig. 5 illustrates the intervals that could have been created by selecting two threshold values for a continuous attribute *age*.

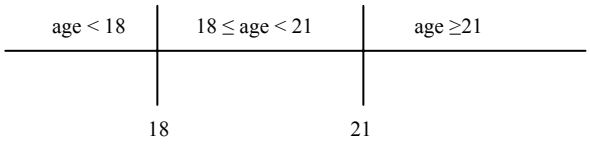

Fig. 5. Illustration of discrete intervals that that could have been created by selecting two threshold values for a continuous attribute *age*. At the end of the MDL discretisation procedure, the interval associated with the lowest entropy value is selected.

V. HEURISTIC FUNCTION

In this section, we would describe heuristic function in Ant-Miner algorithm and cAnt-WUM, then described the differences of them.

Heuristic Function in Ant-Miner Algorithm

For each $term_{ij}$ that can be added to the current rule, Ant-Miner computes the value η_{ij} of a heuristic function that is an estimate of the quality of this term, with respect to its ability to improve the predictive accuracy of the rule. This heuristic function is based on information theory. More precisely, the value of η_{ij} for $term_{ij}$ involves a measure of the entropy (or amount of information) associated with that term. For each $term_{ij}$ of the form $A_i = V_{ij}$, its entropy is :

$$H(W|A_i = V_{ij}) = -\sum_{w=1}^{k} \left(P(w|A_i = V_{ij}) \cdot \log_2 P(w|A_i = V_{ij}) \right) \qquad (13)$$

where :

- W is the class attribute (i.e., the attribute whose domain consists of the classes to be predicted)
- k is the number of classes
- $P(w|A_i = V_{ij})$ is the empirical probability of observing class w conditional on having observed $A_i = V_{ij}$

The higher the value of $H(W|A_i = V_{ij})$, the more uniformly distributed the classes are and so, the smaller the probability that the current ant chooses to add $term_{ij}$ to its partial rule. It is desirable to normalize the value of the heuristic function. In order to implement this normalization, it is used the fact that the value of $H(W|A_i = V_{ij})$ varies in the range $0 \leq H(W|A_i = V_{ij}) \leq \log_2 k$, where k is the number of classes. Therefore, the proposed normalized, information-theoretic heuristic function is:

$$\eta_{ij} = \frac{\log_2 k - H(W|A_1 = V_{ij})}{\sum_{i=1}^{a} x_1 \cdot \sum_{j=1}^{b_i} \left(\log_2 k - H(W|A_1 = V_{ij}) \right)} \qquad (14)$$

where:

- a is the *total* number of attributes
- x_i is set to 1 if *the* attribute A_i was not yet used by the current ant, or to 0 otherwise
- b_i is the number of *values* in the domain of the i-th attribute
- If the value V_{ij} of *attribute* A_i does not occur in the training set then $H(W|A_i = V_{ij})$ is set to its maximum value of $log_2 k$ this corresponds to assigning to $term_{ij}$ the lowest possible predictive power. If all the cases belong to the same class then $H(W|A_i = V_{ij})$ is set to 0, this corresponds to assigning to $term_{ij}$ the highest possible predictive power.

From equation (13) and (14), we will describe to illustration implementation in example training set PLAY below:

Table 1. Table Play for Information Heuristic Computation

Outlook	Temp	Humidity	Windy	Play
Sunny	85	85	false	don't play
Sunny	80	90	true	don't play
Overcast	83	78	false	play
Rain	70	96	false	play
Rain	60	80	false	play
Overcast	64	65	true	play
Sunny	72	95	false	don't play
Sunny	69	70	false	play
Rain	75	70	true	play
Sunny	75	70	true	play
Overcast	72	90	true	play
Overcast	81	75	false	play
Rain	71	80	true	don't play

For computation information gain for term "outlook=sunny" for class PLAY based on equation (13) and (14), is:

- P(Play|*outlook*=sunny) = 2/14 = 0.143,
- P(Don't Play|*outlook*=sunny) = 3/14 = 0.214
- H(W,outlook=*sunny*)=-0.143.log(0.143)-0.214.log(0.214)=0.877
- $\eta = log_2 k - H(W, outlook = sunny)$ $= 1 - 0.8777 = 0.123$

Heuristic Function for cAnt-WUM

Heuristic function in cAnt-WUM is based on closeness principal that used for clustering task of web user profiling [17]. This function is used for time distance measurement of existing user in accessing web page with access time cluster. The closeness principal equation is noted, below:

$$Distance\ (t1, t2) = 1 - \cos(t2 - t1) \quad (15)$$

where, $t1$ is access time number that used by web user in accessing web pages, and $t2$ is access time for every cluster. Web access time is access time sequence as formulated in equation [3]. Using of heuristic function to solve web user classification in WUM domain, because of some attributes in WUM as described in preprocessing phase is same with [17], it is time session of every web users. The difference is we accumulated time total for every web users uniquely, and in [17],the session time used for every web users in web access time cycle without pay attention to existence web user, then one web user has any different time session total.

The implementation of equation (15) for heuristic function in c*Ant-WUM* is formulated in equation below:

$$D(HI1, H2) = 1 - \cos\ (H2 - H1) \quad (16)$$

where:

- D is value *distance* between H1 heuristic to H2
- $H1$ is *heuristic* value for $term_{ij}$ in format $A_i = V_{ij}$, as described in equation (13)
- $H2$ is *heuristic* value for $term_{notij}$ in format $A_i = V_{notij}$.

The heuristic value $H2$ is generated from information gain of term that different with $term_{ij}$ in same class. The equation used to compute H2 is:

$$H2(W|A_i = V_{Nij}) = -\sum_{w=1}^{k} \left(P(w|A_i = V_{Nij}) \cdot \log_2 P(w|A_i = V_{Nij}) \right) \quad (17)$$

where:

- W,k, and P is *same* with equation description (13)
- V_{Nij} is attributes *value* likewise V_{ij} for same class.

The distance computation result is normalized with equation below:

$$\eta_{ij} = \frac{\log_2 k - H(W|A_1 = V_{ij})}{\sum_{i=1}^{a} x_1 \cdot \sum_{j=1}^{b_i} \left(\log_2 k - H(W|A_1 = V_{ij}) \right)} / 1 - \cos(H2 - H1) \quad (18)$$

where the variables of this normalization have same meaning with equation (13) and (17).

The illustration of closeness principal in cAnt-WUM is described in example below. To compute distance of value information for term "outlook=sunny" for class PLAY based on closeness principal is below:

- P(Play|outlook=sunny) = 2/14 = 0.143,
- P(Don't Play|outlook=sunny) = 3/14 = 0.214
- H1(W,outlook=sunny)=-0.143.log(0.143) 0.214.log(0.214)=0.8
- $\eta H1 = log_2 k - H(W, outlook = sunny) = 1 - 0.8777 = 0.123$
- P(Play|outlook=NOTsunny) = 7/14 = 0.5,
- P(Don't Play|outlook=NOTsunny) =1/14= 0.071
- H2(W,outlook=NOTsunny)=-0.5.log(0.5)-0.071.log(0.071)=0.232
- D (H1,H2) = 1 – cos(0.232 – 0.877)=0.200
- $\eta = log_2 k - H(W, outlook = sunny)/(1 - \cos(H2, H1) = 0.123/0.200 = 0.613$

VI. COMPUTATIONAL RESULTS

Evaluating performance of cAnt-WUM with other ACO algorithm conducted with performance comparison between cAnt-WUM (using closeness principal as heuristic function), cAnt-Miner (using information theory as heuristic function) and Ant-Miner with discretisation of continuous attributes in preprocessing step using MDL discritisation by WEKA data mining software. And parameters setting for running these algorithm is described below:

Table 2. Parameter Setting

Folds	**10**
Number of Ants	5
Min-cases Per Rule	5
Max-uncovered cases	10
Rules of convergence	10
Number of Iterations	100

We used data set of WUM from web e-commerce that consists of 492 instances. The data structure of this data se is:

Table 3. Data Structure

Attribute Name	**Type**
Access_Number	continuous
Access_Duration	continuous
Access_Rate	continuous
Login_Number	continuous
Login_Rate	continuous
Byte_Number	continuous
Transaction_Number	continuous
Class	nominal

The result of performance comparison is divided into three aspects: accuracy rate, interpretability, and computational efficiency. The results are described below:

Table 4. Accuracy Rate of Performance Comparison

Test Number	Average Predictive Accuracy (%)		
	Ant-Miner	cAnt-Miner	cAnt-WUM
1	88.76	80	82.5
2	88.74	89	85.5
3	88.75	80.05	81
4	88.75	83	76.5
5	88.77	86.5	87

Table 5. Interpretability of Performance Comparison

Test Number	Average Number of Rules		
	Ant-Miner	cAnt-Miner	cAnt-WUM
1	6	3	3.1
2	6	3.2	3.1
3	6	3.2	3.5
4	6	3.2	3.2
5	6.1	3.1	3

Table 6. Computational Efficiency of Performance Comparison

Test Number	Computation Efficiency (second)		
	Ant-Miner	cAnt-Miner	cAnt-WUM
1	19	0	0
2	21	0	0
3	23	0	0
4	25	0	0
5	30	0	0

The results show that Ant-Miner produces classification rules has accuracy rate higher than cAnt-Miner and c-Ant-WUM, otherwise Ant-Miner has interpretability and computational efficiency less than cAnt-Miner and c-Ant-WUM. In this context, we use Ant-Miner as comparison reference. We will focus on comparison between cAnt-Miner and cAnt-WUM. From five test number show that cAnt-WUM produces classification rules higher then cAnt-Miner three times and balanced in interpretability performance and have same performance in computational efficiency.

VII. CONCLUSIONS

In this paper, we have presented cAnt-WUM as cAnt-Miner implementation with closeness principal heuristic function. This method concerning the handling of continuous attributes in ACO classification algorithms. Following the ideas of cAnt-Miner (Ant-Miner coping with continuous attributes), a new discretisation procedure based on the MDL principle was incorporated in the rule construction process, allowing the creation of discrete intervals using lower and upper bound values (i.e. $v_{lower}\_attribute < v_{upper}$).

As future research direction, it would be interesting to investigate the other heuristic function for web usage mining and other discretisation method.

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The Antecedents and Outcomes of E-Learning Effectiveness in the Manufacturing Industry

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***Abstract*—The manufacturing industry plays a very important role in Malaysia and contributes to the growth of Malaysian nation and economy. The sustained competitiveness of the manufacturing industry in this country is extremely crucial. As e-learning is a revolutionary way for learners to acquire knowledge, the manufacturing companies can and should capitalize on the advantages of e-learning in order to ensure competitiveness of the manufacturing industry of this nation. This research study intends to find out the antecedents and outcomes of e-learning effectiveness in the manufacturing industry. The research model was adapted from the updated D&M Information Systems Success Model. System Quality and Information Quality were the two antecedents of e-learning effectiveness based on this model. Perceived Usefulness was added as the third antecedent. Intention to Use and User Satisfaction were proven as measures of e-learning effectiveness. Besides, Individual Impact and Organizational Impact were found as its outcomes. This research involves descriptive study. There were approximately 400 questionnaires distributed to the potential respondents via emails and hard copies. The overall respond rate was only 29.3% and useful replies percentage was 27.3%. The result revealed that System Quality, Information Quality and Perceived Usefulness influenced e-learning effectiveness positively. Besides the above, e-learning effectiveness also affected Individual Impact and Organizational Impact positively. The manufacturing companies can refer and use the research findings and formulate their own specific strategy to achieve an effective e-learning program for their employees and organization.**

***Index Terms*—e-learning , Effectiveness, System Quality.**

I. INTRODUCTION

Knowledge has been identified as an important asset to the organizations that will create value to the success of the organizations. Training is accepted as a necessary tool for employees to acquire knowledge in order to keep the organisations competitive and constantly creating values. This was supported by Wild *et al.* (2002) who mentioned that training was a necessity in order to keep up with competitors.

Electronic Learning or e-learning is the use of digital technology for deliver learning, training and education by electronic means using the Internet or the private network. The content could be accessed through a stand-alone computer or from the server through networked computers. It combines the traditional means of education with the advantage of technology to improve, capture, disseminate and share knowledge throughout an organisation. However, e-learning is not meant to replace learning through the conventional classroom setting conditions totally. It takes advantage of new contents and delivery technologies to enhance learning. This was supported by a research study conducted by Swan (2003) who found that the outcomes of the electronic learning environment were generally equivalent to the traditional learning method with face-to-face instruction method.

The information and knowledge have been growing at tremendous speed. The use of e-learning as an alternative learning tool has also become increasingly popular. Furthermore, most organizations today are connected to the Internet which makes the access of information to individuals and organizations easier and quicker. Therefore, the need of implementing e-learning to train the workers with new technologies, product and service exists. There are many advantages of e-learning in obtaining information and knowledge. Organizations can have easy access to relevant information and implement a flexible training program for their workers. It has the economic advantage of not having to send the workers to expensive training courses and lose crucial working time in traveling for both the organization and its workers.

Many researchers had also mentioned that e-learning provided benefits to the learners and organizations. Wild *et al.* (2002) stated that e-learning is a revolutionary way to empower the workforce with skills and knowledge. Jeffrey (2001) also mentioned that people are the key to success of any organization, and to provide them with the latest and necessary tools to succeed, will help to ensure greater success to the organization. On the other hand, George (2003) stated that the great contribution of e-learning to organization was sustainable competitive advantages through a continuous and just-in-time learning process which not only increased learning retention rates but also potentially provided an increase in transfer from learning to performance. Apart from this, (Chadha and Kumail, 2002) argued that one of the most significant contributions of e-learning was a learning system that catered to the needs of people in the Internet age. Fry (2003) found that the rapid obsolescence of knowledge and training, combined with a need for life-long training

(i.e. cost effective in delivery and scalable in efficiency) were identified as corporate driver for the use of e-learning. This finding was consistent with other findings from Chadha and Kumail (2002), Collins *et al.* (2003) and Morrison (2003). Chadha and Kumail (2002) also mentioned that delivering training through the traditional educational system was a costly affair. e-learning had economic advantage and often reduced the entire cost involve at the ends. It dramatically cuts expenses associated with the traditional system of education. Likewise, Collins *et al.* (2003) said that one of the key reasons for the growth of e-learning or online learning was due to the fact that it was far cheaper than sending employees away from the workplace to a professional course. Morrison (2002) revealed that the three highest drivers of use of e-learning were 'availability anytime' and 'self-paced learning'.

Suraya (2005) stated that e-learning in Malaysia was initiated by government under e-learning for Life (ELFL) program which was a joint initiative involving the Asia-Pacific Development Information. It was funded by United Nations Development Program (UNDP), Coca-Cola Corp and Ministry of Education. ELFL aimed to bridge the digital divide in Malaysia.

As Malaysia progresses towards achieving developed country by the year 2020, it needs to transform its nation into a knowledge-based economy. Malaysia has gone through two great revolutions namely the agricultural revolution and industrial revolution. Emergence of Information and Communication technology (ICT) has transformed how the world works, learn and live. This has pushed and motivated the country to adopt the third revolution which is a knowledge based economy in order to compete in the new economic environment. The country is also taking steps in transforming its production based economy to a knowledge based economy as a result of the third revolution.

However, the manufacturing sector still accounts for more than one third of the GDP of the country. It still plays a very vital role in the economy of the country. Therefore, the manufacturing companies need to make rapid decisive actions and moves to a more advance technology based environment to improve its products. Research and development needs a pool of talent and knowledge workers who will then form the backbone of the future. In order to make the manufacturing industry stay competitive in the global economy, it is necessary to accelerate the learning process and ensure the workers are constantly enriching themselves with knowledge. Besides, the manufacturing companies can enjoy the benefits of e-learning which is a cost effective means for employees to learn new knowledge and to access information anywhere and at any time. It enables the manufacturing companies to have additional cost savings while employees are still being provided with learning opportunities.

Table 1: General characteristics and the differences between traditional classroom learning and virtual learning environment.

Characteristics	Traditional academic learning	E-Learning/Virtual learning
Focus of course	Group	Individual
Focus of content	Teacher-content	Student-centered
Form	Synchronous	Asynchronous
Time	Scheduled	Anytime
Place	Classroom	Anywhere
Flexibility	Standardized	Customized
Content	Stable, Durable	Dynamic, transitory
Number of students	Space limited	Without limits
Instructor preparation	Some [transparencies]	Extensive pre-preparation
Distribution of material	Hard copy	Electronic download
Interaction	Spontaneous	Structured
Range of interactivity	Full interactivity	Limited interactivity

Adapted from Stonebraker and Hazeltine (2004)

II. Problem Statement

The emergence of information and communication technology (ICT) has changed how the world works today. The innovation through the use of ICT such as Internet has also enabled information to be accessed easily and quickly. The manufacturing industry is one important sector in Malaysia which needs to have knowledge acquisition and organizational learning to ensure success and competitiveness. It can capitalize on the innovation of the ICT whereby e-learning can be used to achieve this purpose. At the same time, there are many benefits in using e-learning. For example, it is a cheaper learning option that could save the industry from the conventional expensive training methods. The manufacturing companies can capitalize the benefit of e-learning to ensure their success and competitiveness. The companies are now attempting o understand and measure the impact of IT so that they can make intelligent decision regarding crucial IT investment (DeLone & McLean, 2004). As the use of e-learning represents organizations' investment, the effectiveness of the e-learning program needs to be evaluated.

Many research studies were conducted by researchers on e-learning (Benjamin *et al.*, 2004; Jebeile, 2003; Lucy and Paul, 2003; Newton and Ellis, 2005; Poon *et al.*, 2004; Sambrook, 2001; Stonebraker and Hazeltine, 2004), but none of them talked about e-learning effectiveness in the local manufacturing industry.

As a result, the antecedents and outcomes of e-learning effectiveness in the manufacturing industry are being studied. These are also the reasons why this research study is being conducted.

III. Research Objectives

This research study attempts to identify the key factors or antecedents affecting e-learning effectiveness in the manufacturing industry today as well as confirming the outcomes of the e-learning effectiveness. It is intended to provide a reference to the manufacturing industry about the antecedents and outcomes of e-learning effectiveness. The manufacturing companies can formulate a strategy to capitalize the advantages of e-learning and contribute towards producing knowledge workers for the industry and improve its performance in order to compete in the increasingly competitive business environment locally and globally. Besides the above, it can also provide cost savings for the industry as e-learning is a relatively cheaper learning means as compared to traditional means.

IV. Research Questions

As stated in the title of this research study which is a study of the antecedents and outcomes of e-learning effectiveness in the manufacturing industry, the work presented in this research paper intends to address the research questions below:

(i) What are the antecedents that affect the e-learning effectiveness in the manufacturing industry?
(ii) How the antecedents influence e-learning effectiveness?
(iii) What are the outcomes of the e-learning effectiveness in the manufacturing industry?
(iv) How the outcomes are influenced by e-learning effectiveness?

V. Significance of The Study

e-learning has been identified as an alternative learning method which is also a means for sharing and disseminating knowledge among workers to achieve improved organizational performance and improve cost competitiveness. The effectiveness of e-learning in the manufacturing industry has to be looked into seriously in order to provide a reference for the manufacturing industry so that they can strategise and enhance e-learning to make the organization more cost effective and competitive, produce more knowledge base workers and achieve organizational excellence.

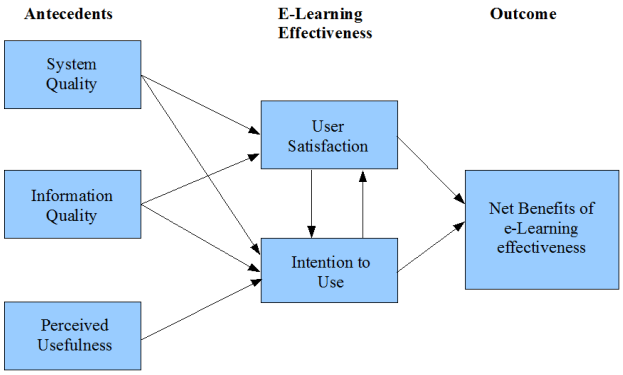
Many local research studies used Technology Acceptance Model (TAM) and Theory of Planned Behavior to study the Internet usage and use of e-learning (e.g. Dahlan *et al.*, 2005). However, Holsapple and Lee-Post (2006) adapted the DeLone and McLean's Information System Success Model and developed e-learning Success Model to study the success of e-learning. The Updated DeLone and McLean's Information System Success Model was adapted in this research study to study the effectiveness of e-learning in the manufacturing industry in Malaysia.

In this research study, Service Quality was excluded because it is believed that most employees of the manufacturing industry would use self-learning or self-dependent approach for e-learning to take place. Furthermore, the respondents involved have at least minimum e-learning experience. They may not have attended a structured e-learning session conducted by an instructor. Therefore, service quality was omitted because it may not be relevant to some of the respondents.

Besides, Perceived Usefulness was added as an independent variable of e-learning effectiveness besides System Quality and Information Quality of e-learning. This is because many research studies revealed that Perceived Usefulness was an important driver for Internet usage and adoption of e-learning (Dahlan et al., 2005; Ramayah, 2005; Ramayah & Jantan, 2004; Ramayah et al., 2005).

This research study is definitely significant in terms of providing a reference to the local manufacturing companies in order for them to capitalize the benefits of e-learning to achieve the organizations' competitiveness and success.

Figure 1: Theoretical Framework



Revised from DeLone and McLean Information Systems Success Model (2003)

Development of Hypotheses

H_{1a}: System Quality is positively related to Intention to Use on e-learning
H_{1b}: System Quality is positively related to User Satisfaction on e-learning
H_{2a}: Information Quality is positively related to Intention to Use on e-learning
H_{2b}: Information Quality is positively related to User Satisfaction on e-learning
H_3: Perceived Usefulness is positively related to Intention to Use on e-learning
H_4: Intention to Use and User Satisfaction influence Net Benefits on e-learning
H_5: Intention to Use e-learning is positively related to User Satisfaction
H_{6a}: System Quality and Information Quality influence User Satisfaction

H_{6b}: System Quality, Information Quality and Perceived Usefulness influence Intention to Use

VI. Methodology

This research study is a descriptive analysis which involves transformation of raw data into a form that is easy to understand and interpret. It uses survey method with questionnaire as the design of the study. The questionnaire developed is adapted from an Updated DeLone and McLean's (2003) Information Systems Success Model. The antecedents and outcome of e-Learning effectiveness are measured using 5-point Likert scale, used to examine how strongly subjects agree or disagree with the statements.

There are three independent variables, two dependent variables and one outcome in this research study. The independent variables are System Quality, Information Quality and Perceived Usefulness; the dependent variables are Intention to Use and User Satisfaction which are measures of e-learning effectiveness; and the outcome is Net Benefits.

The primary data of this research study was collected via survey method. The population of this research study was the employees working in the manufacturing companies who have at least minimum e-Learning experience. Therefore the unit of analysis in this research study is individual. The questionnaires were distributed to the relevant employees working in the manufacturing industry.

The items in the survey were adapted from various researches:

- 6 items on System Quality from Holsappe and Le-Post (2006);
- 9 items on Information Quality from Holsappe and Le-Post (2006) and Armstrong *et al.* (2005);
- 7 items on Perceived Usefulness from Armstrong *et al.* (2005) and Cheong and Park (2005);
- 2 items on Intention to Use from Cheong and Park (2005);
- 4 items on User Satisfaction from Holsappe and Le-Post (2006) and Armstrong *et al.* (2005);
- 9 items on Net Benefits from Holsappe and Le-Post (2006) and Armstrong *et al.* (2005).

VII. The Antecedents of e-Learning Effectiveness

The literature and past research studies discovered that System Quality, Information Quality and Perceived Usefulness, which were antecedents of e-learning effectiveness, had positive relationship with e-learning effectiveness. This research study found that System Quality had significant positive relationship with e-learning effectiveness which was consistent with the findings from previous research studies (Benjamin et al., 2004; Holsapple and Lee-Post, 2006; Jebeile, 2003; Poon et al., 2004; Sambrook, 2003). Also, Information Quality was found to be correlated positively with e-learning effectiveness in this research study. This finding was similar to findings from Benjamin et al. (2004) and Sambrook (2003). Apart from this, Perceived Usefulness was also found to be a significant factor affecting e-learning effectiveness which correlated positively to each other. The finding from this research study was consistent to the previous research findings from Dahlan *et al.* (2005), Ramayah (2005), Ramayah and Jantan (2004) and Ramayah et al. (2005).

This research study also revealed that three variables, namely System Quality, Information Quality and Perceived Usefulness were the significant factors that influenced e-learning effectiveness. 56.5% of the variance in e-learning effectiveness was explained by these three variables. As the result of the findings from this research study, these three aspects had to be looked into seriously by the manufacturing companies in order to ensure success and effectiveness of e-learning. The advantages of e-learning in the manufacturing sector can be enjoyed as well which include cost effectiveness, convenience and flexibility in learning, increased efficiency of learning and Just-in-Time learning as well as benefits from students or learner-centered learning environment.

Looking at the variables individually, System Quality refers to the performance of the e-learning system. It is a measure of the e-learning system itself. System Quality is a desirable characteristics of the e-learning environment such as ease of use, user-friendliness, stability and responsiveness. By realizing that this factor has a positive relationship with e-learning effectiveness, learners tend to achieve higher e-learning effectiveness when they perceive better e-learning system quality, the manufacturing companies ought to ensure that they provide their employees with the desired e-learning system and structure which considers ease of use, user-friendliness, stability, responsiveness and easy access to relevant information of the e-learning system. For example, e-learning can be used to support lean manufacturing activities in the manufacturing companies. Lean manufacturing is a popular process management philosophy widely adopted by most of the manufacturing companies which focuses on reduction of wastes such waste of time, waste of motion and defects created in the production floor. One way to reduce the wastes is to ensure that the workers perform their job correctly and efficiently by asking them to go through the work instructions prior to start of their work. The work instructions can be converted into e-learning format so that the workers can access the work instruction online anytime and no trainers are required. The scalability of e-learning provides learning opportunity to many workers. However, most of the workers in this category are not

highly educated. They may not be able to operate e-learning system if it is too complicated. Therefore, good system quality such as easy to use and easy to access e-learning is important to ensure success and effectiveness of e-learning in the manufacturing companies. By doing so, the workers will more likely have better intention to use e-learning and achieve higher satisfaction from the usage.

Information Quality was the second factor that influenced e-learning effectiveness. In this context, Information Quality is a measure of e-learning output such as relevancy, timeliness and accuracy of the information generated by the e-learning system. The research study found that Information Quality correlated positively to the e-learning effectiveness. Therefore, the manufacturing companies have to focus more on this aspect. They need to ensure that the e-learning system employed by the companies for their employees always has information that is the most up to date, sufficient, relevance to their work, comprehensive, being accurate and free of error. For example, product knowledge training is a common training program that is conducted by the manufacturing companies for their employees. The training can be delivered to the employees via e-learning. More employees have the opportunity to attend the product knowledge training. However, some products may have short product life cycles, the information in the e-learning material may be obsolete by the time the product is phased out and replaced by a new product. The information in the e-learning material should be updated timely and accurately so that the employees are interested ti use e-[earning to find out the latest information on the product. These are the important characteristics of e learning information quality that contribute to the success and effectiveness of e-learning in the manufacturing sector.

The third factor influencing e-learning effectiveness was Perceived Usefulness. Perceived Usefulness of e-learning is the degree to which the learners believe that the e-learning has enhanced their productivity and job performance. Davis (1989) mentioned that system has higher perceived usefulness is one for which a user believes the existence of a positive use-performance relationship. The result of the analysis in this research study revealed that Perceived Usefulness was also correlated positively with e-learning effectiveness, this means that the learners will have higher e-learning effectiveness when they perceived e-learning to be more useful than others. Based on this finding, it is suggested that the manufacturing companies should look into their employees' perception on usefulness of e-learning. The management of the manufacturing companies should introduce and educate their employees about the benefits and usefulness of e-learning before they attempt to send their employees for an e-learning course or conduct an in-house e-learning program. The employees need to realize that a good e-learning course will increase and improve their own productivity, job performance and effectiveness at work. The manufacturing companies can incorporate various training programs into e-learning such as Employee Orientation Program, Technical Training, Product Knowledge Training, Manufacturing Processes Training, Lean Manufacturing, Master Production Scheduling, Inventory Management and Demand Forecasting. The Organizations have to promote e-learning and educate their employees so that the employees will realize that relevant skills and knowledge can be gained from the e-learning program which will enable them to perform their work more accurately and efficiently. As a result, they can improve their productivity and work performance.

By realizing and understanding the importance and the significant influence of these three factors on e-learning effectiveness, necessary steps and action need to be taken to ensure success and effectiveness of e-learning in the manufacturing companies. Newton and Ellis (2005) found That effective e-learning was also affected by organization culture and organization priority, besides learners' need. Therefore, the initiative and effort of the organizations in achieving e-learning effectiveness is important. With the above, the manufacturing companies should be able to capitalize on the benefits and advantages of e-learning to ensure the competitiveness in the business world.

VIII. The Outcome of e-Learning Effectiveness

The data were analysed using SPSS and various statistical analyses were used to test the hypotheses which included Validity or Factor analysis, Reliability analysis, Descriptive analysis, Correlation analysis and Regression analysis.

The research study found that the outcomes of e-learning effectiveness consisted of two variables, which were Individual Impact and Organizational Impact. Individual Impact is the effect of the e-learning effectiveness on the behavior of learners which is closely related to the performance. Organizational Impact is the effect of the e-learning effectiveness on the performance of the organization. It is measured at the influence level which includes organizations' productivity, profitability and revenue.

This research study revealed that e-learning effectiveness had positive influence on the Individual Impact. 42.7% of the variance in Individual Impact was explained by e-learning effectiveness. Besides, the research study also showed that e-learning effectiveness affected the level of Organizational Impact 43.3% of variance in Organizational Impact was explained by e-learning effectiveness. These findings were consistent with previous research studies from DeLone and McLean (2003) and Holsapple and Lee-Post (2006).

As a result, this research study confirmed that e-learning effectiveness gave positive impact to both individuals and organizations. The individuals benefited from e-learning whereby e-learning strengthened the employees' ability to analyze and evaluate information, solve problems, gain relevant knowledge, influence other employees to read and study further and also to acquire more knowledge. Effectively, organizations also benefit from e-learning as well. It is believed that effective e-learning increases and improves the organizations' productivity, competitive position, profitability and revenues.

IX. CONCLUSION

The primary contribution of this research study was in identifying and confirming the relationship between e-learning effectiveness and its antecedents as well as outcomes. The findings of this research study revealed that System Quality, Information Quality and Perceived Usefulness were the significant antecedents of e-learning effectiveness in the manufacturing companies. Also, it was found that Individual Impact and Organizational Impact were the significant outcomes of the e-learning effectiveness.

In order for the manufacturing companies to enjoy the benefits of the e-learning cost effectiveness, convenience and flexibility in learning, increased efficiency of learning and Just-in-Time learning as well as benefits from students or learner centered learning environment, the management of the manufacturing companies can look into those three significant factors which are the System Quality, Information Quality and Perceived Usefulness in formulating their strategies to capitalize on the advantages of e-learning to ensure organizational competitiveness and success.

This research study is considered very significant and meaningful in terms of contributing useful information to e-learning in the manufacturing industry in Malaysia. Future researches on e-learning in the manufacturing industry or other product-making industries can follow up on this and research further based on the above. In this research study in particular, Perceived Usefulness was added as one significant variable in addition to two variables as stated in the Updated DeLone and McLean Information Systems Success Model.

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Evaluation of e-Commerce Web Site Stickiness and its Impact on Firm Performance: Web Hosting Industry

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***Abstract*—The purpose of this research was to investigate the influence of three promotion strategies variables, search engine optimization (SEO), affiliate networks, and word-of-mouth (WOM) on web site traffic in the context of web host industry. Then, the critical driver of web site traffic was identified. Additionally, web site stickiness was examined the influence in the relationship between promotion strategies and web site traffic. This study also intended to investigate the impact of web site traffic on firm performance. Data from the online survey of web hosts in Asia region showed that SEO, and affiliate networks are positively related to web site traffic. The regression result evidenced that web site stickiness has positive moderating effect on web site traffic, whilst web site traffic was also found to have positive relationship with firm performance. The implications of this study highlighted the most active promotion strategies for web host industry, in addition, this provide insight into the selection of the best promotional activities that could adopted by all sorts of e-commerce practitioners. To obtain an ongoing flow of customers, e-commerce practitioners have to ensure that their web sites are easy-to-use.**

***Index Terms*—Search Engine Optimization, Word of Mouth. web Stickiness, web Traffic and Affiliate Networks**

I. INTRODUCTION

Web site traffic is one of the most important performance predictors for e-commerce practitioners. Not only does the traffic reflect popularity of the web site, but also a prerequisite for generating on-line sales (Hans van der Heijden, 2003). To sustain continued growth of income, it is crucial for e-commerce practitioners to retain a sizable flow of customers to the web site. For all these reasons, many companies adopt strategies to drive more web site traffic and to build ongoing customer flow.

Hanson (2000) commented that acquiring traffic is expensive, retaining traffic is profitable, and developing traffic requires value. Internet marketing has become a major strategic consideration for web companies, including web hosts. Web host is the company that provides space on a server they own and Internet connectivity for individuals and organizations to allow their own web sites accessibility via the Internet. These web hosts are competing in the monopolistic industry making huge investment in the promotional activities for instance, banner ads, Pay-per-click and engagement with affiliate networks in order to inform, persuade and remind web site owners of its existence and product offerings (Rowley, 2004). Thus once traffic has arrived at a web site, it is important that the web site is designed in the way that it delivers good usability to increase stickiness and revisit rates, and eventually stimulates online purchases.

Problem Statement

While web engage heavily in marketing activities, the drivers of web site traffic are certainly not clearly identified (Kraut *et al*, 1999). Indeed, obtaining ongoing flow of customers on a corporate e-commerce web site continues to be one of the elusive problems facing the web hosting firms.

Because of the low-barrier entry to hosting markets, where a new hosting business can take off with only the purchase of a new web host server, it becomes convenient for companies of any size and locations to be formed (Heinen, 1996). As competition becomes more severe, it puts pressure on the profit margins of hosting services that are not sufficiently differentiated. Apparently, web hosts also experience high customer turnover when customer starts to switch to other service providers who offer similar hosting packages at lower prices.

Research Objectives

To increase our understanding on the critical drivers of web site traffic, the research objectives of the study are:

- To identify the critical drivers of web site traffic.
- To study the impact of web site traffic on firm performance.
- To investigate the influence of web site stickiness in the relationship between promotion strategies and web site traffic.

Research Questions

- What are the factors that influence the traffic to web site?
- What are the effects of web traffics to firm performance?
- Does web site stickiness moderate the relationship between promotion strategies and web site traffic?

II. THEORETICAL FRAMEWORK

The focuses of this study are two folds: first, it studied the relationship between promotion strategies, particularly search engine optimization (SEO), affiliate networks, and word-of-mouth (WOM) with web site traffic. Secondly, the research studied the relationship between web site traffic and firm performance. These three strategies were taken as key drivers for web site traffic because they form the elements of passive marketing that make prospect contact the service providers, and potentially generate an ongoing flow of customer in the long run (*Eli Research, 2006)*.

The effect of web site stickiness was also examined to understand whether it serve to moderate the relationship between the independent variables and dependent variable. Finally, the research also studied the impact of web site traffic and firm performance.

Search Engine Optimization (SEO)

Many earlier studies provided insight into adoption of SEO as a strategy to increase company presence on the Internet. Internet technologies are increasingly driving one-to-one marketing relationships. On the Web, the first chain in customer relationship building begins not with your site, but in ensuring that customers and other desired demographics (e.g. media) are referred to your site (Green, 2003). According to Forrester Research Inc., search sites (engines and directories) originate 80 percent of all web site traffic. With both individuals and companies alike widely using the Internet to conduct research to inform buying decisions, visibility on the web is critical.

SEO is the process of increasing the amount of visitors to a web site by ranking high in the search results of a search engine. The higher a web site ranks in the results of a search, the greater the chance that the site will be visited by a user. SEO helps to ensure that a site is accessible to a search engine and improves the chances that the site will be found by the search engine (Orsini, 2007).

Green (2003) commented that web sites must be fine-tuned for search engine indexing and compete for prominence using: (1) on-site optimization; (2) paid inclusion; (3) sponsored links and paid listings. Search engine optimization can be conducted in-house following a number of steps:

- Keyword research – find out what words clients are using in their search items.
- Write for the web – produce concise copy that incorporates keywords that are important to the target audience (as identified via the above research). The most important keywords should appear near the top of the page, or in bold, or as hyperlinks.
- Metadata – provide content with context. It is 'information that describes information'. The page browser title is displayed on search engine results listings.
- Links – secure lots of links from relevant third party, especially from the reputable site such as university web sites.
- URL submission – submit your site to the web directories.

Paid inclusion involves a company paying a search engine for the right to submit its site directly to the search engine's database so that the site is available more quickly to the searchers. This method is an effective approach for advertiser because it guarantees prompt inclusion in the search engine database. Conversely, paid listings are short text advertisements within search results screens, with links to the advertiser's site. Advertisers compete with another by bidding to sponsor selected keywords, so advertisers only pay for those visitors who have clicked on their listing to go to their web site. However, optimizing site presence through search engines can be time consuming, and demanding task. It takes months for a search engine to re-index web pages for site owner to see the result. Businesses always outsource this task to SEO companies that specialize in traffic generating or site visibility programs.

Affiliate Networks

During the early stage of e-commerce somewhere around 1998, advertisers engaged in online marketing such as payment for interest (clicks) and email marketing. However, neither one delivered its promise. Clicks were just clicks and often had nothing to do with sales. E-mail quickly digressed into spam and that promise is unlikely to ever materialize in the ways that on-line marketers hope and promised (Duffy, 2005).

With all of the frustrations, many in the marketplace search for true pay for performance marketing. The advertiser is willing to pay when his product is sold, at the same time; many affiliates are to run ads and/or product promotions on web sites knowing that they will earn commissions when successful conversion occurs. There is motivation and reason to believe that this marketing strategy will live much longer than other on-line marketing strategies and will evolve over time and hold its spot as the most genuine and durable marketing activity for e-commerce companies.

The affiliate network works in the way that affiliates place a variety of different kinds of ads, such as banners, text ads, or even product links) on their own web site, with aims to motivate the online visitors to take an action to access, review and potentially buy a product or service from the advertiser web site (advertiser is a term used to represent the party who seeks to sell the product). When it works, the affiliate gets paid a commission.

Apart of affiliate networks, Rowley (2004) suggested another type of communication channel, the banner ads. Banner ads offer links through to the other web pages,

and they are typically placed on web sites that already have established traffic, such as portals in order to increase the likelihood that the banner ad will be seen. Banner ads also play a role in creating and reinforcing brand image. The online visitors see the advertisement and note it consciously or subconsciously (Martin, Nguyen, and Wi, 2002). Visitors who are exposed to a repeated advertisement would recall and recognize an advertiser easily when the times they acquire the product. In the same spirit, Rowley (2004) pointed out that companies place banner ads in pursuit of desired outcome that visitors will see the advertisement and note it consciously or subconsciously; this viewing helps to create and reinforce brand image.

Word-of-Mouth

Online word-of-mouth has become a common topic of research in the area of computer-mediated communication, particularly in the context of consumer-consumer interactions (Sun, Youn, Wu and Kuntaraporn, 2006). Bush, Bush, Clark and Bush (2005) dubbed word-of-mouth (WOM) as "buzz marketing"; it can be an important component for site traffic generation. It is the process of letting Internet users learn about a web site through multiple Internet channels, such as emails, participation in chat rooms or new groups, bulletin boards, forums, instant messenger clients, web blogs, product or service rating on a consumer feedback web site, or via a genuine link on another web site (Daoust, 2007). In the process, online WOM has attracted researchers' attention as a convenient, inexpensive, and less intrusive venue for sharing interests and ideas in online communities (Sun, Youn, Wu and Kuntaraporn, 2006).

Forums create the prime opportunity for the e-commerce practitioners to enhance its marketing communications through the hypermedia environment. As Armstrong and Hagel (1996) observe, "virtual communities not only gather potential purchasers together, but they also arm them with far more information than they have typically been able to access conveniently and cost effectively in the past". By adding value through the provision of content (and facilitating information flows between members), e-commerce web sites can both draw customers in and expose them to the elements of the marketing communications mix. Wills and Wills (1996) state that the benefits of electronic publishing to readers are founded through two predominant motivations: to stay up to date and awareness of development in their area(s) of interest; and to search the body of knowledge on a given topic. WOM communication is likely to be perceived as more persuasive because information from personal sources is considered more credible than information from mass media or marketing sources (Sun, Youn, Wu and Kuntaraporn, 2006). Information from personal sources is both custom-tailored and independent of the intention of an organization to sell something. All of the above factors may contribute to the trustworthiness of WOM communication channels, although consumer comments posted on an independent online forum might not be more persuasive than those posted on a corporate web site. Some current database marketers can also create highly customized messages and deliver them to specific target with the help of sophisticated database management technologies over the Internet. In the meantime, many consumer-generated online reviews are far removed from the personally –tailored messages sent by savvy marketers. They also suggested that responses to consumer comments are moderated by such receiver characteristics as product involvement and experience with offline WOM. It seems to follow that people might not be influenced by where and how the messages are placed as much as by their interactions with products and opinion leaders in the diffusion of innovation process.

Website Stickiness

Stickiness measures the ability of a web site to bring visitors back and again, some determinants of web site stickiness includes: (a) how often a visitor comes back to the web site; (b) time spent per visit; (c) number of page views per visit? These aspects of stickiness are related to the usability of the web site.

Pearson, Pearson and Green, (2007) define web usability as making the design simple enough that customers, who by nature tend to be goal-driven, can accomplish their task as quickly and painlessly as possible. It is also important for design to meet the needs of the customer rather than be attractive and fun. If the customer finds the site too difficult to use, there will not be purchase or return visits. Recent information system literature has focused on web site usability in the context of understanding e-commerce, in which some researchers investigated usability based on multiple dimensions and media richness literature, as shown below (Pearson, Pearson and Green. 2007):

1. Navigation
   In the review of literature on web usability, authors found that navigational controls were important for web sites. They found that customers prefer web sites that lend themselves to navigation efficiency. Results from the previous studies show that users will take path totally different from what designers expect – such as completely skipping the home page. Navigation that is simple, efficient, user-centered, and flexible will help the customer achieve intended goals and increase the likelihood of return visits.
2. Customization and Personalization
   Studies have found customization and personalization, dynamically fitting a site to the user's needs, to be important factors in web sites success. In this spirit, personalization also referred to as "made-for-the-medium" can increase user

satisfaction with an interactive web site, which is essential to establish ongoing relationship with the customer.

3. Download Speed
   Content of a web site such as images, video clips, and/or audio clips can affect the download speed in initially accessing a site and in subsequent request of pages within the site. Research has shown that users find download delay and important factor in web site usability. The author found that waiting too long access online information can lead to anxiety for users and loss of satisfaction within the web site. Thus, these users are reluctant to visit the web site again.
4. Accessibility
   Accessibility is important for web site usability as users will not be able to complete purchase transactions if they are unable to use this site. Accessibility, when pertaining to a web site, means that information has been made available for use by potential users of that particular web site, including individuals with disabilities. However, authors warned that following every accessibility guideline can involve excessive development time for a business, but he suggests that developing reasonably accessible web sites should be a priority. Web site designers should test the sites with text-only browsers and make sure that at minimum, all information is being displayed. Users will be more satisfied with accessible sites and are more likely to make return visits.

If a web designer was able incorporate the above dimensions into the web page design, there is higher chance for the online visitors to return to the web site more regularly.

Theoretical Framework

Figure 1 shows the research framework with the hypothesized linkages between the constructs. These linkage deals with five sets of hypotheses:

1. The effect of search engine optimization on web site traffic.
2. The effect of affiliate networks on web site traffic.
3. The effect of word-of-mouth on web site traffic.
4. The moderating effect of web site stickiness on web site traffic.
5. The relationship between web site traffic and firm performance.

Hypotheses

H_1: The higher the search engine ranking, the larger the impact on generating web site traffic

H_2: The greater the use of affiliate networks, the larger the impact on web site traffic

H_3: The effect of WOM has positive relationship with web site traffic

H_4: The more sticky a web site, the greater impact on web site traffic

H_5: The heavier the web site traffic, the larger the impact on firm performance

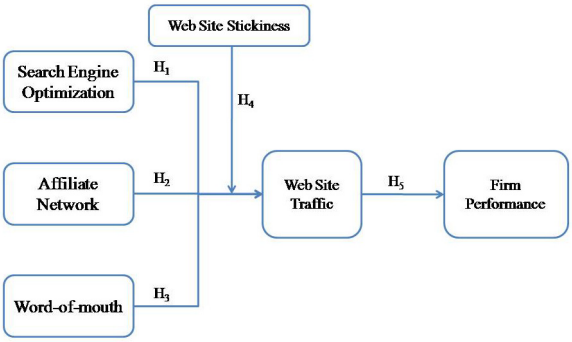

Fig.1. Theoretical Framework and Hypothesized Relationships

III. METHODOLOGY

The present study investigated the relationships between Internet promotion strategies (SEO, affiliate network, WOM) and web site traffic with moderating effect of web site stickiness. Then, the relationship of web site traffic with firm performance was also studied. This was a field study, and thus, no artificial setting was invented. This chapter covers the methodology of the study, research design, sampling and procedures, data collection method, and the statistical tools employed in testing the hypotheses.

Research Design

The research attempts to investigate the relationship between the online promotions strategies on web site traffic, and the impact of web site traffic on firm performance. Thus, there were six variables that formed the framework:

1. Independent variables: SEO, affiliate network, WOM
2. Moderator: web site stickiness
3. Dependent variable: web site traffic, firm performance

Each variable resembles a measurable item that will be used in data collection stage. The following section discusses the population/sample, the items to be assessed, as well as the instruments that will be used to collect data.

Sample and Data Collection

Data was collected via online survey, from the past studies, the respondent rate of using online survey lies between 14 to 20 per cent. Taking this view, this study aimed to receive approximately 200 respondents, hence, at least 1000 invitation emails were required to get the desirable amount of respondents. The focus for the research is the web hosting industry, therefore, a sample of 1000 web hosting companies in the Asia region, was

selected randomly from the industry listed on Web-Hosting-Top, (http://Web-hosting-top.com/Web-hosting/ directory). To gather the contact information of each web site, their web sites are visited, and the general contact email addresses were compiled into a mailing list system. Out of the 1000 companies, 90 personal email addresses of the senior executives or owners of the company were retrieved.

Online Survey

To test the hypothesis, survey instrument was used to collect data. The questionnaire was published through the Web, and then the emails were broadcasted to invite the web hosts to participate in the online survey, where the respondents were directed by a hyperlink to a web page that contained the questionnaire. Cover letter, along with the reason for survey was also posted on the web page. Recipients were also requested to forward invitation to the relevant person in their company/workplace. Online survey method is chosen because it is convenient, time and cost effective to intact with the respondents who are dispersed in different geographical areas.

The online survey form included variety of measures that assess the following concepts: (1) search engine index and ranking; (2) referrals to the web sites; (3) web site traffic analysis including hits, number of visitors; (4) sales performance that related to leads, new orders, customer relationship; (5) proportion of marketing budget on the focused promotion strategy. All measurements are standardized to five-point scales, with 1 being 'strongly disagree' and 5 for 'strongly agree'. One negative statement will be added into questions set for each variable.

A total of 36 questions were asked, which were categorized into two sections: company profile, and the impact of promotion strategies. The major attribute of respondents' company profile, which included years of establishment, number of years engaged in Internet promotion strategies, and the types of promotion strategies that are utilized, were collected. Companies involved in the study remain anonymous, but each has been carefully logged for analyses purpose. To reduce the number of incomplete questionnaire, the survey system highlighted the missed questions, and prompted a message to participants requesting them to complete all the questions, before they submit the survey.

The first wave of 1000 invitation emails that was sent to the general email address of each sampled company, with anonymous reference to the senior executive/marketing manager, producing a very low response rate of 2.0% (20 responses). Few days later, a follow-up email was sent to same general email account for each company, in which we gently reminded them to answer or forward the invitation email. At the same time, a personalized follow-up email for sent to the senior executives of each web host from the 'executive' newsgroup. The cutoff date of the survey was 9 days after the invitation, and was stated in those invitation emails. The follow-up emails then produced additional response rate of 14.4% which raised the total response rate to 16.4% (164 responses).

Measures

Since there is a lack of any established criteria for measuring the success of the uses of Internet promotion strategies, scales were not available for the variables described in the conceptual framework. As a result, measures were developed following the guidelines suggested by Avlonitis and Karayanni. (2000). Thus, to operationalize the constructs of the study, we primarily drew upon the academic and trade literature on IT, the Internet Marketing, and the electronic commerce.

To examine the significance of SEO on web traffic, attributes that were taken into account encompassed Google PageRank, Alexa Trafic Rank (Alexa Internet Inc, 2008), click-through-rate (Mullarkey, 2004) for Pay-per-click (PPC), density of traffic-generating keywords on the web pages, number of referrals from search engines, as well as the agreement about portion of marketing budget allocated for the SEO strategy, and the level of return-of-investment. These items were arranged on the five-point scale and the respondents were asked to indicate their level of agreement as whether or not SEO adequately justified the attributed, based on their experience on the utilization of this strategy (e.g. "Google Page Rank has improved compared to the same period last year."; "web sites can be found in major web directory:; "Search engine referrals has increased").

A measure of the influence of affiliate networks on web site traffic was constructed on five items, followed the example provided by (Phippen, Sheppard and Furnell, 2004). Each item was assessed on the five-scale point. Questions that were posted to respondents required them to state their agreement level, specifically about the effect of banner placements on other web sites, affiliate programs, back links on increasing the visitor flows to web site. Further, questions about proportions of marketing of marketing budget in affiliate networks and its return-of-investments were also queried.

In constructing the survey items specific to WOM, a total of four items (Phippen, Sheppard and Furnell, 2004) was asked to indicate whether promotion strategy relies heavily on WOM, whether referrals from any online forum and from blog sites has increased. In addition, the respondents were posted a question asking whether the inclusion of viral element to the web site, such as RSS Feeds, has decreased the number of visitors. This is an example of negative statements that was used to validate responses to see if the answer is in line with the positive ones.

Web site stickiness was also assessed on the five-point scale, where the respondents were asked to rate their degree of agreement in pertains to the sticky impact of

web sites toward visitor traffic based on the responses to the four items (Hoobin.com, 2007):

1. Repeated visit – frequency of repeated visitors return to web site.
2. Length of visit – number of page views per visit.
3. Depth of visit – average time spent on the web site per visit.
4. Visitor loyalty – percentage of repeated visitors to the web site.

Lastly, to examine the influence of web site traffic on firm performance, sales-related items were developed. Like other measurement items that were assessed from 1 to 5 agreement level, asked to indicate the degrees of increment of the following constructs (Avlonitis and Karayanni, 2000):

1. Number of visitors to the web site
2. Number of unique visitors to the web site
3. Number of repeated visits
4. Sales revenue for the organization
5. Number of sales leads
6. Receipt of new orders
7. Improvement of customer relationship

IV. DATA ANALYSIS

Characteristic of Sampled Respondents

Table 1 shows the characteristic statistic relating to the responding organizations and respondents. This shows that 43.9 percent of respondents' are owners, nearly one quarter are executive and the remainder are director and manager level. More than half of respondent companies have less than 20 employees, 17.1 percent of the respondents have between 20 to 50 employees, and only 1.2 percent has more than 1000 employees. This is considered to be a reliable set of data since it is a representative profile of Asia web hosts companies who are involved in this relatively new hosting industry, and who are currently practice the Internet marketing, illustrated by a plethora of medium and small companies. A few but large companies which had established more than 10 years are also presented. From the statistic result, most companies (14 percent) have been established for 5 years.

In terms of the usage of Internet marketing promotions, the minority (3.0 percent) has three to four years experience, 15.9 percent less than two years experience, and nearly 17.1 percent has four and five years experience. In the other words this reveals that Internet marketing promotion strategies are popular among the web host industry.

Listings of Promotions Strategies Used By Web Hosts

As far as the type of the promotion is concerned, as illustrated in the Table 2, SEO is the most popular strategies that are used by web hosts in the Asia which representing more than two thirds of the sample (84.1 percent). This followed by 70.1 percent of web hosts companies advertise their web sites in the Directory listing sites. Exchange link with other web sites found to be one of the popular strategies, where it was reported 61.6 percent of utilization.

Half of the sampled web hosts use Pay-per-Click strategy, which is a kind of search engine marketing. Out of the 164 respondents, 80 of them adopt banner advertising to promote their web sites, whereas 63 companies (38.4 percent) offer affiliate programs. Participation in forum is less popular among the web hosts, where only 60 sampled companies using it as a promotion strategy. Only 29.3 percent adopts viral promotion, for instance, publishing video clips and loading RSS Feeds on their web site to attract customers, and only 28.7 percent of the sampled companies chose web blog strategy to recommend their products or services.

Table 1. Characteristics of Sampled Respondents

Measure	Items	Frequency	Percent
Position	Executive	36	22.0
	Manager	17	10.4
	Senior Manager	8	4.9
	Director	31	18.9
	Owner	**72**	**43.9**
Number of Employees	**Less than 20**	**96**	**58.5**
	20-49	28	17.1
	50-99	22	13.4
	100-299	11	6.7
	300-499	2	1.2
	500-1000	3	1.8
	Over 1000	2	1.2
Years of Internet Penetration	Less than 2 years	26	15.9
	2-3 years	32	19.5
	3-4 years	5	3.0
	4-5 years	28	17.1
	More than 5 years	**73**	**44.5**

Table 2. Listing of Promotion Strategies Used by the Sample Web Hosts

Promotion Strategies Used	Frequency	Percent
Search Engine Optimization Tool	**138**	**84.1**
Directory Listing	115	70.1
Exchange Links with Other Web Sites	101	61.6
Pay-per-Click (PPC)	83	50.6
Banner Advertising	80	48.8
Affiliate Program	63	38.4
Participation in Forum	60	36.6

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Influence of Web Site Traffic on Firm Performance

As presented in Table 3, the R^2 for the regression model was 0.434, which it suggests that 43.4 percent of the variability in the respondents' firm performance can be explained by web site traffic. Because the study took only single determinant, there were unexplainable factors that have not taken into account for this study, for example external factor like macro economic. In fact, the firm performance is greatly influence by the inflation, taxation, consumer expense pattern. Unique visitor is the most critical factor for the firm performance, and it was used for the next regression analysis.

Based on the calculated *F* statistic (F=124.390, p=0.0000), we can conclude that this model is significant and valid predictors of the dependent variable. Thus, the results support the belief that the web site traffic is significant of the firm performance.

Table 3. Results of Regression Analysis on Web Site Traffic as Driver for Firm Performance

Independent Variable Unique Visitor	
Coefficient Beta	0.659
F value	124.390
R2	0.434
Adjusted R2	0.431
Eigenvalue	1.970
Significance	0.000

Influence of Promotion Strategy on web site Traffic Using web site Stickiness as the Moderator

Next, the regression analysis to determine the relationship between promotion strategies and firm performance was executed. To test the hypothesis relating to the moderating effect (H_4) the similar practice followed by Ranaweera and Neely, (2003). Regression analysis was undertaken hierarchically to test the significant moderating effects over and above the simple effects of the independent variables. The dependent variable used in the analysis was unique visitor, which one of the items for web site traffic. The moderator variable taken into analysis was the customer daily return.

A total of three steps hierarchical regression were conducted. For the first regression analysis, with unique visitor as the dependent variable, five promotion variables were entered. At the next step, daily return was added into model 2. Finally, in the third step, the interaction terms (GOOxDAILY, EXPxDAILY, ROIxDAILY, and BANxDAILY) were added into model 3.

Table 4 depicts the regression results using web site stickiness as a moderator in the relationship between promotion strategies and web site traffic.

The model 1 contained the simple additive model, which had R^2 of 0.427. At the next stage web stickiness was added to the model 2. This resulted in an increase in the significant R^2 value to 0.450 (β=0.181, $p<0.01$). With this, we concluded the model 2 is the better model, because it explained 45.0 percent of variations. The following discussion is therefore based on model 2.

PPC was negatively related to web site traffic, however Google PageRank, PPC and ROI of SEO were positively correlated with web site traffic, thus, this is sufficient to confirm the positive effect of search engine optimization (SEO) (at significance level 0.10), as hypothesized in H_1. Banner ads also had positive relationship with web site traffic, given it was an item of affiliate networks, therefore we can conclude that H_2 was supported. However, none of the items of WOM was found significantly correlated with web site traffic, hence H_3 was not supported.

Table 4. Hierarchical Regression Results Using Web Site Stickiness as a Moderator in the Relationship between Promotion Strategies and Influence in Web Site Traffic

Variables	Coefficients Beta Model 1	Coefficients Beta Model 1	Coefficients Beta Model 1
Independent Variables			
Google Page Rank	0.305	0.246	0.242
PPC	-0.178	-0.212	-0.218
Keyword Exposure	0.249	0.217	0.218
ROI of SEO	0.269	0.254	0.260
Banner	0.209	0.181	0.211
Moderating Variable			
Daily Return		0.181	0.290
Interaction Terms			
GOOxDAILY			0.296**
PPCxDAILY			-0.305**
EXPxDAILY			0.218
ROIxDAILY			0.318
BANxDAILY			0.347**
R^2	0.427	0.450	0.351
Adjusted R^2	0.409	0.429	0.330
R^2 Change	0.025	0.023	0.032
F Change	6.880	6.648	8.271
* $p<0.05$, ** $p<0.01$			

Three of the interaction items were significant. Specifically the GOOxDAILY, PPCxDAILY, BANxDAILY were significant at 0.01 level. These

findings suggested that daily return moderated the relationship between promotion strategies and web site traffic. Hence H_4 was supported.

V. DISCUSSIONS

Critical Factors of web site Traffic

One of the research objectives is to identify the critical factors influencing the web site traffic. This is achieved through the interpretation of the regression analysis, and it identified five factors as:

1. Goggle PageRank
2. Keyword Exposure
3. Pay-Per-Click
4. Banner Ads
5. Return-on-investment of SEO

In terms of web site traffic, the regression analysis suggested that number of unique visit to web site is the critical factor for firm performance. Overall, the statistic analysis showed that search engine optimization (SEO), and affiliate networks on web site traffic were significant and positive. The correlation of WOM on web site traffic could not be determined, this implies that hypothesis H_3 was not supported. The results also showed that as hypothesized, web site stickiness (customer daily return) moderated the relationship between promotion strategies and web site traffic. These results confirmed all the hypothesized relationship H_1, H_2 and H_4 respectively.

Interestingly, out of five critical factors, four of them were factors of SEO. Survey data offered further supporting evidence, as majority of web hosts (84.1 per cent) in the Asia region adopt SEO tool to draw traffic to their web site. Banner advertisement is one of the components of affiliate networks that can use to attract customers. From the coefficient Beta, Goggle PageRank was identified as the critical driver web site traffic. Return-on-investment (ROI) and Pay-Per-Click (PPC) also have significant impact on web site traffic. These two factors are positively related to the web site traffic; therefore, we can conclude that the more money a web company invests in search engine optimization and PPC, more visitors would be attracted to the e-commerce web site.

Based on conclusion, small scale web hosts locating at lower ranking might have invest greater portion of money in the search engine advertising that had contribute to heavier flow of customer to their web sites , as compared to top ranked web hosts. Yet, due to the confidential nature of the web traffic information, we were not able to collect adequate information such as Goggle PageRank, number of unique visitors, sales conversation rate of each web host, and because of the types of promotion strategies utilized are of differs from one web host to another, there is still lack of evidence to explain explicitly the relationship between ranking and traffic among the Asia web hosts.

Impact of Affiliate Networks on web site Traffic

The impact of affiliate networks strategy was found lessen than SEO influences on the web site traffic. Regression analysis evidenced that number of unique visitors has the highest impact on sales revenue. This can justified the most of the unique visitors are potential buying customer, this group of visitors has buying intention and hence, they return to the e-commerce web site. We can infer that the high percentage of SEO tool usage is due to the hefty return-on-investment in attracting visitors.

Regarding the affiliate networks, it has direct relationship with web traffic. There are approximately 38.4 percent web hosts engage in the affiliate marketing program. Similar to affiliate program, most banner ads are managed through several major networks, and the networks provide the technology to support tracking activities (when a referral sends a potential customer to an adviser's web site) (Duffy, 2005). The click-through of banner ads could also contribute to the links/ web site page popularity, and thus, enhancing the Goggle PageRank. Drawing on this view, the use of diffusion affiliate networks can be seen as an example of successful adoption of Internet promotion strategies.

Impact of Moderating Effect on the Relationship between Promotion Strategies and web site Traffic

In a regression model with a moderator effect, interpretation of the coefficient is fundamentally different. What the β value shows is the effect of the independent variable (SEO) when the other independent variables zero. To determine the total effect of an independent variable at the given levels of other independent variables, the separate and moderated effects must be combined, by following the approach practiced by Ranaweera and Neely (2003). By interpreting the β coefficients, when the stickiness of a web site is perceived at average, an increase in GogglePageRank by one unit is going to increase web site traffic by almost 2.5 times (coefficient beta = 0.249). Further, when a web site is sticky, and thus has a higher rate of repeated visits, an increase in one unit of Goggle PageRank is likely to improve the web site traffic by nearly 4.3 times. Having the web site indexed by major search engine was found one of the factors respect impacting the web site traffic, however, due to existence of collinearity, this factor had been eliminated from regression analysis.

Impact of web site Traffic on Firm Performance

With respect to the firm performance, it was found that web site traffic has significant and positive effects upon sales revenue, providing support for the hypothesis H_5. For most organization, sales performance is the primary objective to justify the existence of the company. This finding is consistent with numerous IT studies that suggest that top management support is a decisive factor for the successful implementation of any IT innovation

(i.e., the Internet marketing promotion) leading to superior performance (Rockard and Crescenzi, 1984). Besides, this is always the case for the successful adoption of new organization process; in this case, it refers to the use of Internet promotion strategies in marketing activities.

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Rural Communities' Information Needs and 'Portal Desa' Template

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***Abstract*—This paper presents the findings based on a study conducted in the states of Kedah and Perlis on the information needs of rural communities. A total of 12 villages in both states have participated in the study. The selection of the villages was made according to four economic sectors, namely fishery, paddy, palm oil and rubber. Fieldworks were carried out involving surveys, interviews and observation. The findings show that the types of information requested by these communities include information about business, career opportunity, education, health and ICT. The study then used this information as a basis to design templates of 'Portal Desa' for each economic sector. The portal will function not only as an information gateway for varieties of information related to business, education, and health, but also as a channel for the rural communities to share with the world regarding information of their communities, activities, cultures, and local products.**

***Index Terms*—information needs, ICT applications, rural community, portal design**

I. INTRODUCTION

In Malaysia, interests among government agencies, non-governmental organizations and private sectors in introducing ICT knowledge, skills and usage to rural communities are increasing from time to time. Various efforts have been taken to bring the communities closer to ICT, among others, including organizing ICT awareness program and ICT-related workshops, establishing public Internet access center at villages, and even developing web-based and online applications such as Agro bazaar etc. In developing web-based applications for rural communities, information needs such as their requirements associated with socio-economic activities and daily lives are highly important in designing and delivering relevant and suitable applications. Identification of information needs is essential to the design of information systems in general and to the provision of effective information services in particular [1].

In the state of Kedah, 85.0% of its population resides in the rural areas. The introduction of ICT to these communities has shown that ICT penetration and usage programmes have not been very successful. This is evidenced when most respondents are found to have (i) no computers, (ii) lack of basic ICT knowledge and skills, (iii) lack of awareness about the existence of online applications, and (iv) lack of interests in using ICT and online applications [2]. The lack of interests in using ICT and online applications is demonstrated when the available online applications provided by several parties do not completely fulfill the needs of the rural community. Furthermore, the applications do not reflect their background, ways of lives, and the socio-economic activities. After all, members of the community during the development of the applications may not be involved and present.

A more credible and useful information needs to be identified to develop appropriate content as currently there are too much irrelevant information on the web for the rural communities, for instance the farmers. In line with this, a study was conducted to identify relevant information for such purpose. Data was collected from the states of Kedah and Perlis according to the four economic sectors; fishery, rubber, paddy and palm-oil. Information gathered from this study will be used to develop a template for website development. It is hoped that the findings from this study can contribute in enhancing the interest of rural communities in using computers and the Internet, and eventually boost their socio-economic well-being.

II. LITERATURE REVIEW

As defined by [3], telecentre (TC) is a one-stop centre that provides ICT resources to the public access, dissemination of information and knowledge and e-government services, e-banking, e-health and others to improve the socio-economic status of targeted local communities. For the rural communities, TC could be a major access point for them to search for varieties of

information. Information is important in empowering the communities in rural area to improve the quality of life. According to [4], there are several approaches to improve the rural area community quality of life; which one of them is by empowering citizen to access information and knowledge. This can be achieved if they are equipped with the right information to improve their daily life activities. For instance, in an area where agriculture dominates the economic activity, information regarding agriculture could be beneficial to those communities. Furthermore, they can also increase their income if they could utilize the published information to make decision regarding the input and production [5]. In addition, the farmers also need to coordinate the market in marketing their products [6] not only to local community but also to outsiders.

These communities could also benefit from having a community portal which normally featured local news, discussion forums, links to local business and organization websites, etc. Such a portal collects and integrates relevant data of the community, so that its members can better discover, search, query, and track interesting community's activities [7]. The community portal is a vital tool for communication and development of the community. It helps in disseminating information about community meeting, neighborhood gathering, and even sometime petition to the local authorities. There are a lot of ICT-based projects set up in some countries that use community portal as part of the tool to develop the local communities. Rural human development project such as the famous Grameen microfinance project [8] in Bangladesh, iShakti [9], and Community Information Center (CIC) [10] both from India have shown excellent results in helping the rural community to change for a better life. Hence, community portal have been proved to be a good tool to help revolutionize the community in the present age.

A community portal is supposed to deliver the right and suitable information to the related group of people in that community. It is emphasized in literatures [11], [12] that the contents of a portal must be designed to meet the communities' needs for local information on agriculture, socio economy activities, health, and nearby markets. In relation with this, a good portal must portray the right information needs of one community. Hence, such community portal, henceforth referred to as "Portal Desa" has been proposed to reflect the needs of the corresponding communities. Ultimately, it is hoped that this portal being accessible by the public through the existing telecentres.

III. METHODOLOGY

A total of 12 villages located in the Northern region of Peninsular Malaysia, covering the states of Kedah and Perlis have participated in the study. The selection of the villages was made according to four economic sectors, namely fishery, paddy, palm oil and rubber. Fieldworks were carried out involving surveys, interviews and observation throughout a period of two months. Statistical analysis on the responses was performed to determine the information needs relevant to the communities' daily activities. Finally, together with the application designer, researchers developed the templates in a joint application development sessions.

IV. FINDINGS

The first part of this section presents the findings regarding the information needs according to four economic activities: Fishery, Paddy, Palm Oil, and Rubber. Table 1.0 show the critical group of information needs pertaining to the major activities or functions in the four economic sectors.

The second part of this section is the discussion and comparison between the information obtained and the information required by the communities in each sector. Information are categorized in a few groups namely; agriculture, medical and health, education, religion, business, lifestyle, entertainment, family matters, sport, politics, career opportunities and IT/computer. Figure 1.0, Figure 2.0, Figure 3.0 and Figure 4.0 show the difference between the information obtained and required by the communities in each sector.

A. Fishery Sector

Majority of the communities in the four villages in the fishery sector are fisherman while others are involved in fishery- or sea-related jobs such as in secondary industry (e.g. dried fish, dried shrimp, and shrimp paste). Their daily activities as fishermen involve planning and preparation, fishing, selling, and engaging in the secondary industry. Getting involved in these activities, it creates the needs for a lot of information. Examples of such needs are status of weather, status of boat and other related equipment, location to catch fish, market, order, and middleman (or buyers) (Table I).

Other than fishermen, other members of these communities include the fisherman's family, the Fishermen Association, boat owner, middlemen, and the workers of the secondary industry. The groups of information obtained by them are (in ascending order) (i) religion, (ii) family matters, (iii) education, and (iv) sport (Fig. 1). In contrast, information they have obtained less are (i) IT/computer, (ii) agriculture, (iii) business, and (iv) career opportunity. Interestingly, the communities also identified that they are looking forward to learn more about what they already knew. For instance, even though they have obtained more than 70.0% of information about family matters, they still expect to have more knowledge of the same category in the future. The figure also highlights a greater gap between information obtained and required in relation with (i) IT/computer, (ii) business, (iii) agriculture and (iv) career opportunity.

Table 1. Information Needs according to Activities

Sector	Major Functions/Activities	Information needs
Fishery	Planning, preparation before going to sea, fishing, selling, and secondary industry.	Types of boat, licenses, subsidies, type of catch, loans, weather, engine, equipment, location, middleman, products to sell, buyer, market.
Paddy	Planning, land preparation, growing, and harvesting.	Land, fertilizer, pesticide, paddy seeds, subsidies, irrigation schedules, harvester agents, supporting workers, and farmers' association.
Palm-oil	Planning, planting young tree, and harvesting	Land, fertilizer, pesticide, middleman, oil palm planter, seedling, subsidy, agency and supplier
Rubber	Planning, planting young tree, rubber tapping, and harvesting	Plantation, rubber tapper, subsidy, agency, supplier, seedling variety, fertilizer, pesticide, and middleman

B. *Paddy Sector*

The type of information acquired by the communities in paddy sector is almost similar to those in the fishery sector. In sequence, the most information they acquired are about (i) religion, (ii) family matters, (iii), medical and health, and (iv) education. The least attained are (i) IT/computer, (ii) business, and (iii) career opportunity. Furthermore, there is also a higher difference between the information attained and information needed in IT information. As shown in Fig. 2, the percentage of IT information currently known by communities in the paddy sector is about 20.0% while the required information for that category is almost 60.0%, which is about 40.0% difference. A high gap between information obtained and required is also shown in other categories of information including in business, career opportunity, and education.

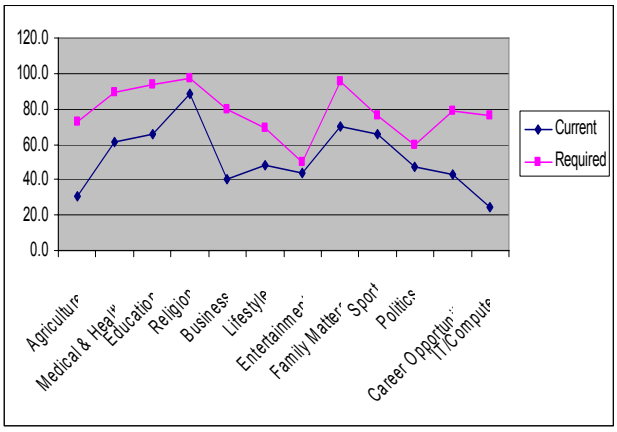

Fig. 1. Level of information obtained and acquired in fishery sector

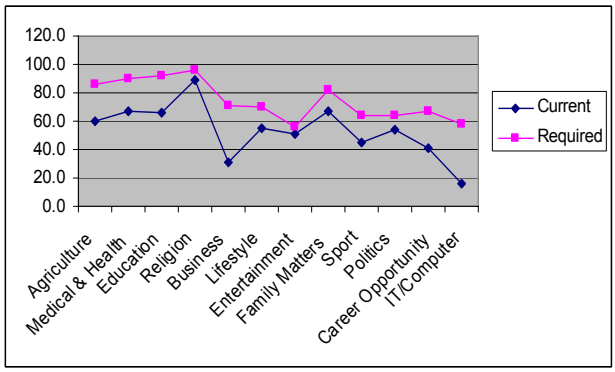

Fig. 2. Level of information obtained and acquired in paddy sector

C. *Palm Oil Sector*

The study has the opportunity to gather information from only three villages in the palm oil sector. In principal, the communities who work in this sector engage in the planning, planting, and harvesting of palm oil. Information needed by the palm oil planters normally are related to land preparation, fertilizer, pesticide, seedling, subsidy, agency and supplier (Table I).

Fig. 3 displays the pattern of information acquired and needed by the communities in palm oil sector. The most information they currently acquired are about (i) religion, (ii) agriculture, (iii) medical and health, and (iv) family matters. The least acquired are (i) IT/Computer, and (ii) business. There is a high gap between the information they already have and need in the area of IT/Computer, business matters, and education.

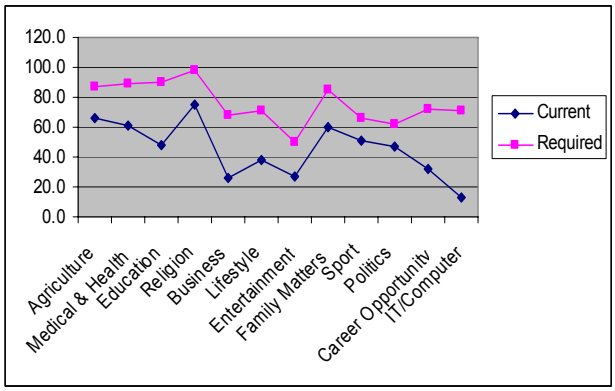

Fig. 3. Level of information obtained and acquired in palm-oil sector

D. *Rubber Sector*

Communities who work in the rubber plantation also involved in the planning, planting, and harvesting activities. They rely on information related to land preparation, fertilizer, pesticide, seedling, subsidy, agency and supplier (Table I).

In terms of information the community currently have are (i) family matters, (ii) medical and health, (iii) education and (iv) religion. The least groups they acquired are (i) IT/Computer, and (ii) business. A high

gap of information already acquired and information needed exists in the group of IT/Computer, and religion.

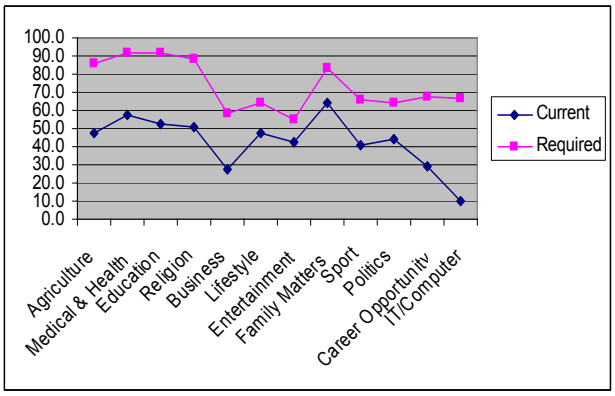

Fig. 4. Level of information obtained and acquired in rubber sector

V. CONCLUSION

This study was conducted to identify information needs by the communities in 12 villages in Kedah and Perlis. The villages represent four economic sectors; fishery, paddy, palm-oil and rubber. Information needs are divided into two categories based on the usage of the information (i) in association with economic activities, and (ii) in relation with daily life.

The activities involved in all four sectors can be classified into three important stages: planning and preparation, execution, and post- execution. To effectively complete each stage, the people involved in the four sectors; fishermen, paddy farmers, palm oil and rubber planters, usually depend on reliable, up-to-date and fast information. In the fishery sector, the planning and preparation include activities such as applying license, preparing for a boat and other equipments and supplies, and checking on the weather condition. The execution refers to the time when fishermen go to the sea,

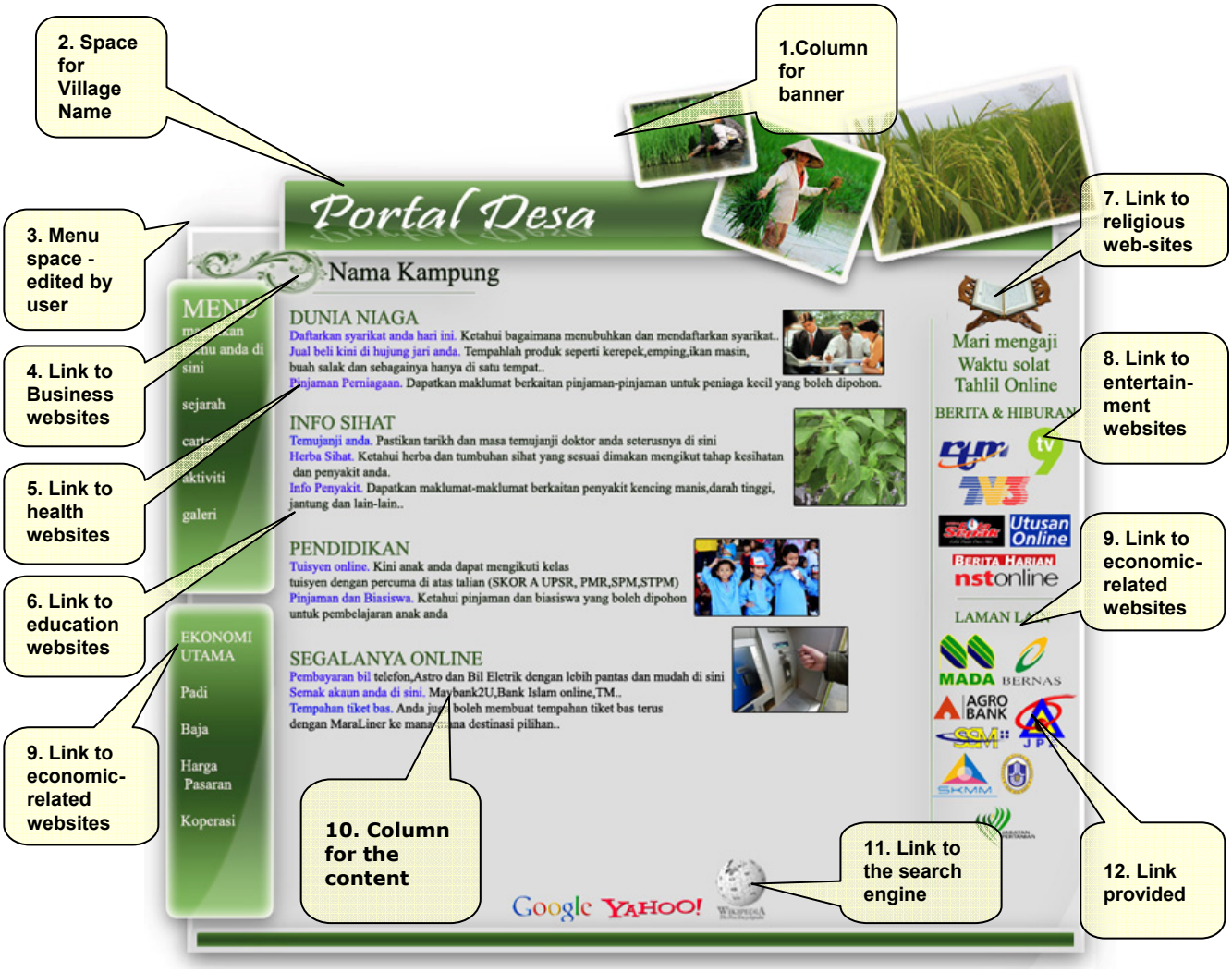

Fig. 5 Template for Portal Desa - Main Page (Paddy Sector)

move from one location to another location to catch fish, and process the catch before going back to shore. Finally, the after execution activities include making contact with middleman, selling the catch, and preparing for the next day activities. These activities show and explain the needs for variety of fishery related information to be captured, processed, distributed, used and updated by the relevant agencies and communities. A similar situation is also shared in the other three sectors; paddy, rubber and palm-oil, with different activities. The planning and preparing stage deal with getting approval to start and preparing land. The execution stage is more on seedling, planting new trees and growing, while the final stage refers to the harvesting activities.

In terms of their daily normal life, the communities currently have obtained a lot of information about religion, education, and family matters. As shown in Table II, religion is the most information acquired by the communities in every sector. Family matters become the second most information obtained, medical and health is the third, while agriculture and education is the fourth.

Table II. Lists of Information Commonly Acquired

Sector	Types of Information			
	(i)	(ii)	(iii)	(iv)
Fishery	religion	family matters	education	sport
Paddy	religion	family matters	medical health	education
Palm Oil	religion	Agriculture	medical and health	family matters
Rubber	religion	Agriculture	medical and health	family matters

To improve their socio economic status and to give a better life to their next generation, the communities looking ahead to have more access for information associated to business, ICT and computer, and career opportunity. Interestingly, the study has also shown that groups of housewives and senior citizens are interested to learn about ICT as well as learn to use ICT if they are given the opportunities.

Based on the findings, the researchers believe that more aggressive ICT programme need to be carried out for the specific target groups to expose them to more information that can help to improve their socio-economic. Appropriate local applications and content can be developed and delivered, through a community portal, to suit the needs of the community, thereby creating the interests among the rural community to use ICT. Since the rural communities are from the four economic sectors, information regarding these four sectors can be included as part of the content, as well as other information related to businesses, agriculture, career opportunities, and others. Above all, to create early awareness and interests, the communities need to be introduced with knowledge and skills in IT and computers.

VI. RECOMMENDATION

The information needs identified from the study is used as a basis to design a *Portal Desa* template for the use of the communities in the four sectors. Using the template as the basis, they can develop their own village portal by inserting appropriate information regarding their village communities. These may include information such their activities, job, and pictures gallery. They can also sell and promote their own product. The portal can become a means to connect them to other communities and the whole world to improve their knowledge, and socio-economic activities. To illustrate this, the template for communities in the Paddy sector is elaborated.

Table III. Justification of Contents

No.	Item	Description/ Justification
1	Column for banner	To represent the economic sector, e.g. paddy
2	Space for Village Name	To introduce the village
3	Menu space - edited by user	To introduce the community committees activities, pictures etc.
4	Link to Business websites- (***DUNIA NIAGA***)	To provide the community with the link to business information, including set up business, registration etc. For example, if user click on *'Daftarkan Syarikat anda'* under *'Dunia Niaga'* title, user will be take to the second page that explain on how to register a company.
5	Link to Health websites (***INFO SIHAT***)	To provide the community with the link to health information, including disease etc. For example, if user clicks on *'Temujanji Anda'* that will bring user to the appointment form page where user can fill in the form and see the appointment date available with their doctor.
6	Link to Education websites (***PENDIDIKAN***)	To provide the community with the link to education information, including online tutorial, scholarship and loan etc.
7	Link to religious web-sites	To provide the community with the link to Islamic information, including online Tahlil and Al-Quran reciting, and prayer time.
8	Link to entertainment Websites	To provide the community with the link to news and entertainment site, including links to RTM, National TV, TV 3 and TV 9.
***9**	**Link to economic-related websites**	**To provide the community with the link to related sites according to their economic activities. For example, communities can link to the other organizations related with their economic activities (i.e. paddy sector), such BERNAS, MADA, Agro Bank and so on.**
10	Column for the content	To provide communities with any online services, for example to pay bills, reserve bus tickets etc.
11	Link to the search engine	To provide communities with access to search for any information.
12	Link provided	To provide search to other organization.

The sample template shown in Fig. 5 is for the community in paddy sector as the images on the top represents activities in this sector. Users can edit almost all the content and menu provided. For example, the menu bar on the left side shows the menu related to the village and their economic activity. User can remove the menu list or add new list into it. Each menu will navigate user to the related pages and user can insert any content or image in there and delete anything that unnecessary to them. The justification for the contents in the first page is given in Table III.

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PORDES: A Vertical Search Engine for Rural Society

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***Abstract*— This paper reports our effort in building PORDES, a vertical search engine for rural societies. The system automatically generates an Internet Portal directory that can be browsed or searched by Internet users. The directory contains structures and links related to information needs of rural societies (i.e., agriculture, forestry, and the like). Ontology was used as the basis for structuring information in the directory. Users can manage the content of ontology. The process that enables generating the portal directory automatically is divided in to stages. The first stage is an offiline process that classifies the Web site category during the crawling process and tags the link with metadata classification scheme. The second stage reprsents an online process that dynamically build a directory structure based on request.**

***Index Terms*—vertical search engine, ontology**

I. INTRODUCTION

he rapid growth of Internet technology in the last decade has been the major driving factor for the fast growth of information that are available on the Internet not only in the quantity but also in the diversity of information category. Nowdays search engine has become a must-to-use tool for Internet users who want to find the informtion they need. Nevertheless, for developing country such as Indonesia, only a small fraction of society who enjoys this luxury. The digitial divide betwen urban and rural societies poses another issue. The problem is not only the lack of ICT infrastructure in the rural area, but almost none of Internet content providers is willing to provide the information need for rural society such as information about agriculture, fishery, forestry, and the like. This is ironic because the majority of Indonesian society reside in rural areas. One of the main reasons, among other, for not providing this needed information is that running this kind of Website is not cost effective for the bussiness model point of view.

This research attempts to tackle the above problem by developing a system that can automatically generate an Internet Directory portal providing information that might be needed by rural society. We accomplish this by employing a vertical search engine (i.e., one with domain-specific corpus) that runs a focused crawler for collecting web page from world wide web relevant to the information needs of rural society. The retrieved web pages are indexed and hierarchically classified according the the web page category. The system then automatically creates Internet Directory portal based on the hierarchically classified web pages. Internet users can locate the information they need either by browsing the directory or by providing search keyword. The system is also designed to allow access from mobile devices with small screen (i.e., PDA, Cell Phone, Pocket PC).

The rest of this paper is organized as follows. Section 2 describes related work. Section 3 describes the architecuter of our system. The description of information needs that form the basis for structuring information of our system is provided in Section 4. Next, Section 5 presents the system implementation, followed by conclusion in Section 6.

II. RELATED WORK

Vertical search engine has been a promising search tool since it gives advantages over global search engine such as Google, Lycos, Altavista, etc. There have been many vertical search engines developed for certain user need. For example, ResearchIndex (also known as CiteSeer) [LAWRENCE1999a, LAWRENCE1999b, LAWRENCE1999c] is a specialized search engine for scientific literature which is currently indexing over 300,000 articles containing over 3 million citations. Other specialized search engine is Cora[MCCALLUM1999], a publicly-available search engine on computer science research papers (www.cora.justresearch.com). Cora employed the web-crawling spider to find domain-relevant documents efficiently by using reinforcement learning framework. Another specialized search engine is DEADLINER[KRUGER2000] which parses conference and workshop information from the web, newsgroup and mailing lists.

Search engines often provide a browsable topic hierarchy such as Yahoo! or OpenDirectory. It covers two main tasks: the hierarchy building and the document classification, which are handled manually in Yahoo! and OpenDirectory. Each Web Site is manually classified to a proper category in the directory structure, resulting in a high-quality search results classification. Because it involves human effort for classifying each Web Site, this approach in general is not scalable, expensive to build and to maintain. This condition has triggered several

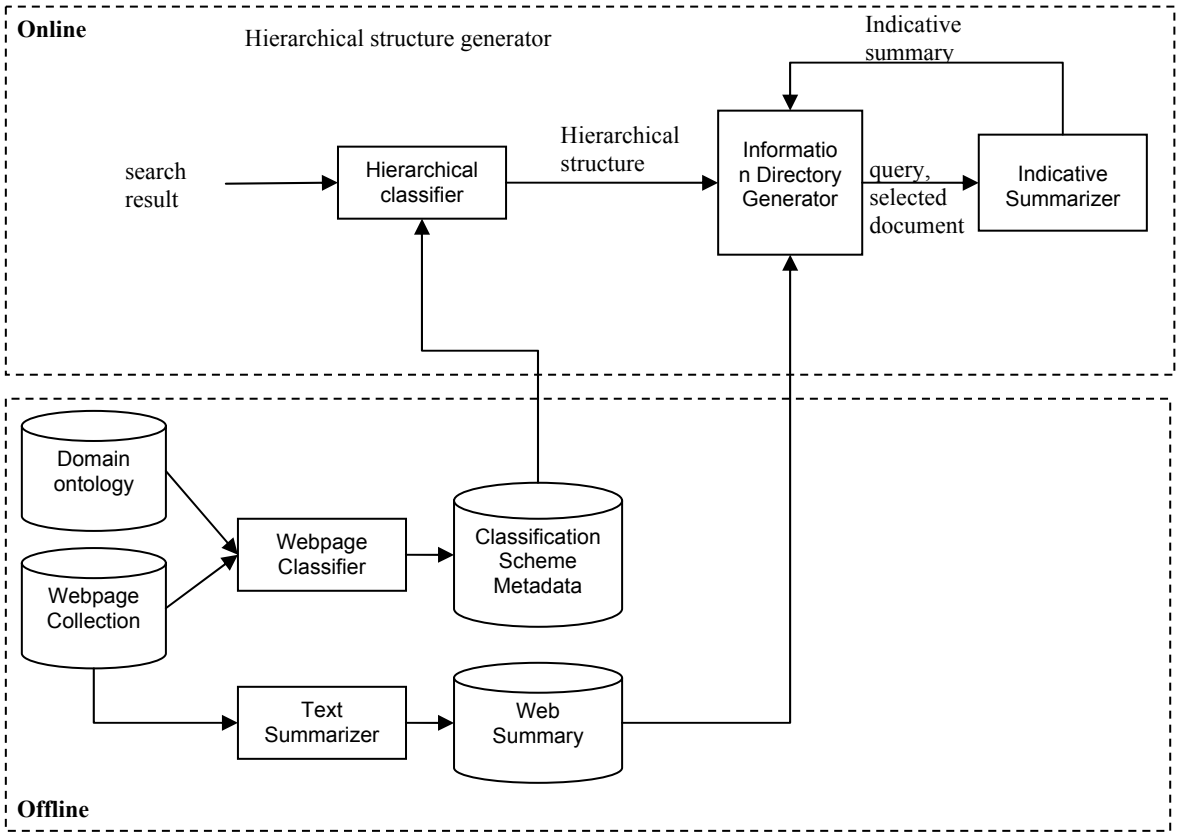

Fig. 1. Pordes main system architecture

alternatives to make the effort cheaper. One alternative is to make use machine learning techniques in order to build an automatic process whether in the hierarchy building or in the document classification task. Unfortunately, building the hierarchy automatically [HEARST1995, ZAMIR1999] has a drawback based on the fact that the data to be clustered (i.e., text) are naturally noisy which eventually cause the low quality of the hierarchy. Here, we chose to build the hierarchy manually because of the limited domain of our vertical search engine and also to assure the hierarchy quality.

In the document classification, using machine learning techniques has shown promising results [CHAKRABARTI1998, CHEKURI1997, MLADENIC1998, DUMAIS1998, DUMAIS2001, MCCALLUM1999]. These researches combined several machine learning techniques to classify each document into category in the hierarchy. Based on the document classification performance and the large number of crawled documents, we made use several machine learning techniques to build an automatic document classification.

III. PORDES ARCHITECTURE

Figure 1 shows system architecture of Pordes. The system consists of two main subsystems: offline subsystem and online subsystem. For each document, offline subsystem generates document category and informative summarization using classifier and text summarizer. Online subsystem builds hierarchical directory structures based from domain category and then creates Pordes user interface. First documents are hierarchically organized using the information provided in the metadata of corresponding documents. This hierarchical structure is then fed to an interface generator that allows users to navigate through the structure.

Domain ontology in Fig. 1 defines the information architecture in rural society domain. It contains the definition of information classes (categories) and their relationships (i.e., information structure). The definition of information class is used for web document classification. The classifier generates a metadata about the classification scheme for each web document (i.e., the document class and its path to the root in the ontology).

We also conducted preliminary study on web page layout adaptation for mobile devices with small screen. This study identifies three ways for presenting information in limited screen: single-column layout, thumbnail, and summary thumbnail. A web page layout designed for high resolution screen can be adapted to low resolution screen by appropriately transforming layout elements. We define a set of rule for layout transformation. These rules can be applied not only to Pordes but also to other Web-based applications.

A. Ontology

Ontology is a specification of conceptualization, that is, description of concepts and their relationships. Although can be defined using different languages and syntaxes, various ontology posses structural similarities. Ontology is composed of concepts, attributes and the relation among concepts. Concept is anything that can be described. It can be a real, fictive, concrete or abstract. A concept in ontology can be described by the assignment value of its attributes.

Ontology is at the heart of this research, which defines the concepts about Web page (document) categories and their hierarchical relationships. The main function of ontology is to provide the knowledge base needed for the classification of search results. Because the definition of each information class is crafted manually by a human expert, it is expected that the classification accuracy will be better than those produced by clustering techniques.

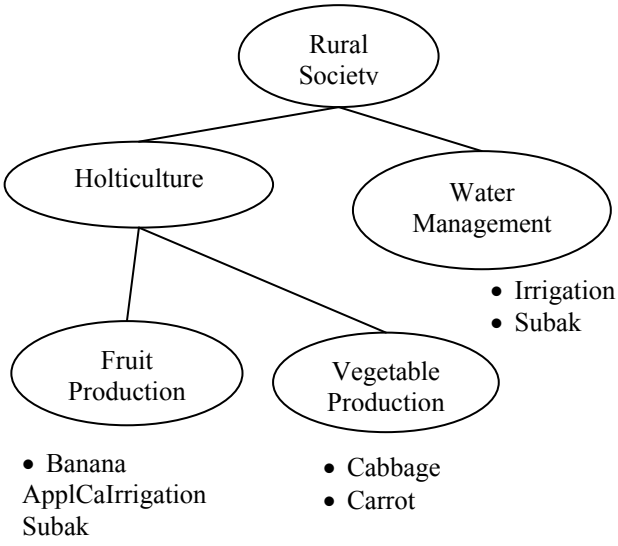

Fig. 2. A simple example of ontology

The development of ontology requires ontological languages. Although many ontological languages have been developed for various purposes, most of them are very complex and have many unnecessary features for this research. Therefore, this research develops its own ontological language that is simple and satisfies the research requirement (see Figure 2). In this language, ontology is a set of concepts and the relation among these concepts forms a concept hierarchy. A concept has concept name, a pointer to parent concept and an attribute list. Parent concept has sub-concept-of relation. The list of attribute names and their weights define the characteristic of the corresponding concept.

This research assumes that the concept hierarchy has the tree structure. Concept attributes are defined only on concepts that are leaf nodes. The descriptions of internal node concepts are derived from those of leaf node concepts. Fig. 3 provides an example of simple ontology describing the concept hierarchy in computer science domain. Horticulture and Water Management are sub-concepts of Rural Society, whereas Fruit Production and Vegetable Production are sub-concepts of Horticulture. Furthermore, leaf node concepts also have attribute values representing the characteristics of the corresponding concepts. In this example, Irrigation and Subak are terms representing the concept of Water Management.

B. Classification

The classification aims at determining the category in ontology that are most similar to web documents. In this research all documents (web pages) and concept definitions are represented as a vector space model. Therefore, every web page in the collection has a vector space model representation, which is a list of terms contained in the web page and their weights. The characteristic of concept in ontology, as described above, is also defined similarly.

Specifically, web documents in vector space model are defined as n-dimensional feature vectors. Let D be a text document, then {(t1, w1), (t2, w2), . . . (tn, wn)} is a feature vector of D where t is a term occurring in D and w is the weight of term t. This representation requires a method to weight each term and to measure the similarity between two document feature vectors. In this work we use normalized term frequency for the weighting scheme and cosine similarity as the basis for classifying the document category.

IV. Rural Society Information Needs

To identify the information need of rural society, we performed a preliminary field study in Cinta Mekar Village, Subang County – West Java Province. The survey results suggest that for the sake of reaching more users and obtaining the greatest impact, the information needs be defined for broader rural society. It conludes that the information needs should be addressed for those who live from agriculture and related industries, as described in the following.

Rural society needs various information including education, economic development, agriculture, government, and development of radio community. 3 provides ontology of agriculture information. There are nine categories of information, namely Tanaman Pangan, Hortikultura, Peternakan, Perkebunan, Ketahanan Pangan, Penelitian & Pengembangan, Pengelolaan Lahan & Air, Karantina, and Pengolahan & Pemasaran Hasil.

Each category has some sub categories. For example, category Tanaman Pangan has four subcategories: Perbenihan, Budidaya Kacang-kacangan dan Umbi-umbian, Sarana Produksi, and Regional. Furthermore, a subcategory has a list of web sites containing related information. These web sites is in web site collection component.

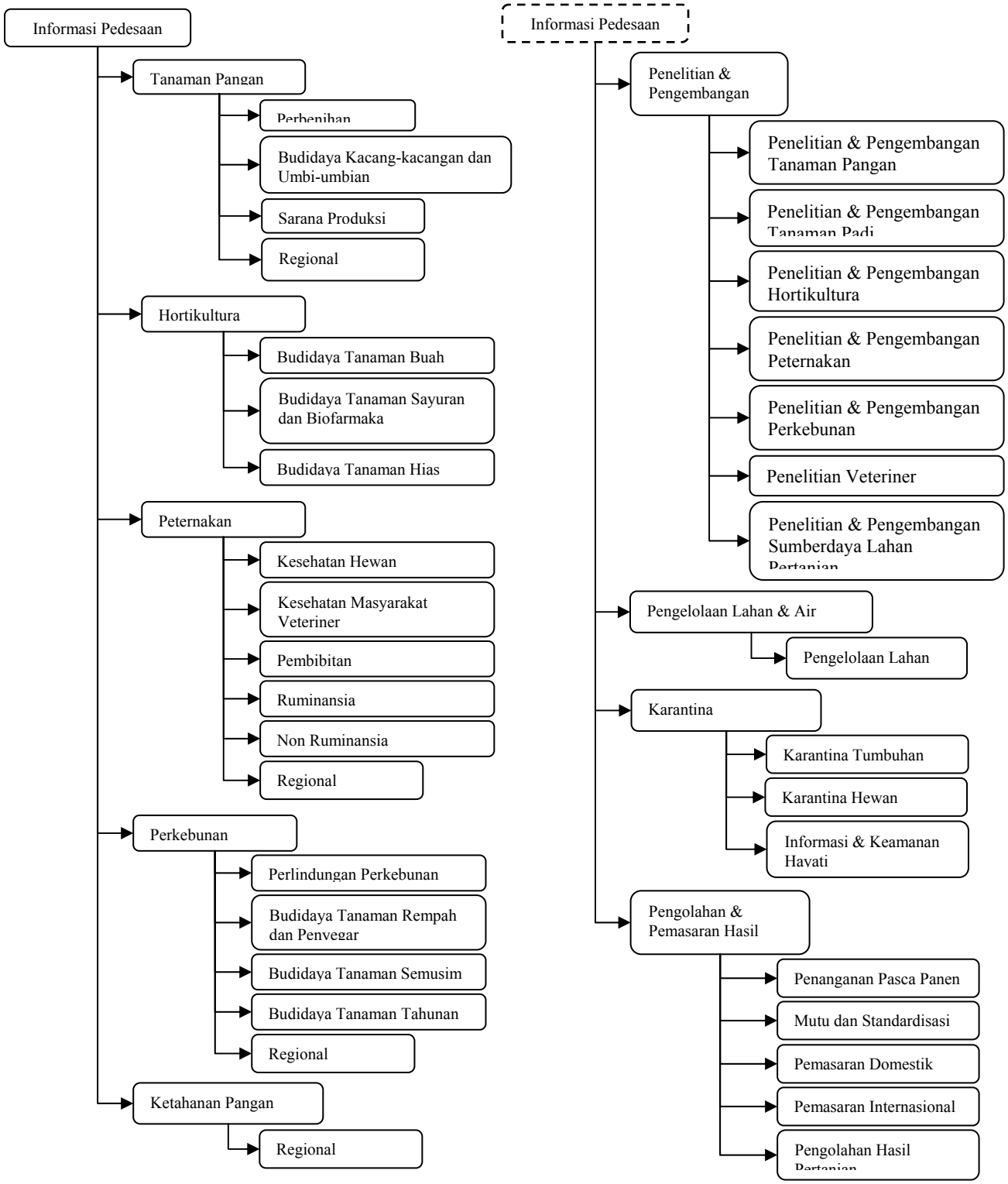

Fig. 3. Ontology of information for rural society

V. System Implementation

Pordes (Portal Desa) extends existing conventional search engines by incorporating ontology for automatic web page collection and search results classification This research employs Lucene as the base search engine. Lucene is an open source software and has been widely used in many commercial applications. Its main functions in the system's architecture are (1) to index Website and other documents collected from the Internet and (2) to provide search mechanism to retrieve information. We also employ Heritrix, one of major crawlers from open

source project, for automatically collecting information from the Web. Given an initial URL address, the crawler will retrieve the corresponding Web page and extract all links found in the page. The process is then repeated for each found link until a termination condition is met. We extend Heritrix by incorporating a classifier, transforming its functon from general crawler to focused crawler. The classfier will identify the topic category of each retrieved web page. The list of topics are pre-defined.

Screenshots of PORDES are presented by Figures 4-7. The front-end user interface is dynamically generated by the Internet Portal Directory Generator component of the system (see system architecture above). This component will generate the main page (Figure 4) based on ontology of rural society information needs (Figure 3).

Fig. 4. PORDES main page

User can manage ontology and list of related websites of a category by using editor as shown in Figures 6 & 7. These websites are collected automatically from the Web by topical crawler component.

Fig. 5. Subcategory page of Hortikultura

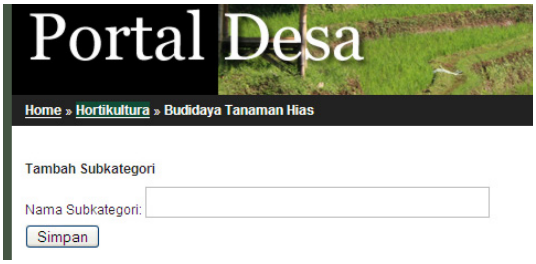

Fig. 6. Ontology editor

Fig. 7. Page editor

User can manage ontology and list of related websites of a category by using editor as shown in Figures 6 & 7. These websites are collected automatically from the Web by topical crawler component.

VI. CONCLUDING

We have presented our work on constructing a vertical search engine for rural society. Our main approach is by automatically building an Internet Portal directory using a domain ontology. Preliminary observation reveals that the main obstacle is to populate the directory with relevan Indonesian sites because the availability of such sites are still rare. Although there is a large number of releven english sites, the majority of intended users are rural society who might not comfortable with English.

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Data Authentication Protocol Modeling on Multilayer Data Hiding for Multilayer Protocol Hiding

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***Abstract*—In this research so it will be created an algorithm of Multilayer Data Hiding with architecture of data authentication protocol as modification detection code for hidden data. Digital Certification Agreement of multilayer data hiding, Digital Certification Agreement of Multilayer Data Authentication Protocol and Digital Certification Agreement for Multilayer Data Protection must be agreed between transmitter and receiver, how to process data. In this research wo it will be created an algorithm of tree authentication coding to create book authentication, an algorithm of tree authentication decoding which it will be applied on book authentication, how to create Multilayer Data Protection. And finally simulation and theoretical modeling of multilayer data hiding will be created with modeling of data authentication protocol.**

***Index Terms*–Data Authentication, Multilayer Data Hiding, Tree Authentication, Multilayer Data Protection**

I. INTRODUCTION

In[1], it had been talked about how to create an algorithm of multilayer data hiding with an architecture of data authentication protocol, theoretical modeling and its simulation. Definition of hidden data is data block which appear as consequence some of data block with definite length which are arranged on a format (row – colomn) an so they are shown an information hiding by using some hiding operation. Definition of data authentication is an process to proof data for some hidden data block which are same and the way by using six authentic layer or six data authentication protocol: authentic layer of data sequence, authentic layer of data hiding region, authentic layer of operation, authentic layer of data segment, authentic layer of positioning and authentic layer of format/placement. The content framework of this paper consist of an algorithm of multilayer data hiding, an algorithm of tree authentication coding on multilayer data hiding, an algorithm of tree authentication decoding for book authentication, an algorithm of tree authentication decoding for multilayer data hiding, an algorithm of multilayer data hiding for multilayer data protection, an algorithm of multilayer data dehiding for multilayer data protection, digital certification agreement about multilayer data hiding, agreement of data authentication protocol and multilayer data protection, analysis and theoretical modeling of multilayer data hiding.

II. ALGORITHM OF MULTILAYER DATA HIDING

An algorithm of multilayer data hiding:

1. Prepare an format or placement (row – colomn) that will be filled by information bit sequence from data block.
2. Use a position or placement on format for each data block with suitable position with the length of data block
3. Use some data block as data segment that will be hidden
4. Use combination of hiding operation that will hide every bit sequence
5. Use data hiding region for example from above to below
6. Use data sequence that will be hidden
7. For some hidden data block which have same length so produce bit sequence as authentic data by using protocol engineering and they are authentic protocol of data sequence, authentic protocol of data hiding region, authentic protocol of hiding operation, authentic protocol of data, authentic protocol of position and authentic protocol of placement

An algorithm of tree authentication coding on multilayer data hiding:

1. Prepare some of IP address (data segment / data block) that will be hidden.
2. Create branch of first layer for each data segment with their length
3. Shape trees by connecting some branch so it will be created some tree and they are: $Tree^{(1)}1$, $Tree^{(1)}2$, $Tree^{(1)}3$, ..., $Tree^{(1)}N(1)$. This tree series are called by Tree of first layer for first information hiding.
4. Create multilayer data hiding on trees that are shaped on tree of first layer.
5. Shape branch of second layer on each hidden data block from multilayer data hiding on tree of first layer
6. Shape trees again by connecting some branch of second layer so that it will be created some tree and they are: $Tree^{(2)}1$, $Tree^{(2)}2$, $Tree^{(2)}3$, ..., $Tree^{(1)}N(2)$.

7. Create multilayer data hiding on trees that are shaped on tree of second layer
8. Do it by same way up to Layer R as the last layer, shape branch of Layer – R on each hidden data block as multilayer data hiding on tree of layer – R-1.
9. Shape tree again by connecting some branch of layer R so that it will be created $Tree^{(R)}1$.
10. Create multilayer data hiding on tree that will be formed on tree of Layer R.

An algorithm of tree authentication coding for book authentication:

1. Use an algorithm of tree authentication coding to create multilayer paper hiding and it is an paper that have some IP address as data block that will be hidden by an algorithm of tree authentication coding. Do it this way on each paper.
2. Use an algorithm of tree authentication coding on some multilayer paper hiding to create multilayer multipaper hiding and it is an multilayer data hiding on some paper which each paper have hidden data that will be hidden by an algorithm of tree authentication coding. Do it this way on each multipaper.
3. Use an algorithm of tree authentication coding on some multilayer multipaper hiding to create multilayer book hiding and it is an multilayer data hiding on some Multipaper which each multipaper have hidden data that will be hidden by an algorithm of tree authentication coding.

An algorithm of tree authentication decoding for book authentication:

1. Use an algorithm of tree authentication decoding on multilayer book hiding to create multilayer multipaper hiding.
2. Use an algorithm of tree authentication decoding on each multilayer multipaper hiding to create some multilayer paper hiding for each multilayer multipaper hiding.
3. Use an algorithm of tree authentication decoding on each multilayer paper hiding to create some data block (IP address) for each multilayer paper hiding.

An algorithm tree authentication decoding on multilayer data hiding:

1. Hidden data block on the last layer will be transformed into hidden data block on layer R-1 by creating branch of tree on layer R for each hidden data block.
2. Hidden data block on layer R-1 will be transformed into hidden data block on layer R-2 by creating branch of tree on layer R-1 for each hidden data block.
3. Hidden data block on layer R-2 will be transformed into hidden data block on layer R-3 by creating branch of tree on layer R-2 for each hidden data block.
4. Do it by the same way until layer 2 which each hidden data block on layer 2 will be transformed into hidden data block on layer 1 by creating branch of tree on layer 2 for each hidden data block.

An algorithm of multilayer data hiding for multilayer data protection:

1. Prepare data block that will be hidden and protected.
2. Create branch mapping for multilayer data hiding by creating some data block with definite length that different one with other
3. For each data block from branch mapping so it will be shown information hiding consecutively with architecture of multilayer data hiding that is selected start from first hiding, product of first hiding will be hidden again, product of second hidiong will be hidden until product of N-1 – hiding will be hidden. The last hiding that is N – hiding will hide each branch from n-1 – hiding.

An algorithm multilayer data dehiding for multilayer data protection:

1. Prepare hidden data block that will be shown Multilayer Data Dehiding
2. Use architecture of multilayer data hiding that is used for N – Hiding and do a demapping from codeword of data authentication protocol on N-hiding become some hidden data block as branch of Multilayer Data Hiding and as N-1 – hiding.
3. For each hidden data block on branch of multilayer data hiding as product of N-1 – hiding so it will be shown demapping of data authentication protocol into some hidden data block as N-2 - hiding and select a protocol as data protection protocol.
4. For each branch of multilayer data hiding so it will be shown demapping data protection protocol on N-2 – hiding into some hidden data block as N-3 hiding and select a protocol as data protection protocol.
5. Do it the same way until first hiding.
6. So it will be shown demapping branch of Multilayer data hiding from some data block on demapping of first hiding into a block data that is hidden.

III. Digital Certification Agreement

Digital certification agreement of multilayer data hiding:

1. Agreement between transmitter and receiver about:
   - Architecture of multilayer data hiding that will be used for data hiding.
   - Data sequence, data hiding region, data hiding operation, data segment, position of data segment, and data format
2. Digital certification agreement still create probability model of hidden data block on receiver or there is same of hidden data block but different information that is hidden.
3. To solve problem of probability model of hidden data block on receiver so data authentication that is consist of some data authentication protocol will be sent than hidden data block

Digital certification agreement with multilayer data authentication protocol agreement:

1. Agreement between transmitter and receiver about:
   - Architecture of multilayer data hiding that will be used for data hiding.
   - Data sequence, data hiding region, data hiding operation, data segment, position of data segment, and data format
2. Agreement of multilayer data authentication Protocol
3. Digital certification agreement with multilayer data authentication protocol has cancelled probability model for same hidden data block but different information that are hidden.

Digital certification agreement on multilayer data protection:

1. Agreement between transmitter and receiver about:
   - Architecture of multilayer data hiding that will be used for data hiding.
   - Data sequence, data hiding region, data hiding operation, data segment, position of data segment, and data format
2. Agreement of Multilayer data authentication protocol for each layer of protection.
3. Data authentication protocol which have function as protocol of data protection for each layer of protection
4. Mapping data block that will be hidden become some branch of data block
5. Sum layer of protection and sum branch of protection.

IV. Theoretical Modeling Simulation of Multilayer Data Hiding

Fig. 1,2,3, and 4 are relation between sum of hidden data block with length of hidden data block for increasing on sum of hiding operation on right triangle model, left triangle model, full triangle model and trapezium model.

Fig. 5 show design on length of codeword protocol of data segment protocol with length of hidden data block. Fig. 6 show design of operation protocol authenticity on right triangle model, Fig. 7 show design of operation protocol authenticity on full triangle model and Fig. 8 show design of operation protocol authenticity on trapezium model. Fig. 9 shown design of position protocol authenticity and Fig. 10 show design of format protocol authenticity.

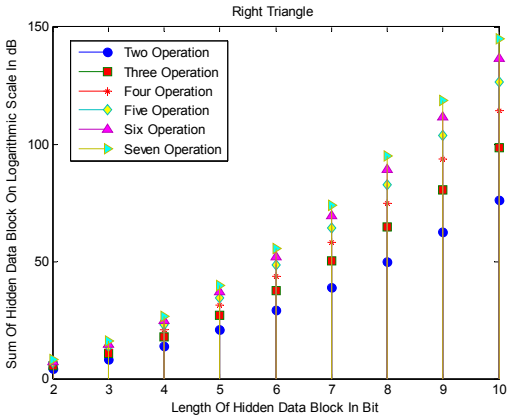

Fig. 1. Right Triangle Model

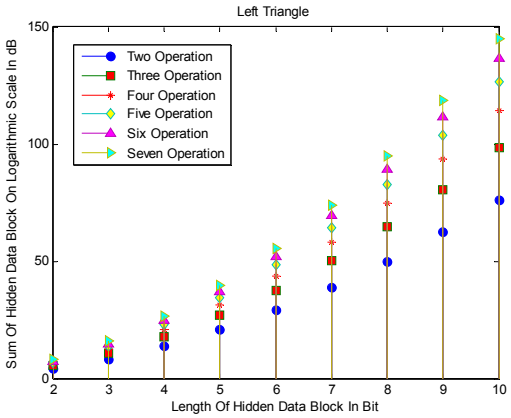

Fig. 2. Left Triangle Model

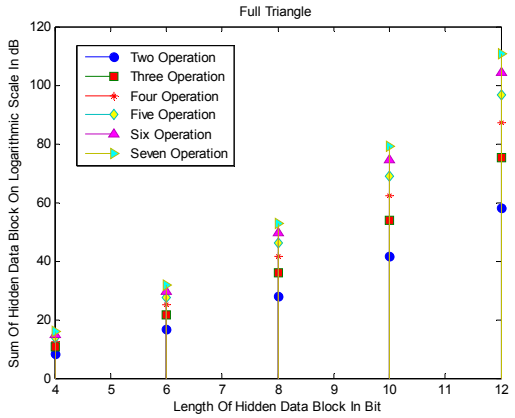

Fig. 3. Full Triangle Model

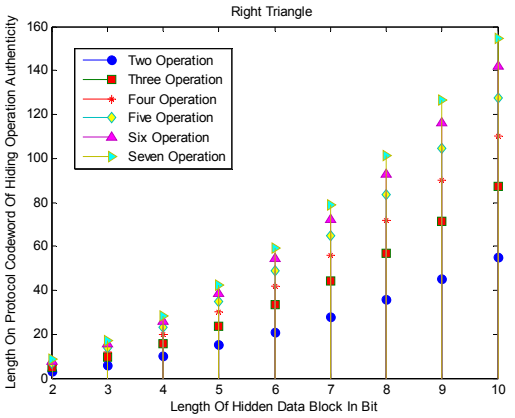

Fig. 6. Design of operation protocol authenticity on Right Triangle Model

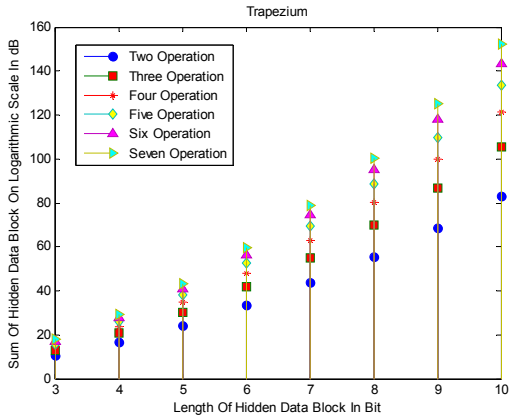

Fig. 4. Trapezium model

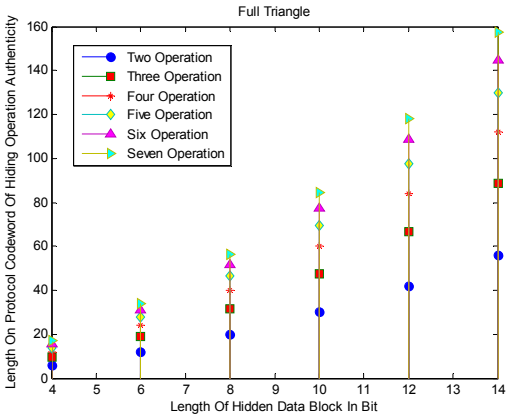

Fig. 7. Design of operation protocol authenticity on full triangle model

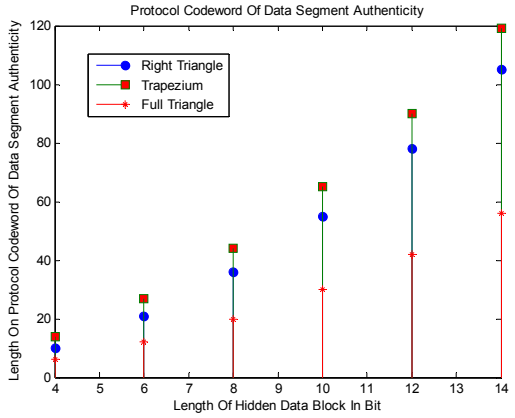

Fig. 5. Design of data segment protocol authenticity

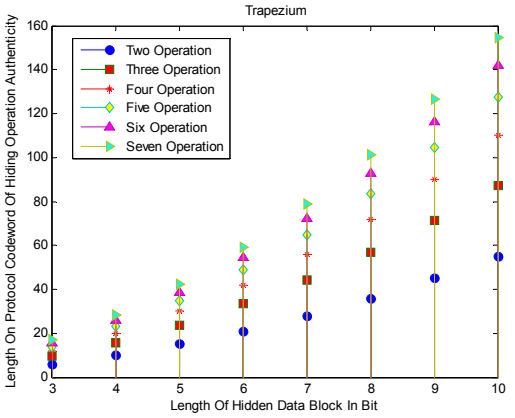

Fig. 8. Design of operation protocol authenticity on trapezium model

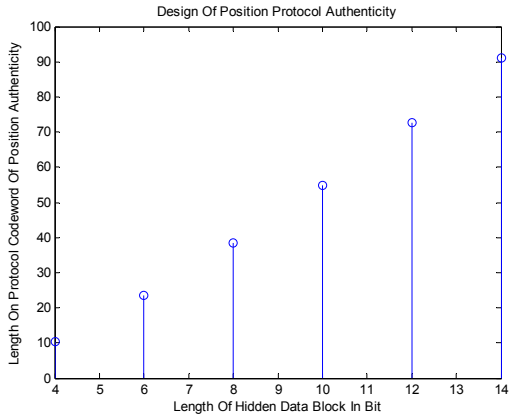

Fig. 9. Design of position protocol authenticity

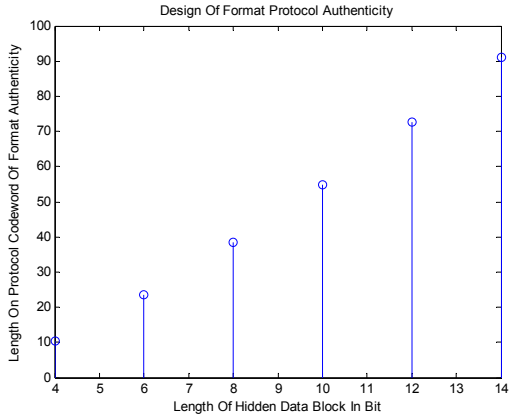

Fig. 10. Design of format protocol authenticity

V. CONCLUSION

1. Sum of hidden data block will increase exponentially with increasing of length of hidden data block and increasing of sum of hiding operation for right triangle model, left triangle model, full triangle model and trapezium model
2. Length of codeword protocol on data segment authenticity will increase exponentially with increasing of length of hidden data block for right triangle model, trapezium model and full triangle model.
3. Length of codeword protocol on hiding operation authenticity will increase exponentially with increasing of length of hidden data block and increasing linearly of sum of hiding operation on right triangle model, full triangle model and trapezium model.
4. Length of codeword protocol on position authenticity will increase nonlinearly with increasing of length of hidden data block
5. Length of codeword protocol on format authenticity will increase nonlinearly with increasing of length of hidden data block.

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Flood Alert Notification System (FANoS)

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***Abstract*—In Malaysia, flood is one of the most common disasters that happen especially in monsoon time at the end of the year; where it will cause death and property lost. Today the human activities is the major problem that contribute for this disaster such as uncontrolled development, obstruction in river, forest harvested that damage rain catchment area and others factor that contributes to flood. In many rural area in Malaysia to detect flood occurance public use conventional way to predict phenomena ; where a they will keep watch for some anticipated event near the river side. This action is risky by observing at the area that had known in danger. The public sometimes have it own humanity weakness, this will affect the result collected. Therefore, a project based on human and properties protection from flood is designed. In this "Flood Alert Notification System" (FANoS), the LCD display were used to show the water level indication to the public ; where it will be placed at selected zone area so the resident will always know and be alert . When FANoS detect dangerous water level, the siren will be alarm and send short message service (SMS) to resident and the authority using GSM (Global System for Mobile) mobile phone. The device plays an important role in maintaining and monitoring the safety of properties and human life. The FANoS has two main systems, the detection system and the action system. The detection system operates as the flood detect by using flood detector. In this project there is three level of water. Level 1(normal), level 2(chary) and level 3(critical). Once the level 3 detected, the flood sensor will send a signal to microcontroller. The microcontroller will trigger the action system that contains four parts which is the LCD display unit, LED unit, siren unit and SMS unit. The LCD will show the condition of river. While the LED will turn red. The siren will emit sound. Finally the system will alert the resident by send a simple message in the form of SMS through the SMS unit. This system will help residence to act before the flood becomes worst and avoid from being trap in flood.**

***Index Terms*— flood, alert, notification, rural, disaster**

I. INTRODUCTION

Flooding is Malaysia commonly occurred natural disaster that causes unsafely manner to human by causing death and great property loses; having 189 river basins throughout Malaysia, including Sabah and Sarawak rivers might be the largest danger to entire corridor areas. The target areas for this FANos are rural area near Muar and Batu Pahat District, Johor where in December 2006 and January 2007, these areas and all other districts in Johor Bahru have been hit by flood due to a couple of "abnormally" heavy rainfall events which caused massive floods that caused damages of life and properties; considered as the most costly flood events in Malaysian history. [1]

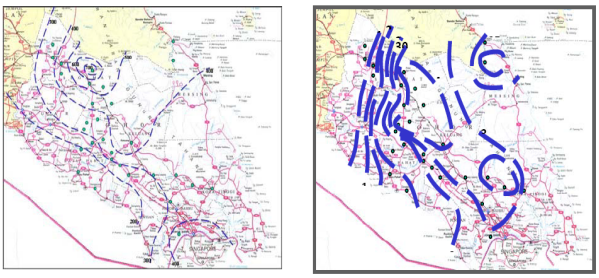
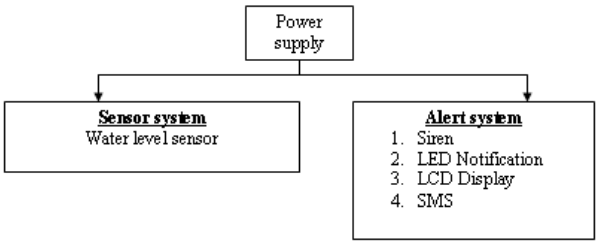


Figure 2: Isohyet Maps from i)18-20 December 2006 and i)11-13 January 2007 for Johor, Malaysia [1]

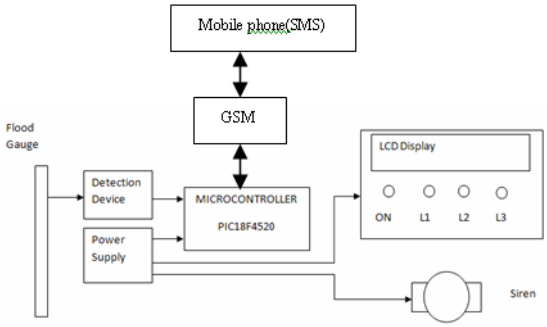
Today many of flood system in rural area in Malaysia used the conventional way to predict the disaster; where the resident keeps watch for some anticipated water raises event near the river side .This action is risky, where the public will observe the area that had known in danger, may perhaps collected the wrong data thus delay in notifying all residents [2],[3].Several work have been done for flooding prediction monitoring system such as [4],[5] and [6] . This FANoS prototype focuses for rural area and remote area application with limited access to telecommunications. This system will display the water level indication to the public using the LCD display; where it will be placed at selected zone area so the resident will always know and alert with water level . When FANoS detect three types of water level; level 1(Alert), level 2(Warning) and level 3(Danger). This prototype will be located at the selected river bridge. The siren will be alarm depending on the level of water indicated to inform all the residents, that the water level status in alarm mode. Thus FANoS will help residence prepared and avoid from being trap in flood. This paper is organized as follows; section discussed the FANOs design. The result and analysis is described in section 3. and conclude in section 4.

II. FANOs Design

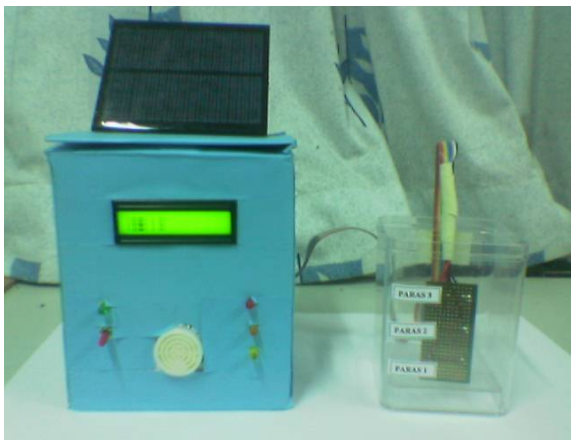
FANOs system were divide into 2 parts; detection system and alert system. Fig 1 shows the overall component for FANOs design



(a) FANOs concept



(b) FANOs architecture

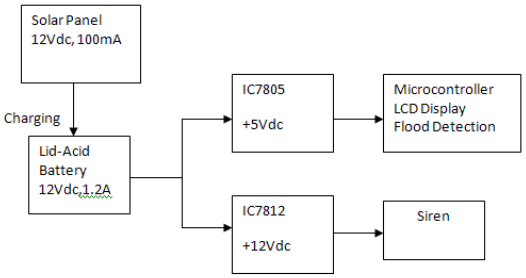


(c) FANOs system

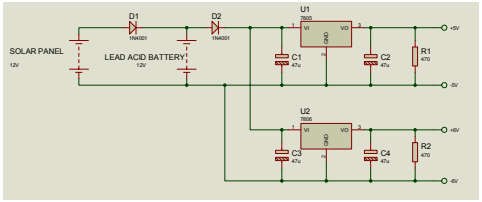
Fig 1: Overall block diagram

A. Hardware

As depicted in Fig. 1, the architecture of the system consist six main component : flood detector, siren unit, LED indicator , LCD display unit ,SMS gateway and the power supply, where the system uses solar panel to charging the battery . When the switch is triggered , the LCD will display value of the water level indicator ; thus displaying several level such as 'LEVEL1/NORMAL', 'LEVEL2/CHARY' and 'LEVEL3/CRITICAL'

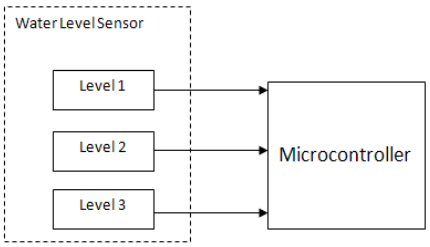


(a) Power supply distribution concept block

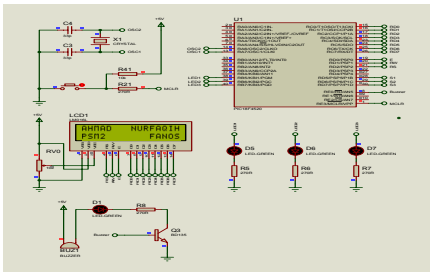


(b) Power supply circuit

Fig 2: Power supply



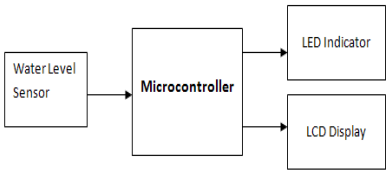
(a) Flood Detection block



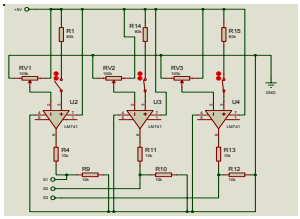
(b) Flood Detection circuit

Fig 3: Flood Detection Block

With the present of water, current will flow from point to another. Which one point connected to voltage source and another one connected to power amplifier IC741; The use of op-amp is needed to make sure sufficient voltage can be detected by the microcontroller because voltage from probe might be low because of unstable resistance of water. For the siren unit, sirens systems have three difference type of sound. Each level will emit their identical sound. This to ensure resident know the level of water although they not come to the prototype to see the LCD display especially in rural area with minimum communication coverage. This makes the resident easier to be noticed about the water level in that time.



(a) Display unit block



(b) Display unit circuit

Fig 4: Display Unit

For display unit, LED indicator for level 1 is green, level 2 is yellow and level 3 is red. The LCD display use to display the water level and to warning resident about the level of water.

B. Software

FANOs uses PIC18F4520 as the main controller. For this project, MPLAB IDE is use to programming the microcontroller in C language. MBLAB IDE allows writing, debugging and simulating. MBLAB use to program the programming in hex file and then it will download and interface with microcontroller that chosen to be use. in order to make programming the basic understanding of microcontroller architecture and the C language are needed. The other software that needs to use is Proteus. Where this software use to design the circuit of the project. This software provides variety of electronic part and circuit simulating that needed for circuit analysis

C. SMS gateway

The Gsm system is selected as the communication medium due to wide coverage and provide mobility

GSM SMS service provides a method of sending alphanumeric and character messages by using mobile phone. Each SMS able to send up to maximum 160 characters. One of the advantages of the system employing GSM SMS for low cost of sending and unlimited distance thus provide information to monitor properties and fast notification.

III. RESULT AND ANALYSIS

A functionally test was conducted to evaluate the system performance based on each system component. Tables below indicate the analysis results for FANOs. The solar panel analysis is shown in the output in table 1 where the reading were taken for four sample.The average voltage obtain is 11.4 V and 86.25mA average current depends on the sunlight lighting .

Table 1 Solar Panel Charge

	Voltage	Current
Test 1	10.53	75
Test 2	11.34	87
Test 3	12.01	93
Test 4	11.73	90

Table 2 Lid-Acid Battery

Test	Voltage	Current
Lid acid 12Vdc,1.2A	12.4	1.23A

Table 3 Flood detector level of detection

Component (LM741)	Not Detect (V)	Detect (V)
IC1	1.54	4.51
IC2	1.48	4.57
IC3	1.61	4.49

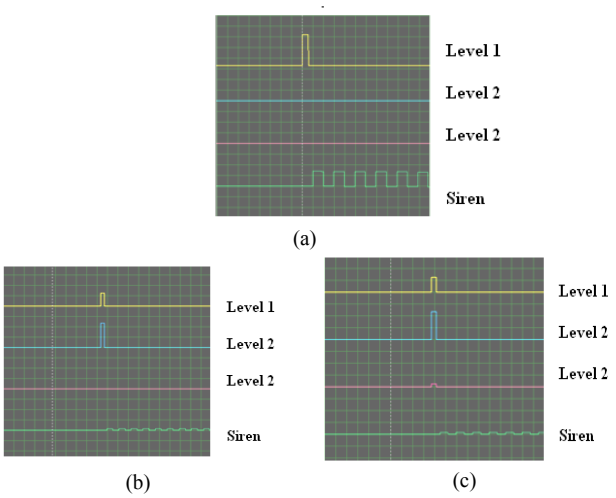


Fig 5: Water detection output (a) Level 1/Normal (b) Level 2/Chary (c) Level 3/Critical

Table 3 shows the output voltage indication of level detection for each level for signal triggering in microcontroller. For siren, 12Vdc with 5-100mA current is needed in order to alarm the residents . The connection of siren to the microcontroller. The LCD display have 16x2 display where the input pin is from microcontroller for D0 to D7,RS,RW and E. V_{ss} use as ground, V_{dd} as power source and V_{ee} use as contrast of backlight. Fig shows the analysis result for the integration system for 3

level of water detection and the siren behavior toward the output.

IV. CONCLUSION

In summary, Flood Alert and Notification System for rural area as a flood preparation suitable for for slow kind reverine flood and catstropic flood types was presented. By implementing the FANOs system , the rural area resident can monitor the water level outside the location causing by water accumulates across an impermeable surface (e.g. from rainfall) and unexpected event e.g. dam breakage. Further studies will focused on verifying this system and perform an experiments for acceptance in handling usage.

V. ACKNOWLEDGEMENT

The authors would like to thank Universiti Tun Hussein Onn Malaysia for supporting this research under the Faculty of Electric and Electronic research scheme..

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Design and Implementation of a Software and Trainer to Simplify AT89S52 Microcontroller Programming

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***Abstract*—Conventionally constructing and downloading program code(s) for microcontroller(s) must be done throughout three steps: Designing and constructing assembly program (codes), Compiling the assembly program, and Downloading program codes to microcontroller as a target. Naturally the three steps above uses different application program that felt as not effective and efficient. So that it must be a way to make it simpler in nature. The application software constructed here is as an alternative solution to solve ineffective and inefficient that conventional procedure, because in this constructed software of application: editor, compiler and programmer had been integrated in a such manner. Each function of these aspects is: editor works as to make an assembly program, compiler works as to compile any program designed and programmer as it called used to download the program codes to related of microcontroller. There are additional facilities needed for this application software, namely: (1) Code Generator, the function of this software is to make some simple codes of program for LED programming, 7 segments, input from the switch and time delay needed; (2) Terminal, used as communication media between the computer and microcontroller needed via available of serial port; (3) Data base of instructions of MCS-51 instructions; and (4) Converter, used to converting the 7 segments LED to hexadecimal form. With these kind of facilities, now in mind, the assembly and its implementation in a microcontroller especially (here) MCS-51 felt as simple and easy, even for the beginner users. From our design and implementation efforts, there was not found any trouble and fatal error. So, the system is works well. For further development, in order to take more benefit of ICT infrastructure, this kind of program via sensors needed and ASCII code converter, the system must be designed so that can be operated remotely.**

***Index Terms*—microcontroller, downloader, assembly program, editor, compiler, serial port.**

I. INTRODUCTION

Recently for creativity aims facilities to its implementation quite almost available everywhere especially in cities area. Intelligent devices are more and more possible to scientists in its each field and/or hobbyist to realize their ideas become true without many obstacle or efforts needed. Microcontroller for example is one of the facility category that unvalued to take its advantageous as maximum as possible. With the comprehension of this microcontroller engineering, accomplished with many ideas to its implementation in the real life's demands/ challenges will, in certain, come up the related peoples. With many aspects of comprehension of microcontroller of a country's peoples, there will for sure, bring the country to a sustain and wealth condition. Beside, microcontroller is not a costly device/ equipment. Nowadays, has been available many type of microcontrollers with low price.

Microcontroller or microcomputer is a complete microprocessor system integrated on an IC (single chip). Microprosesor on the other hand, is could be as a *Large Scale Integrated Circuit (LSI)* or a *Very Large Scale Integrated Circuit (VLSI*) having ability as CPU (Central Processing Unit).

A microcontroller system consist of:

- Microprocessing Unit.
- RAM = Random Access Memory.
- ROM = Read Only Memory.
- Input / Output Unit.

In practical these parts integrated as *single chip microcomputer,* even though some time they need additional ROM as *External ROM*. This addition usually used as extended memory as usually needed. Input/output devices used for communication with outer device(s). This I/O system can be programmed in order system can accept/send data from/to microprocessor. There are to kinds I/O, namely UART (*Universal Asynchronous Receiver- Transmitter)* and PIO (*Paralel Input Output*).

II. AT89S52 MICROCONTROLLER

AT89S52 is one of CMOS 8 bit microcontoller as member of 8051 (MCS51) microcontroller family. In this experiment we used AT89S52 microcontroller because this microcontroller having features:

- Compatible with MCS-51.
- 8 KiloByte Flash Memory In-System Programmable (ISP) mode.
- Writable/ Erassable till 1000 times.
- Operational Voltage between 4.0V - 5.5V
- Operational Frequency: 0 Hz - 33 MHz
- Having 3 level memory lock.
- 256 x 8-bit Internal RAM
- Programmable 32 I/O lines.

- 16-bits Timer/Counters mode
- 8 Interruption sources
- Having UART serial line with Full Duplex
- Low power consumption for Idle dan Power-down mode.
- Interrupted for Power-down mode.
- Equiped with Watchdog Timer
- 2 Data Pointer
- Having Flag for Power-off.

The configuration of AT89S52 micricotroller pin as shown in Figure 1.

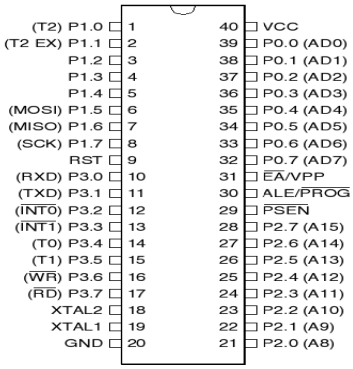


Figure 1. Pin configuration of AT89S51

Where block diagram of AT89S52 is:

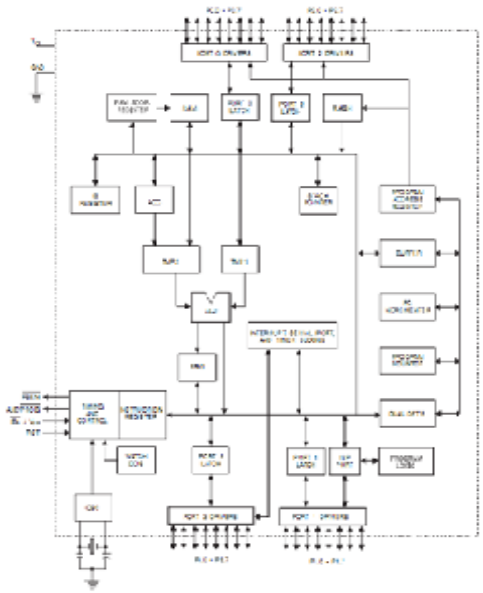


Figure 2. Block diagram of AT89S52

Registers in this microcontroller are: SFR (Special Function Register), Port Register, Stack Pointer, Data Pointer, Power Pointer, Timer/Counter, Serial Data Buffer, Interruption, Program Status Word, Accumulator and Register B.

As generally has been known this microcontroller can be programmed serially or parallel. They have each advantageous and disadvantageous. In this experiment we used serial programming. Instructions and data codes can be programmed using SPI (*Serial Peripheral Interface*) bus when RST made high. SPI interface consist of SCK, MOSI (input) dan MISO (output). After RST was set high, before program/delete operate, programming instruction must be first works. Minimum circuit for serial programming on microcontroller AT89S52 as shown below:

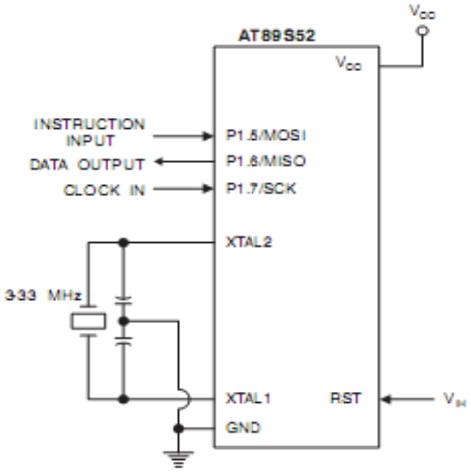


Figure 3. Minimum circuit for serial programming

Here (Figure 3) :

- Vcc = +5 volt voltage
- MOSI = Master Output Slave Input
- MISO = Master Input Slave Output
- SCK = Serial Clock
- RST = Reset
- Gnd = Ground

For sending/ receiving data with serial programming, microcontroller needs a timing. This timing is reserved by giving clock pulses to SCK,so that every bit data will be sent and received/ accepted as valid. Data bit sent from computer to microcontroller are available on MOSI (P1.5) pin, whereas data bit accepted by computer from microcontroller will available on MISO (P1.6) pin (Figure 3).

The serial programming algorithm steps are carried out as follow:

a. Give power supply between Vcc dan Gnd pin, while the others open. Set RST pin high and wait about two cycles clock.
b. Activate *serial programming* by sending serial programming activation to MOSI/P1.5 pin. The frequency for shifting is given to SCK/P1.7 pin.
c. Instruction and data were programmed one byte at one time throughout giving address and data simultaneously with writing instruction. For memory location checking can be checked *(verify)* by using data read instruction on selected address via MISO/P1.6 pin serially.
d. At the end of the algorithm, if programming was done, RST can be made low so that microcontroller will normally work.

In this programming, we used assembly and Delphi programming language. Delphi can communicate with outside world digitally throughout serial or parallel port of a PC. In this case, we used parallel port.

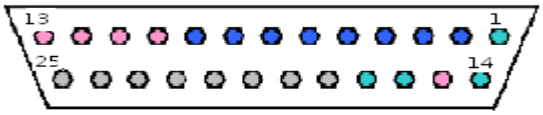


Figure 4. Pin configuration of parallel port.

In parallel port (LPT1), the address for data register is $378, status register address is $379 and control register address is $37A. Unlike on Windows 98/ME,on Windows XP, access to its parallel port is protected. To solve this problem we have to use *inpout32.dll* code where is compatible with Delphi.

III. TRAINER DESIGN

A. Hardware Trainer Design

As a basis to design and identify the components needed, we figure out a block diagram as in Figure 5.

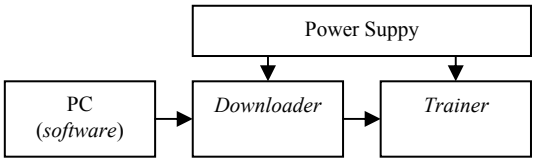


Figure 5. Block diagram of the system designed

The function of each block is:

- **Power Supply**, works for *downloader* and *trainer* power supply. Minimum system here will works well if supplied by 5 volt voltage from power supply. With IC LM7805 we can get 5 volt stable voltage, with source voltage from PC/ computer via USB. The circuit as depicted below:

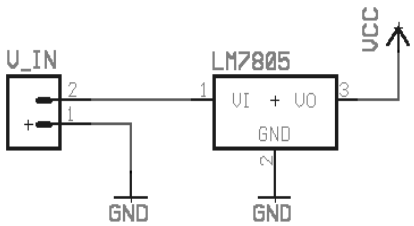


Figure 6. Power supply schematic

- **PC/Computer,** needed as media to build program code which will be downloaded to microcontroller, in addition PC also acts as master in microcontroller serial programming.
- **Downloader**, here is as tool to entering or writing program codes to microcontroller. The circuit of downloader used here as depicted in figure 7 below.

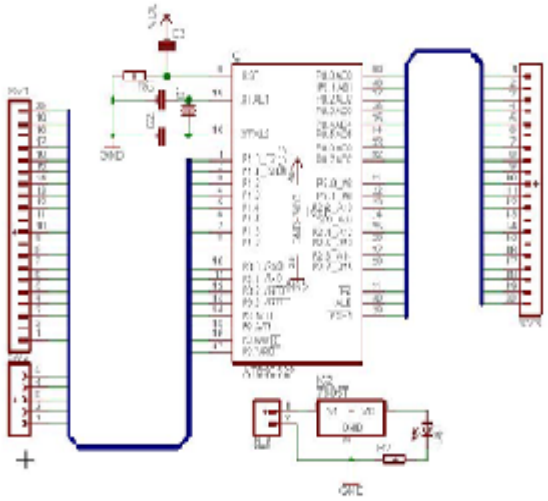


Figure 7. Downloader circuit of microcontroller

- **Microcontroler** will work if there are available a clock to XTAL1 and XTAL2 pin. To generate a clock in this microcontroller, we can use a crystal with frequency range 4 MHz – 24 MHz. In this experiment, we used 11.059MHz crystal. Below is a crystal circuit used.

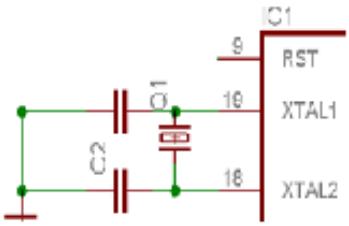


Figure 8. Oscillator crystal schematic

B. Trainer circuit

In this context, trainer designed as display tool and medium to train students in microcontroller programming. Designed trainer used as media to basic input/output microcontroller programming. For output indicator used 8 LED on PORT0 and 1 seven segment on PORT2. For input facility, in this experiment used 2 switch put on P3.2 and P3.4 pin. The circuit of all main system can be saw in Figure 9.

C. Software Design

Usually in MCS-51 programming or the other microcontroller, first we make assembly program, compiling the program and then downloading the program to microcontroller.

Generally, the steps of this process as explained below:

- Make assembly program codes using **NOTEPAD.EXE** and save it with **"asm"** extension.
- Compile the assembly program using **ASM51.EXE** that will resulting two new files which each will have **"lst"** and **"hex"** extension**.**
- If listing file (on extension "lst") indicating no error, then we can downloaded the program code with "hex" extension to microcontroller using application

software **AEC_ISP.EXE** or **ISPPROG.EXE** with their appearance as in Figure 10 and 11.

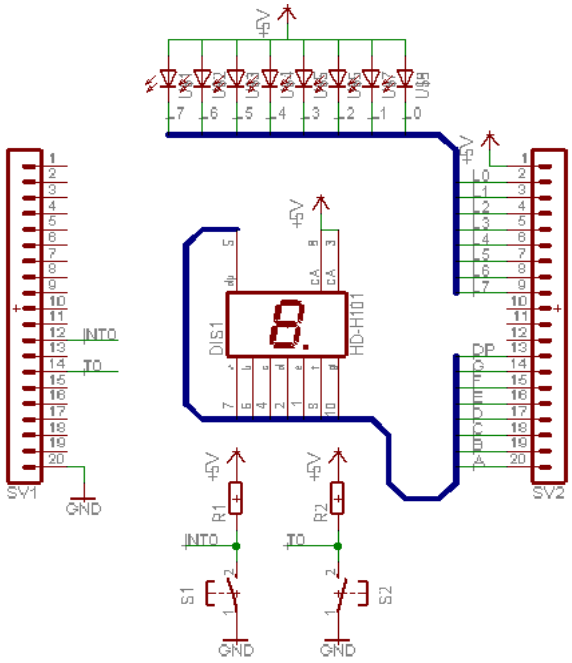


Figure 9. Microcontroller trainer main circuit

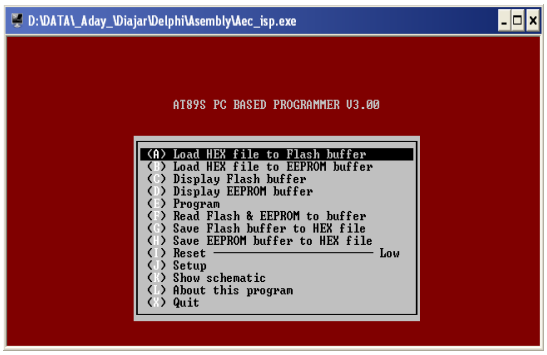


Figure 10. The first appearance of AEC_ISP.EXE

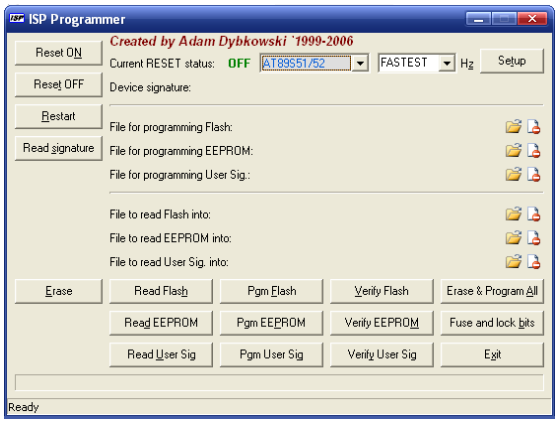


Figure.11 The first appearance of ISPPROG.EXE

From the above explanation, one have to program using three kinds of software. It's felts as not practical and more time consuming. Therefore here, the problem will be overcome with only use one integrated software. Here is integrated: ***editor***, ***compiler*** and ***programmer (downloader)*** in one software. Beside, there will be additional facilities i.e:

- ***Code Generator***, having function to make simple some programs e.g. LED, 7segment, input/output switch and delay programming
- ***Terminal***, used as medium to communicate via serial port between PC/ computer with microcontroller.
- **Instruction (part)**, functions as *database* of every MCS-51 instructions.
- **Converter**, here we can doing conversion the LED display or 7 segment in hexadecimal form.

For reading and writing to or from parallel port, we need some program codes. With **inpout32.dll** code help (as explained before) we can use the program:

```
procedure Out32(wAddr:word;bOut:byte);
stdcall;
external 'inpout32.dll'
function Inp32(wAddr:word):integer;
stdcall;
external 'inpout32.dll'
```

to access external **procedure** and **function** program/codes. And, the program to read and/ or writing data parallel port can be used this code:

```
Out32($378,45);
Inp32($379);
```

Out32 is a ***procedure*** to send or receive data via parallel port with **$378** as data address register . **45** is a byte example in decimal to be sent /wrote to parallel port terminal. **Inp32** is a ***function*** to take/ read data from parallel port. Here, **$379** is the address of ***register status*** of parallel port.

IV. SOME DISPLAYS OF RESULT

A. Software Display

Some of software displays indicated here as below:

- **Menu display**

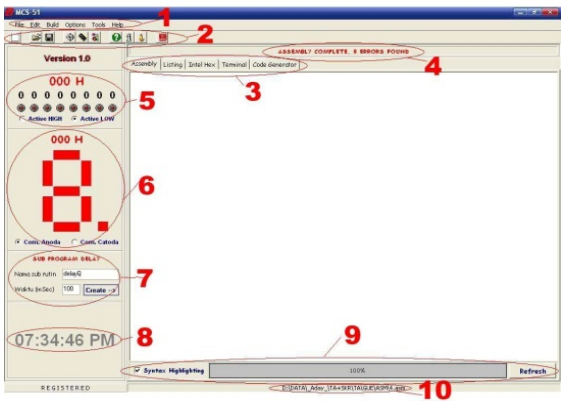


Figure 12. Main Menu Display of The Software

Note:
1. Main menu
2. Toolbar
3. Tabsheet
4. Status Label
5. Converter of 8 bit LED display
6. Converter of 7 *Segment* display
7. Code Generator for delay means
8. Time display (hour)
9. Syntax Highlighting
10. Status bar

- **Assembly Editor Display**

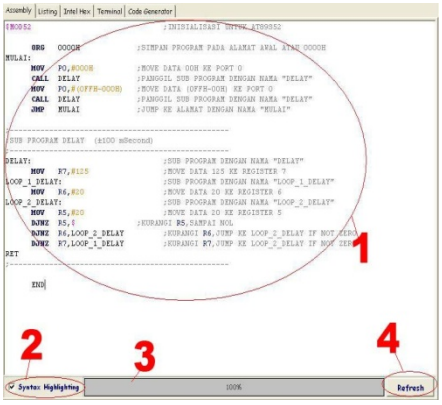


Figure 13. Assembly editor display

Note:
1. Assembly code(s) as typed
2. Syntax highlighting option
3. Progress bar
4. Refresher syntax highlighting button.

- ***Code* Generator *Display***

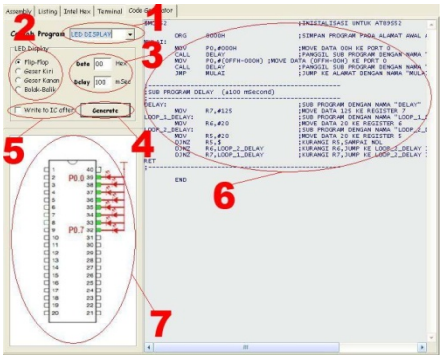


Figure 14. Code generator display

Note:
1. Option Menu for Program available (Lybrary)
2. The content of Option as Menu 1
3. Data input to be sent/ made
4. The button to begin a program
5. Option for direct programming to IC
6. The result of the program generated
7. The circuit of a system as has been selected via Menu 1

Table 1. Software Specification

Specification Items	Note
Microcontroller Supported	AT89S51/AT89S52
Database	Database Desktop (Paradox)
Interface	Parallel Port (LPT1)
PC Specification	Minimum: Pentium III
Operating System	Windows 98/ME/NT/XP
Screen Resolution	Minimum: 800 x 600 pixels
Dimension	L= 8 cm, W= 6.5 cm, H= 3 cm

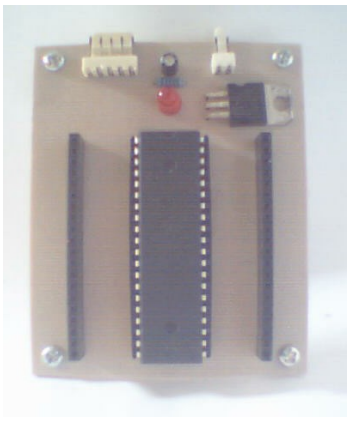
- **Hardware Specification**

Trainer specification made here as shown in table 2 below:

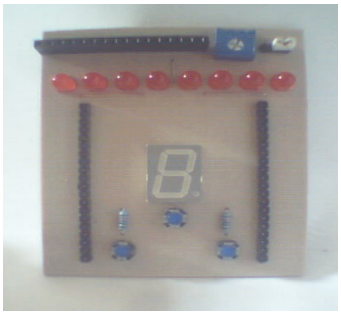
Table.2 Tranier Specification

Specification Items	Note
Voltage	5 volt
Microcontroller	AT89S52 (*Support* AT89S51)
Crystal Frequency	11.059 MHz
Programming	Serially (ISP)
LED	8 on port 0 (active LOW)
7 Segment	1 on port 2 (Common Anode)
Switch	3 on RST, P3.2 and P3.4 (active LOW)

Whereas, the real hardware appearance is in the below figures:



(a)



(b)

Figure 15. (a) Downloader top view (b) Trainer Top view

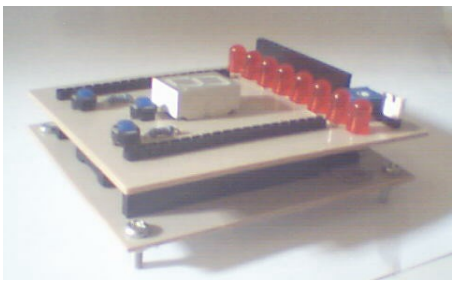


Figure 16. Side view of The Trainer

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

1. With the integration of the system; editor, compiler, programmer, and with interactive menu in the case of MCS-51 family (AT89S52), the process design from the scratch was felt as simple and not too time consuming.
2. Students or others user, will learn this microcontroller programming with easier and faster. Beside, the students/ users will feel comfortable and attractive.

B. Recommendation

It is recommended some items, i.e:

1. To prevent of easy to damage because of its fragile, the trainer system as a whole to be packaged compactly and tediously.
2. The system can be developed where it will more compatible with the others intelligent systems (for example Laptop in general).
3. For interesting means in mind, the trainer system can be enriched with others interfacing facilities. For example some thing that generally available in the industries.

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SMS-Based Electrical Energy Meter: A Hardware Design

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***Abstract*—Besides air and water, electricity is one of the most important elements in human life nowadays. Electricity is needed to make all the electric and electronic devices working properly. In Malaysia, Tenaga Nasional Berhad (TNB) is responsible in supplying the electricity to all houses and premises. This paper describes the development of power meter reading system with integration with GSM network. The device created can help Tenaga Nasional Berhad to overcome their problems in capturing meter reading as it incurs high cost. This project concentrates on designing a system that can send meter reading from the user premises to Tenaga Nasional Berhad office via SMS. The data transmitted will be received by the database system to analyze, generate a bill and store the data. The implementation of the project involved two different components; software and hardware. Microcontroller PIC16F877A was used in this project and was programmed using Mplab software. The program and the designed circuit were simulated using Proteus software to make sure it was working properly. The prototype meter was connected to the circuit to send the data using the GSM modem. At the final stage, the complete system was integrated within its hardware and software to turn these two components into one complete system. Currently, the prototype is suitable to be apply in a rural environment due to the individual house is scattered randomly at particular region. Thus the prototype could ease the authorized to manage the electrical bill efficiently.**

***Index Terms*—SMS, GSM Modem, microcontroller, meter reading**

I. INTRODUCTION

Electrical energy is one of the most important things in modern life. Electricity is required to operate all electrical and electronic appliances or machines in factory. In Malaysia, TNB responsible to supply the electrical energy to all house and premises by providing each house with kWh analog meter. The meter is used as a device to record the energy that has been used. The main purpose of this study is to improve the process of capturing the meter reading from the meter rather than the conventional method. The device can help to reduce the problem faced by TNB in which they have to send a meter reader to record the meter reading. Since the rapid growth of ICT, the use of SMS is increasing dramatically. The SMS is the fastest and the most efficient communication technology in today's world. SMS technology has been chosen due to its low in maintenance cost. This project intends to innovate the current existing meter to be associated with SMS technology through GSM network so that the meter reading can simply be sent by the meter itself without any human contact. The SMS content includes of meter ID, date, time and the total usage. These data were then recorded by the billing system for bill issuance.

Conventional method that is currently being used by the TNB is to download all the previous meter readings into a hand-held device carried by the meter reader. This can only be carried out when the meter reader could get access into the meter. The problem arises when the meter reader couldn't get access to it especially when the house

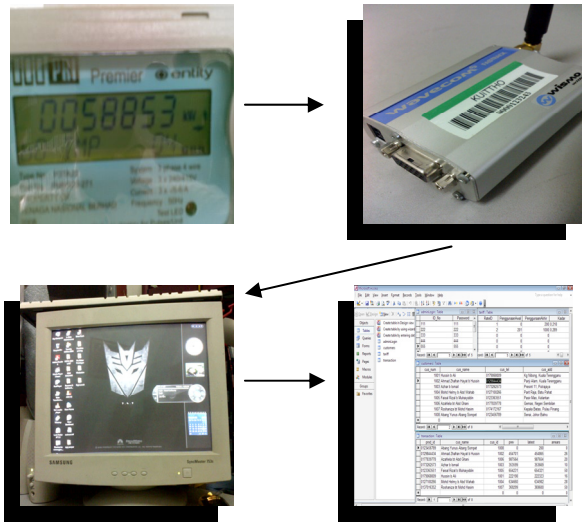

Figure 1: Block Diagram

owner was not in or the entrance gate was locked. The actual meter reading could not be read or recorded and it is merely an estimated value. The need of personnel to read the meter-reading sometimes contributes problem especially when involving cost. These problems could be minimized by utilizing SMS technology for each meter which automatically sends the meter reading to the nearest TNB branches. The meter reading then is used by the billing system to generate the bills.

Figure 1 shows the connection between the major parts in this project. The process starts at the meter unit where the usage value is generated by PIC16F877. The value is transmitted using GSM Modem that has been connected to the meter. Then the data is received by another modem which is placed at the TNB's office. The data are transferred to the computer, analyzed and generate the bill.

II. Related Work

The SMS system has been widely used and gained a lot of attention from many researchers. Study indicates by [8] which developed a system that allows people to monitor and control the house appliances via SMS. The system operates via mobile phone set by sending commands in SMS form. Two types of SMS messages were used in the system. One is outgoing message from the system to the homeowner's mobile and the other is incoming SMS messages from the homeowner's mobile to the system while [6] using the SMS system to transmit a vehicle location and status with aid of GPS. However, the project developed by [4] is a system for remote control and remote monitoring the house appliances via SMS from anywhere as long as in the range of GSM network. The devices that connected to the system such as lights, can be turned on or off through SMS. The reason on why GSM system has been chosen because it has a wide coverage, wireless and mobile.

An SMS application also has been applied in education as indicated by [7]. The SMS system were used for variety of academic and administration services such as notifying the assessment result, exam dates and assigning learning task while a study done by [2] demonstrates the SMS text acceptance among college students in Malaysia. The research shows that SMS user acceptance is very high among college students. In addition, [1] also develop a system that act as a medium between students and lecturers in delivering and spreading information. The system is developed using Active Server Page (ASP), Macromedia Dreamweaver, SQL Server 2000 and also using GSM Modem with Rabbit Processor. A study [3] designs a notice board using SMS system to change the info display on the board. The main purpose of the design is to help the lecturer for example update information to their student while they are not around.

Instead of using mobile phone, PDA and web sites, the SMS data also can be received via GSM Modem [1]. In this study, modem is the main equipment to receive the data. Modem is a contraction of the Modulator and Demodulator. A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves as a dial-up modem. The main difference between them; is a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

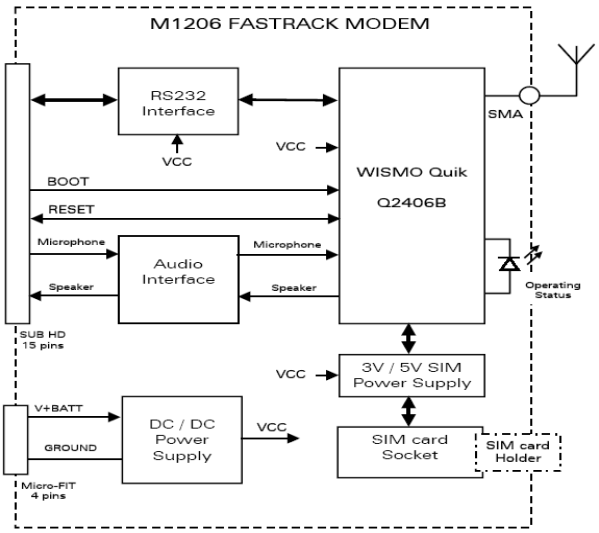

Figure 2: Architecture of GSM modem

Figure 2 illustrates the architecture of GSM Modem. WISMO Quik Q2406B acts as a power supply interface. For the RS232 interface, it is available to allow send/receive to/from the GSM modem data. Meanwhile for Audio interface, it consists of two different microphone inputs and two different speaker outputs. Finally, for SIM interfaces, there is a slot to place the identity chip of the users where the information of the users can be read from it by the modem.

In order to send and receive the SMS data, there are several softwares needed to work with GSM Modem. They are AT commands which is used with HyperTerminal to work with GSM Modem [3] and high-level programming such as Visual Basic, C/C++ programming or Java to send and receive the AT ASCII command and read messages at the computer from the serial port where the GSM modem is attached to.

GSM technology was chosen because its technology has been so popular these days and also its application is very mobile, easy to operate and does not require a lot of maintenance cost.

III. Design and Development

The implementation of the project involved two different components; software and hardware. Microcontroller PIC16F877A was used in this project and was programmed using Mplab software. The program and the designed circuit were simulated using Proteus

software to make sure it was working properly. The prototype meter was connected to the circuit to send the data using the GSM modem. At the final stage, the complete system was integrated within its hardware and software to turn these two components into one complete system. Figure 3 shows the block diagram of the project in general.

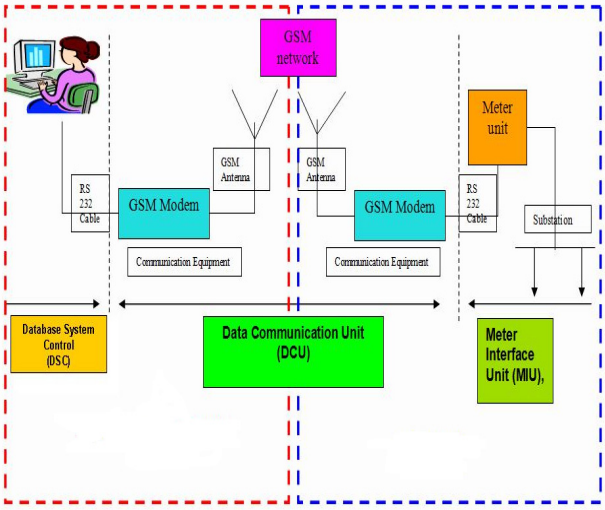

Figure 3: Architecture of the prototype

IV. TEST

A series of tests have been conducted on the complete system to make sure the meter reading system is working properly as it has been programmed. From the test any problem and flaws of any part of the system can be easily identified and rectified.

A. Prototype System Simulation

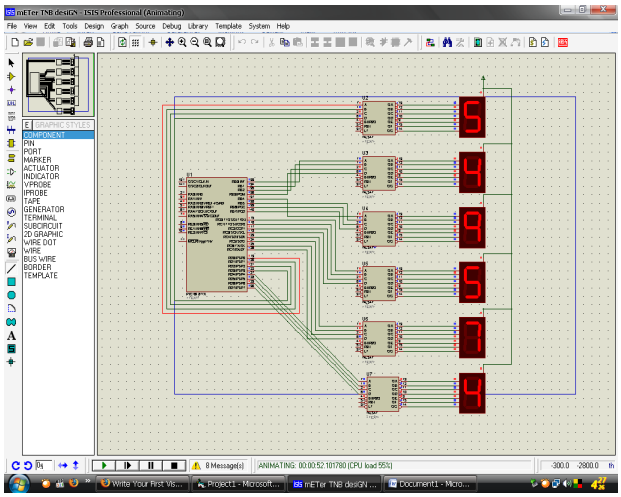

Figure 4: Circuit Simulation

Figure 4 shows the circuit simulation using Proteus software. The simulation is done to make sure the connection between each component in the circuit and the program in the PIC16F877A is correct. The hardware is built after the simulation shows the desired outputs.

B. Prototype Meter Reading

Table 1 shows the increment of meter reading test. The tests were carried out to determine the values generated by the PIC16F877A are increasing each time the switch is pressed. This test is crucial because the circuit needs to generate value that is larger than the previous value generated to make the bill calculation possible.

Table 1: Increment of Meter Reading Test

No. of experiment	No. of switch	Meter Reading (KWh)	Increment of reading
1	0	000000	-
2	1	324562	✓
3	2	549574	✓
4	3	672133	✓
5	4	823837	✓

Electrical Power Usage (KWh) = Latest Meter Reading – Previous Meter Reading

C. SMS Circuit

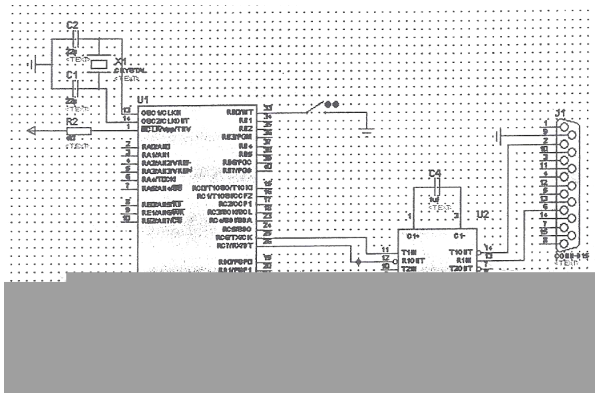

Figure 5: SMS Circuit

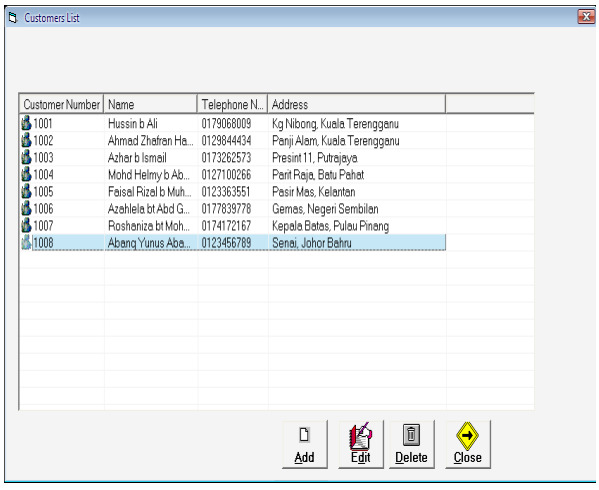

Figure 6: Integrated Customer billing system

Figure 5 shows the schematic diagram of the connection between the circuit and cable connector (RS232). This circuit was tested to make sure its ability to send the data through the GSM modem. From the test it was found that the complete system worked as expected. Some minor problems were identified and managed to be rectified and solved. As illustrated in Figure 6, customer billing system located at the server manages the SMS sent to calculate the amount based on the meter reading. The current meter reading minus with previous meter reading to produce the total usage. Figure 7 illustrates the amount generated from the system.

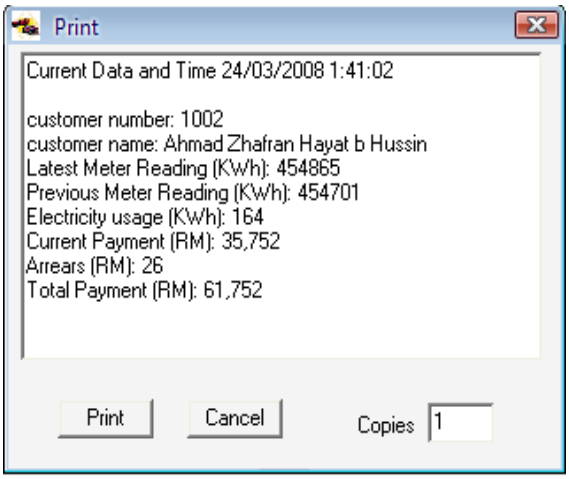

Figure 7: Bill generated from the system

V. CONCLUSION

As an overall, the implementation of the project was a success. However a few recommendation need to be taken into account when developing this project in future, they are; back-up power supply to continuously supply power to the house, memory device that can store the power usage (KWh) in case of power failure, and an LCD display instead of 7-segments display which can display more information than the 7-segments.

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Zachman Framework Approach in Designing Corporate Information Factory

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***Abstract*—The economies gained three decades by automating manual business processes are no longer enough to gain a competitive advantages in today's marketplace. To compete, businesses need to build a new set of capabilities that deliver business inteliggence and business management solutions. The enterprise executives need an exact information as the basic reference in making strategic decision to survive in the competition. Corporate Information Factory (CIF) is a paradigm that specificaly pointed to provide a vital strategic information to the organization. CIF needs to be designed in enterprise information architecture context, so it would achieved a hollistic point of view to the enterprise needs. One of the most adopted approach by practitioner in enterprise information architecture is Zachman framework. Zachman framework provides architectural construction in developing methodology and the whole strategy. This framework became guidance in developing enterprise's CIF blue print. This research work through on how to design CIF that can integrate all data needed by information system and also provide strategic information that supports the strategic decision making. Zachman framework is expected to provide comprehensive and systematic mind frame, so that the process of designing CIF would be more effective.**

***Keywords*: Strategic information, Corporate Information Factory, Zachman framework, Enterprise Information Architectur.**

I. BACKGROUND

Since the 1980s, there were various applications for administering enterprise operational data. Then realized that the most important thing is not just data, but information. This triggered the birth of data warehouse (DWH) technology, then lately evolved became Corporate Information Factory (CIF) in the 1990s. CIF is the detailed planning for the whole enterprise information architecture.

CIF development is a big and not easy job. Too much data integration and consolidation because of the lack of knowledge about enterprise perspectives. Therefore, in CIF development an enterprise information architecture framework need to be adopted, so could be achieved a holistic view about enterprise's condition and requirement. Zachman framework is a framework in developing the Enterprise Information Architecture (EIA) that is recommended by practitioners because it had advantage in comprehensive planning process. This framework would be the guidance in resulting enterprise's architecture blueprint. From the blueprint, would be extracted enterprise's information need, the CIF could be built.

This research would provide the framework for developing CIF that is aligned with the EIA principle.

II. CORPORATE INFORMATION FACTORY

A. Information Ecosystems and CIF

Today, companies start to implement IT to survive in the competition. IT division is being bombarded with a growing number of targeted information architecture, technologies, methodologies, and tools, especially in data processing and information administration. But implementing many data processing tools in the same time can be confusing and not efficient [4]. The needs of strategic information is more related in how to build a healthy organization and the ability in surviving the competition. Critical decision depends on the availability of the strategic information that match in the organization.

An information ecosystem is needed to orchestrate the use of various information technologies and constructs, and to foster communication and cooperative exchange of work, data, process, and knowledge as part of a symbolic relationship. An information ecosystem is a system with different components, each serving a community directly while working in concert with other components to produce a cohesive, balanced information environment. Corporate information factory (CIF) is the physical embodiment of the notion of an information ecosystem. The CIF is at the same time generic in its structure and is unique to each company and organization as it is shaped by culture, politics, economics, and technology [4].

The Corporate Information Factory (CIF) is a logical architecture whose purpose is to deliver business intelligence and business management capabilities driven

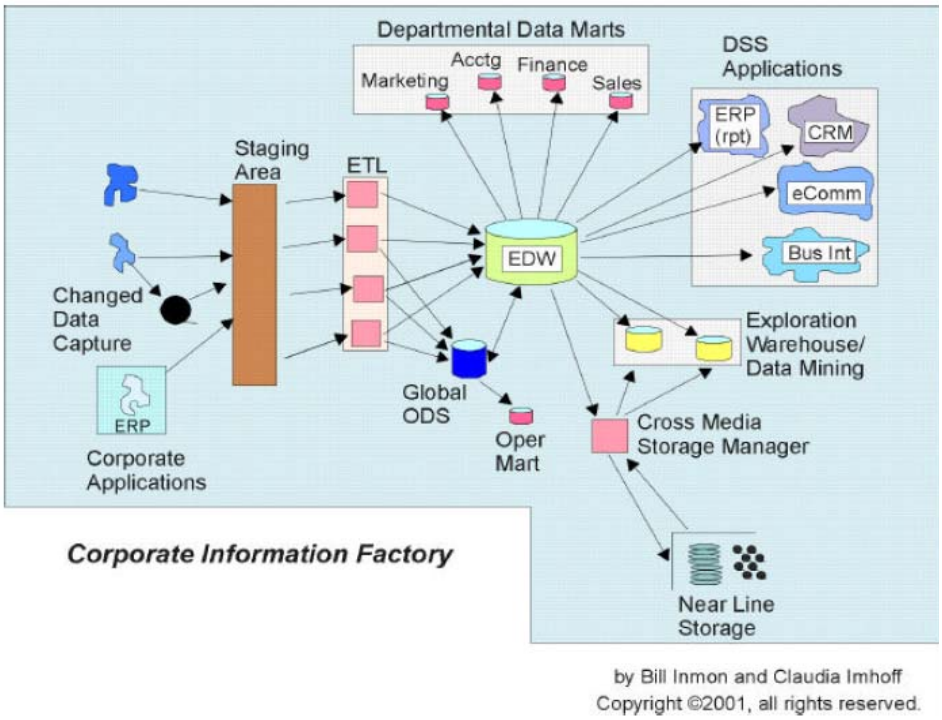

Figure 1 The CIF structure.

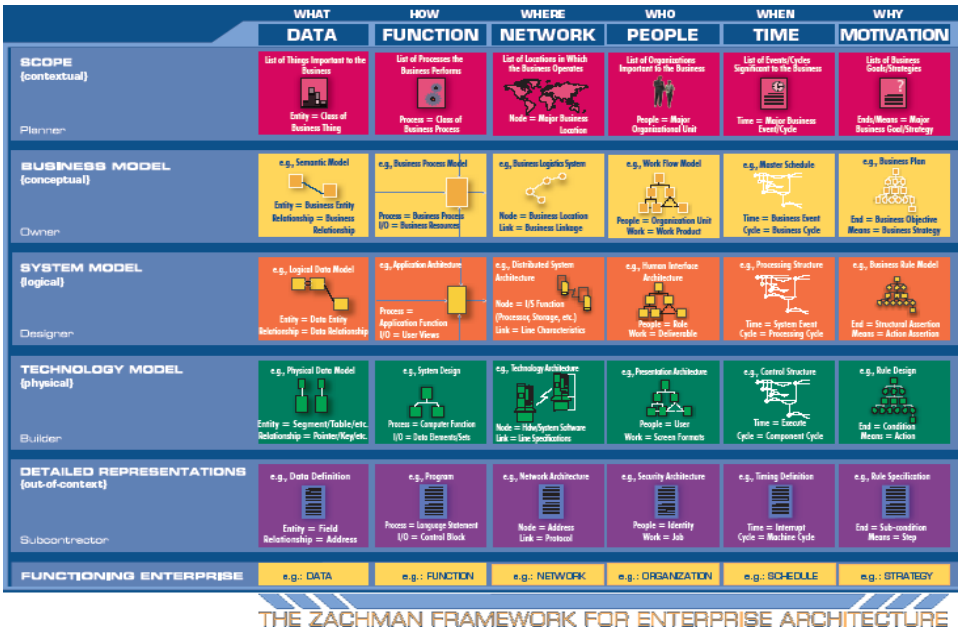

Figure 2. Zachman Framework

by data provided from business operations [3].

B. *The Components*

CIF is built from some componets. The different components of the CIF create a foundation for information delivery and decision-making activities that can occur anywhere in the CIF. Many of these activities are in the form of decision-support systems (DSS) that provide the end user with easy-to-use, intuitively simple tools to distill information from data [4]. The key components of the CIF are shown in Figure 1.

III. ZACHMAN FRAMEWORK

Zachman Framework commonly used in EIA development, because it provides a holistic view and

Planner	**Commitment**			
Owner	**Data Model Analysis**			
Designer	**Resource Analysis**	**Technical Assessment**	**Subject Area Analysis**	
Builder	**Source System Analysis**	**Design Process**	**Technical Environment Preparation**	**Specification**
Programmer	**Programming**			

Figure 3. Development Phase

gives a unique name to each sells on the Framework. Zachman Framework is a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise's systems [10].

Six rows on Figure 2 describe six perspectives, as they are viewed by planner, owner, designer, builder, programmer, and functioning enterprise. Six columns on Figure 2 describe the focus (abstraction or topic) from the enterprise architecture: data, function, network, people, time, and motivation.

IV. CIF AND ZACHMAN FRAMEWORK

A. Development Phase

Planner's Perspective

Commitment [3]

At this point, the basic concept of CIF is formulated. This activity includes a broad definition of the scope and confirmation of the availability of the needed support, funding, and resources. In this phase, enterprise is thinking about things which could be built to improve the business, and through a partnership with IT departement, it is able to understand the role CIF can play in satisfying those needs. The definition of the business opportunity directly addresses all the dimensions:

- identification of vision, mission, and business goals to be achived,
- definition of business goals and the time these are done,
- identification of the business groups,
- location of the business groups,
- identifying the business processes and the related decision support activities which will employ the CIF, dan
- entities are addresses by identifying the subject areas of interest.

Owners's View

Data Model Analysis [3]

The CIF is being built to satisfy decision support needs. The existing decision support activities should be analyzed aas part of the data model analysis. All six dimensions are addressed by enaswering questions such as

- What information is included in the queries and reports?
- Who is receiving the information?
- Where are those people located?
- When are the queries and reports executed?
- How much history is used in the analysis?
- Why is the analysis performed? What are the business decisions being addressed?

Designer's View

The designer's view is addressed by several steps of the methodology. Completion of the data model analysis phase addresses the design implications of the model. Resource analysis and technical assessment phases address the environmental items which must be designed for the CIF to perform as needed. The subject area analysis phase revisits the scope of the CIF iteration based on the information derived from the other phases.

Resource Analysis [3]

In this phase, resources needed is estimated. This analysis may alse help to determine the contens of the various levels of the CIF architecture.

Technical Assessment [3]

The assessment needs to review both the loading of the CIF and its access within acceptable performance requirements.

Subject Area Analysis [3]

The subject area analysis revisits the scope of the CIF iteration based on the information derived from the other phases. Based on the previous analysis phases,

Tabel 1. CIF Artefact Mapping in Zachman Framework.

	DATA ***What***	**FUNCTION** ***How***	**NETWORK** ***Where***	**PEOPLE** ***Who***	**TIME** ***When***	**MOTIVATION** ***Why***
Objective/Scope: ***Contextual*** ***Role: Planner***	Products and Services Entity Candidates	Value Chain Main Business Process Business Process Supported by CIF	Location	Organization Chart Organization Units Supplier Customer Competitor	Milestone	Vision & Mision Business Direction Business Profile Business Goals
Enterprise Model ***Conceptual*** ***Role: Owner***	Dimension Identification	Function Hierarchy CIF's Process Chart Application Identification	Business Concept Diagram	CIF's Process Chart User	Development Plan Performance Criteria Data Periode	Development Goal CSF
System Model ***Logical*** ***Role: Designer***	Logical Data Model (ER/Star Schema) Class Diagram	Use-case Diagram Colaboration Diagram	System Architecture	Use-case Diagram	Maintenance Schedule	System Requirement Data Mart System testing Plan
Technology Model ***Physical*** ***Role: Builder***	Physical Data model Class Diagram	Class Diagram	Network Topology	Menu Diagram Access Rule	Sequence Diagram Data Refreshment Schedule	Technical testing Plan
Detailed Representation ***Out of Context*** ***Role: Programmer***	Database Schema Indexing	Code		Interface Code		
Functioning Enterprise ***Role: User***	Data	Function	System	Resource	Schedule	Goal

information for refining of developing models for each of the level of the CIF is obtained. The models for these level can then be designed as part of the data warehouse design phase.

Resource analysis and technical assessment phases visit the environment that must be designed so that the CIF can perform as well as it is expected. Subject area analysis revisits the data warehouse scope. Resource analysis describes the items of data and location dimensions, while technical assessment phase includes the location, time, and people dimensions. Meanwhile, the performance aspect that needed is on the motivation dimension.

Builder's View

Source System Analysis [3]

In this phase, The data source is analyzed. This analysis revisits the key structure and transformation map. This analysis is crucial for achieving the integrated ant time-variant system.

Technical Environment Preparation [3]

Preparation of the technical environment entails the set of activities which are needed to address the deficiencies identified in the technical assessment phase. The activities in this phase are addressed to fulfill each dimension on Zachman Framework.

- Motivation dimension provide the information related to performance criteria would be achieved
- Time dimension effects the execution time and the process sequence
- People dimension indetifies the need of the users and the facilities for each user
- Location dimension effects the communication facilities
- Function dimension describe the systems's ability (processes running inside the system)
- Data dimension refers to the database systems itself

Design Process [3]

This phase includes basic transformation model, which probably operational oriented, to match the CIF paradigm that is being developed.

Programming Specifications [3]

The specifications adress moving the data from the operational to the CIF. For each element in the CIF, its source and deruvation is documented.

Programmer's View

Programming [3]

The programming defined in the specifications is performed at this time. This activities also include compilations, walk-throughs, and testing at various levels.

B. Proposed Framework

From the previous analysis could be defined the documents that is needed to describe each dimension on each CIF development perspective as shown on Tabel 1.

Zachman framework and CIF work together in harmony in creating enterprise architecture needed for completing complex enterprise system. EIA is the relevant descriptive representation to describe enterprise condition, while CIF architecture is one of the component in the architecture. Zachman framework explained that enterprise need a framework, while CIF describe the structure and content needed by the framework, so the whole enterprise requirement in information and knowledge in strategic, managerial and departemental level could be fulfilled.

V. CONCLUSIONS

a. Strategic planning on CIF development would result integrated and effective system, and resource efficiency.
b. Zachman Framework provides hollistic view to the enterprise and the need of CIF. So CIF development plan could align with enterprise's goal. Zachman Framework provides a comprehensive mind frame and describe the relation between processes so the process of designing CIF would be systematic and more effective.

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Modularity Framework as a New Software Framework in Enhancing Modularity in Open Source Projects

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***Abstract*—In this paper a new Open Source Software Framework called Modularity Framework is proposed and analyzed for the first time. Study by several researchers such as Dekoenigsberg and Gurbani have identified that modularity is one of the key success factors of Open Source Projects, but how modularity should be achieved in these projects are not clearly understood. The primary components of the proposed Software Framework, which are Software Design Patterns and Software Components, are analyzed against some parameters currently attributed to software modularity such as module's size, number of modules, complexity, cohesion, and coupling / dependency (fan in, and fan out). The result of the analysis shows that the composition of these Design Patterns combined with Software Components (interfaces and abstract classes) in a form of Software Framework called Modularity Framework is highly feasible.**

***Index Terms*—Modularity Framework, Open Source, Software Architecture, Software Framework**

I. INTRODUCTION

Open Source currently become one major research topic in software engineering by many researchers worldwide. This alternative software development methodology which is initiated in 1990s by Richard Stallman in his paper "Why Software should be Free" [14] and Eric Raymond in his paper "The Cathedral and the Bazaar" [13] now becomes the mainstream software engineering movement in Information Technology. The development methodology, which allow almost everyone to download, improve, and modify the source code, is creating groups of users and developers called Open Source Communities which are constantly trying to improve the software in rapid and evolutionary manner. Even though the members of the communities are never meet each other in person and only connected using electronic means such as email and forum, this distributed collaboration is eventually able to create some very high quality softwares which are comparable and even competing to the proprietary softwares. Some noticeable success stories about Open Source Software are Linux Operating System (Debian, Ubuntu, FreeBSD, Red Hat, etc.), Apache Web Server, Firefox / Mozilla Web Browser, OpenOffice.org , and many more.

Despite of these success stories about Open Source Softwares, the fact that there are many failures of developing software using this methodology is disturbing. For example, in sourceforge.net, one of the biggest portals for developing Open Source Softwares, is currently having more than 180 thousands Open Source Projects, but the number of projects that is downloaded with more that 25 thousand times are only about 5000 Projects or less than 3%. Several studies have been conducted in trying to identify the possible cause of these failures, and some important causes of these failures are the lack of formal process similar to its proprietary counterpart [3], poor architectural design [5], the lack of documentation that hinder new participants to contribute to the projects [6] and high entry barier for new participant to be able to contribute significantly to the project [15].

Some studies are able to discover the key success factors of the Open Source Software Projects. The important finding is that one of the key success factors in developing high quality Open Source Software is the sound and modular architecture of the software [4] [9]. Eventhough modularity has been identified as the key success factor, how modularity in early phase of Open Source Projects should be achieved, in order to increase its change of survival, is not yet clearly understood. Since most of the Open Source Projects are developed in ad hoc manner, more systematic and repeateable approaches in the development of Open Source Projects using proper Software Framework as the mini-architectural guidance which focuses on modularity are needed. In this paper, a new Software Framework called Modularity Framework is proposed and discussed for the first time. This framework focuses on achieving modularity and addressing the poor architectural design of the Open Source Software Project.

II. CURRENT RESEARCHES

The software framework being proposed will consist of two main components which are collection of Software Components and composition of several Software Design Patterns. The combination of these two main components will create a mini-architecture which can be used as a guidance in starting the modular Open Source Software.

Several researches have been conducted in Software Frameworks, Architecture, and Software Design Patterns.

A. Software Framework and Architecture

There are currently several studies about Software Framework and Software Architecture in Open Source Projects. Stewart studied the development model of Open Source Projects which focused on complexity [15]. Nakagawa in his study of software architecture in Open Source Software proposed architecture refactoring activity to repair software architecture [12]. Study in the composition of patterns for example in MVC (Model – View – Controller) architecture is actually the composition of Composite, Strategy and Observer Design Patterns [2].

B. Software Design Pattern

The study about Design Pattern in 1000 Open Source Projects was conducted by Hahnsler in which he found that Singleton is mostly used Design Pattern and only very few Open Source Developers were actually using Design Pattern [10]. Empirical Study evolution of design pattern of three Open Source Projects which are JHotdraws, ArgoUML, and Eclipse JDT found that patterns used are changed more frequently, and different kind of changes impact differently on co-changed classes, different capabilities of making the system resilient to changes [1].

In summary, it can be seen from above researches that the study about Software Frameworks, Architecture and Design Patterns are mainly focuses on detecting the existing Framework, Architecture and Design Patterns in the Open Source Projects and all of the consequences relating to them. There is no effort have been conducted in trying to enforce the Open Source development process to have sound and modular architecture characteristics. The Modularity Framework proposed in this paper is trying to fill the gap.

III. THEORETICAL BACKGROUND

The theoretical background for this paper will describe Open Source Software Projects and Software Framework and all that related to them such as Software Component, Design Pattern, Software Framework and Software Architecture.

A. Open Source Software Projects

Open Source is a software development methodology based on several distinct characteristics:

- The source code of the application is freely available for everybody to download, improve and modify [13].
- People who contribute to the development of the Open Source projects is usually forming a group called Open Source Communities which is completely voluntary.
- The development methods of the Open Source projects are lacking of formal methodology found in commercially developed software applications.

During the development of Open Source Softwares, the developers and communities depend on some tools. CVS (Concurrent Version System) is used as the repository and version control of the source code. Bug Database software such as Bugzilla or TRAC is used to keep track of all the bugs during developement. All the proposed functionalities and improvement suggestions are kept in a TODO List / Wish List. Documentation of the software is kept using Wiki. The communication among developers and communities are done electronically via websites, forum, mailing list etc. The distribution and modification of the software is controlled by specific licensing scheme such as GPL, LGPL, etc [16].

Currently, many website portals have been developed as an incubator for Open Source software initiators and interested participants to develop and host their projects. These portals are equipped with many development tools and statistics to assist the project initiator or administrator in improving their Open Source projects and other interested contributors to join the projects. Some of the popular portals are sourceforge.net, freshmeat.net, launchpad.net, and Google Code (code.google.com).

B. Software Design Pattern

Design Pattern is defined as micro architecture, and it captures essence of good solution in particular context. The characteristics of software design patterns:

- Descriptions of communicating objects and classes that are customized to solve a general design problem in a particular context .
- Design pattern is not as data structures nor complex domain specific designs.

There are several benefit of Design Pattern, such as it enables large-scale reuse of software architectures, helps document systems, captures expert knowledges and design tradeoffs, improves developer communication, forms a common vocabulary among developers and many more. The descriptions of design pattern are usually consist of [7]: Pattern name, Problem, Intent, Context, When to apply, Solution, UML-like structure, Abstract code, Consequences, Results, Tradeoffs. Design Patterns are categorized into three types [7]:

- Creational: Singleton, Abstract Factory, Factory Method, Prototype, Builder.
- Structural: Adapter, Bridge, Composite, Decorator, Facade, Flyweight, Proxy.
- Behavioural: Chain of Responsibility, Command, Interpreter, Mediator, Momento, Observer, State, Strategy, Template Method, Visitor, Iterator.

Design Pattern is first proposed by Christopher Alexander 1970s, and then the first systematic identification and analysis of Software Design Patterns are conducted by Gang of Four (Erich Gamma, Richard Helm, Ralph Johnson, and John Vlisside) which identified 23 Design Patterns. Currently, other Design Patterns are now being proposed by many researches for specific purposes.

C. Software Components

Software Components are defined as package piece of functionality and usually used as black box (internal structure of the program is not need to be known) so they are to be used as is and is provided to be reused. Software Components consist of collections of abstract classes, and interfaces. This abstract classes and interfaces are created to enable inheritance and implementation of these components by other modules / classes of the software projects. These connections to the abstract classes and interfaces are called hot spots and hooks.

There are two types of Software Components to be used based on the advanced properties of Object Oriented programming principles:

- Interfaces: a special class that all of its methods are abstract. A class may implements one or more interfaces.
- Abstract classes: template of a class that should be inherited and cannot be instantiated in which consisting one or more abstract method.

D. Software Framework and Architecture

Software Framework is a mini architecture of software which is intended to be re-used via "hot spots" and "hooks" [11]. Software Framework provide core infrastructure in creating a software project as required by the programmer. Software Framework is larger, more concrete, and more specific than Software Design Pattern, but it is smaller than Software Architecture. Some examples of Software Frameworks are J2EE (Java 2 Enterprise Edition) for developing enterprise level application in Java, jHotDraws for developing graphical application using Java (Consisting Template Method, Strategy, Observer, Decorator, and Prototype Design Patterns), and Prado to build a rapid web application based on PHP scripting language. Whereas Software Architecture is high level design of large software systems, and it reflects top level design decision. Some examples of software architecture are Pipes and Filters, Data Abstraction / Object Oriented, Layered, Repositories / Data Centered, Blackboard, Event-based, implicit invocation, Client-Server, and many more [8].

IV. Proposed Open Source Modularity Framework

According to Dekoenigsberg and Gurbani, the modularity of an Open Source Software is determined by some parameters, which are size (size of each module and the number of modules), complexity, coupling / dependency (fan in and fan out), and cohesion [4] [9]. Table 1 shows the description of each parameters and short description regarding the preferred characteristics of each parameter to create modular Open Source Software.

Table 1. Intended Characteristics of Modular Open Source Software

Characteristics of Modularity	Description
Small size in each module	Size of each individual module, may be stated as LOC (Line of Code) or FP (Function Point). The smaller the size of the module, the higher the tendency of the source code to become modular.
High number of modules	Number of modules in the system, may be stated as the number of objects, headers, etc. The larger the number of modules, it indicates the increase in granularity of the system (more modular).
Low complexity	The internal structure of the module, such as the decision structure, number of operators, etc. The more complex the application usually reflects the lower modularity of the source code.
Coupling / dependency (high fan in and low fan out)	Interdependence of one module to another modules which measures the strength of all relationships between modules. There are two parameters relating to coupling / dependency: - Fan in: The class or object is being used by many classes or objects, which is the number of modules that call a given module. The higher the fan in of modules, the higher the modularity. - Fan out: The ability of a class or object to be reused, which is the number of modules that called by a given module. The lower the fan out of modules, the higher the modularity.
High cohesion	Internal – interdependency inside module, which measures the semantic strength of relationships between components within a functional unit, and a module is usually stated as high cohesion or low cohesion. The more cohesion inside each module, the higher the modularity

To conform to the these intended characteristics into the proposed software framework, each of the characteristics will be analyzed against each primary components of the framework, which are Software Components and Software Design Patterns.

A. Achieving Modularity at Software Component

Since Software Framework consists of Software Components and Design Patterns, achieving modularity at Software Component level should be analyzed against each of the intended characteristics shown in Table 1. Table 2 shows the intended properties of the Software Components so that modularity in an Open Source Software can be achieved and their justifications.

Table 2. Achieving Modularity at Software Component Level

Characteristics to Achieve	Description
Small size in each module	- Limiting the number of classes in each module to ensure that each module is created only to perform simple function. - Limiting the number of methods in each class to ensure that one class is created only for specific purposes. - Using principles that each method in a class comprising the method is created to do only for a single-simple task.
High number of modules	Module / sub-system that perform more complex task should be created by calling lower level modules in a controlled interface.
Low complexity	- Limiting the number of operators in each module or class or method. - Regulating the the flow of control in each method in the class / module.
Coupling / dependency (high fan in and low fan out)	- Common interfaces shall be created to handle interconnection of similar modules / classes to limit the number of interconnection among modules. - Hirarchy of calls shall be created in which a module / sub-system is only allowed to call lower level module / sub-system and it is not allowed to call each other in similar level without creating higher level module / sub-system.
High cohesion	Using proper coding practices, such as limiting the use of global variables, use private and protected attributes in a class (proper information hiding).

B. Achieving Modularity in Software Design Pattern

Modularity in Open Source Software also should be achieved in the composition of Design Patterns as the second component of the Software Framework. Table 3. shows the intended properties of the Software Design Patterns that will be composed along with Software Components as Software Framework.

Description of each Design Pattern stated in Table 3, as the subject of further research about Modularity Framework [7]:

- Abstract Factory: a creational design pattern, factory for building related objects.
- Factory Method: a creational design pattern, method in derived class creates associates
- Prototype: a creational design pattern, factory for cloning new instances of objects from prototype, Create a new object by copying this prototype
- Strategy: a behavioral design pattern, abstraction for selecting one of many algorithms, Reduce complexity, Increase flexibility
- Decorator: a structural design pattern, decorator extends an object transparently, add additional responsibilities to an object dynamically, alternative to subclassing for extending functionality
- Observer: a behavioral design pattern, dependents update automatically when subject changes, reduce tight coupling
- Composite: a structural design pattern, structure for building recursive aggregations
- Façade: a structural design pattern, simplifies the interface for a subsystem
- Proxy: a structural design pattern, one object approximates another

Table 3. Achieving Modularity using Software Design Patterns

Characteristics to Achieve	Description
Small size in each module	Using Decorator and Composite Design Patterns in making complex function as collections of simple functions. Those simple functions will ensure there will be small size in each module
High number of modules	Creation of new classes or modules by users in controlled manner by using Software Design Patterns such as Abstract Factory, Factory Method, or Prototype.
Low complexity	Reducing the complexity by applying Strategy, Composite and Decorator Design Pattern, so that complex functionality is aggregated from collections of simple functionalities of lower level modules / classes.
Coupling / dependency (high fan in and low fan out)	- Separation of implementation and data by using Observer Design Pattern will reduce tight coupling among modules. - Reduction of interface in module interconnection by using Façade or Proxy Design Pattern.
High cohesion	Not applicable since high cohesion related to the internal structure of each module and not to the higher level.

C. Achieving Modularity using Software Framework

The composition of these Software Components and Software Design Patterns will create a Software Framework which acts as a mini-architecture style platform that enables Open Source Software Developers to create a new modular Open Source Software. Combining all the findings about how to achieve modularity in either Software Components and Software Design Patterns, the general requirement for Modularity Framework are stated in this 8 basic requirements:

- *REQ01*: The Software Framework shall consist of collection of two primary components, which are the Software Components and Software Design Patterns.
- *REQ02*: The Software Components shall consist of modules where in each module shall consist of Interfaces and Abstract Classes to be implemented / inherited by user created modules.
- *REQ03*: There shall be limitation in the number of classes of each module and the number of method of each class / interface, for either the method / class in Software Components or the user created classes.
- *REQ04*: Each user created class shall be created in controlled fashion using Abstract Factory, Factory Method, or Prototype Design Pattern.
- *REQ05*: Complex task should be achieved by calling many modules in higher level of module through the

provided Software Components using Strategy, Decorator, Composite or Observer Design Patterns.

- *REQ06*: Proxy Design Pattern shall be used to reduce calling to other modules / classes. The interface is controlled using Proxy Design patterns.
- *REQ07*: Predefined building blok of user created modules shall be created by using Façade Design Pattern.
- *REQ08*: Proper coding practices shall be enforced, such as limiting the use of global variables, use private and protected attributes in a class (proper information hiding)

These requirements should be used as the base for the construction of the proposed Modularity Framework and they may evolve further. As the Software Framework is intended to be developed in Open Source, the requirements of the framework will eventually added and evolve. The 8 requirements stated above should provide as initial start to develop the framework. The application of this framework by Open Source initiators will enforce the good design principle by applying modularity principle from the beginning of the project.

V. CONCLUSION

Open Source Software Projects are becoming the mainstream software development that attracting many researchers who are trying to find its success factors. Despite many of failures currently observed in Open Source Projects, many studies have found that the key success factor is modularity. The desired parameters currently attributed to modularity have been identified which are small size in each module, high number of modules, low complexity, coupling / dependency (high fan in and low fan out), and high cohesion. Even though many studies has been dedicated to Design Pattern, Software Framework, and Software Architecture, the proper methodology to achieve modularity in Open Source Projects is never studied.

In this paper a new Open Source Software Framework called Modularity Framework is proposed and analyzed for the first time. The intended characteristics related to the desired parameters attributed to modularity in the components of Software Framework (Software Components and Design Patterns) are analyzed. The study shows that the construction of Modularity Framework that enhance the modularity in Open Source Projects is highly feasible by identifying eight basic requirements of the framework.

VI. FUTURE WORK

Since this is only in the early stage of development of the Open Source Software Framework called Modularity Framework, further research in this area is needed. Study about many kinds of software architecture in several successfull Open Source Projects is required in order to find the underlying Software Framework of those projects that may be implemented in the proposed Software Framework. Development of Sofware Components and composition of Design Patterns that makes up the framework need to be created and tested to several group of programmers. Integration of this framework to Integrated Development Environment which is popular to Open Source communities such as in Eclipse or Anjuta is also future possibility.

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Exchange Rate Prediction between Indonesian Rupiah and U.S. Dollar Using Transductive Learning

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***Abstract*—Purchasing goods or services produced in United States would force Indonesian company or investor to purchase US dollar, and vice versa. The drastically changes of the foreign exchange rate between Indonesian rupiah and U.S. dollar would significantly affect the good's price. Those facts motivated many studies focused on the exchange rate prediction. Various algorithms have been developed in which data mining has received arising attentions. The aim of this study is to evaluate the transductive learning to forecast the U.S. dollar price from Indonesian rupiah price. Compared to inductive learning, transductive learning is expected to perform better in prediction task. Tomorrow price of US dollar could be difficult to be predicted because the tomorrow price would drastically increase or decrease. Using transductive learning, only small training data set is analyzed to determine the appropriate rule for prediction result. Since the rule is obtained from only small subset of training data, not from the whole, the rule is not generalized as which is applied by inductive learning approach. The result of the small subset of the training data would be used to find the best result of prediction.**

I. INTRODUCTION

Nowadays, there have many researchers trying to forecast the future value of foreign exchange rate (Forex). They are forced by several factors, not only by economic reason, but also technique reason. Technically, some researchers and actually the authors try to solve financial problem using Artificial Intelligent. Here we want to proof whether business perspective is not the only way to solve the financial problem. Moreover, there have researchers performing better result.

In this paper, we try to determine the tomorrow's price of the U.S. dollar compared to the Indonesian rupiah using transductive learning introduced by Vapnik [1] [2], rather than another method called inductive reasoning approach.

Problem faced in inductive learning, which is difficult to construct the general theory for estimating a function at the given points [2], especially for studies focused on exchange rate prediction, transductive learning is expected to perform better in prediction.

Besides that, the main idea was described by as follow: *"If you are limited to restricted amount of information, do not solve the particular problem you need by solving a more general problem,"* [2].

II. TRANSDUCTIVE SETTING

As mentioned before, transductive learning is expected to perform better in prediction. It can offer substantial advantage over induction whenever the training set is small or moderate [3].

In this section, we describe our basic ideas to implement transductive learning to predict exchange rate data.

A. Preprocessing data

Input data for the prediction process will affect to the affectivity of the process, so it is important to do preprocessing data before the prediction process started. The more suitable input data generalized by this process, analysis process will become easier, because the objective of this process is to improve the data mining analysis with respect to time, cost, and quality [4].

By implementing preprocessing training data, transforming our training data would make it easier defined the most appropriate pattern.

B. Modified nearest neighbor

We assume that predicted value for time point (t + 1) is generated from the addition of value for time point (t) with the result of different value (α) where α can be negative or positive (shows whether rise or fall).

$$x(t+1) = x(t) + \alpha$$

The value α is formalized by implementing modified nearest neighbor method. The method is modification from K-Nearest Neighbor classifier. K-Nearest Neighbor classifier is performed only for classification process, whereas this study does not perform classification to gain the prediction result. Besides that the number of k can be defined every number, since the number is greater than one and less than the number of window size. Moreover,

this method is modified by performing averaging operation after getting k values of data result.

The modified nearest neighbor use Euclidean distance to calculate the similarity distance between data. As the formula given:

$$\left(\sum_{i=1}^{n}|x_i - y_i|^2\right)^{1/2}$$

C. Best Optimization Regression Function

In this section, we describe the more specified method to determine the most appropriate pattern from training data. If we compared to only use one of three regression functions which are linear, quadratic, and cubic regression, finding the best optimization those three regression function should get better result. We assumed that for every chunk of data may generalize different regression function according which function is the most fit from its real price. To determine weather the generalized regression function is fit or not from its real price, Euclidean distance is also implied in this section. Although there are some researches use mean squared error in regression pruning error profile [5], we assume that it performs the same result.

III. Result

The prediction results are derived from 2 data set foreign exchange rate the Indonesian rupiah compared to the U.S. dollar. First data set consists of 1004 rows and the second data consists of 2135 rows. Both of them divided into training set and test set, in which test set = 14 for both.

After getting the prediction result from those both data sets, root mean squared error (RMSE) is performed to calculate how accurate the result compared to the test set given.

Based on the prediction result in table 1, both of data sets do not produce a good result. Approximately, the automated system generates maximum 36% error rate.

Table 1 Prediction result using modified nearest neighbor as transductive learning. Different 10 RMSE values by selecting different 10 k values (1-10).

K	**RMSE1**	RMSE2
1	Rp 194.70	Rp 516.33
2	Rp 156.92	Rp 405.15
3	Rp 155.38	Rp 327.82
4	Rp 160.04	Rp 354.34
5	Rp 166.81	Rp 347.94
6	Rp 163.16	Rp 335.93
7	Rp 152.84	Rp 359.34
8	Rp 163.83	Rp 370.57
9	Rp 183.00	Rp 340.92
10	Rp 170.73	Rp 337.26

Although the RMSE value from both data sets generalized different, but actually those results are in the same error rate. For data set 2, which has the range of different changes from 0 to 1428, the RMSE value generalized higher rate than RMSE value for data set 1 which has the range of different changes from 0 to 749.8.

From the result of prediction data generalized, the calculation for every chunk of training data generalize cubic regression function as the most fit regression function from its real price rather than linear or quadratic regression function. From this analysis, the authors assume that the higher regression function, the most fit regression function generalized.

V. Conclusion and Future Work

We conclude that combination method between modified nearest neighbor and transductive learning does not generate a good result.

As future work, we are going to identify the reason why the system does not generate a good result. Besides that, different method will be also implied but the transductive learning still defined as the approach.

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Analysis of Gen Expression and Microarray Data on Pattern Recognition Techniques: Review

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***Abstract*—Analysis of genes expression can be done with the investigation of a particular microarray data for the description of a gen. This is done to identify what genes that were active in the human body, if wearing a particular treatment. This activity is useful to predict the occurrence of a disease or reaction to medications. This information is an important consideration for medical experts to determine the incidence of disease mechanisms, and determine which therapy is right for the patient. Various studies and research on the microarray data and genes expression has been conducted to identify the genes is. Genes is identified with the introduction of patterns (pattern recognition). Introduction of various technical patterns (pattern recognition) analysis on the expression of genes has been performed. Introduction of techniques such as the patterns in data mining techniques. PCA, k-means Clustering (Partitioning), Bayesian belief Networks (BBN), Hierarchical Clustering, mixture models and EM, Gene Shaving, Hidden Markov Model, GA/KNN, Boolean Network, Novel algorithm. Each has experienced the development of techniques by the researchers in the field, to produce a good performance techniques.**

***Keywords*—genes expression, microarray data, pattern recognition, PCA, k-means Clustering (Partitioning), Bayesian belief Networks (BBN), Hierarchical Clustering, mixture models and EM, Gene Shaving, Hidden Markov Model, GA / KNN, Boolean Network, Novel algorithm.**

I. INTRODUCTION

Science and technology develop rapidly at this time. Many of the development of science and technology has helped people in various aspects of life. In the field of information technology and biological science has developed bioinformatics. Bioinformatics learn that science is the application of the computational technique to manage and analyze biological information. This field include the application of the methods of mathematics, statistics, and informatics to solve biological problems, especially with the use sekuens DNA and amino acids as well as information relating to it. Sample topics include the main areas of this database to manage biological information, sequence alignment, to predict the structure prediction of protein structure and RNA secondary structure, filogenetik analysis, and expression analysis of genes. Next (Nugroho, 2003) [18] states Bioinformatics is a cross-disciplinary science of information technology and biological technology, to address complex problems in the field of biology. Bioinformatics development based on human needs to analyze these data quantity increasing rapidly. Acceleration of the availability of biological data is not released from the harmonious cooperation of information technology and advances in the field of biotechnology [17].

One of the activities in which bioinformatics do is in many investigations of human genes and microarray data. Complete mapping of all the genes possessed by humans have been conducted scientists joined in the field of molecular biology in the call to the Human Genome Project (HGP). Disclosure of data on human genes can recognize all biochemical processes that occur in the human body, the effect on the nature-nature.

Various studies and research on the microarray data and genes expression has been conducted to identify the genes is. Gene is identified with the introduction of patterns (pattern recognition). The introduction is a discipline of learning how to classify the object to some class or category and identify preference of data. This subject is also called the pattern recognition. Pattern Recognition at this time has been learned in the developed and the methods. Activities in this pattern recognition is to map the data in a particular concept that was defined previously [17]. Methods in pattern recognition has been developed. Pattern recognition (The pattern) in the data mining methodology includes: classification, klastering, graphical modeling, etc. Various research has been conducted to analyze microarray data or genes, and different methodologies have also been developed and in use for analize microarray data and gene expression. For example, PCA, k-means Clustering (Partitioning), Bayesian belief Networks (BBN), Hierarchical Clustering, mixture models and EM, Gene Shaving, Hidden Markov Model, GA / KNN, Boolean Network, novel algorithm and many technical analysis genes expression of other microarray data.

II. GEN EXPRESSION AND DNA MICROARRAY

Genom is the genetic material, which is a set of gen-set of genes from a complete organism [19]. Are gen is a DNA Sequence that reduce a protein that has a specific function in a cell is preparing the body, further valavar states. "A DNA molecule is a double-stranded polymer structured in the form of a double-Helix. A gene is a segment of protein coding in the chromosomal DNA that directs the synthesis of a protein. While the cells is a primary and basic unit of work in the body of living creatures [19].

DNA prepared by the four basic molecular units in which a Nucleotides. Each nucleotide consists of a phosphate group, a deoxyribose carbohydrate (sugar), and one of the four nitrogen base called adenine (A), guanine (G), cytosine (C), and thymine (T) (picture 1). Two of the e chain DNA closely related to the hydrogen bonds between nitrogen bases (base-pairs). Base pairing occurs only between G and C, or between A and T [14].

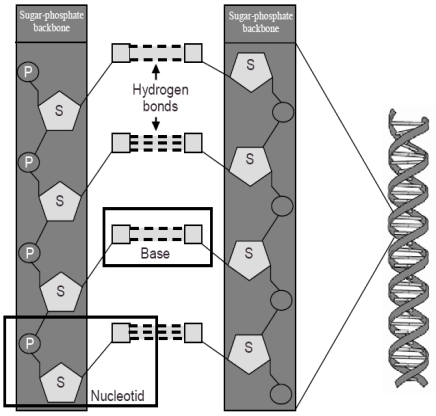

Figure 1. DNA molecule is a double-stranded, double Helix polymer.

Protein in the cell to work efficiently and harmoniously in touch with one another, to prepare an integrated organization in the body. Protein does not hold all available (diekspresi) in the cell but will be available when the protein is needed and will be immediately removed when no longer needed. In other words, the organization of the cells that will provide the protein in the type, amount of time and the right / pas. There is a shift or change, good intention, or when the amount of protein in the provision of a significant, akan can cause illness or aberration.

Provision of protein in the cell body of individuals that this is in an expression with the genes. Protein pattern of providing each individual naturally not the same, it can be said that no two individuals that have a similarity in the pattern of provision of these proteins. However, the differences that still functions in the limit kenormalan overall. Differences in the provision of this protein the cause of the difference between the certainty of the one with the other. Differences are fenotif will seen for example in the form of physical, intellect, emotions, in particular the ability (talent) to all stimulus sensitivity, congenital disease, sensitive against all the influence. Attributes attached to the personal can be tracked from the cell in the provision of protein (genotype). The progress of science in bioinformatics that supported by computer allows the system to be able to analyze the genetic identity that have in each person that will know the nature fenotifnya.

Protein pattern of providing each individual can be in the analysis. Various research has been done to analyze the expression patterns of a large number of genes in human have. Many Bantu tool to help analyze the expression of genes has been developed. With this technology can help people to identify all the inherent nature of someone. This technology can also help people in making the diagnosis, monitor and predict a disease.

III. PROBLEMS IN GEN EXPRESSION AND MICROARRAY DATA

In human genes, the problems that arise is how to understand the structure of genes and the expression, and how genes function in the human body. In this paper will focus on how the techniques in the expression of genes can help in analyzing the expression of genes and microarray data.

IV. GEN EXPRESSION ANALYSIS

Analysis of expression of genes can be done with the investigation of a particular microarray data for the description of one genes, to identify what genes-genes that were active in the human body if wearing a particular treatment. This is useful to predict the occurrence of a disease or reaction to medications .. This information is an important consideration for medical experts to determine the incidence of disease mechanisms, and determine which therapy is right for the patient. Micorarray in the process of analysis can be simply described as follows. First diisolasi from the mRNA sample is returned first in the form of DNA using a reverse transcription reaction. Then through the process of hybridization, only the DNA that are complementary akan berikatan with the DNA on the chip. DNA that has been labeled different colors will show a unique pattern. By using image processing technology (image processing), this pattern is transferred to the next in a numeric expression to be processed with various methods of pattern recognition [17]. Various techniques introduction patterns (pattern recognition) analysis on the expression of genes has been performed [19].

Burge.C, 1997 to do research on the structure of genes with general introduce probabilistic model. By using the computer program GENSCAN to identify genes. Principal Component Analysis (PCA), one technique used in pattern recognition. PCA-based principal components (PCs)., Have been able to reduce the dimensionality

problem space without the more common conditions and information. Karhunen-loe `ve expansion, Mallat (1999) in [19] in research on pattern recognition have been using principal component analysis (PCA), as well as singular value decomposition (SVD) by Anderson (1984) in [19] in statistics is also PCA. Eigengenes used to expand the (model) problem space, which is more accurate. However, the lower the sense of a eigengene, the more noise it. Required balance between the need for maximal expansion of the problem space and the need for noise reduction.

PCA can reduce the problem of dimensional space without losing information in general. This method is easy to understand each eigengene as the main expression vector represents a cluster of expression data (expression pattern). In most studies involving PCA, this technique has been used to find patterns or "modes" in the expression data with the purpose of this link to the transcriptional regulatory action. An eigengene (PC) can be emerge of a major pattern in the data set (expression data). This technique is easy to think of each as eigengene expression vector representation mean a cluster of expression data (expression pattern). In most studies involving PCA, this technique has been used to menemukanpola Modes in expression or data with intent to connect this with the action Modes of transcriptional regulators. This technique is a technique that both when in use in combinasi with the other classification techniques. Hastie, Tibshirani, et al (2000) [25] has developed the Gene Shaving. Gene shaving is a popular approach Statistical pattern detection in the expression of genes in the data developed from the PCA. In the Hastie eksperiment two patient groups were defined from a hirarchical clustering tree grown from a 380 gene cluster. As a predictor, the grouping was just significant in the low IPI group only, at the 0:05 level.

Thus 25/36 = 69% of patients are classified the same way by both groupings. The patients grouping of Alizadeh et al. was based on a cluster of 380 genes, chosen for Their large variation over the samples, the cluster of 234 genes has 38 indicated sign of the gene is to be flipped before averaging); by an asterisk indicates a gene that also falls in the 380 gene cluster from Alizadeh et al, and five of the 234 genes has 38 genes also appear in the unsupervised clusters found earlier, in the second of the three clusters.

PCA has developed many techniques to combine with others to produce the optimal analysis. Bayesian belief Networks (BBN): Bayesian belief Networks (BBN), one technique that has been in use to researchers in pattern recognition. Gifford, et al have used this approach to distinguish between two competing models for galactose regulation. Friedman, et al BBNs use to analyze the genome-wide expression data in the work to identify significant interactions between genes in a variety of metabolic and Regulatory pathway19]. Baldi, et al [2] develop a Bayesian probabilistic framework for microarray data analysis using BBNs to model "value log-normal distribution of expression dependence, parameterized with the way the variances before the appropriate normal distribution to obtain the hierarchical point estimates of both the meter and make a hyperparameter uniform expression of the expression of different genes for each combine with local and empirical different backgrounds with different genes based on proximity. Techniques BBN has developed according to the needs of each analysis, by combination techniques with others, this is done to get optimal results in the analysis of genes expression.

K-means Clustering (Partitioning): K-means Clustering (partition): k-means approach is a disruptive klastering groups. Data (genes or experiments) were divided into groups that have the same expression pattern. k is the number of groups. Number k is the input value is given to the algorithm. The k-mean clustering algorithm is a process of three langkahyaitu: The first step, a random algorithm to provide training data to a group k. In the second stage, the distance mean inter-and intra-class distances are calculated. The average distance between classes (δc) each cluster is calculated with the mean vector (μc) for each cluster, and the average distance between the vectors (data) from the cluster and the average vector. vector is called the average expression vector. In this formula, it is assumed Euclidian distance measurement, and averaging to calculate the arithmetic average. The advantages of k-means algorithm is simple and can be used in the different problem. K-means clustering algorithm designed specifically to evaluate gene spots (on the array images) is done by Bozinov [19]. This technique is based on clustering pixels of a target area in the front and the back of the clusters. Results from the analysis of real gene spots indicate that the performance is very good approach to data analysis methods gen.

Hierarchical Clustering: Hierarchical Clustering is one of the techniques in the analysis of genes and expression microarray data. There are many hierarchical clustering algorithms that can be in the application to the analysis of microarray data. Includes one-linkage clustering, complete-linkage clustering, averagelinkage clustering, weighted pair-group average, and in pair-averaging .. Hierarchical clustering algorithms usually generate a number of the same genes for all combinations of genes. Hierarchical clustering algorithms usually generate gene similarity score for all gene combinations, which put the score in the matrix, genes that have a high similarity value akan join in, and then proceed to combine the pair have little similarity. In the process of clustering, after the calculation of similarity score, the pair identified above related figures-diagonal matrix. At this process node in a hierarchy is created to pair with the highest number, the gene expressed two genes from the profilers average, and merging the elements of weight matrix based on a number of elements in it. elements that are weighted by the

number of elements they contain. For n genes, this process is repeated n-1 times until one element (which contains all the genes) remains.

Wen et al. 26 using clustering and data-mining techniques to analyze data for large scale expression of genes. In the report shows how to integrate the results in the can by using various distance metrics can reveal the differences but the patterns in the data .. Eisen et al.27 also create an elegant demonstration of the ability of hierarchical clustering in the analysis of microarray data. Mixture models: mixture models are a divide and conquer approach to the statistical model. Mixture modeling comes from the fact that not all variables in measuring can. Some of the variables that play a role sometimes described as the behavior of latent or hidden variables. Unconditional varieties are generally used for density estimation, and the one used for Regression condition and Classification problems. Mixture models using a positive convex combination of distribution and the measurement of latent variables to build a model. The use of latent variables that are intended to accommodate the natural system, such as biological and medical can not measure all the variables involved. So that the latent variables that need It is still hidden.

In general there are two types of mixture models, the conditional and unconditional. Unconditional type generally used for density estimation. This condition is used for the problem. Mixture model is used more in the clustering process.

Expectation-maximization (EM) is a two-step iterative process that maximizes the log-likelihood of a mixture model. This valuation of the address can be trusted from the lack of hierarchical clustering in the main the question is sometimes important to consider the data in the study of biological microarray data. Mixture models and EM have been doing clustering in microarray expression data analysis.

McLachlan and colleagues, using a mixture model and EM in developing a software package called EMMIX-Gene. EMMIX Gene-cluster is used to record the microarray expression data from the network examples colon and leukemia. For both data sets, relevant subsets of genes that appear klastering the biological significance of the network in the selection. Cluster-cluster is consistent with the results of the examination or network priori biological knowledge [19].

This method is developed to accommodate data with the variables that are not measurable, with the maximum log-likelihood of the mixture model, this method can overcome the kekurang on hierarchical clustering microarray data in the study.

Support Vector Machine (SVM): Support Vector Machine (SVM) Byun (2003) [24] and Tsuda (2000) [23] have used the Support Vector Machine (SVM) developed by Boser, Guyon, Vapnik, and was first presented in 1992 at the Annual Workshop on Computational Learning Theory in the research. Basic concept of SVM is actually a combination of the harmonic theories of computing have been dozens of previous years, such as margin hyperplane (widower & Hart 1973, Cover 1965, Vapnik 1964, etc..), The kernel was introduced by Aronszajn 1950, and also with the concepts of supporting the other. SVM to solve the problem with the expression vector mapping genes from expression space into higher-dimensional feature, where distance is measured using a mathematical function known as a kernel function, and data may be in for two to the restrictions in the class room linier map features to the restriction non linier expression of genes in space. SVM can be considered as a nonlinear Separation technique. Each experiment generated data points by DNA microarray hybridization represents a comparison of the level of expression of genes under two experimental conditions the differences [4]. SVM uses hyperplanes as separators between the positive and negative points in the feature space.

Select SVM margin hyperplane that provides maximum surface points between positive and negative. After memimisahkan hyperplanes for the points classification function that involves the dot product between points in space. SVM will begin with a set of genes that have a function: for example, genes coding for ribosomal proteins or genes coding for components of the proteasome. In separate groups of genes that are not known to be functional members of a specified class. Both sets of genes in combination form a set of training examples labeled as positive if their genes are in functional class and labeled negative if there is no known functional class. Set of training examples can be easily collected from the literature and data sources. Using this training set of SVM learning akan determine between members and non members of a given functional class based on expression data. After studying the expression-class features, SVM could recognize new genes as members or not members of the class based on expression data.

Results from the Brown experiment with n genes on a single chip, is a series of n expression-level ratio. Results from this eksperiment indicates that some functional classes of genes-genes can be recognized by using SVMs trained on DNA microarray expression data from a comparison of SVMs with four non-SVM methods, show that SVMs provide the best performance [4]. Various studies have been conducted in the SVM's ability to analyze expression of genes. SVM is one of the methods used for the analysis of expression of genes that high dimension. Use of SVM in high dimensions, will not cause negative effects that occur because the curse of dimensionality, from studies with the combination of SVM and development with other techniques shows a good performance compared with other techniques patern recognition in the expression of genes for analysis.

Hidden Markov Models: Hidden Markov Models have been widely learned in the ability for recognition and processing. Hidden Markov models: Hidden Markov

models have been studied extensively to speak and recognition processing. Haussler et. and Krogh et al.36. al.37 is among the pioneers in the use of biological data in the Well has been applied to various problems in biological data mining, such as gene finding and sequence alignment.

Haussler et. al. and Krogh et. al. one of the researchers who use data mining Hmm in biology. HMMs are state-based models, is defined based on a priori knowledge of the biological system into the model. HMMs on data mining applications in biology, among others, find the genes and sequence alignment. Sonnhammer create Pfam, a database of protein Hmm engines to use the provision of a tool to align the various sekuens. Implementation is another Sequence alignment and modeling (SAM) made by Karplus is another example of the application in the sequence alignment Hmm. Hmm, using the binding nucleotides, or groups of nucleotides, in DNA binding sites may be independent [19].

Kulp, D, et all do research for the recognition of human genes using hidden markov model that developed into the Genie gene finding is a model [12].

Genetic algorithm (GA) and k-Nearest neighbor (KNN) (GA/KNN) is another approach in identifying the genes expressed by Li, et al. This approach combines the Genetic algorithm (GA) and k-Nearest neighbor (KNN) to identify genes that can jointly discriminate between different classes of samples. In GA coordinates dots arranged in the problem space as a sequence, as the withdrawal sequence gen. The process of searching the maximum and minimum can be a mutation in the sequence that reaches the new coordinates. In the new coordinates every function in the evaluation, the new points in the set to be more optimal from the past. Points in the new store as the extrema (minimum or maximum) new. Is used in many applications bebagai sequencing. For example, Person has been using GA for DNA fragment assembly. Zhang and Wong GA to implement multiple molecular sequence alignment. Most of the way different types of GA mutation in the sequence, and explore the problem space in a different pattern.

GA/KNN is a supervised stochastic pattern recognition method which is able to select a subset of predictive genes with a set of data that have a data set of large noisy data for sample Classification.

In research Liu, (2002) analyzed the primary sequences using Numerical Characterization and Similarity which defines the scheme provides a logical order of DNA sequences in the primary period of classification based on the nucleic acid. Using logic sequences they produce a set of 4 × 6 matrices to represent DNA primary sequences, which are based on the calculation of all (0,1) triplets in the logic sequences. Using the condensed representation of primary DNA primary sequences and the eigenvalues of the Symmetric real matrix a comparison is made between the primary sequences for exon-1 of human β-globin and seven other species. This method is the development of the matrix method to determine the invariant as new descriptors for DNA sequences [2]. This method is a good method to use for DNA Sequence Analysis to analyze the expression of genes [14].

Kapushesky (2004) have created a tool to help identify and ekspresii genes microarray and other genomic functions, namely Expression profiler. Expression profiler (EP, http://www.ebi.ac.uk/expressionprofiler) is a web-based platform for microarray gene expression and other functional genomics-related data analysis. Web-based design of Expression profiler support data sharing and analysis in a collaborative environment that is guaranteed. Development tool integrated with the microarray gene expression database. EP: NG is an open-source project that gives hope for the distribution and extension of the scientific community [3]. Tools developed in this very helpful in identifying the microarray and the expression of genes, to genes from manganalisis conditions in order to provide optimal results from the analysis of genes [11].

Cho, (2003) tried to explore some classification techniques and feature selection. In percobaannya adopted seven feature selection methods and classification of the four techniques used in datamining and pattern recognition in classifying cancer precisely. Feature selection methods including Pearson's and Spearman's correlation coefficients, Euclidean distance, patcosine coefficient, information gain, mutual information and signal to noise ratio. Classification techniques and multi-layer perceptron (MLP), k-nearest neighbour (KNN), support vector machine (SVM) and structure adaptive self-organizing map (Som) in machine learning. In this experiment also combine several classifiers with majority voting to enhance the performance of classification. Machine learning is defined for a DNA microarray select discriminative genes associated with the Classification of gene expression data, trains a new classifier using the data using the learned classifier.

Gene expression data calculated from the DNA microarray. We predict two-phase system with the feature selection and patternclassification stages. Feature selection can be kemukakan as gene selection, to get a list of genes that may be informative for the prediction with the Statistical, informatioputusan to categorize the pattern of genes located at the input.

This method is very simple and there are many methods to combination classification techniques in the field of machine learning and data mining. Applications with more sophisticated methods from the same datasets to strengthen the results obtained in order to become better. This research has developed an optimal combination of feature-classifier to produce the best performance in classification. Information obtained, Pearson's correlation coefficient is the top feature selection methods, and MLP and KNN is best classifiers [7].

Jaeger (2006) in the research entitled "Selecting

normalization genes for small Diagnostic microarrays" results obtained from the difference in normalizing large microarrays and small Diagnostic microarrays. In this research to include the proposed additional normalization genes on the small Diagnostic microarrays and propose two strategic select for each genome wide microarray studies. The first is a data driven selection of univariate normalization gen-gen. Multivariate and the second is based on the discovery of Diagnostic balanced signature. Then do the second comparison method for standard normalization protocols known from extending widely in the microarray system. Here recognize that this method can be said to provide better GAMI with the ability to express a variable-length motifs and allow GAMI to menhubungkan difference motives in CTFR Data [6]. Method developed is very well applied to the microarray for r not too big not [10].

Congdon (2008) conducted a research entitled "An Evaluation of Information Content as a Metric for the Inference of Putative Conserved Noncoding Regions in DNA sequences Using a Genetic Algorithms Approach." On this research he memperkenakan MC and IC metrics and some of the variation than to use it as a Fitness functions in GAMI. GAMI method is for a set of nucleotide sequence patterns that appear at least once in each sequence. Motif representation is the standard consensus motif: an N-mer base that consists of A, C, G, and T. For example, if we find 8mers, possible motives identified include akan CATGCAAT, TAGGAACT, ACTTACGT, and so forth. As a function of initial fitness, used a metric called the "match count" (MC). To evaluate patterns of MC is given, each sequence of consecutive sought to find the best match in the sequence. Match between Forward and reverse-Complement considered in each sequence. Match maximizes the best of a number of bases is according to the motif in all sequences. But there is one or more of one the most appropriate patterns and nucleotide sequences. Maximum score value of bases matched in each sequence is the motif of the sequence. Score for each motif in the sequence data is the overall score of the motif. MC good performance in this experiment. With the addition to the motif in the matrix that is used to calculate the IC, can increase the IC as a fitness function for GAMI (Congdon) [8].

Yin in research to introduce an exploratory framework for learning patterns of conditional coexpression in the expression data gen. This approach can also estimate how the content of information disseminated by a set of M nodes in a network. (where each node is associated to an expression profile) change the situation on a set of L conditioning variables (in the case of simple direpresentakian a separate set of expression profiles).

VCD algorithm that identifies possible coexpression groups in the data is based on the scope of identification for vector variation gen. Algorithm include the vector variation tendencies have any similarity, that is the same direction will be the same group. Center coverage will always be in the area of space vector space vectors. Centroids of a representative group of vectors, and algorithms are proposed, should meet two constraints:

1. Must include the number of minimized.
2. The number of combination of two elements must be minimized.

This method can investigate biological Annotations for coexpression patterns. This experiment using the Gene Ontology (GO). Saccharomyces Genome Database (SGD). This tool is designed to search for significant shared GO terms of genes and groups provide ways to identify characteristics of genes that may have similarities.

This method is nonparametric and is based on the concept of Statistical coinformation, which is not the same as conventional techniques based on correlation, which does not limit the scope to the linear conditional dependency patterns.dengan applying exploratory method has been able to learn the statistical. significant patterns of conditional.

Also introduced in the research ability is a novel method of detecting linear, the nonlinear patterns of conditional coexpression in the measurement of expression of genes [3] Furthermore Yin (2008) in research, propose a novel scheme, which is a variation diesain-based Coexpression Detection (VCD) algorithm, to analyze the trend of expression based on the diference [21].

Chin, et al (2008) conducted research entitled "DNA Motif Representation with Nucleotide Dependency" introduces a new motif representation called scored Position Specific Pattern (SPSP), which is a generalization of the string representation matriks and that in considering the use dependent occurrences of neighboring nucleotides. In this algorithm starts with a good set of string patterns, based on local search, find several areas related to the optimal SPSP binding sites. Algorithm has two main stages. First, the seed serves as a searching, to find the set of motif length-l string binding in the input sequence. The second phase begins with each length-l string R as a seed SPSP representation and combine some of R's position to the binding sites in the form of SPSP representation with p-value is smaller. Repetition is done until the p-value not dapaat reduced. This research has the SPSP Finder in C + +. SPSP Finder is used to find motifs in biological data between simulation and real [6].

Chalco, (2008) in research to introduce a method based on a modified Gabor-wavelet transform (MGWT) to identify the protein region it. Several methods of DNA it is based on the model independent of specific patterns of nucleotide in the region it .. This result indicates that the source of the identification error generated by the previous method is the fixed working scale, this new method not only avoid the source of the error but also help create a tool that provides a detailed exploration of the nucleotide occurrence. This method allows use on

multiple scales, analysis of coding regions between the small scales with small and larger coding regions with large scales. The advantages of this method is ketangguhannya for different scale on the analysis of DNA sequences [6].

Using logic Sequence we produce a set of matrik × 4 to 6 represents the main DNA Sequence, which base on all the calculate (0,1) triplets in the logic sekuens. Using the condensed representation of primary DNA primary sequences of eigenvalues and corresponding Symmetric real matrix a comparison made between Sequence primer for exon 1 of human-globin seven other species. This study suggests that shrinkage method to bring information from the relevant genes goup. Found that the shrinkage method consistently works well in a variety of scenario [20].

Elo (2008) Introducing a procedure to increase reproducibility-optimization, which allows selection of a statistical ranking of the genes directly from the appropriate data in comparison with existing ranking methods, reproducibility-optimized statistic shows good performance consistently in the different simulation conditions and the Affymetrix spike-in data set. Feasibility of the novel is set in a statistical practical research setting using data from a microarray study in-house cDNA in asthma-related changes in expression of genes. This result suggests that facilitate the procedure of selection of the appropriate statistical test to data set without relying on a priori assumptions and allow the discovery of ienterpretasi be biased. General reproducibility-optimization procedure is not limited to the range of other applications that better [9].

Liang, Fuhrman and Somogyi (PSB98, 18-29, 1998) have described the algorithm for inferring a genetic network architectures from the state transition table that is connected to the time series pattern of expression of genes. Using the Boolean network model, they generate komputasional experiment, and suggested that a small part of the transition state (INPUT / OUTPUT) command pair is suficient to infer the correct original Boolean network. This study provides verification of the mathematics observasinya. They make the computational experiment that in order to ekspose constant factor involved in the notation O (log n). The results show that the Boolean network with a size of 100000 can be identified with the algorithm from about 100 INPUT / OUTPUT, if the maximum indegree pair in the limit 2. algortma virtue of this is also a conceptual simple that can be extended to the next realistic network models [1].

The motivation of this activity is to identify methods for the accuracy of the DR menganalisi genes with higher dimensions and study of protein expression. In this study comparing the three schemes DR nonlinier (Isomap, Locally Linear Embedding and Laplacian Eigenmaps and three DR scheme linier (PCA, Linear discriminant Analysis, and Multidimensional scaling) with the purpose of determining reduced subspace repesentation, where the individual class of objects is more easily can be distinguished. In a statistical significant improvement in the quality of the right womb cancer 10 datasets using three non linier DR scheme in the top three results of the DR technique linier scheme has been in the observation [13].

No.	Researcher	Method	Algorithm	Achievements
1	Akusu T. and Miyano, S	Identification	Boolean network	development of faster algorithms development of faster algorithms
2	Baldi,P, and Long,A.D and Friedman	Identification	Bayesian probabilistic framework with BBN	dependent normal distributions for point estimates
3	Boscolo, R, Liao, J. C. and Roychow-dhury, V. P	detection	Information Theoretic Exploratory Method	conditional coexpression in the measurement of expression genes
4	Brown, M. P. S. et all		Knowledge-based analysis	
5	Bozinov	clustering	K-means clustering algorithm	Development of the pattern analysis of genes and microarray data
6	Burge,C and Karlin,S		general probabilistic model	
7	Chin, F. and Leung, H. C.M.	Analisis	Scored Position Specific Pattern (SPSP)	can not guarantee search optimal motif in SPSP representation
8	Cho, S. and Won, H.	classification	Machine Learning	feature-classifier to produce the best performance on the classification and clustering
9	Congdon, C. B	identification	Genetic Algorithms Approach	Development of other methods with the fitness function
10	Elo, L. L, Lahesmaa, R.and Aittokallio, T	selection	Reproducibility-Optimized Test Statistic	facilitate the procedure of selection of the appropriate statistical test to data set without relying on a priori assumptions and allow the discovery of ienterpretasi be biased
11	Hastie, Tibshirani, et al dan Mallat	classification	Gene Shaving dan Principal Component Analysis (PCA)	Development of the PCA with other techniques
12	Jaeger, J. and Spang, R	identification	Selecting normalization genes	Development of the PCA with other techniques
13	Kapushesky , M	identification	Expression Profiler	Development of software that better
14	Yin, Z. and Chiang, J		Variation-based Coexpression Detection algorithm	analyze the trend of expression based on the differences and similarities

V. DISCUSSION

Various techniques in analyzing the expression of genes and microarray data was done in a lot of research. Research that has been done is the development or testing of a particular method or technique in the field bioinformatics. This is intended to produce an analysis and prediction of gen in the micrroarray data and can provide stimulus for the best match and the conditions and circumstances of a particular man.

The development of techniques in the analysis of genes expression and micrroarray data this is done in order to meet the needs of their data to the gene expression and micrroarray data. All techniques that have been done show that each of the existing techniques have been developed and through advanced research conducted by scientists can be used in the genes expression to analyze the micrroarray data . Each technique has advantages and disadvantages of each. And every technique that has been developed, the ability and reliability in the analysis also depends on the condition of the data to be in the analysis.

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E-Government Implementation Strategy Toward Information Technology (IT) Governance Environment

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***Abstract*—Exploiting IT in life of public widely experiences a real improvement. This condition causes the many alternative of solution IT that need to be considered in determining expansion policy of organization to give optimal benefit. IT implementation in the organization activity to give positive and significant impact. Exploiting IT to support operational activity an organization experiences change, if initially tends to organization images, hence the existing of IT becomes basic requirement in toward globalization and Good Governance. The decision of leader becomes factor that is most dominant in expansion IT policy, especially related about understanding vision and decision makers of development IT. In this paper given about planning of IT Governance on e-Government by using Framework COBIT and SARBANES-OXLEY Act., by attention to some conditions appropriate Indonesia public. Attainment and implementation IT governance is with refer to decision making activity and required existence of mechanism control in the life cycle to measure performance.**

***Keywords*—IT Governance, Framework , Good Governance, Life Cycle, and Performance.**

I. INTRODUCTION

The development of IT in the last decade increased rapidly. Utilization in the life of the community is also widely experienced an increase that is very big. Various interests into consideration basis, from the start just as life-style or as a complement to the device and the facilities that occupy a vital position. This not only happens in each individual community, but also occur widely in the organization. IT needs in each organization will vary according to the interpretation of the vision of the leaders.

The business world in the field of IT, of course, have a positive electrical current. Various devices for IT infrastructure, service, or application, at this time is very much available in the market in various forms and functions. Conditions of a supply-demand will continue to accelerate the development of IT. The diversity of needs that arise in the community will also cause the various devices and means developed to offer.

This condition causes the number of alternative IT solutions to consider in determining the policy of the organization. In addition, various aspects of the organization will experience the impact of the IT policy. Study is needed to make a mature implementation of IT to not only fail to remove the investment of funds but can provide the optimal benefit for the organization. The size of the role of IT in business processes to create organization-race competition for IT to implement integrated process. One is through the implementation of e-Government, where ideally the implementation of e-Government is expected to help increase interaction between government, business community and encourage the development of its political and economic.

Implementation of IT in the organization aims to provide a positive impact and significant. Utilization of IT to support operational activities in an organization both large and small scale, is also changing. If the original problem tends to the image of the organization, then the current IT needs to be fundamental in the global era and Good Governance. The decision to become the most dominant factor in the development of IT policies in their respective organizations.

Understanding of the organization's vision and knowledge in the IT vision of the leadership, related to each other in determining the type of devices that IT will be implemented to encourage progress in its organization. However, device selection decisions are taken in any IT will lead to the change. Change happens in the organization not only in terms of effisiensi workplace but also affect the culture of both the personal, inter-unit, and the entire organization. Many examples show that the failure of the implementation of IT is dominated more by factors such as user: does not match the cultural, ethical, or political, which has been running in the organization, limited expertise, or even rejection of the change. Based on the above conditions, then the paper will be given on planning IT Governance Framework using the COBIT (Control Objective for Information and related Technology) as a tool for effectively implementation of the Sarbanes-OXLEY Act. [2] [4].

II. E-GOVERNMENT

e-Government is the use of information technology can improve the relationship between the Government and other parties, where there otomisasi involve computerization and the paper-based procedures that have to be encouraged in a new way of leadership, a new way in discuss and set a strategy, a new way in business

transactions, in a new way to listen to citizens and communities, and organize in new ways and deliver information, as provided in the figure 1 [5].

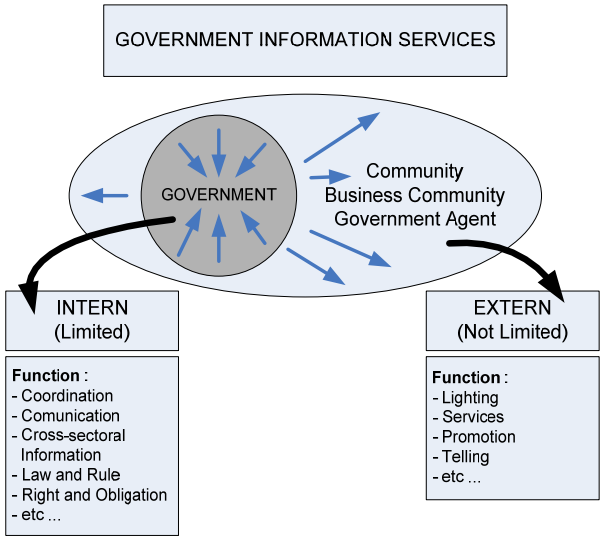

Figure 1. e-Government Services

E-Government services in the four customer focus, namely: citizens, business community, government employees and government agencies. E-Government is expected to be able to make interaction with residents, businesses, government employees, government agencies and other government better, friendly, transparent, effective and cheap.

Implementation of e-government can basically give a very big opportunity for the development area, where the area can use existing facilities to facilitate the process of service, introducing the potential for the organization, to improve interaction with communities and business, and so forth. The benefits that can be obtained from the e-Government [3] [6], including:

a. Streamlining government operations to guarantee the speed of response to community needs. Better services to the community and quickly.
b. Improvement of relations between government, business, and the general public. With the openness (transparency) is expected relationships between the various parties to be better.
c. Community empowerment through information that is easily obtained.
d. Allows the community, business, government level and other employees to easily find information and get services from government.
e. Simplify the business processes and reduce costs through integration and elimination of redundant systems.

Implementation of e-Government is not easy, not only with the computer is installed is called e-Government. There are a lot of planning and the process needs to be done. Many instances the implementation of e-Government in Indonesia, particularly the failure, because of the above paradigm.

There are several aspects that a resistor in the implementation of e-Government [1] [6], namely :

a. Government commitment and transparency in the integration of public
b. There is no culture of information sharing documentation orderly
c. Resistance to change
d. Infrastructure is inadequate and expensive
e. Place a limited access

III. IT GOVERNANCE

IT Governance is a concept that evolved from the private sector, but with the growing use of IT by public sector organizations and government IT Governance should also be applied in many sectors which require repair service for the community. Role of IT Governance is not doubt in the achievement of the goal of an organization to adopt IT. Functions such as management of other organizations in the public, the IT Governance which in essence is how the use of IT in order to produce the maximum output in the organization, to assist the decision making process and help the process of problem solving must also be made. Principles of IT Governance should be integrated, as functions of the management carried out systematically carried out in a public organization.

IT Governance as the decisions taken, which ensure the use of IT in the allocation strategies of the organization [7]. IT Governance reflects the application of principles of organization with a focus on management activities and the use of IT to the achievement of the organization. Thus, the IT Governance essentially covers decision-making, accountability of the implementation of the use of IT, who take decisions, and manage the process of making and pengimplementasian decisions related to IT. IT Governance is an effective means that the use of IT in the organization is able to improve and mensinergiskan between the use of IT with the vision, mission, goals and values of the organization.

IV. IT ELECTION

The main purpose of planning is to select the type of IT is most appropriate to be implemented. Selection is determined by :

a. Vision and Mission to be achieved,
b. Urgent function,
c. Value of the investment,
d. Technology knowledge,
e. Method development,

Each factor has a primary consideration so determined factors that need more priority. Alternative methods that can be used are:

a. Development of appropriate special needs either independently or involving any other party.
b. Procurement of the device is in the market such as package or integration of different devices. The chosen method will affect the implementation of the strategy in the next stages.

The chosen method will affect the implementation of the strategy in the next stages.

V. IMPACT IMPLEMENTATION

From the observation in the field that many government organizations that consider only the development of IT as a project of providing facilities and infrastructure. This result of the readiness of government organization to optimally utilize the system and the impact of changes in various aspects activities appears. IT systems that have been developed and implemented as if becomes less useful. Some aspects of the impact of the implementation of IT is:

a. Time & cost efficiency
b. Requirements & device integration
c. Availability & reliability
d. HR Capability
e. Work Culture

Positive impact that the public expected from the implementation of IT is happening effisiensi the time and cost that will provide long-term economic benefits that are very high. Therefore, the optimum operation is a major concern. In this context, consider that almost all IT devices are multi-function so that the next effort in the development of device integration occurs.

One of the factors that will influence the optimum utilization of IT is the availability of the device. Needs of the device at the beginning of the implementation of IT will continue to develop in accordance with the level of government organization. The availability and reliability of IT devices also generally will be increasingly important aspect of dependence is also the greater IT. This means that evaluation needs to continue to be the device needs.
Other aspect to note is the ability of the Human Resources organization in maintaining and operating the system in order to function optimally and continuously.

Ability and system reliability is high in the long run be less influential when the ability of human resources in the organization the government is not enhanced. The change of culture in both individual, group cooperation, and overall governmental organizations are also aspects that are not less important.

VI. STRATEGY IMPLEMENTATION

During this time in Indonesia still have the view that e-Government is a government which assisted with the use of computers, so only install the computer and operate it are considered e-Government. But in addition to the use of computers, there are many processes that must be done to achieve what the actual definition of e-Government.

To maximize the benefits of e-Government, the necessary process of adequate control on the Lifecycle e-Government to ensure that the system is implemented in accordance with the needs, the investment can be issued, and both operations can support the achievement of the goal area. One is using the implementation of the strategy on the Lifecycle consistent system along with the process of continuous improvement.

Architectural framework of the implementation of the proposed strategy consists of the 4 major high-level control: the integration of research and information, implementation plan, service delivery and performance measurement.

A. Research and Information Integration

E-Governance initiatives must begin the process of research opportunities, potential, strength, and weakness there are obstacles in a region. This condition will serve as a source of information in making an analysis about the e-Government project that will be done. In addition must also set the vision of e-Government, the assessment of the readiness of the implementation of e-Government, and the identification of what you want to achieve a realistic.

B. Plan Determining

From this vision, the identification and assessment of readiness of existing achievements and agenda can be made with the stakeholders in the area / region on important issues and plan implementation rioritas in e-Government, including the change management strategy in the government.

C. Services Delivery

Services that must be produced in accordance with the objectives of the implementation of e-Government, the plan describes the local and regional priorities, the authority and responsibility to achieve the expected results. Delivery of these services also involve the private and public partnership in e-Government project.

D. Performance Measurement

Because the e-Government always involve money, human resources, information, and the political commitment of accountability to be very critical. Therefore, the performance can be used as a measure of the decline e-Governance. Testing the success of e-Government projects include how far the project meet the objectives, such as accelerating the delivery of services, facilitate access to information, or to improve access to government. Assessing the progress and performance of e-Government means to specify a scale, where scale can be provided in one of them through the assessment with a Maturity Level refers to the COBIT Framework &

Sarbanes-OXLEY.

The Concept of Corporate Reporting Supply Chain as in the figure 2 is a model that describes the process of making financial reports, to use the reports for decision making. In the process of financial reporting, management and leadership of the company shoots are in the beginning of the whole series of processes in the system of reporting, ie, the parties are in the first sequence of the entire process of delivery of financial reports to the community, while the parties are in a dominant position in determining the most black and white, or will be submitted to the community, in other words the dominant enough in determining good governance. However, the model above also illustrates how good governance is defined by 3 elements, namely Standard Setters (Sarbanes-Oxley Act), Market Regulators (Institute for Legislative (DPR / DPRD)) and enabling Technologies (COBIT). The three elements of this role is no less important in supporting good governance. Planning good governance in Indonesia by adopting Sarbanes-Oxley Act and COBIT, still must consider several conditions according to the Indonesian people, and there were some adjustments to be done. The view that one often happens, when benchmarking is done solely to see only the system (Sarbanes-Oxley and COBIT) gray-abunya all forms of financial reports as the object, but does not see man as the subject of implementing the system.

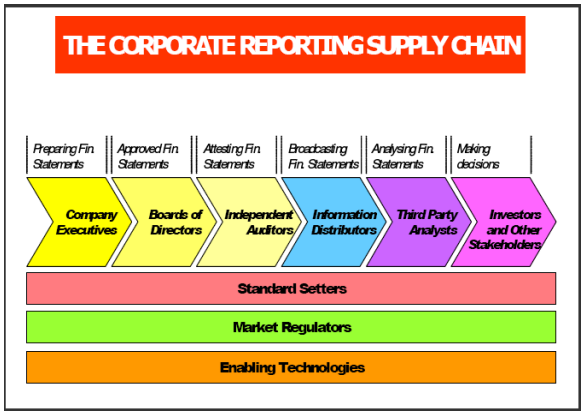

Figure 2. The Corporate Reporting Supply Chain

VII. CONCLUSION

1. Achieving IT Governance in the organization of government, its core is a series of decisions and the determination of the appropriate framework of accountability in the use of IT in government organizations.
2. IT Governance Implementation required the existence of a process control in the Lifecycle e-Government, in this case is done by entering some stage in the implementation of control e-Government in the process and what controls should be carried out and including the measurement of e-Government performance.
3. Planning good governance in Indonesia by adopting Sarbanes-Oxley Act and COBIT, still must consider several conditions according to the Indonesian people, and there were some adjustments that must be done.

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Building Public Trust Through Public Participation Using E-Governance

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***Abstract*—During several decades, public trust toward government has decreased because of some problems in terms of: administrative, political, socio-cultural, and economic development. Public perception of corruption, as a result of lack of transparency, inefficiency, and bad policy, also has significant impact to public trust degradation. Thus public trust degradation must be immediately responsed by politicians, public policy makers, and communities as this jeopardize the legitimacy of government and political process that is running. As a reaction on this matter, the term of governance has been replaced the term of government. Governance was the concept of "governance without governments" – introduced by Rhodes – where command and control paradigm should be replaced by problem solving based on market mechanism with at least government intervention as possible (minimal state). The emergence of bottom-up international civil society networks also influence international policy making with the use of ICT, so that the era of "governance without governments" grow rapidly in the last few years. The use of ICT to support the process of governance (e-governmental process) is also known as e-government. In various recent literatures, e-government also called as e-governance, associated with the emergence of the term governance, which replaces the term government. In this paper we study how e-governance can enhance public trust by involving more citizen participation. Community participation perspective views the concept of good governance. We argued that the ICT, especially e-governance, can be effectively used as a tool to increase public trust by involving more public participation. We also discuss the caused of public trust declined, and investigate the relationship between good governance and public trust. By studying several cases, we find out that e-Governance has an important role in increasing public trust.**

***Keywords*—public trust, participation, government, e-governance**

I. INTRODUCTION

Public trust toward government in all around the world has dramatically declined [20]; [24]; [25]. Moon states the cause of some problems in terms of: administrative, political, socio-cultural, and economic development [20]. Public perception of corruption --as a result of lack of transparency, inefficiency, and bad policy—also has significant impact to public trust degradation. As a reaction on this matter, the term of governance has replaced the term of government. Nowadays, governance term is widely used, replacing 'government'. However, there are several distinct meaning between government and governance. Current use does not treat governance as a synonym for government. There are at least six separate uses of governance [22], which is: as the minimal state, as corporate governance, as the new public management, as 'good governance', as a socio-cybernetic system, and as self-organizing networks.

Related to one of governance function, as the New Public Management (NPM), NPM is relevant to this discussion of governance because its principle to empower citizens by pushing control out of the bureaucracy, into the community. Osborne and Gaebler, as quoted from Rhodes discuss that governance measure the performance of their agencies, focusing not only on inputs but also on outcomes; driven by goals not only by rules and regulations; redefine clients as customers and offer the choices; prevent problems before they emerge, rather than simply offering services afterwards [22].

The emergence of bottom-up international civil society networks also influence international policy making with the use of ICT, so that the era of "governance without governments" –introduced by Rhodes-- grow rapidly in the last few years [22]. The use of ICT to support the process of governance (e-governmental process) is also known as e-government. In various recent literatures, e-government also called as e-governance, associated with the emergence of the term governance, which replaces the term government. In this paper we also study how e-governance can enhance public trust by involving more citizen participation. We argued that the ICT, especially e-governance, can be effectively used as a tool to increase public trust by involving more public participation.

Focusing on potential contribution of poor government performance to the decline of public trust in government, this paper also explores how Information Communication Technology (ICT) can enhance some of the primary administrative values (efficiency, effectiveness, transparency and responsiveness) so that improve public trust in government, in direct or indirect manners. We also discuss the cause of public trust declined, and investigate the relationship between good governance and public trust. Finally, we conclude that ICT, namely e-governance, has an important role in increasing public trust.

II. PUBLIC TRUST AND GOOD GOVERNANCE

According to the World Bank's standard definition, governance encompasses the form of political regime; the process by which authority is exercised in the management of a country's economic and social resources for development; and the capacity of governments to design, formulate and implement policies and discharge functions [5]. Governance has been defined in politically neutral terms focusing on its economic dimensions. Consequently, the main thrust of governance-related activities has been public sector management, financial management, the modernization of public administration, and privatization. Similarly, the ADB, which was the first regional multilateral development bank to adopt an official governance policy in 1995, defines good governance as "sound development management" based on four interrelated "pillars:" accountability, transparency, predictability and participation. For the ADB, "good governance is good government". However, the shift from the notion of "governance" to "*good* governance" introduces a normative dimension addressing the *quality* of governance. A good governance system puts further requirements on the process of decision-making and public policy formulation. It extends beyond the capacity of public sector to the rules that create a legitimate, effective and efficient framework for the conduct of public policy. It implies managing public affairs in a transparent, accountable, participatory and equitable manner. It entails effective participation in public policy-making, the prevalence of the rule of law and an independent judiciary, institutional checks and balances through horizontal and vertical separation of powers, and effective oversight agencies.

Researchers at the World Bank Institute have distinguished six main dimensions of good governance: (i) voice and accountability, which includes civil liberties and political stability; (ii) political stability; (iii) government effectiveness, which includes the quality of policy making and public service delivery; (iv) the quality of the regulatory framework; (v) the rule of law, which includes protection of property rights and independence of the judiciary; and (vi) control of corruption [4]. While UNDP, as quoted from Kettani et al. [32], mentions several characteristics of Good Governance, such as: Participation, Transparency, Responsiveness, Rule of Law, Consensus/Orientation, Equity, Effectiveness and Efficiency, Accountability, and Strategic Vision (see Table 1 for further details).

CAFRAD Report mentions that satisfactory public service provision can in turn enhance trust in government among citizens [3]. While East Grinstead Town Council Report declares that Governance is dynamic: good governance encourages public trust and participation that enables services to improve; bad governance fosters the low morale and adversarial relationships that lead to poor performance or even, ultimately, to dysfunctional organizations [7]. Therefore, we can conclude that good governance has strong relationship with public trust.

Table 1: The UNDP nine underlying characteristics of good governance

Participation	"All men and women should have a voice in decision-making, either directly or through legitimate intermediate institutions that represent their interests. Such broad participation is built on freedom of association and speech, as well as capacities to participate constructively"
Rule of law	"Legal frameworks should be fair and enforced impartially, particularly the laws on human rights"
Transparency	"Transparency is built on the free flow of information. Processes, institutions and information are directly accessible to those concerned with them, and enough information is provided to understand and monitor them"
Responsiveness	"Institutions and processes try to serve all stakeholders"
Consensus/ Orientation	"Good governance mediates differing interests to reach a broad consensus on what is in the best interest of the group and, where possible, on policies and procedures"
Equity	"All men and women have opportunities to improve or maintain their well-being"
Effectiveness and efficiency	"Processes and institutions produce results that meet needs while making the best use of resources"
Accountability	"Decision- makers in government, the private sector and civil society organizations are accountable to the public, as well as to institutional stakeholders. This accountability differs depending on the organization and whether the decision is internal or external to an organization"
Strategic vision	"Leaders and the public have a broad and long-term perspective on good governance and human development, along with a sense of what is needed for such development. There is also an understanding of the historical, cultural and social complexities in which that perspective is grounded"

From citizen expectation view, citizens demand public servants to serve the public interest with fairness and to manage public resources properly on a daily basis. Fair and reliable public services, as well as credible policies and institutions, inspire public trust and create a level playing field for business, thus contributing to efficient markets and economic growth. Those impacts reflect good governance dimensions and characteristics. OECD Report [24] also mentions that public service is a public trust, citizen expects public servants to serve the public interest with openness and to manage public resources properly on a daily basis. Fair and reliable public services inspire public trust and create a favorable environment for businesses, thus contributing to well-functioning markets and economic growth. Based on the experience of all 29 OECD countries, this Policy Brief describes what makes an effective and comprehensive ethics management policy [23].

III. CAUSES OF PUBLIC TRUST DEGRADATION

Summarizing various chapters, in his co-edited book, Nye Jr. [31] addresses four important dimensions that might be associated with the level of public trust including the governmental performance dimension, economic dimension (slow down of economy), sociocultural dimension (i.e. decline in social capital, family crisis, strong sense of individual rights), and political dimensions. Each dimension encompasses various factors.

Many literatures mention that the trust level is significantly influenced by the evaluation of the public economy [14]; [17]; [27]. Hibbing and Morse [17] also found that the optimistic economic perceptions correlate with the support of the parliament in Europe. However, Mansbridge mentions that public expect government performs well in achievement of growing economy without any recession [16]. In addition, government budgeting also determines the level of public trust to the government. Inglehart also points out that public expectation is very much related to the growing impact of economic development. That is happened when the public satisfies and feels secured in their economy level [26]. The other decreasing public trust is corruption, as one of the socio-economic issues, which directly or indirectly cause poverty and decrease the quality of public governance work [2]. From the discussion above, it is clearly visible that economic is one of significant factor in building public trust.

On the other hand, public trust cannot be separated from the concept of political values. This is also known as political efficacy. Political efficacy is defined as the policy of the state in determining the direction of political development (internal political efficacy) and their perception of the government's sensitivity (external political efficacy) [20]. Belanger and Nadeau [8]; VanDuivenboden and Lips [13] use Hirschman's model to describe the public reaction over the government worsened. Hirschman model suggests that someone may react with the self-organization on the move or the other, depending on the level of fidelity (loyalty). It is understandable that citizen cannot move to other countries easily, but however they can express themselves by not using their right (votes) on political activity [8].

It is also found out from various literatures that public trust not only determined by socio-democratic, but also by political resources. Belanger and Nadeau say that trust in government has a significant effect on the behavior of the election vote by citizens of Canada [8]. Thomas emphasizes three main instruments to create trust in the government [5]. First, it is based on characteristics (characteristic-based), which generated by expectation on the demographic characteristics. Second, institutions must create the trust either directly with the professional standards adopted / code of ethics, or indirectly through the observation / administrative law and regulations. Third, based on the trust resulting from the process in which our expectations require the recipient to return the goods or services equivalent to economic value. For example, in the political dimension, Nye Jr. points out factors such as post-cold war syndrome, poor political leaders, the World War II effect, and mass media effects [31]. The assumption is that the public tends to be more willing to sacrifice its individual benefit for public goods like national defense in the cold war era. In addition, the public has lost its confidence in government due to poor political leadership, reaction to the great victorious experience of World War II, and media effects (more information and the mean world effect). Though Nye [31] suggests that the four dimensions (i.e. governmental performance dimension, economic dimension, sociocultural dimension, and political dimensions) influence directly or indirectly the public's trust in government, he acknowledges that their causal relations with the level of public trust are not necessarily clear because public trust is often perceptual rather than objective in nature. In other words, the function of public trust is very complicated and complex so that it requires a multi-dimensional approach to solving the public trust puzzle. Easton, as quoted by Parent et al. [21], first defines two types of trust in the government as a special (specific) and scattered (diffuse). Specific is related to the satisfaction of the community work of government. Diffuse-related behaviors is related to public objects which political power (regime-level political objects), irrespectively of good or bad performance.

However, a case study in Korea showed that increased public satisfaction doesn't get along with public confidence during the period of democracy. Park [25] argues that, although satisfaction and trust in democratic institutions reflect the performance of democracy in general, but the target may be different. Park also mentions that analyzes the political liberalization and democracy is not enough to increase the level of public confidence in government institutions. This determines that a public trust should be fair, transparent, and accountable [11]. A case study in Sierra Leone investigates and proves arguments that openness and information sharing by creating a two-way dialogue between the government and the public can increase public trust in the political system [15].

As mentioned above, public trust is somehow a perceptual reaction to governmental performances. This perception is a cognitive reflection of the information and data obtained by the public regarding governmental performance. In other words, the level of an individual's trust mirrors actual governmental performance and they are positively correlated. On the other hand, public perception indicates the gap between the public's expectation and reality. One who is very frustrated and disappointed with governmental services is likely to have a low level of confidence in governmental services. Accordingly, it could be a highly subjective attitudinal

indicator rather than an objective indicator of governmental performances.

Orren [10], citing Putnam, argues that there is an inverse relationship between public satisfaction and public expectation, while there is a positive relationship between public satisfaction and public perception of governmental performance. Orren suggests that there are different factors involved in the perception and expectation dimensions that jointly affect the level of public satisfaction of governmental performance [10]. Rainey [12] also points out that the public often has wrong information and a biased perception of government performance. It seems that the link between public expectation and biased public perception of governmental performance is initially embedded in the puzzle of public trust. Often, the degree of proximity between citizens and governments affects the level of public trust [6].

IV. Building Public Trust with ICT

OECD survey suggests the following steps for building trust in public institutions [24]:

- **Defining a clear mission for the public service**
  Adapting the mission of the public service to current needs and ensuring that its core values and standards meet changing public expectations are key challenges for governments in a rapidly changing world.
- **Safeguarding values while adapting to change**
  The changing socio-economic environment, especially the growing demand for transparency, requires that governments review and adjust mechanisms to ensure that public servants' behavior corresponds to expected standards.
- **Empowering both public servants and citizens to report misconduct**
  Clear and known procedures that facilitate the reporting of wrongdoing and provide protection for whistleblowers assist the detection of individual cases of misconduct.
- **Integrating integrity measures into overall management**
  Integrity measures are not a distinct activity, but rather an integral part of all management systems in which integrity measures provide complementary support for the overall management environment.
- **Coordinating integrity measures: a precondition for success**
  Successful integrity measures consist of a combination of actions that are consistent and take into account the wider public service environment. Assessing the effectiveness of measures provides feedback to policymakers on their implementation and also lays the groundwork for future policies.
- **Shifting emphasis from enforcement to prevention**
  Sound ethics management policy adequately combines enforcement and prevention measures. However, there is a growing recognition that increased attention to prevention reduces the need for enforcement. Prevention is a less expensive investment in the long term, with a more positive impact on the public service culture and on the relationship between the public service and civil society.
- **Anticipating problems**
  By anticipating situations that might weaken adherence to public service values and standards of behaviour, governments can prepare suitable responses to prevent adverse effects. For example, how can governments meet increasing public demands for more information on private interests that affect public decisions?
- **Taking advantage of new technology**
  Exploring ways to harness new technologies can help governments find new ways to internalize integrity and inform citizens on standards expected of officials serving the public.

Currently, many e-Governance implementations in various countries have made the government's performance more effective than ever before. However, there are some critics of the e-Governance said that: (1) Technology does not stand on its own to bring the impact of changes, although it is able to alter the process will become easier, cheaper, and more effective. (2) Use of e-Governance does not completing all the problems in the government, although it is able to give more power to the public to participate, improve transparency, and reduce the chance of dishonesty the governance process.

However, apart from the above evaluation, some literatures state that the e-Governance is able to accelerate the achievement of good governance, by improving the efficiency and effectiveness of government performance. However, implementation is usually done at the local level and not yet integrated with the overall strategy and the national or international system of governance, so that the results of a case cannot be generalized for other cases. IT services and Web-based public services, through E-Governance can help the government to improve the level of trust with the public issues, such as: corruption, inefficiency, ineffectiveness, and policy that does not stand on the public's concern. The factors that link between good governance and IT, as follows: (1) The Public Value of E-governance (Public Trust; Social inclusion; Community Well Being; Sustainability), (2) Impacts of E-governance (Efficiency; Good Government: Transparency, Accountability, Equity, Economic Development; Change: Changed circumstances, New Processes, New Services, Changed Perceptions / Expectations). While Zucker says that in the process-based trust (process-based trust): the two-way (two-way government) more likely to create public trust in government than one direction (one-way government) [19].

Figure 2 below describes administrative causes of public distrust and how ICT can improve public trust.

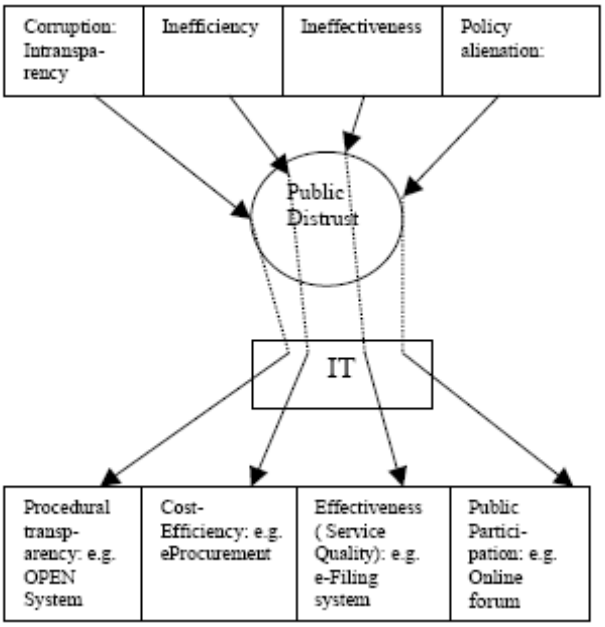

Figure 2 Administrative Causes of Public Distrust and Potential Prospects of Information Technology [20]

V. E-GOVERNANCE CASE STUDIES

There are various strategies that have been associated with mistrust examined. The most popular investigation is the "lack of public trust can be improved by involving public participation in decision-making" [9]. Three cases are selected below to illustrate how IT and Web-based public services can help governments to restore public trust involving public participation in social, economic, political, and administration dimensions.

The cases are as following: BHOOMI Project in India [30], E-Governance in Issy-Les Moulineaux (ILM) France [28], and EU Profiler [34]. The three mini-cases suggest that IT potentially offers technical tools for improving administrative transparency, cost efficiency, effectiveness, and policy participation, which may eventually help governments restore public trust in government.

BHOOMI Project in India (associated with Economic and Social Dimension)

The Bhoomi project, implemented by the Department of Public Administration and Revenue (DPAR), makes available a computerized Record of Rights, Tenancy and Crops (RTC) to all landowners at a kiosk in the Taluka office, on payment of Rs.15 per RTC. The department is promoting private franchise models in which the franchisees have to bear the cost of the infrastructure and the Internet connection. They can charge more than what is normally charged at the Taluka office, but the service charges shall not cross the mandated levels.

Project Outcomes

The generation time of the RTC has been reduced from 30 days to five to 15 minutes. Similarly, the mutation process cycle time has decreased from 90-180 days to 30-45 days. Crop record updating has increased to 90-100 percent from 50-70 percent. Nearly 65% of the farmers are now able to use Bhoomi kiosks without any help and 75 per cent of the users transacted their business under the computerized system without seeking access to a revenue official. Besides this the computer-generated records had fewer errors than those provided manually. Significantly, corruption at the time of distribution of the copies of land records has come down drastically.

E-Governance in Issy-Les Moulineaux (ILM) France (associated with administration dimension)

The town of Issy-Les-Moulineaux (ILM), a suburb of Paris, has approximately 60'000 inhabitants. The unemployment rate is less than four percent. In the last 20 years, ILM transformed from a worker's city into an information society driven town. For the city administration, e-government is not about replacing a counter with a screen, but hopefully about transforming the citizen's relation to the State and the organization of work and procedures in the administration. Since 1996, ILM has regularly developed new services for their citizens. The two key priorities for the development of such services have been access to administrative data and services, and the provision of more innovative services. By spring 2003, the following services have been made fully available online: Ordering a birth, marriage or death certificate; Making a reservation for a parking spot in case of relocation; Paying parking fee using a mobile phone; Indicating a change of domestic situation for the school file; Consulting the state of one's account of school special service access (e.g., restoration); Making reservations for hotel room, books, and for the multi-media library; Receiving publications from the city; Getting access to the kindergarten; Constituting a wedding file; Getting access to the deliberations of the City Council. In addition to these "e-administrative" services, the Cube cultural center, which was dedicated to multimedia promotion, offers online training and workshops for continuing education.

Project Outcomes

At the time of the interview (March 2003), ILM has been the only French city being under 'infogérance', which means that all the technical equipment and resources is being taken care of by a private company (Euriware). However, the decision-making process about which technology to choose and what kind of technological solutions to implement is remaining in the hands of the city administration. Due to crucial regulations for workspace provision, new service development, service level agreements, and material supply, the contractual relations are complex, but have

proven to be successful for the last seven years (1998 - 2005).

On the participatory level, ILM regularly asks the citizens for their opinions about the ICT development in the municipality and the quality of public services. Besides the constantly improving communication between the public service providers and the citizens, ILM is providing its citizens with the opportunity to contribute and intervene during city administration meetings since 1997. In 2002, two other remarkable initiatives have been launched. The 650 people involved in the 'Citizen Panel' constitute a representative group of ILM citizens who are consulted via the Internet by the city council when it comes to decision-making on issues of local relevance (e.g. local safety, associations, information technologies and local urban development). The second initiative was the set-up of a participatory budget at the level of district councils. Each year, the district residents are consulted in order to support the city council for decision-making about investment priorities.

EU Profiler (Associated with Politic dimension)

The tool, nicknamed 'EU Profiler', a voter advice application, due to go online shortly before European elections in 2009, is set to help undecided voters determine which political party most suits their views. EU Profiler will be based on national applications already used in elections in the Netherlands and Switzerland. It consists of a questionnaire of approximately 40 questions on country-specific as well as EU issues, allowing the user (who remains anonymous) to agree or disagree to varying degrees on the questions posed. The application, with the slogan "help is on the way for undecided voters," is also there to help inform on EU public opinion. The programme is being designed by social scientists from across Europe, using party political platforms as the basis for allowing voters to see which party is closest to their preferences.

The system has already been successfully used in the Netherlands, where three million voters used it. The director of the Dutch version, Marijn Bom [34], said the Profiler would not tell voters who to vote for, but give an analysis to show where you stand on various issues. The data on political standpoints is taken purely from political party views taken from their respective manifestos. The funding for the project, in order to ensure complete independence from political pressure, is purely from the EUI with assistance from Kieskompas and Smartvote.

In recognition of the fact that the younger generation use online tools more, Trechsel noted [34] that e-democracy will be the dominant platform for political discussion in the future and this programme will enable younger voters to become more informed about the hot topics of our time. EU Profiler is expected to have more of an effect on young voters who have no real attachment to party politics, thereby stimulating political interest at a younger age. Political spectrums differ in various EU member states, leading the team behind EU Profiler to make a number of decisions regarding the makeup of the programme across the EU. The experimental nature of the programme has left a lot of options open over what to include, and the team behind it expects to finalise this over the next few months. The results of the survey will allow social scientists to see whether voters are more responsive to national or EU issues.

Project outcomes

So far, EU Profiler has online in May 2009, so then it will help voters before elections to the European Parliament take place in June 2009. Recent hits statistics show that 250,000 users have been accessed EU Profiler, in only 2 weeks after it has been launched. However, there is no further evaluation regarding user satisfaction or performance report related to its objective, i.e: stimulating political interest, voter advice application).

VI. Conclusion

Acknowledging challenges faced by governments in coping with the decline of public trust, this paper explores potentially positive utilities of IT in enhancing and restoring public trust and confidence in governments. Though declining public trust itself is not a new phenomenon, it has becomes more difficult for governments to cope with this issue due to the complexities and chronic nature of the problem. In fact, many worries that the decline of public trust has become a pervasive and chronic problem and is even socially constructed due to the changes in the public's view on the public sector. It casts serious questions on the legitimacy of representative government, roles of governments, and democratic values.

Governments should pay more attention to causes of the chronic decline of public trust in governments and take more proactive actions to restore public trust. As the three illustrations suggest, IT appears to offer a useful opportunity to government to enhance public trust and citizen satisfaction by improving procedural transparency, cost-efficiency, effectiveness, and policy participation. While it is too early to judge immediate and clear contribution of IT to the restoration of public confidence, it is fair to state that IT provides governments with tremendous opportunities for improving administrative transparency, efficiency, and effectiveness of governmental performance. It also opens up more ways for the public to be involved and participate in the policy-making processes.

It should be also noted that IT provides positive opportunities as well as many challenges to governments and the public. Though the three selected cases point out some positive prospects of the utilization of IT in improving governmental performance and restoring public trust, we may also easily locate counterexamples

where the effect of IT is not clear or even go in the opposite direction if an IT-related project fails and is perceived to be simply wasteful. It suggests that IT is not an instant panacea but a promising alternative tool offered to governments. We also note that many challenges still remain in the applications of IT in the public sector, such as privacy, equal access, security, etc. Governments should address these challenges, as they expand the scope and depth of various Web-based public services.

As mentioned earlier, this study is exploratory in nature with a preliminary framework. Without rigorous empirical tests of causal relationships between the utility of IT and the enhancement of government performance and public trust, this study provides several suggestive mini cases that only demonstrate potential contribution of IT to the improvement of public trust. To uphold the objectivity of this study, future studies should incorporate counter examples suggesting a negative effect of IT on public trust. We also need to examine a more comprehensive model that includes the effects of other factors such as economy, media, social capital, etc. In addition, the optimistic proposition raised in this study should be also empirically further examined with a large dataset and in-depth case study in the future.

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Overview E-Government User profile and Digital Divide in Developing Country

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***Abstract*—This paper investigates the potential e-government and m-government user. It is important to understand the population and social dynamics of the community in which services are to be provided in order to design the best means of providing those services. For example, factors contributing to a significant digital divide in a society will mean that not every one in the society can use the e-government or m-government services provided. In addition this stage is also significant in determining the different technologies and skills that are needed for the development of e-government/m-government. It also looks at the basic features, perspectives and issues already exposed by the use of e-government and m-government services in those developed and developing countries that have implemented such services, in order to understand which technologies and skills are required for the model to be used effectively. This provides and indicator of the feasibility of using a given model in a particular developing country.**

***Index Terms*—digital divide, e-government, m-government, user profile.**

I. INTRODUCTION

During the last decade there has been something of a "revolution" in Information and Communications Technologies (ICT). This "revolution" does not only change people's daily life but it also changes the nature of the interactions between governments and their citizens. These changes are rapidly being transformed into new forms of government, which is known as E-Government.

E-government is defined as the use of technology to deliver services to citizens, business and other entities. It is undeniable that e-government gives operational benefits for the government and the citizens. The benefits for the governments are things such as such as, a reduction in response time, a reduction in paper work and the provision of new and improved services to the customer. For citizens, e-government offers a huge range of information and services, including information for research, the provision of government forms and other services, public policy information, employment and business opportunities, voting, tax filing, license registration or renewal, payment of fines and submission of comments to government officials. Moreover, the users of governmental information services will be benefited by the fact that many services previously available only during explicit office hours can now be accessed twenty-four hours a day, seven days a week.

Developing countries face particular challenges in implementing e-government. The UN (United Nations) has identified a number of obstacles to the implementation of an effective e-government service in developing countries. As a result, developing countries must be even more innovative in designing their e-government strategies using technologies, which may be less common in developed countries. Developing countries may also be forced to choose between providing services for their business community or for their citizens more generally [25].

The reason for examining the digital divide issue is to highlight common failures that occur in the implementation of e-government. Since developing countries may differ from other countries in term of economic factors, infrastructure, culture, skill and so on, it is important to analyse the digital divide problem so that the difficulties caused by these factors can be avoided, or minimised, thus helping to reduce the failure of the e-government model. In addition it is related to e-government's service user and what kind of skill that user needs in order to access e-government or m-government services

II. DIGITAL DIVIDE

A widely accessible and affordable communications infrastructure is one of the critical success factors for the delivery of government services online. However, the world can be divided into the information rich and the information poor. Therefore, ICT access and e-Government must be closely linked. Many of the most successful e-Government initiatives include, or are launched in combination with measures that are designed to expand access to more of the community. In addition, the availability of e-Government services that can save citizens and businesses time and money will, in turn, tend to drive demand for ICT access, further boosting infrastructure development and driving down the cost of access.

The digital divide exists not only between countries and regions but also within a country's borders, most

commonly between rich and poor, between men and women, and between urban and rural areas. Urban areas tend to receive a disproportionately large share of public and private ICT investment in relation to the rest of the country. Usually, urban areas have at least a basic communications infrastructure and therefore are able to take advantage of ICTs, while rural areas tend to lack the infrastructure. Often ICT service providers do not have an incentive to invest in rural areas. The digital divide may correlate not only with income but also with cultural attitudes towards technology. Given the centrality of ICTs to both education and economic opportunity, those without access to ICTs are likely to fall further behind in a process that becomes a sort of vicious circle.

A. Digital divides by socio use

The digital divide is a social as well as a technological gap. In this case the divide is a matter of who uses the Internet, for what purposes, under what circumstances, and how this use affects socio-economic cohesion, inclusion, alienation and prosperity. Research from various countries indicates that e-mailing and Web searching are the two most important activities that people carry out on the Internet. The Internet is used for communication (e-mailing), information seeking, civic organizing, and accessing online services such as online banking, job searching, and interacting with public authorities [51]. However, users in developing countries tend to consume rather than to produce information on the Internet. Even among the developed OECD countries, less than half of all Internet users access the Internet daily [51].

B. Digital divide by technological literacy

Having access to the Internet and having the ability to use the Internet effectively are two aspects of the digital divide. Using a computer and the Internet is more complicated than sending a text messages by mobile phone or dialling a telephone. Meaningful use of the Internet requires computer, and cognitive skills for such things as seeking information, developing community networks, accumulating social capital, and participating in political activities.

C. Digital divide by Technological Access

Around the world, people, groups and countries use different levels and combinations of technologies, such as: hardware, software, and bandwidth to access computers and the Internet. These differences can affect the efficiency, the volume, and the diversity of Internet use in important ways.

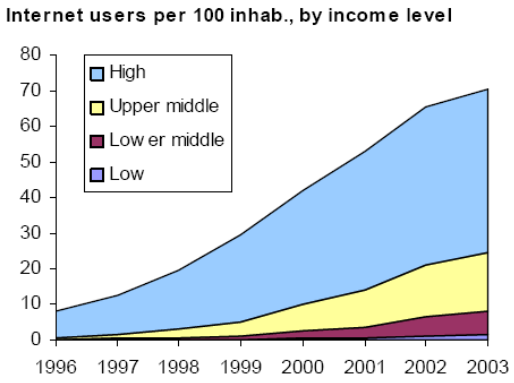

Figure 1: Internet users, by income level[34]

The ITU also indicates that the use of the Internet in developing countries is still below that of developed countries.

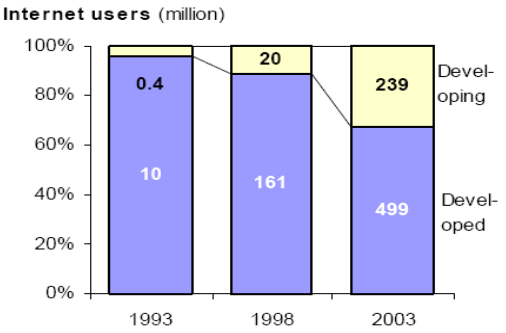

Figure 2: Internet use, in developing countries and developed countries[34]

D. Digital divide by economic status.

The cost of accessing the technology is simply not affordable for many people in most developing countries. Based on the daily income difference between people in developed and developing countries, WIA (2007) [71] reported that the cost of an hour of using the Internet at a cyber café in New York is about 6 percent of the average daily income of a citizen in a developed country, in contrast to citizens in Laos or Nigeria where it costs about 75 percent of their daily income. Compared to people who live in developed countries it seems that people in developing countries pay more for accessing the technology and at the same time get less value for their money.

ITU data also shows that the proportion of people with low income that are using the Internet is below 10 percent. In contrast, more than 50 percent of high income people have ready access to the facility.

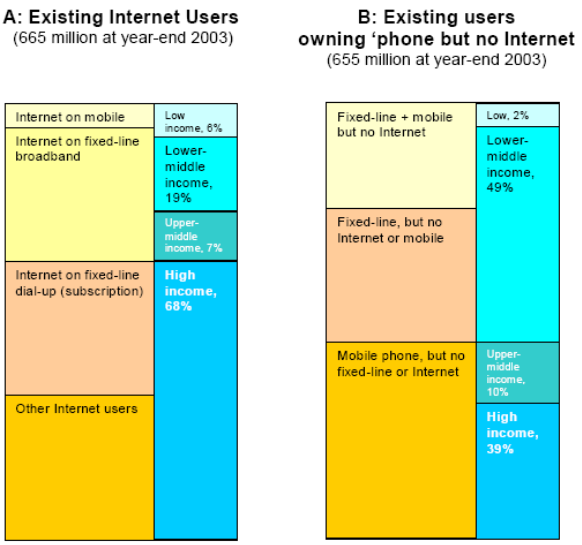

Figure 3: Estimating the user of internet broken down by type of usage category and by income category of country [34]

In Figure 3 the first block (A) is composed of existing Internet users, of which there were around 665 million at the end of 2003. This category can be further segmented into those that access the Internet primarily from their mobile phone, those who access it from a fixed-broadband connection, subscribers who access it from a dial-up connection, and other casual Internet users that may have access to the Internet, for instance, from their school, from a cyber-café, from work etc.

The second block (B) is composed of existing owners of either a fixed-line telephone or a mobile phone (or both) but not an Internet connection. There are almost twice as many mobile phones worldwide as Internet users, so it can be assumed that the minimum number of users in this category is at least 655 million (global mobile phone users minus global Internet users), though it is almost certainly higher as some of the Internet users included in category A probably do not own a fixed line phone or mobile (e.g., students who access the Internet from school or university).

E. The major digital divide between develop and developing country

We can conclude that the major reasons why the digital gap occurs between developed and developing countries are:

- The developing countries do not produce the technology, but they use the technology
- The major barrier limiting Internet access in both developed and developing counties is income level.
- Using a computer and the Internet is more complicated than sending a text messages by mobile phone or dialling a telephone. Meaningful use of the Internet requires computer, and cognitive skills for such things as seeking information, developing community networks, or participating in political activities.

III. E- GOVERNMENT USER'S PROFILE

In an ideal world, e- government opportunity would mean:

- All citizens have easy access to ICTs at affordable prices.
- All citizens know how to use ICT devices for accessing e-government services.

This section provides an overview of the indicators for analysing the e-government user profile. E-Government user indicators consist of:

The first is Infrastructure, which includes the network indicators of the proportion of households with a fixed line telephone and mobile cellular access. It also includes the devices that provide the interface between the user and the network.

The second is Opportunity. In order to participate in the Information Society, the e-government user must have access to ICT services and must be able to afford them.

The third is ICT literacy. This indicator is based on the proportion of potential users, that is, those with access that do actually use the Internet or SMS services provided.

This classification is sequential, with each category is built on the previous one. In order to have access to infrastructure, users must be covered by the service and be able to afford it.

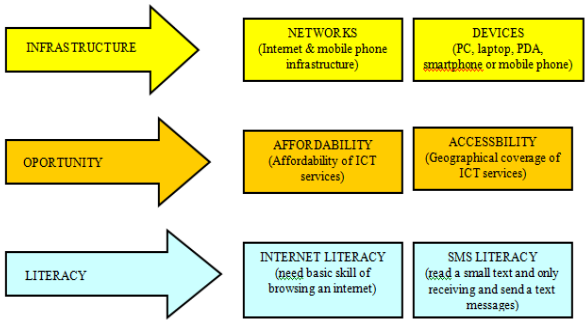

Figure 4: the e-government user indicator

IV. E-GOVERNMENT USER CLASSIFICATION

We envision that some users will use a PC or laptop from home to access network services, some users will use PCs in a kiosk to access networked services, while other users, such as government or NGO employees, may have a PDA or laptop or even a cellular smartphone. The purpose of analysing the user is to give suggestions for government support for four classes of users in accessing the internet and using SMS in order to increase public participation in e- government.

Based on the previous digital divide section, we categorize the e-government user into four groups.

The first class of user, those in a wealthier society, is able to access the Internet by using their own PC and have access to a phone line or wireless connection. Most users of this class are able to provide their own PCs and

internet network access.

The second type of user is those who use public access points, such as kiosks or mobile kiosks. These users usually do not have a PC and internet network access.

The third class of users are those using their own devices, such as smart phones, PDAs, and laptops, but who do not have personal access to the internet network. Such users would use the kiosk-controller essentially as a wireless hotspot that provides store-and-forward access to the Internet.

The fourth class of users is those who have mobile phones. They can use their mobile phone to access e-government services. However, they may have limitations with their mobile phone (e.g. 2G mobile phones).

Table 1: Overview of E-government user profiles categories

User	Facility that the user owns		User Skill
	Devices	Infrastructure	
Home access	- PC - Phone Line	Phone line	Basic using web browser
Public access point	None (The user rent the shared PC)	Using public access terminal	Basic using web browser
User with mobile technology	Laptop, PDA or smart phone	Using fixed point wireless terminal	Basic using web browser
Mobile phone user	Mobile Phone	Mobile phone infrastructure	2G→SMS and voice call

V. CONCLUSION

This paper analyses the digital divide and other factors that contribute to an understanding of the e-government user's profile. The profiles of the e-government user can be summarised as:

- people who access the Internet from home,
- people who access the Internet from kiosks, schools or work places, or by using fixed hot spots,
- people using SMS to get e-government services either in developed countries or in developing countries.

Understanding the e-government user profile is essential in devising an effective strategy for implementing e-government in developing countries in order to provide a service that is not only relevant to the population but useable by and available to all.

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Statistical Analysis in Digital Mammogram Images

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***Abstract*—The presence of microcalcification in mammogram images is an indicator of breast cancer. The analysis of mammogram image is usually done by a doctor or radiologist. The main objective of this research is to detect microcalcification in digital mammograms using ImageJava software tools. In this research, detection of microcalcification in digital mammograms is carried out using statistical analysis and pre-processing of the images. In this paper, a preprocessing technique for reducing the size and enhancing the quality of MIAS mammogram images is introduced. The system detects microcalcification in three steps. Firstly, a histogram equalization is applied on the images as first pre-processing, then cropping to find objects of interest and separate them with the background, sharpen the mammogram images, and then apply Gaussian filter to reduct the noise. The next step of this simulation is carrying on the edge detection of the images. Finally, statistic features of the images are extracted from the images and recognizing the presence of microcalcification in the images. The research uses 25 digital mammograms, consist of five normal mammograms and 20 mammograms which contain microcalcifications. The results show that statistical analysis with a pre-processing technique leads to better performance in recognizing the microcalcification per image.**

***Index-Terms*: microcalcifications, mammograms, edge detection, Gaussian filter, statistical analysis**

I. INTRODUCTION

In the US, breast cancer is the most common form of cancer among women and is the second leading cause of cancer deaths, after lung cancer [1]. Women in the U.S. have about a 1 in 8 lifetime risk of developing invasive breast cancer [2, 3]. Early detection of breast cancer increases the survival rate and increases the treatment options.

Screening mammography, x-ray imaging of the breast, is currently the most effective tool for early detection of breast cancer. Screening mammographic examina-tions are performed on asymptomatic woman to detect early, clinically unsuspected breast cancer. Two views of each breast are recorded; the craniocaudal (CC) view, which is a top to bottom view, and a mediolateral oblique (MLO) view, which is a side view taken at an angle.

Radiologists visually search mammo-grams for specific abnormalities. Some of the important signs of breast cancer that radiologists look for are clusters of microcalcifications, masses, and architectural distortions. A mass is defined as a space-occupying lesion seen in at least two different projections [4]. Masses are described by their shape and margin characteristics. Calcifica-tions are tiny deposits of calcium, which appear as small bright spots on the mammogram. They are characterized by their type and distribution properties. An architectural distortion is defined as follows: "The normal architecture is distorted with no definite mass visible.

Early detection via mammography increases breast cancer treatment options and the survival rate [6]. However, mammography is not perfect. Detection of suspicious abnormalities are repetitive and fatigue task. For every thousand cases analyzed by a radiologist, only 3 to 4 are cancerous and thus an abnormality may be overlooked. As a result, radiologists fail to detect 10-30% of cancers [7-9]. Approximately two-thirds of these false-negative results are due to missed lesions that are evident retrospectively [10]. Due to the considerable amount of overlap in the appearance of malignant and benign abnormalities, mammography has a positive predictive value (PPV) of less than 35% [11], where the PPV is defined as the percentage of lesions subjected to biopsy that were found to be cancer. Thus, a high proportion of biopsies are performed on benign lesions. Avoiding benign biopsies would spare women anxiety, discomfort, and expense. For this research, a typical mammogram must be digitized at a resolution of approximately 1024x1024pixels.

The purpose of this research work is to analyse the statistically the objects of interest and determine the appropriate one for digital mammogram enhancement and microcalci-fication detection.

II. MATERIALS AND METHODS

Database resources: Most image processing systems applies a preprocessing stage as a first stage. The system we introduce here could aid radiologists by highlighting the suspicious regions in mammograms. In this work, pre-processings image are implemented and performed on 25 mammographic images from MIAS databases. These images are available with the same specification (1024x1024 pixels with 8-bit pixel depth). This database is classified to different types of diagnosis: normal, and abnormal. Normal cases are formed for patients with normal exam results that have had previous normal exams

in the last four years. In this paper live volumes of cancer (benign) and one volumes of normal cases are used. The cancer (benign) volumes are: spic(5 cases), circ (5 cases), asym (5 cases), misc (5 cases), calc (5 cases). Whereas the normal volumes are: norm (5 cases).

The pre-processing stage is introduced in this section. The subsections describe the algorithms involved in this process. The procedure required some algorithms such as equalization histogram, sharpening to enhance image, cropping use to crop object and waste the padding from the image, filtering with Gaussian filter. The request with the size of pixels 1024x1024, cropping to get sample image normal and abnormal image. According to Munir (2004), image enhancement is one of the first process in image processing (image preprocessing). Through this processing we can improve the image quality, so the image can be used for more applications, for example, the introduction of the object in the image. Mathematically repair its image can be interpreted as a process to change the image of f (x, y) to f '(x, y) so that the characteristics seen in the f`(x, y) show more activities. At the beginning of this process the image processing are among others for cropping to remove the padding on the image of mammogram, changing the contrast with histogram equalization, sharpen an image, and filtering with the Gaussian filter. The next stage after the pre-processing technique is to find the edge of the object to extract the object characteristics.

Feature Extraction

A mammogram contains a large amount of heterogeneous information; different tissues, vessels, ducts, breast edges, film and X-ray machine characteristics. Reliable features should reduce the amount of irrelevant information and produce robust mammogram descriptors for a specific task. The main goal of our work is to develop feature extraction schemes having the following properties:

To generate features which have the ability to segment the mammograms into two classes: Clusters of microcalcifications and normal tissue. In this work, we define the class "normal tissue" as the one representing all information in a mammogram that are not microcalcifications.

To generate features which can be used in the discrimination between benign and malignant clusters of microcalcifications.

Variations within the limits of normality of breast tissue pose the basic obstacle in achieving these goals. Microcalcifications may be very subtle, be of low contrast, and have hazy borders. As a consequence, microcalcifications are frequently less visible than the variations in the normal tissue. The highly textured regions of breast tissue in mammograms dictate the selection of methods that are successful in dealing with texture regions, example texture analysis methods, and prevents the selection of simpler image segmentation methods, such as edge detection [14].

The term texture is used to characterize important characteristics of the surface of a given object and it is one of many important features used in computer vision and pattern recognition. However, in spite of its importance a precise definition of texture does not exist. Haralick and Shapiro [12] consider texture as an organized-area phenomenon described by two basic characteristics: The first characteristic is concerned with the gray level primitives or local properties constituting the image texture, and the second characteristic is concerned with the spatial organization of the gray level primitives. Sklansky [13] suggested another definition: “A region in an image has a constant texture if a set of local statistics or other local properties of the picture are constant, slowly varying, or approximately periodic."

In this work we suggest new methods for texture feature extraction in digital mammograms. These methods are based on the use of digital filters – together with a filter response energy measure as texture feature extractors. An approach to texture feature extraction frequently cited in the literature is based on the use of spatial gray level co-occurrence matrices. Co-occurrence matrices are second-order statistical measures of image variation and can be useful in the classification context. In the present work we present a new method which improves the classification performance of the co-occurrence approach. This is achieved by combining the co-occurrence approach and one of the filtering approaches.

III. RESULTS

We have used the public database MIAS [13] to test our method. It is a reduced version of the original MIAS Database (digitized at 50 micron pixel edge) that has been reduced to 200 micron pixel edge and clipped or padded so that every image is 1024x1024 pixels. Mammogram images view before image pre-processing shown in Figure 1 (a) – 1 (f) below.

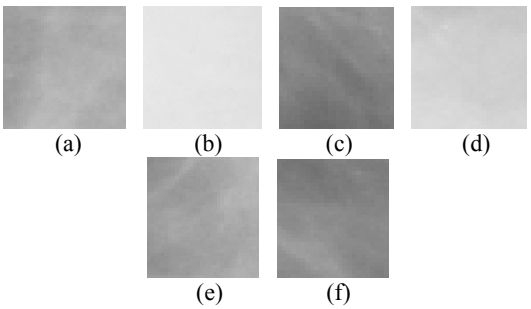

Figure 1. Mammogram images before processing; (a) CIRC, (b) NORM, (c) MISC, (d) ASYM, (e) CALC, and (f) SPIC

The results of image pre-processing in both mammogram images are normal mammogram and abnormal mammogram image shown in Figure 2 (a) - 2 (f) below.

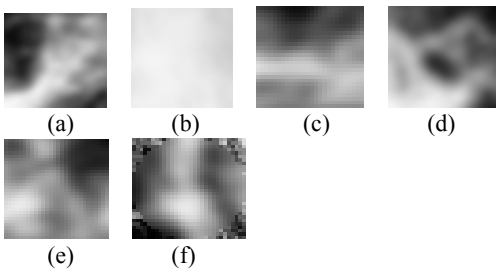

Figure 2. Result of pre-processing technique in image digital mammograms; (a) CIRC, (b) NORM, (c) MISC, (d) ASYM, (e) CALC, and (f) SPIC

Notes:

(a) The digital image mammogram CIRC : circumscribed masses
(b) The digital image mammogram NORM : normal
(c) The digital image mammogram MISC : other, ill-defined masses
(d) The digital image mammogram ASYM : Asymmetry
(e) The digital image mammogram CALC : calcification
(f) The digital image mammogram SPIC : speculated masses

Image edge detection after the pre-processing image of digital mammograms are shown in Figure 3(a) – 3(f) .

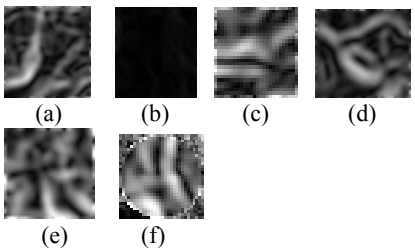

Figure 3. Result of edge detection in digital image mammograms; (a) CIRC, (b) NORM, (c) MISC, (d) ASYM, (e) CALC, and (f) SPIC

We tested the effectiveness of the features computed by processing five normal mammograms sorted out according to the constitution of the breast and the proportion of the connective tissue in relation to the fat tissue. The results are shown in Table 1: average, the standard deviation, skewness, x-y coordinates of abnormality displayed on this table. Statistical analysis object can done with the measurement object detected abnormality of mammograms. Statistical analysis done by extracting the characteristics of the object from the object associated with frequency emergence pixel value is average (mean), the standard deviation.

Table 1. Result of statistical analysis objects in the digital image mammograms

Nama File	Mean	StdDev	XM	YM
CIRC001	132.8	64.946	545.852	436.887
CIRC005	130.1	63.503	504.771	130.64
CIRC010	136.4	75.58	527.93	431.315
CIRC012	130.3	69.497	467.366	465.367
CIRC023	135.5	72.141	535.183	675.731
NOR003	247.4	16.89	632.796	198.487
NOR004	231.4	9.926	481.438	435.252
NOR006	237.2	17.45	560.516	465.817
NOR008	190	17.284	621.468	624.769
NOR011	196.3	11.972	593.244	273.958
MISC013	129.4	63.257	667.366	368.546
MISC030	123.3	60.342	342.206	698.133
MISC032	125.2	69.032	396.481	742.885
MISC058	121.2	59.32	340.469	379.857
MISC063	127.7	66.833	558.704	479.699
ASYM072	127.5	58.965	274.697	531.436
ASYM075	123.7	64.046	484.653	728.345
ASYM081	129.1	63.518	513.019	497.909
ASYM083	126.7	63.625	559.841	211.646
ASYM090	123.8	58.864	528.565	562.967
CALC209	134	66.151	680.938	520.276
CALC211	130.4	68.299	695.479	341.266
CALC213	130.1	48.592	560.091	538.288
CALC218	130.2	60.492	530.126	641.899
CALC219	131	63.717	548.199	761.735
MISC145	133.3	64.757	684.098	561.312
MISC148	123.3	66.214	329.008	614.161
MISC178	131.2	62.308	493.324	605.561
MISC179	123.8	62.331	615.113	528.075
MISC181	131	60.44	522.237	370.086

Notes:

1. The digital image mammogram CIRC : CIRC001, CIRC005, CIRC010, CIRC012, CIRC023
2. The digital image mammogram NORM : NOR003, NOR004, NOR006, NOR008, NOR011
3. The digital image mammogram MISC : MISC013, MISC030, MISC032, MISC058, MISCb063
4. The digital image mammogram ASYM : ASYM072, ASYM075, ASYM081, ASYM083, ASYM090
5. The digital image mammogram CALC : CALC209, CALC211, CALC213, CALC218, CALC219
6. The digital image mammogram SPIC : SPIC145, SPIC148, SPIC178, SPIC179, SPIC181

In Figure 4 we have plotted the mean value of the digital mammogram images that detected the microcalcification (abnormal images).

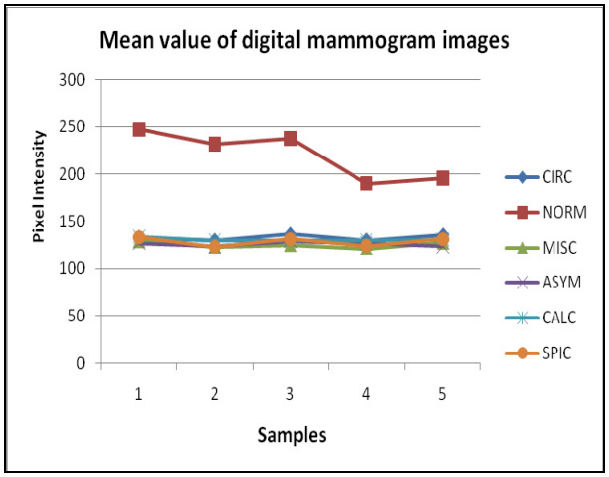

Figure 4. Plot mean values from digital mammogram images

In Figure 5 we have plotted the standard deviations value.

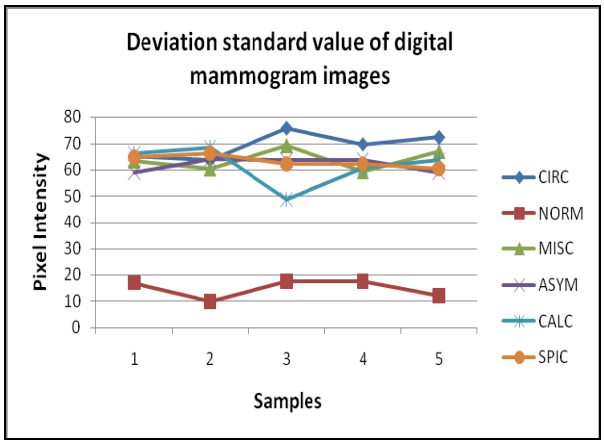

Figure 5. Plot the standard deviation value from digital mammogram images

IV. Conclusion

We proposed methods as follows to improve quality of the image can be done by using histogram equalization and noise reduction with the Gaussian filter method can significantly clarify the contrast of the digital image, then edge detection give better results after being processed to increase the image quality, statistical parameters analysis such as means and standard deviations, which are extracted from the characteristics of the object in the image can show the results of the mammogram images of normal and abnormal can be compared with the respective values of the statistics of the normal mammogram image and abnormal. Results from the statistical analysis found that the statistical features of a digital mammogram images of the normal mean value that most in the abnormal digital mammogram images. Meanwhile, standard deviation values of the normal breast digital mammogram images are smaller than abnormal mammogram images.

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Chest X-ray Image Registration Using Mutual Information Criterion for Supporting Lung Diseases Analysis

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Abstract*—Lung disease is one of the most popular subject which treated using computer aided diagnosis system. This system helps radiologists and medical experts in diagnosing diseases. Some of X-ray images, which are taken from different time, are compared to get the information about disease's progress. These images perhaps have some different contrast or different object position, that can be causing detection and interpretation errors. CAD is reducing those errors by detecting features of diseases. CAD needs input data, one of the example is thorax image, like X-ray image. The very beginning step from all of the CAD's processes is image registration, which is the process of overlaying two or more images of the same scene taken at different times, under different lighting conditions, from different viewpoints and/or by different sensors. The major purpose of registration is to remove or suppress geometric distortions between the reference and sensed images. This is a crucial step, because the next steps are depend on its accuracy. In this final project, chest X-ray images are used as registration input data. X-ray images have wide intensity variety. Therefore, Mutual Information (MI) is used as registration criterion in this project. This criterion is a measure of mutual correspondence between two random variables. In this case, pixel values from images are the variables. For model estimation, rigid and affine transformations are chosen. Affine transformation have more complex parameters than rigid transformation, so its results much better. MI value from the process can be used to evaluate the result of registration. The higher the value means image is registered better. Other ways to evaluate are using standard deviation and values distribution of joint histogram, and observe its spreading value from registered image. The less the spreading means the better registration works. Thirteen pairs of Chest X-ray images from RS H.A. Rotinsulu are used. Program is built by using Matlab. After running the program, the mean of MI value after registration using rigid transformation increase 7.937% compare with mean of MI value before registration. For registration using affine transformation, the increasing value is 10.692%. Standard deviation value for registration using rigid transformation is decrease 5,375%, and using affine transformation decrease 8.042% , compare with standard deviation value before registration.

***Index Terms*—affine, mutual information, registration, rigid.**

I. INTRODUCTION

Since the invention of X-rays by Wilhelm Roentgen [1], the diagnosis of disease can also be supported by the information of organs interpretation in the body condition of the image obtained by X-ray. Image X-ray interpretation is a process influenced by the image acquisition settings (patient position, X-ray beam energy that is used), quality of the film, and radiologists subjectivity. Diagnosis using the X-ray images is quite complicated, because the body's anatomy imaging are overlapping each other. This is difficult for radiologists. As a result, diagnosis using the X-ray images is prone to error detection and interpretation [2]. This error causing some possibilities that there are information in X-ray image associated with the diagnosis of disease, which can not be detected by vision experts. However, X-ray image still widely used in diagnosing diseases, because its low cost.

During this time, increased accuracy and objectivity in interpretation X-ray image are made through efforts such as request opinions from other experts, to give extra concentration to do during the diagnosis, and perform advanced diagnosis with CT or MRI [3]. However, there are obstacles for the points above. One solution proposed is using software as a diagnosing tool. Beside its low cost, this device is expected to help radiologists or experts in detecting abnormalities in images. This tool can be classified as a Computer Aided Diagnosis (CAD). The term refers to the process of diagnosis made by an expert by combine assessment results from the software in the process of medical decision making. The output from CAD software can be a visual or numeric.

The importance of clinical role of chest X-ray image, as well as its display that quite difficult to be diagnosed, are the main reasons for the development of CAD systems. CAD is used to detect the features in the image that indicating Tuberculosis (TB). Features in the image of chest X-ray image that indicating active-TB are represent by cavitary lesion, nodule, pleural effusion, hilar or mediastinal lymphadenopathy. Examination carried out by comparing several images taken at different times, to see how the development of these features. Results of this examination will determine the continuation of TB therapy. In the process of benchmarking a few images, there is a possibility the position of objects in the image is not the same, so that the geometrical alignment of the images that taken in a different time to be very important in determining the

accuracy of diagnosis of TB. Therefore, image registration is done to solve the problem, and become as the very beginning step in CAD system.

Image registration is done to remove the geometric distortions between the sensed image with the reference image. By performing image registration, the measurement of features from the image of X-ray thoraks can be done more accurately. Problems faced in the chest X-ray image registration such as reference features identification to be registered and range of intensity that could affect visualization of reference features which used in registration, and other features related by lung disease, then registration technique which relatively robust with diversity of image intensity and accurate identification of certain features is needed. This need met by the area-based image registration using the MI criterion [4]. MI criteria can reflect the correlation between the values of pixels in two images, without too affected by differences in the diversity of the intensity image and without requiring identification of certain features of the image.

Those requirements are met by using area-based image registration with Mutual Information (MI) criterion. MI criterion can find correlation of pixel values between two images, without too affected by diversity of image intensity and does not require identification of certain features from images.

II. Review of Literature

Chest X-ray Images

Chest imaging is the most-commonly-performed examination using X-ray. It result an image that represent heart, lungs, respiratory channel, blood vessel, spine, and sternum.

X-ray Images Indicating TB

Tuberculosis (TB) disease is examined and diagnosed more than once. Diagnosis needs reference, X-ray image is one of that. Thus, the process of scanning X-ray should be done several times, with the lapse of a few days or weeks. Evaluation on the development of TB tuberculosis carried out by the infiltrate, cavitary lesion, nodule, pleural effusion, hilar or mediastinal lymphadenopathy is visible on the X-ray image. Then by comparing with the observed distribution nodul between the image of the one with the other, it can be evaluated if the condition of patients improved or not.

Example of X-ray image indicating the presence of TB can be seen in Figure 1.

Image Registration

Image registration is the process of overlaying two or more images to the same scene taken at different times, from different point of view, and/or using different sensors. In this process, the two images matched the geometrically.

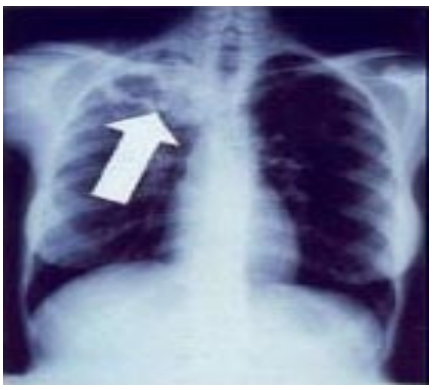

Figure 1. X-ray image indicating TB

Registration method consists of four steps [5], namely the feature detection, feature matching, transform model estimation, and image resampling and transformation. Both area-based registration and feature-based registration has same process sequences. Generally, the methods used in each type of registration can be seen in Table I. The only difference lies on their methods, especially in features matching step.

Table I Comparison of area-based and feature-based registration [6]

	(Intensity) *Area-based* Registration	**(Spatial) Feature-based Registration**
Feature Detection	-	Point, line, region, etc.
Feature Matching: Similarity Criterion	Normalized Correlation, Fourier Descriptors, *Mutual information*	Closest Spatial Distance, Feature Similarity Measure
Spatial Transform Model Estimation	Model Est. (Rigid, Affine, Projective, Global Poly-nomial) and Search Strategies for Model Parameter Estimation (gradient descent, minimax, Expectation-Maximization, etc.)	
Image Re-sampling & Transformation	Image mapping and re-sampling /interpolation	

III. Methods

On this project, area-based method are used as detection method. This is chosen because it is suitable for images which do not have a lot of details and information of differences more likely as graylevel/colour rather than local shapes and structures [5], whereas X-ray images have those characteristics. Area-based method has two major limitations, the reference image and the sensed image must have “similar” intensity function, either those are identical (in this case correlation method can be used) or each other depend statistically (usually found on multimodal registration).

Mutual Information

Mutual information (MI) is one of the criterion of area-based registration. This is widely used in implementing area-based registration because its simple measurement. Relationship between MI and entropy is [7]:

$$\begin{aligned} I(A,B) &= H(A)+H(B)-H(A,B) \\ &= H(A)-H(A\mid B) \\ &= H(B)-H(B\mid A) \end{aligned} \quad (1)$$

Entropy $H(A)$ is known as the amount of uncertainty of independent variable A, and $H(A\mid B)$ is the amount of uncertainty remained in A whereas B is known. $H(A)$ and $H(B)$ are entropy value of variables A and B, then $H(A,B)$ is joint entropy of variables A and B. $H(A\mid B)$ and $H(B\mid A)$ are conditional entropy of variables A and B respectively, and vice versa.

$$H(A) = -\sum_{a} p_A(a)\log p_A(a) \quad (2)$$

$$H(A,B) = -\sum_{a,b} p_{AB}(a,b)\log p_{AB}(a,b) \quad (3)$$

$$H(A\mid B) = -\sum_{a,b} p_{AB}(a,b)\log p_{A|B}(a\mid b) \quad (4)$$

Three commonly used definitions of MI:

- Mutual Information is the amount of that the uncertainty B in (or A) is reduced when A (or B) is known.
  $I(A,B) = H(B)-H(A\mid B) = H(A)-H(A,B)$ (5)
- Maximizing the Mutual Information is equivalent to minimizing the joint entropy.
  $I(A,B) = H(A)+H(B)-H(A,B)$ (6)
- Measures the dependence of the two distributions. In image registration, $I(A,B)$ will be maximized when the images are aligned.

$$I(A,B) = \sum_{a,b} p(a,b)\cdot\log\left(\frac{p(a,b)}{p(a)p(b)}\right) \quad (7)$$

Transform Model Estimation

After the feature correspondence has been established the mapping function is constructed. It should transform the sensed image to overlay it over the reference one. Model of mapping functions can be divided into two broad categories according to the amount of image data they use as their support. Global models use all control points for estimating one set of the mapping function parameters valid for the entire image. On the other hand, the local mapping functions treat the image as a composition of patches and the function parameters depend on the location of their support in the image. Image coordinate transformation called rigid when only translation and rotation are used. When transformation mapping parallel lines into parallel, so it called affine. Matrix of affine transformation contains of four parameters, such as rotation, scaling, translation, and shearing.

Joint Histogram

Histogram is used for plotting the density. High-order histogram plays important role in image analysis applications. In joint histogram, the value at i, j position is the amount of pixels which have i value in one channel, and so do j. On the other hand, 8-bit image (which means it has 256 luminancy levels), matrix dimension of its histogram is 256×256, then it could be as constraint occasionally. Therefore, pixel values usually quantized to reduce the number of levels before processing. Joint histogram can be created by selecting from a set of local pixel features, then arranged as multidimensional histogram. Each entry in joint histogram contains number of pixels represent image which is described by combination of feature values.

IV. DESIGN AND IMPLEMENTATION

This section discusses about general design that includes collecting data and registration process. Registration process includes defining model transformation –rigid and affine-, evaluation criteria, and optimization functions. Unconstraint optimization is used to find the minimum value of objective function.

Data Input

We get input data by scan chest X-ray films using Umax 2000 scanner, from RS Paru H.A. Rotinsulu Bandung. Scan result are saved as .bmp graphic type. There are thirteen pair of images, originating from thirteen different patients. One patient had a pair of images taken at different time. Image dimension as input data can be seen in Table II. below.

Tabel II. Image dimension

Image pair	Dimension (pixel)	
	IM1	IM2
1	1171 x 1314	1196 x 1392
2	1196 x 1392	1121 x 1242
3	1495 x 1200	1189 x 1065
4	1262 x 1089	1495 x 1200
5	1277 x 1129	1412 x 1199
6	1200 x 1327	1122 x 1247
7	1181 x 1116	1576 x 1196
8	1196 x 1392	1062 x 1151
9	1196 x 1576	1006 x 1041
10	1147 x 1121	1199 x 1392
11	1116 x 1316	1196 x 1576
12	1120 x 1243	1200 x 1329
13	1131 x 1282	1196 x 1392

Registration

The process of registration is determined by three aspects, namely transform model, criterion, and

minimization function. There are two transform models used, the rigid transformation and affine transformation. Rigid transformation has four parameters consists of two translation parameters, a rotation parameter, and a scaling parameter; whereas affine transformation has six parameters, consists of the parameter scaling, rotation, shearing horizontal, vertical shearing, and translation. Where angles and lines are not maintained, but still retain parallelism.

MI criterion which used during registration is normalized MI. Normalized value of MI will be on the range 0 to 1. The better images being registered, the closer normalized MI value to 1. MI criterion is used as a solution whether or not the existence of information about features that correspond between sensed and reference image. In addition, this criterion is not influenced by the diversity of intensity, so it is suitable images X-ray registration with their large diversity. In this project we are using –MI (minus MI) as objective function. This function is chosen because we use minimization function as optimization, whereas minimum global value will behave as optimum value.

In this project, `fminunc` is used as optimization function. It is a function of MATLAB. This function is used to find unconstraint minimum value from multivariabel function. `fminunc` has equation:

$$\min_x f(x) \tag{8}$$

where x is vector and $f(x)$ is objective function to measure and evaluate system performance. `fminunc` find minimum scalar function value of several variables, which its process begins with estimate initial parameter $x0$. Parameter can be scalar, vector, or matrix form. We use scalar form. Function `fminunc` is using algorithm with hessian and gradient information. It has limitation that objective function which will be minimized must be continuous, so it is not suitable for discontinuous function, and it could only find local solutions.

Evaluation Parameter

Two parameters that I use to evaluate the registration are joint histogram and value of image difference. From joint histogram, I can get some information such as its form and standard deviations. Joint histogram after registration has more compact and narrow form, than before registration. It is because the less coordinates of pixel value pairs from reference image and sensed image that established. Excellent registration will give smaller standard deviation value, compare with value before registration. Standard deviation value represents the distribution of joint histogram. Then we can see that the better registration is, the less distribution that joint histogram has, so the less standard deviation of joint histogram. Second parameter is energy of image difference. It can be calculated by sum the square value of difference between registered image and reference image. Registration has purpose to get image as similar as reference image. The better the registration, the less value of pixels difference, then energy value will be small.

Implementation

Image registration is run using several Matlab modules. In general, process begin with submit initial estimation value, run optimization, get optimum value of objective function. Next stage is showing registration results, MI values and joint histogram before and after registration.

V. Evaluation and Analysis

This section discusses about testing registration algorithm which is implemented into Matlab-based program and analyze its performance.

Normalized MI Value

Normalized MI values indicate how appropriate sensed image and reference image. The greater the value, means that those images have more similarity. In other words, the better the registration is, normalized MI value will be higher. Table III. shows that normalized MI value before registration has smallest value, compare with after registration.

From comparison normalized MI values between rigid transformation and affine transformation, we find that average value of normalized MI for rigid transformation is 0.626, and 0.642 for affine transformation. From the comparison between the value of normalized MI rigid transformation and affine transformation, is that the average value of normalized MI for the rigid transformation is tranformasi for 0.626 and 0.642 is affine. Compare with normalized MI value before registration, then for rigid transformation the value increase about 7.937 %, and 10.692 % for affine transformation. This result shows that registration has successfully performed with two kind of transformation, and image registered better when using affine transformation.

Table III. Comparison of normalized MI and its increase

Image pair	Normalized MI before registration	Normalized MI after registration using transformation			
		Rigid	Percentage of change	Affine	Percentage of change
1	0.627	0.639	1.910	0.645	2.870
2	0.572	0.645	12.762	0.653	14.160
3	0.573	0.672	17.277	0.697	21.640
4	0.513	0.596	16.179	0.600	16.959
5	0.553	0.569	2.893	0.593	7.233
6	0.574	0.621	8.188	0.623	8.536
7	0.601	0.652	8.485	0.671	11.647
8	0.596	0.681	14.261	0.711	19.295
9	0.573	0.641	11.867	0.691	20.593
10	0.574	0.612	6.620	0.612	6.602
11	0.580	0.581	0.172	0.595	2.586
12	0.629	0.643	2.225	0.644	2.384
13	0.578	0.580	0.346	0.604	4.498
Mean	0.580	0.626	7.937	0.642	10.692

Standard Deviation

With registration, pixels that lie at same location between two images are expected have similarity intensity values, although in certain condition this case do not happen. This is because those have different contrast. By counting standard deviation from matrix of image registered, we can get how far pixel pair values deviate. The bigger value of standard deviation, the less similarity between sensed and reference images.

From Table IV., we can see that standard deviation values are calculated on three conditions: from image pair before registration, after registration with rigid transformation, and registration with affine transformation. From these conditions, the smallest standard deviation value is given by after registration condition using affine transformation, that is 41.96. Followed with 43.177 for rigid transformation, and 45.63 as standard deviation value before registration. Compare with before registration condition, standard deviation value for rigid transformation increase as 5.176%, and 8.704 for affine transformation. This indicates that image pair has most mismatches when they were not registered yet. Changes in the value of standard deviation before after registration with rigid transformation of 5.176%. Changes to the affine transformation of 8.704%. This indicates that the image has a pair of matches at least when the registration is not done. Meanwhile, after registration with rigid transformation, there are less mismatches, and less more for affine.

Energy Value of Images Difference

Energy value of images difference is the square values of difference between pixels that correspond. Values are squared to avoid negative pixel values obtained. The greater the energy value, the greater the difference of pixel values between sensed image and reference image. Registration aims to match two images, which means reduce the difference between them.

Table V shows five of thirteen pairs of images that indicate energy value of difference images after registration are greater than before registration. However, energy of image difference can not be considered as criterion whether the registration is running well or not, because the energy of image difference is about calculate difference between pixel per pixel. This calculation is local counting. Whereas registration using MI criterion is count globally. Then calculating pixel per pixel values are not absolutely correct in describing registration result as a whole.

Computation

Table VI. shows that not all of registration process using affine transformation are longer than rigid transformation. Rigid transformation requires average time as 567 seconds to compute, whereas affine transformation takes 832 seconds. But by using more parameters, affine transformation should have took longer time than rigid. However, by thirteen pairs of image processed, overall affine transformation require longer time than the rigid transformation.

This may be influenced by the initial parameter estimation. The more inaccurate the initial estimation parameter from optimum parameter, the more longer optimization will run. This happen until optimum value and parameter found. Conversely, if initial estimation near from optimum parameter, optimization will run faster. It can be seen at fifth output, where registration with affine transformation took 30 seconds, whereas rigid transformation took almost 20 minutes.

Table IV. Comparison of standard deviations and means before and after registration

No	Standard deviations				
	Before registration	After registration using transformation			
		Rigid	Percentage of change	Affine	Percentage of change
1	48.156	45.737	-5.023	45.689	-5.122
2	42.051	41.292	-1.804	41.164	-2.109
3	48.816	48.138	-1.388	46.315	-5.123
4	41.626	43.631	+4.187	43.398	+4.257
5	52.955	50.978	-3.733	50.662	-4.330
6	42.31	37.428	-11.538	36.059	-14.774
7	46.521	45.49	-2.216	45.243	-2.747
8	39.58	38.032	-3.911	36.709	-7.253
9	51.094	41.733	-18.321	38.719	-24.220
10	38.744	38.708	-0.092	38.669	-0.193
11	43.209	39.491	-8.604	37.56	-13.073
12	54.479	49.475	-9.185	49.103	-9.868
13	43.65	41.178	-5.663	36.823	-15.633
Mean	45.63	43.177	-5.176	41.96	-8.704

Table V. Energy value of images difference

No	Before registration ($\times 10^6$)	After registration ($\times 10^6$)	
		Rigid	Affine
1	5.0744	8.4373	5.0744
2	12.318	9.2601	9.6414
3	10.779	11.204	10.707
4	10.924	6.1109	6.0673
5	12.842	10.808	10.902
6	13.338	12.063	11.804
7	9.8391	6.5797	8.4246
8	9.667	6.2919	4.762
9	7.6054	4.9854	8.0069
10	15.668	8.8149	8.7948
11	9.7647	13.864	11.895
12	6.3167	5.9268	6.0078
13	8.5693	10.071	7.0649

Table VI. Duration of registration using rigid and affine transformation

Image pair	Process duration (second)	
	Rigid Transformation	Affine Transformation
1	455.672	1253.812
2	830.89	806.734
3	686.469	440.812
4	487.734	886.125
5	1031.172	32.562
6	43.969	665.875
7	567.078	1054.063
8	466.765	423.406
9	516.437	853.828
10	456.375	986.984
11	982.297	1694.156
12	416.016	404.047
13	431.422	1324.157
Mean	567.099	832.812

VI. CONCLUSIONS

In this project, I have run chest X-ray area-based registration successfully. I conclude that:

1. Illustration of rigid and affine registration performances for 13 pairs of chest X-ray images:
   - MI value has increased about 7.937% for rigid and 10.692% for affine transformation on average.
   - Standard deviation value has increased about 5.375% for rigid and 8.042 for affine transformation on average.
   - Computation time are 567 seconds for rigid and 832 seconds for affine transformation on average.
2. From conclusion (1), the best result as a whole is given by affine transformation, but initial estimation parameter $x0$ and optimization algorithm play important role. The closer initial estimation value by optimum value, the faster optimization run. We also have to suggest several number of different initial estimation in order to avoid optimization give minimum local value.

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A Preliminary Evaluation of Vector Quantization Coding Performance on Color Retinal Image

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***Abstract*—One of the causes of blindness is retinopathy diabetic. The healing of retinopathy diabetic is constraint on economic issues and geographical circumstances. Geographical of Indonesia is an archipelago, spread from Sabang to Merauke. Health facilities and the infrastructure are concentrated in urban area. Beside Indonesia has a more rural area than urban area. Therefore, we are use information and communication technology to solve the problem. Application of information and communication technology is to transmit and store the retinal image, teleophthalmology. The retinal image has large file size, 1280 × 1216 pixels of the image have file size 4.45 MB. The image must be compress to facilitate transmission and storage. We use vector quantization technique to compress the image. Based on previous research, the color model that we use is RGB. The aim of this paper is to investigate the relationship between rate (bits per pixel) and distortion (Mean Squared Error) and of retinal color image. This research is part of the teleophthalmology and multimedia medical record roadmap. The next process is conducted the image coding in both color model. Bit rate value is based on the calculation of RGB retinal image entropy. The bit rate that we use are 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5 bit per pixels (bpp), then we do the PSNR calculation on each bit rate. In this paper, the data is obtained only up to 4.5 bpp. The result is PSNR value is increase nonlinearly to the rate, whereas MSE value is decrease nonlinearly to the rate. We will calculate the optimum bit allocation for retinal color image coding and conduct the coding using entropy constrained VQ (ECVQ).**

***Index Terms*—Vector Quantization, Color Retinal Image, generalized Lloyd algorithm, Rate-Distortion.**

I. Introduction

One of the causes of blindness is retinopathy diabetic. The healing of this is constraint on the economic issues and geographic circumstances. Indonesia is an archipelago, spread from Sabang to Merauke. Health facilities and the infrastructure are only concentrated in the big cities, e.g. Jakarta, Bandung, Surabaya, etc. While Indonesia has more rural areas compared with urban areas. Therefore, we offer a solution using information and communication technology (ICT). Application of ICT is to transmit or store the color retinal image, teleophthalmology. This image have a large file size, three channels (RGB) color retinal image (1280 × 1216 pixels) have file size 4.45 MB. To facilitate transmission and storage, the image should be compress.

II. Color Retinal Image Coding

Vector quantization coding is done by using open source software, QCCPack (Quantization, Compression, Library & Coding Utilities), which was developed by James E. Fowler [1]. QCCPack using C programming language and can be run using the command line. We use Linux (Ubuntu 8.10) operating system to run the VQ coding.

Algorithm used in the codebook generation is the Generalized Lloyd Algorithm (GLA), which is, also known as k-means algorithm. To get more variation value of the codebook, we use eight different retinal color images. Then, we crop the image into ¼ of original size. The cropped images are combined into one training image (RGB, 2560 × 1216 pixels, 24 bits). Training image is shown in Figure 1.

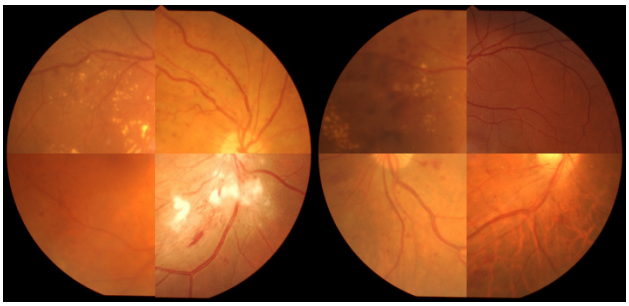

Figure 1. Training image.

The Generalized Lloyd Algorithm [10]:

1. Begin with an initial Codebook C_1. Set m = 1.
2. Given the codebook, C_m, perform the Lloyd Iteration to generate the improved codebook C_{m+1}.
3. Compute the average distortion for C_{m+1}. If it has changed by a small enough amount since the last iteration, stop. Otherwise, set m + 1 → m and go to step 2.

Block diagram of codebook generation is shown in Figure 2. The color component is separate into three components: R component, G component and B component. Then, we use GLA to generate codebook for each color components of the training image. The results are three types of codebook, codebook-R, codebook-G and codebook-B. We generate eight codebook sizes: 16, 64, 256, 1024, 4096, 16,384, 65536 and 262144. Therefore, we have 3 × 8 = 24 codebooks.

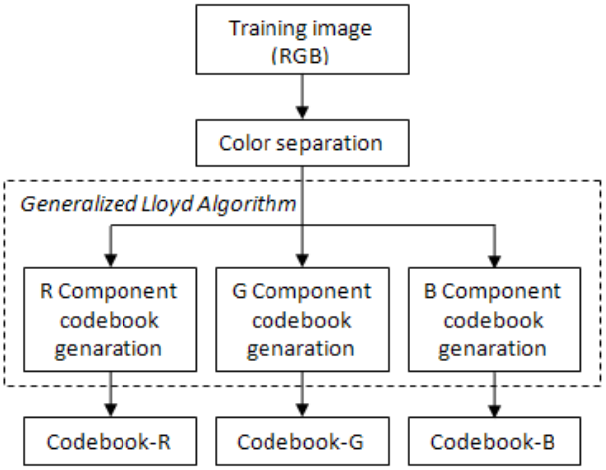

Figure 2. Codebook generation.

We use 30 color retinal images as input image. Then, the input image is separate into each color component: red (R) component, green (G) component, and blue (B) component. The encoding process is done in each channel using its own codebook, codebook-R for the R channel, codebook-G for the G channel, and codebook-B for the B channel. The result is the index file of each component. This index will be stored in a storage media or transmit into another place through communication channel. To get the coded image, the decoding process is done by using the same codebook. Coded color retinal image is obtained by combining the three components again so that we have one color image (RGB). The color retinal image VQ coding scheme is shown in Figure 3.

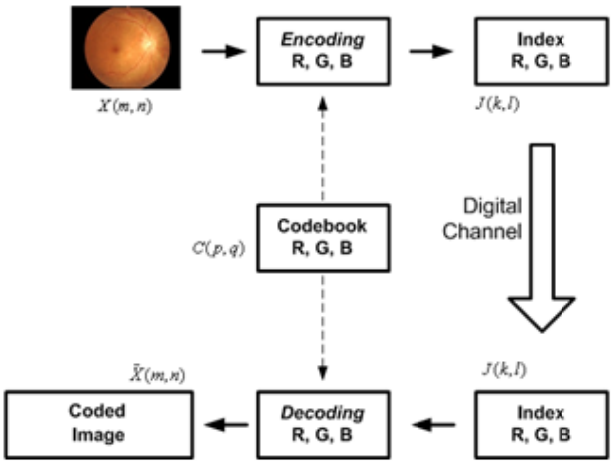

Figure 3. Color retinal image coding scheme.

VQ coding can be used for standalone applications or client-server application. In standalone application, there are two types of files to be stored in a computer, codebook and index files. Whereas, in a client-server application, the codebook is stored on the client, and index file will be sent from server to client through communication channel.

III. RESULTS

The aim of this experiment is to compute the Mean Squared Error (MSE) and Peak Signal to Noise Ration (PSNR) value. We use eight types of codebook size (N): 16, 64, 256, 1024, 4096, 16384, 65536 and 262144. The codeword dimension of the codebook, k = 2 × 2 = 4. In this paper, we will investigate the relationship between the rate and distortion. The rate is defined as:

$$\text{Rate} = \frac{\log_2(N)}{k} \text{ bits per pixel}$$

In addition, the MSE for one component is defined as:

$$MSE = \frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}|f(x,y) - g(x,y)|^2$$

The average MSE for RGB color image is defined as:

$$MSE_{average} = \frac{MSE_R + MSE_G + MSE_B}{3}$$

Table I show the rate and $MSE_{average}$ value. When the rate value is increase, the $MSE_{average}$ value will be decrease. This means that the greater numbers of allocated bits per pixel, the distortion will be decrease. Rate-distortion graph is shown in Figure 4. From the graph, we can see that the relationship between the rate of nonlinear distortion. The Graph is shown in Figure 4 is the same as the rate-distortion theory graphic.

TABLE I
Bits per pixel and MSE Values

Codebook Size (*N*)	Bits per Pixel	$MSE_{average}$
16 (2^4)	1.0	15.82
64 (2^6)	1.5	4.30
256 (2^8)	2.0	2.27
1024 (2^{10})	2.5	1.31
4096 (2^{12})	3.0	0.77
16384 (2^{14})	3.5	0.44
65534 (2^{16})	4.0	0.23
262144 (2^{18})	4.5	0.17

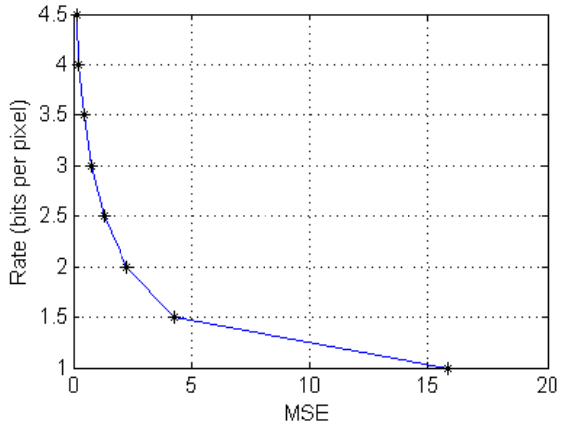

Figure 4. MSE Vs. Rate (bits per pixel).

The PSNR value for RGB color image is defined as:

$$\mathrm{PSNR}_{\mathrm{RGB}} = 20\log\left(\frac{255}{\mathrm{MSE}_{\mathrm{average}}}\right)\ \mathrm{dB}$$

Rate and PSNR values are shown in Table II. The PSNR and rate values graph is shown in Figure 5. From this graph, we can see that the relationship between the rate and distortion is also nonlinear.

TABLE II
Bits per pixel and PSNR Values

Codebook Size (*N*)	**Bits per Pixel**	**PSNR (dB)**
16 (2^4)	1.0	24.34
64 (2^6)	1.5	35.79
256 (2^8)	2.0	41.40
1024 (2^{10})	2.5	46.27
4096 (2^{12})	3.0	51.04
16384 (2^{14})	3.5	56.26
65534 (2^{16})	4.0	62.64
262144 (2^{18})	4.5	65.69

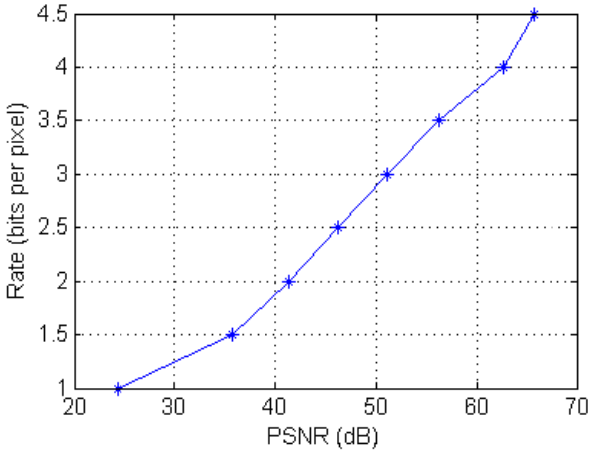

Figure 5. PSNR(dB) Vs. Rate.

The coded images using various kinds of codebooks are shown in Figure 6-13. VQ coding using codebook size, N = 16 produce the worst coded image, the image is not clear and there are so many missing information (the retinal vein appear blurred). The best coded image is using codebook size N = 262144. Subjective and objective assessments give the same results.

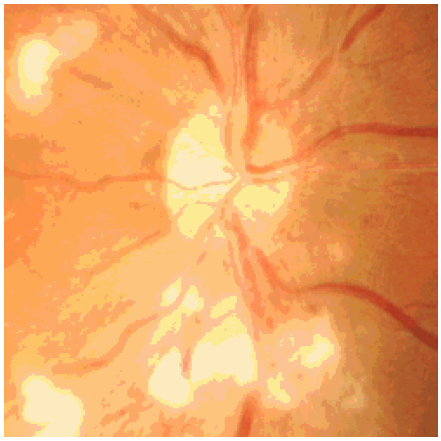

Figure 6. Coded image, N = 16.

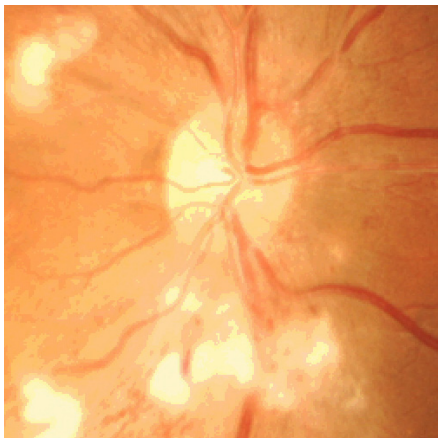

Figure 7. Coded image, N = 64.

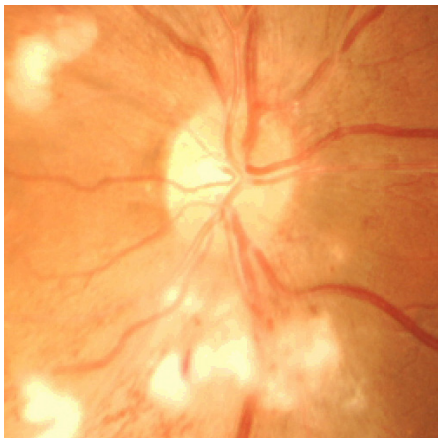

Figure 8. Coded image, N = 256.

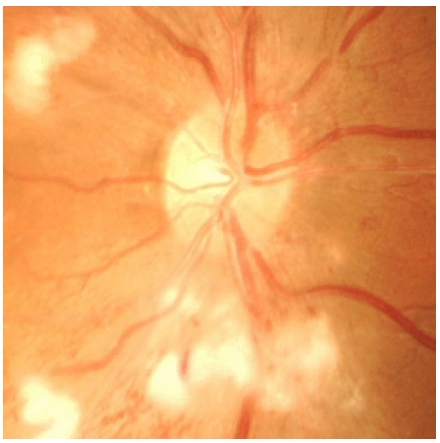

Figure 9. Coded image, N = 1024.

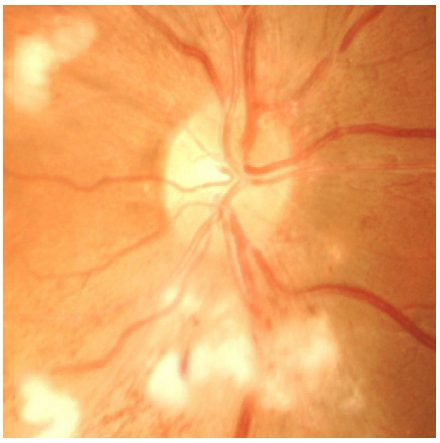

Figure 10. Coded image, N = 4096.

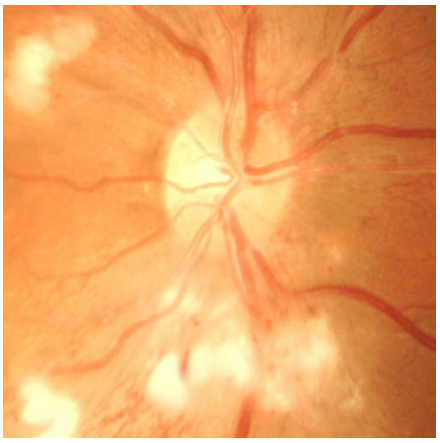

Figure 11. Coded image, N = 16384.

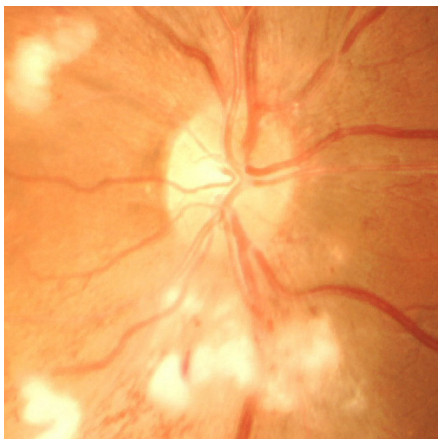

Figure 12. Coded image, N = 65536.

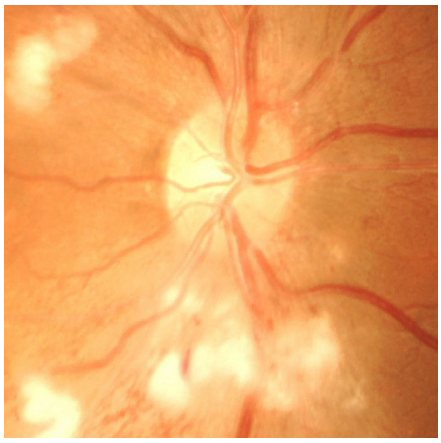

Figure 13. Coded image, N = 262144.

IV. Conclusions & Further Development

Subjective and objective assessments give the same results, VQ coding using codebook size N = 16 give worst coded image and the best coded image is achieved when we use codebook size N = 262144. From these preliminary results, we will continue this research to find the optimum bit allocation of the retinal color image coding using VQ. The number of optimum bit allocation is calculated using rate-distortion theory. The coding will be done using Entropy Constrained VQ (ECVQ).

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Design of an Automated Acid Fast Bacilli (AFB) Identification Module to Support Sputum Smear Microscopic Examination in Tuberculosis Preliminary Case-finding

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***Abstract*— Tuberculosis is one of the leading cause of death worldwide, albeit its preventable and curable nature. Tuberculosis control strategy worldwide aims to reduce the number of cases by accurately identifying the source of disease transmission, i.e. patient with active tuberculosis infection, and focusing the comprehensive curative effort to this part of the community. One of the examination to confirm a tuberculosis case is sputum smear microscopy. This examination involves a series of specimen staining procedure to distinct acid-fast substance from the rest of the specimen and count the number of acid-fast bacilli, which are highly suspected as Mycobacterium tuberculosis, from the overall stained specimen. Sputum smear microscopy is widely adopted for its high level of accuracy and relatively simple and affordable procedure. Problems arises in the mass sputum smear microscopy examination, where every specimen should be stained and observed under the microscope manually to identify and calculate the number of acid fast bacilli. This work presents a digital image processing technique to automate the acid-fast bacilli identification and number calculation. The system is aimed to serve as one of the quality assurance means to support tuberculosis control strategy, especially in Indonesia.**

***Index Terms*—tuberculosis, sputum smear microscopy, acid-fast bacilli, morphological operation**

I. INTRODUCTION

Tuberculosis eradication is one of the focus of the global health initiative today. In 2006, the World Health Organization noted that half of the new cases of Tuberculosis infection (TB) worldwide appeared in 6 Asian countries, that is Bangladesh, China, India, Indonesia, Pakistan, and the Philippines. The rise of new TB cases is associated with poor treatment outcomes and the high rates of Multi-Drug Resistant TB (MDR-TB), brought by uncompleted treatment of Tuberculosis infection at the first place.

In response to this situation, Tuberculosis control strategy worldwide aims to reduce the further spread of this infection, through accurate identification and cure of the most potent sources of infection – pulmonary tuberculosis patients excreting tubercle bacilli. Sputum smear microscopy is a means to investigate the load of tubercle bacilli contained in the salival/mucosal discharge of the suspected patient. It is also used to monitor the progress of infectious patients during treatment, including confirmation of cure.

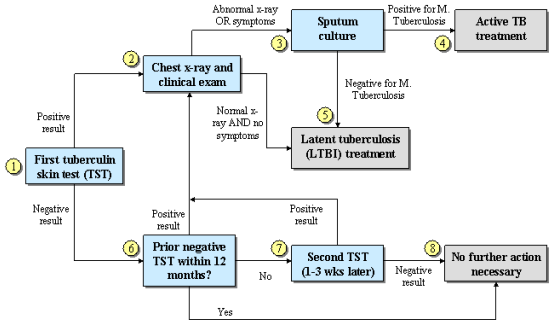

Figure 1. Tuberculosis screening procedure [2]

This paper proposes an image processing algorithm to automate the identification and further calculation of AFB from sputum smear specimen. It consists of segmentation of AFB from the rest of the specimen through a serial of pre-processing and intensity thresholding steps, followed by a morphological operation aimed to count the number of AFB reside in a digital sputum smear image. The proposed algorithm takes digital microscopic images as its input and produces the number, size, and location of every AFB identified. This result is to be validated by the clinical laboratory operator, prior to the report as an official sputum smear microscopy examination result.

The goal of this system is to help reduce the amount of time required to perform a sputum smear microscopy examination and to increase the accuracy of AFB identification and calculation. It is expected that the proposed system could contribute to the quality assurance of Tuberculosis case-finding and infection treatment, thus refine the result of Tuberculosis control strategy.

II. SPUTUM SMEAR MICROSCOPY

Sputum smear microscopy is the front-end action of Tuberculosis case-finding and control strategy. Studies have found that this procedure is more reliable than any other screening methods in confirming TB cases, even when compared to the more sophisticated examinations, such as chest X-ray exam and tuberculin test. It also explicitly indicate the level of TB infection in patients, thus is used not only to confirm TB cases but also to observe the progression of TB therapy regiment.

Sputum smear microscopy for TB case identification consists of two main steps, i.e. the specimen preparation according to Ziehl-Niessen staining procedure, and the microscopic observation to identify and calculate the number of acid-fast bacilli/Mycobacterium tuberculosis suspect. The Ziehl-Niessen staining procedure used in this work is explained in detail on [3], while the microscopic observation standard operating procedure is explained in [4].

Figure 2. Sputum smear microscopy specimen prepared with Ziehl-Niessen staining procedure

Through a serial of steps of smear preparation, tubercle bacilli can be distinguished microscopically from the rest of the sputum specimen from its acid-fast nature. Acid-fast bacilli (AFB) will appear as red-colored rods, while the non-acid-fast counterpart of the specimen will appear blue-stained. A positive case of Tuberculosis infection is confirmed if within a prepared sputum smear specimen there are at least 10 AFB exists in each of the 100 fields of view, observed under the microscopic magnification of 1000x.

Practical problems arise in the manual identification and calculation of AFB from sputum smear specimen. The first problem concerns with the mechanism to make sure that adequate area of the specimen has been visually-scanned by the operator under the microscope without massive Region of Interest (RoI) overlap; a condition that may lead to either AFB multiple counting or insufficient AFB identification from a specimen. Altough there has been rules that arrange how field of view scanning should be done in order to obtain sufficient AFB observation exposure, still there are problems in doing it for large-scale mass examination.

The second problem concerns with the difficulties of identifying the AFB, solely based on a single operator visual sight of a microscopic field of view. AFB may be located in the free, clear area of the specimen, where it can be identified straightforwardly, or intertwine within the granular texture of the blue-stained mucus, where its appearance could be skipped easily.

The second problem concerns with the note-taking of the number of AFB once identified. Manual note-taking are naturally error-prone, especially in a condition where one operator is obliged to do up to 40 examinations each day, which is equivalent to daily observation of 4000 microscopic fields of view. This is where an automated procedure may provide help, especially in the aspect of quality assurance.

III. AUTOMATED AFB IDENTIFICATION MODULE

The proposed automated AFB identification module consists of several submodules, i.e. the image acquisition, image preprocessing, AFB candidates segmentation, AFB classification, and AFB calculation submodule.

A. Image acquisition

The image acquisition module comprises of an integrated hardware and software system to capture series of digital images of each microscopic field of view of the specimen. The hardware configuration is required to automate the movement of the microscope specimen table x-axis and y-axis translational arms, while the software is required to automate and synchronize the capture timing of the digital camera mounted to the ocular end of the microscope, with respect to the automated and evenly-spaced translation scan of the specimen.

The hardware configuration is implemented by two micromotors, which automate the translational movement of the specimen plate x-axis and y-axis shifting shafts respectively. The motor configuration should be able to manage the variability in smear area of the specimen, a measure which is crucial in accordance to the determination of translational steps of the micromotors. In any sputum smear examination for Tuberculosis, it is required to obtain 100 microscopic fields of view of identical area out of the specimen. Therefore, the micromotors steps should be adjustable and adaptive.

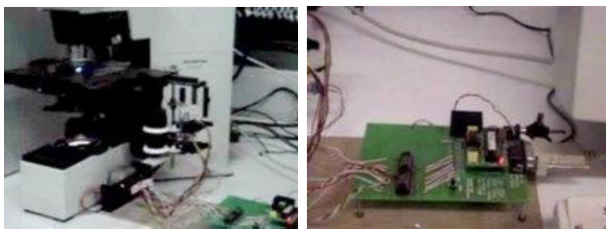

Figure 3. Hardware configuration of the micromotor pair

We plan to request a manual input from the operator regarding the spatial coordinate of the outer bounding box of the observed smear. The hardware controller program will then process this input to find the proper steps of the

micromotor translational movement. The exactly same program will also have to control the onset of the digital camera capture action, and manage to have the series of the captured image sent to the computer for further processing.

B. Image Pre-processing

Image preprocessing steps is required to handle the variability of sputum smear digital image intensity, due to staining and lighting factors. Colour is a sensitive feature in the AFB identification, since acid-fast and non-acid-fast substance is visually confirmed solely from its colour. According to the staining procedure, reddish substance is more likely to be acidic than the bluish substance. A different tone of red and blue indicate different level of acidic nature of the substance. One distinct level of acidic nature may not be appropriate to support a confirmation of an indeed red-stained object as Mycobacterium tuberculosis.

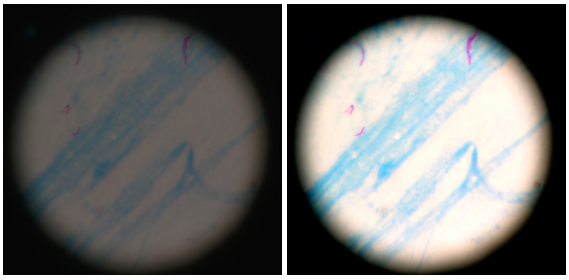

Figure 4. Digital sputum smear image before (left) and after (right) image preprocessing

Lighting factor, i.e. the amount of light that interfere with the digital image acquisition process, is also of a significant importance. Appropriate staining may become visually inadequate under improper lighting. Therefore we propose to attach a direct permanent white light-source to the microscope, to simplify the problem of tone variability due to lighting factors.

Our preprocessing steps consists of image contrast enhancement and normalization using Contrast-limited Adaptive Histogram Equalization (CLAHE) algorithm. The algorithm basically tries to create an even distribution of image intensity on a specific range of contrast band, as determined by the user reference. This method prevent the overwashed appearance of the enhanced image. By specifying a uniform span of contrast, this algorithm also provide a more standardized result within a series of enhanced image.

C. AFB Candidates Segmentation

AFB candidate segmentation basically perform a colour-based thresholding to obtain a preliminary sets of AFB candidates. The colour-based thresholding step is done in the HSV colour space, in the Hue and Saturation band. The threshold for Hue band is fixed on a specific value, according to the appropriate reddish tone of the valid AFB, while the threshold for Saturation band is set adaptively according to the tone of the image. Defining the threshold in HSV color space makes the segmentation procedure become less vulnerable to contrast variability.

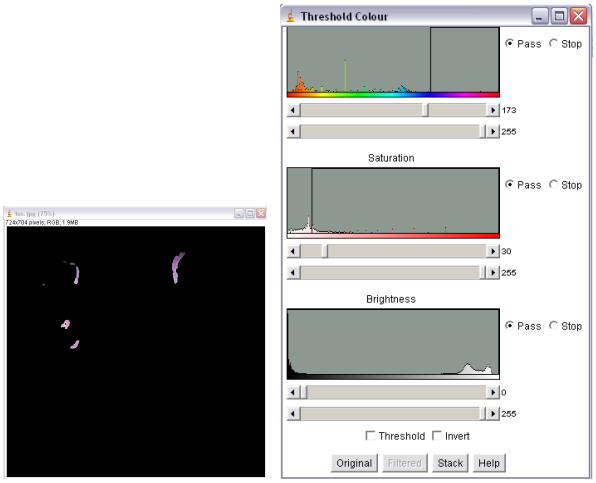

Figure 5. Colour-based thresholding result in Hue and Saturation component

D. AFB Classification

The AFB classification step is aimed to filter the AFB from the rest of the acid-fast substance. It is primarily a morphological operation guided by a set of rules. The morphological operation steps is conducted to filter the AFB from the rest of the acid fast substance. AFB has the characteristic shape of rod-like structure, in the range of specific length (within 2 µm). A morphological operation with the basic element of rod is implemented, comprises of series of opening and closing operations.

However, the existing morphological procedure is not able to handle cases of grouped AFB, where multiple AFB reside in one locus of the specimen area without obvious boundary. We plan to establish a set of rules to help guiding the classification criterion, based on size, ratio of medial axis, and area.

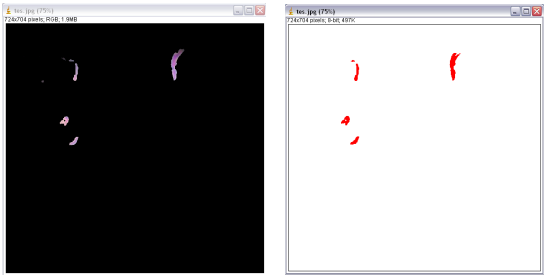

Figure 6. AFB classification result (right) for the image given in the left

E. AFB Calculation

AFB Calculation submodule comprises of a register which value is updated everytime an AFB candidate is confirmed by the AFB classification module. This register

also saves the corresponding area and shape feature of each identified object. Once the AFB calculation for a field of view is completed, the submodule will send an acknowledgement to the image acquisition submodule to conduct next translation along the x and y axis.

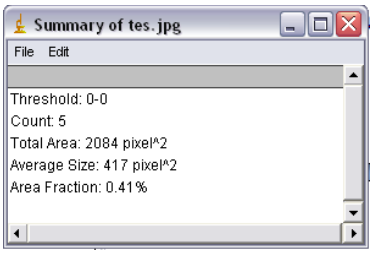

Figure 7. Example of an automated AFB identification result for one field of view

IV. Conclusions & Further Works

Preliminary evaluation has shown encouraging result for the case of sputum smear specimen which is properly stained and prepared. The existing prototype still has some obstacles in decision-making for grouped AFB, but has provide better result for identification of AFBs which are intertwined within the bluish granularity of the saliva/mucosal discharge after staining.

The major improvement provided by this automated AFB identification system up to current is its availability to produce a visually uniform image appearance within multiple sets of data, taken in different times with different lighting condition and different image acquisition modality. This provide a very significant support for sputum smear microscopy longitudinal observation, directed to comprehensive observation of TB therapy regiment.

Further works need to be addressed in the area of rules establishment for AFB classification. More study should be conducted in statiscally finding the characteristics of average area and shape features of AFB, as a basic of rule definition.

V. Acknowledgment

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Text Classification Using Support Vector Machine for Webmining Based Spatio Temporal Analysis of the Spread of Tropical Diseases

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***Abstract*— Tropical diseases such as Dengue Fever, Malaria and Bird Flu have become epidemic and particular problem in Indonesia. As the number of such cases increases, the availability of information regarding these diseases is important in order to help experts in taking proper actions. Meanwhile, web mining is one of significant technologies applied to extract information from the web. By using web mining, spatio-temporal information of tropical diseases will be collected from the internet. The objective of this study is to develop text classification system using Support Vector Machine to classify the Indonesian textual information on the Web. Proper classification for every downloaded text document helps the information extraction system to construct spatio-temporal analysis so then can be visualized. While Support Vector Machine has shown its capabilities for classifying text since it works well in high-dimensional data and avoids the curse of dimensionality problem.**

***Index Terms*—text classification, support vector machine, web mining, tropical diseases.**

I. Introduction

Tropical diseases such as Dengue Fever, Malaria and Bird Flu have become epidemic and particular problem in Indonesia. They spread rapidly from big cities to remote areas and anyone can be the victim. As the number of such cases increases, the availability of information regarding these diseases is important in order to help experts in taking proper actions and predict the pattern of the disease itself. Meanwhile, web mining has been broadly acknowledged as one of data mining techniques aims to gain information from data collected in the internet [3]. By using web mining, spatio-temporal information of tropical diseases will be collected from the internet.

This study has objective in developing text classification system which classified the Indonesian textual information on the internet. As part of datamining research project conducted in BPPTeknologi (Agency for the Assessment & Application of Technology) [8], this study plays important role in web mining system since it has significant contribution in making spatio temporal analysis. Proper categorization for every Indonesian textual document helps the information extraction system to construct spatio temporal analysis so then can be visualized.

Several studies have been conducted regarding text categorization. Experiment on web document categorization have been conducted by Goevert in [4]. The experiment applied based on probabilistic description-oriented representation of web documents and k-nearest neighbor classifier. Apte, Damerau and Weiss stated in [1] that machine generated decision rules able to compete with human performance in text categorization. In [7] Lewis and Ringuette evaluated the performance of text categorization using Bayesian classifier and decision tree learning algorithm, whereas Joachims proved that better result can be achieved by using Support Vector Machines [6]. Joachims also shows the statistical model of text classification in [5].

After introduction, section 2 will briefly explain about text categorization and Support Vector Machine. Methodology will be elaborated in section 3 while section 4 reports the result of the experiment.

II. Proposed Method

A. Text Categorization

Text categorization aims in classifying documents into predetermined fixed categories [6]. Transforming documents into an appropriate representation for the learning algorithm and the classification task is the first step in text categorization. Each distinct word w_i in documents which occurs for certain number of times is corresponded to a feature. The word considered as features if it appears in the training set at least 3 times and it is not *stop-word* (like "and", "or", etc). This model of representation leads to thousands of dimension features spaces which needs feature subset selection to improve

generalization accuracy and to avoid *overfitting*.

Text classification has 5 properties [5]. Firstly, it has high-dimensional feature space. If each word in the training documents considered as feature space, then there will be more than 50,000 attributes in a few thousand training example. The second property is that document has sparse vectors. If each document only contains a small quantity of distinct word, this means that document vector are very sparse. Third, text has heterogeneous use of terms and fourth it also has high level of redundancy. Between each document, there are still possibilities of its document vectors to overlap each other. In this case, the word in particular document are may be contained in other documents identified as another distinct category. Last property is frequency distribution of words and Zipf's law. According to Zipf's law, there is small number of words that occurs very frequently whereas most word occurs infrequently. Moreover, Zipf's law says that if one ranks words by their term frequency, the r-th most frequent word appears roughly 1/r times the term frequency of the most frequent words.

B.Support Vector Machine

Support Vector Machine (SVM) [9] has strategy to find the best hyperplane on input space called the structural minimization principle from statistical learning theory. Structural Risk Minimization means obtaining hypothesis $h(\vec{x})=\{\vec{w}\cdot\vec{x}+b\}$ described by a weight vector $\vec{w}$ and a threshold *b*, such that the lowest true error can be guaranteed, where true error of *h* is the probability that *h* will make an error on randomly selected examples.

Basically SVM is a linear classifier. It finds the hyperplane with maximum Euclidean distance to the closest training examples. The best hyperplane can be calculated with maximizing the margin $\delta=\frac{1}{\|\vec{w}\|}$.

$$\min_{\vec{w}} \tau(w)=\frac{1}{2}\|\vec{w}\|^2 \quad (1)$$

$$\forall_{i=1}^{n}: y_i(\vec{x}_i\cdot\vec{w}+b)\geqslant 1 \quad (2)$$

$$L(\vec{w},b,\alpha)=\frac{1}{2}\|\vec{w}\|^2-\sum_{i=1}^{l}\alpha_i(y_i((\vec{x}_i\cdot\vec{w}+b)-1)) \quad (3)$$

Obtaining maximum margin can be formulized in constraint (1) subject to (2) as Quadratic Programming (QP) problem. Constraint (6) is used to solve the problem through calculating its optimized value. The optimal value can be found when gradient L = 0, thus constraint (6) can be modified like the following constraint.

$$\sum_{i=1}^{l}\alpha_i-\frac{1}{2}\sum_{i,j=1}^{l}\alpha_i\alpha_j y_i y_j \vec{x}_i\vec{x}_i \quad (4)$$

$$\alpha_i\geqslant 0(i=1,2,\ldots,l)\sum_{i=1}^{l}\alpha_i y_i=0 \quad (5)$$

Hence can be inferred that support vectors are α_i with positive value.

III. Model, Analysis and Design

A. Bahasa Indonesia

Bahasa Indonesia is used as national language in Indonesia. It has the root from Melayu language and has been modernized as its development through time. Bahasa Indonesia, or widely known as Bahasa, has its standard for writing and speaking which written in Common Guide of Indonesian Language spelling (*Pedoman Umum Ejaan Bahasa Indonesia yang Disempurnakan*) [11]. The guide explains usage of letter, punctuation, capital and italic letter, also writing of words as well as adaptive words.

In Bahasa, suffixes can be found almost in every word. Suffix is used to make derivation of word and can have different meaning depend on what and how the suffix is positioned. Suffix in Bahasa is divided into three types [11]; simple suffix, combined suffix and specific suffix. Adding suffix into word can alter the structure of the word itself [11]. For instance, word having the first letter *s*, if combined with prefix *me-* will modify the letter *s* with *ny* resulting *meny-*.

Moreover, adaptive word is foreign word that has been assimilated into Bahasa and widely acknowledged by Indonesian citizen. The word usually comes from Arabic, Sansekerta, Portuguese, Chinese Hokkien and Dutch. Adaptive word is used in daily conversation however misconception also often occurs. The most common mistake happen in writing since the standard one is not socialized well, thus make it inconsistent.

B. Tokenization

The first thing in processing documents is to fracture the stream of characters into words or tokens, often called tokenization [10]. Tokenization is complicated task for computer program since certain characters can be found as token delimiters. Delimiters are the character space, tab and newline while the characters ( ) < > ! ? ” are sometimes considered delimiters and may not be delimiters depend on the environment.

In this study, tokenization is generally done by breaking sentence into tokens and omitting the non-alphabet characters including numbers. All capital letters are converted into lower case so that tokens can be alphabetically ordered and treated equally.

C. Lemmatization

Lemmatization, often referred as stemming, is a task in converting collected tokens to a standard form. The purpose of lemmatization is to trim down the number of distinct type in a text corpus and increase the occurrences of some individual types [10].

Lemmatization, in this study, is done manually. The reasons are Bahasa has numerous rules and words in adaptive form may be written differently in each article. As for the last reason, computer program will treat the

particular words distinctively. Therefore, stemming is performed by giving index to words that have the same root.

The process of lemmatization is initiated with eliminating redundant words which occurs in each category (remaining-menyisakan) words to be occurred in one or at most two categories only. The words which are eliminated also include one's name, place and foreign words usage.

The next step is labeling words with number, or indexing. Words having same root are labeled with the same number. Indexing intents to reach a root form with no inflectional or derivational prefixes and suffixes. By indexing number of distinct words is reduced from over 11,000 to 3713 distinct words.

IV. Experiment

The experiment compares performance of SVM using polynomial kernel with 3 other conventional methods which are Naïve Bayes classifier, k-Nearest Neighbor classifier, and C4.5 Decision Tree.

The experiment is conducted on small scale of datasets with 3713 features and 360 instances. The instances are splited into 240 instances as training evaluation and 120 instances to test the method performance.

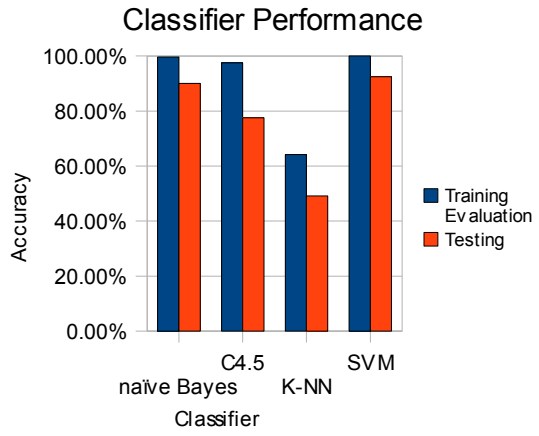

Figure 1. Classifier Performance

The above graph shows performance of each method in percent. SVM performs the best among other methods with 92.5% of accuracy. The SVM kernel used is polynomial with C = 250007 and E = 1. Meanwhile nearest neighbor classifier surprisingly performs the worst among other conventional methods with only 49.17% of accuracy using k = 11. The result opposes this [6] which stated that k-NN performed the best among other conventional methods. Naïve Bayes and C4.5 obtain 90% and 77.5% of accuracy respectively.

	Economy	Def & Sec	Education	Health	Sports	Politics
Economy	**17**	0	0	0	2	1
Def & Sec	1	**17**	0	0	1	1
Education	0	0	**19**	0	1	0
Health	0	0	0	**20**	0	0
Sports	0	0	0	0	**20**	0
Politics	0	1	1	0	0	**18**

Figure 2. SVM Confusion Matrix

Confusion matrix also shows that words in class label economy, defense & security and politics have similarities since misclassification mostly occurs on the respective class label. However, class label health and sports able to successively classify all test articles.

The outstanding performance of SVM shows that SVM still have better performance in classifying datasets with high dimensional features. This matches the characteristic of SVM which able to generalize well in high dimensional features and also omit the necessity for feature selection.

V. Summary

This paper develops Indonesia textual classification system for web mining based spatio temporal analysis of the spread of tropical diseases. The system is intended to classify downloaded Indonesia textual document from the Internet so then the information can be extracted.

The experiment result shows that SVM achieves good performance on Indonesian text classification similar to what it shows on English text classification. SVMs have the capability to generalize well in high dimensional feature spaces so that it requires no feature selection. Besides, SVMs are robust, outperforming other conventional methods in all experiments. Surprising result comes from naïve Bayes which shows good performance among other conventional methods. Language structure plays only minor role in this experiment since there is no difference on SVM performance when it is applied with Indonesia textual documents.

Finally, the experiment is still on process of optimizing. Future works will focus on increasing the datasets and exploring more on Indonesia language structure itself. The lookup table may be substituted with complete stemming algorithm in order to specify the words and distinguish each class label well making the prediction more accurate.

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GQM Paradigm at Measure of System Application Reporting Online of Number Patients for Endemy Disease in Town Semarang Bases on GIS

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***Abstract*—Nowadays, many diseases have been discovered. Health problem is becoming to expand. These Diseases spreading becomes global threat, such as Severe Acute Respiratory Syndrome, HIV-AIDS, and Avian Influenza. While other common acute diseases such as Dengue Hemorrhagic Fever, Polio, Diarrhea, and infant's malnutrition still becomes thread. This incident happens because of many reasons, one of them is less responsiveness and low prevention from the health department. Therefore, excellent quality of health management is needed to decrease the endemic diseases. Reporting System of Healthcare Management Using Web Based-Geographical Information System can be implemented to increase quality of service in Health Department in Semarang. This study focuses on managing the spreading of diseases in Semarang city by designing web based-Geographical Information System. The system that identifies the endemic and variant diseases will help the health department to react at the time endemic disease spreading extensively. On the other hand, it will recognize diseases spreading pattern in specific area. By viewing the location of the spreading, they can isolate the continuity of the endemic diseases. Therefore, the health department will have a quick reaction in order to prevent the diseases become widely. The manual method that has been used at this time is ineffective, comparing with the new online information system that will increase efficiency in reporting system. Finally, This Geographic Information System will increase the quality of healthcare management. This document offers a concise introduction to the Goal Question Metric Paradigm (GQM Paradigm), and surveys research on applying and extending the GQM Paradigm. We describe the GQM Paradigm in terms of its basic principles, techniques for structuring GQM-related documents, and methods for performing tasks of planning and implementing a measurement program based on GQM. We also survey prototype software tools that support applying the GQM Paradigm in various ways and at measurement of GQM paradigm done to increase grade from a system and applied to make this software becomes Decision maker system a. An annotated bibliography lists sources that document experience gained while using the GQM. Paradigm and offer in–dept information about GQM Paradidgm.**

***Keywords*—Geographical Information System, web based reporting system, endemic diseases, health department.**

I. INTRODUCTION

Element of Key from every engineering process is measurement. Measurement is applied to be more comprehends attribute from model which we create. At part of this we apply a measurement by using GQM paradigm doing approach to reach a purpose of measurement which we wish. But measurement applied to show quality of product engineered or system which we are similar also for the shake of taking care of grade from system which we are create in line with which we will that is a system having quality of height and becomes a fundamental which we would use at the time of we to make a software at the time of to the fore his(its. And in the application of measurement with GQM paradigm done at application reporting online of number patients for endemy disease in town semarang bases on GIS with aim to that this system becomes is better and measurement result to become an expansion basis from the application of this and develops the application of this becomes a Decision Maker System.

And in this measurement besides applied information which in getting through kuisioner circularized and information which in taking away from town Public Health Service Semarang. in this more measurement focussed at measurement of dri consumer viewpoint, administrator and observer.

Whats is application reporting online of number patients for endemy disease in town semarang bases on GIS ? Basically usage of this system applied for reporting of disease type and many patients from all the puskesmas in town semarang which visible of coordinate from puskemas being based on web. Reporting done haves the character of online of all information which in yielding comes from the puskesmas. At the application of this level of user is divided by 2 that is administrator and user. administrator data input can at the database and user only did reporting at administrator and cannot change the data. In application of all inscribed coordinates at database GIS earns in access and visible of residing in data in it. At level of consumer can see all data of the system and coordinate from puskesmas. And information yielded that is level of the patient and disease can become a reference material in decision making from on duty Kesehatan Kota

Semarang in decision making.

Goal/Question/metrics (GQM) Paradigm

Goal/Question/Metric (GQM) Paradigm is a mechanism providing a skeleton to develop a metriks. as mechanism to compile characterization, planning, construction, analysis, Iesson and feedback task. GQM paradigm has been developed for all study type, especially learning related to improvement of output. Paradigm doesn't yield specific goal but rather a skeleton to express goal and selects into question to provide a specifications for data needs to help answers goals. GQM Paradgm divided 3 step that is :

1. Establishing Goals
2. Generating Questions
3. Specifying the Measures

At GQM paradigm there is 3 fruit of step which one another is each other respected. Sequence is upper showing process done beforehand

Establishing Goals

First Step from gauging of GQM paradigm is yield a set of goal to base on requirement of organization. determines does you wish to improve. This provides a skeleton to determine yes or not of you has fulfilled does you do. determines does you wish to improve. This provides a skeleton to determine yes or not of you has fulfilled does you do. And in making of other same one goal is each other related and we may not make a other same one goal is each other overlap or makes a goals which dicey of Gol is depicted in relation to object, purpose, focus, viewpoint and area using common templates like:

1. Object : Product or process is being measured, example: tests phase or an end result subsystems.
2. Purpose : Fundamental motivation from gols, which is fundamental question why you makes this, for better understanding, better tuition, control, approximation, improvement
3. Focus : Definition from purpose, what is you will from this, for reliability, business, error, precision, metrics,efektivity.
4. Viewpoint : Perspective of goal (whom viewpoint), from the angle of approach: project manager, promoter, brasque, designs shift.
5. environment : environmental consisted of various factor following: factor process, factor people - people, factor masalah,metode, supporter equipments, definition etc.

And under this is example from an application a translation from a goals:

Fig.1. Five phases of GQM Goals

And after goals made in like five divisions explained to which one other same is each other related and becomes reference in question making or next step from measurement with paradigm explained at next chapter.

Generating Questions

Second step from gauging of GQM paradigm is obtain a set of question purpose, of question is to measure the goal fufilled and can conclude is a goal reached. This requires interpretation about ill defined terminology in expansion environment context. Question is classified with processing or related to product and provides feedback from the qualified perspective. Question related to depicts product and evaluation with reference to certain grade (like: reliability, satisfaction of consumer , process , power source or environment). Question related to processing covers quality of usage , district usage , effort for usage , effect usage and feedback from usage and in making from question set usually has one or more keyword is coming from goals focus which will become a question making basis referring to usage of metrics what applied in this measurement. specifies a set metrics which will be used will be explained at next chapter.

Specifying the Measures

And at last step from measurement with GQM paradigm is develop a set of metriks and distribution of supply of information needed to answers question. In stepping this, data which actual needed to answers question recognized attributed to and each question. When data item is recognized hence having to comprehended as valid data because with reference to accuracy and how well placement of specific question. metrics must have the character of objective, subjective, and must have interpretation indicator that is standard metrics what specified for improvement of higher product, in general metrics single doesn't answer question so required a combination trap from metrics - metrics which is each other related.

When field goal is depicted, question obtained and metrics is developed, reference made indication to the relation of they. First reference is from field goal which will generate question, then question is formed the last

step of measurement with GQM paradigm is metrics. This permits promoter to make metrics applied to answer question and guarantee for each field goal there are question multiple and more than a metrics and a reference summary from field goal can be developed like this drawing:

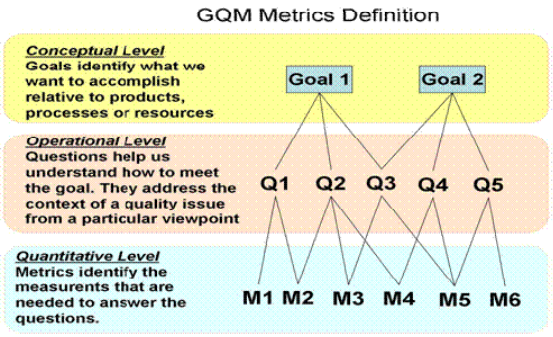

Fig.2. GQM definition Metriks

Case Study With GQM Paradigm

In this paper we have a segment that further discussion on the GQM paradigm (Goals / Question / Paradigm Metriks) that tend to the measurement of a software or an organization that has been running with the aim of measurement, the improvement made at the time or for its future . In this section we discuss how to implement the GQM paradigm Applications Online Reporting System for the number of patients endemi Diseases in the city of Semarang-based GIS. In the description above there is a three step in the measurement will be reviewed as the following:

II. ESTABLISHING GOALS.

The first phase of the GQM paradigm is to establish a goal related to a basic goal that has been described in the basic theory. At this stage, the basic foundation is very important that will be the basis of a measurement that is in the following:

1. Object (what we measure) in this case the Applications Online Reporting System for the number of patients endemi Diseases in the city of Semarang-based GIS
2. The purpose (why we measure the object) in this case, namely the improvement of the SIA system for use on the user or Administrator.
3. Focus (Limitation of goals) in this case is about Aksesbility, reliability, accuracy, security and comfort, in this case is the most important in the formation of a goal
4. Point of view : in this perspective is a person or agency who knows about this system are that it: User and supervisor
5. Environment: all factors that affect the system is either in or outside

Goal Focus	
G – 1	Accessibilty
G – 2	Comfortable
G – 3	Security
G – 4	Accuracy
G – 5	Reliability

Fig.3. Goal Focus of Case Study

At the time we know what our goals and our goal is also to limit the use of focus in this case study there are five keywords that can help us make the next step of a measurement and GQM Paradigm and keywords will be explained as follows:

1. Accessibilty: the use and the level where the user or users can use this program. < G – 1 >
2. Comfortable : Users can also called the Friendly Level where a program can make use of satisfaction in the program. < G – 2 >
3. Security: a mechanism to control the system or to protect the program and data. < G – 3 >
4. Accuracy: The level where the program meet the specification and meet the objectives of the mission system and the target customers. < G – 4 >
5. Reliability: The level where the program monitors its own operation and determine the error that occurred and the ability to improve it. < G – 5 >

And in the goal of making akan mapped in a flow diagram that indicates the goals - goals of making it in the next step of the GQM Paradgm goals - goals that made symbolized with (G - (N)). N is the number indicated on the goal that mapped.

III. GENERATING QUESTIONS.

And the second step is when we know what we Goals then the next step of the GQM paradigm is a measurement of how we follow-up goals by making the above questions refer to the goals aimed at the fulfillment of the goal of measurement applications Online Reporting System for the number of patients in disease endemi GIS-based city of Semarang is there are some questions that may help the fulfillment of goals based on the keywords that are given focus on goals that are described as follows:

1. How the access level of the system ?
   < Accessibilty, Security > (Q – 1)
2. How to improve the quality of the user and administrator ?
   < Comfortable, Reliability> (Q – 2)
3. Whether data validation on this system is real time?
   < Accessibilty, Reliability, Security > (Q – 3)

4. Institutions which can perform data validation and the level of interest ?
   < Accessibilty, Comfortable, Accuracy> (Q – 4)
5. What should be done after validation of data met?
   < Accessibilty, Accuracy, Security > (Q – 5)
6. Institutions which can make decisions about the data that have ?
   < Accessibilty, Accuracy> (Q – 6)
7. What the negative value of the system ?
   < Comfortable, Accuracy, Reliability> (Q – 7)
8. What makes this system is not popular ?
   < Comfortable, Accuracy> (Q – 8)
9. Which part of the system should be improved?
   < Comfortable, Accuracy> (Q – 9)
10. What the basic goal of this system?
    < Comfortable, Accuracy> (Q – 10)
11. How often users access the system?
    < Accessibilty, Accuracy, Security > (Q – 11)
12. What factors resistor of the system ?
    < Accuracy, Reliability > (Q – 12)

From the question above we can see almost all refer to the goals of this question and if we find the answer then we can conclude whether the Application Reporting System The number of patients for the disease in the city of Semarang endemi based GIS has been reached and goals of the above questions we can make a bait back to the initial purpose of the Online Application System for Reporting Julah disease patients in the city of Semarang endemi based GIS and also as a step in determining what metrics will be used yng next step is a measurement of the GQM paradigm.

And the flow diagram of making the question or questions arising from the follow-up goals in the picture with a (Q - (question / questions to how) and after we get our Goals and also determine the question so we can see the relationship between goals and the question was describe in figure 4 as the image using the symbol described above.

	G - 1	G - 2	G - 3	G - 4	G - 5
Q - 1	■		■		
Q – 2		■			■
Q – 3	■		■		■
Q – 4	■	■		■	
Q – 5	■			■	■
Q – 6	■			■	
Q – 7	■			■	■
Q – 8		■		■	
Q – 9		■		■	
Q – 10		■		■	
Q – 11	■		■	■	
Q – 12				■	■

Fig.4. Goals and Relationships question
(Goals => Question)

IV. SPECIFYING THE MEASURES

In this section after we know what Goals and measurements and create questions that refer to the goals and in making a measurement after the question what we do is based on the goals then the next step is to create a specific metrics that aim to answer the questions that are derived from the relation between the goal and the question by using data that is taken based on the correspondent that there is to know how to answer questions with existing data and measurements made mertriks and in this we solve a problem with the one - at a question and provide solutions that are used metrics.

1. How the access level of the system?
   Basically, given a user name can only be used for any member who has been registered. So the public can not see the development of a disease in the city semarang
2. How to improve the quality of the user and administrator?
   Use of this system will be more advanced with the publication and the training to use this system
3. Whether data validation on this system is real time? True.
4. Institutions which can perform data validation and the level of interest?
   Health department and Puskesmas
5. What should be done after validation of data met?
   Basically the data is used as an entry-level health indicators in semarang city, so the data used for the follow-up of a case
6. Institutions which can make decisions about the data that have?
   Health department
7. What the negative value of the system?
   - Less interactive
   - there is no notification when a new data Incoming
   - lack of communication between the user and administrator
   - the output does not look as reporting the results manually
8. What makes this system is not popular ?
   - The lack of a public user
   - the absence of interesting information that the user
   - lack of health services that attract service users
   - look less appearance
   - lack of interest to the community health centers
9. Which part of the system should be improved ?
   - appearance
   - update information of interest
   - security
   - the addition of public user
   - adding more interactive features
10. What the basic goal of this system ?

- Facilitate the distribution of health information data.
- as decision makers determine when a case occurs endemic disease

11. How often users access the system ?
    - less interesting
    - not interactive
12. What factors resistor of the system ?
    - Users who do not actively
    - level of trust in the community health centers
    - information does not update
    - the use of information that is not the maximum

Explanation on the use of metrics over the metrics that are appropriate for use are as follows:

1. Objective < M -1 >
   Measurement based on the basic needs of the system we have this measure as:
   - Measurement of handling and user accounts that have
   - Measurement administrators who take the role of all aspects related to the settings from the system basis
   - Measurements and additional features - a more interactive features such as: health services, information - information of interest, there is a forum that discusses all issues that are part of this system, the reporting of a continu-owned administrator who became a real proof of the system is , the notification on every incoming data to the system, the special marks on the cases that get to be endemic
   - Hardware that supports the creation of this system
2. Subjective < M -1 >
   Measurements made to all things - things that are in addition to the basic needs of the system is usually the dominant factor this place by the user factor
   - Measurement of the level of mastery in the admin user and apply this system
   - Measurement of the role / each active user in the use of this system
   - Measurement of the division of labor that is done to place responsibility of each user level
   - Measurement level administrators in the handling of each of the problems that have
3. Security < M -1 >
   In this section we look at when the system is associated with the measurement that is objective, but in this regard, improvements security system to be an important factor. Thus security becomes a chapter of measurement itself.
   - Measuring the level of system security
   - Measurement of the level of a given user
   - Security Measurement validation of incoming data
4. Environment < M -1 >
   In the measurement of this section is a factor which does not participate in the objective or subjective factor is the environmental factor which must be outside are also in the measurements.
   - Measurement of the participation of the community against the disease endemic
   - Measuring the level of community trust to a health clinic.
   - Measurement of the level of mastery of all technology users that are connected with this system

And metrics on the above explanation is made when a flow diagram with the metrics disimbolkan M - (how to metric). And also if we know the metrics that are based on the question of the relationship we can both see the relationship both in the picture 5 by using a symbol that has been described above.

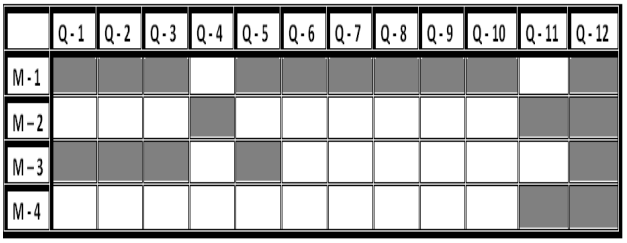

Fig.5. Goals and Relationships question
(Question => Metriks)

And the related between goal and question are as follows: Relationship of the three then a scheme that occurred can be seen in the Fig 6 of the third relationship mengambarkan (Goals => Question => Metriks)

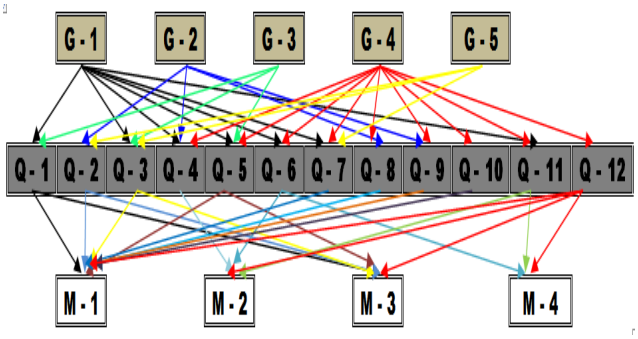

Fig.6. Measurement scheme on the GQM paradigm case study

V. CONCLUSION

After mesuring the method GQM paradigm, the author can take a conclusion: The Need GQM measurement paradigm for the quality of software, 2. Measurement results can be used to repair or improve the performance of existing projects or to further, the need for improvement in this system, particularly in the areas of interest with this system will add features - features that interactive

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Design and Preliminary Result on Content-Based Image Retrieval (CBIR) System for Osteoporosis X-Ray Image Database

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***Abstract*—This paper presents design and preliminary results of research on Content-Based Image Retrieval (CBIR) system for osteoporosis X-Ray images database. System's basic concept consists of two components: features extraction and similarity measurement. We used statistical approach Grey level co-occurance matrix (GLCM) and wavelet transform for extracting textural feature from image. We also used log-polar transform prior to wavelet transform to reduce rotation and scaling effect of image on wavelet transform. Experiment on small databases shows promising result in applying CBIR systems for osteoporosis X-Ray images database.**

***Index Terms*—CBIR, Osteoporosis, and X-Ray Images**

I. Introduction

Rapid computer applications in medical area provide many advantages in healthcare application. Some application including: telemedicine, medical image analysis, and databases on medical information such as medical record or medical image. On medical image database, method on image retrieval became an important factor due to databases performance. Several researches, devoted in finding the most efficient method in image retrieve from the databases. This attempt related to the specific purposes of medical image that is one of diagnostic tools.

CBIR is considered as the most appropriate choice method for image retrieval in medical image databases. This method retrieves images from database using information directly derived from the contents of image themselves, rather than from accompanying text or annotation [1]. Time-consuming process in giving annotations on each image, on the textual-bases images retrieval method, is one of the reasons for choosing this method. The specific properties of medical image, such as recognition image from its pathological value give another difficulty on applying textual-base medical image retrieval. Difficulty found in describing medical image pathological area in word, because of irregular shape of pathological area in the image. Moreover, different radiologist would give different opinion on each medical image. All those difficulties expected to overcome by applying CBIR on medical image database.

In this paper, we purpose a web-base implementation on CBIR systems for osteoporosis X-Ray image database. In this system, user could retrieve image based on user's example image. As the result, system presented five images which has similarity feature as example image. Data in this research are Digitized X-Ray image already known the osteoporosis level based on Index Singh due to simple verification on validity.

II. CBIR on Osteoporosis X-Ray Images Database

A. Basic Concept

On CBIR systems, user searching image based on user's example image. The system will extract user's image future based on image content. Using these properties, the system would then search image or images which has the same properties with the sample image, and displaying to the user. The systems basic concept consists of two components (Fig.1): Feature extraction and Similarity measurement.

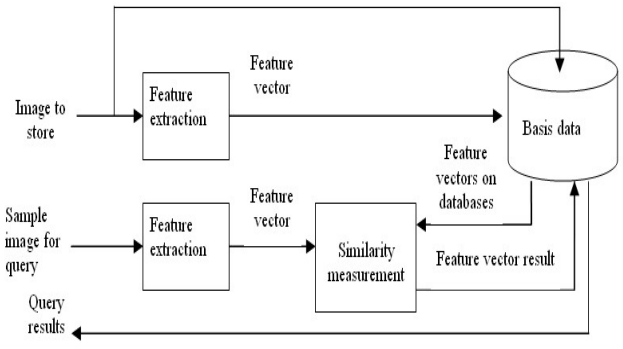

Fig. 1. CBIR Basic Concept Diagram.

Feature extraction conduct for images on database (offline process) and user's image (online process). In offline process, feature extraction process extract feature from images in database to produce feature vector

(descriptor) of each image. This features stored in database along with the image. In online process, system extract feature vector from user's image and uses it on image retrieval purposes. Image retrieval is conducted by computing distance (i.e., similarities) between feature vector of user's image and those of images in database. As result, the system will than provide five most similar images (five closest distance images).

B. Feature Extraction for Osteoporosis Images Based on Textural Analysis

Osteoporosis is characterized by an absolute decrease in the amount of bone to a level below that required for mechanical support of normal activity and by the occurrence of non-traumatic skeletal fracture [2]. Bone mass can be measured by Bone Mineral Densitometry (BMD) techniques using various mode such as ultrasound or Dual Energy X-ray Absorptiometry (DEXA). For the time being DEXA is considered as a gold standard to detect osteoporosis. Bone structure can be estimated by observing the change of *trabecular* pattern in *proximal femur* radiograph.

A number of physicians, due to the lack of diagnosis equipment like DEXA, observe the *trabecular* change visualize in *proximal femur* recorded in radiographs to assess osteoporosis. On radiographs, *cancellous* (*trabecular*) bone structure appears as a distinct pattern. The observation of *trabecular* pattern change for diagnosis of osteoporosis was first proposed in the 1960s using radiographs of proximal femur. The diagnosis was known as Singh Index grading system.

System propose here used this structure pattern as image feature. In this paper, 4 grades of Singh index were used from women patients between 45 – 65 years of age. Image feature extraction is done by image textural analyzing which will produce feature vector of each image. This feature vector is used as descriptor on the image retrieval systems. We used statistical approach and wavelet transform for extracting textural feature from image.

On statistical approach we use grey-level co-occurance matrix (GLCM) methods to extract feature (Fig.2). As X-Ray image represent as grey-level image, this method is considered as suitable method. From GLCM, quantities measured as feature are *Contrast* and *Uniformity*.

$$Contrast = \sum_{i=i}^{K}\sum_{j=1}^{K}(i-j)^2 p_{ij} \quad (1)$$

$$Uniformity = \sum_{i=1}^{K}\sum_{j=1}^{K} p_{ij}^2 \quad (2)$$

Wavelets transforms provide good multiresolution analytical tools for texture analysis and classification [3][4]. Experimental results show that this approach can achieve a high accuracy rate [5]. However, this approach assumes that the texture images have the same orientation and scale, which is not realistic for most practical application. A number works address the problem on rotation and scale on image. One on these works that shows promising results is using log-polar transforms on image [5] and combined wavelet packet transforms. Considered that image data in this research are obtained from scanning X-Ray analog image, which usually subject to certain random skew angles and scaling, we use this method prior to wavelets transforms on image texture-based feature extraction (Fig. 2). Quantities calculated as features in this approach are the norm-1 *e* from all component of wavelet decomposed image (approximation, vertical, horizontal, and diagonal component).

$$e = \frac{1}{N^2}\sum_{k=1}^{N}|C_k|^2 \quad (3)$$

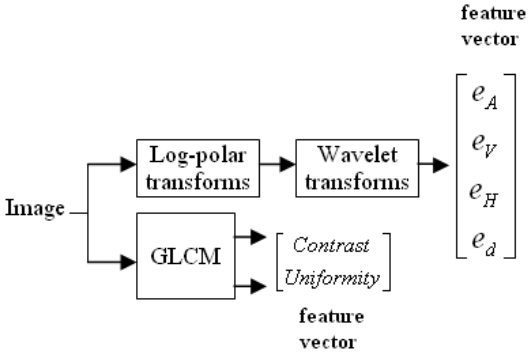

Fig.2. Feature extraction using GLMC and Wavelet transform.

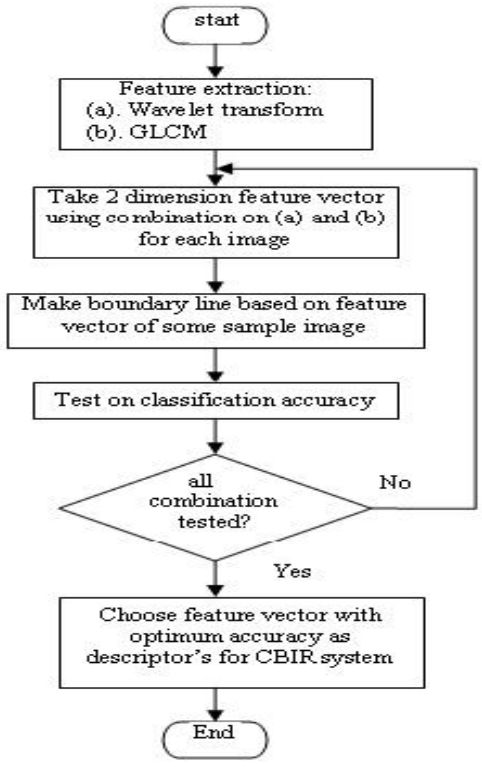

Fig 3. Flowchart on feature vector selection process.

C. Feature selection

Not all of the measure features above are considered as descriptor. In this paper, feature vector as descriptor is a two-dimension vector using combination of two features, one from statistical approach and another from wavelet transform. Defining which feature vector as descriptor is done by trial and error (Fig. 3).

Test on image classification is conduct on some sample data using each combination of two features. A simple minimum distance classifier method was chosen for this testing process. Feature vectors giving optimum accuracy on classification is selected. Feature vectors selected is used as descriptor for the systems and henceforth, system would only extract these features from images.

D. Similarity measurement

Similarity measurement is conduct on image searching from database. The similarity of two images I_a and I_b is the distance between their descriptor $\mathbf{f}_a$ and $\mathbf{f}_b$. In this research, Euclidean distance $D(\mathbf{f}_a, \mathbf{f}_b)$ was adopted to measure the similarity between the query image and example (user's) image.

$$D(\mathbf{f}_a, \mathbf{f}_b) = \left[(\mathbf{f}_a - \mathbf{f}_b)^T (\mathbf{f}_a - \mathbf{f}_b)\right]^{\frac{1}{2}} \quad (4)$$

The smaller distance is, the more similar the two images are. After calculating the distance, systems ranks similarity in descending order and then returns the top five images that are most similar to the user's image.

III. EXPERIMENTS AND PRELIMINARY RESULTS ANALYSIS

Experiment on feature selection shows that two dimension feature vector using combination of *Contrast* on GLCM and Norm-1 on approximation component of wavelet transformed image, is the best choice image descriptor's. Fig. 3 shows classification based on this feature vector. Boundary lines are performed based on feature vectors (descriptor) of sample images. Test on 37 images in databases using these boundary lines, shows that: classification accuracy achieves 91.7% for grade 3; 70% for grade 4; 83.3% for grade 5; and 100% for grade 6. There are no other combination achieve this accuracy.

Web-based implementation experiment using Java RMI shows that systems can perform image retrieval based on image contents. Previously, system presents calculated feature and pathologic indication of user's example image (Fig. 5). Furthermore, after conducting image searching, system present five images result from database (Fig.6). Those five images presented in Scroll Panel and accompany with some textual information (if any): feature vector, grade index, and some comment from expertise.

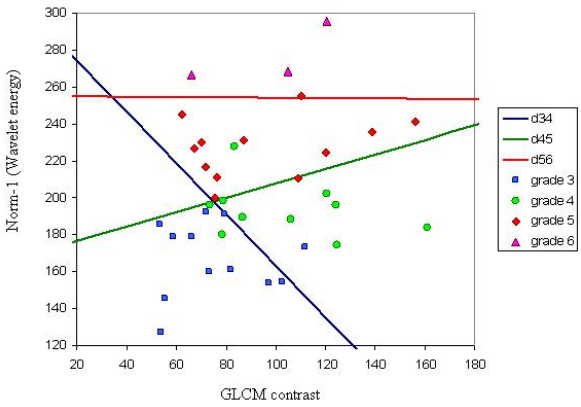

Fig 4. Decision boundary of minimum distance classifier based on selected feature vector for four classes (based on index Singh) on osteoporosis image.

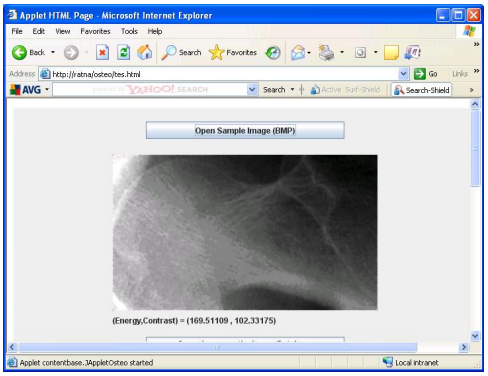

Fig.5. Presentation of user's image on user's screen.

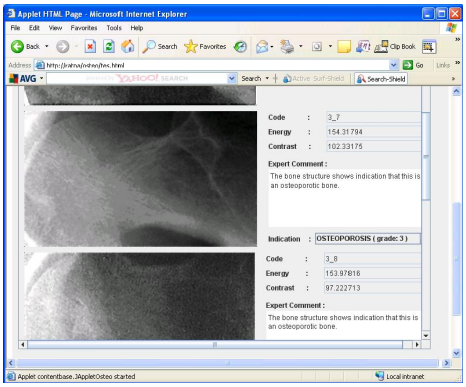

Fig.6. Presentation of retrieval image result in Scrolling Panel on user's screen.

Experiment for examine log-polar transform impact on image rotation and scaling effect shows that log-polar only reducing error in wavelet energy measured on rotated image (0.9% to 0.2%) and not on scaled image. However, as this research use two-dimension vector, combination of wavelet energy and contrast on GLCM, log-polar transform do not giving significant effect in image query result. This small impact on implementing log-polar transform prior wavelet shown that two-dimension feature vector has already reducing the image rotation and scaling affect.

IV. CONCLUSION

Preliminary result in this works shows promising result in applying CBIR for osteoporosis X-Ray image databases. Combination on wavelet energy signature and contrast on GLCM as two-dimension vector descriptor, give sufficient accuracy for the CBIR purposes. This combination also dismissing the rotation and scaling effect on wavelet transform on similarity measurement process, because descriptor not only depend on wavelet energy measured, but also on GLCM contrast.

However, only small database used for verification in this preliminary research, and most of data has already confirmed its index Singh. Further works would be applying bigger database and more indistinct indicated data to the system. Moreover, feature vector dimension would need to be increased.

V. ACKNOWLEDGMENT

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Teleassessment System for Geriatric Patient

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***Abstract*—Medical treatments for elderly patient, known as geriatric, often face problem as the number of old citizens is much larger than the number of geriatric consultants. Furthermore, the geriatric consultants usually reside and provide medical consulting services in big cities. Consequently, geriatric patients from rural areas can not be treated properly. This may in turn cause geriatric patient to suffer from polypharmacy. This kind of problem can be solved by utilizing telemedicine technology. In this paper a teleassessment system for handling geriatric patients is proposed. In this system each geriatric patient is assigned a consultant who is the team leader of a group of persons responsible for caring the geriatric patient, called a geriatric team. The geriatric team normally consists of geriatric consultant, internist, physio, neurolog, dentist, psychic, nutritionist, social worker, and pharmacist. Facilities are provided for each member of the geriatric team. The proposed teleassessment system also has a facility to carry out differential diagnosis analysis, which is based on a case based reasoning technique.**

***Index Terms*—case based reasoning, geriatric, teleassesment, telemedicine.**

I. INTRODUCTION

The Internet has enabled global communication having no distance and time boundaries. One of application that utilizes the Internet is telemedicine. Bellot, d, Cs, have designed a smart agent based telemedicine to handle kidney disease people [3].

Telemedicine is the application of clinical treatment, which utilizes telephone, internet and other communication network for transferring medical information. With this transfer, information can be used for health consultations, and sometimes can also be used for medical procedures in the isolated area (Kusumadewi S, et al, 2009)

Telemedicine technology can be utilized to process the geriatric patient diagnosis that requiring communication among some specialist doctors from different places.

Geriatric is a branch of medicine knowledge discipline that learns old people health problems in connection with promotive, preventive, curative, rehabilitative, and also psycho-social aspects around the old person's livelihood [2].

Some chronic diseases easily become acute and rise clinical symptoms that is not trivial for old person. Investigation results show that 78% of old persons suffer at least 4 kinds of diseases, 38% suffers more than 6 kinds of diseases and 13% suffers more than 8 kinds of diseases [9]. Chronic diseases will affect the increasing number of drug use and increased treatment costs. Survey at a hospital education, get 30% of geriatric patients get 6 - 10 types of medication, 13% get more than 10 types of drugs each day [10].

Rahmawati, et al (2005), identified Drug Related Problems (DRPs) on 20 geriatric patients that were treated in Bougenville Room at the Sardjito Hospital in Yogyakarta. It showed that the DRPs appear in all sampled cases. The types of DRPs included therapy without indication (75%), inappropriate chosen of drug (45%), the rise of Adverse Drug Reaction (ADR) (30%), patient did not receive drug (15%), overdose (20%), sub therapy dose (10%), indication of having no therapy (15%), and drug interaction that is clinically occured (5%) [12]

Geriatric patient is handled by geriatric assessment that is held by geriatric team. In Dr. Sardjito Public Central Hospital, the geriatric team composed from some elements, such as geriatrics, internist, medical rehabilitator, neurology, dentist, psychic, nutritionist, pharmacist, and social worker.

Geriatric Assessment is lead by a case manager who is usually a geriatric consultant. The purpose of the assessment is to determine the patient's needs. The best management is achieved by setting the priority of the patient's needs. This priority setting is based on:

1. Death potential disease.
2. Morbidity/disability potential
3. Benefit time

The problem of carrying geriatrics assessment is the number of geriatrics consultants that is not comparable to the number of old people. Furthermore, the location of the geriatric consultants, which are mostly in the big city, cause problems in carrying out geriatric assessments. Hence, it needs a media to carry out geriatrics assessment in a long distance by utilizing Internet technology.

In this paper, a design of teleassessment system for geriatric patient is explored. The implementation of this design is expected to increase the number of patient can be served by the geriatric team. It is also expected that the system can minimize the cost of the assessment. The member of assessment team can make assessment from their own places. In other side, the patients do not have to travel to geriatric consultants' location. They can be

handled by the local doctor directed by the geriatric consultant.

This teleassessment system will be provided by an analysis of different diagnosis using the case based reasoning method. This facility can be used by the internist, neurology, dentist and psychic. They can select their own variables and cases that may affect different diagnosis. The system then will construct a decision tree based on the variables and cases they selected before. When a new case happens, the system will match the result of different diagnosis by means of traversing the decision tree.

Case-based reasoning (CBR) is a problem solving technique based on previous experience knowledge [1].

The problem-solving life cycle in a CBR system consists essentially of the following four parts (see Fig. 1):

1. Retrieving similar previously experienced cases (e.g., problem–solution–outcome triples) which problem is judged to be similar
2. Reusing the cases by copying or integrating the solutions from the cases retrieved
3. Revising or adapting the solution(s) retrieved in an attempt to solve the new problem
4. Retaining the new solution once it has been confirmed or validated

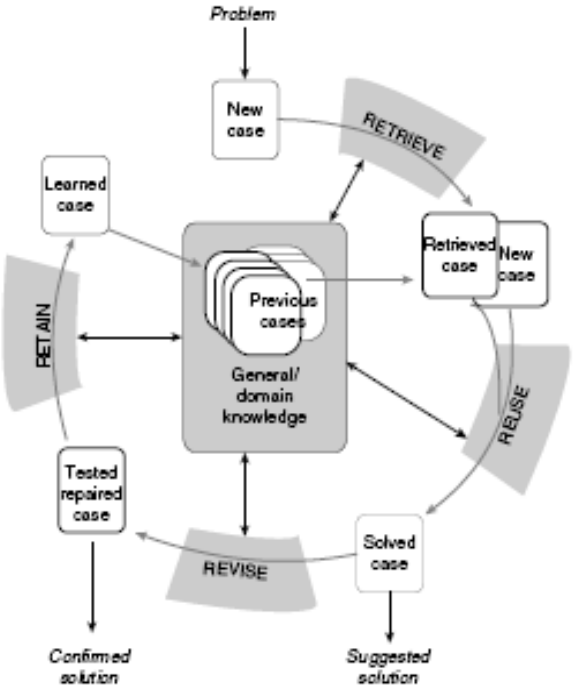

Fig. 1. Case Based Reasoning Life Cycle [11]

One of the benefits of developing CBR application is to reduce bottleneck of efforts of knowledge acquisition process. One of the methods for retrieving a case on the case based system is based on the C4.5 algorithm.

The research on building decision tree by using C4.5 algorithm was developed to classify text data for analyzing the probability of new student cancellation from admission process in STMIK AMIKOM Yogyakarta [5][6][7]. The same algorithm is applied for retreiving image, utilizing image fetures[4], and utilizing a combination of text and image features[8].

II. DESIGN

Geriatric assessment in this teleassessment involves web administrator staff, administration staff, geriatric consultant, internist, physiologist, neurolog, dentist, psychic, nutritionist, social worker, and pharmacist. The web administrator has the privilege to manage other user's access privileges. Administration staff is given the privilege to input patient data and assessment plan. The administrator chooses the geriatric consultant in charge for a geriatric patient when the patient's data is entered.

A geriatric consultant is the leader of the assessment team. He or she will choose the name of other team members. After finishing their assessment based on their respective skills, the geriatric consultant will lead an online discussion. Finally, they reach a final decision of treatment management to the geriatric patient.

The internist has the privilege to assess internist disease of the assigned patient. Internist also has the privilege to manage disease knowledge in conformity with the desired variables. The knowledge built in the case based reasoning system can be used by the internist to analyses the possibility of diagnosis of interna medicine that suffer patient.

A physiologist has the privilege to assess Daily Living Activity (DLA) for the patient under his/her supervision. A neurologist has a privilege to conduct a neurology assessment. Like the internist, a neurologist also has facility to build knowledge and carried out differential analysis diagnosis for neurology disease.

A dentist's privilege is to assess the disease of tooth and mouth. He/she also can build knowledge and carried out differential analysis diagnosis for tooth and mouth disease. A psychologist privilege is to assess psychology disease. He also has the right to build knowledge and performs differential analysis diagnosis for psychological disease.

The nutritionist has the privilege to carry nutritional assessment. A social worker has a right to carry social assessment. And last but not least, the pharmacist's privilege is to carry pharmaceutical assessment to patient.

The schema of the teleassessment system for geriatric patient is shown in Fig.2. Context diagram of this system is shown in Fig.3.

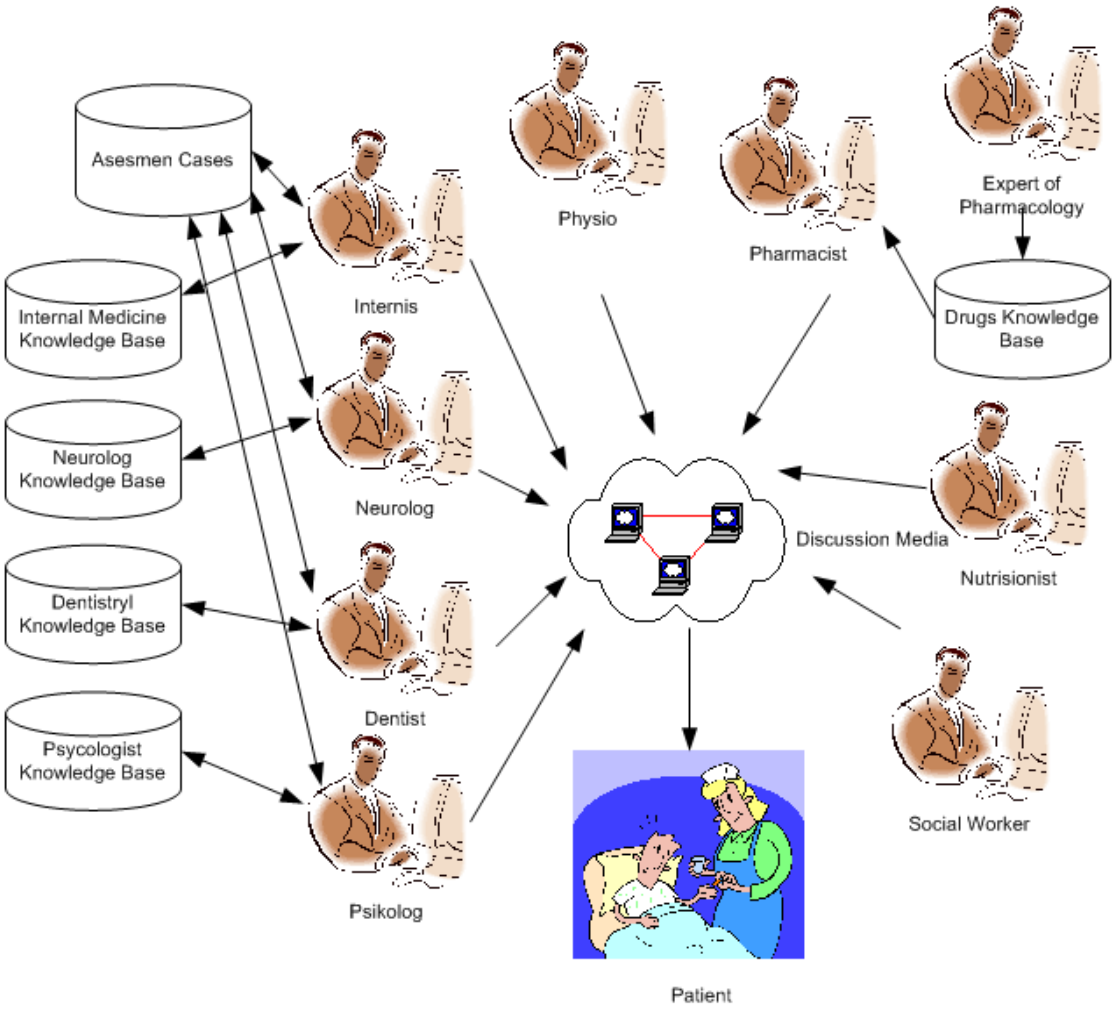

Fig.2. User interaction in the proposed teleassessment system.

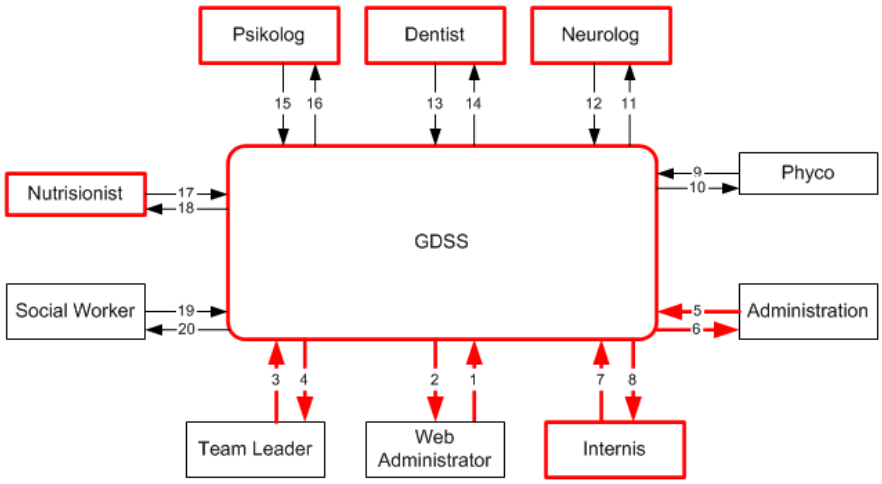

Fig.3. Context Diagram of Teleassesment System

Explanation of Fig.3.:

1. user access data
2. user list
3. assessment team data
4.
    a. assessment team list
    b. patient data
    c. patient identity data
    d. medical history data
    e. physical chek up
    f. supporting data
    g. problem list
    h. FIM assessment
    i. ADL assessment
    j. neurologist assessment
    k. oral assessment
    l. PMR assessment
    m. Social assessment
5.
    a. patien identity data
    b. medical history data
    c. religion
    d. education
    e. job
6.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment
7.
    a. Medical history data
    b. physical chek up
    c. supporting data
    d. internal medicine diagnosis
8.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment
9. Asesmen ADL (FIM)
10.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment
11. Neurolog assessment
12.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment
13. Oral assesment
14.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment
15. PMR assesment
16.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment
17. Nutrision assessment
18.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list

g. FIM assessment
h. ADL assessment
i. neurologist assessment
j. oral assessment
k. PMR assessment
l. Social assessment

19. Social assessment
20.
    a. Patient list
    b. Patient identity data
    c. Medical history data
    d. physical chek up
    e. supporting data
    f. problem list
    g. FIM assessment
    h. ADL assessment
    i. neurologist assessment
    j. oral assessment
    k. PMR assessment
    l. Social assessment

Steps in the health care of geriatric patient:

1. The patient is registered by administration staff.
2. The administration staff determines the geriatric consultant as the leader of the assessment team for the patient.
3. The geriatric consultant appointed the geriatric assessment team members.
4. The patient subsequently assessed by: internist, physiologist, neurologist, dentist, psychologist, nutritionist, social worker and pharmacist.
5. The result of assessment in point 4 will be taken to an online conference of the geriatric team.
6. The result of the conference is informed to the patient.

Meanwhile, to build the knowledge base, the internist, dentist, neurologist and psychologist have to follow the steps below:

1. Select the determining variables that will be used to build the knowledge.
2. Select the cases that will be used as the reference cases to build the knowledge
3. Execute the training process.

By using C4.5 algorithm, the system builds decision tree based on the cases and variables selected by the user. The decision tree can be used as an analysis tool to determine possible disease that the patient may be suffered from.

Figure 3 shows one of the user interfaces of the proposed teleassessment system design specifically for geriatric patient.

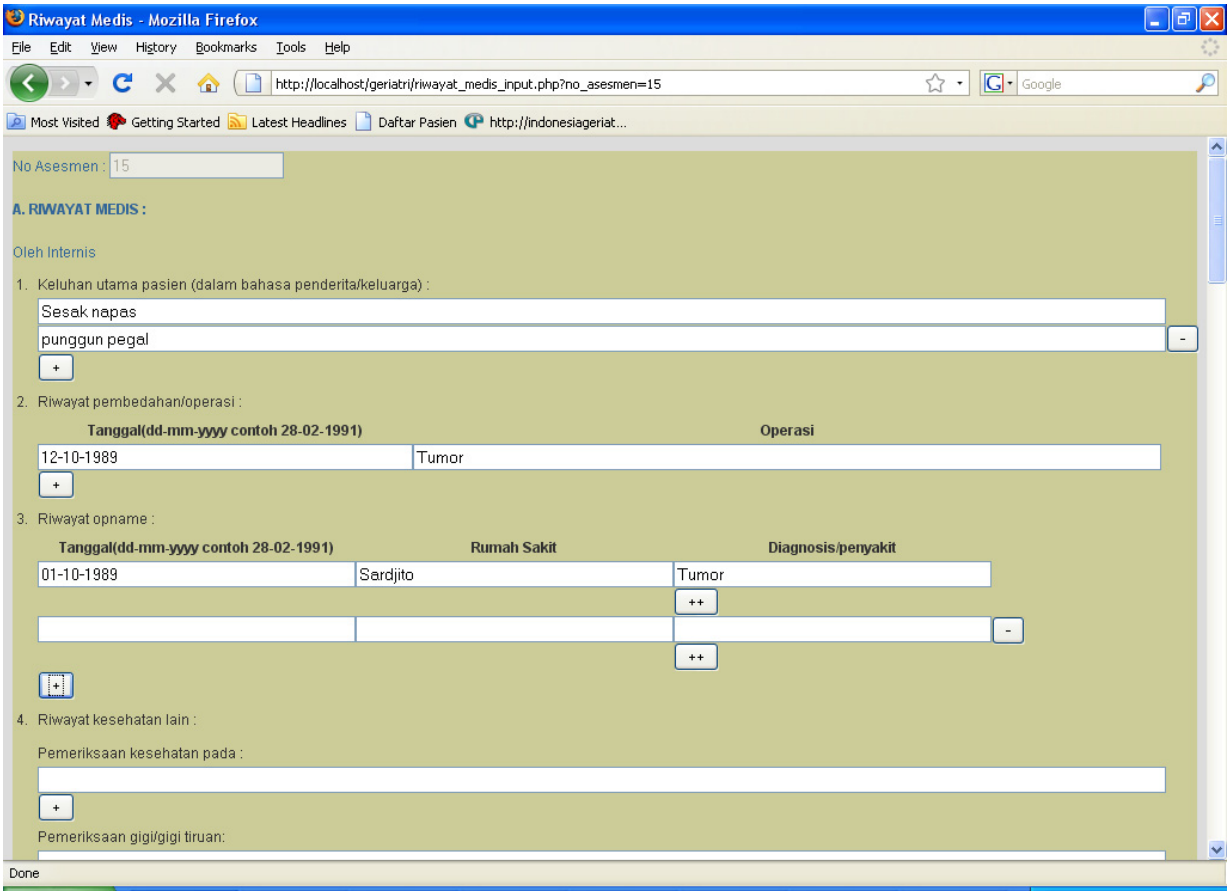

Fig 3. User interfaces of the proposed teleassessment system

III. CONCLUSION

Teleassessment system is one solution for problems in handling large number of geriatric patients due to the lack of number of geriatric consultants. By using the teleassessment system, the cost needed to conduct a geriatric assessment can also be minimized since the geriatric team members are not required to be in the same location. The geriatric patients are also helped for they do not need to travel to a hospital in big cities that is far from where the patient live. The patients can be assessed by local doctor that is member of geriatric team.

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How Interactive Multimedia (IMM) Affect Students' Cognition in Learning Biology at The Midle and Higher Education Level?

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***Abstract*—The aim of this research is to analyze the effect of interactive multi media (IMM) in learning biology towards students' cognition at the middle and higher education level through descriptive methods. Students' cognition consist of generic skills, concept attainment, and retention. The result at junior high school showed that IMM can raise concept attainment of "Organization of Life" and developed generic skill as well between individual IMM and conventional class. The result at senior high school showed that IMM can raise concept attainment of "Nervous System" at "fair" category level, difference significantly (α=0.05) between individual IMM and classical IMM class. Concept mapping test showed that concept attainment raise at "fair" level but there was no significant difference between those classes. Students' retention at both classes was quite high: 109.1 % for individual IMM class and 105.65 % for classical IMM class, different significantly (α=0.05). The use of IMM at university level on concept "Genetics substance and Protein Syntheses" showed that concept attainment was raised at "fair" level, but " low" level on concept mapping. Both tests couldn't reach the mastery learning level but students' retention was quite "high" for objective test and concept mapping as well.**

***Keywords*—concept attainment, concept mapping, generic skills, students' retention**

I. INTRODUCTION

The rapid developments in science and technology area have to be wisely anticipated by the teacher in terms of the usage of multimedia system in teaching, especially in science teaching. The currently applied curriculum in middle education level aims at a student centered learning condition which demands teacher's creativity in managing the teaching process. In different level of education, started from the junior and senior high school, until university level, there are some abstract concepts on biology that demand creativity of the teacher. In order to make sure that these abstract concepts to be understood by the students, both teacher and lecturer have to present their topics in an easy to understand way. One of the methods is to make use of interactive multimedia in education.

In the 7th grade (junior high school), the concept "The organization of life" is one of an abstract concept. Some concepts are difficult to be explained through practical activity and conventional method in class. Interactive multimedia technique is chosen to enhance the comprehension of the abstract concept and also the practical skill of the students. The practical skills that are going to be tested includes: (1) comprehension about cause and effect law, (2) the awareness of measurement units, (3) logical inference, (4) conceptual building. All of these skills are going to be tested using written test and observation of student's performance. The teaching model that was applied is learning cycle model which consists of three phases: exploration, concept introduction and concept application phase (Carin, Arthur, 1997:72).

At high school level, interactive multimedia was implemented in the teaching of the concept of "Neural System" which is an abstract concept for 11th grade. In the learning process of neural system, interactive multimedia is employed to increase the student's comprehension and retention. Student's comprehension is tested by using written and concept map test. Retention is performed three weeks after written test.

At university level, interactive multimedia was implemented in Open University (Universitas Terbuka, UT-Ind.) which employs *Long Distance Education System* and individual lecturing system with modular system in which interactive learning process is not easy to be implemented. Therefore, teaching material is the primary component in Long-distance Education System. In order to overcome student's difficulties in understanding the teaching materials, UT has prepared several additional learning facilities such as Computer Assisted Interactive Learning (CAI) which enables student to give response, receive feedbacks, choose the materials to study, accept corrections, have the opportunity to make corrections and obtain support from the advisor. "Genetic Substance and Protein Synthesis' concept is chosen because it is an abstract concept with complicated process. Those concepts can be visualized in forms of images, charts, animations and even simulated using computer software. In this study, interactive multimedia is employed to increase the students' comprehension and retention on the concept of Genetics substance and protein synthesis and also to produce interactive PBK program which is suitable with the characteristic of Long-distance Education System and

lessen the students' effort to learn the concept of heredity substance and protein synthesis. Concepts' comprehension is measured by written test and concept mapping test. Students' retention was measured by written test three weeks after the first test.

In general, the problem was "How is the role of IMM towards students' cognition at junior high school, senior high school and university level?" Students' cognition that will be analyzed are concept attainment, generic skills, and students' retention.

The objective of this study is to analyze the role of IMM in biology teaching at the level of junior high school, senior high school and university level. In general, the problems that will be further discussed in this paper are: How much interactive multimedia-based teaching can improve student's concept understanding and generic abilities for junior high school student? Also, how much this method can increase concept comprehension and retention for senior high school student and university students?

According to the study that has been performed in each education level, there are several differences in the usage of multi-media. At junior and senior high school, the role of the teacher is still dominant in order to guide the students through teaching in the classroom (face to face). In classroom teaching, the process of knowledge reconstruction is assisted by the teacher through various technique and teaching strategy for establishing interaction between teacher and students. Interactive multimedia, either it is individual or classical is carried out under teacher's supervision. For the current time, interactive multimedia is a new thing in school which needs comprehension and skill of both teacher and students in using computer, therefore the implementation in teaching process is attractive for students and teachers. However the drawback is teacher has to spent longer time for preparing teaching materials. This condition is different compared to distance-education system with the aid of teaching modules which is carried out by the Open University (UT). The position of interactive multimedia is to initiate and establish Computer-based learning.

The interaction of the students with teaching materials in remote learning process can be achieved using interactive media. Computer aided teaching materials has the potential to create interaction. Heinich, et.al. (1996) suggest several form of interaction that can be developed using computer media such as practical experiment and exercise, tutorials, games, simulation, problem finding and solving. The position of Computer-based system in distance teaching in Open University (UT) is as the supplement of teaching materials that can widen student's insight and understanding about materials provided in primary teaching modules, especially to help the students to understand difficult and abstract concepts.

Interactive learning process has been considered to be able to improve the quality of distance learning. Therefore the existence of this learning process is highly demanded and become a prerequisite. Moore in Padmo (1999:172) discussed three kinds of essential interaction i.e. interaction between student and teacher, student and teaching materials, and also interaction between students. Meanwhile, Bates in Padmo (1999:172) proposes two types of interaction that can be achieved in long distance learning process i.e. interaction that is individual or isolated activity (interaction between students and teaching materials) and social interaction (interaction between two or more people about the studying material that is currently being studied). These types of interaction types which are proposed by Bates and Moore are fundamental concepts that when linked together with media usage can be translated into several thoughts which are able to be implemented in long distance learning.

Computer-assisted learning curriculum that are developed in this research has a higher ability to explain materials compared to modules because of the ability to present abstract concept using animation. Computer's features can be utilized to teach concepts, rules, principles, and complicated calculation and also the ability to explain the concept in a simple way by combining audio and visual animation is suitable to be implemented in self learning activity.

According to Dahar (1996:110), learning is useful when students are able to link the old concept and new concept to form a solid concept. Information that is kept as concept can be used in different situations includes some which are totally different with the one that is implemented in learning process. Conceptual learning is an important thing for human especially in education field because conceptual learning is the primary result of education. Concepts can be obtained by two ways, by concept formation and concept assimilation (Dahar, 1996:79). Purwanto (1990:44) stated that concept understanding is a level of ability that expect students to have the ability of understanding the meaning or concept, situation as well as known facts and able to explain with their own words with the knowledge of their own without changing the meaning.

Deese (1959:237) stated that retention is one of the primary aspects in human learning and the working attitude that is acquired from experiment method. Retention is part of phases that can be found in learning process in school. These phases consists of motivation phase, concentration phase, processing phase, retention phase, digging phase, achievement phase and feedback phase (Winkel, 1996:451). Winkel (1996:449) said that retention phase occur between fixation and evocation time. Something that is being memorized is called as the retention. The complete form of retention is not clearly known but there is only something that is kept in the memory for future use. According to Deese (1959:343) a person that has a lot of concepts to be memorized will lead to low retention. Meanwhile a person who has only few concepts to be remembered will lead to high retention.

According to Novak and Gowin (1985:15) concept map such as schematic drawing is a mean that can be utilized

to represent meaningful relationship between concepts in form of propositions. Propositions are a combination of two or more concepts that can be combined by a conjunctive words. The simplest form of a concept map is formed by two concepts with one conjunctive word to build a proposition. In education, concept map can be applied for different objectives i.e. investigate what the students have learned, to observe how students learn, to reveal concepts that are incorrectly understood by the students, and as an evaluation tool. Until now, the evaluation tool that is used to measure student's comprehension is written test in form of objective test or essay test. Concept mapping is one of evaluation techniques to measure student's comprehension about concepts that they have learned.

Related Studies

O' Day Danton (2007) studied the Value of Animations in Biology Teaching: A study of long-term memory retention on Advanced Cell Biology indicated that the students who viewed the animation without narration scored higher than those who viewed the graphic. For the retention, the scores were highest for the animation group. Animations provide a valuable way to communicate dynamic, complex sequences of biological events more effectively than text or a static graph.

Gibbons, Nicola J. et al. (2004) studied Computer Simulations Improve University Instructional Laboratories, reported that the evaluation of two computer-based simulations of chromosomes analysis and bioinformatics can provide significant time savings to students. Under certain circumstances performance can be improved by the use of simulations by 7% of their case study. They concluded that the introduction of the simulation can significantly enhance student learning and can offer significant benefits to teaching staff.

II. METHODS

The method that use was comparative analyzes, that is descriptive study (non-experimental), i.e. study to investigate the relationship between one variable to the other variables by analyzing the role of independent variable to dependent variable in different groups (McMillan and Schumacher, 2001:287). In this case, the role of interactive multimedia for concept comprehension was analyzed, so did the generic skills and student's retention as well.

This research was conduct in:

1. Junior high school, samples 68 students of class VII -using Static group pretest-posttest design
2. Senior high school, samples 172 students of class XI – using Static group pretest-posttest design
3. Open University (UT), samples: 20 biology students – using Pre-experimental design.

III. RESULT AND FINDINGS

A. *Junior High School Level*

According to the calculation of normalized gain between experiment and control class for concept "Life Organization" at junior high school level, there are different mean value ($\overline{X}$) as follow:

- The mean ($\overline{X}$) for experimental class (interactive multi-media based learning) was 0,53(±0,22) and The mean ($\overline{X}$)for control class (conventional learning) was 0,37(±0,19).
- The z-test result shows that there was a significant difference on concept comprehension (α= 0,05) between the two groups. The relation is shown in Figure 2.

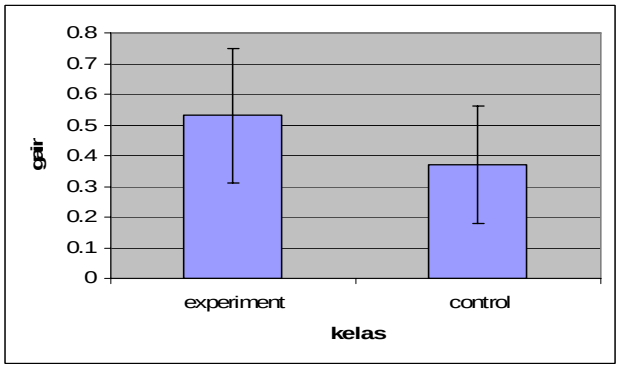

Fig.1. Mean score of the normalized gain on concept "The Organization of life", significantly difference

Generic skills that were measured after learning process in the two different classes were limited at (1) causality, (2) sense of scale, (3) development concept and (4) logical inference. The difference test result by using Mann-Whitney U test show that there was a significant difference between the two classes for every aspect of generic skill with mean result that is shown in Figure 2.

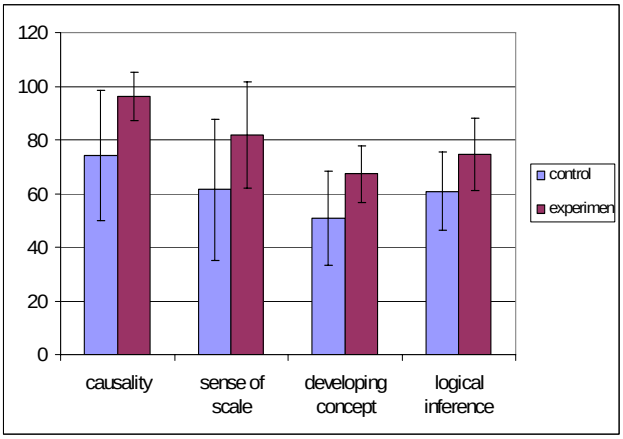

Fig.2. Comparison of generics skills between experiment and control class on concept "Organization of Life" Significantly difference

Interactive multimedia based learning was preferred by the students because they found this method is useful for them to understand concepts. The presentation of the concept through animation, pictures, text, colors, quizzes, and also symbols that is shown in the program, stimulate students to think and motivate them to learn the concept as well. But nevertheless, interactive multimedia-based learning requires teacher's skill to use and operate educational media equipments. This is one of the obstacles that were found in the reality that need to be resolved immediately.

B. Senior High School Level

At senior high school level, concept comprehension was evaluated by using objective test and concept mapping test. Statistics gain calculation result shows the gain criterion was in "intermediate" level, for objective test and concept mapping. The achievement of concept comprehension test that was evaluated by using objective test and concept map is shown in Figure 3. There are four classes used in this research, two control class (conventional teaching using chart, slides, discussion, and tutorial) and two experiment class (individual interactive multimedia and classical multimedia).

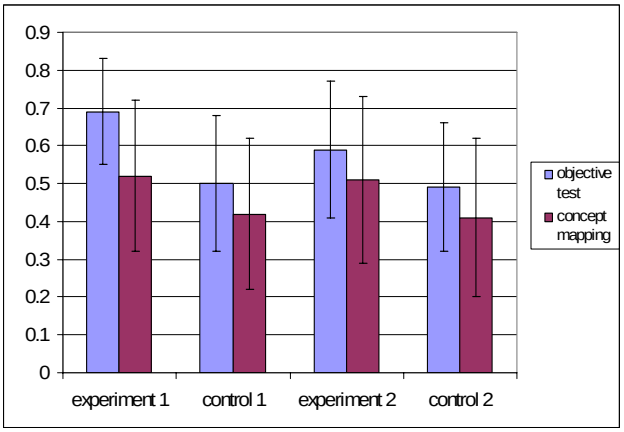

Fig.3. Comparison of the statistics gain on objective test and concept mapping test on Neural System in High School (class XI).

After performing normality test, the data shown in Figure 4 has a normal distribution, therefore the test can be continued with Z test. The result was improvement of concept comprehension in each group i.e. experimental class 1 with control class 1 and experimental class 2 with control class 2 showed a significant difference (α =0, 05). However, there are no significant difference between experimental class 1 (individual multimedia) and experimental class 2 (classical multimedia).

Observation result shows that in general students didn't have difficulties in learning the program. In individual multimedia classes, students showed their enthusiasm and seriously learning the material because they use computer individually and the teacher as facilitator in learning. In classical interactive multimedia, teachers play an important role besides being a facilitator. In controlled class, students also showed their enthusiasm because teachers present the subject in an attractive way with the help of media, discussion, and tutorial.

Retention test (post test 2) which was given three weeks after post test 1 showed a significant increase in four classes, i.e. the experimental class 1 (individual IMM) = 109.01 %; experimental class 2 (classical IMM) = 106.56%; control class 1= 106.59%; and control class 2 = 103.54%. This result shows that learning with individual IMM reach its highest retention compared with the other learning method. The complete result is shown in Figure 4.

C. University Level

Respondents at university level are students in Biology Education department of Open University (UT). Open University uses distance education system with teaching materials in form of modules. In long-distance education system, learning interaction happens between students and modules. Individual learning using modules for concept "Heredity Substance and Protein Syntheses" found to be difficult by the students because this is an abstract concept. Therefore, additional modules are given as supplement in form of interactive multimedia and packaged as Computer Interactive based learning. Interactive multimedia was tested in Open University (UT) with 20 students that have been chosen as samples for the research.

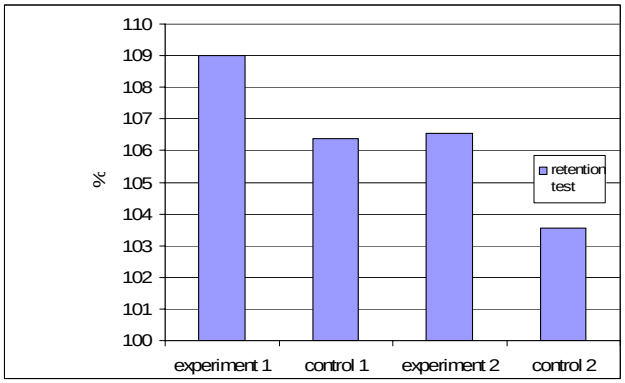

Fig.4. Concept retention test (%) of "Neural System" that was taken three weeks after the post-test.

Concept understanding was tested using objective and concept mapping test. Meanwhile, retention test was performed three weeks after post test. In long-distance learning system, there is a mastery learning criterion achievement score, above 80%. In objective test, there were only three students who can achieve 80% in post test, while the other students cannot achieve that score. The result is shown in Figure 5.

After implementing Computer-based learning, there was an improvement of student's comprehension about the concept of heredity substance and protein synthesis as shown in Figure 6, but the objective test cannot achieve the criteria of mastery learning both in pre-test and post-test.

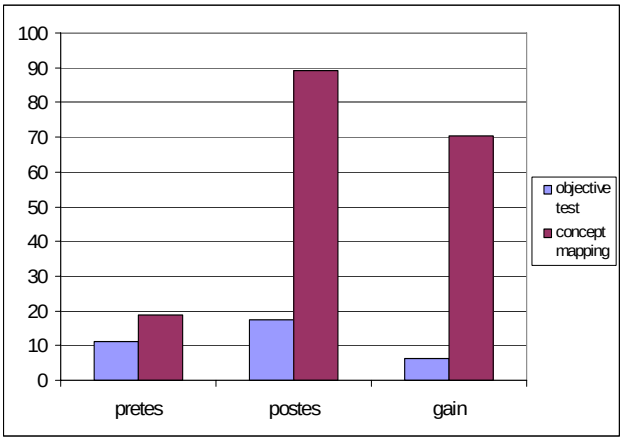

Fig.5. The achievement using mastery learning criterion on post-test that were taken through objective test and concept mapping test.

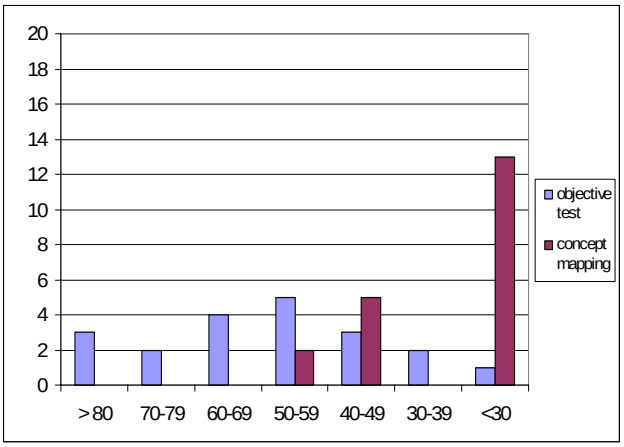

Fig.6. Improvement of students' concept comprehension on "The heredity substance and protein syntheses" after using Computer-based learning.

The retention test result shows that concept comprehension test which obtained from objective test is 86% (good), and the one that was obtained from concept mapping test was 247% (very good). The difficulty that faced by students with Computer Based learning was they are not familiar in learning by computer-based. Only 15% of the students that were familiar in using computer in their working place; 65% students stated that the frequency of computer usage in their office was unscheduled, and 20% of the students stated that they have never used computer before.

IV. DISCUSSION

At junior high school level, it is obvious that there was an improvement in student's comprehension. For interactive multimedia based learning, there was a significant improvement. This condition meets with the point of the constructivism view, that studying is a process to assimilate and connecting experiences, or in another way between the materials that they studied and the understanding that they have so that the comprehension is improved (Suparno, P. 1997). This learning has constructed the value that is invented by the students through what they see, hear and feel.

Implementation of Interactive Multimedia (IMM) in teaching "Diversity in Life Organization" also has a positive impact to the development of generic skills. This can be proved by comparing the average score of generic skill test in the class where Interactive Multimedia was applied with the control class. However, the distribution of that score didn't follow a normal distribution while in control class the distribution of the score follows normal distribution. This result showed that students' ability and experience of using computer varies a lot, so that students who are skillful in using computer obtain higher score compared to those who are not.

At High School Level, concept of Nervous System is a difficult and abstract concept when only taught by conventional method. The score of objective test and concept mapping test in experiment class (1) was higher than the experiment class (2) and both the control class (1 and 2) where the teacher's role is dominant. This fact shows that individual Interactive Multimedia based learning gives bigger opportunity for students to do exploration and simulation in order to build their understanding about concept. This activity is categorized as endogen constructivism. Interactive Multimedia based learning also has a positive effect to student's retention.

Concept understanding achievement at university level which was tested using objective test shows an unsatisfactory result because of many obstacles that is faced by students. Most of the obstacles are lower skill in using computer due to seldom usage or not familiar in using it. In fact, motivation and independent of students in using Computer based learning is high, but due to limitation of time they cannot repeat the materials presented in Computer based learning. Even if some read the materials repeatedly, they didn't have enough time for the other materials because most of the students are employees. However, Computer based learning has no effect to the independence of students either in objective test or concept mapping test which was shown by retention test.

Due to limitation of computer-literate and students difficulties it seems rather contrary to O 'Day Danton (2007) studied for the retention, because in this case animations not provide a valuable result. There is also seem contrary as well according to Gibbons, Nicola (2004) that reported two computer-based simulations of chromosomes analysis and bioinformatics can provide significant time savings to students can significantly enhance student learning and can offer significant benefits to teaching staff. In this study students need more time to enhance their computer skill and more time for the lecturer to give instructions.

Generally speaking, Interactive Multimedia based learning is interesting, not boring and can be read through repeatedly. However the difficulty is the limitation of teachers in utilizing Interactive Multimedia learning and

the limitation in making the Interactive multimedia program.

V. CONCLUSION

Interactive multimedia based learning and Computer based learning is very good to be applied, but in the reality, concept understanding is not always improving along with their implementation. The reason is because there are many factors that affect student's learning result.

Implementation of IMM result significance in junior and Senior High School to improve concepts achievement, generic skills, and retention.

Interesting findings that the implementation of IMM in university level, did not result significance improvement, because the average of individual achievement through Computer based learning didn't reach the mastery learning criterion.

In general, the retention test result which can be categorized as high (>80%) shows that Interactive Multimedia can increase student's independence by repeating and simulation process available in IMM and Computer based learning. The retention test results obtained from high school level and the generic abilities test result in junior high school level also confirm that Interactive Multimedia and computer based learning is interesting and efficient.

VI. RECOMMENDATION

The development of Interactive Multimedia and Computer based learning should be improved continuously especially for abstract concepts in different education level. Therefore teachers should be trained to enable the utilization and development of program using interactive multimedia technology. However, the utilization should be well anticipated because there are some concepts that are better to be understood through hands-on activity or the other activity.

VII. ACKNOWLEDGEMENT

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Interactive Multimedia Learning Model to Improve Concept Comprehension of Special Relativity on Senior High School Students

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***Abstract*—The purpose of this paper is to examine an interactive multimedia learning model in order to improve Senior High School student's comprehension on special relativity concept. This research was carried out by using experimental method. The students of class XII at a Senior High School in Ogan Komering Ilir South Sumatera in 2008/2009 were chosen as the subject of this research and two classes were taken as the sample. This research revealed that the student that used interactive multimedia learning model had more concept comprehension than the students that used convensional method, significantly. The average of N-gain of concept comprehension for experiment class is 0,71 (high criteria) while for control class is 0,45 (middle criteria). The highest N-gain in the experiment class is 0,96, for the concept of the time relativity while the smallest N-Gain is 0,42 for the concept of Newton relativity. The teacher and students gave good comment on the implemented model. We conclude that the interactive multimedia learning model is better than conventional learning model in improving the student's concept**

***Index Terms*—Interactive multimedia, special relativity, concept comprehension**

I. INTRODUCTION

At Senior High School level, physics is considered important to be taught as separate lesson with several considerations. First, besides physics give knowledge for students, physics is also expected to be a vehicle to increase thinking skills which is useful to solve problems in daily life. Second, physics needs to be taught for other specific purpose that is to give students knowledge, understanding and ability which are required for entering higher level education and also for developing science and technology. Physics is deliverd by inquiry to increase thinking skills, working and act scientifically and also to communicate as one of the most important aspect in life skill [1].

Special relativity is one of topic at Twelfth-Grade of Senior High School at 2nd semester. One of the problems that are faced by physics teachers in special relativity topic is concept comprehension that is achieved by students is still low. Content of modern physics consist of three parts, i.e. quantum physics, relativity theory, and nucleas physics Almost all of them are full of information, abstract and difficult [2].

Preliminary study obtained that special relativity topic is hard to be understood. In order to overcome this problem, it needs innovations in physics learning [3]. One of the physics learning innovation is applying interactive multimedia. Abstracts concepts such as, dualism of particle- wave can be understood by students with the assistance of interactive multimedia learning model [3].

According interactive multimedia give real contribution towards education field, because it can be used to overcome individual differences, to teach concept, to do calculation and stimulate students learning. Interactive multimedia give assistant to students, not only for students who are categorized as fast learner and slow learner, but also give assistant to students who are categorized as underachiever, through various assistant and challenge which are repetitive, explorative and dynamic enrichment.

Some research about learning model which based on information technology is summarized in Table 1. Based on above table, it is needed to conduct research about the use of interactive multimedia based learning model to improve concept comprehension toward secondary school students at special relativity topic. The statement of problems in this research is "How the comparison of students' concept comprehension improvement between students who learn with special relativity interactive multimedia physics learning model with students who learn with conventional model?" This research is aimed to construct special relativity interactive multimedia learning model and to test the model at secondary school to obtain information of its effectiveness in improving secondary school students' concept comprehension.

II. METHOD AND RESEARCH DESIGN

This research use quasi experiment method. Quasi experiment is used to find comparison of improvement of concept comprehension, science generic skill and students' critical thinking that use special relativity interactive multimedia learning model with students who

use conventional model. This research is used use nonequivalent group design [9]. Instruments of this research include (1) concept comprehension test that is in the form of multiple choices, (2) questionnaire to know students and teacher responses. Data analyzes is conducted by calculating normalized gain score and two average differences test by using SPSS14, while questionnaire data in the form of qualitative scale is converted to quantitative data.

Table 1. Summary of researches on ICT- based learning model

No	Research Results
1	Technology used in physics learning (*Physics Education Technology/PheT*) more productive compared to traditional method such as, lecture and demonstration [4].
2	PhET simulation for quantum mechanics help students difficulty in understanding quantum mechanics which is considered difficult to understand by students because of its abstract nature [5].
3	The use of web based physics program is very effective significantly towards different score of preliminary test average and final test of FCI at secondary school students and improve their achievement in understanding force and motion concept [6].
4	Hypermedia learning model in magnetic induction material can improve physic concept comprehension and can improve science generic skill and also give good response toward hypermedia learning model with magnetic induction material [7].
5	Multimedia based learning model give effect toward improvement of physics learning output with average score higher at experiment class around 4,73 compared with control class around 3,19. This differences are significant at real level 0,05 [8].

III. RESULTS AND DISCUSSION

A. Improvement of Special Relativity Concept Comprehension Skill

Percentage of pre test, post test and N-gain of special relativity concept comprehension average score between experiment class and control class is provided in Figure 1. It is known that preliminary test average score of experiment class is 31,5% from ideal score, while preliminary test score average of control class is 38,5% from ideal score. Then, based on final test average score from both class, it is known that final test average score of experiment class is 79,6% from ideal score, while final test average score of control class is 66,7% from ideal score.

N-gain average gain for experiment class is 0,71 and control class is 0,45. N-gain average for experiment class include high category while N-gain average for control class include medium category. N-gain averages for experiment class higher than class control N-gain average.

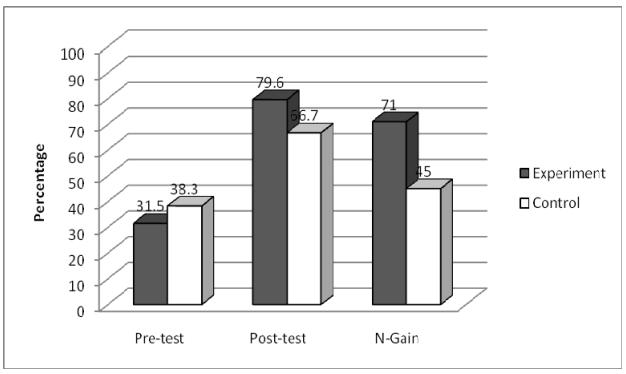

Figure 1. Percentage comparison of average score of pre-test, post-test and N-gain for experiment class and control class

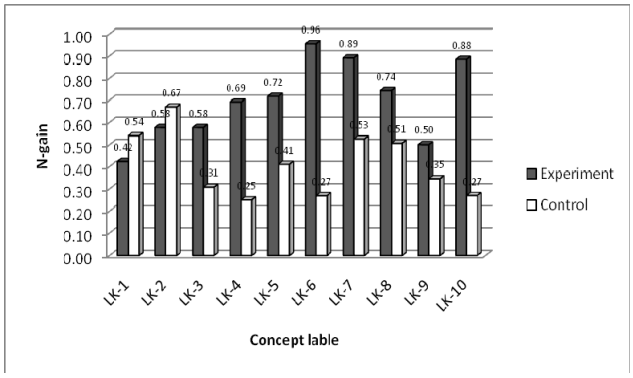

Figure 2. Comparison of N-gain of concept comprehension for experiment class and control class

Special relativity topic discussed in this research consist of ten concepts/labels, i.e. Newton relativity concept, Galileo transformation, ether theory, Einstein relativity, Lorentz transformation, relativistic time, relativistic length, relativistic mass, relativistic energy and relativistic momentum. From data which is obtained, it shows that highest N-gain in experiment class is occurred at relativistic time concept is 0,96 with highest and lowest category occurred at Newton relativity concept is 0,42 with medium category. While at control class, highest N-gain occurred at relativistic momentum concept is 0,85 with highest and lowest category occurred at relativistic time concept is0,27 with low category. N-gain comparison for each concept label can be seen at Figure 2.

Based on percentage of concept comprehension preliminary test score gain at experiment class, the highest score occurred on Newton relativity concept is 69,2% and the lowest occurred at relativistic mass concept is 8,9% while the highest score in preliminary test of control class occurred on ether theory concept (67,9%) and the lowest occurred on relativistic length concept (7,7%). Percentage of final test concept comprehension score on highest experiment class occurred on time relativity concept (96,1%) and the lowest occurred on relativistic energy concept (62,8 %) while on percentage of class control, the highest of final test score occurred at Newton relativity concept, Galileo

transformation, Einstein relativity, and relativistic momentum (92,3%) and the lowest occurred on relativistic energy concept (51,3%). With achievement percentage, concept at each special relativity concept after conducting final test on experiment class and control class is improving.

Distribution normality test, special relativity concept comprehension, experiment class and control class students is conducted by using *One-Sample Kolmogorov-Smirnov Test.* It is obtained that data that distribute normal toward significance each 0,591 toward experiment class and 0,832 for control class. Homogeneity test of special relativity concept comprehension data variance of experiment class and control class by using Levene Tes (*Test of Homogeinity of Variances*) is obtained result that homogenous data variant toward significance 0,077. After it is obtained data of concept comprehension improvement distribute normal and homogenous, then, next is conducted parametric statistic test (t test with α = 0,005). By using *Independent Samples Test* is obtained result that significant differences between concept comprehension improvement of experiment class and control class based on t = 6,818 value. Based on analysis from t test, it can be concluded that concept comprehension improvement of experiment class is better than concept comprehension improvement of control class.

Concept comprehension improvement through interactive multimedia learning is implication from learning that use interactive multimedia assistant. This special relativity interactive multimedia learning model can give students opportunity to be actively found concepts which are presented whether in the form of text and animation by themselves. This is in accord with was proposed that concept is obtained by two ways, i.e. through concept formation and concept assimilation. Concept formation has a close relation with knowledge gain through inductive process. In inductive process, students are involved in discovery learning. Through discovery learning, students would feel something that they learned would get a long way compared with traditional learning (memorizing).

B. Teacher Response Toward Special Relativity Interactive Multimedia Learning Model Application

Physics teacher response on special relativity interactive multimedia learning model was obtained by distributing questionnaire. it is concluded that teacher give positive response toward relativity interactive multimedia learning model which can be seen on Table 2. It is known that teacher response percentage toward relativity interactive multimedia learning model is high.

C. Students Response Toward Special Relativity Interactive Multimedia Learning Model Application

Students response towards special relativity interactive multimedia learning model is obtained by distributing questionnaire which consists of statements about learning model. Based on students' responses that are collected through questionnaire, it is concluded that students give positive response toward relativity interactive multimedia learning model which can be seen on Table 3. It is known that students' response percentage toward relativity interactive multimedia learning model is high.

Based on questionnaires which are distributed to teachers, it is known that teacher give good response towards relativity interactive multimedia learning model. Interactive multimedia learning model facilitate teacher in teaching special relativity model which is abstract and can improve students' concept comprehension, science generic skills and critical thinking.

Based on questionnaire distributed to students, it is known that indicator that shows interested towards physics in interactive multimedia, interested toward performance and facility in interactive multimedia, seriousness in learning special relativity topic with interactive multimedia and seriousness in doing items that is presented through interactive multimedia shows high percentage.

Table 2. Teacher response recapitulation toward relativity interactive multimedia learning model

No	Indicator	Percentage	Criteria
1	Show interested towards physics that use interactive multimedia	93,7	Good
2	Show interested toward performance and facility in interactive multimedia	91,7	Good
3	Show seriousness in learning special relativity topic with interactive multimedia	91,7	Good
4	Show seriousness in doing items that is presented through interactive multimedia	100	Very good

Table 3. Students response recapitulation on relativity interactive multimedia learning model

No	Indicator	Percen-tage	Criteria
1	Show interested towards physics that use interactive multimedia	76,4	Good
2	Show interested toward performance and facility in interactive multimedia	83,3	Good
3	Show seriousness in learning special relativity topic with interactive multimedia	79,2	Good
4	Show seriousness in doing items that is presented through interactive multimedia	77,9	Very good

Good responses which are stated by teachers and students are caused function of interactive multimedia in education field, as learning software, that give facility towards students to learn a material. Multimedia has idiosyncrasies among others (1) interactive by facilitating feedback; (2) freedom to choose learning topic; (3) systematic control in learning process[10].

IV. CONCLUSION

The improvement of concept comprehension for the student who use interactive multimedia learning model is significantly higher compared with students that use conventional learning. Average N-gain of Student's concept comprehension for experiment class is 0,71 (high criteria) and control class is 0,45 (medium criteria). This means that the use of interactive multimedia model is more effective than conventional model. The highest N-gain in the experiment class is 0,96, for the concept of the relativity of time while the smallest N-Gain is 0,45 for the concept of relativity of Newton. Both tacher and students give good response on relativity interactive multimedia learning model. Based on research results, it is reccomended to conduct further research about other interactive multimedia learning model mainly for modern physics topic that are rare to be taught experimentally by physics teachers at secondary school, such as, atomic nucleas and radioactivity.

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Inquiry Based Interactive Multimedia in Rate of Reaction to Enhance High Shool Students' Creative Thinking Skills

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***Abstract*—The purpose of this research is to investigate the influence of inquiry based interactive multimedia in rate of reaction to enhance high school students' creative thinking skills . This research used quasi experiment method. The subjects are grade IX students of Science$_1$ and Science$_2$ classes at one of the high schools at Ternate, Maluku Utara. Instruments used are test of concept mastery in rate of reaction and creative thinking skills, observation sheet, and questionnaires to get students' and teachers' responses on the applied of interactive multimedia. The results showed an increase in N-Gain of concepts mastery is considered high (0.73). The highest gain increase took place in creative thinking indicator of reaction rate which is skill in predicting based on limited information Besides, learning using interactive multimedia can enhance creative thinking skill including skill in looking at information on different point of view and looking at the same information from different viewpoints. In general, teachers and students responded positively and were very motivated and interested in inquiry based interactive multimedia in rate of reaction.**

***Index Terms*—inquiry based interactive multimedia, creative thinking skills, high school students.**

I. INTRODUCTION

Teaching chemistry in school has not gone further than transferring information about chemistry until now. Conventionally, teachers demonstrate facts, formulas, laws, or certain problems and students learn them by heart. With this kind of teaching, product is more important than scientific process and attitude.

At the same time, we have entered information era. The rapid development in information technology and communication has also influenced our personality, activity, life and/or the way we think. This progress needs to be introduced to students so that they have some knowledge and experience to be applied and used during learning-teaching activity. Today, there are a lot of learning processes using computer based media. One of them is software creation and development as teaching media.

Based on preliminary study at one of public high school in Kota Ternate, the data showed that the teaching of chemistry rarely used information communication technology based on computer. Progress in technology and information makes it possible to produce some interactive multimedia to be used as learning process. In turn this facilitates can enhance students' motivation to learn concepts in chemistry. As in [1] explained that computer technology was potential to teach students' thinking skill.

Some literature [2] states inquiry as using and developing higher order thinking for scientific activity. [3] states inquiry as experimental activity to test hypothesis.

Students regard chemistry as a difficult subject, especially when it comes to abstract concecpts. According to a research [4] , the difficulty of mastering chemistry concepts is caused by low rational thinking pattern on the chemistry concepts formation. This thinking pattern is formed because there is no variation in the way teachers teach. Mostly, teachers employ one teaching pattern. Therefore, students become less active in learning process; most of the time they listen and write what is said by the teacher. Thus, chemistry becomes a history lesson need to be learned by heart and understanding real concepts in chemisty becomes difficult. Moreover, students do not dare to ask. Therefore, learning chemistry needs some skills in concepts formation. The concepts learned should be analyzed to get further understanding for concepts application [5].

Theoretically, according to Piaget and other theories developed further, it is believed that for students understand scientific concepts, teachers need media for teaching. They are used to enhance concept understanding . According to those theories, students' concepts will be improved if the teachers use concrete materials, especially in chemistry experiments. However, in our country, school condition and teachers have difficulty in using laboratory activities.

The development of computer based interactive teaching models at junior high school, as in [6] found out that using computer can enhance students' creative thinking skills and be able to provide teacher to give attention more focus to slow learner students. [5] suggested that beside concept mastering, interactive multimedia based learning can also improve students' generic science skills and creative thinking skills.

In this research, one of chemistry learning topic chosen is rate of reaction . Rate of reaction includes its definition, factors influencing rate reaction (concentration, temperature, surface, catalyst, activation energy) and

collision theory. Some sub-concepts rate of reaction include several abstract concepts that difficult to visualize, even using practical experiment in laboratory. For example in learning the concepts of activation energy and collision theory. Besides, this subject contains a lot of mathematical equations. These characteristics make students even more difficult to understand the subject.

Difficulties experienced by students in understanding the abstract concepts of rate of reaction is hard to visualize. It can be overcome by taking advantage of computer technology. Computer technology is an invention which enables us to display some or all forms of interaction, so that learning process can be optimal zed. Chemistry concepts easier to understand through computer program using software. Some form of interaction can be display through computer media, such as practical experience and exercises, tutorial, games, simulation, invention and problem solving.

Through certain design, students are able to respond, give feedback, choose earlier subjects to be learned, receive corrections, have remedial opportunity and acquire enough understanding.

II. METHOD

This research focuses on developing chemistry teaching model which can enhance concept mastery and creative thinking skills at one high school in Kota Ternate, Maluku Utara . The research done using *Pretest - Postest Control Group Design*. Two classes out of five classes were chosen randomly. Sample used was 30 students at experiment class and 26 students at control class.

The implementation of interactive multimedia based laboratory inquiry teaching model at the experiment class, beginning with pretest, followed by teaching-learning process. The control class carried out beginning with a pre test, followed by conventional laboratory model teaching-learning process. Both classes receive post test. The instruments used is a test of concept mastery of rate of reaction integrated with creative thinking skills, observation sheet, and questioner to had teachers' and students' response of the applied teaching model.

III. RESULT AND DISCUSSION

A. Concept Mastery at Experiment and Control Classes

Data obtained from scores at pretest, post test and N-Gain for rate of reaction concepts at control class and experiment class is presented in the Table 1.

To know the improvement of students concepts mastery, we take data from N-Gain scores of both classes. There are 8 sub concepts learned. . The concepts are (1) definition rate of reaction, (2) factors influencing reaction rate, (3) concentration factor, (4) surface factor, (5) temperature factor, (6) catalyst factor, (7) reaction equation and reaction order, (8) activation energy and theory of collision. In order to know student concepts mastery a test is used. The test consist of 20 multiple choice questions and 6 essay-questions. The distribution of each concept is shown in Table 2.

Table 1. Concept Mastery of Control Class and Experiment Class

	Control Class			Experiment Class		
	Pre test	Post test	% N-Gain	Pre test	Post Test	% N-Gain
Mean (%)	35,30	63,46	39,85	27,33	79,20	70,22
Deviation Standard	13,04	9,77	12,00	6,26	10,39	21,15
N(Number of Student)	26			30		

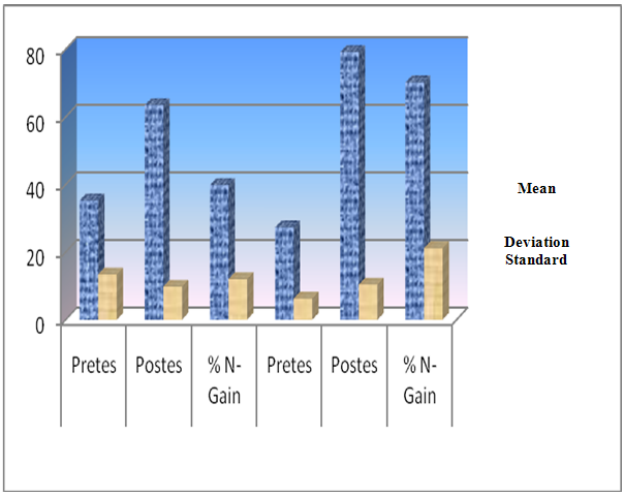

Figure 1. Mean, deviation standard score for pretest, post-test, N-Gain of both classes

Experiment class shows a higher improvement in abstract concept with N-Gain mean 0.80 while the lowest improvement in principle based concept with N-Gain mean of 0.58. As in [7]-[9] stated that learning using interactive multimedia could enhance the concepts mastery of a topic/subject in chemistry better than conventional method.

After teaching process, students understand concepts better and they could remember what they have learned using computer animation displayed by software. This was in line with [10] who suggested that chemistry is one of sciences containing a lot of abstract concepts that difficult to understand by students. Many chemical phenomena are caused by interaction of particles at microscopic level. Learning process involving microscopic level, using microscopic/particle model was believed to be able to increase students' understanding of chemistry concepts . In general, the increase in students' mastery rate of reaction using laboratory inquiry teaching model is considered high with N-Gain of 0,70.

Table 2. Distribution mean score of sub concepts at control class and experiment class

No	Concept understanding	No.	Mean of Control Class			Mean of Experiment Class		
			Pre-test	Pos-test	% N-gain	Pre-test	Pos-test	% N-gain
1	Definition of Reaction rate	1, 4	34,62	67,31	44,23	28,33	90,00	80,00
2	Factors influencing reaction rate	3, 26	23,40	50,64	30,81	26,11	82,78	67,23
3	Concentration	6, 12, 19, 22	45,51	76,60	58,61	15,83	80,28	73,24
4	Surface	23, 24,	30,77	65,38	42,31	13,33	70,00	63,33
5	Temperature	5, 13, 14	33,33	75,64	64,10	43,33	87,78	64,45
6	Catalyst	15, 16, 18,	46,15	57,69	20,51	33,33	88,89	76,11
7	Reaction rate equation and order of reaction	2,8,9, 10,11, 20	30,13	50,00	26,48	36,67	78,11	57,95
8	Theory of Collision and activation energy	17,21	31,80	28,44	31,73	21,67	82,78	69,45

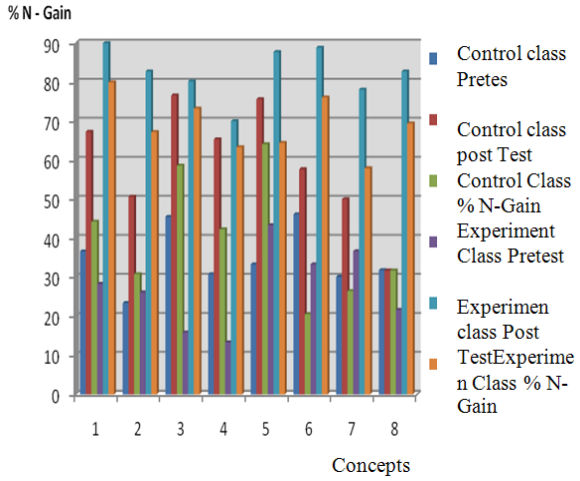

Figure 2. Graph of distribution of Pretest, Post test, and N-Gain Scores for Control Class and Experiment Class for Each Concept

A. *Creative Thinking Skills*

Interactive multimedia based inquiry laboratory learning for rate of reaction concepts also measured students' creative thinking learning. Creative thinking skills that measured in this research consists of four aspects. These four aspects are: (1) Raising curiosity (7.7%), (2) Developing knowledge acquired by students (50%), (3) Looking at information from different point of view (11.54%), and (4) Predicting out of limited information (15.38%). View of this improvement in students' creative thinking skill can be seen from Table 3.

The high score for predicting out of limited information (0.88) is supported by interactive animation within the software and students are directed to represent the table and graph. Through this exercise using inquiry based interactive multimedia, students learned to find the pattern, regularity, table and graph by themselves. The exercises given in the test are considered average and easy. This might be caused the score of predicting from limited information was high.

Table 3. Relation between Creative Thinking Skill and Mean of Pre-Test, Post Test and N Gain

No	Creative Thinking Skill	Number	Mean of Control Class			Mean of Experiment Class		
			Pre-test	Pos-test	% N-gain	Pre-test	Pos-test	% N-gain
1	Raising curiosity	3, 21	38,36	76,92	53,53	35,00	85,00	74,72
2	Developing knowledge acquired previously by students	1, 2, 6, 7, 8 ,9 10,11,12, 14,15, 16,26	23,08	55,13	40,62	21,80	72,33	60,31
3	Looking at information from different point of view	4, 5, 20	32,05	62,82	45,51	37,78	88,12	78,90
4	Predicting out of limited information	13,18, 19, 25	24,36	59,29	42,95	27,50	87,22	79,92

Highlight of students' mastery of Creative Thinking Skill before and after learning process at control class and experiment class is shown at Figure 3.

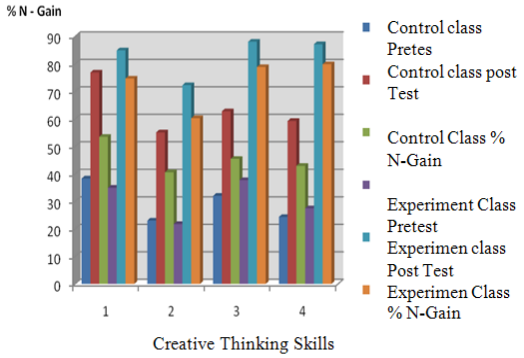

Figure 3. Graphic of Mastery in Creative Thinking Skill at Control Class and Experiment Class

There is an increase for raising curiosity with N-Gain of 0.75. This might be due to the facts that students understand better and are interested to learn the concepts provided by interactive animation within the software of reaction rate learning. The pictures and the video displayed are very attractive and the interactive questions succeed to raise students' motivation to learn the concepts such as: definition of reaction rate, factors influencing reaction rate and activation energy and collision direction.

The lowest improvement was in development of students' existing knowledge (0.60). This might be due to the fact that students' understanding at the beginning of learning activity is very low. Moreover, the learning process experienced by students before was teacher oriented. However, in general, there is an increase of N-Gain for students' creative thinking skill, 0.73.

B. *Teachers' and Students' Respond for The Teaching Model*

In general, students respond positively toward learning rate of reaction using interactive multimedia. This is due to the technique and the method used by teacher in providing and managing the subject to the students.

Students claim that this kind of learning is can be applied to other concepts having the same characteristics with rate of reaction . The increase in students' interest and motivation is triggered because students felt that the material was related directly to their everyday life.

According to [11], positive attitude is needed in learning process. This attitude facilitates learning process. Interactive multimedia based inquiry laboratory model developed in this research was easy to operate, can activate students, supported by exercises at computer laboratory, increase students' motivation, and increase mastery in rate of reaction concept. It also trained students to think because they are forced to understand the text/table/graph.

IV. CONCLUSION

Based on the result, research problem, finding, and discussion above, it can concluded that the teaching model produced in this research can develop concepts such as: principle based concept, concrete concept, and abstract concept. On the other hand, the learning model used in this research can display animation at macroscopic and microscopic level from practice design using interactive multimedia. The model shows molecular state concept in rate of reaction completed with tables, and experiments data, graphics, interactive questions, and exercises which enhances students' understanding of concepts.

Interactive multimedia based inquiry laboratory teaching in rate of reaction concept can improve students' mastery of concepts and creative thinking skill, with considered high N-Gain.

This teaching model received positive responds of teachers, attracted students because this interactive multimedia developed in this research is easy to operate. The model can activate students, supports the theory and experiment in the virtual laboratory, increased students' motivation and students' mastery in rate of reaction concept, trained students to think because students have to understand texts/tables/graph.

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ICT Based Instruction of Chemical Equilibrium Phase: Improvement of Students' Critical Thinking and Generic Science Skills

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***Abstract*—This research aims to improve CTS (critical thinking skills) and GSS (generic science skills) of chemical education students through learning model of ICT based instruction in chemical equilibrium phase. Multimedia for E-learning had been developed using macromedia flash platform for the instruction. This teaching model could detect the weaknesses and made the finger print of the students' conceptual understanding. Students' conceptual understanding showed the development CTS and GSS of the student. Teaching materials are divided into three types of learning: (1) video clip of experiment about equilibrium phase of one component system of gas-liquid and gas-solid, (2) interactive text, and (3) using simulation of interactive graph. There were 26 students of the Physical Chemistry I course (Chemical thermodynamics and chemical equilibrium class) become the sample of the research. By using the internet, we kept teaching model software back to the server computer, and students tried to access it from client computer in a classroom in order to learn individually. The result showed: (1) video clip of experiment really help students to get the competences of observation, one of the important GSS; (2) interactive text and simulation of interactive graph can improve students' CTS and GSS. The improvement of students' CTS was 12.1% (from 35.6% to 47.7%). There were three CTS developed by this model, those are: deducing and judging deductions; defining term and judging definitions; and identifying assumptions. Meanwhile, the improvement of students' GSS was 12.0% (from 40.4% to 52.4%). The GSS that could be developed by this model were: logical self consistency of natural law, logical inference, law of causality, interpretation of graph, and concept formation. According to this data, ICT based instruction of Chemical Equilibrium Phase could be used in to improve CTS and GSS of the students.**

***Keywords*: critical thinking skills, generic science skills, ICT, phase equilibrium.**

I. INTRODUCTION

CTS (critical thinking skills) could not be neglected in all courses in the university. Critical thinking is very useful for students after they graduated from the university and have a role as teachers [1]. Therefore, teaching is not only acquiring conceptual understanding but also equipping with other purpose, i.e. students have adequate CTS.

Nevertheless, because of the rapid development of science and technology, only have CTS insufficient to be able to compete in employment. Student need to have other skills that is GSS (generic science skills). GSS is one of skills that require high attention. Especially for Indonesia, those skills needed to earn parallel development with the developed countries. The existence of human resources what has GSS reliable is very required. It is because, GSS shows quality and capacity [2], and GSS plays an important part to develop the field of science and technology [3].

Institute of teacher training (LPTK) has a high responsibility for produce good quality of students' CTS and GSS. After students graduated from LPTK and become teachers, they should be able to teach in line the whole of curriculum demand. In science and technology high school curriculum, besides the students' conceptual understanding, they have to pay attention in teaching through the scientific methods critically, creatively, and independently [4]. Giving a number of CTS and GSS to the teacher candidates can overcome the demand.

The problem is how to implement CTS and GSS in the science teaching. CTS is an establish theory in education. According to Ennis [5], there are five categories of CTS can be developed in teaching such as 1) elementary clarification, 2) basic support, 3) inference, 4) advance clarification, and 5) strategy and tactics.

On the other hand, GSS is still debatable. This ability derived from generic skills concept. In many countries, like Australia, America, Canada, and England, generic skills defined as a vocational ability aspect [8] and [9]. In this research, GSS derived from many perceptions of generic skills, especially Brotosiswoyo views [6]. Brotosiswoyo divides GSS to eight categories, such as 1) observation, 2) sense of scale, 3) symbolic, 4) logical self-consistency, 5) inference, 6) causality, 7) mathematical modelling, and 8) concept formation [6].

According to Wu, both of CTS and GSS inherent with students' conceptual understanding [3]. Therefore, to develop students' CTS and GSS, teacher have to design a science teaching model that correlate conceptual understanding-CTS and conceptual understanding-GSS.

In addition, lecturers generally gave courses

conventional with a large number of course objectives. They decided teaching without detection conceptual understanding of each student before. Lecturers find difficulties in checking conceptual understanding of the student when teaching started. It is because of the limited time and large number of the student in the class.

ICT (Information and communication technology) has probability to overcome the lecturers' difficulties. Computer technology of the ICT was able to assist lecture at a short time and large amount of students. Recently, ICT has many influences in education. Through available network, whether by using LAN (local area network) or internet, we can access and get information quickly. ICT promises various excellences, which can be applied in processes of the teaching compared to conventional class. Teaching that conducted by website more effective than traditionally [7]. Besides, students can access the information in various representations, like text, graph, picture, animation, simulation, and even video. These representations made learning more attractive.

In teaching chemistry, especially physical chemistry, experiment is a very important working. Students have verification experiment of theories or laws. However, conducting of experiments frequently cause pollution and expensive cost. Exploiting ICT, make experiment lower cost and decrease pollution. Therefore, virtual experiments are not only inexpensive but also green chemistry.

To answer those problems, it is important to conduct research in developing ICT based instruction teaching model to improve students' CTS and GSS. This paper is a part of the research.

II. Teaching Implementation

Multimedia for E-learning had been developed using macromedia flash platform for the instruction. This multimedia is a computer software teaching model on chemical equilibrium phase one component system. This software can detect the students' conceptual understanding and make the finger print of learning. Therefore, through this software, lecturer is able to know weaknesses and students' conceptual understanding as soon as possible, before students start the teaching.

E-learning software has two kinds of menu, condensation and decomposition menus. Each menu consists of two activities, such as experimental and theoretical activities. The experimental presentation provide video clip of experiment activities. This virtual experiment consists of two-recorded real experiments. The first, one component system of gas-liquid described experiment of condensation and evaporation, whereas the second that of gas-solid described experiment of sublimation and decomposition. Objective of this type is detection of the observation skills of students toward the existing phenomenon, and substitute the real experiments to virtual experiments.

In addition, theoretical presentation consists of a number of interactive texts that represent the topics, and its might have simulation of interactive graph. The interactive text consists of a number of probing questions that were used to guide students toward finding the concept through constructivism. Each number of questions has two options, and each answer will continue sequentially to the next question. Algorithm of the program showed in Figure 1.

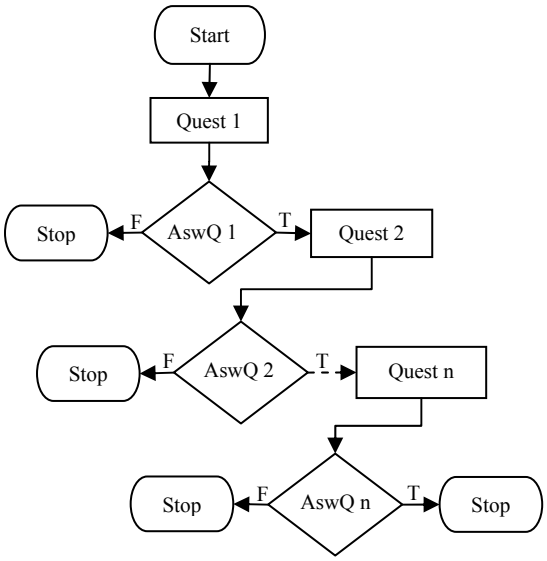

Figure 1: Algorithm of the probing strategy

If student answered, true or false, computer will continue to the next question without any comment, but it will make and record the score. Computer will count and save any students score. At the end of the topic, students can check the total score. This result is a prerequisite to follow the evaluation of conceptual understanding.

Both condensation and decomposition topics have a simulation of interactive graph (Figure 2). Using this method, students can manipulate variables of the graph.

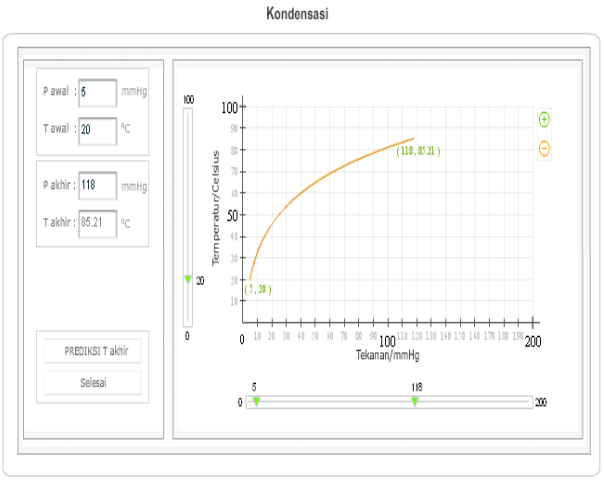

Figure 2: Simulation of interactive graph

Through simulation, students learn the equilibrium of condensation or vaporization phenomena using the graph. They can manipulate variables of graph by input data or drag the arrow.

The research was conducted in one of LPTK at Bandung. Method of this research was quasi experiment, with one group pre-post test design. There are 26 participants of Physical Chemistry I course (chemical thermodynamics and chemical equilibrium class) become the sample of the research.

The first step of the course was implementation of pre-test. This test intended to know the initial conceptual understanding. Having taken this test, then the second step, students attended the course using internet in the computer laboratory of Directorate of Information and Technology of the LPTK. Finally, at the end of course students conducted post-test.

The pre/post-test data obtained were analysed based on percentage of the students CTS and GSS. This percentage produced by transformation the amount of students who had true answer to the total of students. This percentage showed the effectiveness and efficiency of the teaching. On the other hand, observation ability of the student on virtual experiment had been scored.

III. Result and Discussion

A. Students' CTS ability

Result of data analysis shows the students' CTS (Figure 3).

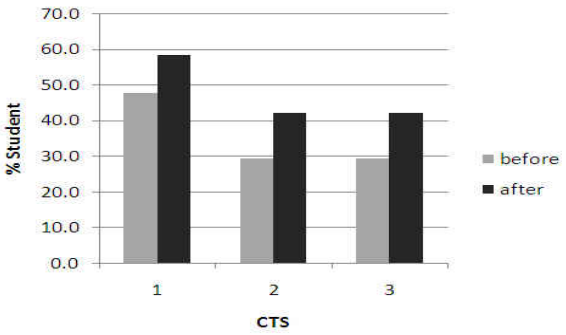

Figure 3: Students' CTS

More detail, the students' CTS data of this figure show in Table 1.

Table 1: Percentage of Students' CTS

No	CTS	before (%)	after (%)	Increasing
1	deducing and judging deductions	47.7	58.5	10.8
2	defining term and judging definitions	29.5	42.3	12.8
3	identifying assumptions	29.5	42.3	12.8
average of students		35.6	47.7	12.1

This research developed abilities of CTS according to Ennis [5]. Result of the study there are three CTS, which suitable for developed through one component system of chemical equilibrium phase, those are deducing and judging deduction, defining term and judging definition, and identifying assumptions.

According to data, amount of the students in each CTS before teaching were very low; there were only 35.6% students. However, after the implementation of the teaching model, there were increasing number of the student who has those skills; there were 47.7% students. This means that usage of the model can increase the amount of students who has of those CTS; there were 12.1% in average increasing of the students.

The highest skill of the student was the deducing and judging deductions, 58.5% students. This is inference skills. On the other hand, "defining term and judging definitions ability" and "identifying assumptions" are only 42.3% students. Both of abilities are advanced clarification skills. Therefore, students' mastery of inference was better than advance clarification skills. This situation means that students have difficulties in advance clarification skills. In this case, they had difficulties to find out the equivalent expression of the statement, to operate the mathematical equation, to identify and handle equivocation, and to identify assumption.

B. Students' GSS ability

There were two kinds of data that described competence of GSS, virtual experiment and theoretical aspect. The experiment aspect described observation skill of the student. On the other hand, theoretical aspects described logical self-consistency of natural law logical inference, interpretation of graph, concept formation, and causality.

Video clip could help students to get the observation competency. There were two video clips those will be able to describe observation skill in experiment phenomenon of decomposition/ sublimation and condensation/evaporation aspect. In this activities, students did not do pre-test. They only observed the phenomenon, and then answered the question according to the virtual experiment showed. According to data, the observation skill about decomposition phenomenon ($\bar{X} = 70.1; SD = 15.07$) was better than condensation phenomenon ($\bar{X} = 51.8; SD = 15.18$). These results indicate that student competency on observation was influenced by the visibility of the phenomenon. The decomposition phenomenon is very clear, easy to observed, and interesting, whereas condensation phenomenon is not.

There were five kinds theoretical aspect of students' GSS, i.e.: (1) logical self consistency of natural law, (2) logical inference, (3) causality, (4) interpretation of graph, and (5) concept formation. These data show in Figure 4.

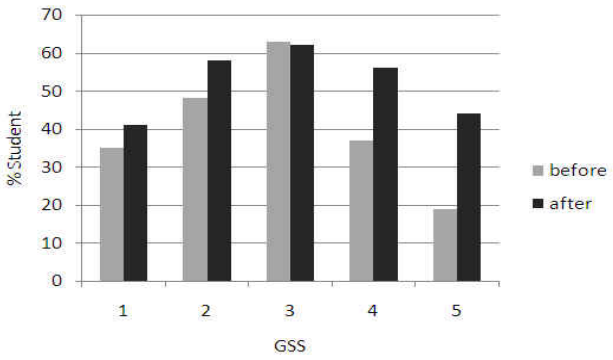

Figure 4: Students' GSS

More detil, the students' GSS data of this figure show in table 2.

Table 2: Percentage of Students' GSS

No	GSS	before (%)	after (%)	Increasing
1	logical self consistency of natural law	34.6	41.3	6.7
2	logical inference	47.7	58.5	10.8
3	causality	63.5	61.5	-1.9
4	interpretation of graph	37.2	56.4	19.2
5	concept formation	19.2	44.2	25.0
average of students		40.4	52.4	12.0

Data show that there were 12.0% in average increasing of students who master GSS, from 40.4% before teaching model treatment to 52.4% after that treatment. This means that, although there were only 12.0%, usage of the model can increase the amount of students who had of those GSS.

In complete the model could increase almost all of the GSS, such as logical self-consistency of natural law (6.7%), logical inference (10.8%), interpretation of graph (19.2%), and concept formation (25.0%). Therefore, the highest increasing of the ability occurred in concept formation skill.

The exceptional result was causality. There was a small decreasing (1.9%) of students' GSS. It seems that 61.5% was a maximum of the result. It showed that some students had been confusing about the causality skill by this teaching model.

According to findings of the study, there was a new ability of the GSS i.e. interpretation of graph. This ability complements to Brotosiswoyo views. Therefore, according to the teaching model, topic of one component system of chemical equilibrium phase could supply six kinds of GSS, such as observation, logical self-consistency of natural law, logical inference, causality, interpretation of graph, and concept formation.

IV. Conclussion

According to the result, it was concluded that: (1) video clip of experiment really help students to get the competences of observation, this is one of the important GSS; (2) interactive text and simulation of interactive graph can increase students' CTS and GSS; (3) there were three CTS developed by this model, those are deducing and judging deductions; defining term and judging definitions; and identifying assumptions; meanwhile, (4) the model could develop GSS i.e. logical self-consistency of natural law, logical inference, causality, interpretation of graph, and concept formation.

According to this data, ICT based instruction of Chemical Equilibrium Phase could improve CTS and GSS of the students.

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Onlineboard Learning Support System

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***Abstract*— The growing of information technology has impact on implementation of distance learning, so that the learning activity becomes easier with higher quality as well as better performance of network to enhance the education quality. In this paper we introduce a concept of Onlineboard to support collaborative learning on Web. The Onlineboard is a shared workplace for sharing notes, images, drawings and chat over the internet/intranet, to support an effective learning activity based on collaboration between teacher and students in distance learning. Teacher could use this tool in order to describe a learning material more detail collaborating with students who are enrolled in a course. Using this tool the teacher remotely and synchronously not only could explain a learning material similar as condition in the conventional classroom, but also asynchronously make collaboration with students in two ways direction between them. In other word, the proposed tool has many advantages for implementing distance learning based on collaboration learning.**

***Index Terms*— Internet, Onlineboard, Distance Learning, Java, Collaboration.**

I. INTRODUCTION

Computer Supported Collaborative Learning (CSCL) using advance information technology such as Web-based contents delivery technology over internet or intranet is able to provide a virtual learning environment where anyone from all every where at worldwide scale could access and participate in online learning or education at lower cost to get more knowledge synchronously or asynchronously.

E-learning is one of alternative methods at each level of education in order to improve the quality and the productivity of education itself. In higher education, we will face many problems when using traditional method of education, because the participators come from different background of work with limited time. Therefore, to cover this kind of problems is facilitating a virtual space for learning where they can participate in it from their each place connected to the network.

In general, there are two types of distance learning according to time of usage of system; synchronous and asynchronous [1]. Both of them have each advantages and disadvantages. The presentation using Onlineboard is a synchronous process to conduct learning together in the same time, but also it is an asynchronous process to review and reuse the result of a presentation. In the future, the better infrastructure of network, there would be more demand of real time software application of e-Learning that should be considered in implementation of Onlineboard.

Collaborative learning is a type of a group learning that plays important role in sharing knowledge each others by transferring opinions among students or between teacher and students [3][4], because the learning process in collaboration always is performed in two ways between teacher and students or between students. All students could be motivated to be more active in acquiring knowledge although they are learning the same theme from the separated place connected to internet/intranet.

Web E-Learning System called WebELS [2] is a e-Learning platform in which teacher could put learning material in the system using many formats of document such as word file, power point file, and adobe pdf file. Teacher could also rewrite learning material directly using the editor tool provided in WebELS. In this paper, we introduce a new embedded tool for WebELS called Onlineboard that facilitates teacher and students to prepare and to do a presentation of a learning material on Web using graphic and text in real time. Onlineboard is also to support collaborative learning activity among students so that students could get more knowledge.

In the higher education level such as post graduate program, the collaboration between users in education activity plays important role to share their knowledge among them and to change opinion each other about a theme. This method not only encourages students to show and to explain what they are thinking in mind, but also it is useful to correct each other about the knowledge they have, because without conducting collaboration their knowledge would be stagnant and have a lack of correctness.

One of the most important collaboration methods in higher education is presentation. Many learning materials for examples journal, research report, etc can be used for presentation. After learning these learning materials, students would make presentation of it based on their each point of view. During the presentation there would be a discussion between them under teacher's control, to change opinion each other about a theme, to correct it

each other, and also to develop their knowledge. The discussion of a theme in the same time usually is limited to achieve satisfied knowledge, so that it should be continued in different time asynchronously.

Therefore, our research concentrates on developing Onlineboard tool to support such learning activity described above. This tool is able to be executed at many platforms of operating system and network, in order to support e-Learning system on Web. This kind of tool is necessary to be implemented in distance learning system using general network platform such as internet or intranet, so that many users who will act as student or teacher have the same chance to use it for conducting learning activities in real time. This is the basic consideration on developing Onlineboard in order that many users are allowed to participate in a group to make collaboration of e-Learning easily via internet/intranet with different bandwidth of network.

II. ONLINEBOARD

Onlineboard system has been constructed based on Web using Client/Server model, basically we use Java as core technology for developing it.

Onlineboard is a software for a meeting. The one we present is part of WebELS. The whiteboard we present is a means of sharing notes, images, drawing, and chat using voice/text over the internet/intranet as an effective support tool for e-Learning and communication between education people.

A. Features

The benefits of our tool in supporting distance learning should be clear because the distance learning especially the synchronous type needs this kind of tool into order to help collaboration between teacher and students or between students only, in enhancement of student's knowledge acceptance.

There are many advantages of our Onlineboard in general as follows:

- Anyone, anywhere, anytime availability. Teacher and students using computer connected to internet are allowed to access into our system, and participate in learning using Onlineboard. The system automatically synchronizes the current content of Onlineboard for students who participate in it lately.
- Combination of synchronous and asynchronous mode of distance learning. Using synchronous mode, users can select text or voice chat to communicate between them.
- Multiple mode of education, as standard Onlineboard supports synchronous online presentation in a group of the same user class. But users are also allowed to use standalone mode when they want to review of the result of past presentation asynchronously, so that users could find benefits from the past knowledge generated from discussion of presentation's theme.
- Multiple purpose, this tool can be used not only for e-Learning, but also for multiple proposes of presentation such as online meeting.
- Multiplatform, we use Java based platform in system development, so that user of this system can use different web browser on any platform of operating system.

B. Functions

Onlineboard has many functions to support efective learning on Web. First, we need to create the basic functions to implement Onlineboard similar to the conventional whiteboard as described before, and then add typical functions of Onlineboard on Web. The supported functions are as follows:

- Slide Presentation for Power Point learning material.
- Drawing kinds of objects and Writing comments. All objects can be resizes, removed, moved, and changed their properties.
- Multi pages with navigation tool. Many pages are available to support course that needs multiple contents.
- Storing all contents in the Web Server.
- Selectable modes are standalone or group learning mode. Standalone mode is useful for students to learn according to their condition.
- Annotation text per page, to write any additional important description related to each page of presentation.
- Chat by text and chat by voice tools. According to the network condition users can choose one of these two types of chat tool.
- Asynchronous Q&A regarding each page of presentation in order to improve understanding of learning material. This function is benefit especially when student learns at self-paced in standalone mode.

C. Learning Process

Onlineboard is an alternative tool to perform collaborative learning on Web. It provides the learning space in which the students are able to acquire and to improve knowledge through collaboration between them.

Onlineboard can be used without installing additional software because it is developed using java technology of applet so that it can be executed on many platform of client computer using Web browser. To use Onlineboard users are required to follow the learning process as described in Figure 1. First, the student has to select a course to participate in it. After that, the student has to select mode whether to acts as presenter or as listener. During collaboration they can change their mode. However, if the teacher wants to use Onlineboard, after he selects mode as presenter, all students will be set as

listener. All questions related to content of Onlineboard will be stored using Q&A tool, and can be used later in learning asynchronously.

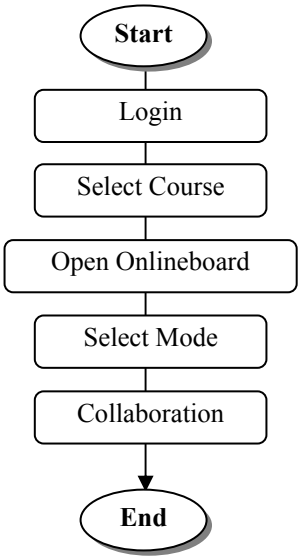

Figure 1: Learning Process

III. System Configuration

Figure 2 describes our system that basically is separated three modules as follows.

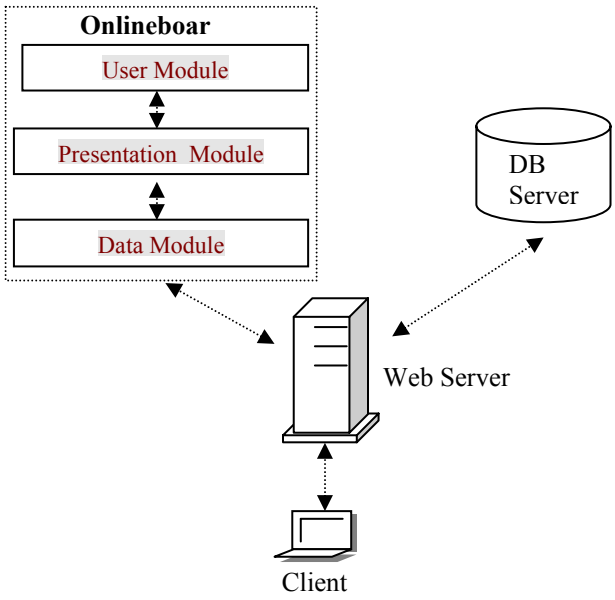

Figure 2: System Configuration

User module, it controls user access, decides the user mode and allocates user into a session of course.

Presentation module, it controls which data to be displayed and to be distributed to all users in the same session of course. Basically there are two kinds of data used in Onlineboard; one for contents of presentation, and another for controlling the session.

Data module, it has functions to manage data used during presentation, and to save data for reusing in the future when users need to review the past presentation's contents. Leaning data includes uploaded learning materials such as pdf file, power point file, html file, text file that saved in the file system of Web server. On the other hand, some of data required by system to manage learning process, text based chat data are stored in the database server.

The data of all courses used for Onlineboard will be under the control of Web Server. This design differs than similar system such as NetMeeting[5], Breeze[6], and Lotus Sametime[7] that manage data without using Web Server. It is considered to keep client users' resources at minimum, and also to make management of courses easier. All data of courses are stored in database server and Web server. Users download these data related to a course they want to participate in it.

Client-Server architecture is basic design in developing Onlineboard tool. Many users can access into the server and use our system from their Java-enabled Web browsers to observe and participate in learning. The server application components are as follows.

SERVER SIDE		
OS	:	Linux, Windows
Programming	:	Java, JSP
Database	:	MySQL
Web Server	:	Tomcat powered by Apache
Others	:	XML, HTML
CLIENT SIDE		
Browser	:	IE, Firefox, Safari

We have been developing our system using Open Source Software, and Java especially is selected in our research as programming language in order that the Onlineboard could be executed in different platforms of operating system using applet.

IV. Implementation

Onlineboard is implemented basically using java technology of applet in order that this tool can be executed in many client platforms of operating system using Web browser.

As shown in Figure 3, currently we have e-Learning platform of WebELS, and Onlineboard is embedded in it which has function of text and voice based communication between users via internet/intranet. However, Onlineboard can be used not only for distance learning using WebLS, but also can be used as independent tool for supporting other collaborative learning system, because it is developed as separated software module. It can be embedded with other system to perform online presentation.

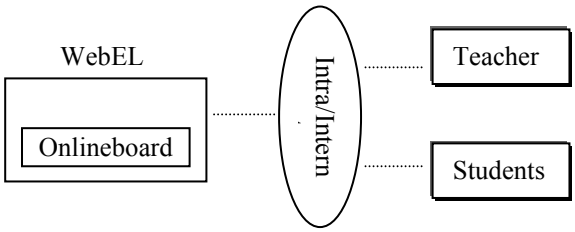

Figure 3: Whiteboard Position in WebLS

The main interface of Onlineboard consists of two tabs, one for Online Presentation, and another one for Onlineboard. Each form as shown in figure 4 is divided into three parts.

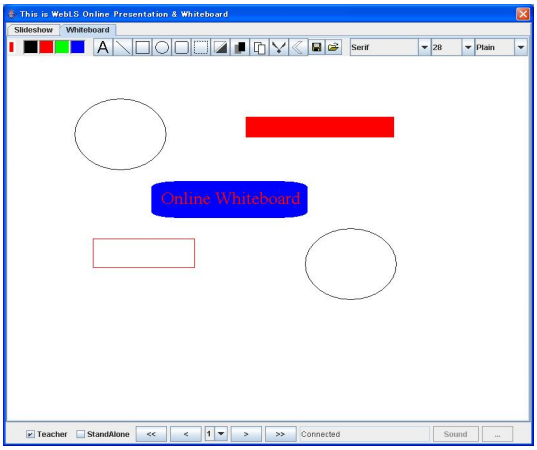

Figure 4: Online Whiteboard Interface

Upper part is drawing tool where users can choose basic and simple operation of board application for example drawing shape, line, and writing a text with different colours.

Middle part is for displaying the contents of presentation or whiteboard. It is the main frame of Onlineboard where user can create important information here during communication with others. Each shape is an object so that users easily can change the size, move the position, copy it, erase it, and other manipulations.

Lower part is for controlling communication between users. It consists of displaying page/slide number, communication mode group/standalone, presentation navigator, and voice chat.

The other text based collaboration forms are also displayed in the separated window as shown in figure 5, where users (students and teacher) can communicate each other about a theme related to the course. These two forms are chat form and asynchronous Q&A form.

Chat form mainly includes additional explanation from the presenter to all participants about the content of learning material displayed on Onlineboard. If the page on the main Onlineboard changes, automatically it will be displayed on the chat form. It is also available to confirm an online question related to displayed page just clicking the button of question mark / "?".

Q&A form that users make a text of question regarding each page of Onlineboard. This form will be appeared by clicking the button of "AsyQA". Moreover, the question and its answer also can be done asynchronously after the presenter finished the online synchronous presentation.

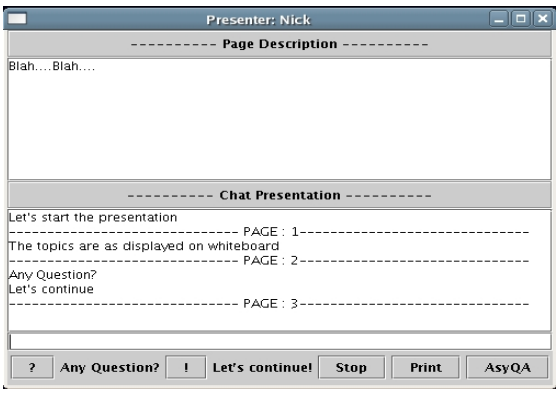

Figure 5: Onlineboard's Chatting Tool

V. CONCLUSION

Onlineboard is an alternative useful tool to conduct e-Learning based on collaboration among participants, to acquire better knowledge as well as to improve the quality of education using distance learning on Web. Users can use this tool without installing additional software because this tool is developed using java technology of applet so that it can be executed on many platform of client computer using Web browser.

In current research we focus on Onlineboard using chat of text and/or voice as two ways communication. In the future, we have to consider other multimedia function so that collaboration learning will be facilitated with other media such as video, and to improve the performance of it. We are also planning to add the function of recording voice and video as alternative annotation tool. This kind of function could be useful for teacher and student to prepare an online presentation with text and voice in order that learning process more interesting as well as more knowledge could be accepted.

More experiments are needed to be conducted to check and to improve the performance of our system in many different platforms environment of network and in large scale of learning environment, and also to capture more users' requirements so that we could realize more satisfied Onlineboard for supporting collaborative e-Learning on the Web.

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Competencies Based Knowledge Management Model with Learning Style Approach for Empowering Rural Society

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***Abstract*—Information and communication technologies in Indonesia have been developing rapidly in last decade. One of the roles of information and communication technologies is as transfer media of knowledge in a community. Knowledge is made always available for community elements by providing interactive processes based on infrastructure support of information technologies. The research is trying to study the prospect of information and communication technologies as the enabler of empowering rural societies. In spite of that, by approaching on the rural society characteristics, there is a need to pay attention on the pressure to elements of society in face of change of technology and speed of information streams. Thus, there is a requirement for systematic knowledge management perspectives which not only focused on the efficiency and effectiveness of knowledge storing and distribution but also on selection of the source of knowledge substances, recognition of specific knowledge needs, and delivery mechanism of appropriate knowledge. The paper will provide a view and a conceptual model of rural society knowledge management based on the concept of competencies and the concept of learning style. The first concept will have two roles that are as the mechanism for choosing competent agents as the source of certain knowledge substances and as the mechanism for recognizing knowledge needs to avoid information explosions. The other concept will be used as base in determining the effective knowledge delivery mechanism for specific targets.**

***Index Terms*—Competency, Knowledge Management. Learning Style, Rural Society.**

I. INTRODUCTION

Information and communication technologies in Indonesia have been developing rapidly in last decade. But, the development is still "urban-oriented" and information and communication technology exposure in rural area is very low. Direction of the development is surely not in line with principles and the plan of action of the first World Summit on Information Society in Geneva on 2003, the development of information and communication technology is for all.

One of the roles of information and communication technology is as transfer media of knowledge in a community. There are abundance of literature declare knowledge as main factor of competitive advantages [1]-[3]. Knowledge is made always available for community elements by providing interactive processes based on information technologies.

It is very difficult in current time to define an area as urban area or rural area. In order to categorize an area as urban or rural, there is a need to view multiple indicators such as main livelihood, social stratification, heterogeneity level, and interaction pattern.

Rural area, especially in Indonesia, usually consists of relatively small and permanent communities where individuals are tied by family relationship and surrounding environment. There are some distinct attributes of rural community which directly or indirectly as inhibitors in increasing information and communication technology development. The attributes are low income and education level, mental attitude to knowledge which not yet constructive, passive attitude and lack of creativity, lack of competitive spirit, and fanatism toward experience and knowledge of the past.

Based on those attributes, communication pattern which usually used in course of knowledge sharing between community elements is conducted with face-to-face interpersonal communication. Thus, rural society grows as listener society. As listener society, the correct method of forwarding information is by using extension agent or information carrier which submitting knowledge by oral. This method surely has weaknesses because very base on competencies of information carrier. The required competencies are not merely technical competencies regarding submitted information but also soft competencies in sharing knowledge and influencing others.

On that account, this research will try to develop a knowledge management model based on competency requirements. The model will be completed with learning style approach which will be explained in future sections.

II. STATE OF THE ART

A. Knowledge

Davenport and Prusak (1998, p. 5) was defining knowledge in community enterprises context as "*a fluid mix of framed experience, values, contextual information,*

and expert insight that provides a framework for evaluating and incorporating new experience and information. It originates and is applied in the mind of knowers. In organization, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms" [4].

Webster Dictionary (1976) was giving a definition of knowledge as a condition of mental understanding processes through instruction, study, research, or experience of one or more event, fact, principal or perception to an object.

Knowledge can be differentiated into four main categories: (1) descriptive knowledge which also known as the knowledge of *know what*, (2) technical or procedural knowledge which also known as the knowledge of *know how*, (3) analytical/theoretical knowledge which also known as the knowledge of *know why*, and (4) creativity [5]-[7].

Besides above knowledge categories, there is relevant knowledge category for rural society which called indigenous knowledge. Indigenous knowledge is traditional and local knowledge which owned by a group of people which is live on certain area for a long duration [8]. This knowledge has the character of collectivity, experiential, and subjective [9].

Information and communication technologies facilitate speedy data, information and document exchange and in a certain degree facilitate documented knowledge transfer. When speed of transfer of information and data increase, emerge new challenge in selecting data, information, and documents.

According to Nonaka (1994), knowledge can be classified into two dimensions that are tacit and explicit. Explicit knowledge could be transmitted in a formal system because easy to be recorded in archives or databases. Tacit knowledge, on the other hand, entangles cognitive and technical elements, so it is difficult to implement the knowledge into formal system.

B. Knowledge Management

Challenges for knowledge manager are consist of organizing knowledge resources and giving togetherness to all of knowledge owners in order to share explicit and tacit knowledge.

Knowledge management is systematic and specific process to obtain, manage, maintain, share, and renew knowledge in order to improve performance and create values [12]-[13].

Jonjoubsong (2008) declares that knowledge management can be considered with two approaches: artifact-oriented approach and process-oriented approach. The artifact-oriented approach focuses on system theory, information processing and use of information technology for codification of knowledge. From this perspective, knowledge is considered to be a visible product which can be codified and stored in computer systems. The process-oriented approach, on the other hand, focuses on knowledge creation. From this perspective, knowledge is managed through social interaction and requires a combination of humans and technology [14].

Nonaka (1994) defines knowledge activity model which focuses on conversion between tacit and explicit knowledge. According to Spiral Model which proposed by Nonaka, knowledge creation can be done in four modes: socialization (tacit to tacit), externalization (tacit to explicit), internalization (explicit to tacit), and combination (explicit to explicit).

Socialization mode is started from interaction between knowledge owner and knowledge receiver in order to share tacit knowledge, experience, and point of view.

Externalization mode is happened after dialog and discussion step which try to articulate point of view and tacit knowledge, and combine both with data and external knowledge into concrete and sharable knowledge specification

Combination mode is done by coordination between knowledge owner and existing documentation.

Internalization mode is related to explicit knowledge transformation into tacit knowledge by interaction and trial-and-error process. Figures 1 shows the spiral model which proposed by Nonaka.

C. Learning Cycles and Learning Styles

Conversion between tacit and explicit knowledge could be considered as learning process. The success in this changing world requires ability to explore chances and learn from failure and success of the past.

Kolb (1976) explained a model of how human learns which called experiential learning model [15]. In this model, learning process was modeled as a four stages cycle. Figure 2 shows the model.

Principle of Kolb's Learning Cycle is that human being follows four stages in learning and obtaining knowledge, experiences, and skills. The stages are Concrete Experience, Reflective Observation, Abstract Conception, and Active Experimentation. Concrete experience is a base for observation and reflection. Observation results will be assimilated into theory of abstract conception where the implication of action could be deducted. The implication or hypothesis is actively tested later by experiment. Concrete experience from the experiment will start the learning cycle over [15].

With those explanations, we could assume there is a linkage between learning cycle which proposed by Kolb with spiral model of knowledge management activities which proposed by Nonaka. Learning cycle model could be seen as internalization mode and externalization mode which are happened inside the learner.

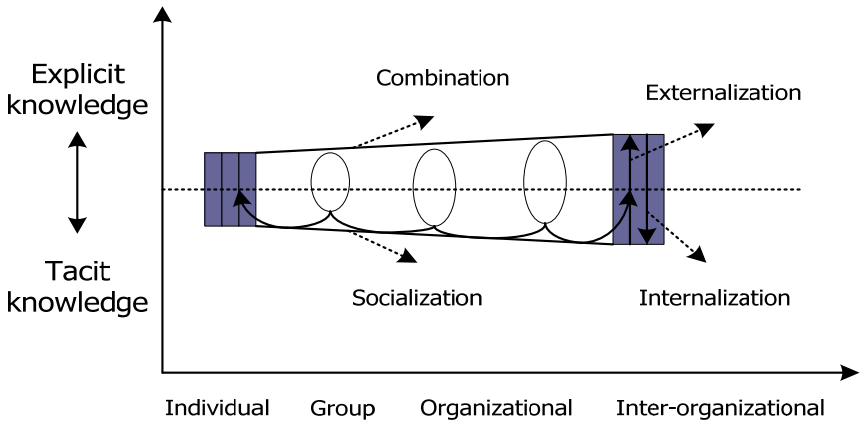

Figure 1. The Spiral Model of Knowledge Creation [10]

Every individual have tendency toward particular knowledge internalization and externalization processes as a consequence of different learning style. Kolb defined four basic learning styles which are based on research and clinical observation on score pattern of Learning Style Inventory (LSI) tools [16]-[18]. Table 1 shows relation between learning styles and learning cycles.

D. Competency

The next challenge in knowledge management process is to identify competent individual as source of knowledge.

Spencer & Spencer (1993, p.9) defined competency as human basic characteristic from real experience (showed in behavior) and being found to influence or could be used to predict (level of) performance in workplace or ability to overcome problems in certain conditions [19].

By recognizing competencies as human basic characteristics and using the concept as a basis in knowledge management for rural society, we could create knowledge management with certain characteristics:

1. Knowledge comes from individual who has competency on the knowledge.
2. Agent who acts as knowledge source or supplier will actively being selected according to practical skills, then gathered knowledge is already selected by source and quality.
3. Knowledge distribution activities could be very selective and only for individual who need and/or has interest on the knowledge, so knowledge "junk" could be prevented.
4. Knowledge user will not suffer information and knowledge explosion (overflow of knowledge and information) but will receive selected and tested knowledge from competent-proved source.
5. Knowledge user will act as knowledge transfer media who actively selected according to his/her competencies level for sharing knowledge.

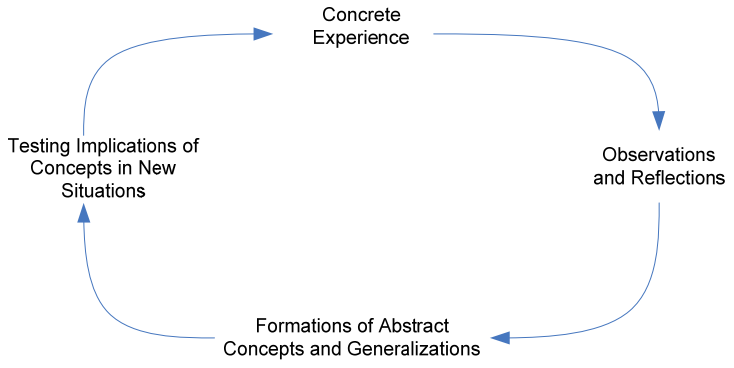

Figure 2. Experiential Learning Model [15]

Table 1. Relation between Learning Styles and Learning Cycles (resumed from [15])

Learning Style	Learning Cycles	Short Description	Detailed Description
Diverger	Combination of Concrete Experience and Reflective Observation	Feeling and watching	Have a strong imaginative ability, excel in the ability to view concrete situations from many perspectives, performs better in situation that call for generation of ideas, interested in people, tend to be imaginative and emotional, have broad cultural interests, tend to special in the arts, characteristic of managers from humanities and liberal arts background such as personnel managers
Assimilator	Combination of Abstract Conceptualization and Reflective Observation	Feeling and thinking	Have a strong ability to create theoretical models, excel in inductive reasoning, less interested in people and more concerned for abstract concepts, less concerned with the practical use of theories, characteristic of basic sciences rather than applied sciences, found most often in the research and planning departments
Converger	Combination of Abstract Conceptualization and Active Experimentation	Doing and thinking	Have a strong practical application of ideas, best in situations on conventional intelligence tests where there is a single correct answer or solution, focus on specific problem, hypothetical-deductive reasoning, relatively un-emotional, preferring deal with things rather than people, narrow technical interests, characteristic of many engineer
Accommodator	Combination of Concrete Experience and Active Experimentation	Doing and feeling	Have a strength in doing things and carrying out plans and experiments, tend to be risk taker that the other learning styles, excel in situations where must adapt to specific immediate circumstances, in situation where the theory or plan do not fit the facts will likely discard the plan or theory, at ease with people but sometimes seen as impatient and pushy, characteristic of action-oriented jobs such as marketing or sales

III. Proposed Knowledge Management Model for Empowering Rural Society

A. The Differences between Formal and Rural Knowledge System

Hess in "*Reader: Knowledge Management and Knowledge Systems for Rural Development*" declared that one of reason of information transfer failure in rural areas is the clash between knowledge system [20].

Agricultural experts acquire knowledge which is generated from formal education settings (school, university, research institute) and circulated through the global network of professionals, institutions, and publications ([21] in [20]). This system is called formal knowledge system.

Farmers have usually received little formal education. They acquire knowledge by customary practice, trial-and-error experience. They learn what they know from the social and cultural group they live with. This system is called indigenous knowledge system. Indigenous knowledge systems are complex and embedded in traditional and customary practices [20].

Knowledge transfers within one knowledge system, either formal or local, are relatively easy. However, transferring knowledge from different knowledge system is very difficult because the transferred messages do not much sense within the other knowledge system. Figure 3 will illustrate the phenomenon [20].

On that account, information or knowledge carrier (e.g. agricultural advisor) as the bridge between both knowledge systems must have soft competencies in enough level besides technical competencies about particular information or knowledge.

B. Proposed Model

Pursuant to study about various models and concepts around knowledge management, this research try to give a preliminary model addressed as enabler of rural society empowerment. Figure 4 shows all components of proposed knowledge management models. On the following section, the model will be explained in detail based on the Spiral Model of Nonaka.

B. 1. Externalization Mode

This mode is conversion process from tacit knowledge which is owned by knowledge source into codified explicit knowledge.

In this mode, competency assessment is conducted to select competent knowledge source. Besides that, competency assessment will arrange a competency profile for all of knowledge sources. The profile will be used as filter which knowledge could be entered into content management system by certain knowledge sources. Content Management System (CMS) will act as explicit and documented knowledge repository.

B. 2. Combination Mode

This mode is conversion process from explicit knowledge which is entered by knowledge source into explicit knowledge which is formed by codified information of content management system.

The codified information will then being organized and structured based on existing information and documentation structure.

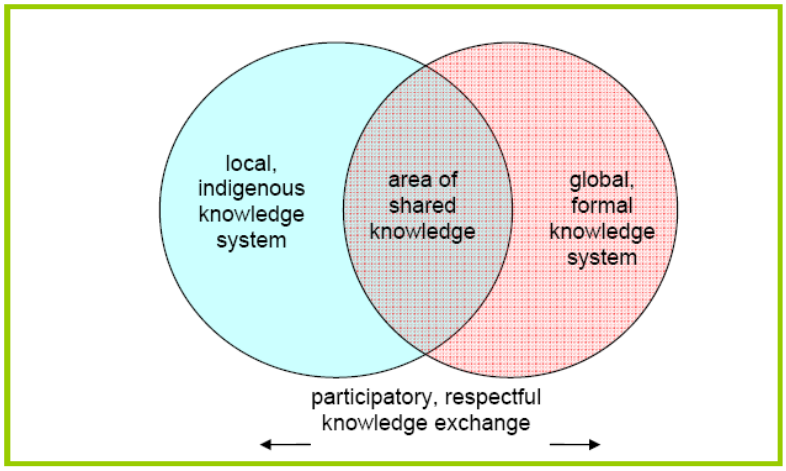

Figure 3. Intersection between Formal Knowledge System and Local Knowledge System [20]

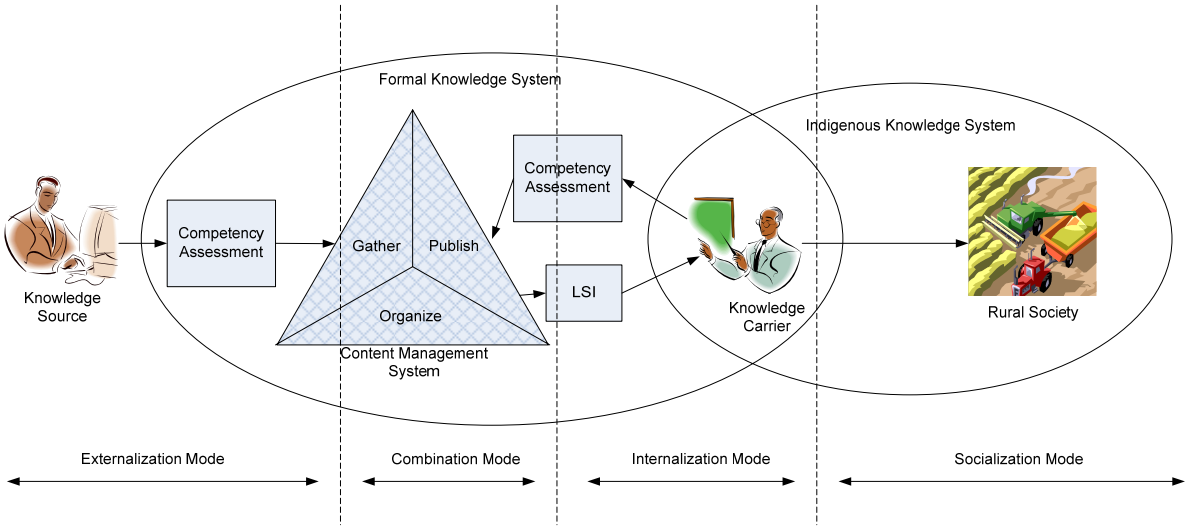

Figure 4. Knowledge Management Model for Empowering Rural Society

B. 3. Internalization Mode

This mode is conversion process from published explicit knowledge which exists in content management system into tacit knowledge which is resided in knowledge carrier. Knowledge carrier will be the connector between formal knowledge system and indigenous knowledge system.

Knowledge carrier will be tested by competency assessment to measure two things: (1) level of competencies for sharing knowledge (*soft competencies*) and (2) level of the need of knowledge or level of interest for particular knowledge in order to avoid information overflow (*hard competencies*).

Beside that, knowledge management system will try to detect the learning style of knowledge carrier with Kolb's Learning Style Inventory (LSI) tool. The style will be used to decide suitable way to serve information from the content management system.

B. 4. Socialization Mode

This mode is conversion process from tacit knowledge of knowledge carrier into tacit knowledge for rural society. The mode needs certain level of soft competencies in order to transform information as compatible messages for indigenous knowledge system.

Knowledge conversion process is done by dialog between knowledge carrier and rural society with certain approach. The approaches are [20]:

1. build up mutual trust and respect,
2. develop a common language,
3. create a shared knowledge basis,
4. welcome and appreciate other's knowledge (system),
5. show a learning attitude,
6. spend time together for exchanging ideas,
7. and spend time together working and investigating.

IV. Conceptual and Technical Considerations

Above model is still using dialog mechanism between knowledge carrier and rural societies because there is a need to pay attention on the pressure to elements of society in face of change of technology and speed of information streams. On the implementation, cultural transformation which is triggered by technology is done step by step in order to minimize the pressure. If rural society is directly connected to the knowledge management system then there will be a clash between different knowledge systems.

Knowledge management model will function better if there are operational and supportive systems. First, process of gathering knowledge and learning is accompanied with knowledge codification and content management tools which support effective learning. Second, process of gathering knowledge and learning is supported by a reward and incentive system, especially for knowledge source whom creates new knowledge.

Beside that, the model operational process better accompany with the financing support, information and communication technology support, and competent human resources in operating technology.

V. Conclusion

The model which is proposed in this paper is a preliminary model based on the result of study about existing model and concept around knowledge management and the consideration about rural society characteristics.

To gain maturity of the model, there is a need of future research with more practical approach and case study to test fitness of the model.

Knowledge management model have to be refined with modern knowledge management concepts such as networked knowledge distribution, supporting systems, and study about differences on socio cultural factors, especially in diverse Indonesia rural societies.

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A Conceptual Model of Indonesian Virtual Herbarium (IVH)

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***Abstract*—Indonesia has the world's second richest biodiversity. A virtual herbarium is a way of preserving any information related to the biodiversity, especially the vegetational biodiversity in order to share the information for scientific, economic, and ecological purposes. Our research is aimed at providing an Indonesian Virtual Herbarium (IVH), an open sourced web application that provides information on Indonesian flora as well as a way to maintain the data. A conceptual model, consists of a use case model and a conceptual data model, is described. The model is the basis of further design and implementation process. A prototype will be constructed based on detail design and implementation model and will be tested using medicinal plant data of Toba Samosir region of North Sumatera.**

***Index Terms*—Biodiversity, virtual herbarium, conceptual model, Indonesian Virtual Herbarium (IVH).**

I. INTRODUCTION

Indonesia has the world's second richest biodiversity (second only to Brazil) due to its size, tropical climate, and archipelagic geography [8],[9]. Located in between the continent of Asia and Australia, Indonesia's flora comprise from an intermingling of Asian, Australian, and native species. Varieties of regions, from tropical rain forests to seasonal forests, from hill and mountain regions to swamps and coastal regions, support a huge vegetational biodiversity. Indonesia is the home of an estimated of 38,000 higher plants species including 477 species of palms with 225 of them endemic which is the highest of the world list. There are around 28,000 species of flowering plants in Indonesia, as well as 6,000 traditional medicinal plants, 122 species of bamboo, 400 species of *Dipterocarpus*, including ebony, sandalwood and teakwood, and some unusual species such as *Rafflesia arnoldi* [8],[9],[18]. Indonesia is also the home of a large number of agricultural crops.

There is no question on the priceless scientific, economic, and ecological values of this world heritage; not only for the people of Indonesia, but also for the rest of the world. Thus, all information related to the plants is required to be preserved in order to share the knowledge to the world. This knowledge is important not only for scientists, but also for practitioners, e.g. people involved in agriculture, such as farmers.

A way to preserve this knowledge is by creating a herbarium. A herbarium is a collection preserved (usually dried) plants specimens which are mounted and systematically classified for study. A physical herbarium usually requires a relatively large space and thus, can contain only limited number of plants; while there are a vast number of plant species that must be recorded for preservation and research purposes. Thus, the idea to put all information about plants on computer, using the idea of a virtual herbarium or simply a vegetation database, emerges. The information about the plants is stored multimedia forms such as text, image, and sound. To share the information, websites over the Internet are used.

These virtual herbaria usually accompany their physical counterparts to provide access of information about the collections to the public. With the vastness of space provided by the computer, virtual herbaria may provide a lot more information than the physical ones.

The aim of our research is to provide an Indonesian Virtual Herbarium (IVH), a open sourced web-based application which considers not only how to provide information about Indonesian flora, but also how to maintain (insert and update) information regarding to the vegetation species. Indonesia is the home of a number of physical herbaria such as Herbarium Bogoriense (the oldest and largest herbarium in South East Asia), Herbarium Bandungense of Institut Teknologi Bandung (ITB) [16], Herbarium Celebense of Tadulako University, Herbarium Balikpapan, etc. Most of these physical herbaria are not yet equipped with virtual herbaria that provide information to the public on the collections of the herbaria.

Although there are a number of international virtual herbaria that provide access to some information of Indonesian flora, we believe that the people of Indonesia must provide themselves with their own virtual herbaria that are free and can be maintained by Indonesian experts.

This paper is intended to describe a conceptual model of the IVH version 1. Our conceptual modeling is based on object-oriented modeling method. It is basically the analysis model of the system. The main focus of this paper is to describe the requirements of the system, the global use case model, and conceptual data model. In the end, some considerations toward design and implementation are explained.

II. Related Works

A number of biodiversity information systems have been developed by organizations around the world which provide information on global or local biodiversity including the Global Biodiversity Information Facility (GBIF) [10], Biological Collection Access Services for Europe (BioCASE) [3], and Australia's Virtual Herbarium (AVH) [2],[19]. These information systems provide free access to the biodiversity data around the world and they are interconnected through standards of data exchange such as Access to Biological Collection Data (ABCD) [1], Darwin Core [7], and Herbarium Information Standards and Protocols for Interchange of Data (HISPID) [6].

In Indonesia, there are already virtual herbaria such as Herbarium Bandungense by Sekolah Ilmu dan Teknologi Hayati (SITH) of ITB which holds specimens from around Indonesia, especially West Java [16] and National Biodiversity Information Network (NBIN) [15]. Currently there is no Indonesian virtual herbaria that are directly connected as datasets of the international biodiversity information systems, such as GBIF.

III. Data, User, and System Requirements

Before discussing the conceptual model of the virtual herbarium, especially the IVH version 1, the requirements of the system must be provided. The requirements are divided into three categories: data, user, and system requirements.

A. Data Requirements

A virtual herbarium is a data-intensive application. Thus, it is important to properly define the structure of data. In a virtual herbarium, the following items of data must be stored and maintained:

- Taxon
  A taxon (plural: taxa), or a taxonomic unit, is a name designated to an organism or a group of organism in any taxonomy ranks (species, genus, family, etc.) [11]. Information that must be stored on a taxon is: the name of the taxon and the taxonomy rank of the taxon. Other items of information that can be stored for a taxon are: typical characteristics of the taxon, vernacular names of the taxon (i.e. traditional name, Indonesian name, English name if any), chemical substance, its uses, its images, etc. The location on which a taxon can be found or endemic should also be recorded. Some taxa (as well as their respective specimens) may be classified as restricted data that can only be accessed by certain group of people, e.g. some endangered species. Thus, taxon data can be divided into public and restricted data.
- Taxonomy
  Taxonomy is the scientific classification of animals and plants [14] (in this case we will consider only plants). Taxonomy organizes taxa into a tree-like structure based on the taxonomy ranks of the taxon. There are a number of ways to do taxonomy [4], but in IVH version 1, the traditional and most common classification by Carolus Linneaus is going to be employed [4]. Fig. 1 depicts some major taxonomy ranks and its hierarchy within a taxonomy tree. Each node of the tree is a single taxon. Thus, for example: a taxon of Species rank is actually an instance of a higher level of taxon of Genus rank. Note that only major taxonomic ranks are shown. There are a number of minor taxonomic ranks that must be put into considerations as well.

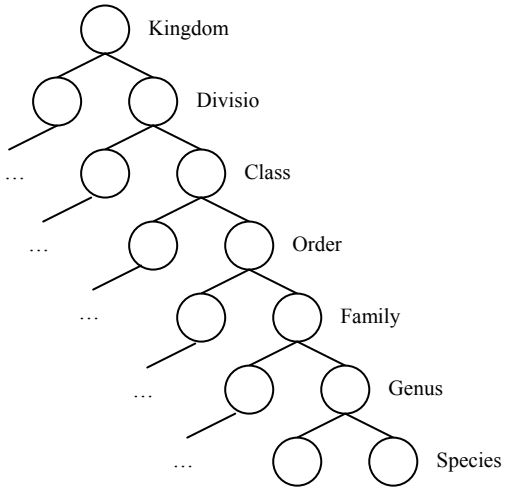

Fig. 1. The hierarchy of major taxonomy ranks

- Specimen
  A specimen is a sample of plant or part of plant used as a representative to study the whole population of a species or subspecies [17]. In a virtual herbarium, data of a specimen can be a representative of a physical specimen stored in a physical herbarium, or a living specimen, that is a plant that is still alive. Each specimen must be given a unique identifier. Some items of information that can be stored for a specimen include which species/subspecies it belongs to, its image, its physical location, its collector, date/time on which it is registered, its restriction level, etc.

To support these most important data, there are other items of data that should also be recorded including: site/location data, users and their roles data, but to avoid too many details we will leave out the discussions on these data.

Although for the first version of IVH we do not intend to provide connectivity to other systems, we pay a high attention to the standards of biodiversity/herbarium data provided by international organizations in order to make the IVH data compatible to those standards. The data recorded for the current version will be limited only to text and image data.

B. User Requirements

There are several types of users that will involve in the system:

- Public user: represents a user that can have access to view all public data.
- Registered User: represents a user that is granted an access to view both public and restricted data.
- Collector: represents an expert user that can propose new specimens to be stored in the virtual herbarium and edit specimens that they have proposed and have been verified by Curator. They are granted access to all public and restricted herbarium data.
- Curator: represents an expert user who manages all taxa and their taxonomy, as well as all specimen data. They can have access to all public and restricted herbarium data. They also have the right to verify new specimens provided by Collectors.

In addition, there is a group of users called Administrator who manages supporting data of the herbarium, such as user and location data.

For this first version, some important user requirements of the system are the following:

- Public users must be able to view and search data of a taxon, except for restricted data. They should be able to view the data according to the hierarchy of the taxonomy.
- Registered users, Collectors, and Curators must be able to view and search both public and restricted data of a taxon. They should be able to view the data according to the hierarchy of the taxonomy.
- Collectors must be provided with a way to propose a new specimen to the system. They must also be provided with a way to edit specimens that they have entered to the system.
- Curators must be provided a way to manage (add, edit, delete) all taxa as well as the taxonomy of the taxa.
- Curators must be provided a way to manage (add, edit, delete) all specimen data as well as a way to verify new specimens provided by Collectors.

C. System Requirements

The first version of IVH must be provided by a wide range of audience, especially for the people of Indonesia. Thus, we choose to use of the web technology. Furthermore, the IVH application/website must be provided in Indonesian, so that more Indonesians (including the ones with limited knowledge in English) can access the information. Nevertheless, the website must also be provided in English so that international community can still have access on it.

IVH will be provided open source so that other parties can use the system freely as well as develop the system for their own purposes.

The first version of IVH will not be connected to other systems. So, it will operate as a single virtual herbarium. This is intended to create a stable prototype and, furthermore, application, before stepping further into connecting with other systems.

IV. GLOBAL USE CASE MODEL

Based on the requirements, a global use case model is described as depicted in Fig. 2. This model provides the interaction between actors (types of users) and the system. There are four actors of the system which imply the four types of users described in the user requirements (see section III.B). Only important actors are defined in this section.

The IVH version 1 system consists of several use cases that for the sake of simplicity are not explained in details in this paper. The use cases are the ones that provide functionalities on which actors can carry out their tasks.

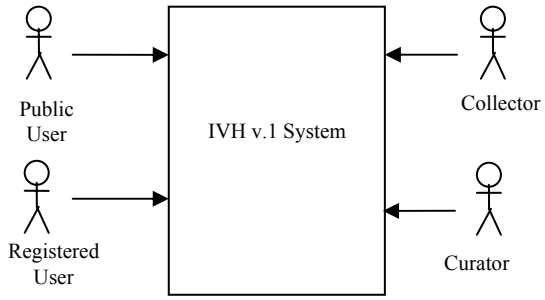

Fig. 2. Global use case model of IVH v.1

Some important use cases are:

- View Public Data
  Actor: Public User; description: to view public taxon (including its position in taxonomy) and specimen data.
- View Public and Restricted Data
  Actor: Registered User; description: to view both public and restricted taxon and specimen data.
- Manage New Specimen
  Actor: Collector; description: to provide data on new specimen and propose it to be part of the herbarium data as well as to edit specimen data.
- Manage Specimen
  Actor: Curator; description: to manage (view, add, edit, delete) specimen data, including to verify a new specimen data provided by collectors.
- Manage Taxon
  Actor: Curator; description: to manage (view, add, edit, delete) taxon data.
- Manage Taxonomy
  Actor: Curator; description: to manage (view, add, edit, delete) the taxonomy of taxa.

The use case model implies several components of software that must be designed in further details such as:

- Taxonomy viewer and editor
  This component provides a way to present all available taxa in the structure of taxonomy. A natural way to do this is by presenting the taxonomy in tree-like format. The tree format is also used to edit the taxonomy, i.e. to update the arrangements of taxa in the hierarchy.
- Taxon editor
  Taxon editor is used for managing (viewing, adding, editing, and deleting) taxon data.
- Specimen editor
  Taxon editor is used for managing (viewing, adding, editing, and deleting) specimen data, including to verify a proposed specimen.
- Database
  The database is a component of the software that is used to store all required data. The database is designed based on the conceptual data model (see chapter V).

V. CONCEPTUAL DATA MODEL

Based on data requirements, a conceptual data model is created. The conceptual data model provides a blue print for implementation the storage of data. It is constructed using Entity-Relationship (ER) modeling approach. The conceptual ER diagram of IVH version 1 is shown in Fig. 3 Note that, the diagram is not completed; some details are left out.

Taxon is represented as an entity in the ER model. In reality, each taxon is recognized by its scientific name, but there is no guarantee that this will be the unique way of identifying a taxon. Thus, we introduce an identification number to uniquely identify a taxon.

Specimen is also represented as an entity in the ER model. It is identified uniquely by an identification number.

Between Taxon and Specimen there is a 1-n relationship, denoted by Specimen_Taxon relationship type. Each Taxon can have at least zero Specimen and at most n Specimens. Each Specimen, on the other hand, must belong to one Taxon.

The most interesting part of the structure of data is how to model the taxonomy. The taxonomy consists of taxa, arranged in tree structure which is organized in a hierarchy defined by the taxonomy ranks. Each node of the tree structure is a taxon. We model the tree structure by defining the relation between two adjacent nodes as parent-child relation. The parent is the node in the higher hierarchy, so that the lower node is the child. For example: the Taxon *Acacia abyssinica* (which is a Species) belongs to Taxon Acacia (which is a Genus) [16]. In the taxonomy rank, Species is lower than Genus. Thus, Taxon *Acacia abyssinica* is the child of Taxon Acacia; Taxon Acacia is then the parent of Taxon *Acacia abyssinica*.

Each Taxon has at least 0 child Taxon (e.g. Taxon of Species rank may not have children) and at most n child Taxa; whereas a Taxon has at least 0 parent Taxon (e.g. Taxon of Kingdom rank has no parent) and at most 1 parent.

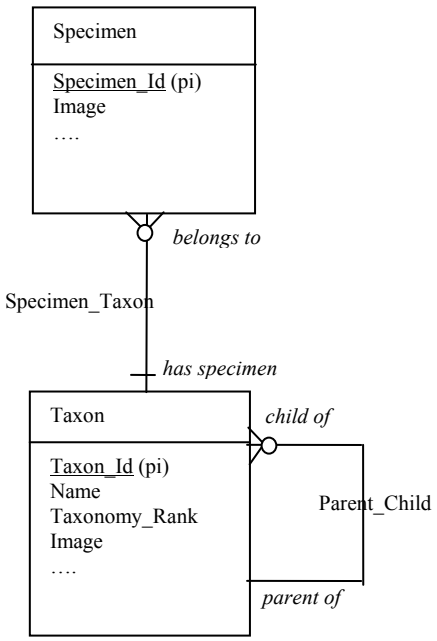

Fig. 3. ER diagram of IVH v.1

VI. DESIGN AND IMPLEMENTATION CONSIDERATIONS

The use case model and the conceptual data model form the conceptual model of IVH version 1. The next step is to put the model into more detail design model and then, implementation model.

As design consideration, each use case in IVH version 1 is developed using Model View Controller (MVC) [5],[12],[13] architectural pattern approach. The MVC pattern requires each use case is split into three layers:

- Model: represents the domain-specific representation of data/information. Typically, in a three-tier architecture, Model connects to the persistent data stored in Data Server. In the conceptual model of IVH version 1, the Model layer is modeled as classes with the purpose of connecting to databases.
- View: renders a Model into a form suitable for interaction with the users, typically in user interface elements. In the conceptual model of IVH version 1, the View layer is represented as classes and web pages which are provided to the users.
- Controllers: processes events, typically by user's actions, and indirectly invoke changes to the Model. In the conceptual model of IVH version, this layer is also modeled as classes.

Each layer contains several classes designed for the specific purposes. See Fig. 3 for the interaction between Model, View, and Controller.

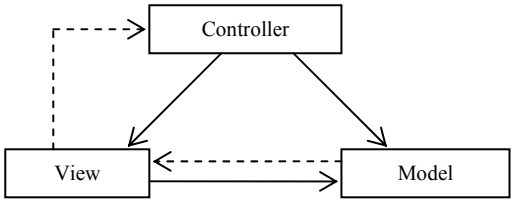

Fig. 4. Relationship between Model, View, and Controller in MVC pattern [13]

In IVH version 1, we propose the use of at least two types of physical databases that are going to be used: the relational database and XML database. This requires two "types" of the Model layer; one is a Model to connect to relational database; the other is for connecting to XML database. Nevertheless, there should only a single the presentation of these data to the users no matter from which database the data is retrieved. Thus, the Controller classes have a specific job to "wrap" the data handling of both types of database and to provide a single presentation of the data. This type of Controller is often called Adapter. Thus, Adapter works to decouple the View from the Model such that the View can be used for multiple Models. See Fig. 5 for the relationship between Model, View, and Adapter especially for IVH version 1.

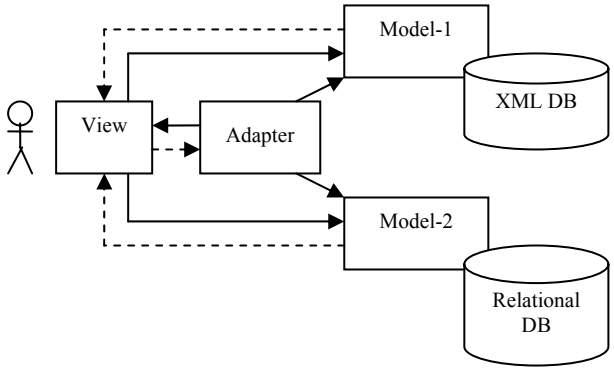

Fig. 5. Relationship between Model, View, and Adapter in IVH version 1

In implementing IVH version 1, the system architecture of the first version of IVH is three-tier client-server system (see Fig. 6):

- a front end webserver: provides a presentation logic to the users, in this case, using web pages.
- a middle tier known as application server: provides business process logic and access to data,
- a data server: provides the data or the database (see chapter V and VI for further discussion on the data server).

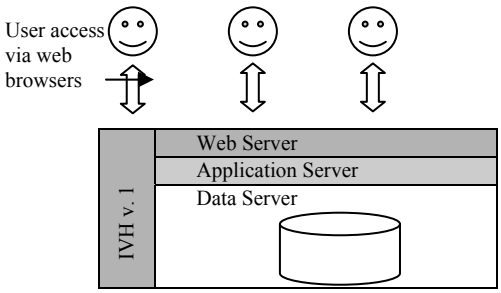

Fig. 6. Three-tier architecture

VII. Conclusions and Future Works

This paper discusses a conceptual (analysis) model of IVH version 1. The requirements of the system have been described. A global use case model of the system and the conceptual data model are provided based on the requirements. The global use case model defines several use cases of the system which imply several software components such as taxonomy viewer and editor, taxon editor, specimen editor, and a database. The software components are required to be designed in further details.

A detail study on the structure of the taxonomy is also provided while discussing the conceptual data model. The conceptual data model provides a basis for further design and implementation of the database.

In the future, this model shall be put into a design model in which technology are put into considerations. The design process employs the MVC design pattern as the main principle of defining the design model. Afterwards, a prototype of the system is going to be implemented using three-tier architecture. This prototype is then going to be tested with a collection of medicinal plants of Toba Samosir region of North Sumatera.

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Pinteraktif – Learning 2.0 Platform

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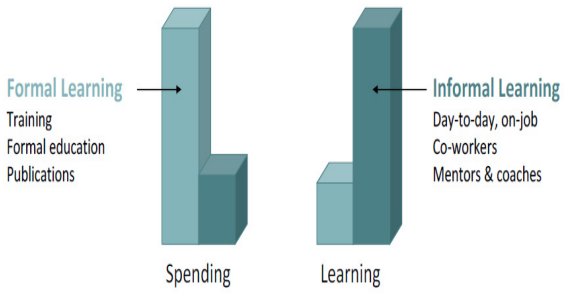
***Abstract*—Learning is acquiring new knowledge, skills, behaviors, values, preferences or understanding, and may involve synthesizing different types of information. Based on the definition of learning, we develop a new kind of e-learning environment in web technology which based on community and social networks. It is called Pinteraktif, a combination between "pinter" which means smart, "aktif" which means active and "interaktif" which means interactive. All of pinteraktif facilities are provided to support user and make it easy and fun to learn. Another innovation in the pinteraktif's site is combining the benefit of virtual social world and learning environment. These kinds of communication make sharing information easy and fun. We call it "learning 2.0" where people share their own content, manage them and share them in multimedia content platform.**

***Index Terms*: Learning 2.0, Pinteraktif, Web 2.0**

I. THE BEGINNING OF E-LEARNING

In this era of communication and information, learning has become easier than before. The traditional way of face-to-face teaching and learning in the old days has been changed with online learning tools such as website, desktop application and mobile gadget. People have realized that, in reality learning happens all the time in a multitude of learning settings which can take place in a classroom, but obviously most of the time in an informal situation. Still, it is about 80% of the training budget that goes to formal learning which means that people overinvest in formal training programs, while missing out on the opportunity to foster the more natural and informal learning processes [1].



This new ways of learning and teaching which so called e-learning has been lead us to a new era of mobile learning. According to Andreas Schmidt (FZI Research Centre for Information Technologies, Karlsruhe, GERMANY), e-learning is a changed in concept of lesson to computer-based courses, consisting of several learning resources that are connected with one another in a meaningful way. But the fact that e-learning grows rapidly these past few years, it gives basic revolution in learning concept more than just media in which the lesson is transferred. At a surface level, it is commonplace to observe that young people no longer have to remember so many facts and figures – search engines have had a similar effect on literacy and knowledge acquisition as calculators have had on numeracy. You can "google" whatever you want to know. New learning have access to vast amounts of excellent resources on any topic imaginable, so the research aspect of learning tasks tends not to be how to find the resource, but how to judge quality, how to sift, to eliminate and to integrate myriad resources to produce an outcome fit for purpose [2].

E-Learning enables us to deliver both learning and information at will, dynamically and immediately. It allows us to tap the knowledge of experts and nonexperts and catapult those messages beyond classroom walls and into the workplace. And it lets us know, through the magic of technology, who is learning, referring, and contributing and who is not. Then there's the bad news. Many simply fail to embrace e-learning. The customer service representative looks at two of the six e-learning modules and completes only one. The supervisor, who had the best intentions, is too busy with work to be anybody's e-coach. The executive, also with good intentions, never gets around to listening to the podcasts and is AWOL on a related blog.

Every industry study reveals marked increases in training and development delivered via e-learning, often with disappointing numbers characterizing participation and persistence. Jack Phillips and Holly Burkett (2007) reported grim news about what their studies have shown: "Participants in e-learning programs are less likely to follow through than in an instructor-led program."

A 2003 study by The MASIE Center found an e-learning dropout rate of about 26%. Although this rate is vastly higher than classroom attrition rates, the MASIE number is optimistic compared to what others have found. Frankola (2001) and Diaz (2002) estimated dropouts at 20–50%, with Flood (2002) pointing to an eye-popping rate of 80% [3]. Grim news about what their studies have shown: "*Participants in e-learning programs are less likely to follow through than in an instructor-led program.*"

Classification	Explanation
Social Networking	Professional and social networking sites that facilitate meeting people, finding like minds, sharing content uses ideas from harnessing the power of the crowd, network effect and individual production/user generated content.
Blog	The term web-log, or blog, was coined by Jorn Barger in 1997 and refers to a simple webpage consisting of brief paragraphs of opinion, information, personal diary entries, or links, called posts, arranged chronologically with the most recent first, in the style of an online journal (Doctorow et al., 2002). Most blogs also allow visitors to add a comment below a blog entry.
Wikis	A wiki is a webpage or a set of web pages that can be easily edited by anyone who is allowed access (Ebersbach et al., 2006). Wikipedia's popular success has meant that the concept of the wiki, as a collaborative tool that facilitates the production of a group work, is widely understood.
Social Bookmarking	Social bookmarking systems share a number of common features (Millen et al., 2005): They allow users to create lists of 'bookmarks' or 'favourites', to store these centrally on a remote service (rather than within the client browser) and to share them with other users of the system (the 'social' aspect). These bookmarks can also be tagged with keywords
Multimedia sharing	One of the biggest growth areas has been amongst services that facilitate the storage and sharing of multimedia content. Well known examples include YouTube (video) Flickr (photographs) and Odeo (podcasts). These popular services take the idea of the 'writeable' Web (where users are not just consumers but contribute actively to the production of Web content) and enable it on a massive scale.

II. Era of Web 2.0: Active Participation

In this past few years, internet has changed and improved by the new set of web technologies so called Web 2.0. The term "Web 2.0" became popular in the aftermath of a conference held by O'Reilly Media in 2004. New website that adopted the web 2.0 concept is arising and growing rapidly around the world. Based on a website that maintains a catalogue of the logos of every web 2.0 application (Go2Web20.net), there has been 1,952 applications registered as of January 23, 2008 and still growing.

There are some big different between the web 2.0 and its latest predecessor known as web 1.0. First, there has been a dramatic increase in user control over content and data. End users simply have much more ability to create meaningful content and manage data on the Web than ever before. What used to involve production crews, writers, editors, and teams of programmers can now be done by an individual with relatively inexpensive equipment and a few clicks of the mouse.

1,952 applications as of January 23, 2008

Image Source: http://www.go2web20.net

Second, there has been a significant increase in the ability to interconnect software applications using new technologies like XML-based Web services and other application programming interfaces, or APIs. Anyone who has used a tool like iGoogle, for instance, knows how easy it is to plug in a variety of different applications to the iGoogle portal interface.

Third, there has been a tremendous leap in the ease with which users can form meaningful communities and collaborate with one another. The rise of the open source software movement is the example most often cited in this regard, but there are many other types of productive communities that have formed using Web 2.0 tools. Part of YouTube's power is the tools it provides for easily commenting on, rating, and distributing videos, in addition to the baseline ability it offers for users to upload video. It is this social interaction with the user-produced media that leads to the term "social media" [4]. Some of the web concept usually known as web 2.0 technologies can be classified as:

The main aspects that makes web 2.0 different and created so many enthusiastic participation from its users are their six 'big' ideas which derived from originally outlined by Tim O'Reilly. Those ideas are Individual production and User Generated Content; Harness the power of the crowd, Data on an epic scale, Architecture of Participation, Network Effects, Openness [5].

III. Learning 2.0: New Evolution of e-Learning

"Web 2.0" or "social computing" (a term we prefer to use in this report) refers to the range of digital applications that enable interaction, collaboration and sharing between users. Such digital applications include those for blogging, podcasting, collaborative content (e.g. wikis),social networking (e.g. MySpace, Facebook), multimedia sharing (e.g. Flickr, YouTube), social tagging (e.g. Deli.cio.us) and social gaming (e.g. Second Life) (cf. Pascu, 2008). Alternatively, the concept of "social software" is employed, which broadly refers to any webbased software tool that supports or fosters group interaction (Vuorikari, 2007; Owen et al., 2006).

Asian countries lead in the usage of social computing with more than 50% of Internet users across all applications, followed by the US (with about 30% of Internet users) and Europe (with about 20-25%). Creation, use and adoption of social computing applications have been growing strongly since 2003. (Pascu, 2008). With the increase use of web 2.0 technologies, there is also new evolution in e-leaning technologies. Combination with web 2.0 is hoped to be the answer in lack of participation in e-learning which then known as Leaning 2.0.

Social computing applications allow users to communicate and collaborate in diverse ways and in a variety of media, which also helps learners to act together and to build knowledge bases that fit their specific needs (cf. Owen et al., 2006). Siemens suggests that when a learner is engaged in creating and recreating their own learning network, understanding arises through applying meta-cognition to the evaluation of "which elements in the network serve useful purposes and which elements need to be eliminated".

The main point in learning 2.0 is that it is a collaborative learning, which means that anyone can be a teacher and make learning content, and anyone can choose their own learning time and place easily. In the Learning 2.0 paradigm, the old teacher-centric, expert-dominated model breaks down, and the remaining constraints on time and geography are loosened to the point of almost disappearing entirely.

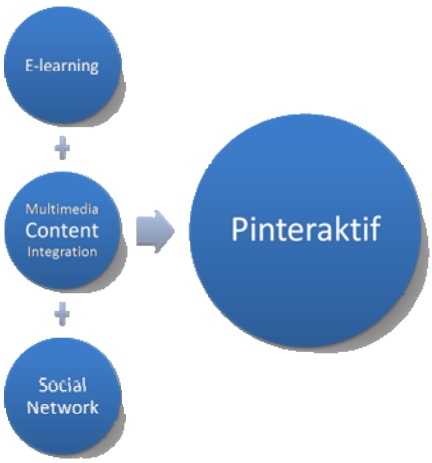
Fischer & Sugimoto (2006) emphasize that industrial nations in their transition to an information age, face a profound lack of creativity and innovation. They argue that, although society often thinks of creative individuals as working in isolation, much human creativity is social and results from the interaction and collaboration with other individuals. According to them, social computing applications with their potential for supporting collaboration can contribute to raising creativity. Rudd et al. (2006b) add that the growing opportunities to generate, share, edit and publish material will trigger the emergence of new forms of digital creativity.

Coenen (2005) supports the same argument by claiming that social software may be able to influence creativity through the support of knowledge sharing between people. He argues that creativity occurs by associating previously unconnected concepts in a cognitive system, for which the integration of knowledge from various fields is often important. This knowledge in turn can be gathered over social contacts in different domains and is thus related to communication in a social network structure. Social computing applications, imitating face to-face interactions without constraints in space and time, may allow for rich and effective knowledge exchange, thus supporting creativity (2005).

IV. PINTERAKTIF: LEARNING 2.0 ENGINE

With the rapid growth in learning 2.0 definition and concept, we need an engine that support learning 2.0 researches. This Engine must have at least all technologies that a learning 2.0 should have -according to recent definition-. It also must support all facilities that a learning 2.0 should support.

Institut Teknologi Bandung as one of education and research institution has started the research to build the engine. Pinteraktif (http://pinteraktif.com) is one of ITB's innovations to support learning 2.0's movement. The word pinteraktif itself is a combination between "pinter" which means smart, "aktif" which means active and "interaktif" which means interactive. So pinteraktif has purpose to help building a smart community in a sharing culture where everyone involved actively based on learning 2.0. pinteraktif's implementation can help us understand the impact of learning 2.0 in the community, and can be a platform to test and improve on learning 2.0 concept and definition.



Pinteraktif combines e-learning concept, multimedia content, and social networking, packaged with web based technologies. E learning support in pinteraktif makes it easy to create curriculum, provide self online tests and quizzes, moderate online discussions, class member's authorization and provide leaning content or event collaboration content creation among its user. With multimedia content support in pinteraktif, everyone can share their knowledge and information to the community in variety interactive content types such as video content, online presentation, online document etc.

While the last facilitiy, social networks support in pinteraktif, pinteraktif adopted the latest social networks technologies such as facebook (http://facebook.com) and ning (http://ning.com). Davies & Cranston (2008) observe that young people tend to use social networking services primarily to (1) keep in touch with friends, (2) develop new contacts, (3) share content and engage in self-expression, (4) explore their identity, (5) hang out and

consume content, and (6) access information and informal learning. As Childnet International (2008) points out, there are a number of educational benefits and opportunities inherent in the use of social networking among young people, including in particular their potential for making young people social participants and active citizens as well as the fact that they encourage discovery and exploration, thus facilitating self-directed learning, broadening users' horizons and supporting young people in becoming independent.

When integrated into education and training, social networking invites for more creative and motivating ways of learning by strengthening the social and explorative aspects of learning (Rudd et al., 2006a). According to Childnet International (2008), the potential uses of social networking services for schools and educators lie in (1) developing e-portfolios as online space where learners can record their achievements and collect examples of their work, exploring and promoting their talents and interests; (2) facilitating literacy and communication skills; (3) fostering collaboration and group work; (4) supporting learning about data protection and copyright issues; (5) learning about self-representation in a digital world; (6) learning about e-safety issues; (7) producing public showcases for work, events or organizations; and (8) forming communities of practice around particular topics or interests. In addition to providing a whole community with useful information about a school, college, organization or event, an educational institution's profile on a social network sends a clear message to learners that the institution is aware of the types of spaces students enjoy online.

V. CONCLUSION

Looking back at the different areas in which social computing facilitates learning processes presented in this paper, three key features emerge as crucial properties of social computing contributing to the development of new learning processes and outcomes. The key features are:

a. *Multimedia*: the ease of producing, distributing and consuming multi-media representations by students and teachers which facilitates learning processes by making learning material more readily available, addressing new sensory channels and alternative cognitive skills and increasing student motivation;
b. *Collaboration*: the collaborative aspect of social computing tools which provides the individual learners not only with a social network of peer support and assistance, but also engages them in a productive discourse, critically reflecting their own ideas and reacting towards the ideas of others; and
c. *Learner as producer*: the fact that social computing tools encourage and support active authorship, supporting the learner as a producer of content and giving him a sense of ownership and responsibility of learning materials and procedures.

These three factors are constitutive for each of the different learning objectives. They might be balanced in different ways to yield different results, emphasizing in some cases the collaborative and collective aspect of the learning process rather than the individual's contribution, whereas in others the multi-media aspect prevails or the individual's creative power is at stake. However, the full potential of Learning 2.0 can only be embraced if the interplay of all three aspects is respected and promoted [5].

In this rapid growth in leaning 2.0 researches in the world, we need an engine that can test the impact of learning 2.0 to the communities. To be part in learning 2.0 development, the platform must support the latest technologies used in leaning 2.0 while collect feedback from its user at the same time. Pinteraktif which is one of ITB's innovations meant to support learning 2.0 reseach and development. Pinteraktif adopted the latest technologies used in web 2.0 such as social networking, multimedia sharing and combine them with e learning environment. Pinteraktif's implementation will help the research on learning 2.0 implication and definition.

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Assessing Web 2.0 Applications for Indonesia Distance Learning in Rural Areas

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***Abstract*—The emergence of fast-growing Web 2.0 applications in various categories such as social bookmarking, blogs, wikis, social networking, social media sharing, mashups, VOIP, and virtual worlds opens up the potential for Indonesia rural higher education development in the present and in the future. With the existence of Web 2.0 applications, the improvement potential on Indonesia distance learning education for Indonesia rural areas are limitless; however, there are many obstacles that might hinder the possibilities to implement the Web 2.0 applications for Indonesian students in rural areas. This article presents the assessment on the Web 2.0 applications' potential based on the Indonesia rural areas' condition from policy, infrastructure, human resource readiness, and cost-benefits perspectives. Although there are many challenges to implement these applications in Indonesia rural areas, the Web 2.0 applications will still become potential tools to expand the learning opportunities for Indonesia rural areas communities. The researchers draw assessment and propose recommendations based on the previously published research in other developing countries and literature reviews.**

***Index Terms*—distance learning, rural areas, Indonesia education, Web 2.0.**

I. INTRODUCTION

Indonesia is an archipelagic country with over 17,500 islands. The over 230-million Indonesian population placed the country as the fourth most populated countries in the world, just below China, India, and the United States of America [1].

Most Indonesians are populated in big cities located in Java, Sumatra, Kalimantan, Sulawesi, or Bali islands. As an archipelagic country, it is a challenge for Indonesia to provide communication infrastructure that will serve urban, suburban, and rural areas equally. Therefore, despite the advance development of technology infrastructures in its big cities, the rural areas development in Indonesia is limited in term of infrastructures of communication and technology. With the current available infrastructure, as of March 2008, the communication technology only served approximately 40 percent of the Indonesian population [2].

Following the low service level of communication technology for Indonesian population, there is also a problem for higher education participation. Indonesia has approximately 15% gross enrollment ratio in 2006, approximately four million students enrolled in 82 public and 2,800 private higher education institutions [3]. It is noted that the quality and resource gaps are among the important issues facing Indonesia higher education due to its geographical challenge as an archipelagic country. Therefore, the use of technology to provide better opportunity for communication as well as education is worth consideration in the near and long-term future.

Several initiatives in the Indonesia higher education development to provide Information and Communication Technology (ICT) for education included the followings: free library service automation systems, development of management information system and database systems for Indonesia higher education, SISDIKSAT (satellite-based education system – a tele-teaching initiative via satellite, GDLN (Global Development Learning Network), UT (Universitas Terbuka, Indonesia Open University), and INHERENT (Indonesia Higher Education Network) [3].

INHERENT, specifically offers the opportunity to serve wider areas with distance learning education, and provide the infrastructure needed for institutions to use Web 2.0 applications when serving learners in rural areas.

This paper will first give the overview on Web 2.0 applications and their use in education, discuss the Indonesia country-specific condition for rural area education, assessing the Web 2.0 applications for Indonesia rural areas' education, review lessons learned from previous researches in other countries' experience when serving rural areas' education, and finally provide conclusions and recommendations for further development on the potential of using Web 2.0 applications in Indonesia rural areas.

II. WEB 2.0 APPLICATIONS

The development of the first generation of Web applications in the 1990s marked a significant change in world-wide information dispersion [4]. The possibility to exchange information through electronic mail (email), web sites, or audio/video conferences opened up the possibilities to communicate beyond the boundaries of

geographic locations.

The failures of dotcom business in 2001 became the inflection point of the web technology development [5]. Although the dotcom business failures created a perception of the saturation in the World Wide Web market, the development of web applications was never stagnant. Instead, there was a development of ideas between O'Reilly and MediaLive International which marked the birth of Web 2.0 Conference [6].

A. What is Web 2.0

Web 2.0 is defined as the following [7]:

"A perceived second generation of web development and design, that facilitates communication, secures information sharing, interoperability, and collaboration on the World Wide Web".

The Web 2.0 is different than its first generation in term its demand-pull approach which stimulates users to contribute the contents or materials which will be published to the members of the community or the entire web users, depending on the access settings [4].

The demand-pull approach of the Web 2.0 technology made us experience the explosion of the web contents which comes along with the explosion of the web global users. As an illustration, Vaughan [6] compared the Web 1.0 and Web 2.0 using the following Fig. 1 which described the Web 1.0 as "the most read-only Web" and the Web 2.0 as "the wildly read-write Web".

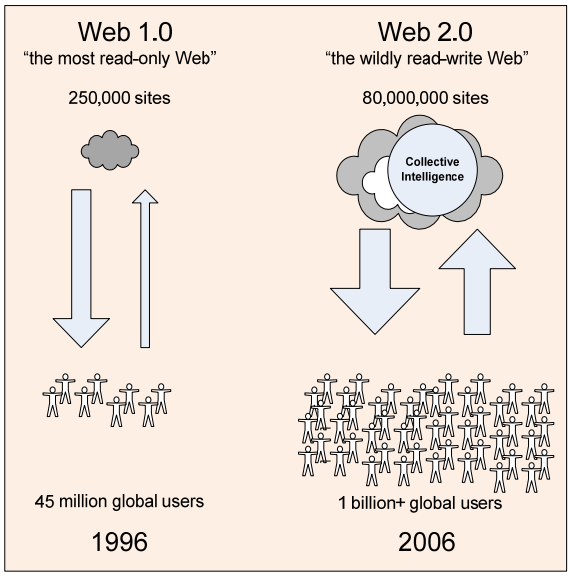

Figure 1. Comparison *Web* 1.0 and *Web* 2.0 [7]

B. Web 2.0 Applications

There are several types of Web 2.0 applications that are currently available:

1. **Social Bookmarking:** applications to share favorite bookmarks of URLs. E.g. Del.icio.us (http://del.icio.us/); Connotea (http://www.connotea. org/).
2. **Blogs:** applications to share personal or public journal entries which mimic personal diary. E.g. Google's Blogger (http://blogger.com/); Edublogs (http://edublogs.org/).
3. **Wikis:** applications that enable multiple users to edit a web page collaboratively. E.g. Wikispaces (http://www.Wikispaces.com/); PbWorks (http://pbworks.com); Google Docs (http://documents.google.com).
4. **Social Networking:** applications that use social networks that connects people to people within groups or similar interests. E.g. Facebook (https://www.facebook.com); MySpace (http://www.myspace.com); Friendster (http://www.friendster.com).
5. **Social Media Sharing:** applications that enable media contents posting and sharing. E.g. Flickr (http://flickr.com/); YouTube (http://youtube.com); Slideshare (http://www.slideshare.net).
6. **Mashups:** applications that enable visual data and concept integrations in order to find connections among them. E.g. Quintura (http://www.quintura.com/); Visuwords (http://www.visuwords.com).
7. **VOIP (Voice Over Internet Protocol):** applications that enable real-time synchronized communications among users, whether they communicate using text, audio, or video. E.g. (http://www.wiziq.com/); Dimdim (http://www.dimdim/com/).
8. **Virtual Worlds:** applications that mimic real world environment and provide virtual environment with real-time synchronized and collaborative communication environment in 3 dimensions world. E.g. Second Life (http://secondlife.com/).

Educators around the world view Web 2.0 applications as a new mean of delivering teaching and learning materials to their students. However, it is important to realize that the Web 2.0 applications are not the substitutes of teaching methods, but instead, they will facilitate and enhance the teaching and learning processes in the classroom, whether it is face-to-face, online, or hybrid courses. Hartman, Dziuban, and Brophy-Ellison [8] stressed on the importance of "Faculty 2.0" which represents the new generation of faculty who must keep up with the rapidly changing technology savvy students. Although using technology for teaching and learning, the notion of "learner-centered" approach must be maintained [9].

C. Web 2.0 for Distance Learning Education

Web 2.0 applications provide vast opportunities for educators to deliver their teaching and learning materials in pure online or hybrid (face-to-face and online) classroom environments. Distance learning education

which relied heavily on the use of texts, videos and audio recording packed in a video tapes or CD-ROMs will be able to utilize the power of Web 2.0 applications in order to facilitate distance learning.

Specific Web 2.0 applications such as the VOIP and Virtual Worlds provide the possibility for students who are located in different areas of the world to participate in a real-time synchronized classroom environment, communicate instantly with other students and their instructor, and even view each other during their classroom time.

The remaining of Web 2.0 applications provide the opportunity for instructors to assign certain tasks or projects that can be done collaboratively regardless the students locations that are scattered all over the world. Although Web 2.0 applications such as social bookmarking, blogs, wikis, social networking, social media sharing, and mashups will not provide full possibility for real-time communications among its users, they bridge the gap of communication and connectivity that distance learners could not do in the past.

III. Assessing Indonesia Rural Areas Readiness for Web 2.0

Indonesia is relatively new in providing ICT-based distance learning education to serve the needs for education in rural areas. There are specific challenges that are prominent to the government and to the Indonesian community. Although it is not impossible to overcome the challenges, the complexity of the challenges specific to the Indonesia rural areas will require higher level of efforts from the government as well as the academic community when serving education in those areas.

A. Distance Learning Policy and Regulations

Indonesia began to provide distance learning education since 1978 in junior secondary schools and 1980s for in-service primary schools teachers using scheduled radio broadcasting method [10]. As the initial effort to provide distance learning education yield signs of success, the distance learning education for higher education, through Open University (Universitas Terbuka) was later implemented in 1984 using postal mailed learning materials and tests, with supplements of dedicated television broadcasts and internet [10]. Following the development, in 1992, distance learning for primary schools was adopted using interactive radio communication technology as supplements to the face-to-face method [10]. The distance learning education nowadays has further been enhanced with more advanced computer technology and internet access.

Although the distance learning education for higher education initiated in 1984, it was not until 2003 that this type of education finally received its formal acceptance. It was in the National Law on the National Education System No. 20/2003 (UU Sisdiknas No. 20/2003) that Indonesia has finally acknowledged distance education as one of the many choices available for Indonesians to obtain education. With the national law, distance learning education has been accepted as equal education to the traditional face-to-face education provided by public higher education and private accredited higher education institutions [11].

Today, the Open University's distance learning education has been viewed as the solution to Indonesian population with economical, geographical, and/or time constraints and limitations [11]. The enrollment experienced ups and downs since its first establishment – for example, in 1996, there were 397.543 students, which remained increasing to 442.897 students in 1998 as the highest point, then it was decreasing consistently until it was only 225.000 in 2003 [11]. The enrollment figure in Open University is now increasing again. In early 2009, the Open University has approximately 532.000 registered students, 98% of which are government employees [12]. This is viewed as one of the indications that distance learning education for higher education in Indonesia has attracted a large population in Indonesia and has potential growth in the future.

Despite the increasing enrollment in Indonesia Open University, the ICT literacy of the students is still very limited. As of early 2009, there were only approximately 6,000 students (1.1 % of total student population) who were familiar with and used ICT to support their learning [12]. This figure gave an illustration on the next challenges for Indonesia distance learning education, especially in the rural areas.

Finally, in addition to the Open University, by 2003, there are also over 1,800 private universities and 86 public universities who provide distance learning education using ICT-based [11]. Several of the public institutions have received support either from the Indonesia government or special projects from the World Bank (GDLN project) for conducting distance learning education. These conventional universities now become the competition to the Open University in term of providing equal access to education for Indonesians resided in rural areas. In a way, this trend will hopefully become positive enforcement for better quality in providing distance learning education in Indonesia.

Based on the current active policy and regulations in relations to the distance learning education, Indonesia government has shown its support for ICT use to improve education for rural areas. In consequence, this positive support from the policy and regulations perspectives is favorable for using Web 2.0 applications in educating students in rural areas.

B. Internet and Communication Infrastructure

The geographical layout of Indonesia remains one of the most difficult challenges to address in term of providing the access to the Internet and Communication

technology. The unequal spreads of Indonesian population in its wide-spread geographical layout has consequently provide unequal potential benefits for commercial companies. It is highly understandable if commercial companies that provide internet and communication technology are not attracted in providing the access to areas with low profit potentials. Therefore, the Indonesia government and public companies have to be the ones who step up to the plate and provide the access to rural areas.

For the purpose of assessing the Web 2.0 applications' potential for distance learning education in the rural areas, the researchers are specifically assessing the Internet and Communication technology network readiness and availability in Indonesia. This approach is chosen as the Web 2.0 applications rely heavily on Internet connection, although those applications can be provided either through the International Internet connection or only through the Indonesia Internet Exchange (IIX) connection if the higher education institutions set up their own server infrastructure in their home institutions rather than using the resources available on the world wide web.

The Global Information Technology Report 2008-2009 from the 2009 World Economic Forum [13] provides indicators for Indonesia (see Appendix) in comparison to the other 133 countries in the world. Among the other countries in the same neighborhood such as Singapore, Malaysia, Thailand, and several others, Indonesia is still among the lowest ranks for the network readiness (Table 1).

Table 1. Network Readiness Index [13]

Country/ Economy	Rank 2008-2009	Score
Singapore	4	5.67
Malaysia	28	4.76
China	46	4.15
Thailand	47	4.14
India	54	4.03
Brunei Darussalam	63	3.87
Vietnam	70	3.79
Sri Lanka	72	3.79
Indonesia	83	3.62
Philippines	85	3.60

More specifically, in term of infrastructure environment, overall, Indonesia is ranked 103. It is ranked 97 for the number of telephone lines, ranked 105 for Secure Internet servers, ranked 107 for electricity production. These several items of the infrastructure environment shows current and potential limitations and challenges for Indonesia Higher Education that would like to implement the Web 2.0 applications which require International Internet connection or National Internet connection at the very least.

As of March 2008, the communication technology only served approximately 40 percent of the Indonesian population [2]. It is highly predictable that the 40 percent would represent Indonesian population that resides in the urban and sub-urban areas rather than the rural areas. Additionally, in 2008, there are 64.4% of rural areas without telecommunication service and infrastructure [14]. Thus, the Internet and Communication infrastructure will be the biggest issue in trying to implement Web 2.0 applications for rural area distance learning education.

The government deregulation on telecommunication services that allow private business to operate telephone services which was once monopolized by PT. Telkom and Indosat (both are National Telephone companies) have opened up the possibility for less expensive and more affordable variety of telecommunication services. Although this change was expected to accelerate the process of adoption of ICT-based distance learning education, there are multi-dimensional problems that arise from variety of factors such as: software, hardware, infrastructure, human resources, and the culture of academicians [11].

Several efforts that have been done for providing Internet and Communication services for rural areas including the utilization of internet kiosks (warung internet) and telecommunication kiosks (warung telekomunikasi). From these channels, students in rural areas should have better access to the Internet, which enable the Web 2.0 applications implementation on their learning. However, the affordability of the internet costs might remain an issue for the rural areas.

One more recent alternative for Internet connection for education is the availability of INHERENT (Indonesia Higher Education Network) which was established in 2006 with 32 nodes in 32 higher education institutions as the network backbone. By 2008, INHERENT [15] has grown and connected 82 public higher education institutions, 140 private higher education institutions, 12 regional offices for private higher education institutions coordinators, and SEAMOLEC (Southeast Asian Ministers of Education Organization Regional Open Distance Learning Centre). As of 2008, INHERENT bandwidth capacity provides 30 MBps for advance level connection, 8 MBps for medium level connection, and 2 MBps for basic level connection [15]. The existence of INHERENT in Indonesia provides a positive encouragement of the possibility of implementing Web 2.0 applications for distance learning education for students in rural areas.

In 2006, there was also an establishment of National Education Network (Jardiknas, http://jardiknas.org/) that combined the City Wide Area Network (WAN), ICT centers, and higher education institutions in Indonesia. By 2007, Jardiknas has connected 1,014 institutions and 11,825 schools [16].

The most recent development for Internet infrastructure is the effort to integrate Indonesia's network with neighboring countries in South East Asia through collaboration with SEAMOLEC since 2008. The use of

multicast technology with satellite is expected to overcome the geographical challenges faced by Indonesia when providing the internet connection using cables [16]. Although the collaboration with SEAMOLEC is intended to provide connectivity and network with global education world, the Indonesia rural areas might also benefit from this collaboration with better access to the internet.

Based on the recent development in ICT infrastructure in Indonesia, there is certainly a better prospect for implementing the use of Web 2.0 applications for Indonesia rural area distance learning education. Although it will be harder for the rural areas to acquire sufficient and appropriate access to the Internet, it is certainly a positive trend for future distance learning education in those areas.

C. Human Resource Readiness

The human resource readiness in Indonesia can be viewed from two perspectives – quantity and quality. The following discussions will cover both perspectives to assess the use of Web 2.0 applications for distance learning education in Indonesia. Although the researchers had difficulties to obtain recent, accurate, and consistent statistical data, the following discussion will at least portrait the situation in Indonesia.

Based on United Nations Development Program (UNDP) Human Development Report 2007/2008 [17], Indonesia is placed in the medium human development countries, ranked as the 107th country. By 2005, Indonesia telephone mainline users were 58 per 1,000 peoples, cellular subscribers were 213 per 1,000 peoples, and internet users were 73 per 1,000 peoples [17]. By 2007, there are 353 mobile telephone subscribers per 1,000 peoples and 56 internet users per 1,000 people [13]. These are quite interesting changes which indicated that the growth of population and the growth of internet users are not at the same pace or speed, while the mobile telephone subscribers grew rapidly over the course of two years. By the end of 2007, the total of internet users in Indonesia has reached 25 million users [18]. In term of quantity, those figures portrait the condition that Indonesian population is still far left behind in term of their technology utilization. However, the growth rate, especially in the mobile telephone subscribers shows positive trends and potential for future development. As Web 2.0 applications use the Internet can be accessed either from telephone lines or mobile telephone, despite the low penetration at the present, this show positive trend for the future adoption of Web 2.0 applications.

Although the ICT penetration and usage in Indonesia shows a positive trend, Indonesia faces bigger challenge in term of quality. Not only that the general population knowledge and skills in using ICT are still limited, but also that the workforce who would support the use of ICT is still far from sufficient.

Based on the Global Information Technology Report 2008-2009 (see Appendix), Indonesia readiness component combined for individual readiness, business readiness, and government readiness for ICT is ranked 65 among 143 countries [13]. Among the three sub-components, the worst is the government readiness which is ranked 111 among 143 countries. The rank shows that Indonesia government is not yet prioritizing ICT development at their maximum.

Indonesia faces complex problems in term of human resource quality, especially in the rural areas. One of the major problems is the availability of human resources who are ICT literate and the availability of workforce to support the use of ICT in rural areas. Efforts to provide qualified ICT workforce in Indonesia includes providing formal and non-formal ICT education [19].

Based on the data from Center for Research and Application of Information and Electronic Technologies of the Office for the Research and Application of Technologies, 2001 [19], the internet users in Indonesia comprise the following:

- Based on the usage, 42% for commerce, 30% for higher education, 21% for government, 6% for research institutions, and 1% for non-government offices.
- Based on their professions, students 39%, workers 22%, managers 17%, assistant managers 5%, professionals 5%, directors 4%, entrepreneurs 3%, and others 5%.
- Based on their educational backgrounds, elementary school/junior high school 2%, high school 41%, college graduates 9%, undergraduates 43%, and graduates 5%.

Since there is no recent data that reflect the present situation, those figures might not be accurate, but at least give the illustration on the profile of internet users in Indonesia.

Assuming that the use of Web 2.0 applications for distance learning will be targeted on students who completed high-school education and will continue to higher education level, efforts to improve the ICT uses in high schools has been one of the government programs (e.g. Jardiknas). However, the educational reach to rural areas might still be limited. Prioritization for scholarships in education was given to poor students, although misallocation to the higher economic status students remained a problem [20]. Nevertheless, there were efforts to provide better education for those who are in needs.

Stepping ahead, there is also a need to educate the potential instructors who will teach the distance learning education in rural areas. Since Web 2.0 applications are relatively new for Indonesian communities, instructors who will deliver the teaching materials to their students must also be well-educated on using the applications [8]. Although there were no hard data available to provide facts on the Web 2.0 literacy among instructors of distance learning education, it is an important issue for Indonesia to resolve.

Based on the discussions on this section, it seems that the human resource readiness of using Web 2.0

applications for distance learning in rural areas will be a major problem on top of the limitation in infrastructure. Not only that the students are not ready, the instructors might not be ready to use the applications either. More efforts are needed to be pursued to enable the use of Web 2.0 applications for distance learning purpose.

D. Costs vs. Benefits

To assess the costs and benefits of using Web 2.0 applications for distance learning education in Indonesia rural areas, there are several considerations:

1. Whether the Web 2.0 applications used would be those available in the international internet connection or within the national internet connection (either in the INHERENT, Jardiknas, or other connection within Indonesia network only).
2. What kind of facility that distance learning students in rural areas will use to have the Internet connection? Are they going to connect to the Internet from Internet kiosks, telecommunication kiosks, higher education institutions or other educational institutions with the international internet connection or the national internet connection? Are they going to use their own cellular phone connection or local phone connection to access the internet?
3. Whose costs are being assessed? Costs of the educational institutions that provide the education and utilize the Web 2.0 applications, or costs of the students who purchase the education?
4. Currently, the Web 2.0 applications has been viewed as beneficial applications for better learning and better collaborations among students and between students and the instructors [21]. However, the issue is how to measure those benefits in tangible monetary values.

A wide range of Web 2.0 applications listed previously in Section II provides different alternatives for implementations. Without any modification, those listed are all available in the international internet network, but only some are available in the national internet network in Indonesia. Applications such as blog, wikis, social media sharing, or VOIP can easily and economically (e.g. use the free ones) be installed in the local/national servers located in Indonesia for better rural area access, but applications such as social bookmarking, social networking, mashups, or virtual worlds might be harder or more expensive to be installed in the local/national servers due to royalty or copyright of the software.

Depending on the availability of the telecommunication infrastructure and facility in the rural areas where students reside, costs and benefits of using Web 2.0 applications will be affected. Costs will increase when students use cellular phone connection for internet connection because of geographical limitations. If students would like to utilize the internet connection available in the higher education institutions or other educational institutions, distance between home or working location with the institutions will affect the costs. Thus, it is going to also affect the overall costs of using Web 2.0 applications for distance learning education.

Since costs and benefits can be viewed from both sides from the institutions' perspective and students' perspective while those two types of costs will affect each other, the use of Web 2.0 applications for distance learning education might not always be advantageous for both constituents.

The researchers decided to leave those costs and benefits assessment on using Web 2.0 applications open as there are too many variables involved for accurate assessment. At the very least, the discussions will trigger further thoughts on assessing the quantitative costs and benefits of using the Web 2.0 applications for conducting distance learning education.

While it is difficult to measure the benefits and challenges in term of financial or quantitative manner, it is possible to assess Web 2.0 applications implementation in term of qualitative benefits and challenges. Therefore, the researchers summarized the benefits to learning and technical challenges in Table 2.

Although the assessment above is somewhat very limited, at least this will give the idea on how those Web 2.0 applications can be considered for distance learning education in rural areas.

IV. LEARNING FROM OTHER COUNTRIES' EXPERIENCES

It will be advantageous to look at other countries' experiences in resolving problems and challenges to provide distance learning education in their rural areas. Therefore, the following section will primarily discuss and present a summary of past research or discussions within this topic.

Several selected studies on rural areas in other countries revealed the following findings:

- The use of satellite-based telecommunication in Malaysian rural areas provides the lowest-cost remote area connectivity options in the area where cellular or landline connectivity is not available [22].
- WiMAX is one of the best alternatives to provide internet connectivity for rural areas with low population density [23].
- Flexible network for internet using CDMA access is one of the alternatives to provide internet connectivity in Africa rural areas [24], where 80% the population live. Based on this study, the low cost and the audio/video features provided with this alternative are promising.
- In order to provide internet connectivity to low population, as low as 25 users in rural areas of Canada will require the following four considerations: Fiber Optic Connectivity to the Internet through regional municipality, tower space at low cost and co-location of transmission equipment in the town building, cost effective wireless

transmission equipment, affordable Interconnection with the Public Switched, Telephone Network [25].

Table 2. Benefits and Challenges to Implement Web 2.0 Applications for Indonesia Rural Areas Distance Learning Education.

Type of Web 2.0 Applications	Benefits to Learning	Technical Challenges and Possible Solutions
Social Book-marking	Improve information sharing for students and instructors in the learning process	At the moment, only available in the international servers.
Blogs	Improve reflective and analytical thinking from students on certain issues which can be shared with greater audience.	There are already many free blogs sites available within Indonesia national internet network. Alternatively, there are free blogs applications that can be installed on servers placed in Indonesia internet network.
Wikis	Improve potential for collaborations among students who are located in scattered locations.	At the moment, only available in the international servers. However, there are free wikis applications that can be installed in the servers placed in Indonesia internet network.
Social Net-working	Improve connectivity and networking among students and instructors.	At the moment, only available in the international servers.
Social Media Sharing	Improve the variety of course content materials for teaching purposes and improve the possibility to communicate not only through texts but also through audio and video media.	At the moment, only available in the international servers. There is a need of high internet bandwidth that might make it very difficult for rural areas. It can be costly if the internet cost is based on bandwidth utilities.
Mashups	Improve students' conceptual thinking in a collaborative work space.	At the moment, only available in the international servers.
VOIP	Improve the possibility to communicate through audio and video on real-time basis. This application opens the potential use of real-time virtual classroom.	At the moment, only available in the international servers. There is a need of high internet bandwidth that might make it very difficult for rural areas. It can be costly if the internet cost is based on bandwidth utilities.
Virtual Worlds	Improve the possibility to communicate through real-time environment, and increase the visualization of the course materials when lecture is done in the virtual worlds.	At the moment, only available in the international servers. There is a need of high internet bandwidth that might make it very difficult for rural areas. It can be costly if the internet cost is based on bandwidth utilities.

- WCDMA technology is the best option among CDMA and GSM technologies to provide internet connectivity in Africa, especially in rural areas where high signal loss is experienced [26].
- A case study in Hungary revealed the potential of using HAPs (High altitude platforms), either aircraft or airships operating at 17- 22 km altitude, for the provisioning of broadband wireless services because HAP based telecommunications networks have the potential to deliver a range of communications services and other applications cost effectively (e.g. broadband and third-generation mobile for rural area) [27]. Similar proposal on the use of HAP to provide WiMAX connectivity as it is one of the cost effective alternatives provided that collaboration with major broadband and wireless alternative can be pursued [28].
- IPTV (Internet Protocol Television) provides the possibility of applying e-learning in China rural areas [29].
- A very good alternative for community in rural areas of developing countries is the Asynchronous Network (Asynch-NET) provided by Mobile Access Point (MAP). This asynchronous network is the footstep for e-services implementation in the communities with low-income and low population density. Study revealed that the Asynch-NET framework provides 'the always-on' e-services at the similar operating cost of Asynch-NET which is economical to other options [30].
- E-learning can be one of the best learning methods for rural areas population [31]. This study proposes a framework for providing Internet access to rural areas using wireless network. Several challenges identified in the study were the high cost of initial installation, the human resource literacy for the internet kiosks, and natural disaster potential in rural areas.
- Assessment on possible digital learning platforms in China showed that Blog, distance network education, the combination of the fourth and fifth media are potential to provide digital learning platform in China's rural areas [32].

While those studies only cover alternative solutions partially to the problems in Indonesia, those are potential ideas to be implemented in Indonesia rural areas distance learning education.

V. Conclusions and Recommendations

The assessment on implementing Web 2.0 applications in Indonesia rural areas' distance learning education provides several conclusions:

- Indonesia policy and regulations on the use of ICT are positive enablers for potential implementation of Web 2.0 applications in providing distance learning education in rural areas.
- Internet infrastructure and human resource readiness are the major problems/challenges that might hinder the implementation of Web 2.0 applications for learning purpose. However, in the long-term, when those two problems/challenges resolved, Web 2.0

applications are definitely potential to facilitate learning in distance learning education.

- The availability of national education network such as INHERENT, Jardiknas, and others give the vast possibility to accelerate distance learning education for Indonesia rural areas.
- There are various costs and benefits considerations to judge the possibility of implementing Web 2.0 applications for learning purpose in rural areas of Indonesia – the setup of Web 2.0 applications, type of facilities used, type of costs, and the translations of benefits itself in comparison to the costs.
- Various alternatives such as the use of WiMAX, WCDMA, or HAP arouse from previous studies in other countries' rural areas.

Thus, based on those conclusions, the researchers view Web 2.0 as potential applications to implement in Indonesia rural areas distance education in the future.

Consequently, the researchers would like to recommend the following:

- Efforts to solve the problems of internet connectivity infrastructure and human resources must be at the highest priority before the actual implementation.
- There would be intensive training to use Web 2.0 applications provided, especially for the future distance learning instructors.
- Indonesia also needs to consider different alternatives as learned from other countries' experiences to serve rural areas with Internet connectivity.

Finally, considering the difficulties experienced by the researchers in obtaining accurate and recent statistical data on Indonesia rural areas, potential future improvements for future research would be the following, but not limited to:

- There should be specific study to obtain the statistics on the number of internet users, area of Internet coverage, Indonesia ICT education, and other such detail statistics.
- It is potential to develop Indonesia ICT Database portal that will collect and monitor data on the development of ICT in the future.

VI. APPENDIX

Indonesia

Key indicators

Population (millions), 2007	225.6
GDP (PPP) per capita (int'l $), 2007	3,728
Internet users per 100 population, 2007	5.6
Internet bandwidth (mB/s) per 10,000 population, 2007	0.5
Mobile telephone subscribers per 100 population, 2007	35.3

Networked Readiness Index

Edition (number of economies)	Rank
2008–2009 (134)	**83**
2007–2008 (127)	76
2006–2007 (122)	62

Global Competitiveness Index 2008–2009 (134)	55

Environment component	81
Market environment	**55**
1.01 Venture capital availability	41
1.02 Financial market sophistication	72
1.03 Availability of latest technologies	61
1.04 State of cluster development	18
1.05 Utility patents, 2007*	85
1.06 High-tech exports, 2006*	41
1.07 Burden of government regulation	45
1.08 Extent and effect of taxation	16
1.09 Total tax rate, 2007*	54
1.10 Time required to start a business, 2008*	122
1.11 No. of procedures required to start a business, 2008*	100
1.12 Intensity of local competition	44
1.13 Freedom of the press	63
1.14 Accessibility of digital content	69
Political and regulatory environment	**83**
2.01 Effectiveness of law-making bodies	75
2.02 Laws relating to ICT	71
2.03 Judicial independence	80
2.04 Intellectual property protection	102
2.05 Efficiency of legal framework	66
2.06 Property rights	117
2.07 Quality of competition in the ISP sector	78
2.08 Number of procedures to enforce a contract, 2008*	78
2.09 Time to enforce a contract, 2008*	71
Infrastructure environment	**103**
3.01 Number of telephone lines, 2007*	97
3.02 Secure Internet servers, 2007*	105
3.03 Electricity production, 2005*	107
3.04 Availability of scientists and engineers	31
3.05 Quality of scientific research institutions	39
3.06 Tertiary enrollment, 2006*	90
3.07 Education expenditure, 2006*	126

Readiness component	65
Individual readiness	**52**
4.01 Quality of math and science education	46
4.02 Quality of the educational system	39
4.03 Internet access in schools	58
4.04 Buyer sophistication	25
4.05 Residential telephone connection charge, 2005*	89
4.06 Residential monthly telephone subscription, 2005*	96
4.07 High-speed monthly broadband subscription, 2006*	72
4.08 Lowest cost of broadband, 2006*	79
4.09 Cost of mobile telephone call, 2005*	58
Business readiness	**49**
5.01 Extent of staff training	31
5.02 Local availability of research and training services	43
5.03 Quality of management schools	48
5.04 Company spending on R&D	34
5.05 University-industry research collaboration	54
5.06 Business telephone connection charge, 2005*	91
5.07 Business monthly telephone subscription, 2005*	97
5.08 Local supplier quality	57
5.09 Local supplier quantity	50
5.10 Computer, comm., and other services imports, 2007*	35
Government readiness	**111**
6.01 Government prioritization of ICT	124
6.02 Gov't procurement of advanced tech products	87
6.03 Importance of ICT to government vision of the future	106
6.04 E-Government Readiness Index, 2008*	92

Usage component	94
Individual usage	**107**
7.01 Mobile telephone subscribers, 2007*	102
7.02 Personal computers, 2006*	103
7.03 Broadband Internet subscribers, 2007*	101
7.04 Internet users, 2007*	106
7.05 Internet bandwidth, 2007*	85
Business usage	**65**
8.01 Prevalence of foreign technology licensing	36
8.02 Firm-level technology absorption	65
8.03 Capacity for innovation	53
8.04 Availability of new telephone lines	101
8.05 Extent of business Internet use	73
Government usage	**99**
9.01 Government success in ICT promotion	99
9.02 Availability of government online services	73
9.03 ICT use and government efficiency	108
9.04 Presence of ICT in government offices	98
9.05 E-Participation Index, 2008*	105

* Hard data

Note: For further details and explanation, please refer to the section "How to Read the Country/Economy Profiles" at the beginning of this chapter.

Source: Global Information Technology Report [13]

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e-Learning Ecosystem Model for Rural Area in Pekanbaru

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Abstract—In the recent decades, e-Learning technology has been offered new opportunities for both educators and learners to enrich their teaching and learning experiences through virtual environments inside and outside formal education. Although the technology can be used to support learning activities, there are some concerns about existing e-learning model that can be improved by implementing e-learning ecosystem model. This paper presents an e-learning ecosystem model for rural area in Pekanbaru, Riau – Indonesia, which analogically to nature ecosystem that consists of species, population, and communities. The proposed model describes interactions, processes, and activities between users (species) and environment that are involved for education in rural area in Pekanbaru through e-Learning system. The species of the e-Learning ecosystem are citizen (learners), teacher, Dinas Pendidikan (Local Government), and non government organizations. The model also considers social capital as important part in to e-Learning ecosystem. E-Learning ecosystem model as a second generation of e-learning gives more possibilities to be implemented specially in rural area that has various species and environment involved. As the result, this model is expected can contribute as guidance for local government in order to give an alternative of education access for citizens in rural area in Pekanbaru.

***Index Terms*—e-Learning, ecosystem, learners, rural area, species.**

I. INTRODUCTION

This paper provides an overview of e-Learning ecosystem model within the context that be implemented in rural area. The model will be proposed as alternative choice to solve education problem in rural area because of some issues related with gap of education such as limitation infrastructure, lack of teacher qualification, limitation of learning material, and geographic distance [1].

E-Learning has the potential to bridge the educational gaps that exist in society and solve the issues because of leveraging of ICT, quality improvement of learning process and shifting the learning paradigm from an instructor-centric learning experience (*lecture-driven, knowledge acquisition*) to one which is student-centric.

Although, it has witnessed significant growth and massive changes in the e-learning industry, but there are some concerns about the existing e-Learning such as: isolation of learners, lack of teachers' feedback, student collaboration, and loss of learning context between national/local organizational and environment especially on cultural grounds. Therefore, current e-learning still will face the problem for more complexity of learning. E-learning ecosystem model is a solution to solve the problem.

II. E-LEARNING

A. Definition

Here, the preferred definition would view e-Learning simply as: *online access to learn resources, anywhere and anytime*.

e-Learning refers to the use of internet technologies to deliver a broad array of solutions that enhance knowledge and performance [2]. It is based on three fundamental criteria:

1. e-Learning is networked, which makes it capable of instant updating, storage, retrieval, distribution and sharing of instruction or information. So, important is this capability that it is fast becoming an absolute requirement of e-Learning.
2. It is delivered to the end-user via a computer using standard internet technology. This is a little tricky because the definition of just what is a computer is constantly changing. The key characteristic is the use of standard internet technologies, such as TCP/IP protocol and web browser that create a universal delivery platform. New technology such as IP over satellite provides very fast connections and meets this requirement.
3. It focused on the broadest view of learning. Learning solutions that go beyond the traditional paradigms of training. e-Learning is not limited to the delivery of instruction, characterized by Computer-Based Training (CBT). e-Learning goes beyond training to include the delivery of information and tools that improve performance.

B. Benefits of e-Learning

At least can be identified 11 major benefits of e-Learning:

1. ***Lower cost***. Despite outward appearances, e-Learning is often the most cost-effective way to deliver instruction (training) or information. It cuts travel expenses, reduces the time it takes to train people, and eliminates or significantly reduces the need for a classroom and instructor infrastructure.
2. ***Enhances business responsiveness***. e-Learning can reach an unlimited number of people virtually

simultaneously. This can be critical when business practices and capabilities have to change fast.

3. ***Messages are consistent or customized, depending on need***. Everyone gets the same content, presented in the same way. Yet the programs can also be customized for different learning needs or different groups of people.
4. ***Content is more timely and dependable***. Because it is web-enabled, e-Learning can be updated instantaneously, making the information more accurate and useful for a longer period of time.
5. ***Learning is 24/7***. People can access e-Learning anywhere and anytime. It is "just in time-any time" approach makes an organization's learning operation truly global.
6. ***No user "ramp-up" time***. With so many millions of people already on the web and comfortable with browser technology, learning to access e-Learning is quickly becoming a non-issue.
7. ***Universality***. e-Learning is web-enabled and takes advantage of the universal internet protocols and browsers. Concern over differences in platforms and operating systems is rapidly fading. Everyone on the web can receive virtually the same material in virtually the same way.
8. ***Builds community***. The web enables people to build enduring communities of practice where they can come together to share knowledge and insight long after a training program ends. This can be a tremendous motivator for organizational learning.
9. ***Scalability***. e-Learning solutions are highly scalable. Programs can move from 10 participants to 100 or even 100.000 participants with little effort or incremental cost (as long as the infrastructure is in place).
10. ***Leverages the corporate investment in the web***. Executives are increasingly looking for ways to leverage their huge investment in corporate intranets. e-Learning is emerging as one of those applications.
11. ***Provides an increasingly valuable customer service***. Although not internally focused, a business e-Commerce effort can be enhanced through the effective and engaging use of e-Learning that helps customers derive increased benefit from the site.

C. Second Generation of e-Learning

A successful e-learning course requires taking the following contextual elements into consideration:

1. ***Environment***, learners need a certain environment (PC, Connection, software) and some preparation needs to be done to make sure that the student has that.
2. ***Teach skills***, learners need to know something about how to use whatever learning system exists.
3. ***Subject matter skills***, learners need to have some prerequisite skills to benefit from the course.
4. ***Support***, there has to be a mechanism to get support when learners run into problems.
5. ***Content***, must be designed for interaction.
6. ***Instructor***, aware of learners' needs/concerns and involvement levels, attempts to draw learners into discussion early, organises schedule, provides resources for learners in need of additional learning (remedial).
7. ***Technology,*** should play a servant role.
8. ***Organization***, focused on learning, time and resources made available, learners supported through help-desk.

These elements belong to e-learning ecology or ecosystems that lead to the emergence of a second generation of e-learning [3]. These applications are less content intensive and more contexts based, less pioneeristic and more aware of learners' needs and early adopters' experiences. The emergence of second generation e-learning is made possible because of [4]:

1. The worldwide diffusion of online courses in blended formats.
2. Greater attention to the emotional side of e-learning experience.
3. Growing awareness of the different styles of potential elearners.
4. Emergence of adaptive hypermedia and the growth of open source software (OSS) and open content for learning.
5. Peer to peer learning and support.
6. User centered services increased attention to quality of e-Learning provision.
7. Pursuit of better learning via ICT for lifelong learning.
8. Emergence of different modes of learning access and delivery.

III. DIGITAL ECOSYSTEM

A. Concepts and Definitions

The concept of a Digital Ecosystem (DES) has been recently adopted by the computer and information society. DES is analogous to the biological ecosystems in nature. It is a dynamic and complex system that is composed of a variety of interrelated digital species that interact with each other and with their digital environment.

The DES infrastructure is a Digital Environment (DE) which is populated by Digital Species (DS). DS are analogous to biological species and usually form communities. The majority of DS consist of hardware together with its associated software. The hardware is analogous to the body of biological species whereas the software is analogous to the life of biological species. In nature, a body without life is dead. Similarly, hardware without any application running on it is useless. DE is analogous to the biological environment. A DE is an environment in which DSs are situated and in which they live and function. DSs together with DE form a dynamic and interrelated complex DES. DES transposes mechanisms from living organisms like autonomy, viability and self-organization to arrive at novel knowledge and architectures.

The DES involves three interdisciplinary domains: Social science, Computer Science and Natural science (see Fig. 1). The three disciplinary domains give basic framework for DES theory [5].

As a definition, Digital Ecosystem is the dynamic and synergetic complex of Digital Communities consisting of interconnected, interrelated and interdependent Digital Species situated in a Digital Environment, that interact as a functional unit and are linked together through actions, information and transaction flows [6]. A Digital Ecosystem is a system that supports cooperation, knowledge sharing, open and adaptive technologies development, and the evolution of knowledge rich environments. Digital Ecosystems consist of human and digital populations and their creation depends exclusively on interactions between humans and digital systems [7].

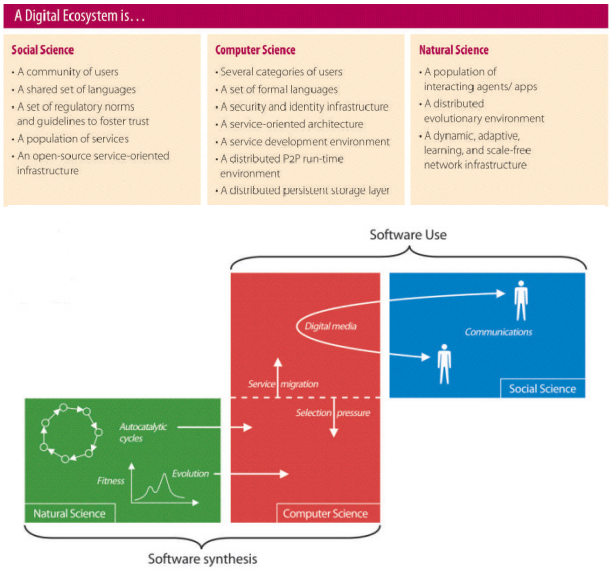

Fig. 1. Three disciplinary for DES domain

B. Evolving Digital Ecosystem

The Digital Ecosystem evolves through the following stages [8]:

Stage 1 : Physical Communities. Members from various offline communities begin adopting basic e-tools like internet, email, online search engines and so on. There is no significant change in the flow of information between members neither of the community nor in the operations

Stage 2: Electronic Communities. Adoption of e-technologies by members forms the next step in transferring the information flows to the digital domain. With more participants using e-tools, online services start evolving which require two ways information flows, or at least permit online information access, like in the various governance services. In this stage, the network evolution is sustained by a promoting agency, like various government departments, NGO sponsors etc., which acts as a central authority – financing and monitoring the project.

Stage 3: Digital Ecosystem. The evolution of the network breeds a dynamic cooperation between the players which encourages the online communities into greater sharing of knowledge and resources, while providing more opportunities for economic and social development. Local content is created and shared throughout the network. New services evolve online instead of different agencies developing services to meet member needs, increasing the types of players involved. These benefits encourage other members of physical communities to join the network. Most of all, the responsibility of sustaining the network is shared by all the participants and the role of the e-champion (that is, the central node who facilitated the sharing process in the e-community stage) is reduced. The ultimate aim to create a participative society, which supports economic inclusion, empowers the creativity and participation of all potential action (public and private organizations, communities, individuals) in open socio- economic processes.

IV. E-LEARNING ECOSYSTEM

Researchers have used the nature ecosystem in three different dimensions: i) meaning, ii) model and iii) metaphor, to define e-Learning ecosystems to represent specifically learning environments and their characteristics. The meaning refers to the technical definition, the domain and the characteristics; the model offers instruments to apply the meaning in a specific context; the metaphor is used in informal situations.

A. Nature Ecosystem

In nature, an ecosystem is a natural unit consisting of all plants, animals and microorganisms (biotic factors) in an area functioning together with all the non-living physical factors (abiotic factors) of the environment [9]. Biotic factors are organized in levels, which can be considered a set of entities, grouped in a growing complexity order: species, populations, communities and ecosystem as shown in Fig. 2. A community is an assemblage of populations of different species.

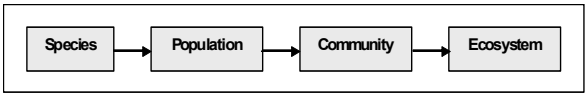

Fig. 2. Nature ecosystem

B. Components e-Learning Ecosystem

An ecosystem is the set of all the relationships between organisms and between organisms and the environment. A group of communities interacting with each other and acting on or suffering the action of abiotic factors constitute an ecosystem. Ecosystems have a nested structure, one ecosystem can contain other ecosystems; their size is variable, they can be microscopic or macroscopic; their spatial and temporal extensions are defined, they can be persistent or last a short period of time.

An e-Learning Ecosystem is similarly to nature ecosystems consist of species, populations and communities interacting with each other and with the environment (see Fig. 3). In nature ecosystems, it is defined as the set of all relationships between biotic factors (human and digital) and abiotic factors (environment).

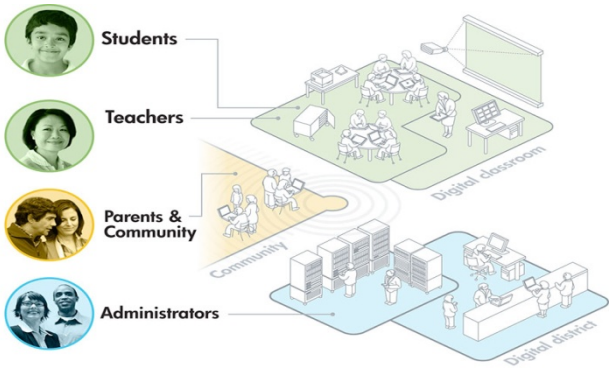

Fig. 3. Sample of e-learning ecosystem

Table I tells about species involved in biotic factors. Species are organized in populations; populations are organized in communities. Actors are organized in populations that can be learners, teachers, content creators and etc. Populations are linked together in communities. School staff and children, families, museum staff and visitors are some examples of communities. Populations of content are basic types of content: text, image, sound and etc.

TABLE I
THE SPECIES IN BIOTIC FACTORS

Species	Actors (Human)	Content (Digital)
Populations	- Learners - Teachers - Parents - Tutors - Content creators - Engineers - Technicians	- Text - Images - Sounds - Videos - Animations
Communities	- School (staff and children) - Home (family) - Museum (staff and visitors) - Company (users and technical support)	- Learning objects - Sites and Web portals - Learning environments - Authoring tools - Games

Communities are broader sets of populations of content, such as browsers, games or authoring tools. Each of these species can contribute and want to benefit from the system in its own way. The species also has role and responsibilities in the ecosystem. For example:

Learners. Learners study and learn from the course provided. Learners will engage better in learning if they believe the course can help them step into their desired career. Students will also learn better if the course is interesting and enjoyable. Students can help to improve the outcome of curriculum by voicing their concerns, learning needs and expectations. However, students need to make a commitment to the course by first enrolling and subsequently staying in the course until graduation.

Teachers. Teachers design and teach courses as well as carry out research in their chosen field. However, without learners, teachers will not be needed. Teachers can contribute to the design and development as knowledge experts in the field but also their experiences in pedagogical issues. Traditionally, teachers are entrusted with the task of curricula design and development; however, being in a field as dynamic as IT, input from other perspectives will certainly help keep the balance needed for sustainability.

Abiotic factors compose the environment that supports interactions between biotic factors and consist of hardware, software, network and database technologies as well as pedagogies.

Tabel II shows examples of abiotic factors are mentioned in the following table:

TABLE II
ABIOTIC FACTORS

Hardware	Desktop, laptop, tablet PC, PDA and cellphones.
Software	Virtual reality (VR), augmented reality, simulation, Artificial Intelligence (AI) and game engine.
Databases	Relational and Object Oriented (OO)
Network	LAN, WAN, WIFI and wireless technologies.
Pedagogical Theories	Constructivism and constructionism.

V. EXISTING E-LEARNING ECOSYSTEM MODEL

A. Model 1

Two resaerchers, Uden and Damiani [10] define an e-learning ecosystem as the combination of three major components (see Fig. 4): content providers, consultants and infrastructure.

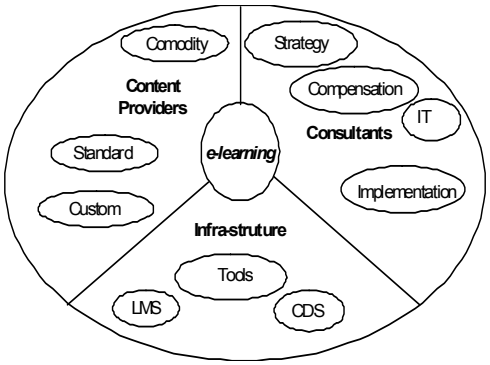

Fig. 4. Uden and Damiani model

Content Providers. Content providers offer content for learning solutions that is typically linked to competency development, personal development, or a critical business issue requiring improvement. there are three types of content providers: A brand name content provider that is typically associated with a leading publisher or business school; A Commodity Content Provider is content

aggregator that offers hundreds of titles, courses and modules in a variety of formats; Custom Content Provider is an organization that will tailor internal content and/or develop new content based on a specific requirement.

Consultants. There are four different types of consultants in the e-learning ecosystem. A strategy consultant helps an organization to develop a new business strategy. Compensation Consultant specializes in developing compensation strategies designed to ensure employees are motivated to achieve business goals. Information Technology Consultants help organizations set up the infrastructure required to perform e-business and the processes to operate efficiently and seamlessly. Implementation consultants help organizations put new systems, strategies and plans in action. They work with IT teams and strategy groups to successfully implement a new system.

Infrastructures. Infrastructure is defined as the "plumbing" for the management, delivery and tracking of e-Learning. It consists of learning content management system; content delivery system and tools. A learning content management system (LCMS) is a software solution that enables organizations to efficiently manage the process of training and development. A content delivery system (CDS) is online software that allows training to be delivered over the Internet. Tools transfer core intellectual property into a learning object.

B. Model 2

Chang and Guetl [11] define a generic e-learning ecosystem as the environment that contains the learning stakeholders (biotic factors) interacting with learning tools (abiotic factors) as shown in Fig. 5. For Chang and Guetl, Learning stakeholders are for example learners, teachers or content creators. The environment has defined borders and the learning ecosystem conditions suffer internal and external influences.

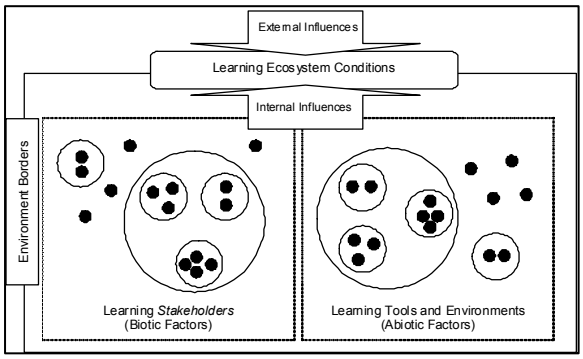

Fig. 5. Chang and Guetl model

C. Model 3

According to Ficheman and Roseli [12], e-Learning ecosystem consists of species, populations and communities that interact with each other and with the environment; it is the set of relationships between biotic (human and digital species), and between biotic and abiotic factors (environment), as shown in Fig. 6. The researchers also consider four important aspects of learning tools: authoring, collaboration, immersion and mobility.

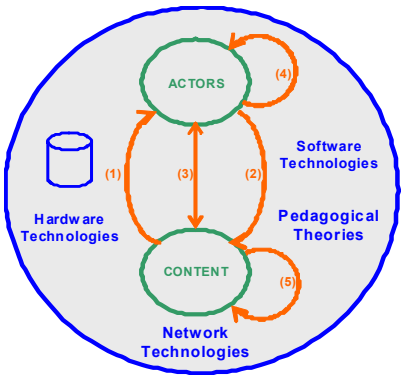

Fig. 6. Ficheman and Roseli model

In this model actors interact with content supported by technologies and pedagocial theories. Interactions are represented by arrows and they occur in 5 different ways. Interaction 1 occurs when content is exhibited to the actors (displayed on a screen, projected or played if it is a video or sound). Interaction 2 occurs when actors create content. Interaction 3 occurs when actors interact with content and trigger a change in content state (like in an assistant or a car simulation when the user uses an interface to accelerate the car speed). Interaction 4 occurs when actors interact with each other actors and interaction 5 occurs when content interacts with content.

VI. Limitations of Existing Models for Rural Area

Although existing models present significant opportunities to improve current e-learning system, there are faced several limitations that are not suitable if be implemented in context of rural area.

1. The existing models are developed within the context and to support existing formal education. Therefore, the major learning contents in the existing models are created based on standard curriculum. It is limited for customization. In other hand, in rural are context, learning contents are customized with local social capital.
2. Face to face context among the species in the existing models occurs only in formal situation. In this case, most of learning environment occurs in limited time. In rural area, there are not border between formal and informal situation.
3. The teachers in existing models are hired and assigned by government and came from various area. Most of them only focus in formal situation and poor understanding for local situation. Teachers in rural area are volunteers and came from its area. The can more focus, good local understanding, good motivation, and can in charge anytime.
4. Existing models have limitation of biotic factors. They just translate traditional formal education into digital environment. Rural area requires extra species such as non government organizations and social capital.

VII. The Proposed Model for E-learning Ecosystem In Rural Area

The proposed model of e-learning ecosystem model for rural area in Pekanbaru is adopted from 3 models that are mentioned in previous section. The model highlighted social capital factors as important part of ecosystem. Most people in Asia always consider social capital such as norms, ethics and socio culture in human life relationships and activities. As the pilot, the model will be proposed to provide digital learning environment in rural area through Society Learning Activity Center (Pusat Kegiatan Belajar Masyarakat/PKBM). The model is shown in Fig. 7.

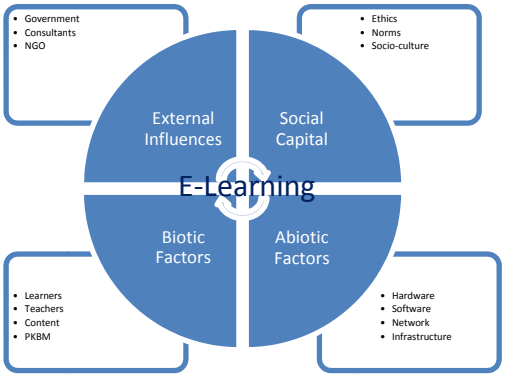

Fig. 7. The proposed e-learning ecosystem model for rural area

A. Biotic Factors

Learners. Learners are citizen that do not have opportunity to study in formal education.
Teachers. Volunteered or hired and be assigned as a teacher.
Content. It is digital material such as texts, images, audio, video and animations.
PKBM. It is communities as non formal education institution and founded by society.

B. Abiotic Factors

Abiotic factors are infrastructures that are required to support e-Learning ecosystem. They include hardware, software, and network.

C. External Influences

External influences are institutions or external regulations that influence to ecosystem. They are local government, non government organizations, IT/Content consultants and regulations.

D. Social Capital

Social capitals that include in the ecosystem are norms, ethics and socio culture that are influence in learning environment and learning contents.

VIII. Conclusion

This paper has presented an overview of e-Learning ecosystem model. Several basic theories associated with e-Learning ecosystem have been discussed. E-Learning ecosystem takes place in online environment that range from providing information and to engage the learner in complex interactive simulations. The proposed e-learning ecosystem model for rural area aims to reduce several limitations that are faced in existing model. It is a managed learning environments that will developed to provide an electronic solution within learning ecosystem, not only for pedagogical aspects but also interaction with external environment and social capital. In rural area context, e-Learning ecosystem provides extra biotic and abiotic factors such as social capital and external influences. The proposed model is expected can be a guidance and an alternative way to give education opportunity for citizens in rural area in Pekanbaru that have limitations in infrastructure, financial, time and motivation. Developing prototype, strategic implementation and challenges of the proposed model can be conducted for future research.

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ICT-based Approaches for Improving the Quality of Primary Education in Rural Areas

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Abstract— **Improving the professionalism of primary school teachers is a very urgent need, particularly for those in rural areas. In this paper, we propose approaches for addressing the problem using Information & Communication Technologies (ICT). There are at least three approaches in which ICT will be useful: (1) for interaction among teachers, (2) for classroom-teaching sharing, (3) and for enhancing students' learning process. While it takes multi-year commitment in order to demonstrate the usefulness of the above concepts, this paper primarily discusses our initial attempt in implementing the first approach. As case studies, we choose three rural primary schools (two schools in Subang and one school in Cianjur) as well as primary schools in Bandung. In the participating schools we install desktop (laptop) computers with Internet access capability. We conducted basic ICT training to participating teachers and set up an activity that will encourage them to interact with each other using these infrastructures. While the research is in progress, preliminary finding shows that the approach is promising.**

Index Terms—**Information and Communication Technology, Education, Rural**

I. INTRODUCTION

The problem of national education quality has gained much attention recently. Comparative studies showed that the ranks of Indonesian students are 34th in Math and 32th in Sciences out of 38 participating countries, and are much lower than the average globally (Mullis et al, 2000). More recent comparative study (Gonzales et al., 2004; OECD/UNESCO-UIS, 2003) indicated the need for improving the quality of primary educations.

Field observations reveal that most primary schools students are not interested in Math and Sciences and have difficulty in learning these subjects. This is reflected by the low scores of primary school students in national final exam. One of the root problems is that most primary school teachers have non Math and Science backgrounds and they deliver these subjects in conventional ways. For examples, learning sciences is conducted by lecturing only and requiring students to memorize all sciences' terms and concepts. As a result, students misunderstand many abstract concepts of math and sciences.

A quick look at the above facts suggests that improving the quality of education for primary schools is an urgent need. Conventionally addressing this problem is often obstructed by the lack of qualified trainers. The number of teachers that need professionalism improvement is much larger than the capacity of training provider (i.e., LPMP, P4TK and Higher Education) for conducting the upgrading programs. In addition, the unfortunate geographical condition, i.e., located in a vast, remote area that is very difficult to access, is another challenge. Teachers residing in these areas often do not have a chance to participate in professionalism improvement program.

One of the most promising, non conventional means of overcoming these issues is by utilizing Information & Communication Technologies (ICTs). The main research question is how ICT can be used to improve the quality of primary school teachers and improve the students' learning process so that improves the quality of primary education. In this paper, we report our effort and work on progress in designing and implementing ICT-based environment and learning process for primary schools.

The rest of this paper is organized as follows. Section 2 provides the overview of related work. In Section 3, we describe framework of ICT-based scenario for improving the quality of education. Next in Section 4 we discuss our effort in implementing the concept of using ICT for empowering the interaction among teachers regardless of the geographical location of the teacher. Finally, we provide our preliminary conclusions in Section 5.

II. RELATED WORK

Improvement of Math & Sciences education has a close relationship between the use of science method and the comprehension of Math & Science themselves, which are influenced by scientist attitude and students' scientific attitude on the subjects. These attitudes include curiosity, facts appreciation, tolerant to uncertainty, creative, open minded, critical thinking, cooperative and sensitive to living things and believe (Ward et al, 2006). Math & Sciences as the core curriculum in primary education is

believed contribute to providing basic skills (Harlen, 2000). The teacher professionalism is of great importance in delivering Math & Sciences. The teacher should be able to maintain the class fairness, to provide world class education, to support the family, to respect class diversity and to use educational technology (Cruishank et al, 2007).

State-of-the-art of ICT has made adaptive learning process possible, allowing students to build knowledge at their own pace (i.e, personalized learning) (Heinich, 1996) as well as systems to control students' learning activities. Currently, it is not very difficult to create a multimedia or hypermedia-rich learning resource. The use of hypermedia helps students understand many abstract concepts of Math & Science. Schade research revealed that using multimedia for learning can improve the students' recall of the lesson by 25-30 percent (Munir, 2001). Learning dynamic electricity using hypermedia improves the student mastery of concept, scientific process skill and critical thinking of middle school students by 60% (Suwarna, 2004). Recent studies on online learning involving forty teachers show that teachers had the feeling of getting support from instructor and peers as well as in developing instructional design (Clarke & Rowe, 2007).

Math & sciences develop as fast as that of social issues. Therefore, the development of teacher professionalism in the subjects represents a continuing and long-life learning (Widodo et al., 2006). Professional development for teacher should include (1) integration of math & science knowledge with teaching method, (2) tutor demonstration on applying the learning model, (3) sufficient enrichment, and (4) instructor-guided practice session on applying the learning model (Hinduan & Liliasari, 2003). Math learning shall be emphasized on students' active learning, which will change students perspective on math from *uninteresting* to *interesting* and from *dislike* to *like* (Tumudi & Dasari, 2000; Surachman, 2000; Sabandar & Turmudi, 2001; Turmudi & Sabandar, 2002).

Nevertheless, traditionally delivered class still dominates the learning process and remains the common practice in the most part of the country. It certainly will hinder the creative thinking of students and prevent them from reinventing math concept as discovered by mathematicians in the past (de Lange, 1996). Teacher professionalism programs conducted through LPMP, P4TK, *Dinas Pendidikan*, and professional organization in Indonesia are untouchable by most teachers because of their hard-to-reach geographical location.

III. ICT ROLE

The disparity of high-quality teacher distribution and the existence of many hard-to-reach geographical locations suggest that a non-traditional method of delivering programs such as through on-line learning can be a good alternative for addressing the above issue. This is where ICTs plays it important role. Figure 1 shows the ICTs roles form improving the learning process for primary school students.

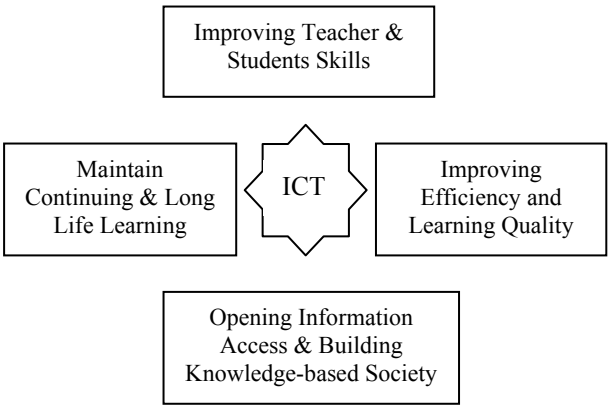

Fig. 1. ICT Roles

First of all, ICT broadens information access needed by teachers and students. Additionally, information access lays the foundation for developing knowledge-based community of teachers and students so that it will generate multiplier effect for improving the society quality of life. Secondly, ICT can improve the efficiency of learning process, e.g., offering greater flexibility in the management of learning schedule. As a result, it is expected that the learning outcome will also improve. Thirdly, the availability of ICT infrastructure requires its users (teachers and students) to effectively use and take benefit from it. Consequently, their IT-usage skills such as using email services, chatting and related educational technology will improve. Lastly, ICT can support continuing as well as long-life learning.

IV. ICT-BASED SCENARIOS FOR IMPROVING THE QUALITY OF PRIMARY EDUCATION

The use of ICT for learning process is not meant to replace the teacher role with technology but to help and support the learning proces while maintaining the interaction between the teacher and his/her students. The concept of ICT-based approches for improving the quality of primary education, particularly in rural areas, is summarized as follows:

- ICT for Teachers: developing teacher community network, learning resource repositories as well as teaching best practices.
- ICT for Class: creating virtual class that will help teacher delivering the lesson.
- ICT for Laboratory: consisting of virtual laboratoy and structured computer lab
- ICT for Students: creating a condusive environment for students self-learning
- ICT for Community: allowing the learning process to be delivered and conducted from any where and any time (e.g., particluarly from homes).

We will elaborate each of the above scenarios in the following sections.

A. ICT for Teachers

This concept relates to the use of ICT for providing electronic services to teachers and experts. It requires an Internet-based networking of teachers and experts so that allowing them to interact with each other, to share learning resources as well as teaching best practices.

This ICT concept for teachers is being implemented in a pilot project involving two primary schools in Subang (representing rural schools whose teachers have little knowledge about using computer), two primary schools in Bandung (representing schools in Urban schools with computer literate) and one primary school in Cianjur (representing a sub-urban school with modest knowledge of computer usage). The common ground among these teachers are that they are very motivated and interested in participating in the pilot project.

This effort is part of our ongoing research funded by ITB research grant. The main objective of this research is as follows:

- Improving the quality of primary school human resources by creating learning community.
- Establishing basic ICT infrastructure in the target primary schools.
- Providing repository of learning resource, scientific publication and best practices.
- Providing training and repository enrichment services
- Managing and measuring the program achievement

The research activities include: (1) need assessment analysis of teachers for supporting the learning process, (2) ICT training for teachers (e.g., how to use ICT-based tools such as email, learning management system, etc.), (3) developing and implementing ICT-based learning programs for teachers (4) program progress monitoring and evaluation.

The participating schools are provided with computer (laptop) and necessary softwares as well as subscription to Internate access. With this basic ICT infrastructure, a set of program are setup for teachers from the participating schools. Among of them are weekly chatting session where all participating teachers synchronously interact with each other online as well as online discussion forum among teachers and experts.

These activities are coordinated by Digital Learning Center in ITB and have produced a learning community connecting teachers form the five participating schools in the pilot project. The program is still on going and we are in the stage of monitoring its progress.

B. ICT for Classrooms

This concept provides virtual class services for supporting distance learning. The main idea is that ICT will be used to allow a teacher help teaching a class in different school without having to physically attend to that school, for example using a recorded multimedia or (if possible) through multimedia streaming on the Internet.

Fig. 2. Learning community in the pilot project

In the concept of ICT for classroom, a teacher teaching in a classroom session is recorded in VCD/VCD or directly broadcasted at the same time to other classes in different schools via Internet. In the off-line mode where the class session is conducted by running VCD/DVD, a teacher acts as a facilitator who motivates and engages students to discuss the presented subjects. While in the on-line mode that uses teleconference system, a more interactive session can be conducted between students and remote teacher. Figure 3 illustrates this concept.

C. ICT for Laboratory

ICT for laboratory is using ICT for providing virtual as well as structured computer lab. This concept is supported by thin-client based computer system connected to a server hosting various supporting applications. When the system is connected to Internet, it will link to similar systems from other schools, forming larger interconnected systems. Students can access services provided by system in his/her school and other schools as well.

D. ICT for Students

The main idea of ICT for students is to use ICT for providing open area and self-learning services for students. Using the infrastructure of ICT for laboratory, this concept can be realized by adding self-learning resources (including educational resources from Internet) that can be accessed by students. Figure 4 illustrates the interplay between the concept of ICT for Laboratory and ICT for students.

The system architectures provided by Figures 3 & 4 assume that each school is reachable by wireless communication signal (e.g., Telkomsel) with at least GPRS service enabled.

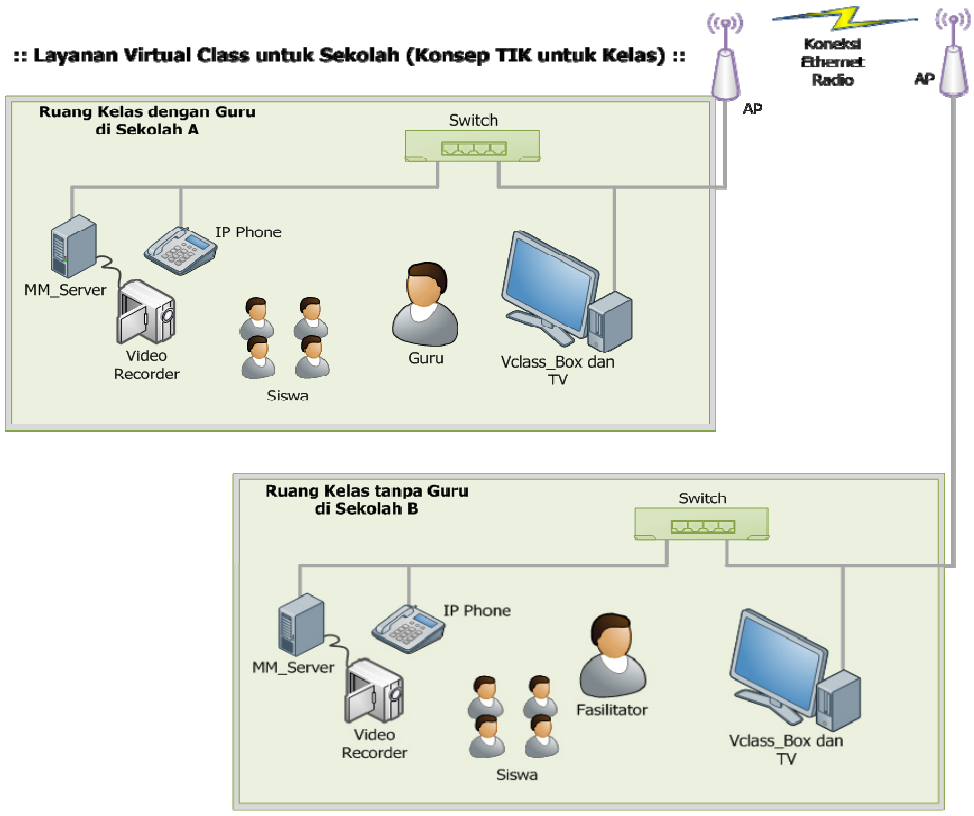

Fig. 3. An illustration of ICT for virtual class.

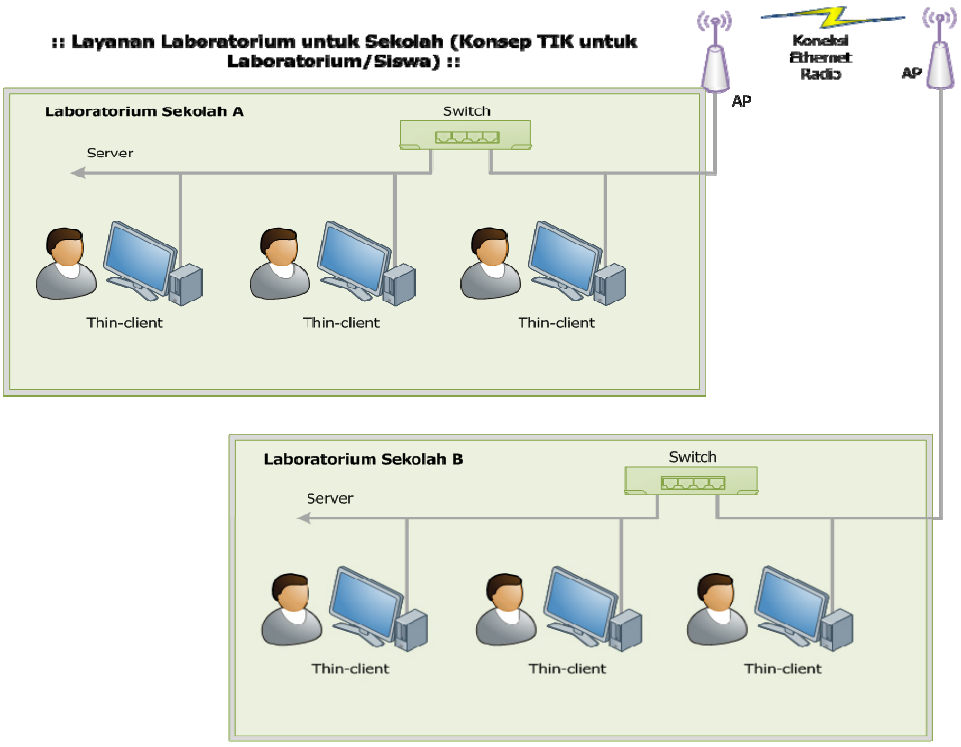

Fig. 4. An illustration of ICT for structured laboratory and students.

This is not a problem in a dense populated island such as Java. However, for rural areas with no wireless communication signal available, a slightly different approach is needed. The cheapest solution is using VCD/DVD for delivering classroom teaching particularly for schools that do not have enough teachers nor have a qualified teacher for delivering specific subjects (e.g., math & sciences). A more expensive solution, but is still affordable and quite effective, employs DVB satellite broadcasting (this solution needs inter-departmental collaboration). The most expensive solution involves VSAT technology for data communication. This is an approach we propose to be implemented as Pilot Project in East Sumba (see Figure 5).

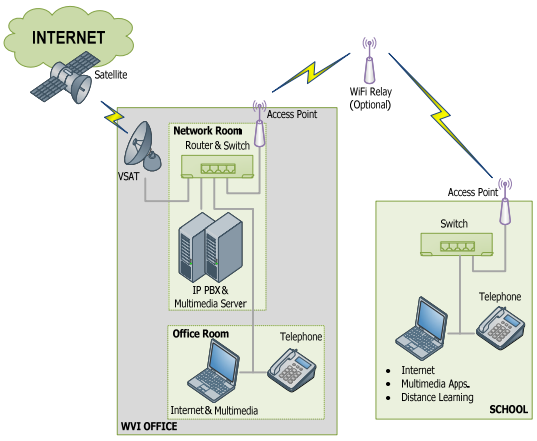

Fig. 5. An ultimate solution in a remote area with no wireless communication signals.

All the above scenarios will be supported by a Digital learning center. The main task of this center is to provide:

- Long-life services for teachers and other professionals in education sector.
- ICT-based learning resource developement
- Future educational technology development, and
- Distance learning development services

V. Concluding Remarks

We have described in this paper our various approaches in utilizing ICT for improving the quality education in primary schools. At this moment, the implementation of ICT for teachers is still in progress. It is interesting to note that many non technical aspects came up, some times slowing the implementation process down particularly when introduce learning activities that are new to them (e.g., online discussion). Although the result has not been conclusive yet, our approach could be promising.

Acknowledgment

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The Use of Interactive Multimedia to Enhance Students' Generic Science Skills

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***Abstract*—To face against challanges in the 21st century Indonesian people should be smart and competitive. Science education has an important role to reach those skills through scientific thinking. Scientific thinking can be created through generic science skills mastery. Teaching models used interactive multimedia software had been developed to enhance students' generic science skills in primary, secondary and tertiary education. Through quasi experimental method, three topics : Animal Reproduction (Biology) for junior high school, Chemical Bond (Chemistry) for senior high school and Elasticity (Physics) for physics education students had been chosen, to develop 7 indicators of the generic science skills; i.e. Indirect observation, symbolic language, causality, sense of scale, mathematical modelling, logical inference, and concept formation. All three topics consist of 41 essential concepts. The implementation of the models of teaching to 44 junior high school students in State Junior High School at Cimahi, 33 senior high school students in State Senior High School at Lembang, and 35 prospective physics teachers in State Teacher Training Institution at Mataram (NTB) showed that student easily mastered indirect observation, concept formation and causality, but difficult in mastery mathematical modelling and logical inference. The matery of generic science skills increased as well increasing of educational level. In fact generic science skills mastery helped students comprehend many science concepts. Therefore using interactive multimedia could enhance students' thinking skills from science concepts attainment to scientific thinking.**

***Keywords*—interactive multimedia, generic science skills, scientific thinking.**

I. INTRODUCTION

Global challenges should be faced by Indonesian people that make their life more difficult. Resession at the end of the year 2008 and further in 2009, caused vacancy hardly to be found. Only the smart and competitive people win on the competition at work. How to prepare smart and competitive people is a big problem in Indonesia. Smart people usually competitive. Therefore earlier development of youth thinking skills is needed to make smart people. Science (biology, physics, chemistry) education has an important role in the development of thinking skills.

Many Indonesian students learn science concepts and principles through recall. Their concepts' mastery usually low because the concepts are not meaningfull to them. On the other hand there are too many science concepts and principles that make students fed up to learn the subject. Learn science that way make students cannot applied the concepts in their everyday life. They have not competency that should be reach as hoped in content standard as stated in [1]. To reach the competency there should be new paradigm on learning science, to give students many experiences to master science and guide them to use science knowledge [2].

In order to overcome the problem, students need to learn science thinking skills to make their science knowledge application easier. The science thinking skills are described as generic science skills [3]. Therefore the alternative solution to enhance science education in Indonesia is to change science education paradigm from recall scientific concepts to generic science skills mastery.

Generic science skills consist of soft skills. It is abstract and hard to be learned. ICT has capacities to make the abstract concepts to be concreted. There are many of abstract concepts representations made easier by ICT. [4].The research problem is how can generic science skills mastered by the students through ICT based science instruction?

II. SCIENCE AS THINKING VECHICLE

As in [5] stated that science thinking frame consist of principles: (1) in the universe there are consistency and universal framework; (2) science is a proses to get knowledge that comprehend phenomenon; (3) science always change and not the end of truth: (4) science is only an approach to the "absolute" therefore it is not "values free" dan (5) science is limited, that cannot decided "true" or "false".

Science also has common themes, i.e. system, model, consistency, profile of change, and evolution. Students should also be conscious on those science characteristics in learning science. Besides learning science full of thinking activities that developed through 8 indicator of generic science skills, e.i. (1) direct and indirect observation; (2) sense of scale; (3) symbolic language; (4) logical self consistency; (5) logical inference; (6) causality; (7) mathematical modeling; (8) concepts formation [3]. The ninth indicator of generic science

skills, especially in chemistry is spatial [2].

Science learns nature phenomenon through **direct observation** to search causality of things that being observed. The limitation of human sense, make the direct observation should be helped by instruments. As an example in chemistry an indicator is needed to prove acid-base property of poisonous solution, amperemeter to observe electric current, tensimeter to measure blood pressure. The observation helped by instruments described as **indirect observation**.

There are several scales in nature that different size of many things in daily life. Protein has big molecular size and complex in structure. On the contrary electron has very small size and simple. Half life of radioactice element vary from $1,6 \times 10^{-4}$ seconds of Po to 5×10^{9} years half life of U-238. **Sense of scale** is needed to study those things.

Symbolic language is used in science communication all over the world**,** for example: elements' symbols as H, O, Na etc; ampere for electric current scale, arrow as symbol for male and plus for female. Long time observation of nature phenomenon will discover many scientific laws, but there will be several logically "anomali". **Logically self consistency** of natural laws answered the "anomali" by defined new theory. Difficult biochemistry reaction as an example can exist in vivo at the temperature lower than in-vitro. The answer of the phenomenon is the existence of enzyme as catalyst of couple reactions.

Many facts in science cannot be observed directly but it can be discovered through **logical inference** from logical consecuencies in science thinking, i.e. zero Kelvin degree is really right although it is not be proven in real life, but only proven by graphic. If concentration of the reactant larger, than rate of the reaction larger. If the temperature of the system is reduced, than exoterm reaction conducting in better way. Explanation of those phenomena can be answered by **causality**.

Mathematical modelling can help to explain a lot of phenomena relationship in nature. Through the modeling it is hoped to predict relationship or changes of the series nature phenomena tendency precisely. For example: gas pressure in the contrary with volume according to Boyle that formulated as PV = C. Not all nature phenomena coul be explained in daily language, therefore it is needed to explain in special terminology, named concept. Concepts formulation is needed to prove for their application in further development. The process in science named **concept formation**.

Chemistry as a science discipline needs another generic science skill that is **spatial view**. This generic science skill becomes important because chemistry studying structure and changes of the structure of matter. The structural change if there are changes in particles bonding direction in space.

Higher order thinking skills consist of critical thinking, creative thinking, problem solving, and decition making [6]. Students can develop higher order thinking skliis through the 9 generic science skills. Critical thinking can be developed by direct and indirect observation, sense of scale, mathematical modeling, dan concept formation. Creative thinking can be applied if students formulate symbolic language, logical inference, and logical consistency of natural laws.

Problem solving can be applied if students learn about causality in several nature phenomena they observed. Further, decision making can be applied by students through concepts formation, mathematical modeling, and logical inference. Therefore if students learn science only by memorizing scientific terminology, they are not learning science at all. They cannot apply thinking science.

ICT can overcome the difficulties faced in developing higher order thinking. The abstract characteristic of scientific concepts should be learned through several representations. The computer flash program such as interactive multimedia can be used to make verbal, graphical, mathematical and symbolic representation more concrete and easy to understand (Heinich, et al 1996)

III. METHOD

Rapid developments of the science knowledge caused too many scientific concepts needed to be learned by students. Therefore it has been needed to choose essential science concepts to be learned. The chosen essential concepts based on importance of the concepts on students' daily life to give students enough scientific thinking skills.

Science education research has been done with R & D method. The research aimed to develop generic science skills on the three levels of education, e.i. junior high school, senior high school, and institute of teacher training. The reseach also conducted on different science disciplines i.e Biology oin junior high school, Chemistry on senior high school, and Physics on the institute of teacher training. The topics choosen are Animal Reproduction (Biology), Molecular Interaction (Chemistry), and Elasticity (Physics). Those topics learned through ICT based instruction. Interactive multimedia flash has been chosen to represent many abstract scientific concepts. Concepts analysis of the topics has been done before instructional development used descriptive method [6]-[11]. The analysis result and relationship between the concepts and generic science skills can be seen on Table 1.

Tabel 1. The relationship of topics, scientific concepts and generic science skills

No	Topics	Concepts	Generik science skills
1.	Animal reproduction	reproduction, asexual reproduction, spliting, sprouting, fragmenting, sexual reproduction, fertilisation, external fertilisation, animal reproduction system, invertebrata reproduction system, vertebrata reproduction system, pisces reproduction, amphibi reproduction, reptile reproduction, aves reproduction, mamalia reproduction, reproduksi human reproduction, man and woman reproduction ,ovulation, menstruation, contraseption, sexual desease	Logical inference, causality, modelling, concepts formation
2.	Molecular interaction	molecular interaction, intermolecular attraction, dipolar interaction, london force, hydrogen bond	Indirect observation, symbolic language, causality, mathematical modelling, concepts formation
3.	Elasticity	Elastic substance, plastiecs substance, tension, stretch, spiral potential energy, Young modulus, friction modulus, bulk modulus, energy strain density, Poisson comparablility	Indirect observation, sense of scale, logical inference, causality, mathematical modelling, concepts formation

Further concepts analysis shows concepts characteristics and generic science skills relationship. Analysis result given on Table 2.

Table 2. Concepts characteristics and generic science skills relationship.

No	Generik Science Skills	Concepts characteristics
1.	Indirect observation, modelling,causality, sense of scale, logical inference	Abstract concept, abstract concept that has tangible example, concepts that name process, concepts that related to properties
2.	Symbolic language, mathematical modelling, concepts formation	Principles based concept, concept that represents symbols

Table 2 shows that learning science concepts give students complex thinking skills. Usually each science concepts develop more than one kind of generic science skills. Therefore learning scientific concepts is parallel with the development of science thinking skills as higher order thinking skills. It shows that generic science skills as a way to develop students' higher order thinking skills that make them smart and make them competitive.

ICT based instruction planned in this research with interactive multimedia software aimed to develop scientific thinking and made microscopic aspect of the science topics chosen clearly. In learning science those aspects become important because they were scientific part that difficult to understand.

Implementation of the instructional models used quasi experiment method of the control group pretest-postttest design (except the implementation on senior high school because of the limited amount of students, used one group pretest-posttest design).

Subjects of the research in a state junior high school at Cimahi state are two of nine grade classes consist of 44 students, as an experimental and control classes.Topic learned was Animal Reproduction in Biology lesson. Other subjects were 33 students of eleven grade senior high school as experimental class on a state senior high school at Lembang. The topic learned was Molecular Interaction in Chemistry lesson. Elasticity topic of Fundamental Physics course in a state teacher training institution in Mataram West Nusatenggara was chosen as the third topic. Subjects of research were two classes first grade students consist of 35 students. Result of the research explained as follow.

IV. RESULT AND DISCUSSION

Students' generic science skills mean score of Animal Reproduction topic on experimental and control classes at junior high school school can be seen on the Table 3 and Figure 1. Further generic science skill mean score of Molecular Interaction topic on experimental class at senior high school can be seen on Table 4 and Figure 2. Generic scince skills mean score of Elasticity at teacher training program on experimental and control classes can be seen on Figure 3.

Tabel 3. Mean score of generic science skills on pretest, posttest dan N-gain students on Animal Reproduction topic [11]

No	Generic science skills	No test	Control class mean score			Experimental class mean score		
			Pre test	Post test	% N-Gain	Pre test	Post test	% N-Gain
1.	Modelling	5, 8	11,76	18,54	17,33	10,26	24,88	20,09
2.	Concept formation	3, 7	16,43	20,15	22,14	12,47	18,97	14,92
3.	Logical inference	4, 6	21,73	21,11	25,78	16,02	30,80	22,22
4.	Causality	1, 2	14,24	25,84	26,10	13,40	19,76	20,79

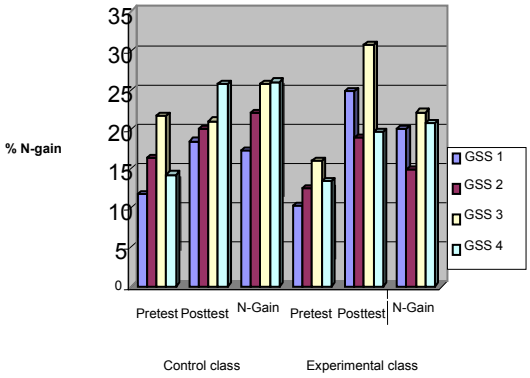

Figure 1. Mean score dan N-gain junior high school on each GSS of Animal Reproduction Topic

Tabel 4. GSS mean score on pretes, postes of the Molecular Interaction topic (Agustin,2009)

No	Generic science skills	No test	Score		
			Pre test	Post test	% N-Gain
1.	Concept formation	1, 2, 6, 7, 13, 16, 22, 25,	28,79	55,05	36,87
2.	Modelling	3, 4, 11, 12, 15, 18	43,93	67,67	42,33
3.	Logical inference	9, 10, 19, 20, 24	39,39	59,39	32,99
4.	Indirect observation	5, 14	22,72	50	35,30
5.	Causality	8, 17, 21, 23	20,45	42,42	27,62

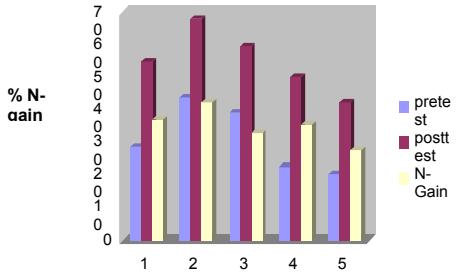

Figure 2. Mean GSS Score of pretest, posttest dan N-gain of Molecular Interaction topic [10].

Tree science topics chosen have similarity on concepts characteristics. They all consist of abstract concept, abstract concept that have tangible examples, concept that represent process, concept related to properties, principles based concept, concept that involved symbol. On the other hand concepts that represent processes is the only concept that not found in Animal Reproduction topics.

Based on concepts characteristics, chemical concepts were more complex than biological and physics concepts. The consecuency of the similarities concepts characteristics of the three science disciplines, there are similar generic science skills developed on the three models of teaching. That means generic science skills covered science interdiciplines. Therefore generic science skills can unify all science disiplines. Related to the limited properties of concepts on the models of teaching, other generic science skills might be developed through different science topics on the further research.

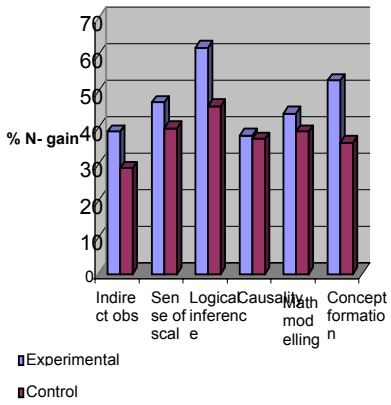

Figure 3. GSS mean score on control and experimental classes of Elasticity topic

The result of statistical analysis of students score on generic science skills shows that there were significantly differences between control class and experimental class of Animal Reproduction topics (Z= 4.809 and p = 0.05). N-gain of control class is Students' generic science skills score shows significantly differences of posttest and pretest (p=0.05) and N-gain 42.33 % on Molecular Interaction topics. That shows a low generic science skills development. Generic science skills of prospective teacher students show the significantly different score between experimental class and the control class. The result of experimental class got N-gain 51.1 % and the control class got 29.3 % on the Elasticity topics.

These result shows generic science skills as higher order thinking skills less developed in junior high school. This fact was not in line with Piaget's cognitive development theory. The theory described that 11 year old students have a formal operational thinking stage [11].

On the senior high school and university research shows that generic science skills have been mastered. Although students of senior high school had not successful on all generic science skills developed. They had small score on mathematical modeling and symbolic language. On the contrary generic science skill 'causality' matered well by senior high school student, but fail to be mastered by the university students. That means the development of generic science skills not only determined by educational level of the students but also dependent to topic characteristic. Based on the research used 3

scientific topics consist of 41 concepts, could be developed 7 indicator of generic science skills. That means concepts variation larger than scientific thinking skills variation. Therefore through few scientific thinking activities students mastered many science concepts and thinking based learning science should be very important.

V. CONCLUSION

Based on research result several points was concluded, those are: (1) learning science in new paradigm through development of generic science skills as higher order thinking skills; (2) the development of generic science skills made students mastered scientific concepts; (3) Thinking science that consist of indirect observation, symbolic language, modeling, mathematical modeling, causality, logical inference, and concepts formation; could be learned through topics Animal Reproduction, Molecular Interaction, and Elasticity; (4) Generic science skills increased parallel with the increasing of educational level; (5) Scientific thinking mastery make learning science easier, because it can wrap a lot of scientific concepts. Therefore scientific thinking is a basic skill needed to enhance individual thinking skill.

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Current LAPAN Program on Satellite Technology and Application Development

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***Abstract*—As a country with extensive maritime continent region inhabited by more than 235 million populations the utilization of space is important for Indonesia to address solutions to the present and real problems of the people and nation. Small/micro earth observation satellite systems have become a significant approach for space technology development due to the opportunities of international cooperation and low development costs. LAPAN implemented a LAPAN-TUBSAT micro-satellite development for earth observation in cooperation with Technical University of Berlin that was launched into orbit by Indian Space Research Organization (ISRO) on January 10, 2007. The satellite carrying one high resolution and one wide coverage video camera payloads is still in operation today. LAPAN is in preparation of developing successive satellites, they are the LAPAN-A2 satellite for earth observation, and also the LAPAN-ORARI satellite for amateur radio communication and earth observation. Both satellites are based on the LAPAN-TUBSAT satellite design, and are planned to be inserted to near-equatorial orbits to provide maximum orbit overpass over Indonesia. The objective of satellite development is to acquire the capability to develop a remote sensing satellite with multi-spectral imaging payload for food security applications, and other land and marine applications. This requires several stages of satellite bus and mission payload technology development.**

I. INTRODUCTION

Indonesia is located approximately between $94^0$45'E and $141^0$65'E or around 5,150 km along the length of the equator (or about $1/8^{th}$ of earth circumference), and the widest breadth is between $6^0$8'N and $11^0$15'S or around 2,000 km, with more than 237 million population (July 2008 estimate). It is an archipelago positioned between the Indian and Pacific oceans, and between the Asian and Australian continents. The utilization of space in Indonesia is significant to address solutions to present and real problems of the Indonesian people and nation.

Indonesia needs space application to solve several problems due to extensive and diverse maritime continent geography of its region. The utilization of space technology and application will grow to cover needs on:

- Telecommunication (first domestic satellite telecommunication system in operation in 1976);
- Earth observation (natural resources, rural and infrastructure development, land use, environment, weather, climate and others);
- Navigation;
- Defense and security;
- Disaster mitigation and relief;
- Health;
- Education;
- Others;

These needs require utilization of progressive space technology, industry and its application for sustainable development of national prosperity and resilience.

II. DEVELOPMENT OF SATELLITE MISSION

Based on Government National Middle Term Plan (RPJM) 2004-2009, the research activities focuses on six priority sectors, namely food security, health care and medicine technology, new and renewable energy resource, transportation technology and management, information and communication technology, as well as defense and security. As a government institution, the Indonesian National Institute of Aeronautics and Space (LAPAN) has the responsibility to support the government in meeting its national goals.

Due to guidance of National Minister of Research and Technology at 2002, LAPAN has to establish the program of satellite development to support the national food security program. This program is relevant and reasonable according to several considerations:

- Food security is high priority of national development program by government
- Remote sensing satellite is one of LAPAN's main assignment
- Development of high technology satellite will fulfill the most of space mission needs.
- Satellite development is technology opportunity that can be achieved with several steps or phases.

Satellite mission utilization to resolve food security usually employs remote sensing satellite which carries the payload of multi spectral imaging sensor. The development of remote sensing satellite needs knowledge, skill and experience of both imager payload technology and spacecraft technology with high accuracy of control. These capabilities of satellite development will be achieved by LAPAN in several phase of satellite development program. Fig. 1 presents the satellite development program of LAPAN.

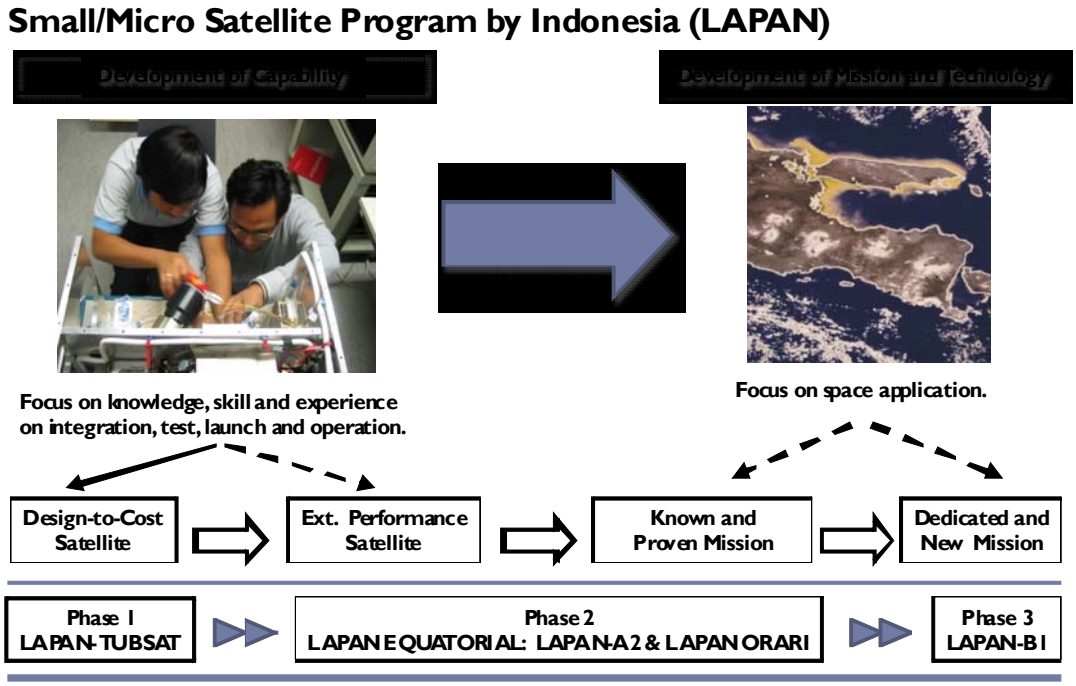

Fig.1. LAPAN Satellite Development Program

LAPAN started the satellite development program by developing micro satellite as strategic approach. The main objective of micro satellite program was development of capability. This program was focused on gathering of knowledge, skill and experience on integration, test, launch and operation. The program was arranged by design to cost approach to produce a cost-effective small satellite mission for Earth observation. This approach is very important for developing country such as Indonesia which has a modest research budget. Ongoing reduction in mission complexity as well as in those costs associated with management, together with the possibility of launching to orbit as an auxiliary payload on launch vehicle has made the small/micro satellite become interesting for future space mission.

In the field of micro satellite technology, there are many opportunities for international cooperation. Micro satellite is often used by governments, private companies and universities for experimental application and technology demonstration satellites. It gives advantages for developing country with little or no experience in space technology to enter the field of space borne Earth observation and its application.

Micro satellite development also gives opportunity to access current advanced technology. Micro satellite has possible approach to take full advantage of the ongoing technology developments leading to further miniaturization of engineering components, development of micro technology for sensors and instruments which allow designing dedicated, well-focused Earth observation mission.

The first phase of LAPAN micro satellite program was started by developing LAPAN-TUBSAT. Currently, LAPAN is in preparation of developing successive satellites, they are the LAPAN-A2 satellite for earth observation, and also the LAPAN-ORARI satellite for amateur radio communication and earth observation. Both satellites are based on the LAPAN-TUBSAT satellite design, and are planned to be inserted to near-equatorial orbits to provide maximum orbit overpass over Indonesia. The objective of all those satellite development is to acquire the capability to develop a remote sensing satellite namely LAPAN-B1. LAPAN-B1 will have dedicated mission to support food security program.

III. LAPAN-TUBSAT

The LAPAN-TUBSAT is a video surveillance micro satellite that was developed at the Technical University of Berlin Germany, by a team of Indonesian engineers. The satellite has been launched as piggyback on January 10, 2007 by a Polar Satellite Launch Vehicle (PSLV) launcher from Sriharikota India. The satellite is carrying a S-band data transmission system, a high-resolution video camera, a low-resolution video camera, and a short text store and forward messaging. The objectives of LAPAN-TUBSAT development program is to provide the Indonesian engineers with the skill to design, construct, test, and operate LAPAN-TUBSAT class micro satellite as well as to provide Indonesian engineers with the knowledge on the micro satellite 'off-the-self' components.

Fig.2. LAPAN-TUBSAT Satellite on Upper Stage of PSLV-C7

LAPAN-TUBSAT is carrying two color video cameras. One of the camera payloads is a high resolution video camera. The hardware is CCD video camera with color splitter prism. Therefore, the incoming lights is split into red, green and blue components and conveyed to 3 CCD arrays. Each CCD array has effective picture element of 752 x 582, and because of the beam splitting each element could contribute to become one pixel, and therefore improve the picture quality. A 1000 mm cassegrain lens is mounted on the camera and therefore could produce image with the swath of 3.5 km and ground resolution of 6 m from 630 km altitude. Another payload is a low resolution video camera. The hardware is a color CCD video camera with effective picture element of 752 x 582. Lens of 50 mm is mounted on the camera so that it could produce image with 81 km swath and ground resolution of 200 m from 630 km altitude

LAPAN has operated two ground stations to control the LAPAN-TUBSAT satellite, namely the Rumpin ground station located in Jakarta and the Biak ground station in Papua, East of Indonesia. The ground station location is chosen in such a way so that the coverage area is large enough to cover the nation archipelago. Fig. 3 shows the coverage of the LAPAN-TUBSAT from both ground stations.

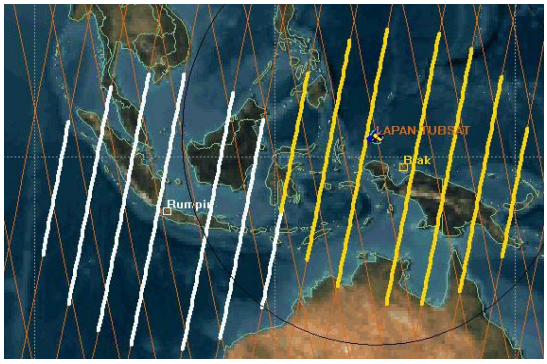

Fig.3. LAPAN-TUBSAT Coverage

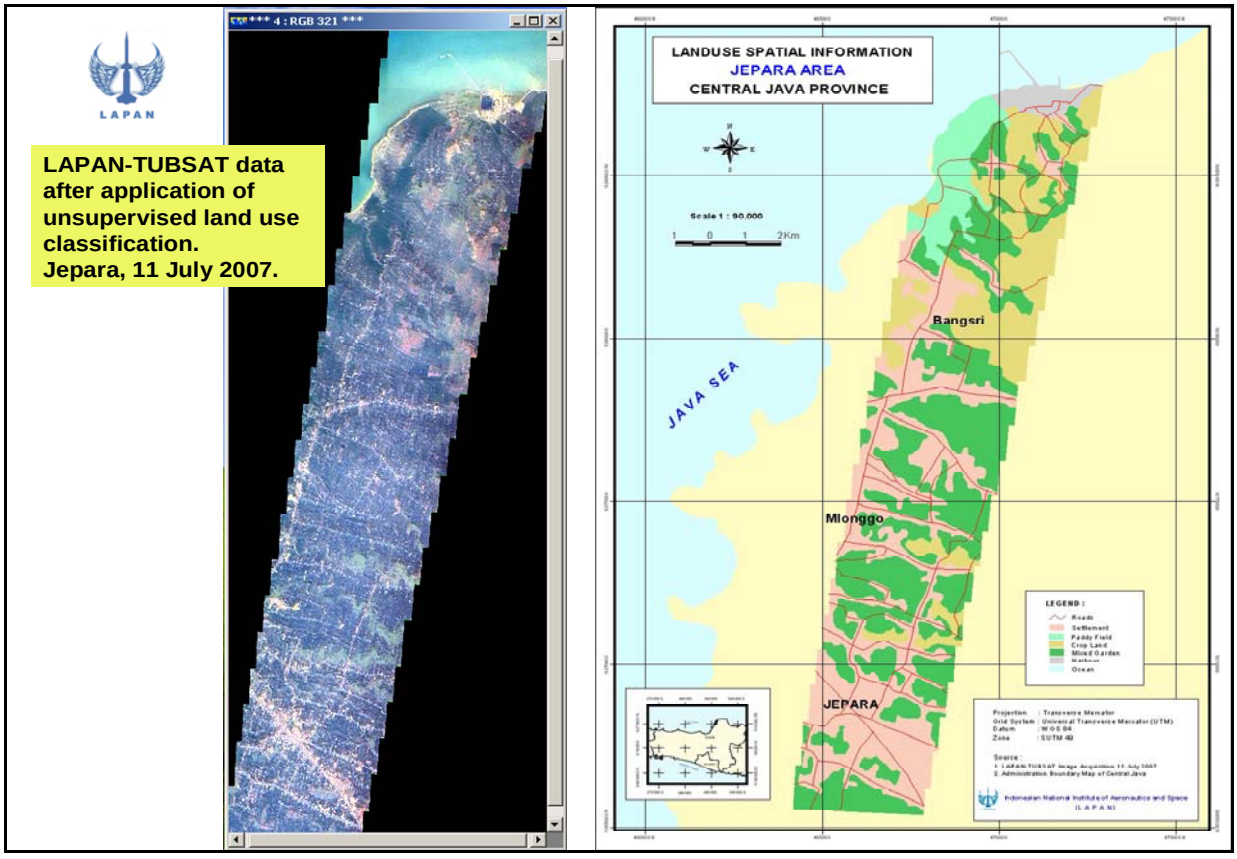

Fig.4. Processing of LAPAN-TUBSAT Video Image Data

LAPAN-TUBSAT ground station consists of two systems: one is the S-band system to receive video image from the camera payload, and the other is the TTC system to send command and receive telemetry from the satellite. The TTC station consists of steer-able UHF antenna, transceiver and ground station computer. The computer run two programs, one is to determine the pointing direction of the antenna and the other to generate command protocol and interpret the satellite telemetry. The S-band station consists of steer-able S-band antenna, antenna control computer, FM analog video receiver and PAL video recorder/display. An additional computer to convert analog video into digital image frame can be attached to the video recorder. The ground station has 4.5 m S-band disc.

IV. LAPAN EQUATORIAL

LAPAN Equatorial consists of LAPAN-A2 satellite for earth observation and LAPAN-ORARI satellite for amateur radio communication and earth observation. The development of LAPAN-A2 and LAPAN-ORARI are carried out in Indonesia. Those satellites have same bus or spacecraft and will be launched on middle of 2010 by PSLV-ISRO India. Both of the satellites are based on LAPAN-TUBSAT satellite bus with enhanced performance.

There are several enhancements on LAPAN Equatorial spacecraft in comparison to LAPAN-TUBSAT performance:

a. Global Positioning System (GPS) receiver to acquire data on satellite time and orbit position (e.g. Geodetic coordinates), primarily for periodic calculation of satellite orbit elements.
b. Attitude Determination and Control System (ADCS) to obtain precise satellite platform attitude stability during earth observation data acquisition.
c. Time and position tagged satellite attitude control to achieve programmed autonomous camera lock-on to a geographic target location under observation.
d. On-board solid state memory for storage of camera payload video data and housekeeping data.

The enhancements of spacecraft are needed to improve the spacecraft capability so it could support next mission of remote sensing imager. The spacecraft has to provide high accuracy of attitude control system and automatic mission management of the spacecraft On Board Data Handling (OBDH). Besides to approve the spacecraft for the next mission, LAPAN also use the satellites as in-orbit flight test platform to verify the experiment component that develop by LAPAN engineer.

LAPAN-A2 satellite will carry the same payload as LAPAN-TUBSAT i.e. color video camera Kappa RGB PAL with 50 mm and Sony RGB PAL with 1.000 mm cassegrain lens. The other one, LAPAN-ORARI is carrying amateur radio communication payload as the main mission with the specification:

a. *Automatic Position/Packet Relay System* (APRS): communication system which can receive and transmit digital data in the satellite coverage area. These digital data contain position of the objects or electronic messages from users.
b. *Voice repeater*: communication devices for receive and transmit voice between users in the satellite coverage area.

The special characteristic of these satellites are their orbit. Both of them will be put into near equatorial orbit with altitude about 650 km and inclination 8 degree. On their orbit, each satellite will pass over Indonesia about 14 times a day. This advantage gives chance for satellite operators/users in Indonesia to access the satellite frequently. This advantage also gives possibility to the satellites to observe Indonesian region rapidly.

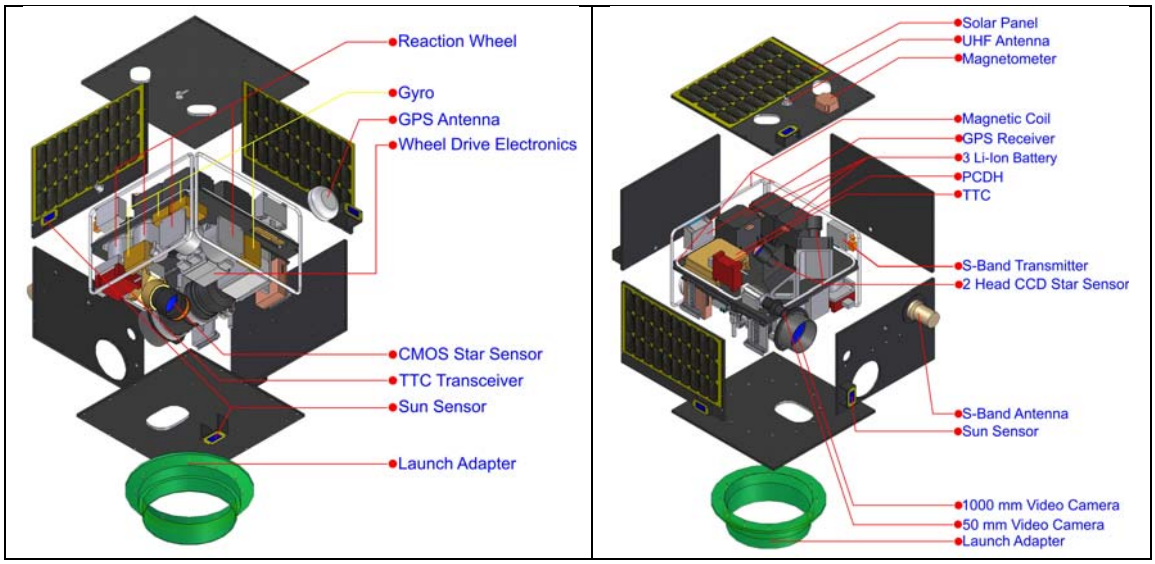

Fig.5. Satellite Bus of LAPAN Equatorial

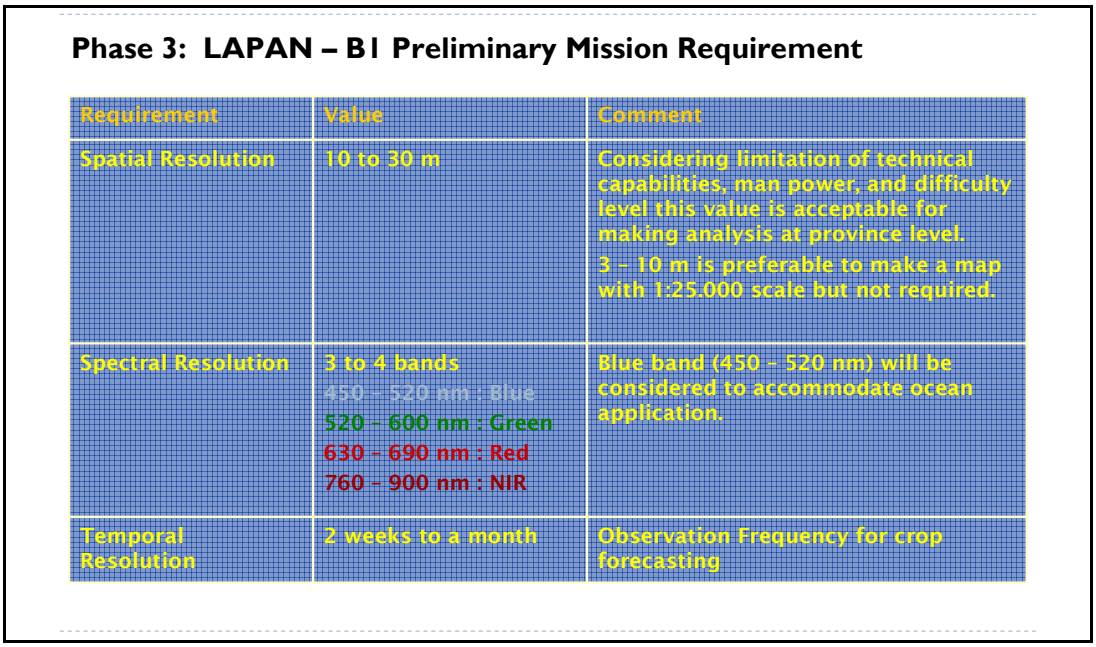

Fig.6. Preliminary Mission Requirement of LAPAN-B1 Satellite

V. Remote Sensing Satellite

The goal of LAPAN satellite development program is to acquire capability on development of remote sensing satellite. This phase requires capability on developing imager payload besides developing satellite bus or spacecraft. If the spacecraft development capability has been achieved by LAPAN Equatorial program, this remote sensing satellite phase will be focused on application development.

There is possibility to use LAPAN-ORARI for experiment of imaging satellite system beside of telecommunication mission. It will accelerate the acquisition of capability on remote sensing satellite development. LAPAN-ORARI could carry multi spectral imaging sensor with 3 or 4 spectral bands. The mission of the payload is multi spectral remote sensing for land use and land cover monitoring, natural resources management, land and coastal zone environment monitoring. The priority of the data application is for food security application and disaster management, e.g. land slide, volcano, tsunami, floods and forest fires.

LAPAN-B1 satellite will carry remote sensing payload to support national food security program especially to make food security analysis. Since accurate and up to date information are vital aspect to assist decision maker in making policy and outline strategy, satellite will provide related information to estimate food production by monitoring crop planting and harvesting area, crop growth stage, etc. As alternative, LAPAN-B1 could choose the same spectral band with Disaster Management Constellation (DMC Satellite) which is also same with Landsat Thematic Mapper. If only 3 spectral band are available, the spectral band 520-600 nm (green), 630-690 nm (red), and 760-900 nm (near infra red) will be selected. Those 3 spectral bands have been used by Landsat and SPOT user for land application. But if 4 spectral bands are available, the spectral band 450-520 nm (blue) will be added. By using 4 spectral bands, satellite data could be use for land and coastal zone application as Landsat TM.

VI. Conclusions

As a government institution, the Indonesian National Institute of Aeronautics and Space (LAPAN) has the responsibility to support the government program on food security. LAPAN has established satellite development program to fulfill its responsibility. The goal of this program is acquiring the capability to develop a remote sensing satellite with multi-spectral imaging payload for food security applications. This requires several stages of satellite bus and mission payload technology development.

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Indonesian ICT Infrastructure for Poverty Alleviation

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***Abstract*—Poverty in Indonesia is ubiquitous, immense, resilient and complex. Approximately 30 per cent of populations live in poverty, therefore poverty reduction efforts are direly urgent to do with much better program than it has at present. One of the focuses is by using the information and communication technology (ICT) to give more information access for the poor. An ICT is a tool for poverty reduction when it is applied to meet the information and communication needs of the poor. However the paradox is that mainly telecommunication infrastructures available in big cities and the poverty exist in the rural area. To bridge such discrepancies a number of plan had been launched such as computer literacy program where less information access people have been trained to operate computer and introduce them on how to use Internet. This paper will explain the effort done by our agency to reduce the poverty by employing the ICT in a number of provinces in Indonesia. A number of examples will be explored since each area targeted has different approaching schemes.**

I. INTRODUCTION

Indonesia is well known as one of the biggest Muslim country in the world with total population of 205 Million people. In 1998 Indonesia faced social, political and economic turmoil followed by the fell down of President Soeharto and replaced by President B.J. Habibie. It has affected wide spread of population with the increasing number of people fell under the poverty line. It was estimated that almost 30% of population can be considered as poor, depending on the definition of poverty lines which in Indonesia it is considered as political theme, because the number of poverty people is really depends on how the government defines poverty lines. Poverty has become major problems in Indonesia in facing the global economic challenges

Technological infrastructure that had been built for almost 30 years also influenced by the closure of a number of Industrial strategy agencies which was heavily related to the technological development of the country. However, the telecommunication infrastructures are still intact with a growing number of users in the country, even though some strategic telecommunication companies have been bought by foreign investment. Telecommunication infra structures are the basic tools needed to enhance the use of information and communication technology (ICT) to help reducing the poverty in the country.

Therefore, an analysis of the economic and social – in addition to the technical – implications of ICTs is desperately needed. If the Millennium Development Goals 2015 are to be taken seriously, the contribution of ICTs to poverty reduction must become a major issue in the forthcoming international debate.

Poor people needs information to support their lives, some of them includes: information about market price for the goods they produce, about health, about the structure and services of public institutions, and about their rights. In political arena they need political visibility and voice in the institutions and power relation that shape their lives. Additionally poor people lack access to knowledge, education and skills development that could improve their livelihoods.

II. DEFINITIONS

ICT includes a whole range of technologies that facilitate communication and the processing and transmission of information by electronic means – from conventional radio and landline to computers, Internet and mobile phones. While radio and telephone have a long histories demonstrating their utility in developing countries, 'modern' ICTs like the Internet or wireless mobile phones are just starting to prove their usefulness in developing countries. There are four advantages of ICTs: (1) Interactivity - ICTs are effective two-way communication, Technologies through online communication tools; (2) Permanent availability - the new ICTs are available 24 hours a day; (3) Global reach-geographic distances hardly matter anymore; (4) Reduced costs for many-relative costs of communication have shrunk to a fraction of previous values.

On the other hand poverty can be defined in multiple ways; however the UNDP poverty category has been adopted as followed (UNDP, 2002):

- income poverty, the lack of sufficient income to satisfy essential needs
- capability poverty, a deprivation in the range of things people do
- Participation poverty, a deprivation in the range of thing people can be.

One of the Millennium Development Goal plan is to reduce the number of people living under poverty lines by half between 1990-2015. However, the people living under poverty lines increase significantly in Indonesia, although recent report says it has reduced to 14% []. The main characteristics of poor people are:

1. very low incomes
2. subsistence, unskilled wage labor as main income sources
3. low education and high illiteracy
4. mostly life in rural area

III. INDONESIAN ICT STATUS

Much of the recent attention to the role of ICTs in development has focused on new technologies, such as the Internet and mobile phones. Yet the full range of ICTs is relevant to the fight against poverty. Radio and television are important information tools that are much more widespread in developing countries than telephones or the Internet. Print media is vital both to the spread of information and to fostering participation and diversity of views in society. Computers, even if not linked to global networks, are an important tool to increase efficiency in all sectors of society. New technologies do not change the fundamental role of information and knowledge as drivers of development and poverty reduction, nor obscure the role of more established information and communication technologies. However, they create new opportunities to expand the availability, exchange and impact of information and knowledge

Indonesia is the fourth most populous country in the world with total population of 205 million people resides in 13500 small and big islands. Indonesia is a maritime continent with more than 80% of its area consists of ocean and only 20% land. This geographical position has created a number of features such as the use of ICT to enhance link between local and central government through PALAPA ring optical communication networks. Internet becomes one of a major communication exchange amongst population. However, the lack of info structure has created further hurdle for rapid information exchange amongst nation.

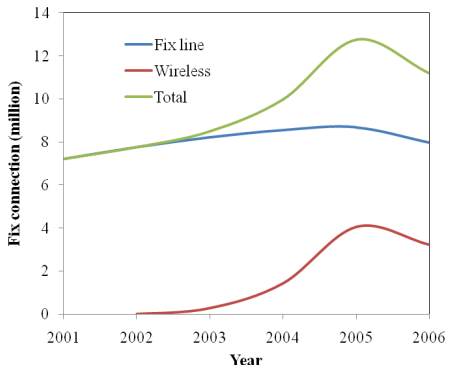


Figure 1. Fix telephone line development

Indonesia is lack behind its counterpart in ASEAN country in term of telephone access. Based on data published by International Telecommunication Union (ITU) average fix telephone per 100 populations is 8.23, meanwhile Indonesia has only 5.73 per 100 people, which is far below average ASEAN countries. According to TELKOM Indonesia, a government own telecommunication company, telephone density per 1000 people is 45. Figure 1 shows the total fix telephone connection up to 2006.

Total telephone connection increase each year, but fix line connection shows a steady increase. Meanwhile the wireless connection increase quite well due to decreasing price of hand phone and abundance availability of service providers. However fixed line connection still memegang peranan penting in the whole connection lines.

Figure 4 shows a development of public telephone available in Indonesia. Wireless telephones have taken significant market share compared to the private telephone box, mainly caused by the abundance availability and significantly cheap price of wireless communication systems. Additionally in most area it is very difficult to find public telephone available with good condition mainly broke due to vandalism and low maintenance effort. Therefore more people switch their communication by using hand phones.

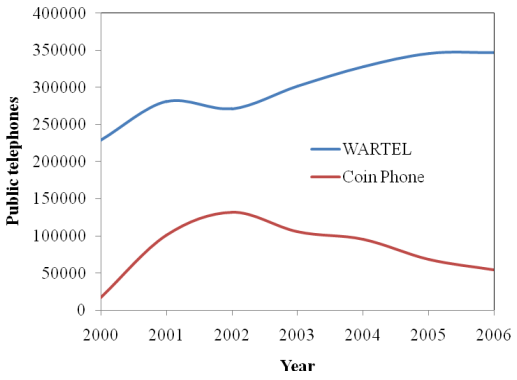
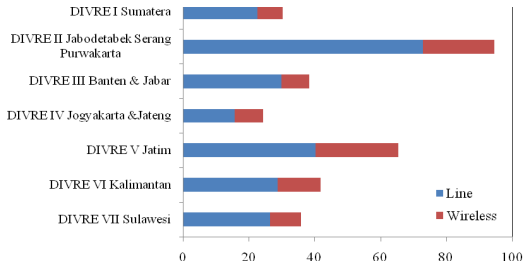


Figure 2. Public telephone distributions

The role of ICT in the so-called digital divide has been hotly debated: whether it contributes to poverty reduction, or whether it just reinforces existing divisions between the rich and the poor. No one can deny the fact that the digital divide exists. Figure 3 shows tele density of fix telephone line per 1000 people in each regional division (DIVRE) in Indonesia. Definitely the divide occurs in Indonesia judged by the number of telephone available in each household. Higher tele density mostly concentrated in big cities and economically more prosperous area such as capital city Jakarta and its surrounding area (DIVRE I) with 94.73 people per 1000 population connected to telephones. On the other hand, Yogyakarta and middle Java province are far left behind with 24.31 telephone connection. Sumatera Island, one of the biggest islands in

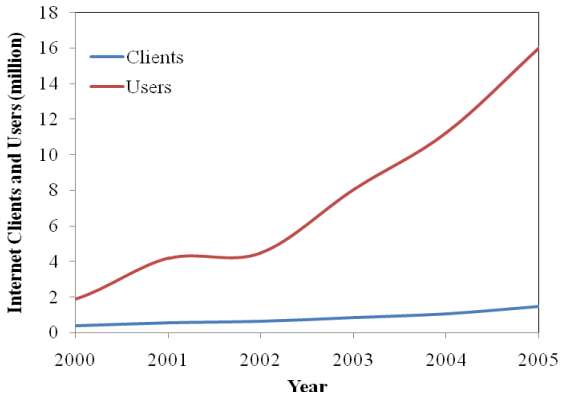
Indonesia has only 7.72 telephone connection even though this island is the second most populous island after Java Island. However Java population density is much higher compared to Sumatra's. The tele density difference has increased disparity in information access to people.

Internet connections, the Middle East is the least developed region in the world, followed by Africa. The most developed region, judged by the same standard, is North America, followed by Europe. There are digital divides also within the regions. In South-East Asia, for example, the higher the HDR rank, the higher the ICT indicator value. The higher the human poverty index, the lower the number of ISPs, telephone lines, PCs and TV sets per 1000 persons. The higher the value of ICT indicators (as in the case of Singapore, Brunei and Malaysia), the lower the poverty rank. (Flor 2001).



Source: PT. TELKOM Tbk. Juni 2006

Figure 3. Teledensity composition per 1000 people



Source: APJII

Figure 4. Internet clients and users

Figure 4 demostrates a comparison between Internet customers and users during the year 2000-2005. Customers are person who have special membership to Internet providers meanwhile users usually access the Internet through a special store which provide access to the Internet. The store usually name as Warung Internet (WARNET). Interestingly the customers growth basically very steady with Internet users increase very significant during the years. The reason is because to become the Internet customers one needs to pay monthly installment for the services, meanwhile the Internet users do not need to pay such installment. Internet users can come to the WARNET and pay hourly with the amount of Rp. 5000/hour (USD 0.5/hour). Furthermore, it shows that people become aware the important of Internet for information resources. However, no data available to show the information content accessed by the Internet users whether it is related directly to their prosperity or productivity.

IV. Poverty in Indonesia

There is no question the world is clamoring for poverty reduction. The World Development Report 2000/01: Attacking Poverty classifies three priority areas for poverty reduction: opportunity, empowerment, and security. The use of ICT applications can enhance poor people's opportunities by improving their access to markets, health, and education. Furthermore, ICT can empower the poor by expanding the use of government services, and reduce risks by widening access to microfinance. The roadmap out of poverty must incorporate health, education, information, and business activities.

Poverty condition in Indonesia increases significantly during the economic turmoil that hit Indonesia in 1998. Figure 4 shows poverty data in cities and rural area which fluctuates from 1996-2005. The peak occurs in 1998 where economic trouble hits Indonesia as results a lot of people lost their jobs and recession increase sharply. Money exchange rates also plunging into the highest record up to USD 1=Rp. 25.000 followed by the fell down of President Soeharto and replaced by President Habibie. The worst hitting area is in the rural area where concentration of poor people resides.

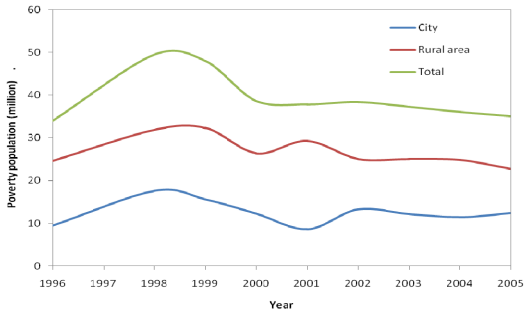


Figure 5. Poverty distribution in rural and city region in Indonesia

V. Bridging the Digital Divide

From the above data, Indonesian can be divided into people who have and who do not have access to or capability to use modern artifacts, such as telephone, television, or the Internet; digital divide exists between those in cities and rural areas, educated and uneducated,

economically well off and deprived classes; developed, developing and least developed region. Further, the stress is on access, knowledge and content. Thus any endeavor to reduce digital divide should take care of these three aspects together.

There are more than 100 local languages officially recognized, each having a different character set. Only a small fraction of 205 million people can speak English. Despite a strong and fast growing telecommunication industry, access to ICT remains very low, particularly in rural areas. For any revolution to take place, there are certain prerequisites needed. The digital revolution too requires an enabling environment that Indonesia has not put in place as yet. The main bottleneck is infrastructure. Access to technology is constrained by infrastructure parameters like electricity, telephone penetration, teledensity and Internet industry.

To help bridging digital divide a number of projects has been prepared. One of those is the computer literacy program that was implemented in 10 provinces in Indonesia. Each province has its different approach to implement the program. To convince people to come to the center, the local government had been actively involved to promote such information on such training. The main reason for them not to come into the center is because most of the Internet is in English so that it is very hard to them to understand the information. For example in one area the target mainly for high school students to give them ability to operate computers and used it to access the Internet through the help of local government. Figure 6 shows one class that had been trained to learn computer.

VI. FINAL THOUGHT

Poverty is a very complex phenomenon that cannot be solved instantly. It needs persistent, perseverance and solid commitments from governments to put good programs to solve it. It is hard to estimate exactly what it is a good guideline of poverty measurement as to whom they are the poor, and where they do live now, and how we can investigate poor conditions over time. Because poverty measurements tend to be subjective and are often pertinent to living quality of housing status and land ownerships associated with social and cultural circumstances and economic policies and developments.

The use of ICTs for poverty alleviation has not achieved the status of a mass movement, despite the many promising results that have emerged from experimental installations. Aside from the difficulties of measuring their impact, which should not be underestimated, there are considerable challenges in turning a promising experiment into a mass deployment. The widespread diffusion of a technology beyond the pioneering adopters requires a number of key enabling factors that serve to reduce the uncertainties of adoption. Advocates of the use of ICTs for poverty have yet to formulate these enabling factors, although they are getting there.

In Indonesian case, the ICT approach has yet to be implemented since it has not reach mass movements. The efforts mainly depend on small number of organization supported by unserious government policy. Despite a number of success story, poverty alleviation efforts should be put as one of the national agenda in handling the issues.

Up to now Indonesia has not yet fully recovered from economic trouble, therefore focus to alleviate poverty is shifting to more complex issues such as political struggle rather than focusing their effort to get out from poverty that engulf Indonesian people. Furthermore, the cost to build telecommunication infrastructure for simple communication exchange is hardly been developed since the government does not have money to support it. Therefore, roles of private entity become important to help solving this problem. Private companies through its corporate social responsibility programs help government to install telecommunication infra structure in rural area so that the cost become less. As a result poor people can use these cheap infra structure to access their information. Since WARNET is very popular in Indonesia each poor people can use this facilities with very low cost.

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Acting As a State: Open Source Development in Indonesia

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***Abstract*—This article uses translation approach to analyze open source development in Indonesia. Two-folds of analysis are presented. One is to provide an account of historical backgrounds from open source initiatives among academicians and hobbyist in early 1980s and government initiatives in 2000s. This account examine translation happened from academic purpose to support national information communication technology (ICT) independency. Built up from actor-network literatures, actors discourse is presented through artifacts related. Second, it examines open source development as politics. Supporting by the Government through Presidential Decree No. 6/2001 managed five-year National Information and Communication Technology Action Plan and *Indonesia Go Open Source!* (IGOS) Declaration, open source deployment has spread to more heterogeneous actors. Thus, the main purpose of the second-fold is to examine Academician, Business, Government and Communities (A-B-G-C) actors' role in open source software development in Indonesia.**

***Index terms*: A-B-G-C, actor-network theory, OSS, translation.**

I. INTRODUCTION

In the last decade, Open Source Software (OSS) movement has spread over the world. The predominance of proprietary software—imposes a restrictive dynamic of the market, limiting consumer choice, constraining user freedom and fostering increased levels of vendor dependency—encouraged hackers to develop it counter through OSS: software that allow users to run, study and change it, and to redistribute copies with or without changes [1]. Years later, OSS development is no longer dominated by hackers and academicians. Government policies on promoting and encourage software migration have facilitated the greater use of OSS within the public and private sectors.

Involvement of heterogeneous actors fosters OSS development, yet also raise question on how it being managed. To answer the question, I use some analytical concepts developed in the actor-network theory (ANT) literature. In particular, concept of triple helix is used to gain deeper insight on actors specific role. In this article, I begin by explaining ANT and triple helix as theoretical basis. A review of OSS development, subsequently follows, with supporting positions articulated. This is followed by identification of open source actors into Academic-Business-Government-Community (A-B-G-C) groups. The article concludes with analysis on how the groups are being managed; how one actor locks other actor into the roles desired i.e: government intervention through policy. Moreover, it examined how actors from A-B-G-C groups interact and define their self as part of Indonesian state.

II. ANT MEET TRIPLE HELIX

ANT started in Science and Technology Studies (STS) field. As others in STS, ANT argued scientific expertise as part of social, historical and philosophical context. ANT assumes that nothing has reality or form outside the enactment of actors including objects, subject, human beings, machines, CDs, computer, code, organizations, systems architecture, and policy arrangement. In the very similar way, scientific facts and the functioning of efficient engines draw resources from heterogeneous elements to support their durability [2]. As operation tools, Bruno Latour suggests 'follow the actors' technique to understand how the heterogeneous actors are being black boxed. As Latour (1999) describe, "the way scientific and technical work is made invisible by its own success. When a machine run efficiently when a matter of fact is settled, one need focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the more opaque and obscure they become [3]."

One truth: the 'right' world. (Copy) Right means exclusive access for a certain time period of a product, including its publication, distribution and adaptation. It also conferred by the legal system in relation to discrete items of information that has resulted from some form of human intellectual activity [4]. As Microsoft CEO Steve Ballmer said, "Our goal is to try to educate people on what it means to protect intellectual property and pay for it properly [5]." The 'right' black box begin to open when copyleft emerge. As a counter, copyleft give it user permissions to reproduce, adapt or distribute the work as long as any resulting copies or adoptions are also bound

by same licensing scheme and allows the original author to be acknowledged.

The use of ANT in addressing technology assessment is conceptualized in "triple helix" model of innovation proposed by Henry Etzkowitz (2002) that captures multiple reciprocal relations at different points in the process of actor-network construction. The model denotes the university-industry-government relationship as one of the relatively equal, yet interdependent, institutional spheres which overlap and take the role of the other [6]. In the model, Etzkowitz argue that although academic-industry-government networks are emerging from different institutional starting point, they have common purpose of stimulating knowledge-based economic development. Each element of the network plays specific role: academic produce knowledge use in industry and in policy making, government launched policy to support industry (business) and university (academic), and industry use knowledge from the university to develop knowledge-based economy. An example of how the three elements interact and share their role can be observed through Bayh-Dole Act launched in 1980. The Act gives US universities, small business and non-profit institutions freedom to pursue ownership of an invention in preference to the government. In return, universities are expected to file for patent protection and to ensure commercialization upon licensing. The royalties from such ventures are shared with inventors and the remainder is used to support technology transfer process. In the Bayh-Dole Act, government play role as a regulator to promote technology transfer and yet increase university and industry productivity. In Indonesia, triple helix was popularized by Kusmayanto Kadiman, Indonesian Minister for Research and Technology with name: Academician-Business-Government (ABG) [7].

To explain why actors in university, industry and government interact, Latour (1987) and Michel Callon (1986) propose the notion of translation to trace how actor-network comes to existence and how it might collapse [8]-[9]. Callon (1986) goes further by classifying translations into four moments: (a) problematisation: the actors become indispensable to other actors and negotiate the 'obligatory passage point' (OPP); (b) interessement: a series of processes by actors to lock other actors into the roles that been proposed; (c) enrolment: a set of strategies in which the actors sought to define and interrelate the various roles they allocated to others; (d) mobilization: a set of methods used by the actors to ensure that the spokesmen/ representative for various relevant collectives were properly able to represent those collectives and not betrayed by the later [9]. Starting from politics field, Charles E. Lindblom (2001) explain actors interaction as mutual adjustment process, the only permissible way to obtain desired performances or objects from another person, unless they are given as gifts, is through contingent offers of benefit to the other: *quid pro quo* [10].

III. Brief Review of OSS in Indonesia

From historical perspective, *quid pro quo* principle can be observed from OSS adoption in 1980s. In those days, computer was dominated by DEC, Prime, Data General, Hewlett-Packard, and Honeywell-Bull that run on different operating system and raise incompatibility issues. It is UNIX an operating system developed by AT&T that could switch from and outlive its original hardware used to solve the incompatibility issues. UNIX characteristic as an interface has stimulated many programmers to develop their own version as occurred in Berkeley through Berkeley Sofwtare Distribution (BSD), or AT&T through System III and System V. In Indonesia, *Universitas Indonesia* (UI) used UNIX version 7 in its Dual 83/20 computer as part of research covered topics such as computer network, email development, documents transfer, X.25, LAN Ethernet, and network printer server. Later, presence of UNIX has triggered it users to form INDONIX, group of UNIX users. Moderated by Partono Rudiarto, this group held a monthly meeting to discuss their experience using UNIX [11].

Development of UNIX in Indonesia was also influenced by US export regulation that restricts UNIX source code to a non-US country. As an alternative Andrew S. Tanenbaum develop a simple operating system named MINIX (Mini Unix) that can run in Personal Computer (PC) without hard disk. However, according to Rahmat Samik-Ibrahim, MINIX has two weaknesses. First, relate with it simplicity and therefore not sophisticated. Second, the high price of MINIX reached US$ 100 per package. Despite of those weaknesses, Faculty of Computer Science, UI use MINIX as part of Operating System course in late 1990s [11].

Alternative of MINIX was introduced by Linus Torvalds through operating system named Linux. All of Linux source code can be used, freely modified, and redistributed by anyone under the terms of the GNU (Gnu Not Unix) GPL (General Public License) and other free licenses. In Indonesia, it spread was introduced by Paulus Suryono Adisoemarta from Texas, USA through *PAU-Mikro* mailing list. In 1992 when Adisoemarto came to Indonesia, he brought Soft Landing System (SLS) distro version 0.9X (alpha testing) although it adoption was limted due to expensive price of Ethernet board (used for local area network).

Year 1992-1994 became a vacuum period of Linux development in Indonesia. This period was ended through appearance of *Slackware* (kernel 1.0.8)—a relative complete and stable distro, and presence of internet providers. The year after, several institutions such as BPPT, IndoInternet (kakitiga.indo.net.id), Sustainable Development Network (www.sdn.or.id and sangam.sdn.or.id) and UI (haur.cs.ui.ac.id) started to operate GNU/Linux as production system. During 1995-2000, GNU/Linux spread into a wider community

through mailing list (tanya-jawab@linux.or.id, nusalinux@yahoogroups.com), IRC (dalnet, efnet, allnetwork) and websites [12].

The new phase of Linux/OSS development started in early 2000s through government involvement. In 2001, the government launched Presidential Decree numbered 6/2001 on 'Telematics (Telecommunication and Information) Development and Utilization in Indonesia' stated OSS need special attention. Two years later, Law numbered 19/2002 on Intellectual Property Right became basis of illegal software sweeping conducted by government agencies upon cyber café (warnet). The sweeping has triggered cyber café migration to OSS. Aditantra, owner of 34 cyber cafés in West, Central and East Java is one who migrates. In three weeks, Aditantra has switched his entire computer to OSS. He got information on migration from his internet provider, PT Pasifik Satelit Nusantara (PSN) at (http://www.psn.co.id/igos). Resistance came from cyber café users who were not familiar with the new system. At the beginning of the migration, number of users decrease and affecting decline of the cyber café incomes from Rp. 18 millions to 12.5 millions [13].

As a national movement, OSS found it momentum in *Indonesia, Go Open Source!* (IGOS) joint declaration involved Minister for Research and Technology, Minister for Communication and Information, Minister for State Administrative Reform, Minister for Justice and Human Right, and Minister for National Education. Aim of the declaration is to optimize the utilization of information technology for encouraging the nation economic growth, creativity and innovation as part to support self effort and competitiveness of Indonesia. To reach its target, the five Ministers agreed to (a) use legal software in any government institution; (b) disseminate utilization of Open Source in Indonesia; (c) prepare the guidelines for development and utilization of Open Source in Indonesia; (d) urge to establish open source-based software competency training centers and their information technology business incubator centers in Indonesia; and (e) urge and improve coordination, capability, creativity, willingness and participation for optimum utilization of OSS in government and civil societies.

The Declaration was followed by OSS Grand Scenario 2005-2010 with programs divided into six groups as follows: policy, procedure and standardization; infrastructural and OSS equipment means; institutional and human resources development; OSS-based content development; socialization, awareness improvement and implementation; and collaborative program. Besides empowering program, Indonesian government also use regulation as instrument to foster OSS adoption in government institution. As the movement exemplifies, different translations were pursued by different groups (A-B-G). The story traces translations enacted by four actors from group A, B, and G all of them have different pattern of OSS development in Indonesia.

IV. Open Source Actor-Network

As mentioned earlier, academicians' involvement with OSS have started since 1980s although limited in skilled communities. It intersection to a broader communities was conducted through POSS (OSS Utilization), organization formed as part of Research and Technology Ministry program to support IGOS in cooperation with universities. According to respondent from Research and Technology Ministry, POSS is mentioned as OSS developer while IGOS Center as intermediary to connect developer and user. Using POSS UI as case study, it runs on four pillars as follows OSS developer, center for OSS service and consultation, center for open source-based repository content development and center of information society learning. As part of UI community, POSS built communication with OSS communities such as *Komunitas Studi Linux* consist of Linux hobbyist, *Hibernate*, tend to entrepreneur aspect, and UI Kernel Club formed by POSS UI to support Linux kernel development in UI. With extra-campus, POSS UI interlaced cooperation with MASTEL (Telematics Society) and SENADA through Indonesian Competitiveness Program (grant from USAID) to develop Rural Internet Center (RIC). For daily activity, RIC run by POSS local partner, Nuurul Iman *pesantren*. As part to prepare young generation to be adaptive with OSS, POSS UI supervise *Budi Mulia* junior high school with aims to make it as center of OSS utilization in Teluk Jambe sub district and Karawang city; to be sustain and exist in Karawang territory; and to create junior high school graduate that able to utilize legal software [14].

Actor from business, while also migrates to OSS, moved in different direction. According to Indro Utoyo, Director for IT and Supply in Telkom, Indonesian Telecommunication and Information Company, "We have started to develop OSS for internal use. Hopefully, OSS utilization can reduce cost of operation and increase Telkom value in the competitive era." To implement OSS migration, Telkom designed four steps as follows:

Scenario for OSS migration activity arrangement, including (a) road show and awareness improvement program; (b) knowledge sharing, education and training for installation and also utilization; and (c) monitoring and evaluation program.

Computer system preparation, including (a) guarantee availability for terminal OSS server and client infrastructure; and (b) guarantee network infrastructure support OSS implementation.

OSS solution preparation, including (a) assess OSS maturity; (b) standardization to guarantee interoperability issues; (c) OSS need identification.

Support system preparation including (a) guarantee availability of technical support; (b) preparing Integrated Web Based Help Desk System to support monitoring and evaluation of the implementation; (c) providing user guide for OSS Office Application in soft copy and hard

copy.

Besides OSS migration, Telkom SGM RDC initiated new activities in OSS development such as using OSS in developing telecommunication product and services, outsource OSS project to local software industry, establish strategic partnership with Sun Microsystems who created open source technology, and involved with open source community activities. "We also facilitate local partners to use RDC facilities, and conduct joint research with several academic institutions in the development of human resources and products," said Taufik Hasan from Telkom SGM RDC [15]. Research on OSS in RDC has resulted FIONA (Fiber Optics Network Management), INMS (Integrated Network Management System), Switching & Transmission, Flexi INMS, INMS and STP INMS Soft switch System (NGN) for Operating Support System Tools; Fraud Management and Revenue Assurance Tool for Fraud Management Application; and SMPP Gateway, JESMSC Voucherless and JESMSC Content for Fixed Wireless Applications.

The third actor is Jembrana district. As poor district in Bali Island, Jembrana gains its income from farming, animal husbandry and fishery. To support those activities, Jembrana local government focuses their development to improve human resources. Since 2001, the district with 258,421 people (2006) has liberated student tuition fee from primary to high school level. Taking human resources as basis, one of Jembrana local government focus is ICT development. Through Computer Literacy program held by technology assessment and application agency (BPPT), Jembrana held training and software development program. In 2002, Jembrana declared to use OSS as basis. According to Gede Winasa, Jembrana Regent, 51 villages' office and 4 sub districts office connected to Jimbarwana Network (JiNet) has used OSS and by the middle of 2007, 181 schools based on OSS will be integrated into JiNet. "Main aim of OSS adoption in Jembrana regency is to support public services and create good governance. One of good governance characteristics is effectiveness and efficiency. OSS converges with those characteristic, and as long there is free solution with the same function and quality, Government of Jembrana Regency will choose that one," said Winasa [16]. In Jembrana, OSS is used to support OSS operating system with open office applications; Voice Over Internet Protocol (VOIP) to substitute telephone role; video meeting among bureaucratic actors; local government intranet access; and to support internet access.

Jembrana success in e-government implementation can not be separated from actions conducted by I Gede Winasa at the beginning of his leadership. To support change, Winasa conducted steps as follows: (i) bureaucracy structure rationalization through re-structuring government institution, re-grouping non-rational elementary schools, and re-grouping public-health centre and (ii) Placing Human Resources based on their competency through placing public officer based on functional analysis, shifting from structural position to functional, hired contracted worker, requirement for structural position through job tender, evaluation system through functional credit value, evaluation of structural position through Government Agency Accountability Report (LAKIP) and Strategic Planning (Renstra). Similar with structure reformation, ICT innovation in Winasa governance also represent control through an integrated system: JiNet. The system covered Jembrana website, Short Message Service (SMS) center, call center, Kantaya (virtual office), Hand key (online attendance machine), CCTV (in the office and vulnerable places), SIAK, birth license with finger print, J-Sidik, SIMAKDA, SIPEGDA, SIM RSU, and touch screen in public service area.

To supply ICT human resources, Jembrana local government in cooperation with BPPT, recruit ICT professionals from various universities and build Jembrana Technical High School (STITNA). Subsidized by the local government, STITNA focused on Informatics Engineering and Electrical Engineering and designed as part of technology transfer from BPPT to Jembrana citizens.

In national level, government fosters OSS adoption through regulation instrument. On March 2009, Minister for State Administrative Reform launched circular letter numbered SE/1/M.PAN/3/2009 on Legal Software and OSS Utilization followed by its derivative in local level. As pilot project, Ministry for Research and Technology support two provinces migration to OSS held by Air Putih Foundation in Nanggroe Aceh Darussalam (NAD) and Daerah Istimewa Yogyakarta (DIY). The project is hold with support from NAD and DIY local government, YPLI (Foundation of Indonesian Linux Driver), POSS UGM, KPLI Jogja, KPLI Aceh, Combine Resource Institution, BlankON developer, Indonesian Ubuntu Community and Hivos. Beside regulation, government triggers OSS development through Start up Capital (SUCP) for OSS developer, socialization and conduct seminars. Some Non-Department Research Institution (LPND) such as LIPI and BPPT also play role as OSS developer. From the three groups presented above, community, both national and foreign, play role as intermediaries connecting developer and user.

V. ACADEMICIAN-BUSINESS-GOVERNMENT

Using coordination as based, relation between OSS actors can be classified into five groups as presented in the Figure 1 below. OSS activities in academicians group have been started long time before Indonesian government start to promote OSS. In relation with other groups, the coordination is based on mutual adjustment. The academicians create programmers, ICT human resources and develop OSS, but mostly still run with teaching university model. After IGOS program,

connection between academician and other groups increase through joint organization. Government play role as initiator and sponsor, besides funding from international agencies, while academician role is to provide human resources and technology. Another scheme offered by the government to increase research on OSS is through incentive program coordinated below Ministry for Research and Technology (R&T). Assuming academician-business-government as elements to build a complete ecosystem, to be sustained, academician needs to maintain it relation with the market and government, whether to distribute it graduates/programmers/OSS products or to gain income.

The business group gives a unique pattern. Represented by Telkom and cyber café, OSS business model in those entities are different with the models developed by Sandeep Krishnamurthy. In his article *Analysis of Open Source Business Model*, Krishnamurthy divides main of open source business model into three groups: the distributor, software producer with non-General Public License (GPL) model and software producer with GPL model. The ways distributors make money are through selling OSS CD; providing support services to enterprise customers; and providing upgrade services. For software producer with Non-GPL model, benefit can be gained from incorporate the source code of an existing product, and develop a new software under non-GPL model, while software with GPL model gain benefit from innovation acceleration [17]. In one hand, Telkom position as IT Company is quite similar with distributor model. Using OSS as based for its product, Telkom change the intangible (source code) asset into tangible asset. In the other hand, Telkom already has a complete OSS ecosystem for internal purpose: policy on OSS utilization, OSS developer, and users. Opposite with Telkom, cyber café migration to OSS was mostly influenced by illegal software sweeping. The migration has stimulated cyber café entrepreneur to develop OSS for cyber café purpose such as PINUX.

In coordination context, OSS adoption in business group has two approaches: voluntary and mandatory. In Telkom as IT Company, decision to adopt OSS was based on economic calculation, thus voluntary, while its derivative in the operation level is mandatory. For cyber café, the approach is voluntary although sweeping has stimulated some cyber café to migrate and the other chooses to close their café until sweeping period has past, and keep using illegal software [18].

Differently with triple helix model assumed universities as knowledge producer, in Indonesia government agencies play role as knowledge/technology producer, and on the same time as consumer. As seen in Government group in the Figure 1 below, Jembrana regency has policy, knowledge/technology producer and consumers on OSS. The same pattern also occurs in government department and research institution. Existence of knowledge/technology producer and consumer on the same group theoretically will support group stability, although in reality it failed to maintain the group unity. IGOS Joint Declaration was betrayed by

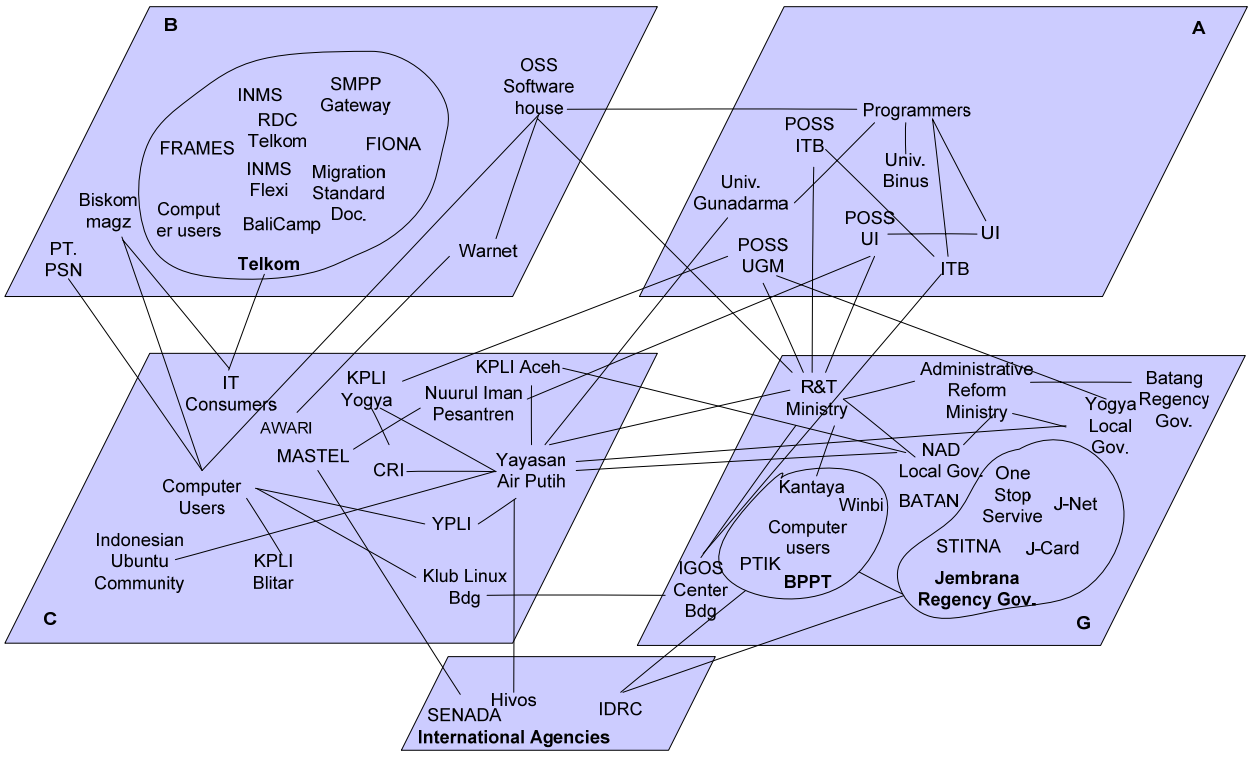

Figure 1 OSS Actor-Network Based on ABGC Classification

Table 1 A-B-G-C in Moments of Translation

	Academicians	Business	Government	Community
Problematization	To solve interoperability problem; hobby; support IGOS Joint Declaration	Expensive price of proprietary licenses; support IGOS Joint Declaration	Optimize the utilization of information technology for encouraging the nation economic growth	Receive grant from the government/ international agencies; hobby; gain income
Interessement	Conducting seminar, workshop to a broader community	Avoid sweeping conducted by the government; migrate to OSS	Involving multi-ministries in OSS Grand Scenario arrangement	Socialization as part to expand OSS user
Enrolment	Built a new organization named POSS in cooperation with R&T Ministry	Conduct awareness improvement program	Providing incentives through grant, SUCP, supervision and disincentive through sweeping	Maintain OSS network
Mobilization	Conduct joint activities; develop OSS; produce human resources	Arranging guide user for OSS office application in Bahasa; developing PINUX	Conduct joint activities; make sure the other actors play role as designed	Conduct joint activities, especially in connecting developer and user

Minister for Communication and Information, Sofyan Djalil action due to Memorandum of Understanding (MoU) with Microsoft on November, 2006. The MoU contains Indonesian agreement to buy Microsoft licenses for government institution. Although a year later Djalil decided not to continue the agreement with Microsoft, it shows government disunity.

Community group in the case presented plays role as intermediary to connect OSS developer and user. In Krishnamurthy model, community gain income by providing services. A non-economy model can also be seen through hobbyist involvement. For hobbyist, element of knowledge (A), money (B) and power to decide (G) are accumulated in individual level. A programmer in an establish corporation for example, can spent his/her spare time in OSS communities. From the community, s/he can share knowledge, gain network and as an exchange, s/he has to give his/her time. In flow of money perspective, s/he subsidizes his/her hobby activity with the money s/he gains from working.

In national level, relations between the five elements below show inequality. Initiated by the government, OSS activities are still concentrated in government institution/agencies. According to respondent from R&T Ministry, POSS was designed as OSS developer that can answer local software demand. In implementation, POSS role varies influenced by its local partner and area.

As an initial market, government through Minister for State Administrative Reform launched regulation to support OSS migration. With approximately 800,000 computers in the government, migration to OSS will create a huge demand and stimulate local software house. From the supply side, government trough Minister for R&T has OSS Start up Capital program focused on OSS developer and OSS program for junior high school and vocational school.

Referring to Figure 1, R&T Minister scenario will increase relation (represented by line) between government and business group, yet also with the academic group.

Using moments of translation developed by Callon, differences between actors in Academic, Business, Government and Communities in national level can be explained in Table I.

It is noted that translation is a process, never a completed accomplishment, and it may fail as happened in the case of government disunity.

VI. Concluding Remarks

This paper has shown how actors in A-B-G-C groups translate as part of negotiation and continuously set strategies to ensure the actors play role as designed. As group/institution/entity, it is possible for actors to betray their groups, vice versa, extend their group to broader actors and built a new actor-network. In the empirical considered, A-B-G pattern in an actor-network can be found in different scale. For business, the boundary can be seen in either company level or national level. Borrowing concept in Mathematics named fractal, the actor-network constructed—from the self to international level—has fine structure at arbitrarily small scales.

Government group unity was disturbed due to intervention from Microsoft, an international company. Influence of international agencies also emerged with grant from Hivos, SENADA and International Development Research Center (IDRC). This intervention shows disunity of constructed actor-network, thus evolution to another actor-network. Using *quid pro quo* (mutual adjustment) principle: what do the international agencies get as return? Is it relevant to speak OSS

development in national boundary or this is an international movement against proprietary and dominance of one vendor (see [19]-[20])?

In the cases presented, to guarantee OSS development sustainability Academician-Business-Government are the main keys, although how the actors define OPP, lock other actors into roles, set strategies and methods to guarantee that other actors will not betray have not made clear. Using actor-network theory, innovation is a process. Rather place actors in a well-established group and determine their roles based on a given structure, ANT suggest a reflexive approach: actors to become attentive to nested processes, structures, interactions, and interdependencies, both immediate and more removed, within which they operate. This is the real challenge and opportunity for OSS development in Indonesia.

VII. ACKNOWLEDGMENT

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e-Health Implementation for Rural Areas in Indonesia - Review on Data and Technology Readiness

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***Abstract*—e-Health can be defined as the utilization of information and communication technology (ICT) in the health sector. This paper will give a review of e-Health implementation readiness in Indonesia, especially for data and technology readiness for the rural areas in Indonesia. One of the problems in Indonesia is the health service providing still not well-distributed among the areas. It is expected, that by using ICT in the health sector, the gaps between the city and rural areas can be narrowed. The target audiences for this paper are the government that will make policies on health sector, the health service providers including hospitals and doctors, patients and people, especially in the rural areas. The challenge here is narrowing the health service gaps between the city and the rural areas, for example the unequal number of doctors, hospital and health services in both areas. The criteria for a good solution are increasing of the health rate. Our solution approach is by using information and communication technology in supporting health sector. We will review several components of e-Health both in data and technology readiness, so we can see what is current condition and what can be developed from that.**

***Index Terms*— e-Health, ICT, rural areas.**

I. INTRODUCTION

e-Health is a new and very dynamic term that is used in the last decade. So there is no exact definition of that term, but we can give a minimal definition of e-Health as the utilization of information and communication technology (ICT) in the health sector. It encompasses the use of digital data for clinical, educational and administrative purposes. This paper will give a review of e-Health implementation readiness in Indonesia, especially for data and technology readiness for the rural areas in Indonesia. One of the problems in Indonesia is the health service providing still not well-distributed among the areas. The city areas have very good health services, many hospitals, doctors, and paramedics, while the rural areas are in the contrary.

It is expected, that by using ICT in the health sector, the gaps between the city and rural areas can be narrowed. So people in the rural areas can enjoy a good quality of health service in quite similar way to the people in the city areas.

The target audiences for this paper are the government that will make policies on health sector, the health service providers including hospitals and doctors, patients and people, especially in the rural areas. By providing e-Health services especially for the rural areas, the health rate and life quality in Indonesia will be increased. The challenge here is narrowing the health service gaps between the city and the rural areas, for example the unequal number of doctors, hospital and health services in both areas. The criteria for a good solution are as follows. The health rate is increasing. The health services in the rural areas will be better. The health service gaps between the city and the rural areas are narrowed. The people in the rural areas can get health services easily, with quite similar quality as people in the city.

Our solution approach is by using information and communication technology in supporting health sector. For the first step, we will make a review on e-Health implementation readiness especially for the rural areas in Indonesia on data, technologies and policies, so we can define the next step to do to make future plan in the short and long term to design and implement the e-Health system in Indonesia, especially for the rural areas. For e-Health data, we will review on how to get the data, how to process the data, and how to report the data to the stakeholders of e-Health (the government, the health providers, patients, and the people). For technology review, we will have several current ICT that can be used for e-Health implementation, for example Internet, mobile communication, database, and software engineering.

The remainder of this paper is structured as follows: Section 2 summarizes related work on e-Health. Section 3 describes the research issues and section 4 introduces the reviews on technology and data. Finally, Section 5 concludes the paper and identifies further work.

II. Related Works

A. e-Health Definition

According to the ESCAP report [5], the term e-Health is commonly used to described the utilization of information and communication technology (ICT) in the health sector. It encompasses the use of digital data for clinical, educational and administrative purposes in the health sector. e-Health is used as an all-inclusive term, capturing the use of internet technologies and the rise of the information economy, including information technology, telecommunication technology and data transmission protocols and techniques. It is also all-inclusive in a way to capture all types of health care and health-care professional: it is not limited to medicine and not limited to doctors. We will use this broad definition of e-Health term for this whole paper.

B. The use of ICT in e-Health

Andrew Chetley et.al.[4], categorize the uses of ICT in health sector into 3 categories, i.e. (1). Improving the functioning of health care systems, (2) improving the delivery of health care, and (3) improving communication about health. The first category focuses on how ICT can be used for enhancing the functionality of health care systems by improving health information management and the access into the information. The systems include patient records, administrative systems, management of logistic of patient care, and ordering and billing systems. The second focus on how ICT improve the quality of health care delivery by enabling health workers to do better diagnosis, better treatment for patients, and to share knowledge among them. To mention just a few, the category includes biomedical information search and retrieval, diagnostic imaging, critical decision support systems, telemedicine and remote diagnostic support, and disease surveillance and epidemiology. The last category includes the uses of ICT in order to improve communication and information flows among all parties which are involved in health sector, including any persons who need health information, patients, health workers, health service providers, and the government. People can be virtually connected to each other through health message board or mailing list and discuss or share their health problem. The followings are some examples. A candidate patient can search for a doctor in the internet, and send an email to the doctor for having an appointment. The government can deliver the information to the community concerning the environment that need to be taken care. A hospital can collect any feedback from the patient trough the internet.

Ouma [7] divides e-Health components into Hospital Information Systems (HIS), Telemedicine, Electronic Health Records (HER) and Internet. HIS are information systems that can be used to monitor, inform and evaluate a health system and to make clinical and management decisions. Telemedicine is a using of internet to offer medical consultation and diagnosis through e-Health. EHR are health records of people that kept electronically which enable fast and secure access to the medical records of very mobile people nowadays. Internet can be recognized as a technology to help patients to get more information and not just rely on physicians for all the information concerning their health.

III. Research Issues

A. Problems and Challenges in General

Yamuah [11] identified 5 main areas of e-health challenges, namely inaccuracy and incompleteness of information, inadequate or brain drained of human resources, lack of infrastructure, quality and security of data and legal issues, and financial and sustainability issues as well.

Referring to Rao [8], Chetley et.al [4] summarizes problems and challenges of e-Health into eight categories, i.e. connectivity, content, capacity, community, commerce, culture, cooperation and capital.

Connectivity deals with policy and availability of communication infrastructure, while content deals with content creation, information availability, accuracy, and completeness. The capacity related with how much capacity to use ICTs effectively and to service and maintain them. The community related with who is using the ICT.

Commerce deals with the potential of developing internet economies supporting online transactional capabilities that will be beneficial for consumers, for business, and for public health interests. Culture means how to make content that is appropriate and relevant with respect to the culture of the community, how to decrease cultural problems of effectively use ICT.

Cooperation deals with different stakeholders, i.e. Citizens (including patients), Professionals, Hospitals and academia, Health-related businesses, Governments, International agencies, must cooperate with each other in order to achieve successful e-Health implementation. While capital means the investment in ICT for health sector.

B. Problems and Challenges of e-Health in Indonesia

In this section, using the approach presented in Yamuah [11] we addressed several problems in Indonesia that need to be solved in order for developing E Health.

Human resource. The human resources includes lay person (patient, common user), e- health system provider (IT experts, operator), health service provider (doctors, nurses, midwives). In general, we assume that in Indonesia lay persons are still far from ready to utilize e-health system. In some cases, especially in big cities, only middle/top class communities that have enough skill and resource for utilizing e-health system. In addition, we also

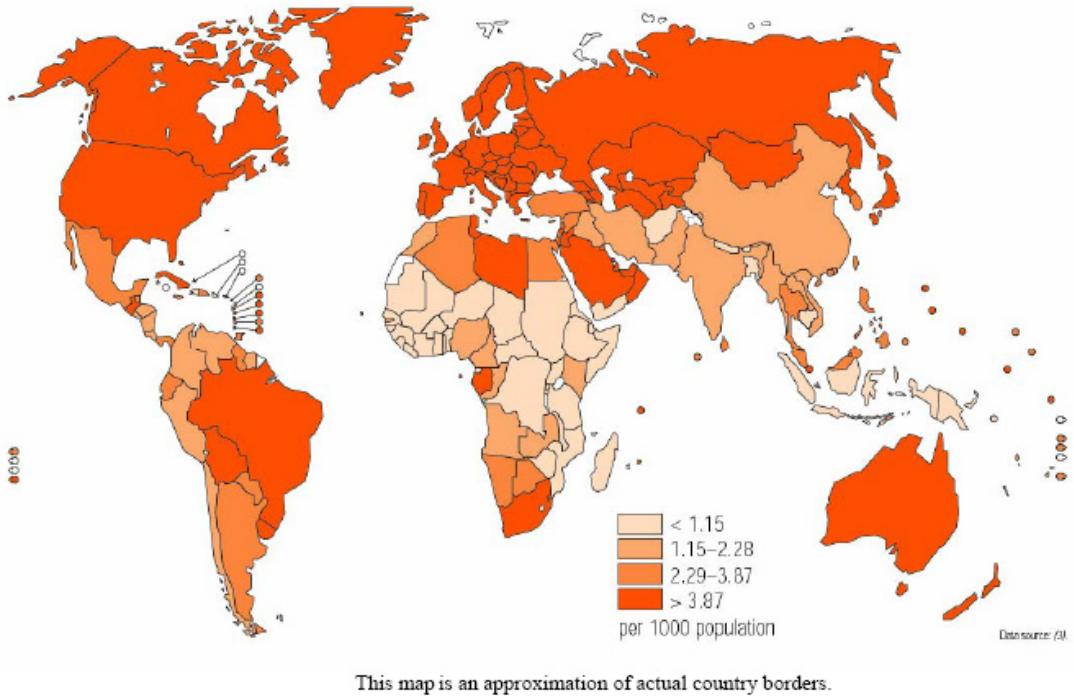

Figure 1 Ratio of health service providers per 1000 population across the countries in the world

have problem of high population with low density of health service providers. A WHO report on 2006 put Indonesia in a group of countries with the lowest density of doctors, nurses, and midwives, i.e. less than 1.5 providers per 1000 people. The same problem arises in the availability of IT experts and operators.

Infrastructure. The penetration of IT infrastructure has been rising very rapidly. However, compared to other countries, it is still very low (Nuth [6]). We still have digital divide problem. Although the idea of developing Indonesia National Backbone has been released several years ago, it is still far from the implementation. In addition, in general we still lack of computer hardware. As an illustration, the word bank reports that in our case only 1.5 personal computers are available per 100 person in 2006, while on average there are 4.1 PCs per 100 persons in East Asia and Pacific countries (World Bank [10]).

Data and Information. We lack of the availability of digital e health data and information. Most of 6300 puskesmas (community heath centers) in Indonesia still manage data manually. Thus, the automatic processing, the completeness of the data, standardization and interoperability are still far away from the current situation. However, several efforts has been done by the Government (the ministry of health) on the legal issues, i.e. by releasing health record law. Nevertheless, it still needs to be enforced in the implementation level.

Investment. It is interesting to note that in 2003 the People's Consultative Assembly (Majelis Permusya-waratan Rakyat or MPR) had released a decree that Indonesian government should allocate 15% of State Budget of Revenue and Expenditure (APBN) for health. This amount is inline with standard budgeting released by WHO. However, in fact, the government allocated only less than 3% of APBN 2009.

IV. REVIEWS

A. Technology Reviews

In this part, technologies needed by e-health implementation and current technologies own by health provider and common people are reviewed. Technology evaluation can be centered around many different components, including reliability, performance measures, standards and interoperability, customized tradeoffs, usability, and usefulness. The initial question that must be asked is whether the vendor specifications meet the needs of the institution as defined by the EHR system chosen. Is the throughput time acceptable? Does the system operate as intended, assuming that the vendor promises and the client expectations are synchronized?

To answer these questions, comparison between technologies needed and current owned are needed. Technologies needed meaning kinds, characteristics, names, and brands of the modest technologies that should be had to run e-Health. Current technologies owned meaning kinds, characteristics, names, or brands of the modest technologies that exist and owned by Indonesia. The technologies that can be obtained free also included on current owned one. The lists of software technologies are listed below.

Data Entry. Currently more than a half of hospitals in big cities like Jakarta and Surabaya have data entry technology, but almost of more than 6,300 Puskemas don't. They needed tools that can allow health practitioners to input data into e-Health system. The input can be automatically using other tools or software, or manually by typing. Bar code readers, data loggers, or APIs are kind of data entry tools.

EHR System. Currently the government does not provide guidelines or certifications to EHR system that can be implemented in Indonesia. Most hospitals develop their own EHR system that may do not comply with portability, interoperability, and standards. They will have a lot of problem if want to integrate with other systems such as pharmacy's, insurance's, and government system. Most health providers, more than 6300 Puskesmas, don not have EHR system. They record all health data using manual system.

The EHR system tool is a central system that allows storing, managing, and retrieving e-Health data easily. This system should be consisted of database management system (DBMS), interface, and report tools. This system also should provide ability to communicate with other system such as pharmacy's, insurance's, and government system. Standards such as CCHIT standard can be used as guidelines.

Reporting. Health providers using manual system provide reports by writing it up manually. Other health practitioners using EHR system provide reports by generating it using some brand names such as Crystal Report and Pentaho. Unfortunately, there is no standard report except administrative report for Ministry of Health and Ministry of Internal Affair.

Technology to support generating report is mandatory in telemedicine as a administrative function. It can automatically generate report from application form or directly from database. Some GPL report generator can be used such as BIRT and Pentaho.

Communication tools. Recently, most health providers and practitioners use traditional tools to communicate each others. Letters, fax, and telephone are those tools that are most used by them.

There are some kinds of telecommunication tools that should be used to comply with security, integrity, affectivity and efficiency principle: teleconference, telephone, fax, email, or private portals. An example of a good GPL communication tool is Conference XP.

Data security. Recently, installed EHR system usually provide security function to protect confidentiality but security procedure have not be enforced. Accessing data to system or a pile of health data hard copy can be done without legal protectors. Ministry of Health publish UU Rekam Medis (EHR Law) with emphasizing on conceptual without technical procedures. UU ITE by Ministry of Informatics and Telecommunication Technology also support confidentiality enforcement but still on conceptual without sufficient technical procedure.

Data security should be embedded with data system with additional security procedure and physical security. Standard procedures in accessing data – in term physical or logical - should be developed. Law enforcement in protecting security and confidentiality data should be done with legal aspect support. Such legal aspect in US: HIPAA can be used as reference.

Reviews on hardware technologies, including technologies for health providers and clients (patients) are as follows.

Communication. Most system in health business in Indonesia use dial-up internet modem which is still very expensive and exists centrally on some big cities.

Communication hardware needed included computer-to-internet connection and infrastructure connection between computers. Most common problem in integrated system involved many organization and people such as EHR system is client-to-internet connection called modem. Internet modem, three of dial-up, broadband, and cellular phone based internet modem can be used easier today. There are some technical requirements to run EHR system such as teleconsultation that needs minimum 384 kbps up and down link. Wimax modem should be used moreover with the success of PAU-ITB in developing connection hardware supporting Wimax (VSilicon [9]).

Data Entry. Installed EHR systems have manual data entry using keyboard and handwriting on EHR legacy systems. It takes a lot of time and human resource, increase entry errors.

Data entry tools that can be used today are: keyboard, handwriting recognition or touch screen, speech to text system, and scanner. Those tools can be customized depending on system requirement or the capability of health practitioners and patients to provide. Research on Indonesian speech to text growth rapidly in STEI-ITB coordinated by Arry Ahmad Arman [1].

Installed EHR systems have manual data entry using keyboard and handwriting on EHR legacy systems. It takes a lot of time and human resource, increase entry errors.

Data Storage. Installed EHR systems usually have used hard disk. Manual system use a pile of paper, so searching and accessing data will be hard.

Data storage system or common hard disk can be used to store data so that can be access easily. Other media such as VHS or tape can be used but accessing data will be a problem. For managerial and computational reason, local hard drive and centralized storage are the best solution on health-data storage management because it decrease time processing query but still keep the data is controlled centrally by authoritative agency.

B. Data Reviews

In this section, we review the data needed in e-Health System. Much different kind of data is needed in a complete e-health system. However, in this paper we focus only in EHR. We start with recite the definition of

EHR and how it can be represented. Then, we addressed several issues concerning the use of data in e-Health System, and discuss current situation in Indonesia.

Electronic Health Record (EHR) is defined as:

"The Electronic Health Record (EHR) is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter - as well as supporting other care-related activities directly or indirectly via interface - including evidence-based decision support, quality management, and outcomes reporting". (World Bank [10])

EHR can be represented in free text (e.g. patient discharge summary), semi structured text, structured alpha numerical data, or even multimedia (image) format. Figure 2 shows an example of patient discharge summaries represented in free text (Bramsen et. al. [2]), and an example of CT scan of an abdomen (Capital Health [3])

In order for developing a mature and useful e health system, several issues related to the data should be addressed, including availability and completeness, accuracy and integrity, Interoperability, and Privacy, Security and Legal Issues.

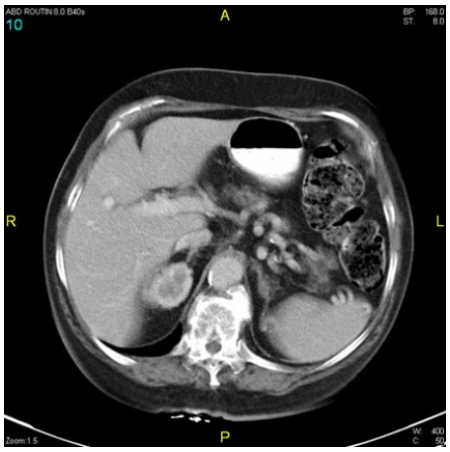

Figure 2 Example of EHR representations

A 32-year-old woman was admitted to the hospital because of left subcostal pain, bouts of fever, and a mass in the left hepatic lobe. Three months before admission an evaluation elsewhere included an ultrasonographic examination, a computed tomographic (CT) scan of the abdomen, and a magnetic resonance imaging (MRI) scan. She had a history of eczema and of asthma. On examination the patient was slim and appeared well. Scaling eczematous plaques were present on the hands and elbows. An abdominal examination revealed a soft systolic bruit in the midepigastrium that overlay a firm, nontender mass. A rectal examination was normal; a stool specimen was negative for occult blood. The arms and legs were normal, and a neurologic examination was normal

Availability and completeness. Most of health data maintained in community health centers (puskesmas) are not digitally available. In many hospitals, they are digitally available but in different degree of completeness.

Data should be available and complete. Available means it exists in appropriate format and accessible trough well known available device, such as PC and network. Completeness means it contain enough items necessary and useful for automates clinician's workflow.

Accuracy and integrity. Several efforts have been done especially in hospitals in big cities. They collect and manage EHR using well known DBMS and tailor made software in different levels of accuracy and integrity.

Due to it relates human life, it is important to ensure that the health data is accurate and error free w.r.t. who, what, when, how medical events happen and are represented. It should also be consistent regardless by whom, when, and how the data is accessed.

Interoprability. To the best of our knowledge, an interoperability issue has not been taken as the important issues by the health service/care provider.

Interoperability means data (and information) can easily exchanged by different systems without any semantic gap of interpretation. In order for that, standard representation (such as OpenEHR) and semantic representation (using medical terminologies and ontologies e.g. UMLS) should be defined and used.

Privacy, security, legal issues. Several regulation has been released by the government, such as Medical Record law no 269/2008 (by the Minister of Health) , and Information and E-Transaction Law no 11/2008 (by The Minisitry of Communication and Information). More efforts are still needed in order to put the regulation *down to the earth*.

Data should be collected, used, analyzed, and transmitted in secure and legal manner. Patient privacy should be protected. Law, policies and procedures related to the issues should be defined and enforced. Technologies should be utilized to support them.

V. SUMMARY AND FURTHER WORK

We have presented data and technology reviews on e-Health implementation readiness especially for rural areas in Indonesia. In general it is possible to implement e-Health in the rural areas in order to increase the health rate of Indonesian society and bridging the health availability gaps between city areas and rural areas.

Good willing and policy from the government are needed to plan, design and implement e-Health in Indonesia. The scientists and health providers should help each other to build the e-Health system in Indonesia.

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A Case Study of E-Procurement System Implementation in the Procurement Branch of Logistic Department Royal Malaysia Police

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***Abstract*—E-Government has become a well known application throughout the globe. The invention of this application has created opportunities for citizens to interact with government facilities in a new mode. In Malaysia, one of the E-Government applications that available for Malaysian is the E-Procurement. The E-Procurement or well known as E-Perolehan in Malay has been instructed to be used for e-business process by the Ministry of Finance since the year 2000. However, it is not been utilized fully by companies and the government agencies. This paper aim to analyze why those problems occurs. In order to do that, the implementation of E-Procurement in the Procurement Branch Department of Logistic Royal Malaysia Police Bukit Aman is studied. Based on personal observation it is found that there are eight problems that undermine the objectives of e-procurement system in the department. The problem can be categorized into three namely the tight procedure of the system implementation, lack of system requirement, and the capability of staff to operate the system. Realizing this problem, four suggestions on improving the system's problem towards a better system implementation is done. By making these changes, it is hope that the E-Procurement operations can be done effectively.**

***Index Terms*— E-Government, Malaysia, E-Procurement, Logistic Department, Royal Malaysia Police.**

I. INTRODUCTION

The demand to have a better service from the e-Government is emerging across the world. As a result, more governments are relying on IT especially the Internet and Web-based network to improve their services. With the fast introduction of technology involving government services such as G2B, G2B, and G2E, each government has to make tremendous changes to cope with the need.

E-government is variously defined but the common focus is on the application of ICT to improve the internal management of the government, to offer more flexible and convenient services to the public and to a limited extent, to enhance public participation and democracy [1]. The implementation of e-Government means welcoming the citizens to be online with the government. In the other words it is to allow citizens, businesses and government employees to think about being able to gain access to information wherever they are, whenever they want [2]. Everybody should have an equal chance to interact with the government regardless of who there are and where they were.

In Malaysia, the e-Government initiative was launched as a catalyst to lead Malaysia into the information age. The government hopes that by introducing this technology, it will improve the government's operation internally, and it is might as well provides better services to the public. Hence, to cope with the needs, the government has introduced seven pilot projects of the e-Government flagship application. They are Project Monitoring System (SPP II), Human Resource Management Information System (HRMIS), Generic Office Environment (GOE), Electronic Procurement, Electronic Services (E-Services), Electronic Labour Exchange (ELX), and E-Syariah.

This paper intends to focus attention on one of the e-Government flagship applications called electronic procurement (E-Procurement). The interest was put on this topic since it is one of the ways businesses interact with the government agencies to do business transaction such as tender announcement, payments, and a lot more. In order to be more specific to discuss this matter, this paper will present a case study on the implementation of E-Procurement system by the Procurement Branch Logistic Department, Royal Malaysia Police, Bukit Aman, Kuala Lumpur.

II. E-PROCUREMENT

E-Procurement is a new phenomenon for certain people, but what it wants to achieve is not new. As long as the companies have been around, they are sought to improve the efficiency and effectiveness. According to [3], E-Procurement is a method of fulfilling the organization's internal demands with external sources. This means that requirements needed by an organization will be accomplished by external suppliers. Efficiencies can be achieved by eliminating paperwork and streamlining processes, as well as purchase re-

organization. Meanwhile, the availability of wide range of information to buyers will make the information processing to be faster; hence increasing the effectiveness of the system.

In Malaysia, E-Procurement system, better known as "e-Perolehan" is an initiative provided by the government to improve the quality of service. The system is executed via Internet connection to enable suppliers to present their products on the web portal; managing and process purchase orders, and later receive the payment from government agencies. The implementation of the system was first started back in October 2000. With the system implementation, the Ministry of Finance instructed all suppliers to mandatorily subscribe the system in order to bid for any government procurements. Until now, six modules are available for the system; they are namely central contract, direct purchase, ministry contract, quotation, tender, and eBidding. Activities available inside the modules include e-notification, e-tendering, e-awarding, e-ordering and e-invoicing/e-payment.

III. E-PROCUREMENT IMPLEMENTATION AT THE PROCUREMENT BRANCH LOGISTIC DEPARTMENT IN THE BUKIT AMAN POLICE HEADQUARTERS

For every public departments and agencies of Malaysian government, the financial system was controlled by the Ministry of Finance. It was a clear cut rules stated that this ministry has the authority to allocate the budget for other existing ministries under the government. In the case of Royal Malaysia Police, this legislative body was assigned as one of the department under the Ministry of Home Affair. In order to manage the all the financial allocations, the Chief Secretary General of Ministry of Home Affair was elected as the 'Control Officer'. He claims the highest authority where all financial policies are managed by him. Meanwhile, the Inspector General of Police (IGP), Police directors, and Chief Police of each contingent is appointed as the "head of program" in financing system. Therefore for the logistic department of Royal Malaysia Police, the Director of Logistic Department is bound to lead this department's procurement and financing business activities.

The Bukit Aman Police Headquarter is very important for the Royal Malaysia Police since it is the point where the implementation of every new policy started. Other than that, it also become the best place to conduct academic research since literature from [4] mention that for law enforcements studies, the domain location should be done in the metropolitan area or capital city. The Procurement Branch Bukit Aman in charge of all projects on Nine Malaysian Plans, yearly expenditure management budget financial on new policy, one off policy and existing policy. Any requirement of procurement from Police Contingent, District or Formation will gather and analyst before further action taken. In the logistic department of this headquarter, there are 34 officers selected to manage the allocation warrants and local procurements. The details can be seen as stated in Table I.

Table I. Police Officers involved in managing the allocation warrants and local procurements.

Designation	**Total**
Chief Assistant Principal Director of Logistic (Procurement)	0
Assistant Principal Director of Logistic (Technical)	1
Assistant Principal Director of Logistic (General Item)	1
Staff Officer In charge of Procurement (General Item)	1
Staff Officer In charge of Procurement (Transportation)	1
Staff Officer In charge of Procurement (Air Wing)	1
Staff Officer In charge of Procurement (Marine)	1
Staff Officer In charge of Procurement (Weapon and Amour)	1
Staff Officer In charge of Procurement (Technical Aids)	1
Staff Officer In charge of Procurement (Radio Communication / ICT)	1
Staff Officer In charge of Procurement (Section I)	1
Staff Officer In charge of Procurement (Section II)	
Staff Officer In charge of Procurement (Section III)	1
Staff Officer In charge of Procurement (Section IV)	
Staff Officer In charge of Procurement (Transport)	1
Staff Officer In charge of Procurement (Technical Aids)	1
Supporting Desk Job	5
Supporting Desk Job	3
Supporting Desk Job	5
Clerical Staff Admin	4
Clerical Staff Finance	2
Typist	1

The implementation of E-Procurement in the headquarter require all payment processes to the suppliers are employed via the E-SPKB (*Sistem Perancangan dan Kawalan Belanjawan* or Electronic Budget Planning and Control) system. E-SPKB is a system that was developed to cater the need for financial control as well as financial information as required by the apprentice projects under the Electronic Government application [5]. Currently the system is controlled by the Accountant General Department of Malaysia. E-SPKB starts by producing the local order to suppliers. The transactions goes on until the last payment is received the suppliers. All activities involved should be done automatically using the system. The system is very good to handle all processes since it has several compartments module designed for each phases.

The Malaysian government has provided a good platform for suppliers and its agencies to do transactions. This can be proved by the monetary value managed to be captured from the system implementation. However, the usage amount of the E-Procurement in 2008 is still low compared to the annual allocation for source and government services [6]. Table II shows the achievement of usage for all modules of E-Procurement on 2008 by the Ministry of Home Affair as taken in [6].

Table II. Achievement of usage for all modules of E-Procurement on 2008 by the Ministry of Home Affair.

Modules	Transaction amount	Value (RM)
Central Contract		
Direct Purchase	68,809	1,153,501,468
Ministry Contract	79	132,119,780
Quotation	2	398,000
Tender	1	200,000
eBidding		

Based on information taken from Table II, it is clearly shows that the Ministry of Home Affair is not fully utilizing the E-Procurement. Online quotation, project tender, and eBidding modules are under utilization. Although the transaction amount for direct purchase module is excellent, but this condition cannot be used to indicate the usage of E-Procurement system since the transaction might happened using traditional methods such as email, face-to-face and paper-based documents. By having such kind of data, it can also be assumed that the usage of the E-Procurement in the Royal Malaysia Police is also low in number. This perhaps also include the headquarter office where the usage of the system is also little.

III. PROBLEMS IDENTIFIED IN IMPLEMENTING THE E-PROCUREMENT AT THE PROCUREMENT BRANCH LOGISTIC DEPARTMENT IN THE BUKIT AMAN POLICE HEADQUARTERS

In order to the actual problem of low utilization of E-Procurement in the department, researcher has done personal observation for almost nine months on the matter. It is lucky to have this opportunity since researcher is one of the officers in the department. Apart from the observation, interview session also has been conducted with 14 senior and junior officers in order to identify the problem. Based on both methods, the problems can summarized as written in Table III.

Based on all problems listed inside Table III, we can make a conclusion that these problems can be categorized into three. First, the problem is about the tight procedure implemented by the ministry to run the E-Procurement system in the department. Problem 1,3,4,7, and 8 are examples for this category. For this matter, the ministry should hand over more authority for the department to make its own decision. Meanwhile, the system also has some drawbacks which need to be approved. For problem 2 (the time consumption) and 5 (the system is not suitable for certain item), it is clearly seen that the system still require other requirement in order to implement the E-Procurement. For example, the system run time should be faster and more items should be available for transaction. Lastly, the lack of staff's capability to operate the system is also become the problem. Problem 6 occur since the staff involves handling the system is lack of trustworthy. Staff should be trained to be nobler so that all suppliers have an equal chance to win the bid. By having this condition we can ensure the government mission to have the E-Procurement system runs successfully can be reality.

Table III. Problem identified in implementing the E-Procurement in the Bukit Aman Police Headquarter

	Problem
1	The Procurement Branch of Ministry of Home Affair will synchronize all tenders process whether use normal process, eBidding or E-Procurement. The Royal Malaysia Police have no obligation according to circulation letter Ministry of Finance.
2	Time taken to register new users from the department to use the E-Procurement system sometime too long.
3	The authority to approve project tender which amount exceed RM200,000 can only be done by the Procurement Branch of the ministry. This police department's officers can only approve project less than RM200,000.
4	Under the "*Slip Penambahan Barangan- SPB*" or Provision Order (PO) for all Royal Malaysia Police, general goods such as shoes, uniform, badges, cap, security vest, traffic cone, police road barricade, touch light, dog and horse food, medical equipment, medicine etc. can only be processed by the procurement branch of Ministry of Home Affair. In Royal Malaysia Police, the general goods and equipment comprise more than 4000 line items. The Central Police Store Material Specific (SMS) will check all nil stock and produces the PO to Procurement Branch Bukit Aman. After finalizing all the applications, PO will be sent to Procurement Branch Ministry of Home Affair for further action.
5	The E-Procurement system suitable for fast moving item such as stationary where the process easy to implement. Quotation and tender which involve technical specification sometimes involve benchmarking where it is not available in the system.
6	There is a loop hole where the staffs are able to negotiate product price with suppliers. They might share the information with the appropriate supplier hence; supplier will reduce the price from original price list just to win the bidding.
7	There will always the similar supplier manage to win the bidding since they offer lower price. Therefore many other suppliers will not get their turn in normal process.
8	Latest amendment on Treasury Circulation Letter No. 12/2007 for direct purchase below RM50,000/- part 3(i) mention that any supplier whether registered or not with Ministry of Finance and native or non native status can participate in government procurement. These policies have to be clear for non-registered with Ministry of Finance supplier. If not, the registered supplier with E-Procurement standard operating procedure (SOP) has to do amendment.

IV. TOWARDS A BETTER IMPLEMENTATION OF THE E-PROCUREMENT AT THE PROCUREMENT BRANCH LOGISTIC DEPARTMENT IN THE BUKIT AMAN POLICE HEADQUARTERS

The problems as stated in Table III should be solved immediately to ensure a better implementation of the E-Procurement. In order to gain such benefits, recommendation as proposed by [7] can be implemented. According to them there are three prerequisites for a successful development of E-Business and E-Government as what apply in E-Procurement system. First, there should be a rapid development of infrastructure and skills to meet the demand of a new economy. As mention in [8]

also, the Malaysia citizen is still struggling with low IT literacy. Therefore, efforts such as creation of knowledge-based society should be given priority in the department's plan. This can solve the lack capability of the personnel to do their job.

Secondly, to ensure successful deployment of E-Business and E-Government, initiatives in the small and medium size enterprise (SME's), should be encourage. The collaboration between these SMEs and the government agencies can lead to a better partnership, hence making the system implementation to be superior. The government should ensure the industries are supplied with all the ingredients to work on the system. This condition can reduce bureaucracies. As a result transaction can be done faster and more efficient.

Thirdly, they also proposed that there is also a need for a greater collaboration and smart partnership between the world of academia and the corporate sector. In this context, issues such as competitive reward schemes for research and local publication in addition to development of prototype business models could be established. Even though for some this is not important, but from our point of view it is essential to have such link. Universities are great for their research and development (R&D) activities since they have many experts working in it. However, one of the major problems faced by these experts to do the R&D is the research grant which can be translated into monetary. Supplying them with enough budgets can encourage them to produce a better solution to the problems that the system is currently faced. Therefore, by having such collaboration, we can guarantee a better system and model to be implemented.

Apart from the recommendations, we also feel that there is a need to revise some of the SOP to implement the E-Procurement system in the department. The top management should grant more space for the officers to make their own decision. As mention in [9], apart from end-user uptake, process reengineering, and performance measurement, the other critical success factor for E-Procurement system is the top management support. So far, in the department, the system is used for certain project involving small scale amount of money such as procurement for stationeries. However, the tender on big amount project which required complex technical aspect and technology would not be able to use system. The related agencies still prefer to use the normal process. Hence, the procurement Branch Department of Logistic Bukit Aman only will utilize the system depending on circumstances and instruction from top management. This condition ought to be changed. The SOP should be revised and authority for the officers must be broadened.

V. CONCLUSION

This paper has presented a case study on the implementation of E-Procurement system at the Procurement Branch Logistic department in the Bukit Aman Police Headquarter. The enforcement to use the E-Procurement system has been announced by the Malaysia government since 2000. However, there still exist some loopholes decelerated the achievement of the system. In the department studied, eight problems occurred which can be categorized in three major problems. These problems need attention from all stakeholders of the system. Four solutions to these problems has been identified; they include the importance to develop the human capital, encouraging the partnership between SME's and the government, strengthening the collaboration between academia and the industries, and revising some procedure to give more authority for the officers to operate the system. Conclusively, Malaysia has a great platform to implement the E-Procurement in the future. All the infrastructures are almost complete, however the awareness amongst the business and the government workforce need to be increased.

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Development of a logistics brokering system for South Africa's displaced rural residents

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***Abstract*—A key challenge in rural environments is to overcome constraints such as high transport cost, irregular or unpredictable transport services, transport of low passenger and freight volumes, low logistics service demand and supply, limited local skills availability and isolation from or limitations to accessing the information society or knowledge networks. The use of ICT and relevant service systems holds the potential to overcome such constraints, and could improve the general accessibility of rural households and enterprises (e.g. to services, peers and markets). During 2008/9 the Council for Scientific and Industrial Research's (CSIR) Built Environment unit initiated a research project to develop and test a logistics brokering system that could overcome rural transport challenges facing local residents. The system, using a session oriented service known as Unstructured Supplementary Services Data (USSD), provided a mechanism to capture demand for transport which could then be organised and be matched with the supply of transport (the local transport providers). The project utilised a living labs approach to overcome sustainability challenges normally associated with systems in rural areas. A service system framework was applied to develop the system: It distinguishes that different aspects need attention in the design of a new (service) system which includes a service concept, an organizational network and a technical architecture. The paper expands on both the living lab approach; the service system framework used to develop the logistics brokering demonstrator, and lists factors that affected the outcome of the system development.**

***Index Terms*—Displaced rural, ICT, Logistics brokering, Mobile phones.**

I. Introduction – Displaced rural areas in South Africa

Rural areas in South Africa, especially those defined as deep rural often experience the following realities: Literacy is low, especially among woman and female participation in the public sphere is limited. Settlements are scattered spatially and for many residents quality health care, agriculture information, and formal education are out of reach or expensive to access (high transport costs). Distances to services and facilities are long and often roads are poor and severely affected during rainy seasons. Transport services are infrequent in places which further constrains the accessibility of local residents: these conditions severely limit the ability of residents to access basic services, social infrastructure and support, attain higher education, or have regular social interaction (social networks) to name a few. Another issue to note is that South Africa is still a 'society in transition' – where it is not only a matter of economic development but also about social change [1]. Designing solutions in an African way might therefore differ from indigenous tradition and might not be similar to the western world approaches as well, but what is similar is that both need to be 'community driven'.

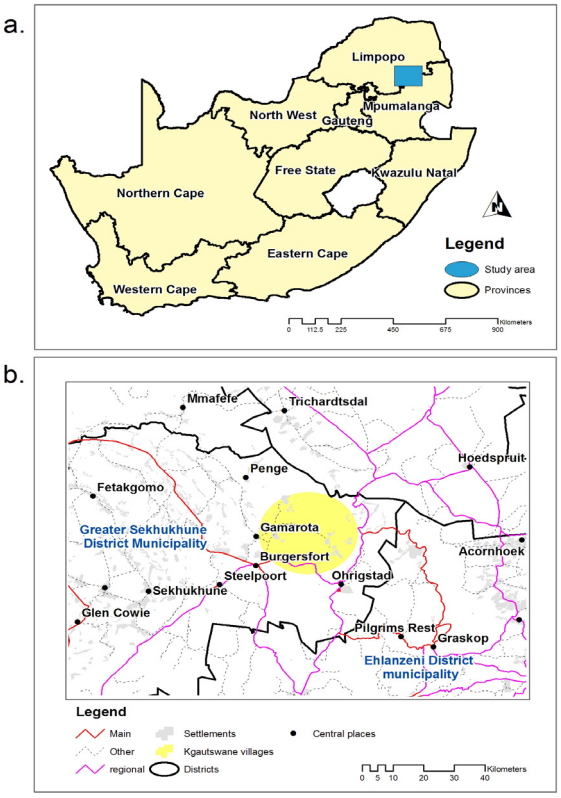

Fig. 1: Location of study area within South Africa.

One technology that holds much potential for reaching and servicing such rural communities is Information and Communication Technologies (ICTs). Although several related technologies comes to mind, two tend to

dominate, namely mobile phones and the Internet. In the low-density, low travel volume context such as those found in displaced[1] rural areas; the provision of logistics services through a brokering service system is a possibility. Through the brokering service system the rural dwellers could be able to access information regarding available transport services, thereby making rural transport service delivery more predictable.

During 2008 the Council for Scientific and Industrial Research (CSIR)'s Built Environment unit undertook a project to develop such a logistics brokering demonstrator within the Sekhukhune district of the Limpopo province, a province with a high number of displaced rural settlements (Fig. 1a). The Kgautswane area (Fig. 1b) within this district was selected due to an already well established working relationship with some key local stakeholders. The area also suffers from accessibility constraints mentioned earlier.

The main objective of this project was to develop a (demonstrator) system that could overcome rural transport challenges facing local residents through providing a mechanism to capture demand for transport, which could then be organized and be matched with the supply of transport (taxi association). The focus of the system was on travel demand between the morning and afternoon peak periods.

II. Approaches and Research Design

To achieve the objective the design science paradigm was followed, which is used to conduct research in information systems and organizational settings. Design science strives to create innovative and valuable artifacts, whereby the researcher attempts to create things that serve human purpose, and the outputs are assessed against criteria of value or utility [2]. It is fundamentally a problem solving paradigm. It seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished [3] – [4].

This paradigm is used to create and evaluate the brokering system (also referred to here as the artifact) in facilitating and improving (value) logistics service delivery in rural areas. To obtain knowledge on the logistics situation in rural areas, action research was applied to study the general characteristics of the rural service delivery environment using case studies. Since the goal of the work is to facilitate and improve the development of logistics brokering services, various research instruments were employed. Exploratory case studies was used in the initial phase to get a better understanding of the main issues to be considered in developing logistics brokering services. Design science guidelines were used to design the brokering system that fulfils the user requirements identified, and to determine the real business issues (problem relevance) to be solved by the system. During the Kgautswane study, interviews, questionnaires, and observations were used to obtain both qualitative and quantitative data from the stakeholders. It is however not only design science which are important when developing information systems, behavioural science also plays an important role as it deals with the human element. It seeks to explain or predict human phenomena surrounding the design, implementation and use of information systems [5]. Both paradigms are needed to inform researchers and developers of the interactions among people, technology and organisations to be managed if the information system is to achieve its planned/intended purpose.

According to Lee [6] technology and behaviour are inseparable. Fortunately according to Smrča [7] design has become more human due to more human-centred design approaches. Thanks to this human centeredness, applications are easier to use and better suited to their purpose. Field studies enables behavioural scientists to understand organisational phenomena, as does the construction of artifacts enable design scientists to better understand the problem to be addressed. It is also in this context that a living lab approach is favoured – it is system development within *real* settings.

A. Living Labs Approach

The logistics brokering project utilises a living labs approach - rural living labs are user-centric, real-life research and development contexts, involving people, businesses and public players in the co-creation of services enhancing rural development. It also seeks to overcome sustainability challenges normally associated with systems in rural areas. According to Mulder [1] the main advantage of a Living Lab approach over more traditional user-centric methodologies, is its multi-contextual sphere in which the co-creation if ICT product and service development takes place. It is also about research and technology development institutions setting up long-term relationships with the inhabitants of the real-world context in a way that will ensure active participation by the latter in the research and development (R&D) process [8]. The ability to interact with the users is what differentiates the Living Lab Approach from other cross disciplinary approaches. Living Lab research is viewed as the place where both fundamental research and pure applied research meet, it embraces use inspired innovation research (See Fig. 2).

The objective of such approaches is also to establish affordable and sustainable applications and services that can contribute to social inclusion, local economic development and ICT innovation. A further advantage is that users that are part of the Living Lab community are

[1] Displaced rural areas are associated with South Africa's past political reality where high density communities developed often long distances from towns and service centers.

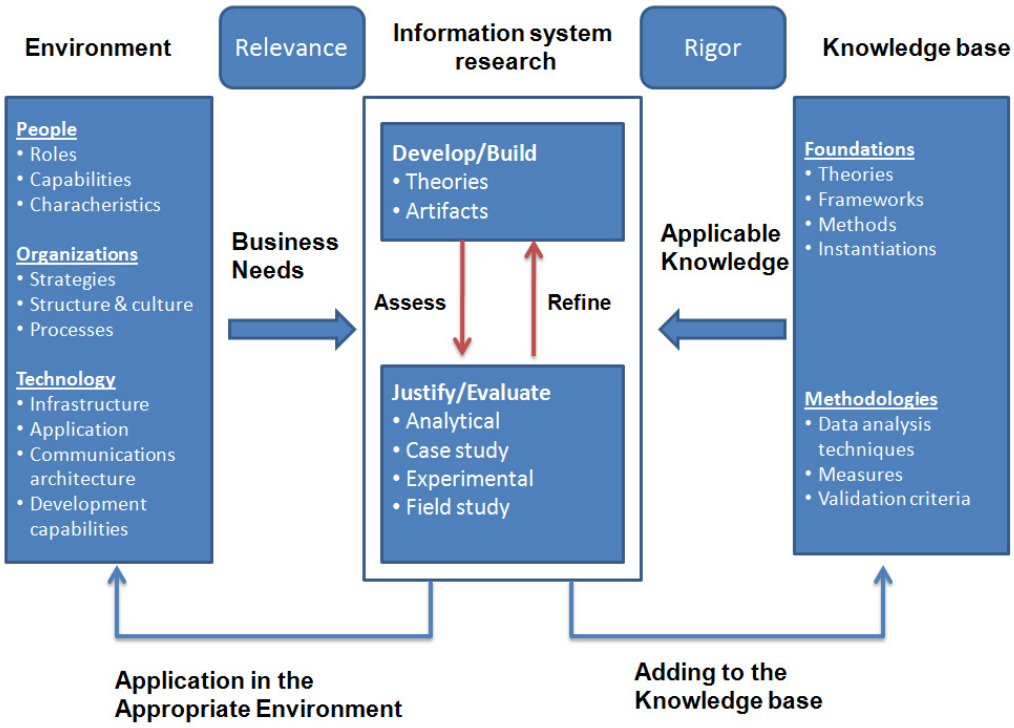

Fig. 2: Information system research framework [5]

more committed to experimentation, open for change and innovation [9]. Fig. 2 presents the Henver, March, Park, and Ram conceptual framework for understanding, executing, and evaluating Information Systems research that combines both design-science and behavioral-science paradigms [5]. The environment defines the area where the problem or need site [10]. The environment it is made up of people, organizations, and their existing (or planned) technologies [11]. In it are the goals, tasks, problems, and opportunities that define business needs as they are viewed by people within the environment. Business needs are assessed and evaluated within the context of organizational strategies, structure, culture, and existing business processes. They are positioned relative to existing technology infrastructure, applications, communication architectures, and development capabilities. These define the problem (need) as perceived by the researcher. Formulating research activities to address the perceived problems/needs then assures relevant research.

The knowledge base is composed of foundations and methodologies. Prior IS research and results from reference disciplines provide foundational theories, frameworks, models, methods, and instantiations used in the develop/build phase of a research study. Methodologies provide guidelines used in the justify/evaluate phase. Rigor is achieved by appropriately applying existing foundations and methodologies. This is also the area where new methodologies are developed and where knowledge is generated. The contributions of behavioral science and design science in IS research are assessed as they are applied to the problem in an appropriate environment and as they add to the content of the knowledge base for further research and practice. Design-science research addresses important unsolved problems in unique or innovative ways or solves problems in more effective or efficient ways. The key differentiator between routine design and design research is the clear identification of a contribution to the knowledge base of foundations and methodologies.

According to Markus, Majchrzak, and Gasser, L [12] existing knowledge is used where appropriate; however, often the requisite knowledge is nonexistent.

For design science to be effective, it needs to suitably address the following (design) problems:

- requirements and constraints that are ill-defined due to incomplete understanding of the environmental contexts
- complex interactions between sub-components of the problem and its solution
- inherent flexibility to change design processes as well as design artifacts (i.e., malleable processes and artifacts)
- a critical dependence upon human cognitive abilities (e.g., creativity) and social abilities (e.g., teamwork) to produce effective solutions

Technology has influenced the nature of work over decades; with the advent of new ICTs the ways of working is influenced. For example; villages previously unconnected to the telecommunications grid now have cell phone access. As technology becomes easier to use,

more affordable and widespread, new sustainable development solutions become a reality [13].

Technology is not the real challenge according to Fourie [14]: The human factor remains the greatest barrier to development and the major reason for project failures. ICTs need to be available, affordable and accessible to the rural poor. ICTs can assist by helping the rural poor in their daily life, by giving them a voice and by increasing their empowerment – but this needs to be carefully planned, implemented and managed. Some systems, especially large information systems are developed in a top down manner (also known as the waterfall model). Working out user requirements is the most difficult as these do not take the users into account, which results later in more disruptions or rework [15]. A systems development project in a research environment is ambiguous in the beginning to allow creative solutions to evolve. Often (and in the case of this project) several potential solutions are considered, and only the most suitable prototyped.

B. Service system approach

It is not the development of systems that is a concern, rather the sustainability of service systems. Past experience has indicated that systems often fail due to incomplete design – or simply not taking local realities into account. Some research is also needed in terms of design, development and the management of service systems. This project therefore looked at approaches that could be applied to ensure appropriateness of systems. Beyond the system is also the need to manage and monitor it. To start of it is important to understand the term "service system". Van Der Kar and Verbraeck [16] reviewed several definitions: According to Kotler [17] it is 'any activity or benefit that one party can offer to another that is essentially intangible and does not result in the ownership of anything'. Grőnroos [18] defines it as 'activities of more or less intangible nature that normally, but not necessarily take place in interactions between the customer and systems of service provider, which are provided as solutions to customer problems. In this project, services are also viewed from a more systems engineering perspective – largely due to the relationship with the University of Delft's Systems Engineering group (Faculty of Technology, Policy and Management). Due to the convergence in the service industry it is becoming more challenging to design effective service systems. The design object (the service system – Fig. 3) is a combination of the service concept itself, the organisational structure, and the information technology architecture [16]. Focusing on only one of these is ineffective and the boundaries between these are also not clear (yet mutually interdependent).

The service system framework (as described by Van Der Kar and Verbraeck [16] was applied to develop the system (see Fig. 3). A service system distinguishes that different aspects need attention in the design of a new (service) system where trade-offs are made between the service system elements. Firstly, a service concept is needed – this determines the strategy used to create value for the users. Secondly, an organizational network must be in place (or established) that supports the service. Thirdly when looking at services supported by ICT, a technical architecture should be provided. The organisational network and technical architecture are determinants of the actual service delivery.

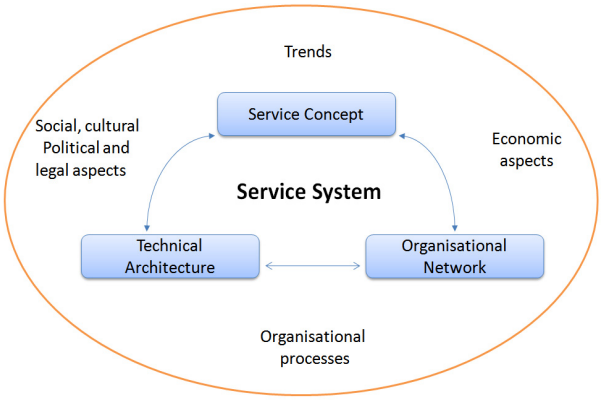

Fig. 3: Elements of the service system [16]

It is also important to note that the system operates within a wider environment that is dominated by issues such as local politics, operational issues and ethical considerations. These need to be taken into account in the design of the system. This became especially evident during the initial interactions within Kgautswane: the extent of such 'environmental issues' had to be limited – boundaries had to be set for the system in order to proceed with its development. Where possible the current organisational networks were used in the design of the system.

C. ICT-based system and the role of the human service broker

From research conducted during the preceding two years and contributions from the work of Muniafu [19], it was clear that automated systems would be less likely to work from the start – rural areas such as Kgautswane relies more on personal relations and relationships. Locals are sceptical of new 'solutions'. In addition, the C@R project also made use of a local human service broker known as the Infopreneur[2]. People in such areas prefer to work with people that are familiar to them. Also the type of application/system can be complicated and the use of a broker would add an element of flexibility to the system.

In order to develop a system the user related needs had to be captured – the interaction with users (of public transport) provided a good indication of the extent of the 'problem'. For any system development it is important to

[2] Infopreneurs are self employed social entrepreneurs utilizing ICT to enhance the range of services thy offer and are the basic enablers and delivery channels for integrating services in under-serviced communities in sustainable commercial manner.

be sure of what problem is being addressed. Top-down approaches will simply not work in an environment where users ultimately decide on using or not using the system. The users must be convinced that it contributes or improves the current situation. For services to be accepted they have to reflect the local user needs [19].

To extract this information, engagement with different groups were necessary, particularly the residents and the local taxi association. The system also had to consider other requirements such as:

- The service should contribute to the business of the current suppliers and not contain costs which are a burden on any other party. It had to operate sustainably.
- The system should contribute services that meet local needs and relate to the current way rural logistics operates.
- Support in the long term has to be transferred to the broker.

It is clear that when undertaking such an exercise the outcome is always uncertain especially when working in a multifaceted human realm.

III. Developing the Kgautswane Logistics Brokering System

In this section the design and development of a logistics brokering system is discussed. It is a system designed in a rural context as a real world system and derived from the inputs sourced from within this rural living lab. Its design is based on the service system framework (discussed earlier). Firstly, the context is elaborated followed by the requirements, the design and the system.

A. The importance of context

The key conclusions from the field survey process were that using a logistics brokering system would provide opportunities to improve the overall logistics situation. From the initial investigations it became clear that such a service would require an easy to use and manage system that would not require too much input from users or processing by the broker. The system would, facilitated by the service broker, fulfil the logistical needs of the rural areas it serves. Although some value was drawn from literature it became evident that local realities were specific and would play a commanding part in the system. Previous research undertaken as part of the Collaboration at Rural (C@R) project indicated the extent of technologies available in the Kgautswane region. Communication relies on mobile phones, which is widely used in the region. Bandwidth is low which places constraints on the amount of information that can be accessed over this infrastructure. The Infopreneurs, based at the Kgautswane Thusong Centre[3], have access to personal computers, mobile modems, printers etc typical of a local ICT enterprise.

A challenge faced in coordinating rural logistics service processes, as observed through the surveys and interactions with several local groups, relates to the identification of local travellers wanting transport and ensuring that such demands could be managed to form viable local trips (for the service providers, namely the taxi association). The nature of the formal transport service providers is known but the extent of demand during the day (the focus of the system) was unknown. The challenge was therefore to setting up a system that could obtain/source such demand and cost-effectively schedule the transport of people from with Kgautswane's geographically dispersed settlements.

The challenge therefore was how the service broker could best provide logistics services using an ICT-based intervention to enable the consolidation and synchronization of service demand and supply (initially pertaining only to passenger transport). It is hoped that such a system would reduce the operational inefficiencies and time costs for passenger transport during the day, whilst being a financially viable services. Muniafu in an earlier work detailed the typical (South African) rural logistics technology challenges as represented in Fig. 4.

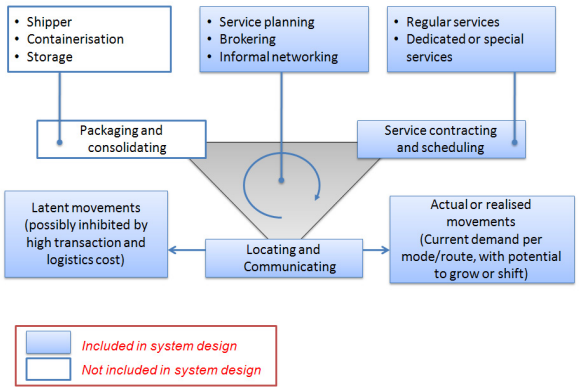

Fig. 4: Triad of rural logistics technology challenges [20]

From engaging the local stakeholders, information was obtained and used to identify the functionality for the initial system. The key elements that would be addressed by the system would be location and communication, service contracting and scheduling, and linked components. Again it is important to note that a thorough understanding of the context is needed. Similar to the research by Muniafu [19] in this project there is a need to facilitate the service brokers in: determining the demand for logistics services in a given area; determining the logistics service supply situation (dependant on Taxi association); matching the demand with supply

[3] Community centers aimed at bringing the services of government, closer to outlying areas where people live.

opportunities (or rather generating supply opportunities) and communicating this with the logistics suppliers. All of these have to be incorporated in the design of the logistics brokering system to meet the logistics challenges faced in the region (for passenger transport). Although rural logistics also involves freight, it was decided to initially focus on the passenger transport as it appeared to be a more pressing need in the region. It was however anticipated that the system be expanded later to include freight logistics elements.

B. Eliciting user requirements

The main challenge in the design of any new service is the process to obtain the user requirements. Den Hengst, Van Der Kar, and Appleman [21] state that the people involved in the process be carefully chosen to ensure that the most objective requirements emerge. Group sessions are also good for such a process. The suggestion is that the participants be carefully chosen to avoid biased or one-sided inputs. In literature it is suggested that Group Support Systems (GSS) be used as it contains several tools that can assist in structuring activities, generating ideas etc. This according to the experiences in Kgautswane is not so easy to achieve.

Often the participants are illiterate, which makes the use of some tools impossible. Then there is the cultural makeup of the area. Often people would indicate positiveness in the hopes of getting 'something' out of it. They perceive such research as leading to something good and are not as objective, honest or critical as would normally be the case (or the case in other settings). Honest and open discussions are often not possible at the first discussion and this therefore requires some relationship building and the creation of trust. This process is made harder by strangers entering such environments and creating expectations which often does not materialise or lead to anything. Strangers are then viewed with some mistrust. A further challenge in the region is that of language – English is not the preferred language and results in long meetings where translation is required. Translation in itself can distort the intent of the original message. In the case of Kgautswane the presence of local Infopreneurs made this easier as they also understood the intended system objectives.

The Kgautswane requirements was sourced using more basic activities which included; stakeholder interactions (such as the taxi association), surveys conducted with the use of locally trained research assistants and inputs from the Infopreneurs. The requirements elicitation process depended on the Infopreneurs and the Thusong centre manager for arranging meetings, group sessions and surveys. Such reliance can both be positive and negative: Negative in the sense that the process could be biased through selection of participants that would favour such a system; positive in the sense that if not for their assistance the process could be extremely difficult to arrange or would receive no support from locals.

The main actors in the region identified for user requirement elicitation were:

- The rural transport providers
- The Infopreneurs (future logistics brokers)
- The Thusong centre manager
- Groups such as representative from the youth, aged, support groups etc.
- Individuals such as farmers in the area

The groups were not always strictly selected, at the time they were also suggested. The process used in the group sessions (held in the Thusong facility) was in the form of group meetings. The meeting themselves had structure and followed planned activities. Only posters and flip-charts were used in the discussions and no 'complicated' group support systems were used. Issues were recorded and provided insight and input into the development of the system.

C. System development and contextual challenges

One of the crucial issues when dealing with the development of, or introduction of an ICT system is that it should be able to make a real contribution or value. From investigations in the region the predictability of transport demand, especially during the off-peak hours, are problematic. Transport suppliers do not know the nature of off-peak demand which also creates the value offering of the system: providing and matching demand for public transport within-and out of Kgautswane after the morning and prior to the afternoon peak period. It must also be emphasised that transport services within Kgautswane are also influenced by other environmental factors such as the condition of the gravel roads. All roads in Kgautswane are gravel and some are in poor condition, thus at times resulting in a reluctance of service providers to undertake trips. They prefer not taking trips that might result in low ridership. The demography of the region also adds to the difficulty experienced by transport users: long distances from the main road (to some villages), villages dispersed within Kgautswane. The intention of the transport brokering system was as a centralised information booking, scheduling and coordination service for public transport users. The system would 'fit into' existing services and not impede or cater for the peak transport periods. The system (and service) will be delivered from a central office such as the Thusong centre. The system should be accessible via a mobile phone and should also be managed /accessed remotely. Although a system such as this holds much potential in future and could affect transport services in the region, the key challenge was its development and the buy-in/ support from the local taxi association. The Thusong centre is appropriate as the 'home' of the service and although the region experiences problems such as bandwidth constrains, periodic unreliable infrastructure, etc. the centre is well equipped with ICT systems and can provide such a transport brokering service (along with other services currently already provided by the Infopreneurs). The service itself

does not have to be hosted in the rural environment, as it is not influenced by the same constraints as the rural area in question. The system should aim to achieve the coordination of (new) trips and the provision of information through the ICT-enabled service to customers.

Developing such a logistics brokering system would inevitably also lead to raising expectations with stakeholders. The technological environment was also limited with few people having access to personal computers and the Internet. The only viable technology that could be considered at the time (as communication medium) was mobile phones. The use of mobile phones is widespread in the Kgautswane villages but is however predominantly entry level phones, which excluded the use of more modern mobile phone technologies

A further constraint was costs – whatever system would be used had to be affordable to the user whilst be sustainable in the long term. This was also done to make the research more manageable. The brokering system as initially envisaged also depended on the services of a (human) broker – the local Infopreneur who would play a vital role in the execution of brokered transport services.

D. Designing with the service system framework

After initial sessions with a number of stakeholders and after the data collection phase where surveys were administered within Kgautswane several issues became clear as mentioned they include the following:

- Peak travel times are catered for by taxi and bus services, during this period there is also no spare capacity left for taxis to perform other services.
- There remains unsatisfied demand during the day between peak periods where users often sit without taxis providing a service.
- A system should focus on capturing and brokering a service in this intermediate period.
- Bakkies[4] would not feature in a passenger freight system (not a legal acknowledged form of public transport)
- Support from the taxi association is essential for such a system
-

The service system was therefore also aimed at leveraging ICT to mitigate some of the mismatch between supply and demand experienced in Kgautswane resulting in; trips with low numbers of passengers, lack of information on public transport trips occurring. The intended logistics brokering system had to be simple to use, affordable, and based (largely) on existing ways of doing things, it had to solve a real problem and create a type of leverage or dependence (Example: if you use the system the service will be delivered on time). This was quite a challenge taking into consideration the informal nature of such transport transactions currently. The anticipated service should provide the following services:

- Service that can capture logistics transport demand (mainly passenger transport)
- Service which can consolidate and cluster demand (i.e. combine to trips sought in the same period to have a more optimal trip)
- Supplying the brokered trip information to the service provider to deliver the service
- Service that provides information to users regarding trips provided.

E. The service concept and proposition

The following describes the system components and the roles played by the various stakeholders. The service concept as conceptualised was simple but relies on key relationships between the various stakeholders. The transport user is the main client and the need for transport originates here. Under normal circumstances the user would go to the road and wait for taxi transport, not knowing if such transport would be coming or not. Through the system the user would communicate his/her need for transport using a mobile phone (Fig. 5). The information would be accessed by the Infopreneur who would undertake the clustering and scheduling. The Infopreneur would see if a trip already exists at the time and with matching destinations to that of the user. Through the system the user can also see what if any trips have been scheduled. This would provide an opportunity for the user to join a trip. The trips once scheduled and fixed, are passed on to the service provider who would then be responsible to deliver the service (trip).

To make the system work there needs to be trust relationships – between the transport user and the service provider (taxi association): The user wants to be sure that if they use the system and book a trip that the taxi would in fact be there and on time. The service provider also needs to have trust that if they undertake a trip, the users who booked would be there. Without such trust relationships the system would not work. The Infopreneur or broker in this context simply plays a coordination role – he also has to undertake to do his part namely, to process the requests and forward the booked trip information to the service provider. As the use of the infrastructure has a cost attached, it is also important to note that users will pay for it.

The booking system cycle - Fig. 6 indicates the current cycle for the system starting with the requests for trips and ending at the trip being undertaken as booked. As brokering cannot be done in a very short time period it was necessary to deal with brokering transport in a longer time period. Essentially there needs to be time allowed for making requests. Request cannot be made for trips in the same week, but only for trips in the following week. The week leading up to Friday provides the opportunity for users to put in their request for transport into the system, the system collects and stores these requests until the Friday when the Infopreneur then processes the requests

[4] Vehicles better known elsewhere as small pick-up trucks.

and schedules the trips. The trips are finalised and information sent to the users via Short Message Service (SMS) confirming and providing them with the necessary information regarding the trip. The trips information is given to the service provider who then through its own systems assigns the trips to the taxi that undertakes the trip.

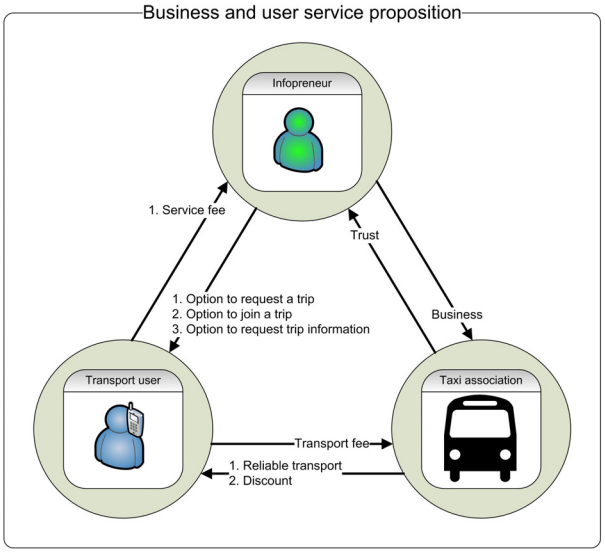

Fig. 5: The business and user service proposition.

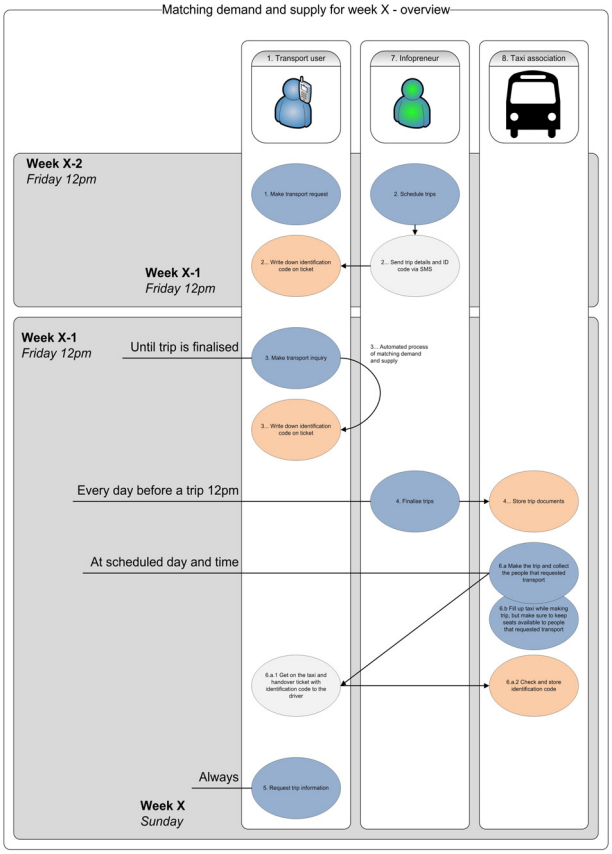

Fig. 6: The system booking and service cycle.

The taxi driver is given a booking sheet containing the information on the trips; where pickups will be, and how many there will be from the location. When a trip is booked the requestor receives via SMS a number (ID-code) which is given to the driver upon entering the taxi. This number is system generated and also on the list that the taxi drivers uses. The use of this number is to ensure that passengers that booked the trip is picked up and not confused with incidental passengers also waiting for transport. The booking cycle is therefore always a week, allowing users to plan ahead, book and providing the opportunity for information to be brokered and passed on to the service provider.

IV. TECHNICAL COMPONENTS AND DESIGN

A. Using Unstructured Supplementary Services Data (USSD)

After scoping visits to Kgautswane, it became apparent that mobile phones had to be the communication instrument (medium) for users. Although the Short Message Service (SMS) is a widely used data application in South Africa, it has cost implications and was not seen as an affordable system to use within the impoverished rural communities of Kgautswane. Several other communication options were considered including the use of human language technologies and Unstructured Supplementary Services Data (USSD). Eventually it was decided that USSD was suitable given the type of mobile phones used – it is also an established technology with several local service providers to support and assist in development. USSD allows for the transmission of information via a Global System for Mobile communications (GSM) network. In contrast to SMS, it offers real time connection during a session. USSD is a session oriented service, and can support a sequence of exchange of information [22]. USSD messages are simple to form and easy to send. User can directly enter the USSD string and press 'call' to send the message. In terms of costs it is also cheaper than SMS.

B. Technical design

Fig. 7 illustrates the components of the eventual system. A transport user wanting transport request this by dialling the USSD number on his mobile, the request is sent via the GSM network to the Service provider's menu server.

If data is requested (example: a transport inquiry – see Fig. 7) or data needs to be stored, this is done using the service provider's database. Finally this data is made available through an application that runs on the local personal computer of the Infopreneur and he makes contact with the service provider database using a General Packet Radio Service (GPRS) internet connection. The Infopreneur lists the transport requests that have been made in the week. Based on these

transport requests the web application would then visualise these requests, facilitate the grouping of requests and the scheduling of trips. After finalising a trip the Infopreneur would hand over a trip document noting trip details such as route, passengers and arrival times, to the taxi association. The taxi association then arranges for a taxi to make that trip using their normal work procedures through the queue marshal[5].

C. Technical architecture

Here we briefly list at the elements that compose the technical architecture and functionality namely; the data layer, business logic layer and the presentation layer.

Data Layer - The part of the system that contains the information that is entered remotely also allowing for changes when updates are made or new information added to the database. The information stored in the database includes the structural options for the system namely the towns and settlements that can be selected as either origins or destinations. It also has rules such as the number of seats that can be booked for a trip. It records the details for each submission namely the mobile phone number, time, date and the origin and destination selected along with the relevant day and time period for the trip. The database layer is accessed via web services.

Business logic layer - This layer addresses the main part of determining the demand for service and creates a business process such as scheduled transport trips. The infrastructure used to communicate with the user is USSD which is provided by a local service provider, Truteq. The costs for using the system are recovered from the user directly. In this layer the brokering activity takes place with the use of a website with incorporated functionality to display requests and to process it until a confirmed trip is arranged. The communication between the user and the database takes place over the mobile phone network. The Infopreneur accesses the website with PC and linked modems.

Presentation layer - The interface layer contains two levels of interface: First the transport user interacts with the system through the USSB interface modified for the specific tasks. This is essentially custom text menus that appear on the mobile phone screen (Fig 8). This does not require the download of phone specific software in order to be read or accessed.

At the level of the broker (Infopreneur) the interface to the system takes place though a website. The website is simplistic and follows a sequence of steps necessary to broker requested trips. The broker accesses the system using GPRS modem connected to a PC. The broker can also handle trips manually should he/she be requested to enter a transport request.

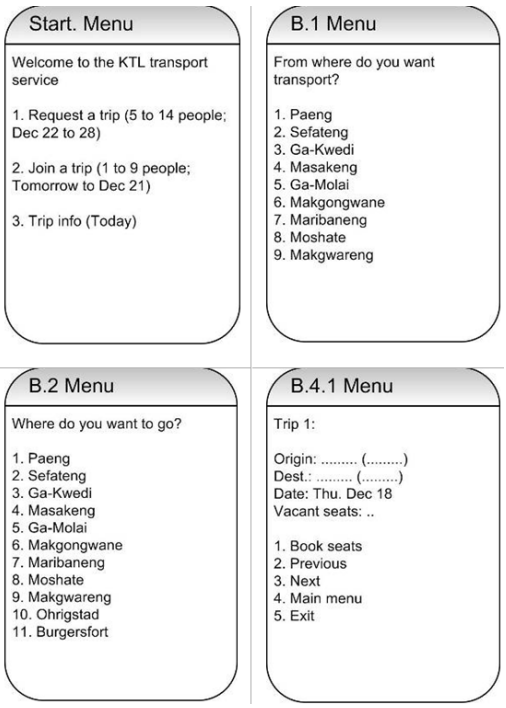

Fig. 7: Examples of some USSD menu option screens.

D. Organisational network

This is a crucial part of the system: these are the actors involved in making the logistics brokering system viable. These include the following;

The Infopreneur - Is responsible for running the brokering service. He/she acts as the intermediary between the transport users and the logistics service providers (taxi association in this case). Without a person in this space the system will not work – there always has to be a person performing this processing function. This actor is also responsible to assist those who would want to use the system but do not have the know-how or the technology (device), thus requiring human support. This person ensures that the system works the right way and delivers the service as scheduled. This person needs to monitor the system, its use and records problems or deficiencies. The Infopreneur can receive a minor financial benefit from such a system – this is however not the objective. The Infopreneur should not incur costs to provide this service.

The transport user (customer) – Is the main beneficiary for the system. Responsible to request transport through the use of the system. In return they receive information on a booked transport service. These can include all residents in the Kgautswane area. They pay for the service whilst accessing it via mobile phone. The cost for the trip is paid separately by the user when doing the trip on the day in question

[5] Person appointed at the taxi rank to assign a trip to a taxi driver

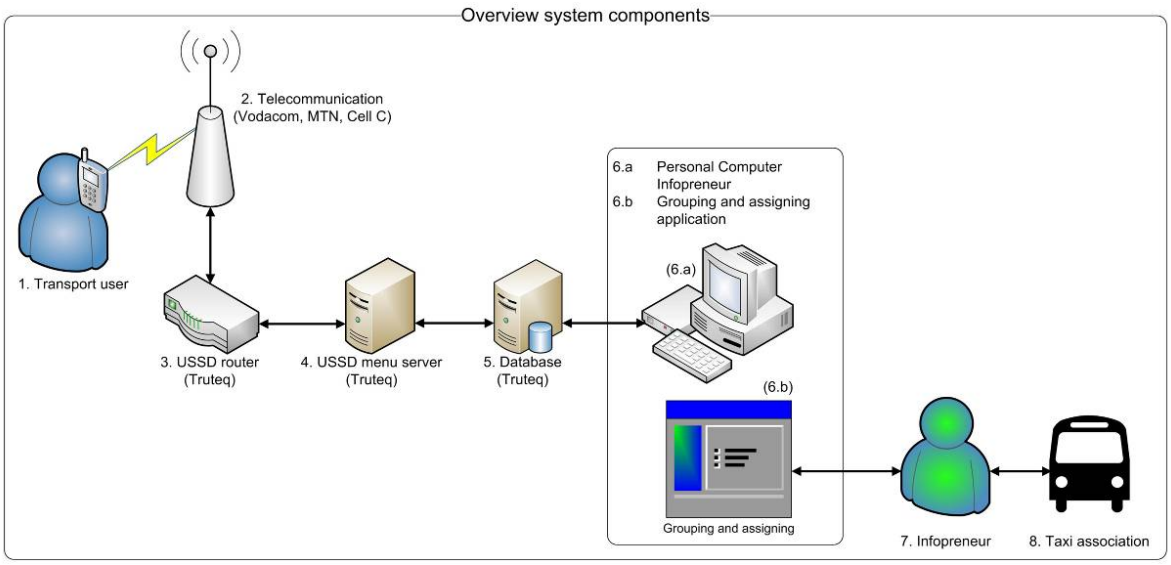

Fig. 8: Technical overview of the system and its components.

The logistics service provider - This actor provides the requested service namely the transport. The local taxi association is this actor and is also key to making the system work. They need to assign the trips internally through their own structures. The trips must be undertaken on time and as scheduled. Information is also recorded on the usage of the system. This information can later be assessed and analysed by the developers to evaluate it usefulness etc.

The communications provider - Represents the actor that facilitates the communication between user, broker and service providers within this dispersed rural environment. This service is provided by the mobile phone operators in the region. The second player here is the service provider that provides the test based USSD infrastructure on the infrastructure of the mobile phone operator. They are responsible for keeping the network operational which allows communication between the other actors.

The application provider/developer - This role is performed by the CSIR BE with assistance from Softwave solutions. They are responsible for constructing the website, and the customised USSD menu system, which is used to offer users the service. They are also responsible for building the database which is used to record requests and assigning and finalising trips.

Whilst in development, the CSIR will be responsible for the maintenance and support.

V. Conclusion

The following outlines the main findings of this project; it also indicates the future activities related to its implementation. Firstly, the system was developed within the current transport reality and it does not place current operations at risk. The system operates in a wider environment that is dominated by issues such as local politics, operational issues and ethical considerations. These played an important part in the development process. The process therefore also utilises the existing institutional structures within the Kgautswane region as far as possible.

The analytical phase indicated that there is a definite need for transport during the day, periods that are often not serviced as service providers are not aware of the transport demands across Kgautswane. The analysis and interactions with numerous stakeholders allowed the research team to come up with possible solutions also taking technology into account. Initially two technologies appeared to have much potential namely; Spoken Dialog System and Unstructured Supplementary Services Data. After reviewing both, it was decided that USSD was the most suitable technology.

Substantial effort was put into developing the system. Interactions with Truteq and Softwave led to the construction of a basic system that was accessible to users within Kgautswane. Currently the application has entered a test phase where users and service providers will be monitored and subsequently questioned to determine the viability and practicality of using such a system. There are still constraints that affect its use, including literacy (inability to use the menu system) and the fact that users need to change behaviour from planning to travel on the day, to behaviour that requires pre-planning and using a more scheduled services.

On the public transport service provider's (taxi operators) side there also needs to be a change in behaviour – from one where everyone along a road is picked up to one where preference is given to users that have booked a trip. On the system development side

much have been learnt – especially on how to approach a system development project in an impoverished and constrained rural environment. Top down approaches will not work and users need to be part of the development process. During the next months the system needs to be implemented and tested. Changes will be made where necessary. Over the longer term the system also needs to be monitored as this is where the real impact can then be observed.

VI. ACKNOWLEDGMENT

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Low-cost Highly-interoperable Multiplatform Campus Network: Experience of YARSI University

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***Abstract*—To some organizations, building campus network is sometimes considered to be very expensive; and this has made the project uneasy to perform. Moreover, if the organization without sufficient IT knowledge does not have capable IT engineers, leaving this project to third parties without supervision would lead to unexpected larger expenses. For this reason, in the year of 2003, YARSI University formed CMIS (Center for Management Information System) to perform tasks in designing, operations and maintenance of campus network and its services. By combining open source operating system run on local assembled personal computer as gateway and router, and switching technology from Cisco, we designed a low-cost UTP-based campus network which covering rooms and buildings in YARSI environment. Meanwhile, the internet access through several broadband connections and a dedicated wireless was shared to more than 100 simultaneous users by a captive portal system. With this strategy, we can signifycantly reduce cost for purchasing, maintenance and operations of network infrastructure and internet access. Our model in designing low-cost campus network and internet connections could be adopted by rural community or organizations that have limited budget to have internet access.**

***Index Terms*—campus network, broadband, switching technology, captive portal, open source**

I. INTRODUCTION

In the internet booming in Indonesia after 1998 crisis, only a few organizations could have network infrastructure and internet access. YARSI University started to provide internet access for students in the early 2001, by opening public access services to accommodate students' need for literature search. At that time, a 64kbps leased line was used with no less than Rp. 12,000,000 subscription cost a month, a fantastic amount of budget for a very limited bandwidth when compared to the recent technologies. Besides that, this speed only served no more than 10 computer clients in a small room, while other office rooms, laboratories, and classrooms were standalone without networks. Recently, that amount of money could be used to purchase about 1 Mbps on a dedicated connection type like wireless, leased line, fiber optic, and some others.

In fact that internet has a strategic role in higher education, a campus network with sufficient internet bandwidth is absolutely required. A wise and smart strategy was required in designing this networking project, to balance the need and the limited budget. Open Source (OS) becomes a smart choice and cost efficient to address this problem, because there is no investment needed in purchasing OS software, and we are allowed to use the resource even in commercial sector. The booming of Facebook[1] and Wordpress[2] are some of the amazing success stories of web applications which were built on Open Source, that are used by millions of people in the world, and invite commercial interest. Based on this reality, some institutions of higher education included Open Source course in their curricula [1].

With empirical experience, in early development of campus network in 2003, we started by searching references of network solution in the OS domain. Based on TCP/IP routing knowledge, hand-on experiences with UNIX, and a preliminary study to Cisco switching technology, we found a cheap solution to develop campus network with limited LAN segmentations. By using VLAN concept from Cisco[3] switched network, we divided faculties, offices, laboratories, library and public access facilities in the university environment into several LAN segments. The routing between VLANs and internet was performed by a FreeBSD[4] server, which was installed on a PC. Meanwhile, the internet bandwidth was provided by an ISP with wireless technology.

Nowadays, some internet broadband technologies i.e. ADSL (Asymmetric Digital Subscriber Line), cable modem and mobile internet (3G and CDMA) are sold with a relatively low subscription price. This is an opportunity for more people to access the internet with better speed. To get more advantages to our campus network, we use some ADSL connections to increase total internet bandwidth. A captive portal has been developed

[1] http://www.facebook.com
[2] http://www.wordpress.com
[3] http://www.cisco.com
[4] http://www.freebsd.org

to distributed internet load from local LAN to internet through several proxies. Each proxy server was connected directly to customer premise equipment (e.g. ADSL modem, wireless receiver) on each ISP, servicing any web pages requested by users. For this model, YARSI University only spends about nine million rupiahs a month for internet access subscription, with up to 7 Mbps aggregated bandwidth. A low-cost network solution was found and could be an alternative model to rural area with limited budget.

The next section will describe the strategy to build the low-cost campus network as implemented in YARSI University environment. Section III explains about the internet connection design, while the Section IV describes the latest development of our multiplatform campus network. Section V describes the network utilizations, and the last section will be conclusion of this paper.

II. Campus Network Infrastructure

Considering that the university environment is located in a relatively small area, which is about 2.5 hectare, and divided into three clusters, it is possible to design a UTP-based campus network on each cluster and several options in interconnection method between clusters. The first cluster is a 4-floor old building, which has more than 20 rooms (classrooms, labs, office) on each floor. The main cluster is a new 13-floor tower building which is still in finishing stage. The last cluster is the old buildings that will be demolished and replaced into another 13-floor tower building, planned for hospital. The optimal method we chose for interconnecting the three clusters was wireless bridge and UTP backbone, based on the distance and analysis that only internet packets on port 80 were found and needed by the users in remote clusters. Besides, it is temporary until the allocated rooms in the new 13-floor building for the users are finished and ready to use. Once they all move into the new building, the old one will be demolished.

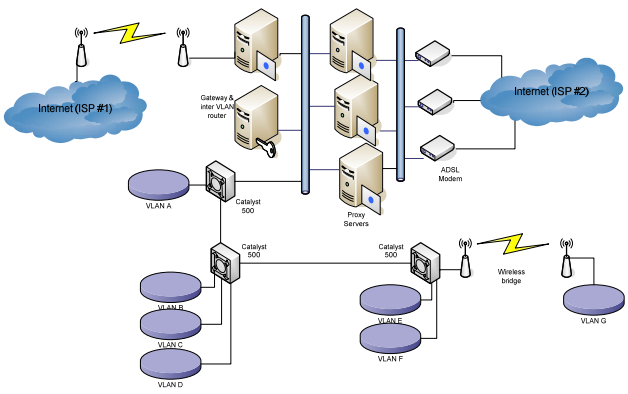

Figure 1. Low-cost campus network design

Figure 1 describes the scheme of our campus network design, and it has already proven to be reliable, scalable, and low-cost implementation. LAN segmentation is formed by VLAN encapsulation on Cisco Catalyst Express 500, which is routed by a UNIX FreeBSD server. The server also acts as firewall and captive portal to redirect internet packet request from users to proxy servers. With this configuration, we can reduce cost for backbone and active devices, which in some organizations will cost too much. The need of distribution layer switch that was usually provided by higher Catalyst series i.e. Cat3600, was replaced by an entry-level manageable switch from Cisco, Catalyst Express series, which is usually used as access layer switch. The DHCP services, VLAN management, inter VLAN routing and access control list tasks are performed by PC server. This combination (Catalyst Express and FreeBSD) has replaced the function of communication server that usually was performed by distribution layer switch, and the purchasing budget is reduced to three times cheaper than conventional configuration, which is usually proposed by certified professional network consultant.

From server side, only a trunk backbone cable is connected to its network interface. This connection is treated as trunk where all VLAN segments transmit and receive data. Any data frames entering the interface are analyzed, and then forwarded to the destination network or blocked. By default, all the traffic to outside network is blocked. Only the interested packet will be forwarded to the destination based on access list rules.

For security reasons, we will describe a modified IP addressing scheme for the proposed campus network, and eliminate the DMZ (demilitarized zone) from network diagram in Figure 1, which covers server farm (web, database, mail, etc). The management VLAN has one segment IP address 192.168.1.0/24, where the trunk cable from each catalyst and proxy servers are plugged. Captive Portal Server or gateway has virtual VLAN interfaces configured on the same gigabit network interface. Each trunk cable entering server interface or Cisco Catalyst Express 500 series uplinks (2 ports are gigabit Ethernet port) are cat6, allowing maximum speed access up to 1000 Mbps. With this setting, the preliminary requirement of backbone is fulfilled.

Other catalyst switch ports are configured with some VLAN IDs and connected to unmanageable 100 Mbps switches as access layer. At the end points, users' PCs are connected to those switches and acquired VLAN IP addresses automatically from DHCP server. As catalyst switch does not support layer 3 encapsulation, DHCP service is provided by VLAN gateway. We configured several VLANs with different IP address, e.g. VLAN 2 is 192.168.2.0/24, 192.168.3.0/24 for VLAN 3, and so on. It is also possible to users in different physical locations to be members of certain VLAN by assigning the VLAN ID to the appropriate catalyst switch port.

III. Internet Connection Design

To figure out the users' need, we analyze the data traffic across VLAN gateway. Most of packets are http,

and some of them are well known port number which is usually used by IT staff. Since we did not implement active directory yet, virus like traffic i.e. netbios family, are dropped by access list. We only passed some selected well known ports in the access lists, and some other ports based on user's blocked reports. This configuration will prevent each VLAN segment to infect others while a computer infected by viruses or spyware.

What we have done was in line with Cisco strategy in developing new framework of campus network evolutions. It is said that the campus network needs to target services to end-user as the new business focus, i.e. applications, information, and network security move rapidly to address end-user needs and interest [2].

Since only web request as the most end-users' interest to be considered as the interesting packet, we decided to choose the best connection method for optimal performance and cost. Table 1 shows the comparative price on some internet technologies. From the table, we could map the requirement, availability and budget for our gateway to internet i.e. several broadband ADSL connections which have a reasonable price for small to medium business.

Table I. The Comparison of Several Internet Connections Price (offered in 2008-2009)[5]

Technology	Cost/month	Availability
ISP A: broadband SOHO (ADSL) up to 1 Mbps	2,000,000 IDR	Yes
ISP A: dedicated wireless 256 kbps 1:1	6,000,000 IDR	Yes
ISP B: dedicated wireless 128 kbps 1:1	5.000.000 IDR	Yes
ISP B: dedicated wireless 256 kbps 1:1	6,500,000 IDR	Yes
ISP C: broadband ADSL Up to 1 Mbps	800.000 IDR	Yes
ISP D: broadband FO 1 Mbps 1:1	34,500,000 IDR	No
ISP D: broadband wireless 1 Mbps 1:1	30,500,000 IDR	Yes
ISP D: broadband FO 256 kbps 1:1	18.000.000 IDR	No
ISP D: broadband wireless 256 kbps 1:1	11,000,000 IDR	Yes
ISP E: broadband wireless up to 512 kbps 1:4	2,000,000 IDR	Yes

To prevent single point of failure, we also subscribe a dedicated wireless connection of other ISP. In 2005, the total incoming bandwidth we had possessed was approximately 1,256 kbps (a 512 kbps wireless and two 384 kbps ADSL) which cost about five millions rupiahs a month. This cost was less than a quarter compared to a dedicated 1 Mbps broadband wireless or leased line at that time. Recently, broadband ADSL technology became cheaper and bandwidth increased. With the wide range of copper telecommunication infrastructure that reaches more rural area in Indonesia, the internet penetration will grow faster using ADSL technology.

Captive Portal

For more details on how a user can access a URL in the proposed network campus, we can refer to the Figure 2 below. A packet requested for port 80 or 8080 will be captured by VLAN gateway, which acts as captive portal. This server forwards the request to an authentication page, asking for username and password. In the early development, user-name and password were stored in a MySQL database. Once a user was authenticated, other information like bandwidth utilization, IP address, login time, and activities are stored in database. When idle for more than 10 minutes, the user would automatically sign off from the system.

A php script ran as background process to investigate all incoming traffic from VLANs. This script managed forwarding rules in the ACL, activities logging, and real time bandwidth utilization of each users. A set of implicit rules were defined to balance the load among proxies. Simple Network Management Protocol (SNMP) was used to get information of interface status (up or down) and current traffic passed the interface in real time mode. The purpose was to simplify network administrator tasks in controlling and monitoring the network performance.

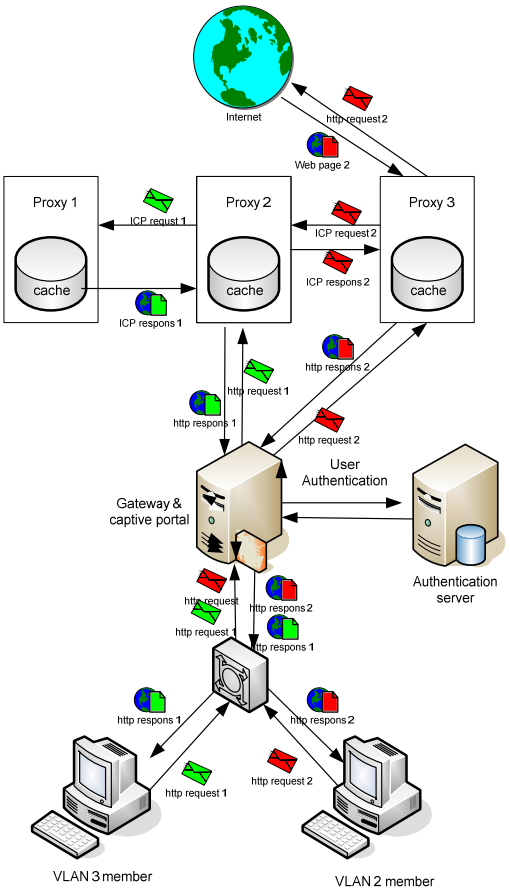

Figure 2. The description of http data across network

[5] collected from offering letters and quotations that came to author

Proxy Load Balancing

Other developed feature of the gateway is proxy load balancing. A load balancing scheme is designed to distribute the internet traffic load, by analyzing layer 4 data across VLAN interfaces on the server. The packets to port 80 or 8080 (HTTP request) are forwarded to a certain proxy server based on load balancing rules. Then proxy server will check its cache for local copy of a requested web page, and if exists, an HTTP response which contains requested web page is passed to the client. Otherwise, the proxy on behalf of the client retrieves the requested page to internet. This method will improve the performance and the response time in user's perspective.

Further, several proxy servers could be configured to be a local synergy and use WCCP (Web Cache Communication Protocol) to communicate to router, which was developed by Cisco [3], [4] or use CARP (Cache Array Routing Protocol) developed by Microsoft [4], [5]. Other collaboration methods of communication use ICP (Internet Cache Protocol), cache digest, and other cooperation protocols [6]. ICP is said to be the best example to produce global synergy of proxies within internet across different networks [4].

For that reasons, ICP becomes the popular and typical method used by various organizations when implementing collaborative internet caching system. Several proxies are configured to work together within ICP environment with two choices, equal sibling or parent-child configuration. A proxy will retrieve from its cache any incoming HTTP request, and if not found, it will send ICP request to sibling in the network for the requested page. When no proxy in the network has the page in their cache, the origin proxy will retrieve the page directly to remote server. Parent-child configuration works similarly, if a requested page comes to a child proxy, it first searches for local copy. Whenever not found, the child requests the page to its parent. If parent proxy does not have either, it will get the pages to internet. Only the parent has responsibility to retrieve any un-cached pages directly from remote servers, and the child gets from its parent cache [4], [5], [7].

Local Synergy Design

Proxy family is placed in a separate LAN segment in the campus network. Referring to Figure 1, each proxy has two network interfaces, but none of them are configured to allow IP forwarding as a router. This is aimed for security reasons, to reduce vulnerabilities in many redundant internet connections.

The first interface of each proxy is connected to server segmentation (core link), where various busy network traffic passes through. Another interface is connected to proxy segmentation (proxy cluster), where the ICP and HTTP data flow among interfaces. We did not design a cross connection between proxy and ADSL modem to avoid single point of failure. By forming a separated LAN segment for proxies and ADSL modems, an alternate route could be set to a certain proxy when a problem occurred to its default gateway. SNMP could be utilized for early detection in internet connection, and a simple shell script could be written to automatically alternate the default route to other ADSL modem.

If all broadband connections failed, captive portal will forward the http request from clients to the proxy which connected to dedicated wireless. With this strategy, we can reduce a possibility of single point of failure, and users are always able to access internet, unless all connections are in trouble.

Considering that only simple tasks will be performed by proxies, we utilized old PCs (Pentium III or Pentium IV) with limited specification to be a part of the proxy system. With this strategy, we can save more budgets for internet infrastructure, and utilize unused old PCs which are still in good conditions.

Network Address Translation (NAT)

To accommodate users' need to access outside network other than web pages, Network Address Translation (NAT) is set up. Basically, all clients in VLANs are permitted to access other applications outside network as long as they are reported to Network Administrator. When the applications are blocked, net-admin analyzes the traffic, determines the blocked port, and then creates new access lists to permit the applications.

For these requirements, another PC is used as router and firewall, which is not drawn in Figure 1. This router will allow access to university information resources (official websites and corporate mail), both from inside campus network and from internet.

IV. LATEST DEVELOPMENT

To form a better security and easier user management, we implement single sign on for many applications, e.g. internet access authentication, email account, information systems, e-learning, blogs registration, and profile management. We implement active directory with LDAP which runs on a Linux server. Clients' PC with Windows operating system are joined to domain controller, which provided by Linux PDC (Primary Domain Controller). A Backup Domain Controller is also configured on Linux. By logging on to domain, users could store their personal files in their home directory on file server, and easily access them anywhere in the campus network.

Internet authentication is also served by LDAP. It is performed by forwarding any http request to YARSI website where users have to log in. The aim is to force users read something in the university official website, as it is common that many members of the organization are not familiar with their organization website.

In early development, captive portal forwards authentication request to database server, but today, the username, password, and other personal information are stored in LDAP. Authentication data is sent by a secure http connection after log in to YARSI website. Database

is still used to store current log activities of the users, IP addresses from where they access internet, log on time, size of data transfer and bandwidth utilization.

Mail and other information system are also LDAP authenticated. All the mentioned services are provided by several PC servers that placed in the core segment in a VLAN. As this segment becomes the busiest LAN in the campus networks, we used catalyst 2950 series. In the future development, we will replace this core switch with higher level catalyst, i.e. layer 3 Catalyst 3560 series with 24 gigabit Ethernet port.

Our campus network then become sophisticated, which is composed by several operating systems (i.e. FreeBSD and Linux as server, Windows XP and Vista as clients), several Open Source applications (i.e. web, database, LDAP, domain controller, firewall and proxy), several internet connections (dedicated wireless and broadband ADSL links), and also layer 2 and layer 3 switches from Cisco. A low-cost highly- interoperable campus network that has fulfilled end-users' needs with complete services, is invented.

Network Performance

Currently, internet traffic growth has increased rapidly. We count the intranet users who access internet and remote users who browse university website. The result is shown in YARSI website. The maximum count on working days reached 200 users from outside network and 120 concurrent users from intranet. Figure 3 below shows the capture of real time count of user who access YARSI website. The number of Civitas online represents the real time users who access internet after authenticated by LDAP.

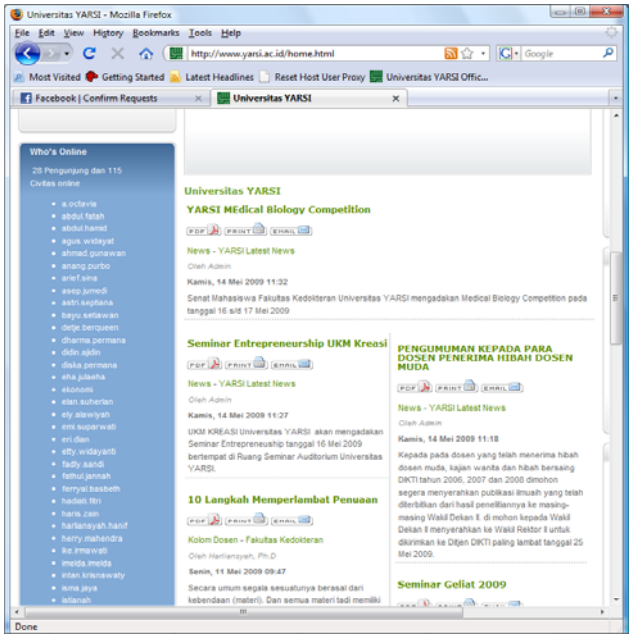

Figure 3. Online authenticated users in YARSI website[6]

Meanwhile, Figure 4 shows the proxies' traffic loads which were captured on business day. Referring to Figure 4, implementing local synergy with several proxies and redundant internet connection as explained in Section III, can reduce the internet traffic load significantly. Although many users are concurrently accessing the internet, the proxies system still can handle. It is shown by the real time traffic from each SNMP capture, which no figure reaches the peak.

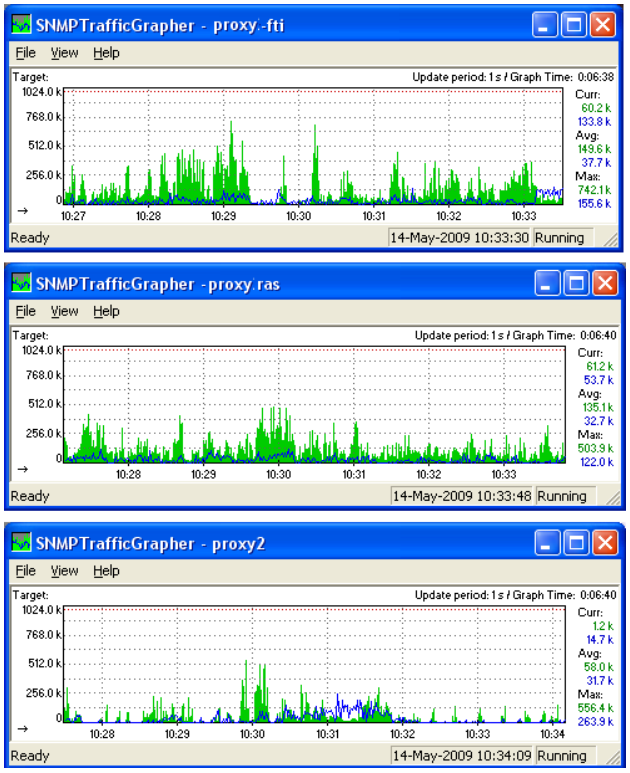

Figure 4. Some captures of proxies' load[7]

A general issue in low-cost Open Source is the contribution to widespread sophisticated development practice [8]. We realize that our low-cost campus network model with highly-interoperable components, devices and platform, makes the system quite complex and not easy to hand over. For this issue, an organization who wants to implement this model has to have a capable network engineer to design and maintain the operations of the overall system.

V. CONCLUSION

Theoretically and having been proven, our network campus model could provide the need of accessing documents from internet in a rational tolerance delay perceived by user; on the other hand, organization is not burdened with the expensive cost for purchasing and operations. In six-year experience, implementing this strategy has provided great advantages in terms of cost saving, and could be an optimal solution for small and medium business and rural area with limited internet budget.

[6] Captured on May 15, 2009 at 13:10 Jakarta time

[7] Captures on 14 May 2009, on about 10.30 Jakarta time

VII. ACKNOWLEDGMENT

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The Influence of Community Characteristics towards Telecentres Success

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***Abstract*—Telecentres (TCs) are physical spaces that provide public access to information and communication technology particularly the Internet for educational, personal, social, and economic development. This paper will closely look into the characteristics of the community that influence the success of these kinds of TCs. Although there a number of influential factors in regards to community characteristics, the emphasis will be on groups and networks factor. Survey was conducted to collect data from users regarding their use of TCs. In the questionnaire, apart from the users' profiles, items related to the groups and networks were also included. The responses were captured based on five-point Likert scale. Sampling was done based on a population comprising TCs implemented by state governments, NGOs, and private sectors. The findings suggest that there are indications that shows belonging to a group and establishing networks contribute to the success of TCs.**

***Index Terms*—telecentres, social capital, groups, networks**

I. INTRODUCTION

Telecentre (TC) provides various information and communication technology (ICT) services, such as access to the Internet, to computers and software, to electronic commerce applications, and to other public information services with the aim of achieving various development objectives especially the Internet for educational, personal, social, and economic development [1]. In addition, the local community can used the centre for various activities such as social gathering activities and interactions. A TC can be also referred to as a one-stop centre that provides ICT resources to the public access, dissemination of information and knowledge and e-government services, e-banking, e-health and others to improve the socio-economic status of targeted local communities [2].

In Malaysia, by 2008 there is a total of 1169 TCs established under the Universal Service Provision (USP). These TCs, among others is comprised of 42 Pusat Internet Desa, 39 Medan InfoDesa, 58 Community Access Centres and 78 Computer Literacy Classes were set up to improve computer education and empower rural communities to access and utilize information to improve their economic and social well-being [3]. Other TCs include 85 Community Broadband Centres (CBC), 105 Community Broadband Library (CBL), 108 Regional Medan InfoDesa (MID) at Mukim's level, and 267 MID at village level. The TCs that are involved in the initiatives above are mainly sponsored by the federal government. Apart from that, there are 169 state owned TCs, and also TCs which are initiated by the Non-Governmental Organizations (NGOs) and private sectors, and these types of TCs are the focus of this paper.

A range of important issues is linked to the operation and success of TCs. Besides sustainability, government policy, information and community technology, business planning, and TC objectives, [4] have included (i) community partnerships and participation, and (ii) community relevance as another important dimensions in creating a successful TC. There must be participating communities in the planning and managing activities related to TCs project. Participating communities share several characteristics. According to [5] participating communities must embrace six major pillars:1) involved in the community's activities; 2) division of responsibilities and tasks according to small groups; 3) knowledge sharing; 4) ideas are treated with respect and appreciated; 5) no discrimination among various groups and types of personalities; and 6) open minded people.

In regards to community relevance, TCs need to be relevant to their clientele, especially in the contents provided to communities. Much of the information available via electronic networks, for example through websites, portals may not meet communities' needs for local information on agriculture, socio economy, and health and nearby markets. Irrelevant contents and materials would be useless to communities if most of them are not delivered in national or local language.

Among other TCs' success factors include leadership, location, cleanliness, computer literacy, management skill, and business skill [6]. Moreover, this is inline with [4] that stated application content should be

made and tailored to the community needs. In addition, [4] also mentioned that technology should also be made more available to all due to its cheaper price, and subsidies and financial support given by telecommunications companies [6].

There has not been much work that have examined into the relationship between TCs success from the sociological perspectives using the social capital theory. This paper will closely look into the characteristics of the community that influence the success of these kinds of TCs (established by state governments, private sectors, and NGOs).

The objective for this research question was to find out the positive characteristics of communities as indicators for TCs to succeed. In order to understand and answer the research question regarding the characteristics of communities – Social Capital Theory was used. The main purpose to use the theory was to examine the sociological aspects of the members' in a community. Although there a number of influential factors in regards to community characteristics, the emphasis will be on groups and networks factor.

II. Literature Review

A. Community

The term *community* originated from the Latin word *communis*. Fernback and Thompson [7] suggest that *communis* can be formed by pairing (i) *cum* refers to together and *munus* refers to obligation, or (ii) *cum* meaning together and *unus* meaning one. *Community* can be referred to a group in which individuals participation is based on an obligation to one another or as a group in which individuals participates to be one in purpose [5]. Therefore, a sustained social interaction, shared attributes and values, and a delineated geographical space need to be in place for the community to function effectively and efficiently [9]. However, management scholar suggests that it is membership rules not the geographical boundaries, which help sustain the community [9].

The community to the ordinary inhabitant is where he lives, and probably works. It is associated with a place and a name in his thought [10]. They further add that community is where one goes to shop, to attend a show, to meet friends, or simply to loaf. The common-sense concept of community is that it involves an area, people, and the relationships among people (structure). The elements of structure in a community consist of groups, formal organizations, institutions, division of labor, values, social differentiation, and functions. Therefore, community may be formally defined as [10]:

> *..the structuring of elements and dimensions to solve problems which must be or can be solved within the local area.*

B. Social Capital Theory

Recently, the understanding of social capital is becoming critical and significant apart from the financial, human, intellectual, and other capitals in today's communities. Social capital is the social fabric or glue that holds communities and other social networks together. The basic premise here is the interaction that enables people to build communities, to commit themselves to each other, and to knit the social fabric [11]. Those concerned with social capital have examined the density of social networks that people are involved in; the extent to which they are engaged with others in informal social activities; and their membership of groups and associations.

It is important to note that social capital is becoming a core concept in business, political science, healthcare, and sociology. Social capital is a common framework for understanding the depth of a community's social connectedness. It refers to features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit [12]. The World Bank refers social capital to the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions [13]. Increasing evidence shows that social cohesion is critical for societies to prosper economically and for development to be sustainable. Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together [13]. Another view of social capital is that social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviors that bind the members of human networks and communities and make cooperative action possible [14]. Hence, we have adapted the Social Capital Theory [15] to measure the characteristics of communities. The selected variables used in the survey were:

a. *Groups and Networks.* The questions here consider the nature and extent of one's participation in various types of social organizations and informal networks, and the range of contributions that one gives and receives from them. It also considers the diversity of the membership in group, how its leadership is selected, and how one's involvement has changed over time.
b. *Trust and Solidarity.* This category seeks to procure data on trust towards neighbors, key service providers, and strangers, and how these perceptions have changed over time.
c. *Collective Action and Cooperation.* This category explores whether and how household members have worked with others in their community on joint projects and/or in response to a crisis. It also considers the consequences of violating community expectations regarding participation.
d. *Social Cohesion and Inclusion.* Questions in this category seek to identify the nature and extent of the

various forms that can lead to conflict, togetherness, and everyday forms of social interaction are also considered.

e. *Empowerment and Political Action.* The questions in this section explore members' sense of happiness, personal efficacy, and capacity to influence both local events and political outcomes.

The survey instrument attempts to reflects the group membership ("structural") and subjective perceptions of trust and norms ("cognitive"), the main ways in which social capital operates (collective action and cooperation), and major areas of application or outcomes (social cohesion and inclusion, and empowerment and political action) [15].

III. METHODOLOGY

The base sampling for this research is TCs establishment. Sampling was done based on a population comprising of TCs implemented by state governments, NGOs, and private sectors. The population list is based on Internet searches, list from the K-Economy Section, Economics Planning Unit (EPU) of the Prime Minister's Department, state government offices, as well as telephone calls to non-governmental organizations (NGOs) and private sector TCs. A total of 132 TCs have been identified for this study. These 132 TCs are part of the 1945 TCs registered under the EPU list in addition to a few TCs which are not in the EPU list. The data collection sites were divided into four regions: Northern Region (Perlis, Kedah, Penang, Perak), Central Region (Selangor, Wilayah Persekutuan, Negeri Sembilan), Southern Region (Malacca, Johor), and Eastern Region (Kelantan, Terengganu, Pahang). Based on the sampling used, we distribute questionnaires to the TCs' users through mail or hand-delivered while visiting the TCs. Table I shows the distribution of questionnaire according to the regions and method of distributions.

Table I: Distribution of TCs and Questionnaire

Region	Total TCs	TCs visited	TCs via mail	No. of Questionnaire Distributed
North	**44**	4	40	453
Central	**33**	6	27	311
South	**29**	9	20	290
East	**26**	8	18	260
Total	**132**	**27**	**105**	**1,314**

Survey was conducted to collect data from users regarding their use of TCs. Based on the total of 132 TCs, 1,314 questionnaires were distributed with response rate of 41.1%. In the questionnaire, apart from the users' profiles, items related to the groups and networks were also included. The responses were captured based on five-point Likert scale. The characteristics of a community that contribute to the success of a TC is assessed based on five main factors namely (1) Groups and Networks, (2) Trust and Solidarity, (3) Collective action and cooperation, (4) Social Cohesion and Inclusion, and (5) Empowerment and Political Action.

However, in this paper the emphasis will be on the groups and networks factor. In regards to groups and networks, there are five questions that respondents need to answer. The first is regarding the importance of them belonging to a group or association. The second question is related to the benefits gained by belonging to a group. The third question tries to capture if the leaders are chosen democratically. The fourth question inquires whether the chosen leaders are effective. Finally, the respondents were asked regarding the public acceptance of their group.

IV. FINDINGS

This section presents the findings of the study. In terms of the demographic profile, majority of the respondents (93.4%) aged below 40 years old with overall is fairly distributed between male 48.3% and female 51.7% (n=540). Most of the respondents' education levels are moderately low whereby 72.2% is up to Form 5 (upper secondary school). Almost 70.0% earn less than RM1,500 a month with 21.8% is comprised of those who fall under the poverty level.

Regarding IT facilities ownership, 52.8% of the respondents own a computer at home. Out of this, almost 41.0% have Internet connection, either through dial-up (70.0%) or Broadband (54.3%). Pertaining to the usage of TCs, majority of the respondents indicate that they have experienced using the TCs (79.8%).

In this study, a successful TC is identified through the length of TC usage (in this case more than seven months) by the users. This is to reflect the duration for a TC to be able to retain recurring users. It has been discovered that, based on this factor, three TCs, namely the E-Desa (state government), TMPintar (private), and Pusat Bestari (state government) falls under this category with the percentage of 66.0, 100.0, and 64.3 respectively. Then the respondents from these TCs have been chosen to rate the importance of groups and networks factor through five statements listed below:

i. Being a member of an association or group in my community is important to me.
ii. I gain a lot of benefits by belonging to a group or association.
iii. Leaders are chosen based on democratic process.
iv. As an overall, the group leader is effective.
v. The group that I belong is well recognized and supported by the community.

These questions are adopted from well-tested social capital theory. The findings are as tabulated in the following Table II.

Table II. Findings

Group & Network Factors	E-Desa (%) n=46	TM Pintar (%) n=20	Pusat Bestari (%) n=67	Overall (n=134)
Being in a group/association	91.3	100.0	86.6	90.2
Benefiting from being a member of a group/association	91.8	100.0	81.1	90.3
Democratically chosen leader	73.9	100.0	92.4	87.1
Effective leadership	89.4	85.0	92.3	89.4
Acceptance by the public	95.7	85.0	95.4	89.3
Average Group & Networks Factor	80.4	100.0	79.4	82.8

More than 90.0% of the respondents agreed that it is important to belong to a group or an association. Their views are supported by their responses on the second question where they (90.3%) believe that they will get benefit from being a member of a group or an association. In order to be a member of any group or association, 87.1% of the respondents deem that the leader needs to be elected democratically. In addition, effective leadership of a group or association has also been identified (by 89.4% of respondents) to be one of the important aspects for a successful group or association. Finally, the respondents (89.3%) feel that it is important for their group is being recognized and accepted by the general public. In general, the five questions have captured the essence of groups and networks factors. The findings suggest that, groups and networks factor is present in the communities surrounding the three successful TCs.

V. CONCLUSION AND RECOMMENDATIONS

The findings suggest that there are indications that shows belonging to a group and establishing networks contribute to the success of TCs. It has been found that, most TCs' users belong to a group or an association. Being so, they could use the TC as a platform to organize any group or associations activities. This would encourage members of the group or association to be familiarized with the facilities the TC offers, thereby creates awareness among them. Having networks of friends or peers, they would also help in creating the awareness by being attracted to the TCs. With having networks of friends, TC could offer discount and benefit to the person that brings his network of friends to use the TC. For example, if a person invites four of his friends to the TC, the management would offer the person ten minutes of free Internet usage per person recommended.

A high percentage of them also agreed that they could gain benefits by being in a group or association and leaders in the group are being chosen fairly. This would reflect the norms used in the group can be implemented in choosing appropriate leader to manage the TC. This kind of the leaders would have the characteristics and the potential to influence the people from the group in particular and the community as a whole. This is important to the success of TC, especially in terms of its usage.

Most importantly, it was found that the feeling that their group is being accepted by the general public is significant to the success of the TCs. This creates the sense of belonging to the community, which in turns would help them to participate in the advancement of the TC's achievement. Activities that are planned and designed for such community would gain support and commitment from the surrounding community. As a result, the TCs will be more 'vivacious'.

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Strategy for Telecentres' Sustenance

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***Abstract*—This paper presents the findings of a study to formulate strategy for telecentre (TC) sustainability in Malaysia as part of the Malaysian government initiative under the Universal Service Provision (USP) program to bridge the digital divide. TC sustenance refers to the capability of a particular TC to stand on its own and well-supported by the community where it is located. The aim of the study is to assess the implementation of telecentres throughout Peninsular Malaysia that are funded, managed and/or operated by state governments, non-governmental organizations (NGOs), and the private sectors with a view to formulate viable strategy for its sustainability. A survey was conducted involving 132 TCs drawn from a population comprising TCs implemented by state governments, NGOs, and private sectors. Data analysis was done based on frequency counts, percentages, mean scores, observations and interviews with users and operators of TCs. This study found that TCs in Malaysia do not have formal strategy or business plan. Based on data gathered, there are two major situations in which TCs can use the business model in terms of sustaining their operation. The situations include: (i) the communities' awareness on the value of TC and ICT resources, and (ii) the agencies' awareness on the value of TC and ICT resources as platform that link them to the community.**

***Index Terms*—Telecentre, bridging the digital divide, ICT for development, rural informatics**

I. INTRODUCTION

Telecentre (TC) project by the Malaysian government offers opportunity to bridge the digital gap between the rural and urban communities. The TC provides IT skills training and IT awareness programs to all underserved groups of people including rural communities, women, the elderly, people with disability, and children. This is part of the national Vision 2020 policy to strengthen the nation's capacity, capability and resolve in meeting future challenges [1], particularly one of the key strategies of enhancing the usage of IT towards knowledge-driven and productivity-driven strategy.

The diffusion and usage of ICT within and across sectors is further expanded as ICT has a strategic role in accelerating economic growth. Accordingly, the ICT infrastructure is upgraded through several initiatives including increasing the capacity of the transmission backbone up to 10 gigabits per second and introducing the Network Management System for better service availability. The ICT infrastructure is also unrolled to the rural areas to reduce the digital divide and to achieve a balanced development. TCs were set up to bring the Internet to small towns and rural communities in Malaysia. The Economic Planning Unit (EPU), Prime Minister's Office and other government ministries and agencies are responsible for the project. To date, there are more than 2000 TCs in operation throughout Malaysia according to the EPU directory on e-community.

II. TC IMPLEMENTATION

Various agencies are involved in the TC rollout since the mid-1990s. Among these, 42 rural internet centres were established by the Ministry of Energy, Water and Communication, 1169 TCs created under the universal service provision (USP) initiative by the same ministry, 85 community broadband centres and 105 community broadband libraries by the Malaysian Communication and Multimedia Commission (MCMC), 108 regional (*mukim*) Medan Info Desa (MIDs) and 267 village MIDs by the Ministry of Rural Development, and 169 state-owned TCs. These figures are expected to increase beyond 2010 with almost RM13 billion has been allocated for ICT related programs under the ninth Malaysia plan.

Despite the huge budget allocation for ICT development to cater for the increased demand for TCs, sustainability of existing TCs is of primary concern. Studies have shown better services and facilities, including application and content are among success factors of TC sustainability [2], [3], [4]. This paper examines strategies for sustainability of TCs implemented in Malaysia and identifies success factors that contribute to social and economic sustainability.

III. METHODOLOGY

This study commenced on the 1st March 2008 for 1½ months till 15th April 2008 involving TCs implemented

throughout Peninsular Malaysia. In order to meet the objective of the study, i.e. to formulate viable strategy for TC sustainability, data were gathered on TC implementation covering two units of analysis, i.e. TC operators and users. Data were categorized according to Delivery and Services, Operations, Location, Staff, Facilities and Infrastructure, Strategy, Promotion, TC Structure and Finance. A survey was conducted involving questionnaire design and data collection. Types of questions used to capture responses include categorization, selection from list, Likert scale, and open-ended questions. The data collected from the questionnaire for analysis can be categorized into dichotomous (Yes/No), ordinal scale, interval scale, and ratio. Sampling was done based on a population comprising TCs implemented by state governments, NGOs, and private sectors. The population list is based on Internet searches, list from the K-Economy Section, Economics Planning Unit, Prime Minister's Office, state government offices, as well as telephone calls to NGOs and private sector TCs. A total of 132 TCs were identified as suitable respondents for this study. These 132 TCs are part of the 1945 TCs registered under the EPU list in addition to a few TCs not in the EPU list.

Data collection started with fieldwork by visiting selected sites that are divided into four regions. These are the Northern Region (covering the states of Perlis, Kedah, Penang, Perak), Central Region (states of Selangor, Wilayah Persekutuan, Negeri Sembilan), Southern Region (states of Malacca, Johore), and Eastern Region (states of Kelantan, Terengganu, Pahang). The rest of the TCs were contacted through telephones and questionnaires sent through mails, with self addressed envelope. Administration of questionnaires took eight days of fieldwork and 14 days of postal returns. Meanwhile data entry and data processing were carried out using statistical software that took five days to complete. Data analysis was based on frequency counts, percentages, mean scores, observations and interview feedbacks.

IV. Findings and Discussions

In order to ensure long-term sustainability of TCs, strategies need to be formulated to help TC owners and operators plan their short-term and long-term business. This study found that TCs in Malaysia do not have formal strategy or business plan. Based on observation and interviews with TC owners and operators, TC strategy is not formally written. However, owners and operators are able to describe what they plan to do for short and long term business strategy of their TCs.

A good strategy for TC sustainability is to propose a business model to make sure all of the TCs can compete and are able to sustain in the future. Based on data gathered, there are two major situations in which TCs can use the business model in terms of sustaining their operation. First, TCs must convince the community that they are important to the lives of various groups of people. Without the awareness of the value of TCs to the community, and the value of the information and communication resources available, TCs will have a difficult time surviving. It will not be sustainable. TCs need a business strategy to do this awareness-raising systematically, effectively, and efficiently. We know that the promotion of TCs in a community is often not a high priority unless there are special programs and funding from external sources available.

Second, TCs can help other community agencies, both government and non-government bodies, to use their facilities in an effort to improve life in the community. Schools, health centres, farming support organizations, local government officials and others need to communicate with various groups they serve, and the TC can be one of the links between these groups and their constituencies. By helping these organizations design business strategies, TCs will be providing them with the knowledge and resources to do this well.

There are various benefits to preparing an implicit business plan strategy. These include:

1. Building coordination and cooperation.
2. Controlling the flow of activities.
3. Estimating resource needs.

One of the important components of a TC business model is membership. Membership is a form of commitment and long-term support by community to the TC. Generally, majority of TCs in the study do not impose membership where only a small number of TCs collect fees from its members. This range from as low as 12.0% for NGOs to 19.3% (private), and 30.0% for state TCs and TCs in East Malaysia as presented in Table I. Operators of TCs generally agree that fees imposed by TCs are reasonable (84.1%). Federal government TCs indicated requirements for membership (62.4%) however there is no indication of fees imposed. Membership fees can be a good source of revenue for the TCs and members could feel a sense of belonging and would demand better quality of service where TC operators would be obliged to deliver.

Table I: Types of TC with Membership Fee

Types of TC	Imposing Fee (%)
Federal	n/a
State	29.9
NGO	12.2
Private	19.3
Sabah/Sarawak	30.1

Community should also be made aware of the existence of TC within their vicinity. This is important so that members of the community can reach out to the TC and enjoy the services provided that can benefit them individually. Findings show that majority of members obtain information about TCs in their community from

friends and relatives, ie words of mouth (NGOs 60.3% followed by State TCs 44.4% and private TCs 40.7%). A strategy to promote TC existence is to initiate words of mouth by encouraging the use of community bulletin board and schools as they are accessible and cheaper means of promotions. Alternatives for other sources of TC existence are printed media and radio as presented in Table II.

Table II. Source of Knowledge on Community TC

Sources	State	NGO	Private
Friends & Relatives	44.4%	60.3%	40.7%
Printed Media	11.5%	10.3%	7.7%
Community Notice Board	16.8%	11.8%	11.1%
Radio	10.2%	1.5%	5.1%

The type of services offered by TCs is very important to ensure sustainability of the TC. More services would appeal to larger population of the community thereby increase community participation. The findings suggest popular services offered by TCs are Computer Class (78.7% for State, 100% for NGOs and private sector), Internet Access (72.3% for State, 80% for NGOs and 88.9% for private sector). See Table III for details. Other services that are popular include Advisory Service for buying computers, Computer Sales and Services, Order Invitation Cards, Formal Letter and Poster. Promotions for these services should be done more rigorously by the TCs where new and innovative ways of promotion should be encouraged. Examples are Loyalty scheme where members can redeem points accumulated to utilize other services and/or obtain free gifts. Findings from the users indicate popular TC services are Internet Access (32.8% used more than 10 times for State TCs; 42.4% used more than 10 times for NGO TCs; 36.0% used more than 10 times for private TCs).

Table III. The type of services offered by TCs

Services	State	NGO	Private
Computer classes	78.7%	100%	100%
Internet Access	72.3%	80%	88.9%

The next strategy to ensure sustainability of TC is sponsorship. Sponsorship can be monetary or non-financial. Whilst monetary sponsorship is crucial for new and start-up TCs, long term sustainability requires a shift from monetary to non-financial. TCs should not be relying entirely on sponsorship for survival. Findings show that source of sponsorship come from Federal Government, State Government, NGOs, Private Sector and Multinationals, Individuals, and Institutions of Higher Learning. Federal sponsorship includes financial (computers and training), infrastructure and office equipment. State sponsorship includes financial and infrastructure. NGO sponsorship comes in mostly for supply of computers and training. Institutions of higher learning (IHLs) provide volunteers for workshops, training and academic advice. Additionally the findings suggest non-financial sponsorship includes volunteers, advice, expertise, collaboration and leadership. Table IV lists the source of sponsorship according to type of TC.

Table IV. Sponsor

Types of TC	Sponsors	Percentage
State	State Government	61.1%
	Federal Government	22.2%
	Private Sector	5.6%
	Individual	11.1%
NGO	Individual	25.0%
Private	Private Sector	60.0%
	Individual	40.0%

It is important to take advantage by adding value to some of the most popular TC services offered such as Internet Access and conducting Computer Classes. This study found that among the popular applications used are web surfing and e-mail services. This is where more e-government and e-business applications can be introduced to the local community where the benefits of using such services should be highlighted such as substantial savings of money and time. Moreover, a better strategy to encourage usage can be adopted such as introducing discounts and reductions involving monetary e-government and/or e-business transactions.

Collaboration with Institute of Higher Learning (IHLs) can include life-long and distance learning education, where training programs can be based on modules that lead to certification. Certification can be very meaningful to community members to ensure continued education advancement and will be an advantage to TC as a form of training accreditation. Development of modules is to ensure standardization of training materials and achieve standard competencies, which allow flexibility for members to gain education anytime and anywhere. This idea was suggested by a number of TC owners and agreed by others during interview sessions held at respective TCs throughout the country.

Another important strategy for TC sustenance is promotion. This section has basically deliberated on this subject even from the beginning. The membership system introduced earlier is one form of promotion, what more with creative loyalty scheme would attract more users to subscribe. Programs such as e-Melaka for instance not only provide free IT literacy training to registered members, but participants are also given daily allowance to attend the training. A number of the TC operators interviewed have even offered discounts to ex-members for other advanced courses and services as a form of loyalty. Services offered by TCs could vary and tailored to meet specific community requirements. TCs should be creative to look for innovative ways to serve the community.

Promotions can also be extended to sponsorship by engaging wealthy individuals and conglomerates in win-win situations. Another means of sponsorship is through the adoption program as part of the public-private partnership service to the community. Even universities and other IHLs can adopt a TC by organizing events such as bridging the digital divide and other community development programs involving students and lecturers.

Other ways of promotion that contributes to TC sustenance are by creating promotional programs for specific target groups within the community. The study found differing promotional strategies for different target groups. Table V lists the different kinds of programs that respondents of the study perceived as suitable for the specific target group.

Table V. Promotional Programs at TC for Target Groups

Target Groups	Promotional Programs
Children	Story-telling Coloring Edutainment
Teenagers	Workshops IT Competition Edutainment
Youth	IT Learning IT Competition Edutainment
Senior Citizen	IT talks References & site visits Free classes
Women	Workshop – related activities Reading materials Free classes
Farmer	Agriculture activities Entrepreneurship Reading/ Learning

It is interesting to note from Table V, the need to organize entrepreneurship as a promotional program for farmers. This is particularly relevant for TCs located in the rural areas where agriculture is primarily the occupation of the community. A recommended strategy to support this kind of program is to incorporate the concept of incubation centre in the TC to develop entrepreneurs for downstream agriculture activities. The present structure and mechanisms to support entrepreneurship and incubation can also be extended to the TCs.

Several suggestions were made by respondents of the study to improve the TCs. The top three most popular suggestions were 1) Increase facilities and activities in TC; 2) Increase size of TC and its appearance; and 3) Increase number of PCs, printers and software. A full list of suggestions is presented in Table VI.

It is also interesting to note that the fourth popular suggestion can easily be achieved by extending existing rural library functions to include TC services. This would encourage utilization of local libraries and cost savings in terms of the management and operation of the centre.

Table VI. Suggestion to improve TC

Rank	Suggestion
1	Increase facilities and activities in TC
2	Increase size of TC and its appearance
3	Increase number of PCs, printers and software
4	Increase reading materials
5	Access to broadband services and high speed internet
6	Increase the number of ICT awareness programs, computer classes, workshops
7	Strategic location of PCs
8	Increase promotion of TC
9	Increase operation time of TC
10	Increase number of TC operators and improve their knowledge & skills

Table VII lists popular suggestions by respondents on how to encourage community to use TC. It is interesting to note from the suggestions that there are TCs that operate based on standalone PCs with no internet connectivity which is ranked second in terms of popular responses. As part of developing the TC business model described earlier, internet and/or broadband connectivity should be part of the business model for future TCs.

Table VII. Suggestion to encourage community to use TC

Rank	Suggestion
1	Organize workshops and computer classes
2	Provide internet access
3	Give free service and good service
4	Promotion through brochures
5	More campaigns and promotions
6	Improve TC facilities

IV. CONCLUSION

Good and effective strategy, some of which are identified and presented in this paper, is critical to ensure sustainability of the TC in the long run. Findings from this study suggest TC strategy should be formalized in the form of a TC business model. This model can act as a benchmark for quality assurance for TCs to comply. New TCs can use the business model as guidelines to develop strategy for short and long term survival, profitability, user satisfaction, quality of service, and TC sustenance.

Existing TCs should plan for non-financial sponsorship to ensure long-term sustainability. This can be done through public-private partnership by extending existing corporate social responsibility of large corporations or transforming the TC business into a social entrepreneurship. Promotions have also been found to be of paramount important to sustainability of TCs. This study suggests devising creative and innovative ideas to attract usage of the TC. Apart from membership and loyalty schemes, other promotional strategies should be formulated for different target groups and underserved

communities with support from relevant agencies with similar interests and missions to pursue.

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The People Factor in Supporting Sustainability of Telecentres: A Malaysian Perspective

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***Abstract*—Telecentre (TC) sustenance refers to the capability of a particular TC to stand on its own supported by (i) good management and operation, (ii) human resource capacity and capability, (iii) infrastructure and technical support, (iv) processes and standard operating procedures, (v) strategies, (vi) structure, (vii) systems, (viii) shared values, (ix) financing and ownership, and (x) people factors such as human resource capacity and capability. Previous studies have indicated that there are a number of challenges associated with the operations of TCs in Malaysia, which are detrimental to the TCs sustenance. This paper addresses the challenges faced by the non-federal government TCs in rendering their services to the communities. These include the people need such as the expectations of the users and TC operators in encouraging community participation. The main method in collecting data for this study was through two sets of questionnaires, which were distributed to users and TC operators. This study reveals that users and TC operators are vital to the TCs sustenance in realizing the mission and vision of the government in terms of accessibility and connectivity. Continuous effort and support from all stakeholders are necessary for the success of TCs.**

***Index Terms*—Community Participation, Telecentre Service, Telecentre Sustenance.**

I. BACKGROUND

In mid-2000, the eight major industrial nations (the G-8) acknowledged that Information and Communication Technology (ICT) "is one of the most potent forces in shaping the twenty-first century and its revolutionary impact affects the way people live, learn and work, and the way government interacts with civil society" [1]. The G-8 has also indicated that human capacity is one of the areas in harnessing the potential of ICT to accelerate social and economic development in terms of building a critical mass of knowledge workers, increasing technical skills among users and strengthening local entrepreneurial and managerial capabilities [2].

One initiative to stimulate and respond to the public demand for information and communication services is by establishing TC [3]. Basically, TC is a public place that offers connectivity to computers and networks. In Malaysia, the Economics Planning Unit (EPU), one of the unit in the Prime Minister's Department, defines TC as a one-stop centre that provides ICT resources for public access, information dissemination, e-government services, e-banking, and e-health to improve the socio-economic status of targeted local communities [4]. TCs in Malaysia are established under various initiatives and led by different agencies, including: federal government, state government, private sectors and Non-Governmental Organizations (NGOs). Previous studies have indicated a number of challenges associated with the operations of TCs in Malaysia such as lack of promotion, imbalanced categories of users, inappropriate operation hours, inadequate IT training programs, improper physical facilities, and lack of manpower [5]-[8]. These challenges are detrimental to the TCs sustenance.

One of the issues in managing TC is to sustain its operation. TC sustenance refers to the capability of a particular TC to stand on its own supported by a few factors including good management and operation, infrastructure and technical support, processes and standard operating procedures, strategies, structure, systems, shared values, financing and ownership, and people factors such as human resource capacity and capability. The services offered in the TCs must be able to fulfill the expectations from the users and as well as to provide a variety of income-generated activities in order sustain their operations.

This paper addresses the challenges faced by the non-federal government TCs in rendering their services to the communities, and also discusses the people needs such as the expectations of the users and TC operators in encouraging community participation. It starts with the definition of TC, follows with Section II, discussing the methodology adopted in the study. Section III presents the findings and discusses the challenges and expectations from the users' and TC operators' point of view regarding the services rendered by the TCs. Concluding remarks and recommendations are discussed in Section IV.

II. METHODOLOGY

Two sets of questionnaires were used to collect data from TC operators and users. The first set (set A) is used to solicit users' views regarding their demand on TC services. Meanwhile, the second set (set B) is used to solicit TC operators' views on the services demanded by the community. Both sets comprised of the users' and TC profiles, and items related to the demand on the TC services in terms of their frequency of visits and use, membership scheme, the awareness of TCs' existence, and services and training offered, participated and requested.

In Malaysia, there are 1,945 TCs registered with Economics Planning Unit (EPU) of the Prime Minister's Department, which have been established under various initiatives by federal government. In addition, there are also other TCs initiated by state government, private sectors, and NGOs which will be the focus for this paper. These TCs are identified through state government, private sectors, and NGOs which amounting to 132. Since these types of TCs are not directly reported to EPU, the paper intends to report the findings on the above-mentioned aspects.

The data collection sites were divided into four regions: Northern Region (Perlis, Kedah, Penang, Perak), Central Region (Selangor, Wilayah Persekutuan, Negeri Sembilan), Southern Region (Malacca, Johor), and Eastern Region (Kelantan, Terengganu, Pahang). Based on the sampling used, questionnaires were distributed to the TCs' users through mail or hand-delivered while visiting the TCs. Table I shows the distribution of questionnaire according to the regions and method of distributions. Out of the 1,314 questionnaires distributed (Table I) for set A, the response rate is 41.1%, and for set B questionnaires, of the 132 questionnaires distributed the response rate is 46.2%.

Table I: Distribution of TCs and Questionnaire

Region	Total TCs	TCs visited	TCs via mail	Number of Questionnaire Distributed
North	44	4	40	453
Central	33	6	27	311
South	29	9	20	290
East	26	8	18	260
Total	132	27	105	1,314

III. FINDINGS AND DISCUSSIONS

In this study, the TCs that are being assessed consist of those initiated by the local state government, NGOs and private sectors. The number of TCs established by the state government is 77.0%, NGOs is 8.2% and private sectors, 14.8%. More than 50.0% of the non-federal government TCs was established in 2003. In terms of the start-up cost, most of these TCs (42.9%) established beginning 2003 have incurred between RM50,000 to RM100,000. Fifty-six percent (n=50) of the TCs offer membership scheme to attract more users to use the TCs regularly. Majority (72.1%) of the TCs operate between 8.00 am to 7:00 pm. Other TCs operate between 2.00 pm to 10.00 pm (10.0%) and 8.00 am to 10.00 pm (14.8%). Of all the 59 TC operators, 50 of them are being paid to man the TCs. Consequently, the operating hours of some of the TCs are expanded until 12 pm.

A. TCs Services Demand

The demand on TC services from the users' and TC operators' point of view can be described from the following aspects: usage, promotion, and services and training required. As reported by the TC operators, the most frequent users of the TCs are among schools students (85.2%) and they find using TCs can help them in their learning activities. This result also conforms to the purpose of visiting the TCs as indicated by the TC operators, where majority of the users visit TCs to complete their assignments (43.0%). On the other hand, the less frequent (67.2%) visitors are pensioners, housewives, farmers and fishermen. This may due to the fact that they may find there is no urgency to visit the TC frequently.

In terms of the services needed to be offered by the TCs, the study discovers that Internet and computer introductory courses are highly required by the users. This is evident from the high numbers of attendees in the conducted trainings particularly on basic computer/Internet usage. However, the users also stated that they need other services such as photocopying, faxing, printing, and scanning.

As for the facilities, the users are keen if the TCs are also equipped with prayer room, ample parking space, rest-room, air-conditioner, additional computers, and webcam. In addition to the services and facilities needed by the users, they also required advanced trainings on Adobe Photoshop, 3D animation, programming, and webpage development.

B. TCs Existence

Slightly more than 80% of the respondents find out about the TCs through their friends and relatives, 28.9% from the community bulletin board, and others from their workplaces, television, radio and newspaper. The findings indicate that schools have not been utilized to the best possible in promoting the TCs especially when most of the users are among school children. Therefore, schools can be one of the potential channels of promotion, and the teachers should be more proactive in encouraging the students to use the ICT facilities in the TCs. This is tabulated in Table II.

Table II: How does the user know about TCs existence?

Medium of Promotion	Percentage
Friends & relatives	80.9
Community bulletin board	28.9
Newspaper	19.8
Radio	16.5
Workplace	15.5
Television	13.5
Schools	4.7

C. TCs Promotional Activities

In terms of promoting the TCs, the TC operators suggest to carry out more promotional activities to attract more users. The following table (Table III) lists out the activities to attract different segments of users. The finding reveals that most of the TC operators perceived that workshop on introduction to computer and internet is crucial in promoting the TCs. This may eventually boost the number of users visiting the TCs. Other suggestion made by the TC operators is to increase the educational activities conducted in the TCs, such as organizing tuition classes, essay writing and drawing competitions in order to promote the youngsters to come to the TCs. Similarly, for the adults, educational activities such as entrepreneurship courses, religious talks, and handicraft workshops could help them gain socio-economic benefits. Apart from benefiting from those activities, the adults are also being exposed to the TCs environment and services indirectly.

Table III: Promotional Programs at TC for Target Groups

Target Groups	Promotional Programs
Children	▪ Story-telling ▪ Coloring ▪ Edutainment
Teenagers	▪ Workshops ▪ IT Competition ▪ Edutainment
Youth	▪ IT Learning ▪ IT Competition ▪ Edutainment
Senior Citizen	▪ IT talks ▪ References & site visits ▪ Free classes
Women	▪ Workshop – related activities ▪ Reading materials ▪ Free classes
Farmer	▪ Agriculture activities ▪ Entrepreneurship ▪ Reading/ Learning

The findings of this study also indicate that TC operators are facing many challenges in ensuring the best of TC's services to the community. Since the study discovered that most of the frequent users are the youngsters, more concerted effort need to be undertaken to ensure the participation from other segments of community. In view of that, more promotional initiatives need to be carried out not only by the TC operators, but also the other stakeholders. For instance, the school administrators, parents, community leaders, and those who have influences in the community can give support to promote the TCs services to school children, senior citizens and farmers. In addition, varieties of promotion channels, including mainstream communication media needs to be exploited.

The study has also discovered that the services and facilities offered are not up to the users' expectation. This is evidenced from the users' responses in which, more trainings on ICT are requested. In addition, they also insisted that the basic facilities, such as café, restrooms, ample parking space and prayer room are provided or upgraded accordingly.

VI. CONCLUSION AND RECOMMENDATIONS

People factor is of paramount importance in ensuring sustainability of TCs. This study has successfully identified pertinent people-related factors, both from the perspective of users and operators of TCs. Among the factors found in this study were ability to formulate creative promotional programs, membership/loyalty schemes, ability to understand requirements of the different target groups, ability to organize relevant community-based events at the TCs, flexibility in terms of opening hours, value-added services provided by the TCs, environmental conditions, and specific ICT competency programs for career prospects and development.

Obviously, sustaining TCs operation undertakes a continuous effort and support not only from the community, users and TC operators, but also from other stakeholders, such as the federal government, NGOs, state government and private sectors. To cater for the demand from users as well as TC operators, more promotional activities, facilities and short courses are needed to improve the TCs services and therefore increases the number of TCs customers. Ultimately, to ensure long-term sustainability of TCs, strategies need to be formulated to help TC operators plan their short-term and long-term business.

Some recommendations for the TC operators to improve their services would be introducing membership system or loyalty scheme. The membership system would be beneficial for the users as a form of promotion and loyalty scheme which would attract more users to subscribe. In addition, discounts to ex-members for attending advanced courses and services would stimulate more business for TCs. Services offered by TCs could vary and tailored to meet specific community requirements and target groups. TCs should be creative to look for innovative ways to serve the community.

Numerous events such as religious, medical and agriculture advice could be organized for the community in order to attract people to the TCs.

Promotions can also be extended to sponsorship by engaging wealthy individuals and conglomerates in win-win situations. Other people-related factors identified in this study include user preference to use the TCs. TCs with flexible operating hours would appeal to the different target groups as youths and other adults are busy working in the daytime, whilst children and women may have more free time to use the TCs during the day. The study also found people tends to use TCs with value-added services. The idea of a one-stop centre for TCs would benefit the community in the long run, hence would contribute to its success. Environmental factor also plays an important role in supporting sustainability of TCs. This is also related to the people-related factor since a TC which is conducive will create a pleasant atmosphere for users, and this by itself would attract users to patronize the TCs.

Finally, another people-related factor is the public-private partnership programs where TCs could form smart or strategic partnerships with conglomerates and institutions of higher learning as part of the organization's corporate social responsibility and joint certification programs for life-long learning and other skill competency programs. Universities can adopt a TC by organizing events such as bridging the digital divide and other community development programs involving students and lecturers.

In a nutshell, meeting the expectations of the people, particularly users and TC operators are vital to the TCs sustenance. Continuous effort and support from all stakeholders are necessary to ensure the successful of the TCs.

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ON TECHNO-ENTROPY: Considering Socio-Cultural Dimension of the ICT Implementation in Rural Area

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***Abstract*— The synergic relationship between human and technology has been established as old as human civilization. For years, technology helps human in opening possibilities for life explorations towards better future. In fact, the ever-increasing development of technology has consequences to the human's socio-cultural aspects whereas, as Helga Nowotny writes, acceleration in technological development means acceleration in social change. The rapid development of Information and Communication Technology (ICT) with all its intriguing promises has already attracts everyone's attention. Today's implementation of ICT in Indonesia is flourished in almost all regions, including the rural area, under the support of authoritative national ministry. As this ICT implementation offers the alternate ways of working and living in everyday life, it actually creates alternate entropy, a techno-entropy. For those who used to live in urban situation might find ICT as a complementary device. But a different response might come from the rural people. In this case, the ICT will ramify the situations of everyday socio-cultural life of rural people that will eventually put them at the crossroad, heading to prosperity or fatality. This paper will emphasize in the topic of ICT in everyday life, including the logic of ICT development, and its potential implication to everyday socio-cultural situation. The potential contribution of this paper will be a socio-cultural perspective which could be considered during the real implementation of ICT in rural area.**

***Index Terms*—Technoculture, Globalization of the Self, Rural Mentality, Techno-Entropy, Techno-Rural**

I. INTRODUCTION

The implementation of technology in the people's everyday life opens the possibility in forming a life-pattern that is different from what people have been experienced before. It is because the technology presents as a human extension or prosthesis. As prosthesis, technology requires a translatability effort from people before creating a synergic cooperation with various kinds of technologies. In this sense, ICT also requires the same translatability effort form the prospective users. In fact, the ICT, in several cases, contributes in ramifying some patterns in the people's everyday situation. In short, it creates an entropy.

The presence of entropy in the whole life is inevitable. In fact, entropy exists in almost all aspects in everyday life. In the study of complexity and/or chaos theory, entropy becomes one significant factor. A scholar namely Boltzmann sees the entropy as the increase of randomness [1]. However, this randomness and the presence of entropy are not in the negative interpretation only (although there is a paradigm on negative entropy). The existence of these concerns is actually a potency in human adaptation. Kordeš [2] argues that the entropy is obviously needed for human to survive in life.

This paper tries to explore the socio-cultural paradigm that is potentially emerged from the ICT implementation in the rural area.

II. ICT AND EVERYDAY LIFE

In contemporary society, ICT has been accepted widely regardless to age, social stratification, economic status, level of education, or job education. However, this situation does not prove that accepting the ICT is already free from obstacles. People still need to pay more attention on what could be happened next after they intensively use such technology in everyday life. In fact, there should be notes that can be used as a reflective field in thinking on people's relationship with everyday technology, such as ICT.

A. Technoculture

In general term, technoculture is a paradigm of culture that is formed from the intervention of technology in human life. This intervention eventually produces some life-patterns in the everyday life culture that are compiled together with the existing culture. Technoculture is not a new subject. In fact, the technocultural issue is already existed since the prehistoric time, especially when the people begin to think that they need some tools to survive and to respond their surrounding environment. In the modern time, innovations and inventions play an important role in producing a different life experience and some changes in the mechanism of life. A telegraph, for

example, changes the way of communication and releases the interdependency with the pony express. The invention of automobile by Henry Ford replaced the people's interdependency with a horse-powered carriage. What these two examples offer to the people is the alternative mechanism of life. In this case, people obtain a new layer of experience, especially experience of space, distance, and time. Therefore, the value of either innovations or inventions is on its ability in producing a consciousness relativity; a situation that will in turn give the people to determine the context of reality –including the selection of appropriate technology– that s/he would like to live in.

In the era of information and communication like today, ICT becomes the motive of the emergence of contemporary technoculture. Lelia Green [3] notes that the variant of technoculture arises from the intensive usage of information technology by which the perception of space and time is changed. It can be seen that this notion applies in the last two decades when the information and communication are negotiated and exchanged in the accessible networked world. In this sense, the connectivity and accessibility begin to be the most influential aspect in the everyday life experience.

B. Globalizing Self

In general situation, the emergence of globalization is actually driven by the economical interest. Thomas L. Friedman [4] notes that the world has gone towards globalization in three phases/versions: globalization 1.0, globalization 2.0, and globalization 3.0. Globalization 1.0 was motorized and marked by the expansion of the states. Meanwhile, globalization 2.0 was motorized and marked by the expansion of companies or corporations. And the globalization 3.0 was motorized and marked by the expansion of individuals. Interestingly, this situation shows that in the movement of each phase/version of this globalization, the amount of agent that may participate in the globalization process is lesser, and the characteristic of globalization becomes more personal. This might produce the paradox of the globalization itself. In this sense, the contemporary people who want to globalize theirselves would not need a reputation of a company or a state. The ability and the opportunity in establishing a connectivity and in creating an accesibility become the important key. Friedman adds that there is a convergency behind this situation.

In a broad interpretation, this Friedmans's convergency is made up from three factors, which are: the convergeny of hardware/software, horizontalization, and accessibility. The hardware/software becomes the agent of convergency in the context that the current technology, say computer, performs the ability in multi-tasking. Computer can perform not only as the task accomplisher, but can also perform as an entertainment media, or social media. The horizontalization, as the second factor, appears to be a paradigm shift in the context that the vertical order or top-down system might be irrelevant in the current peer-to-peer situation. In several companies, for example, each division may hold an authority in pursuing a peer-to-peer cooperation with any division that is located anywhere in the world, without a strict and continuos bureaucratic coordination to the upper level/division. Accessibility, as the third factor, completed the previous two factors in creating a flat-world. Here, accessibility is interpreted as the opportunity by which everyone in this world can explore the world without any significant obstacle and without a particular consideration to the limitation of physical boundary.

Hence, the paradigm shift emerges from the globalization progress is also in the context of the orientation of spatial occupation. At the first and second globalization, people tends to occupy the physical space in a physical reality. By the development of ICT from which a virtual reality can potentially be constructed, the globalization will no longer need the physical space/reality as a strict constraint. An individual may also globalize him/herself by using a virtual space/reality to establish an existence in a networked world.

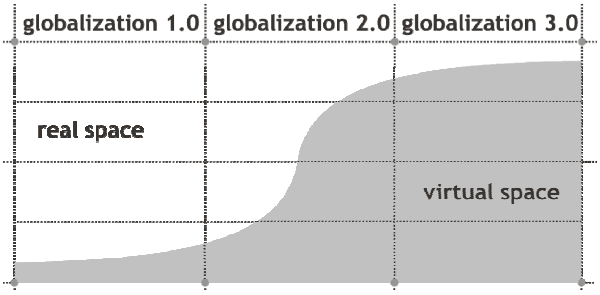

Fig. 1: Globalizations and the Space Occupation (Source: Author's Interpretation)

As shown in fig.1, the ICT development provides an opportunity in establishing a connectivity that will release the users from the bound of physical reality and will enable them to explore some relatively new realities. What is happened here is the globalization of the self. Infromation technology is a technology of the mind and allows the transmission of aspects of the essential self [5]. In this sense, the ICT has been enabling its users to release their mind from the physical body and explore the whole networked world through the connectivity and accessibility of information.

In accordance to this situation, Paul Virilio gives note on disappearance: the earth (deterritorialization), the body (disembodiment), and architecture (deconstruction - in the literal sense of the word, not the architectural style) [6]. In this sense, the everyday situation of contemporary technoculture would be on the mobility of mind. ICT brings the dimensions of cognitive ramification to the society; a dialectic of reality and virtuality.

III. SITUATING THE RURAL

"...massive development has resulted in the concentration of 'new rich' in Jakarta and its surrounding areas ...On the other hand, a larger proportion of poor people living in remote rural areas ... mainly earn their living from traditional sectors and are barely able to support themselves." [7]

Most common problem in rural area lies on its diametrical situation with the urban or capital area; a dialectic of the undeveloped with the developed area. What depicts in the first cited paragraph from economist Dorojatun Koentjarajakti might only be a generalization of the actual situation in rural area. Although there is a potency towards a problematic perspective in seeing the rural area, this notion, however, can be an entry point towards a better understanding of the real reality that this country is dealing with.

From this paragraph we can obtain two key points: tradition(al) and poor. These words are actually intertwined in some context. In this paper, the context of mindset or cognitive will be the focus. Tradition deals with the mechanism on how people live. Tradition inherits a idiosyncratic cultural pattern from generation to generation. Traditional society produces both material and immaterial culture to preserve its existence and to keep its harmonious relationship with environment. The traditional mindset will generally be in the perspective that people are part of this universal system. In this sense, people are eager to pay more respect to its natural surrounding by treating it as appropriately as possible, and the traditional culture becomes the manifestation of such mentality. Moreover, based on the idiosyncratic mentality, each traditional society has some identical cultural pattern. That is why some traditional societies are closing their selves from the outer world to prevent a fundamental contamination on its ideological dimension.

Meanwhile, the poor reflects the situation of the competency in economic capital. In general, this situation is reflected through the reality that there is a different quantity of earning among society. Hence, the economic capital may also determine the possibility in obtaining access to everyday objects and facilities. Opportunity in education, for instance. Although there is a free-school program from the central government, it still does not automatically change the poor situation better. Lower income may affect the ability in accessing a better education. Then, this inaccessibility to better education may affect the sensitivity of life; the ability to develop a critical thinking in the everyday situation.

This is actually the problematic perspective in the previous notion from the well-known Indonesian economist. It seems that traditional is equal with the poor in the context of economical earnings. The text connotes that the traditional situation makes the society cannot obtain what they need. In fact, the tradition(al) and poor are different in several aspects. If a traditional society is considered poor, from the perspective of a wealth urban society, it is because they probably have rules to obey. They do not actually forbidding the member of society from being rich, but they are frequently stepped aside from this mundane situation to preserve the hereditary mentality. For them, it is not about how to enjoy a life, but it is more about how to value the life. Meanwhile, the poor is more to the economical paradigm. There is nothing to do with an ancestral hereditary. In this case, due to the different context of mentality, the origins of mentality should also be carefully investigated. Misapprehension may imperil the context of mentality and its origins.

In this paper context, the dialogue between tradition(al) and poor will end up at mentality; the mentality that determines the capacity in responding to the ever-changing world. Moreover, this mentality is also determining the capacity in translating a technology into everyday life situation.

III. TECHNO-ENTROPY

Entropy may present as a necessity towards life survival and adaptation process. In this case, technology brings its own complexity that in turn will be a techno-entropy for the people; an entropy that driven by the presence and intensive use of technology.

Accessing the technology will not only deal with the physical dimension of the technology, but also the content inside the technology. Therefore, there are two dimensions of accessing technology: technological access and content access [8]. Technological access addresses hardware and infrastructure considerations, whereas content access concerns the motivation to use information technology and the ability to process meaning once the user is connected to a communication system. Technological access has two dimensions which are the physical access and the system access. Similarly, the content access has also two dimensions of cognitive access and social access. In other hand, in the twenty-first century, civilized urbanity will grounded upon the flow of information, electronic connectivity, and intelligent management [9].

Here, it can be summarized that accessing the ICT is not only in the meaning of accessing the infrastructures of this technology, but also the infrastructure of the user; the cognitive and social dimensions or the mentality. In this sense, the flow of information, the electronic connectivity, and the intelligent management (or, in the author's perspective, the intelligent working process) should be seen as the process of creating a complexity where a new paradigm in life is overlapped the existing one. In short, it is a process towards an ambiguous reality.

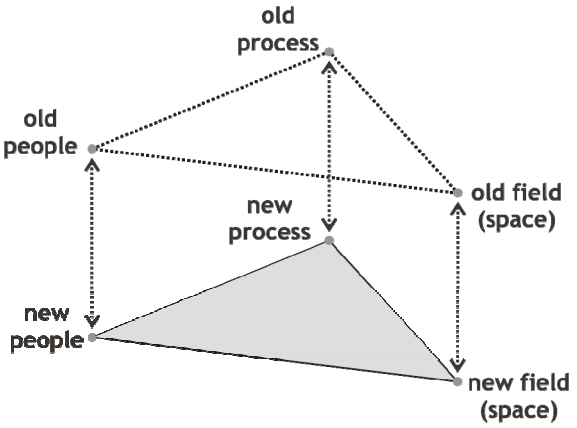

Fig. 2: Overlapped Complexity in Technocultural Society (Source: Author's Interpretation)

Fig. 2 depicts the complexity in the technocultural society. Through the use of ICT, People who have an existing real body, occupy the real field or space, and undertake a real (working) process will experience a different dimension of life experience as they will have a "new" body, space, and process as well. This "newness" is not embodying in the state of physical realm, but in the state of non-physical realm; it embodies in the mind or cognitive dimension. Moreover, the realm ICT seems to emphasize what Bruce Sterling mean with "The Line of Empire" [10]. In a broad sense, "The Line of Empire" is a "boundary" that is created by the technology. It is a sort of a techno-standardized realm that can only be entered by those who possess some standard capacities "demanded" by technology itself.

A. Imagining the Techno-Rural

Different situation produces different mentality. The mixture of one situation, as well as its embedded mentality, with another may create entropy. For the rural people, any developmental program that addressed to the rural area may create entropy to their mentality. In this case, implementing a technology, such as ICT, in rural area increases a complexity to the native inhabitants. Rural people are facing the technocultural paradigm that would potentially shift the everyday mentality to a strange one and they would have to experience the ambiguous reality as depicted in fig. 2.

This ambiguity of reality is caused by the presence of the virtual reality, or cyberspace. For the rural people who still hold the traditional life, this cyberspace may jeopardize their existence. Moreover, Ziaudian Sardar sees that the existence of *cyberspace* is intended to the erasure of all non-western histories [11]. In this case, the authenticity, identity, or even, in the larger context, the whole form of eastern culture may be in danger. If this happens, techno-rural will have the same meaning with "no more rural".

In the other hand, the ambiguity of reality may also raise from the affordability of ICT infrastructure. Most technology implementations have put affordability into primary consideration. However, the impact of this affordability to the overall mechanism of people socio-cultural life may frequently be overlooked.

IV. CONCLUSION

ICT implementation in the rural area offers some opportunity, especially in creating an equal quality of life. However, such technology implementation program should also be accompanied by an appropriate understanding in the overall situation of the intended area, especially the socio-cultural dimension of local people as potential users. Creating a techno-rural might be a good starting point in leveraging a national techno-literacy. In fact, at the same time, it also withdraws the rural people from its own reality and shifting the existing socio-cultural paradigm. Therefore, a thorough investigation on rural area, especially the socio-cultural dimension, should be undertaken towards successful implementation of any technology, including ICT. It should be a consideration on rural people's translatability of technology. It is human that determines the life, not the technology.

V. ACKNOWLEDGMENT

This paper is a part of the research-in-progress towards doctoral degree which is focused on embodied space in technocultural society.

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Factors that Influence Ethical Behavior of Cyber Cafe User Based on The Theory of Planned Behavior

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***Abstract*—This paper attempts to report on a recent study in investigating the ethical use of Information and Communication Technology (ICT) services at cyber cafe in Malaysia. It aims to identify the factors that could have influenced ethical behavior of cyber cafe users based on Theory of Planned Behavior (TPB). TPB is known for three factors namely (i) attitude, (ii) subjective norms, and (iii) perceived behavioral control. This paper also reports the intention of the study to enhance the theory by adding another variable namely an external factor. The external factor comprises of environment, layout and location of the cyber café. A survey was conducted and the data were analyzed using SPSS. Out of six hundred and fifty (650) questionnaires distributed to cyber café users, four hundred (400) responses were received which represent 61.5% returns. The result shows that all the factors; (i) attitude, (ii) subjective norms, (iii) perceived behavioral control and (iv) external factor have a strong relationships with the behavioral intention towards the usage of ICT services at cyber café. The correlation shows that attitude, subjective norms and external factor are significant at 0.01 levels except for perceived behavioral control whereby some of the items are not significant.**

***Index Terms*—Bridging digital divide, public internet access center free from unethical activities, conducive environment and atmosphere, TPB**

I. INTRODUCTION

During 1990s, the Government of Malaysia starts encourage cyber café business with an objective to provide computer-related services to the community. The Companies Commission of Malaysia (SSM) defines cyber café as a type of business that offers computer related services and internet connections. In general, cyber café is operated by private individual and open to public with a certain amount of fee [1].The impact of ICT development can be witnessed through the increasing number of cyber cafes in Malaysia. As of July 2007, there are 3161 cyber cafes in the country [2]. They can be found in many locations not only in a city center, but also in rural towns. Table I presents the total number of cyber café in each state in Malaysia by 2007.

'POEM' is the first cyber café in Malaysia which is located in Bangsar Baru, Kuala Lumpur. 'POEM' began its operation in October 1995. Another popular cyber café at that time was CYBERJACKS, a network of cyber café which operated in two states namely Penang at Bukit Jambul, and Selangor at Subang Jaya [3]. Most of cyber cafés open from 9.00 am to 12.00 pm every day.

Table I: The Number of Cyber cafe in Malaysia

State	Number
Perak	214
Selangor	991
Pahang	145
Kelantan	169
Johor	270
Kedah	141
Labuan	13
Melaka	185
Negeri Sembilan	171
Pulau Pinang	217
Perlis	15
Terengganu	94
Kuala Lumpur	528
Sabah	4
Sarawak	4

Source: SSM, 2007

The Malaysian government has shown its commitment in the use of ICT for national development and moving towards a knowledge-based society. In this sense, cyber café plays an important role in promoting ICT usage and bridge the digital divide among the community. [4] indicates that the numerous cyber café in the developing country is a testament to the fact that private sector plays an important role in bridging the digital divide. This is further supported by [5] who points out that Internet connection in public places such as cyber café were often proffered as an answer to the digital divide, and [6] who indicates that cyber café can act as a public tool for enhancing ICT usage.

Despite the benefit it brings in terms of promoting ICT usage, there is a gap in the ethical aspects of ICT usage that people often neglected. Unguided and uncontrolled usage cyber café may lead to misuse of technology [7]. As the ethical issue regarding the use of cyber cafe came to light in Malaysia and became a national issue recently [8]-[12], this aspect should be given high priority.

Among the ethical issues on cyber café are the misuse

of cyber cafe among children, in which they use the cyber café as a place to loiter and hence wasting their time [13]. [14] reported that illegal on-line gambling at cyber cafe has become more serious. Apart from that, unrestricted access of internet at cyber cafe exposes the user to access inappropriate materials such as pornographic images.

This paper attempts to report on a recent study in investigating the ethical use of Information and Communication Technology (ICT) services at cyber cafe in Malaysia. It aims to identify the factors that could have influence ethical behavior of cyber cafe users using a social cognition model known as Theory of Planned Behavior (TPB).

II. THEORY OF PLANNED BEHAVIOR (TPB)

The study will be based on a social psychology theory known as Theory of Planned Behavior (TPB). The theory constitutes a promising framework for understanding and predicting behavior. It was earlier proposed by Icek Ajzen in 1991. TPB is an extension of the earlier Theory of Reasoned Action (TRA) [15] and has been successfully applied in ethical situation involving academic dishonesty [16], IT ethics [17] and computer ethics [18]. The theory could also be appropriate for investigating a wider range of ethical decisions related to ethical computer usage [19].

Figure 1 depicts the composition of the TPB: (i) a dependent factor, the Behavioral Intention, and (ii) three independents factors namely the Attitude, Subjective Norms and Perceived Behavior Control. TPB posits that individual behavior is driven by behavioral intentions. Behavioral intentions are affected by either attitude, subjective norms and perceived behavioral control or all of them. Perceived behavioral control may influence behavior directly.

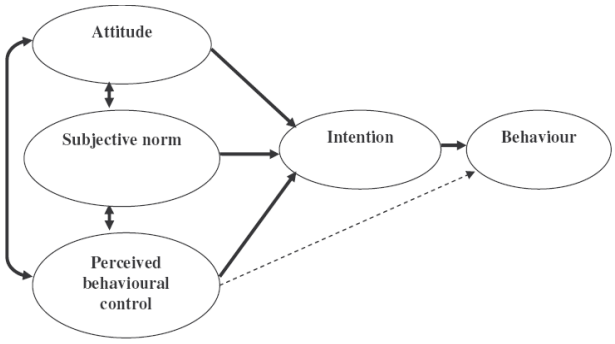

Fig. 1: Theory of Planned Behavior [15]

Behavioral intentions refer to the subjective probability of individual's engagement in any behavior [20]. The stronger the behavioral intention, the more likely the execution of the behavior. As the relationship between behavioral intention and the execution of the behavior is so strong, researchers often replace actual behavior measurement with behavioral intention when studying individual behavior with TPB [15]. Attitude toward the behavior is defined as the individual's positive or negative feelings about performing a behavior. Subjective norm is defined as an individual's perception of whether people important to the individual think the behavior should be performed. Behavioral control is defined as one's perceptions of the difficulty of performing a behavior.

Despite the success of the core components of the theory in predicting behavioral intention and subsequent behaviors, it has been recommended that TPB is expanded by including other variables. All the three independent variables in TPB are referred as internal variables.

There is a possibility to consider and add some external variables such as environment, social organization, situational variable, task characteristic and punishment [21], [20]. This is consistent with the several ethical decisions making model such as Trevino model which suggests that a person's decision to act ethically or unethically is determined by environmental characteristics [22]. Other research has also recognized that ethical and unethical behavior is heavily influenced by characteristic of the social organization [23]. According to [24], social organization surrounding the cyber cafe may influence the operation of the cyber café. The study shows that cyber cafe which is located at rural area tend to follow the rules better than cyber cafe which is located at urban area.

III. RESEARCH MODEL

This section describes the details of each variable used in the study.

A. The Dependent Variable

Behavioral intention is the dependent variable in the model. Behavioral intention is defined as an individual's subjective probability that he or she will engage in behavior. The stronger the intent to perform a behavior, the greater is the likelihood that an individual will engage in that behavior. An intention indicates how hard a person is willing to try, and how much of an effort he or she plans to exert in order to perform the behavior. An individual would behave in accordance with his or her intention [15]. In the context of activities at cyber café, if a person intends to perform unethical activity, he or she is likely to carry out the actual unethical behavior. In this study behavioral intention is operational as the opportunities to perform the activities.

B. The Independent Variables

There are four independent variables namely attitude, subjective norm, perceived behavioral control and external factor. Attitude refers to the degree of a person's general feeling about performing a behavior, whether

favorable or unfavorable. Such feeling can be in the form of exhilarating, experience, rights of an individual and feeling of impersonation. This feeling is in line with the suggestion given by Leonard who mentions that attitudes consist of several values such as personal value, experience, moral obligations and believe system [17]. In the context of unethical activity at cyber café, if a person view performing unethical activity is wrong he or she is unlikely to perform the unethical behavior. Ethical computing research has shown attitudes to be important predictors of individuals' ethical computing behaviors [20].

Subjective norm refers to the perceived social pressure to perform or not to perform the behavior. In other word, subjective norm is an individual's perception of whether people important to individual think the behavior that an individual has to comply with the wishes of that referent. In this study the perceived social pressure came from peers, parents, close friends as well as teachers. This is based on a research conducted by [25] that suggests the pressure groups that may affect behavior intention of a person are supervisor, group leader, colleague and peer.

Perceived behavioral control refers to the individual's belief in the ease to execute a behavior. Perceived behavioral control means an expectation of the individual about conditions (e.g. time, money, prices) which ease or constrain the actual behavior [20]. However from our observations, in the context of ethical activity at cyber café, the control factor can be external (e.g CC TV, rules and regulation) and internal (e.g. religious believe, cultural believe) to an individual.

External factor refers to environment, social organization, situational variable and task characteristic that may influence behavioral intention to perform the actual behavior. [22] in his Ethical Decision Making Model suggests that a person's ethical decision making is determined by environment characteristic.

Fig. 2 provides the schematic view that includes all the variables in the above description.

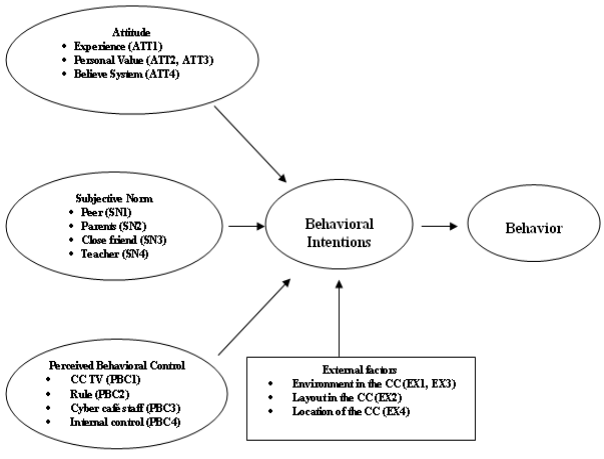

Fig. 2: The schematic diagram

IV. RESEARCH METHODS

A. Questionnaire development

At early stage of the study an initial survey was conducted to define the unethical activities at cyber café. The result is then used to generate the questionnaire to identify the activities at cyber café and to examine the factors that influence an individual to perform unethical activities at cyber café. The first part of questionnaire asks for demography of respondent, the second part is about cyber café usage and the last part is to predict their behavioral intention while using ICT services at cyber café.

B. Reliability of Questionnaire

The alpha values were calculated to assess the internal consistency reliabilities of the scales. The reliability of a measure indicates the extent to which the measure is without bias (error free) and hence offers consistent measurement across time and across the various items in the instrument [26]. It also indicates the stability and consistency with which the instrument measures the concept and helps to assess the "goodness" of a measure. A good research instrument has alpha value above 0.8, but for preliminary version of a research instrument, the alpha value above 0.6 is accepted [27]. The reliability result for the questionnaire used in the study is shown in the Table II.

Table II. Reliability of instrument

Variable	Cronbach Alpha
Attitude	0.73
Subjective Norms	0.71
Perceived Behavioral Control	0.78
External factors	0.60
Behavioral Intention	0.74

C. Data Collection Method

A survey was conducted on cyber café users in Alor Star and Jitra., Kedah. The normality test was conducted to show the homogeneity of the sample. The skewness and kurtosis for this sample is 0.164 and 0.178 respectively. A statistical rule of thumb says that a variable is reasonably close to normal if its skewness and kurtosis have values between -1.0 and 1.0 [28]. Therefore the sample for this study can be assumed as homogenous. Six hundred and fifty (650) questionnaires were distributed and 400 (61.5%) responses were received. The respondents are users of cyber cafés located in Alor Star and Jitra, Kedah.

V. RESULT AND FINDINGS

A. Demography

More than half of the respondents (53.3%) are female. Based on the age group, 66.8% of the users are between 15 to 24 years old which comprised the largest age group. The second largest group is school children below the age of 14 (27.4%). Only 5.8% of the respondents are above 24 years old. In terms of the highest level of education, 42.2% of respondents are SPM/STAM holders while 21.4% have UPSR qualification. Only 12.2% have diploma, 6.6% have degree and 1.0% are post graduate students. The responses show that 43.9% are currently studying at diploma level, 26.4% are still at primary school, and 14.4% are at secondary school. In general, about 91.7% of the respondents are still studying at different levels including primary and secondary schools, whereas only 8.0% is already working. In terms of marital status, only 2.8% of the respondents are married.

B. The Data Analysis

A regression analysis was used to estimate the value of a dependent variable on the basis of the independent variables**.** Table III depicts the model for the study. R is a measure of correlation between the observed value and the predicted value of the dependent variable. R square (R^2) is the square of this measure of correlation and indicates the proportion of the variance in the dependent variable which accounted for by the model. However, R square tends to somewhat over estimate the success of the model when applied to real world. So an adjusted R square value is calculated which takes into account the number of variables in the model and the number of observation (sample/ participants) of the model [29]. Thus, an adjusted R square value gives the most useful measure of the success of the model. The model (Table III) shows that all four (4) independent variables together account for 47.2% of the variance in behavioral intention.

Table III: The Regression Model

Model	R	R Square	Adjusted R Square	Stnd. Error of the Estimate
1	0.703[2]	0.494	0.472	0.60915

The Table IV shows the result for the regression coefficients. The beta value is a measure of how strong each independent variable influences the dependent variable. The higher the beta value the greater the impact of the independent variable on the dependent variable. The beta regression coefficient is computed to make comparison and to assess the strength of the relationship between each independent variable [29].

Refer to the regression model, seven (7) independent variables are significant ($p<0.05$). The result shows that, perception of peers (beta= 0.242) is the most important factor that influence the cyber café users to perform their behavioral intention.

Table IV: Correlation coefficients

Independent variable	Operational item	Beta	Sig.
Attitude	Experience	0.084	0.056
	Personal value	0.167	0.000
	Personal value	0.051	0.270
	Believe system	0.022	0.635
Subjective Norms	Peer	0.242	0.000
	Parents	0.051	0.225
	Close friend	0.241	0.000
	Teacher	0.114	0.009
Perceived Behavioral Control	CC TV	0.078	0.051
	Rule	0.001	0.926
	Cyber café staff	0.024	0.563
	Internal control	0.033	0.425
External Factor	Environment in the CC	0.081	0.045
	Layout in the CC	0.074	0.121
	Environment in the CC	0.034	0.387
	Location of the CC	0.002	0.969

VI. DISCUSSION

The result shows that out of 16 factors that have been examined, seven (7) factors have shown significant influence on the behavioral intention of the cyber café users. The factors are the perceptions of their peers, perceptions of one's close individuals, personal value in terms of rights of individuals, perceptions of teacher, experience of an individual, environment in the cyber café and external control using CC TV. However, experiences of an individual and external control using CC TV are were found to be slightly significant as the *p* values are 0.056 and 0.052 respectively.

The result reveals that three out of 16 factors (42.8%) represent subjective norm, two (28.6%) from attitude, and one (14.3%) from perceived behavioral control and external factor respectively. The result demonstrates that perceived social pressure from people who have closed relationship with cyber café users user such as peers, close friends and teachers may influence their behavioral intention. This is in line with [30] who suggests that social relationship or social pressure may help to shape an individual's behavior. The finding reveals that attitude is the second important factor that may contribute to the behavioral intention of cyber café. This result is in line with [34] that mention attitudes are recognized as one of the major factors that guide human behavior.

Generally, three (3) factors in perceived behavioral control and external factor are not significant as the *p* value is larger than 0.05. It shows that control through rules, monitoring by cyber café staff, reminder by religious teacher, noisy environment in the cyber cafe, the layout of the cyber café, and location of the cyber café

have no effect on the behavioral intention. The *p* value for perceived behavioral control through rules and regulation is the highest. This could be due to the lack of enforcement of the rules. Rules without enforcement are not effective. Even though there are rules and regulations regarding ICT usage at cyber cafe, the implementation and enforcement of the rules is also important to prevent unethical activities. Another factor that is found to be not significant is perceived behavioral control through monitoring by cyber café staff. User may have a feeling that cyber café staff are like their friends, thus they feel they can do anything without worry. Moreover, from the observation, most of the cyber café staff is very young. Internal control such as reminder or advice from religious teacher had been found to be not significant. Perhaps religious teachers do not really emphasize on ethical usage of ICT services while giving advice at schools, mosque or other places.

Finally, the location of cyber café also does not influence the behavioral intention of cyber café users. This shows that cyber café located at rural area may have the same influence on CC as those located at urban area.

VII. CONCLUSION

The result of the study shows that the perceptions of their peers, perceptions of close individuals, personal value in terms of rights of individuals, perceptions of teacher, experience of an individual, environment in the cyber café and external control using CC TV influence influences on the behavioral intention of cyber café users. Friends or peers of cyber café user may encourage them to perform the activity at cyber café. [31] in her paper reports that friends and peers do influence one another's behavior at least for some degree or for some people. In order to encourage cyber café user to behave ethically while using ICT services at cyber café, the people close to the user such as their peers, parents and teacher plays an important role. Besides friends and peers, parents also play an important role in influencing an individual behavior. This is in line with [32] who suggests that children and teenagers consider their parents as being a source of orientation and compelling them to follow their directions. Parents should always remind their children to perform ethical activities at cyber café.

[33] in his paper mentions that personal experiences significantly influence behavior over time. Positive experience of cyber café user in using ICT services at cyber café may influence them to use ICT services ethically. Therefore, cyber café operators must encourage positive experience among the users.

Hence, with regards to the influence of performing ethical behavior, the most important factors that influent the user behavior are the subjective norms, and attitudes. In principal, it has been found that for the subjective norms the most influencing individuals are peers, close friends, and teachers. For the attitudes, individual experience and rights of an individual have been identified to be important.

In conclusion, the aim of the study, that is, to identify factors that influence ethical behavior of users of cyber café have been successfully met. Based on the findings, there is evidence to suggest that attitude of users, particularly users' experience and personal values, subjective norms in the form of peers, close associates and teachers, perceived behavioral control in the form of CCTV, and cyber café environment that make up the external factor, are factors identified in this study to influence ethical use of the cyber café. Future implementation of cyber café may want to consider other forms of innovative ideas to manage and control the attitudes of users, particularly with the advent of ICT and incorporating elements of intelligence and analytical processing that would help operators and other relevant authorities to quickly and swiftly contained and eliminate unethical activities. Likewise, community can also play a vital role in eradicating unethical usage by being vigilant and act as watchdogs on behalf of the community. Operators can also play their part by creating conducive environment and atmosphere for learning, working and edutainment, apart from providing adequate facilities that would make patronizing cyber café an enjoyable and professionally managed public access internet centre free from unethical activities.

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Operability and Reliability Success Factors of Rural Telecommunication Sets

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***Abstract*—Telecommunication in Indonesia brings important mission to increase society life-quality and prosperity. Government, with other parties (i.e.: education institutions, industries, etc.) endorsement, pitches in distribute evenly telecommunication's extent until reach rural areas. With existing references, such as success stories of Village Phone implementation at Bangladesh and its replication at Uganda, Indonesian researcher started to implement Village Phone Operator. Case study is carried out at the village Cinta Mekar – Subang (West Java) to support Indonesian Government program in providing IT and Telecommunication services at affordable cost. Surmountable geographical and devices problems are not guarantee yet this replication can reach optimal operability and reliability of used devices. As we had known, if the best performance of each device can be reached, best advantages are expected for society of the targeted Village Phone replication. Eventually, there are other factors was considered as operability and reliability success factors in this replication case, so that all related devices can reach their best performance when they used. Those factors are divided into three layers i.e.: Device (means hardware and software), Management (means standard operating procedure(s) of each device, maintenance procedure, etc.), and Sustainability (means "can we get proportional value of each used-device?"). During research and replication process, four factors were discovered as operability and reliability success factors of telecommunication set that used in village phone replication. Those factors are telecommunication set reliability, telecommunication set sufficiency, Village Phone business model, and Village Phone operator organization.**

***Index Terms*—operability, reliability, village phone, rural telecommunication**

I. PREFACE

Device is reliable when it has passed several examinations and measurement in definite usage-times at definite user's segments. Recommendations from any user who already have experience(s) with intentional device would be indicator(s) for new-user to choose appropriate device that will accomplish their need(s). So that, designate-consumer will put high expectation directly to that device and forgetting even there are others factors that involve peak-performance reached.

There are three remarkable factors to guarantee operability and reliability of telecommunication device(s), i.e. sustainability, management, and device itself.

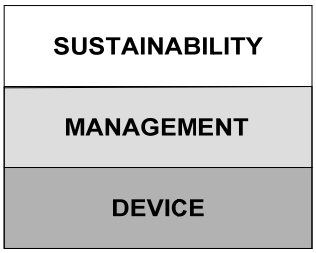

Fig. 1. Operability and reliability success factors of telecommunication set layer

A. Device

Any device – that will use for – implicitly must have high reliability. It means to minimize device failure when it operates. Device here means hardware and software.

B. Management

Manageable things at this layer are supporting operational procedures for telecommunication sets and related human resources.

Why are those things important to manage? Because reliable telecommunication device may loss its value faster than supposed reliable-age if it's not supported by good operational procedures and it's not operated by qualified person.

C. Sustainability

Big question at this layer are

1. Is it possible for that management system to produce comparable value with maintenance that has done? Assumption:
   - Reliable device has supported by appropriate procedures & persons in management system).
   - Maintenance here means device maintenance & management system maintenance.
2. What should management system do to reach comparable value?

II. VILLAGE PHONE DEVICES

A. *Village Phone Architecture*

Village Phone replication has been done since 2005 at Punclut.

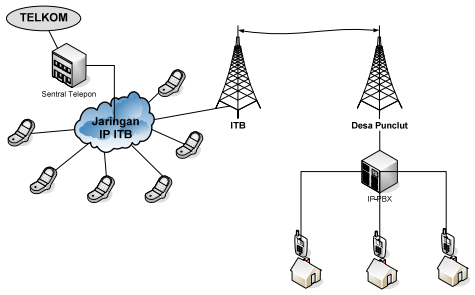

Fig. 2. Village phone replication at Punclut

Based-on examination result of Punclut replication (operational time = 24/7) two models are derived as Village Phone Architecture for next replication (figure 3 & 4).

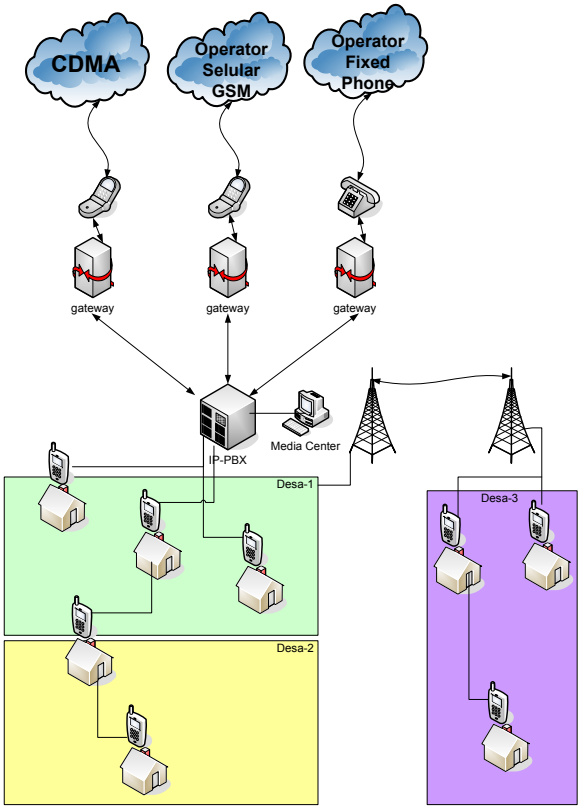

Fig. 3. Village phone architecture (model-1)

First model (figure 3) can be used if signal condition from each CDMA and GSM operator is good, or (minimal requirement) there is one operator that give good signal.

For no-good or totally-no-good signal condition from any operator (CDMA and/or GSM), Village Phone replication can use second model (figure 4).

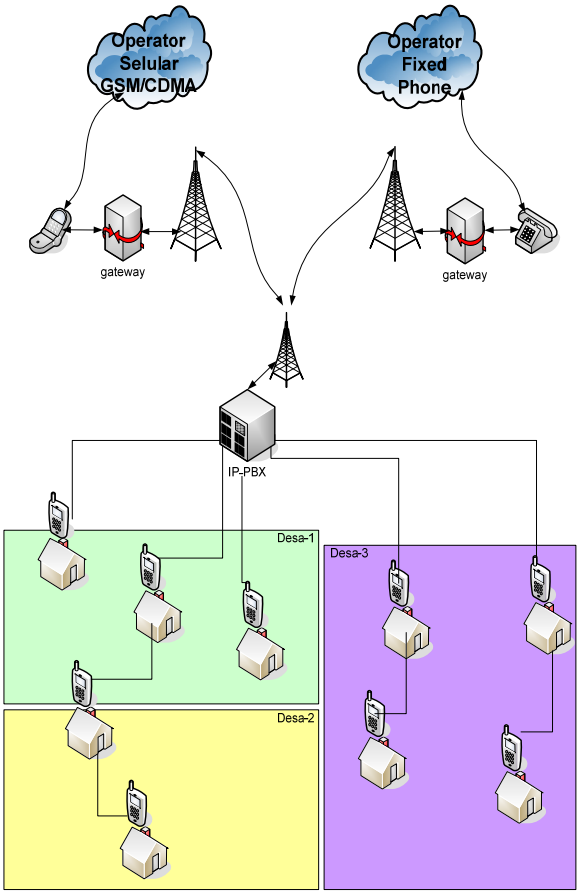

Fig. 4. Village phone architecture (model-2)

B. *Case Study: Village Phone Replication at CintaMekar – Subang*

Now on, Village Phone Replication is implementing at Cinta Mekar, Subang, Jawa Barat as the second pilot-project after Punclut.

Almost all folk at this village have occupation as farmer and entrepreneur. Beside farming and entrepreneurship, some folk have occupation at non-rural area around CintaMekar as officer or (company) employee. There are various education background in CintaMekar.

Solve any internal and external communication problems is not the only one expectation for success-replication at this village. Success-replication is expected to increase CintaMekar economics value, where increasing economics value will give good impact for education and health, too.

C. *Supporting Device*

Devices that used in Village Phone replication at CintaMekar are IP-PBX, IP-Phone, and GSM Gateway considering economic and ergonomic factor.

Fig. 5. Supporting device of village phone replication

IP-PBX

IP-PBX is communication device based-on Internet Protocol (IP) technology that has functions i.e. connecting, controlling, translating communication protocol, translating communication media or transcoding, and controlling IP Telephony devices (i.e. VoIP gateway, access gateway, trunk gateway).

NGN (Next Generation Network) concept at IP-PBX can integrate conventional telephone network (PSTN/POTS), mobile phone network (CDMA/GSM), satellite telephone network, cordless network (DECT) and based-on-package network (IP/ATM).

IP-PBX, with its multi-service capability, potentially give many communication service at IP network such as Voicemail & Voice Conference, Interactive Voice Response (IVR), Automatic Call Distribution (ACD), Computer Telephony Integration (CTI), Unified Messaging System (UMS), Fax Server & Fax on Demand, Call Recording System, Billing System, serta Web-based Management System.

GSM Gateway

GSM Gateway (also known as GSM Router, Fixed Cellular Terminal, Fixed Wireless Terminal, Cellular-Gateway) is a device enabling a GSM SIM card to be utilized from a fixed line handset as though it was calling from the GSM Mobile telephone/Cellular Telephone.

When using a fixed handset with a GSM gateway, users make and receive calls, from the fixed line handset, through a Mobile/Cellular Network.

The GSM gateway can be connected to a PBX system; so all calls into cellular networks will be routed via the gateway instead of via the PSTN. That's the reason why GSM gateway inheres of Village Phone replication supporting device.

Another fact is GSM not equal with "new-gadget, new-thing" around CintaMekar folk. When IP-PBX and IP-Phone facilitate CintaMekar folk for internal communication, GSM Gateway will complete external communication need when they're outside their village.

Beside it – unrelated fact with replication need is – mobile-to-mobile calls are cheaper than fixed phone-to-mobile calls.

IP-Phone

IP-Phone use VoIP technology that enables phone-calls via IP network as internet. It has some features more than and takes lower price than fixed-phone has.

That's the primary reason to choose IP-Phone as one of Village Phone Replication supporting device at CintaMekar.

III. Village Phone Operation Management

There are several remarkable things to maintain reliability value of Village Phone Operation Management, i.e.

1. System Documents,
2. Operator Specifications,
3. Other supported-things.

A. System Documents

Operator-candidate will facilitate with device operational manuals besides some training(s).

Those manuals included:

1. IP-PBX operational manual,
2. IP-Phone operational manual,
3. GSM-Gateway operational manual,
4. Application operational manual.
5. Application here is dedicated to manage Village Phone as Telecommunication path.

Normally, manual number 1-2-3 are available as part of those devices. Manual number 4 is easy to find just because the application is free. But, one thing that may not be forgotten is the difference between urban and rural culture and environment. Those manuals need to simplify their language and presentation.

Before start to learn about Village Phone operational device manuals (IP-PBX, IP-Phone, and GSM Gateway), operator-candidates should supply themselves with basic knowledge about computer network, device installation, and some technically things to handle trouble-shooting.

B. Operator specifications

Operator-candidates should meet minimum requirements to save mastery-time of device operational; expected to minimize error/failure when it operates, to handle any potential problem (predictable and/or unpredictable problem in definite scale and condition).

In CintaMekar case, operator-candidate minimum requirement is productive-aged SMK (Sekolah Menengah Kejuruan) graduate that eventually get direct training from the experienced-user (an expert) at certain time.

C. Other supported things

The supported-thing for smooth device operability & device reliability optimization is a Call-Tree for the operator.

Call-Tree will contain contact-list (minimal: name, phone number, address) that could reach by operator

whenever he can't handle any problem by himself. Every person in this list had agreed and had known every consequence when they put their information inside. All organization members will be added in this list automatically. And, according to operability continuity, supporting technician (device technician) will be added in this Call-tree, too.

Some regulation will bring together with this Call-tree and operator must obey them. Those regulations will avoid any misappropriation of Call-tree usage.

Last but not least, water and electricity resources are two important supporting-things in this replication. Without both of them, optimal operability and reliability of Village Phone device will difficult to reach.

IV. VILLAGE PHONE SUSTAINABILITY

A. *Review: Success Story from Uganda's Replication*

Village Phone replication in Uganda was brought by Grameen Technology Center and was avowed as the first success replication program after Bangladesh. More than 10000 Village Phone businesses in Uganda had recorded until December 2007.

At first, this replication program target is to develop 5000 businesses (new cell-phone) in five years. But, in actual practice, MTN Village Phone had reach 6700 new business in three years with average growth more than 150 new businesses monthly.

Village Phone replication in Uganda got significant impact. On the average, each VPO (Village Phone Operator) sell five airtimes more than urban customer with their private cell-phone. Each VPO can upgrade education level of their children, access personnel medical treatment to support their health, and make their business growth; even develop other business to create opportunity in their own community.

Nowadays, MTN Uganda is the fully a hundred percent owner of Village Phone and has right to manage it. This project is continued to increase amount of communication access and economic opportunity in all village at Uganda.

B. *Business Model for Village Phone*

Village Phone replication will:

1. begin business chance(s) without any solicitudes about communication matter cause distance, geographical, etc among village folk in village-internal-area
2. begin business chance(s) that require direct-interaction between folk and external-parties of their village
3. bring more consumer (related with their business), not only from around of their village
4. open information-entrance from the outside of their village that will increase folk knowledge indirectly
5. distribute rural internal communication scope evenly

Considering all chances above, we will find there are three ways to increasing life-quality and prosperity of rural folk, i.e.

1. supporting village economic activities (business)
2. supporting daily activities (society innate energy)
3. negotiating isolation (subsidy)

Village Phone replication in rural will enable those ways to do parallel. Till Village Phone position becomes stronger together with village economic outgrowth.

V. ORGANIZATION

Village Phone Management Organization is formed fits in rural character to avoid confusion and conflicts that collide with Village Phone replication's object. Its purposes are Village Phone operability continuity.

In this Village Phone organization, several sides will be defined as responsible-side to one or some certain activities, including their authorities. Time-honored/respected persons will be entangled according to their capacity.

Proposed Village Phone Organization Structure will be shown at figure 6.

1. Kepala Desa
   Kepala Desa has responsible as a supervisor and will receive any periodic report from Koperasi.
2. Koperasi
   Koperasi has responsible in Village Phone service(s) marketing, Village Phone billing system management, and to collect Village Phone usage bill. Koperasi is supported by expert(s) from institution and provider when billing system is not running well in operating-time.

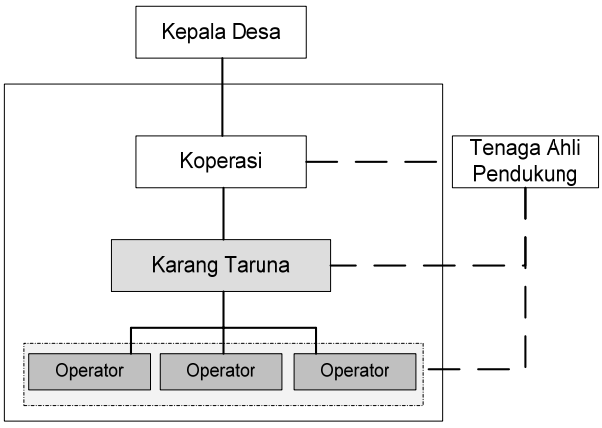

Fig. 6. Village phone organization

3. Karang Taruna
   Karang Taruna has responsible to coordinate Village Phone operator(s) and arrange any training(s) for operator-candidate(s). Karang Taruna is supported by expert(s) from institution and provider.

4. Operator
   Operator has responsible in device's operation and maintenance, and handling any device-disruption. Operator can coordinate with Karang Taruna or provider's technician if disruption is technical-disruption.
5. Tenaga Ahli Pendukung
   Tenaga Ahli Pendukung here means an expert from institutions and/or telecommunication' set provider. They have responsible to carry needed-training(s) for any parties that directly-related to billing system and device. Whenever disruption has found at system and device, Tenaga Ahli Pendukung must be ready to solve any problem, mainly any problem that need special handling.

VI. CONCLUSION

From this research, we can conclude that operability and reliability success factors of telecommunication set that used in village phone replication are:

1. Telecommunication set reliability, in this case is village phone sets.
2. Telecommunication set sufficiency, in this case are: system document(s), operator specification(s), and other supporting part(s).
3. Supporting business model(s) of Village Phone.
4. Village Phone organization.

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Image Quality Assessment of Fast Fourier Transform Domain Watermarked Images

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***Abstract*—Digital watermarking is the processing of embedding digital signature into the host media such as image, video, text, audio etc. During the watermarking process, images are subjected to variety of attacks such as noise in transmission channel, geometric attacks, compression, processing like filtering, etc, all this affect the visual quality of watermarked image. Thus, there is a need for image quality assessment of watermarked images in relation to the original images. Several measures of image metrics are available in the field of image processing however they are application based. This paper discusses watermarking in FFT domain and some of the image quality metric that can be applied. Experiments are conducted using the Full Reference (FR) images. We used Mean Square Error (MSE), Root Mean Square (RMS), Structural Similarity (SSIM), Image Fidelity Measure (IFM), Correlation Coefficient Index (CCI) and Peak Signal to Noise Ratio (PSNR) as our quality assessment. Result shows that CCI, SSIM, and IFM are most appropriate for measuring quality of watermarking system.**

***Index Terms*—Fast Fourier Transform, Image Watermarking, Image Quality Metric.**

I. INTRODUCTION

Digital watermarking is an approach that involves embedding of digital mark into a multimedia object (cover work: image, audio, video text) such that it is robust, secure and imperceptible to the human observer, but can be detected algorithmically. Due to digital watermark's crucial features such as; imperceptibility, inseparability of the content from the watermark, and it's intrinsic ability to undergo same transformation as experienced by the cover work, this has made it superior and preferable over other traditional methods of protecting data integrity, authentication of information resources and ownership assertion. This preference has been proven experimentally [1] to provide improved security. Image quality assessment plays an important role in digital watermarking such as assessing the imperceptibility of the watermarked image. The traditional image quality has been evaluated by human subjects' method. Though this method is reliable, however it is expensive and time consuming [2]. A great deal of effort has been made in recent years to develop objective image quality metrics that correlate with perceived quality measurement. In this paper, one of the crucial requirement of digital watermark, which is imperceptibility of watermarking system, has been assessed and analyzed using objective quality measure.

II. WATERMARKING IN FOURIER TRANSFORM

Discrete Fourier Transform DFT-domain watermarking serves as the pioneering research in transform domain watermarking. In DFT domain, watermark can be embedded in the phase or magnitude of DFT. Authors in [3]-[5] embedded the watermark in the phase coefficient. This is because the Fourier transform phase captures the most intelligible part of the original signal. Embedding watermark in the most important components of image improves the robustness since tempering with this important component in attempt to remove the watermark will severely degrade the quality of image. On the other hand, many watermarking schemes [6]-[9] embedded watermark into the magnitude of Fourier coefficient of the original image. This amplitude modulation is used because of its shift invariant properties and the cyclic translation of the image in spatial domain does not affect the DFT amplitude. More so, Fourier transform magnitude can uniquely specify almost all typical images. Fast Fourier Transform (FFT) is the fast way of implementing DFT. In this paper, FFT and DFT are used interchangeable.

III. QUALITY METRICS ASSESSMENT OF IMPERCEPTIBILITY OF WATERMARK

The watermark imperceptibility greatly depends on the size of watermark which also influences the visual degradation of the watermarked image. For fair evaluation, some objective image fidelity measure was use as evaluation criteria. Image fidelity refers to the ability of a process to render an image accurately, without any visible distortion or information loss. For example, if we cannot detect the difference between an original and a watermarked image, we conclude that the watermarking process was visually imperceptible. It is possible to develop computational measures of image fidelity based

on human vision models because these types of judgments depend upon our ability to detect differences between images [10].

A. *Pixel based approach*

In table 1, It shows some distortion measure, where $U(m,n)$ represents the pixel of host image, whose coordinates are (m,n), and $V(m,n)$ represents the pixel of watermarked image, with coordinates (m,n). The most common Image Quality Assessment are the Mean Squared Error (MSE), root MSE (RMSE) and Peak Signal to Noise Ratio (PSNR). These measures are based on difference (pixel error) between the original image, Full Reference (FR) and the distorted, watermarked image. These metrics are very popular due their simplicity. However, it is well known that these difference distortion metrics are not correlated with human vision [11]. This might be a problem in applying such metrics in digital watermarking since sophisticated watermarking methods exploit Human Visual System (HVS), one way or the other. Using the above metrics to quantify the distortion caused by a watermarking process might therefore result in misleading quantitative distortion measurements, such as shown in Fig. 1. Furthermore, these metrics are usually applied to the luminance and chrominance channels of images. If the watermarking methods work in the same color-space, for example luminance modification, this does not pose problem. However, if the methods use different color spaces, these metrics are not suitable. The limitation of simple pixel error based metrics is also experienced in applications of medical images, as reported in [12] in a private communication with [13], where the compressed diagnostic breast images with lower PSNR values are preferred by doctors over those with higher PSNR values. That is, the images favoured by PSNR do not agree with the judgment of human eyes.

B. *Perceptual Quality Metrics*

Due to weaknesses of the pixel-based distortion metrics, more and more research now concentrates on distortion metrics adapted to the HVS, by taking various effect into consideration [14],[15]. The perceptual quality measure exploits the contrast sensitivity and masking phenomena of the HVS such as , Masked Peak Signal to Noise Ratio (MPSNR) in [11], weighted Mean Square Error (wMSE) by [16] metric that takes into account properties in the neighborhood of each pixel. Also a Structural Similarity Index (SSIM) is proposed in [17], for measuring the similarity between two images.

C. *Correlation Based*

Correlation (often measured as a correlation coefficient) indicates the strength and direction of a linear relationship between two random variables. The correlation between two images (cross correlation) is a standard approach to feature detection. It can be used as a measure for calculating the degree of similarity between two images [18]. Its mathematical definition is defined in Table 1.

Table 1. Objective Image Quality Assessment Definition table

Accr.	Meaning	Equation	Measure		Explanation
			Min. value	Max. Value	
ADI	Average difference indicator	$\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}(U(m,n)-V(m,n))$	0	1	Lower value signify closeness
MSE	Mean square error	$\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\lvert U(m,n)-V(m,n)\rvert^2$	0	1	Lower value signify closeness
RMSE	Root Mean Square	$\sqrt{MSE}$	0	1	Lower value signify closeness
IFM	Image fidelity measures	$1-\frac{\sum_{m=1}^{M}\sum_{n=1}^{N}\lvert U(m,n)-V(m,n)\rvert^2}{\sum_{m=1}^{M}\sum_{n=1}^{N}(U(m,n))^2}$	0	1	higher value signify closeness
PSNR	Peak signal to noise ratio	$20log_{10}\frac{Max(V(m,n))}{RMSE}$	0	∞	Higher value of PSNR indicates that the two images are similar
SSIM	Structural similarity	$\frac{4\rho_{u,v}\bar{U}\bar{V}}{(\rho_u^2)+\rho_v^2)[\bar{U}^2+\bar{V}^2]}$	0	1	1 shows that the images are similar to each other
CCI	Correlation Coefficient Index	$\frac{\sum_{m=1}^{M}\sum_{n=1}^{N}[U(m,n)-\bar{U}][(V(m,n)-\bar{V}]}{\sqrt{\sum_{m=1}^{M}\sum_{n=1}^{N}[U(m,n)-\bar{U}]^2\sum_{m=1}^{M}\sum_{n=1}^{N}[V(m,n)-\bar{V}]^2}}$	-1	+1	1 indicate that the two images are highly similar while -1 indicate that the two images are exactly opposite

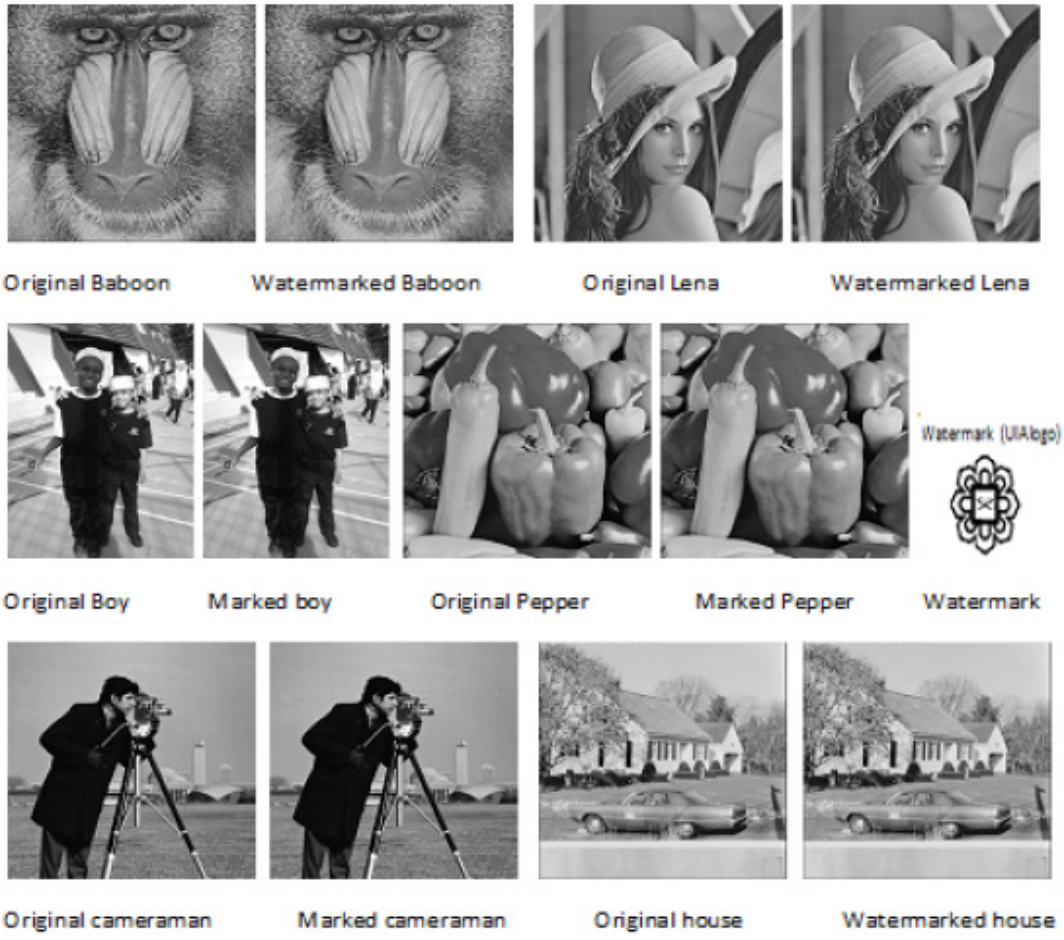

Figure 1. Host Images, watermarked version and the watermark (UIA logo)

IV. METHODOLOGY AND EVALUATION CRITERIA

A. The watermark Embedding Procedure

Let $f(x_1, x_2)$ of size MxN grayscale be the host image. For $x_1 = 0, 1 \ldots M-1$ and $x_2 = 0, 1 \ldots N-1$, It DFT is given by:

$$I(k_1, k_2) = \sum_{x1=0}^{M-1} \sum_{x2=0}^{N-1} f(x_1 x_2) e^{-j2\pi\left(\frac{k_1 x_1}{M} + \frac{k_2 x_2}{N}\right)}$$

Let $Mag(k_1, k_2) = |I(k_1, k_2)|$ is the magnitude, $P(k_1, k_2)$ be the phase of $I(k_1, k_2)$ and $W(k_1, k_2)$ be the watermark. We embedded in the Fourier magnitude by modifying it.

$$Mag'(k_1, k_2) = Mag(k_1, k_2) + f(Mag(k_1, k_2), W(k_1, k_2), \beta)$$

The watermarked image $f'(x_1, x_2)$ is the inverse Fourier transform of $Mag(k_1, k_2)$ and $P(k_1, k_2)$ in our case, FFT is used. Therefore,

$$f'(k_1, k_2) = IFFT(I'), I'(Mag', P)$$

Host images and it watermarked version is shown in Figure 1. In this study, digital watermarks were embedded in the mid-frequency of Fourier magnitude of the image. Different images have different capacity, so the amount of information that can be embedded invisibly is different.

B. Evaluation Criteria

One of the requirement of watermarking is imperceptibility. It should be noted that the main goal of watermarking is to embed securely in a completely undetectable region. That is, a third party who is not the intended recipient should not be able to distinguish in any sense between cover-objects and the watermarked image. The imperceptibility of watermark is one of the most important measures that evaluate the performance of the watermarking algorithm. The criteria used in the objective image quality measure is Full Reference (FR) quality assessment with respect to imperceptibility of the watermark. That is, the availably of the original image which is considered to be distortion free or perfect quality. For a fair evaluation of the metrics, one should use a wide range of picture sizes, from few hundred to several thousand pixels, and different kind of images.

That is why in this paper, images of different size and types under same and different conditions are employed.

V. Result and Discussion

The output obtained for pixel based image quality assessment, MSE, RMSE, and ADI, Perceptual based such as CCI, IFM and SSIM and for PSNR in measuring imperceptibility of the watermarked image is shown in Table 2. It shows the measure of imperceptibility obtained between a watermarked image and the host image for 5 different images namely baboon, Lena, boy, pepper, cameraman and house as shown in Fig. 1. Images of sizes 512x512, 480x640 and 256x256 were used as Full Reference (FR) images. The visibility of a watermark is affected by image texture, edges and luminance. The watermarks are less visible if it is in an area that has high spatial frequency meaning a lot of texture as shown in baboon and pepper. If the area is flat digital watermarks are more easily noticed. For MSE and RMSE, it only measures gray-level difference between pixels of the host and the watermarked images without considering correlation between the neighboring pixels. That is why the watermarked images with MSE and RMSE have significantly different visual quality compare to the value obtained. The result has also proven that, for all the images irrespective of the sizes, the performance of pixel based metric are not suit- able for measuring imperceptibility of watermark especially MSE and RMSE because the results diverge visually compare to the images in Figure 1. The result obtained was due to the facts that MSE and RMSE works satisfactorily when the distortion is mainly caused by contamination of additive noise. However does not take into account the viewing conditions and visual sensitivity with respect to image contents. Only gray-value differences between corresponding pixels of the original and the watermarked version are considered. Pixels are treated as being independent of their neighbours. Moreover, all pixels in an image are assumed to be equally important. This is of course, far from being true. In fact, pixels at different positions in an image can have very different effects on the human visual system (HVS). Results of SSIM, CCI and IFM for all images is between 0.9906 and 0.9999 as shown in Table 2, which indicates that the watermarked images are very similar to the host image by it definition in Table 1. The visual subjective measure also buttresses this point.

VI. Conclusion

In summary, this paper has examined some common Image Quality Assessment metrics for watermarked images. In the analysis, results showed that CCI, SSIM and IFM are powerful tools that show superior performance over others for assessing watermark imperceptibility. These tools can be use for various images of different sizes and texture. In all the experiment performed, CCI has the highest imperceptible value. MSE and RMSE failed to provide correct results in evaluating quality of watermarked images. The result showed these assessments were in apparent contradiction with subjective judgments, and this is corrected by using other powerful tools like the Correlation and perceptual based metric. This suggested that caution should be taken when using metrics such as MSE and RMSE have obvious value in comparing pixel to pixel algorithms, but do not always have the same interpretation value when dealing with the visual quality of an image. Visual image evaluation, such as the SSIM index, IMF and CCI provides alternatives that have application to watermark images, which will allow proper evaluation of imperceptibility.

Table 2: Test images showing their sizes and performance results of metrics used.

Size of image	Time in sec.	Performance Metrics							
		Test Image	MSE	RMSE	ADI	PSNR in dB	IFM	CCI	SSIM
512x512	3.1824	Baboon	0.3377	0.5811	0.2371	46.4038	0.9927	0.9993	0.9943
512x512	3.0420	Lena	0.2749	0.5243	0.0632	46.1042	0.9989	0.9997	0.9906
480x640	2.9796	boy	0.2227	0.4719	0.0543	47.3467	0.9991	0.9999	0.9933
512x512	3.1356	Pepper	0.8189	0.9049	0.1377	44.9200	0.9967	0.9997	0.9887
256x256	1.4508	Cameraman	0.3935	0.6273	0.0644	43.0337	0.9983	0.9999	0.9928
512x512	3.0264	House	0.7298	0.8543	0.1133	43.0252	0.9971	0.9994	0.9903

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Software Cryptography Issues

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***Abstract*—Most cryptographic systems are software-based system. There are some issues related to software cryptography, such as performance, portability, and interoperability. This paper addresses the performance aspect. Various mathematical and programming refinements are used to address the performance issues.**

***Index Terms*—cryptography, software.**

I. INTRODUCTION

The push to bring information and communication technology into rural areas will make digital information even more important in our daily lives. The secrecy or confidentiality of information is essential in information transactions. Authenticity of documents and persons involved in the transaction is also critical. The solutions to these problems involve the use of cryptography.

Various cryptography algorithms have been proposed, used, and even broken apart. The strength of a crypto algorithm depends on the resources needed to break the algorithm. The stronger the algorithm, the larger the amount of resources and time needed to break it. Unfortunately, the resources needed to use such algorithm in regular operation also increase. This is the reason why symmetric-key cryptosystem is preferable compared to asymmetric-key cryptosystems since the former uses less resources and faster than the later.

Cryptographic algorithms can be implemented in software and hardware. Most cryptographic systems are implemented as software, either as software running on a general-purpose computer or as firmware in embedded system.

There are issues in software implementation of cryptographic algorithms, such as performance (speed, memory size), portability, and interoperability. In this paper we only touch the performance aspect.

II. SOFTWARE CRYPTOGRAPHY

Software implementations of cryptographic algorithms in general are slower compared to their hardware counterparts since they run on general purpose computing platforms that are not designed for cryptographic algorithms. For example, general-purpose computers use 32-bit or 64-bit processor, while some cryptographic algorithms such as RSA [16] and elliptic curve crypto algorithms [8][11] use 768 to 2048-bit data and 140 to 240-bit data respectively. Various refinements must be done to make the software runs reasonably well on general-purpose computers.

If a software implementation of a cryptographic algorithm is slow, it is not going to be accepted. Usually, security is sacrificed in order to make the software acceptable. One way to do it is to reduce the key length of the crypto algorithm being used. Unfortunately, this approach makes the system susceptible to various security attacks, including brute force attack (i.e. by trying all possible keys). The shorter the key length, the smaller the key space that needs to be search.

One way to increase the performance of cryptographic software is to run it in a faster hardware without modification to the software. However, crypto attackers also have access to faster hardware making the system susceptible to attacks. Thus, replacing the hardware alone is not enough. Changes must be done within the software itself.

The use of mathematics manipulation to reduce complexity is also essential. Straightforward computer program implementation from mathematical equations may result in inefficient application or even render it unusable. Some mathematical equations can be transformed or manipulated into different equations so that they lend to more efficient software implementations.

Hardware implementation may also benefit from novel ideas implemented in software. Some crypto systems are implemented in constrained or limited hardware (e.g. smartcard). Thus, they also face similar performance issues.

Many hardware implementations are done by writing their description, in hardware description language, similar to software implementations. Thus, hardware development is similar to software development, but with more constraints in constructs they can use.

A. Mathematical Foundation

In essence, software is an implementation of algorithms in computer. Specifically for cryptography, the algorithms are implementation of mathematical equations or functions. Cryptographic algorithms are usually implemented with big integer numbers with multi precision operations.

Depending on the type of cryptosystem, basic cryptographic operations include addition, multiplication, squaring, and modular exponentiation. Since big numbers are involved in the operation, careful mathematical transformation must be chosen so that software implementation is possible.

By understanding the underlying mathematical foundation, better algorithms can be developed. For example, equation in the form of x^y mod z is commonly used in public key cryptographic algorithms. It can be implemented as multiplication of x done y times before performing modulo by z. It should be noted that x and y are big numbers. Thus, the amount of calculation is significant. Fortunately, there is fast exponentiation algorithm that takes the binary expansion of the exponent and only use the expansion in the modular operation [4]. This reduces the number of multiplications significantly.

One cryptographic algorithm might use prime fields as the underlying field while the others might use binary fields.

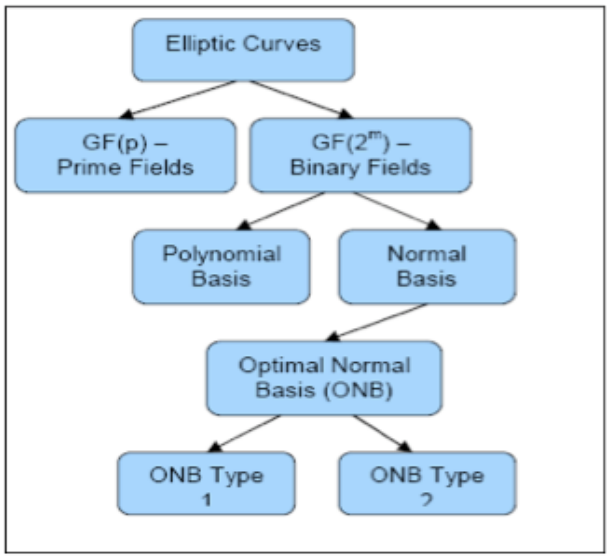

Figure 1. Choices in implementing ECC

Figure 1 shows different layers and choices used in Elliptic Curves Crypto implementation [12]. Software implementations usually use prime fields, while hardware implementations tend to use binary fields. The choice may create differences in terms of performance or resources needed in the implementation.

B. Mathematical Transformation

Clever or novel mathematical transformation can be done to make computation cheaper or use fewer resources. In [13] a novel algorithm is developed to make basis conversion, from polynomial to optimal normal base and vice versa, uses less memory. Instead of requiring 140-by-140 matrix, only a 1-by-140 matrix - which is actually the first row of the 140-by-140 matrix - is needed. Further improvement of the algorithm shows that only single multiplication is needed. This is just an example of what mathematical transformation can do to improve performance.

C. Data Structure

Selecting the appropriate data structure (and related algorithms to manipulate the data) is critical to make software efficient and fast. In cryptography, the cost of computation is high. Therefore if some computation can be avoided or cached, time can be saved. Here is an example. If a hash of a document is already computed and there is a minor update to the document, then the amount of updating the hash should be proportional to the amount of update. Data structure for incremental cryptography is the result of such research [3].

In general, implementation of a software uses libraries. Big integer and multi precision arithmetic libraries are developed to facilitate fast software development. Unfortunately, these libraries have different performances. In [1] comparison of various software libraries for public crypto cryptography is studied. The difference between one library with another one can be substantial. One library might perform twice or even 400 times slower than the other one. Selecting the appropriate library is very important in software implementation.

D. Algorithms

Algorithm is the heart of computer programs. To efficiently implement an algorithm into software, one must understand the mathematical foundation and the corresponding computer's machine language [7].

There are cryptographic algorithms that are more suitable to software than hardware. This is due to the large size of tables that are being used, e.g. for S boxes or permutation. Examples of such algorithms are Blowfish, SEAL, and RC5. Most of their implementations are done in software.

The problem with cryptography is that the operations involve big numbers. Thus, selecting the most efficient algorithm (according to a certain criteria, such as speed or memory size) is crucial in software. For example, there are several algorithms to implement greatest common divisor; Euclidean algorithm [4], Lehmer [9], Generalized binary [6]. A more elaborate discussion on various basic crypto operations and algorithms to implement them can be found in [10]. More algorithms, with better efficiency, are still sought.

E. Programming Tricks

There are programming tricks to make software faster (but may require more memory) or vice versa. Examples of programming tricks are loop unrolling, and exploiting parallelism. Loop unrolling or unwinding is done by expanding the statements inside a loop into multiple statements. This can reduce the number of loops, tests, and jumps but it requires more memory.

```
for (int x = 0; x < 100; x++)
   {
   do(x);
   }
```

The above loop can be unwind into the following code.

```
for (int x = 0; x < 100; x += 5)
   {
    do(x);
    do(x+1);
    do(x+2);
    do(x+3);
    do(x+4);
   }
```

Instead of 100 loops, only 20 loops and tests at the end of the loop are needed. Tests and jumps are expensive. If the unwind statements inside the loop are independent of each other, they can be executed in parallel. This can further improve the speed of the implementation. Further refinement can be done by utilizing platform specific features.

F. Implementation Issues

On top of the above issues, there are issues specific to how cryptographic algorithms implemented in software. These are implementation issues.

G. Language

It is believed that the use of assembly language might speed up the implementation. However, this is not always true. Careful consideration must be taken [5]. In ECC implementation, finite field mathematics can be easily implemented in assembly language [17]. Another example is an implementation of Montgomery multiplication, which is part of RSA decrypt routine in OpenSSL package. An optimized assembly implementation was added in OpenSSL version 0.9.8j. This version is three time faster than non-assembly implementation in version 0.9.8a [2].

Unfortunately, the use of assembly languange makes the code not portable and thus limit the distribution. It is also difficult to find programmers with assembly skills.

H. Platform specific fine tuning

Our software may be used in a specific platform with specific microprocessor. At the cost of sacrificing portability, we can fine tune our implementation to the particular platform. An example of such approach is the use of Intel® cryptography library, which can increase OpenSSL performance by more than 35% on Intel-based processor [14]. A similar approach has been done for SPARC architecture processor for different algorithm. Another example of fine tuning various cryptographic algorithms (Blowfish, SEAL, RC4, RC5, Khufu/Khafre) for Intel processor is available in [18]. By understanding the feature of the processor, one can rewrite the implementation for better performance.

III. OPEN ISSUES

The search for better cryptographic algorithms and their implementations never stops because they are always under attack through cryptanalysis and brute force attack. The US National Institute of Standards and Technology (NIST) offers crypto competition requlary to update crypto algorithms currently being used for government and business [15]. Efficient and high performance software impementation of the winner are being develop continuously. Thus issues elaborated in previous section are still relevant today. Novel solutions are still sought. Issues elaborated in previous sections cannot be solved by engineers alone or by mathematicians alone. They must be solved together. Cross discipline research is needed.

IV. CONCLUSION

Implementation of cryptography in software is important. Research and development are still needed to make the implementation more efficient and acceptable. Performance is the most important factor in software cryptography. Mathematical and programming tricks are still sought. It is hoped that the availability of software cryptosystems can improve security of information transactions.

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Randomness Analysis of Block Cipher Using Chaos Game Method

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***Abstract*– Block cipher can be considered as a random permutation function which maps a set of plaintext character mathcalP to a set of ciphertext character $mathcalC$. Block cipher is designed in a way that the effort to distinguish it from a random permutation function will be very difficult or computationally infeasible. It this paper, block cipher randomness analysis is performed by using chaos game method. In this method, block cipher is treated as a mapping function of a discrete time dynamical system.**

The random sequence is analyzed by chaos game method in order to reveal its characteristic or regularities. The applicability of the method to reveal some characteristics of a block cipher is verified by using it for comparing the randomness of three-round and four-round SPN-network and distinguishing them from each other. So, the method can role as a distinguisher.

***Index terms*–Block cipher, distinguisher, mapping function, random permutation function, randomness analysis.**

I. INTRODUCTION

The main characteristic required by a block cipher is its behavior must be very similar to a random permutation function. Since its main function is to provide confidentiality, the security of block cipher becomes one of the main requirements that need to be fulfilled [1]

A block cipher is considered to be secure if any attacks methods that may be conducted against it need so many resources that is considered to be infeasible[2]. Cryptanalysis is a technique that is developed to exploit the weakness and break the security of the cipher. Generally, the first step in cryptanalysis technique is to create a *distinguisher* for randomness analysis and then using it for distinguishing certain block cipher from random permutation function[3].

In this paper, randomness analysis toward a block cipher is performed by using *chaos game method*. First, block cipher is treated as a mapping function of a discrete time dynamical system. The next step is using symbolic dynamic method to generate a random sequence based on the output of the dynamical system. Then, chaos game method is used to perform randomness analysis toward the sequence.

In this paper, the block cipher will be analyzed using the technique which is usually applied in a dynamical system analysis. The dynamical system which produced by using block cipher as its mapping function will behave like chaotic dynamical system [8]. Then, we could use symbolic dynamics methodto generate a sequence of symbols and then perform the analysis towards that sequence [3, 12].

If a randomness analysis method of a certain block cipher could act as a distinguisher, then the method may potentially be used further to launch an attack against the cipher. This attack method, if any, will be classified as a *adaptive chosen-plaintext attack*.

II. RANDOMNESS CHARACTERISTIC OF BLOCK CIPHERS

A block cipher is a kind of symmetric cipher. The other kind is stream cipher. The main difference between those two ciphers is that the stream ciphers encrypt character by character using a transformation which is time varying, while the block cipher use one fixed transformation to encrypt a block of character. The common characters are bit or byte.

A block cipher is a function which maps n-bit block of plaintext to n-bit block of ciphertext; n is then called as block length. This function is parameterized by m-bit key k which is inquired from the set $\mathcal{K}$ which is the subset of the whole sets of m-bit vectors $\{0,1\}^m = \mathcal{V}_m$.

In a block cipher, a ciphertext $\mathcal{C}$ and plaintext $\mathcal{P}$ have the same and limited number of elements (look back at the description for definition. The length of characters of

[1]The other two aspects are the encryption/description throughput and flexibility[7]

[2]Some criterias that determine the feasibility of an attack towards a cipher are time complexity, data complexity, success probability and memory complexity.

[3]A distinguisher isn't always possible to be extended to an attack technique against cipher.

a plaintext and ciphertext is n-bit and every plaintext and ciphertext can be uniquely defined as an element of set $\mathcal{V}_n$. An n-bit block cipher is a symmetric cipher where $\mathcal{P}$ and $\mathcal{C} = \mathcal{V}_n$.

Definition 1. *Let $\mathcal{P} = \mathcal{C} = \mathcal{V}_n$ be a plaintext and ciphertext space and $\mathcal{K} = \mathcal{V}_m$ is a key space. Define a function $E : \mathcal{P} \times \mathcal{K} \rightarrow \mathcal{C}$. Then E is an n-bit block cipher, if for each $k \in \mathcal{K}$, $E(.,k) = E_k(.)$ always has an inverse. The inverse of $E_k(.)$ is symbolized by $D(k,.) = D_k(.)$. n represents the length of the block and m represents the length of the key.*

Every element of $\mathcal{P}$ is called as a block of plaintext while every element of $\mathcal{C}$ is called as a block of ciphertext. Further in this document, this two terms are reffered to as plaintext and ciphertext.

A block cipher can be considered as a mapping function which is deterministic and memoryless. There exists a main criterion which becomes the basic principle for designing the block cipher algorithm which determines its characteristics.

Definition 2. *Let $\mathcal{F}_n$ be a set of all permutations from one finite set domain that has n numbers of elements to a finite set codomain that has the same number of elements. A function that takes the elements of $\mathcal{F}_n$ randomly is called a* ***random permutation function****.*

The main criteria of a block cipher are listed below:

Criterion 1. *Block cipher, practically, must be impossible or difficult to be distinguished from a random permutation function.*

III. Chaos Game

There are two main methods for generating fractal images, namely deterministic algorithm and chaos game algorithm (random iterated algorithm). In deterministic algorithm, an IFS (iterated function system) which consists of a set of mapping function is used to iterate a set of points and eventually. This process will eventually converge to an invariant set of point which called attractor. The attractor is usually, but not necessary, a fractal image. The chaos game algorithm needs a random sequence as input and uses it for selecting one of mapping function of the IFS. It only maps one point in one iteration. This algorithm also converges eventually to an attractor corresponding to the IFS.

The chaos game method will be used for block cipher randomness analysis. If a chaos game algorithm uses a random sequence for its input, then the set of points produced by the algorithm will hit all parts of the attractor.

Iteration of the block cipher produces output that used to generate random sequences, then the chaos game algorithm takes the sequence as its input. This analysis process is performed in order to reveal some regularities of the cipher and to distinguish it from a random permutation function. This section explains the most important concepts of IFS and chaos game algorithm which are relevant to the analysis method [2].

A. Iterated Function System (IFS)

IFS is a system which consists of a set of mapping function which its iteration on a set of points will converge to an *attractor*. The attractor is in fact a *fixed point* of the IFS.

Definition 3. *A transformation $f : X \rightarrow X$ on a metric space (X,d) is called contractive or a contraction mapping if there is a constant $0 \leq s < 1$ such that*

$$d(f(x), f(y)) \leq s.d(x,y) \forall x,y \in X. \quad (1)$$

Any such number s is called a contractivity factor for f.

The transformations are mapping functions that become an integral part of the IFS.

Definition 4. *An* iterated function system *(IFS) consists of a complete* metric space (X,d) *together with a finite set of* contraction mappings $w_n : X \rightarrow X$, *which respective contractivity factors s_n, for $n = 1,2,\ldots N$. The notation fir the IFS is: $\{X : w_n,\ n = 1,2,\ldots N\}$ and its contractivity factor is $s = Max\{s_n :\ n = 1,2,\ldots N\}$.*

The following theorem explains how IFS iteration on a set of points in a metric space (X,d) could result an attractor.

Theorem 1. *Let $\{X;\ w_n,\ n = 1,2,\ldots,N\}$ be an IFS with contractivity factor s. Then the transformations $W : \mathcal{H}(X) \rightarrow \mathcal{H}(X)$ defined by*

$$W(B) = \bigcup_{n=1}^{N} w_n(B) \quad (2)$$

for all $B \in \mathcal{H}(X)$, is a contraction mapping *on the complete metric space $(\mathcal{H}(X), h(d))$ with contractivity factor s. That is*

$$h(W(B), W(C)) \leq s.h(B,C) \quad (3)$$

for all $B, C \in \mathcal{H}(X)$. Its unique fixe point $A \in \mathcal{H}(X)$ obeys

$$A = W(A) = \bigcup_{n=1}^{N} w_n(A). \quad (4)$$

and is given by $A = \lim_{n\rightarrow\infty} W^{on}(B)$ for any $B \in \mathcal{H}(X)$

Theorem 1 shows that iteration of an IFS on a set $B \in \mathcal{H}(X)$ will eventually converge to A.

Definition 5. *The* fixed point $A \in \mathcal{H}(X)$ *described in the theorem is called the attractor of the IFS.*

B. Using Deterministic Algorithm to Generate Fractal

This algorithm uses theorem 1 directly to generate fractal image. It performs iteration by calculating $\{A_n = W^{on}(A_0)\}$. An intial set A_0 (may be a set of points) is previously chosen for the iteration.

C. Chaos Game *(*Random Iterated Algorithm*)*

The main difference between chaos game algorithm to the previous algorithm is the chaos algorthm needs as set of probabilistic value to generate an attractor.

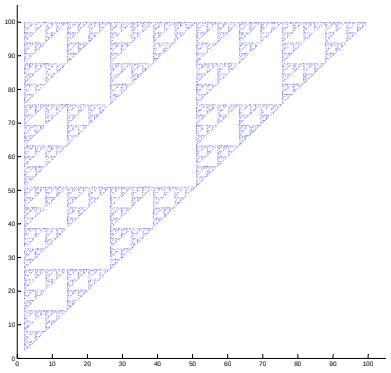

Figure 1 Sierpinski triangle fractal produced by chaos game algorithm

Definition 6. *An IFS (*iterated function system*) with probabilitas consitsts of an IFS* $\{\mathbb{X};\ w_1, w_2, \ldots, w_n\}$ *together with a set of numbers* $\{p_1, p_2, \ldots, p_N\}$ *such that*

$$p_1 + p_2 + p_3 + \cdots + p_N = 1 \text{ and } p_i > 0$$

for $i = 1, 2, \ldots, N$ *with each probabilistic value* p_i *is associated with the transformation* w_i*. The full notation for such an IFS is* $\{\mathbb{X};\ w_1, w_2, \ldots, w_N;\ p_1, p_2, \ldots, p_N\}$.

These are explanations for how the algorithm executed: let $\{\mathbb{X};\ w_1, w_2, \ldots, w_N\}$ is an IFS with probabilitas $p_i > 0$ for each w_i for $i = 1, 2, \ldots, N$, with $\sum_{i=1}^{N} p_i = 1$. Then choose a pont $x_0 \in \mathbb{X}$ as an initial point. In any one iteration x_n can be described as follows:

$$x_n \in \{w_1(x_n - 1), w_2(x_n - 1), \ldots, w_N(x_n - 1)\}$$

for $n = 1, 2, 3, \ldots$, with probability for the event $x_n = w_i(x_n - 1)$ is p_i. That iteration will produce a sequence $\{x_n : n = 0, 1, 2, 3, \ldots\} \subset \mathbb{X}$. If the set of probabilistic values for choosing a transformation from the set $\{w_1, w_2, \ldots, w_N\}$ are uniformly distributed and independent in any iteration step, then all points in the the sequence $\{x_n\}_{n=0}^{\infty}$ will construct the attractor of the IFS.

Example of attractor image (sierpinski triangle fractal) produced by a chaos game algorithm based on the same IFS from the previous example is plotted in figure 1.

D. Attractor and Measure

In this paper, *measure* is used to calculate distribution of points generated by chaos game algorithm in a specified area. If a transformation w_i is always picked randomly from the set $\{w_1, w_2, \ldots, w_N\}$ [4], then the points generated by the algorithm will be distributed uniformly on the attractor A. This fact can be used to investigate a block cipher randomness. These are steps to perform such analysis:

- iterate the block cipher,
- use output of the iteration to generate a random sequence,
- use the random sequence as input to a chaos game algorithm corresponding to a specified IFS
- analyze the pattern of distributed points generated by chaos game algorithm.

Let $\{\mathbb{X};\ w_1, \ldots, w_N;\ p_1, \ldots, p_N\}$ be an IFS with probabilities. Let A the attractor of the IFS. *Measure* of IFS denoted by μ assigns "mass" to many subsets of $\mathbb{X}$. For example, $\mu(A) = 1$ and $\mu(\phi) = 0$, that is the "mass" of the attractor is one unit and the mass of the empty set is zero.

Definition 7. *Let* $\mathbb{X}$ *be a space. Let* $\mathfrak{F}$ *denote a nonempty class of subsets of a space* $\mathbb{X}$*, such that*

(1) $A, B \in \mathfrak{F} \Rightarrow A \cup B \in \mathfrak{F}$.

(2) $A \in \mathfrak{F} \Rightarrow \mathbb{X} \backslash A \in \mathfrak{F}$.

Then $\mathfrak{F}$ *is called a* field

The following is a definition of *measure* on a *field*

Definition 8. *A* measure *on a field* $\mathfrak{F}$ *is a real non-negatif function which maps* $\mu : \mathfrak{F} \rightarrow [0, \infty) \subset \mathbb{R}$*, such that whenever* $A_i \in \mathfrak{F}$ *for* $i = 1, 2, 3, \ldots$*, with* $A_i \cap A_j = \phi$ *for* $i \neq j$ *and* $\cup_{i=1}^{\infty} \in \mathfrak{F}$*, we have*

$$\mu\left(\bigcup_{i=1}^{\infty} A_i\right) = \sum_{i=1}^{\infty} \mu(A_i)$$

let B denotes a closed ball in $\mathbb{X}$. Here is how to calculate the "mass" of the ball, $\mu(B)$. Apply the chaos game algorithm to the IFS with probabilities to produce a sequence of points $\{x_n\}_{\infty}^{0}$. Let $\mathfrak{N}(B, n)$ be number of points in $\{\{x_0, x_1, x_2, \ldots, x_n\} \cap B\}$ for $n = 0, 1, 2, \ldots$. Then, $\mu(B)$ can be calculated as follows:

$$\mu B = \lim_{n \rightarrow \infty} \left\{ \frac{\mathfrak{N}(B, n)}{(n+1)} \right\} \tag{5}$$

"Mass" of the ball B is the proportion of points in B generated by the chaos game algorithm.

IV. Randomness Analysis of Block Cipher

The randomness analysis of a cipher is performed to examine whether the cipher really behaves randomly. In stream cipher context and pseudo random number generator (PRNG) the randomness analysiss purpose is to test whether the series of bits that is generated cannot be distinguished statistically from the series that is resulted from an ideal random number generator [11]. In block cipher context, the randomness analysis is used particularly to identify the regularity in the block cipher algorithm. This analysis generally preceded by an analysis to find internal weakness of a block cipher and use the result to predict the deviation of block cipher behavior from a random permutation model [13]. The randomness analysis is then performed to verify the prior weakness analysis and then to mount a real attack to the cipher.

This section will explains randomness analysis of a SPN-Network block using chaos game method. The block cipher will be treated as a mapping function of a discrete time dynamical system used to generate a random sequence [14]. The chaos game method then will be used to analyze the sequence. The randomness analysis method used in this paper is very closely related to a research field which investigate the application of chaotic dynamical system methodology in cryptography [1, 5, 6, 8, 9, 10].

[4] real random in the iteration means each possible event has a uniform probabilistic value and independent from events in all previous iterations

This paper uses a SPN-Network block cipher whose block length 16-bit and key length 32-bit (see figure 2). All the cipher parameters refers to paper [4, 13].

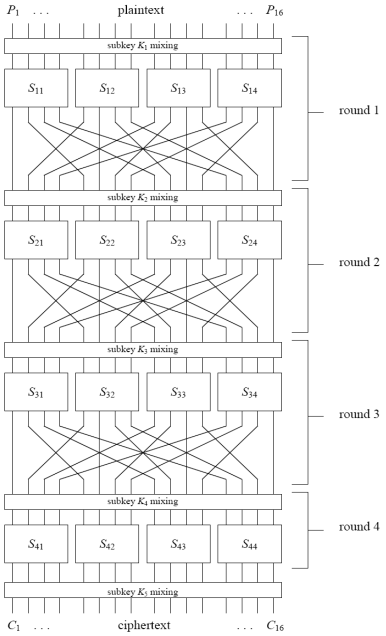

Figure 2 Subtitution and permutation network

A. *IFS Construction*

The IFS used in this randomness analysis is one that maps a rectangle to a rectangle such that if $A_0 = \{(x, y)\,;\, 0 < x < 100 \text{ dan } 0 < y < 100\} \subset \mathbb{R}^2$ then the deterministic algorithm will result $A_n = A_0$ for any $n = 1, 2, \ldots$. The IFS can be presented mathematically as follows:

$$w_i \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0.25 & 0 \\ 0 & 0.25 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} ((i-1) \bmod 4) \times 25 \\ \left\lfloor \frac{(i-1)}{4} \right\rfloor \times 25 \end{bmatrix} \quad (6)$$

with $i = 1, 2, \ldots, 16$. IFS in equation 6 is similar with the IFS which generates sierpinski triangle. The main difference is the number of transformation in those IFSs. [5]

The chaos game algorithm needs a sequence $s = l_0, l_1, \ldots$ dengan $l_n \in \{1, \ldots, 16\}$ as its input. Each term of the sequece is used to choose one of transformations from the set $\{w_i : i = 1, 2, \ldots, 16\}$. We can construct a discrete time dynamical system which represents the chaos game

[5] The fact is there is always an IFS which maps $A_0 = \{(x, y)\,;\, 0 < x < 100 \text{ dan } 0 < y < 100\} \subset \mathbb{R}^2$ back to A_0 with a set of transformations $\{w_1, w_2, \ldots, w_N\}$ for $N = i^2$ with i is an integer value.

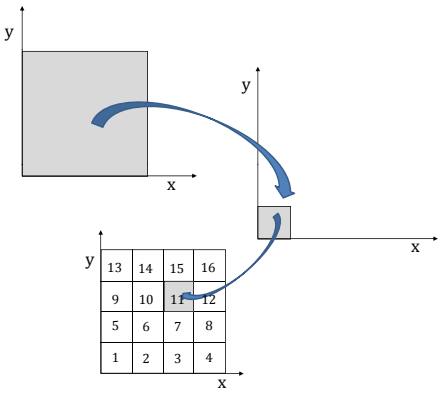

Figure 3 Graphical illustration of transformation w_{11} according to IFS in the equation 6

algorithm as follows;

$$\begin{bmatrix} x_1(n+1) \\ x_2(n+1) \end{bmatrix} = \begin{bmatrix} 0.25 & 0 \\ 0 & 0.25 \end{bmatrix} \begin{bmatrix} x_1(n) \\ x_2(n) \end{bmatrix} + \begin{bmatrix} (l_n \bmod 4) \times 25 \\ \left\lfloor \frac{(l_n)}{4} \right\rfloor \times 25 \end{bmatrix} \quad (7)$$

with $n = 0, 1, \ldots$. The initial point is chosen previously from the set $(x_1(0), x_2(0)) \in \{(x, y)\,;\, 0 < x < 100 \text{ dan } 0 < y < 100\}$.

B. *Random Sequence Generation*

The Block cipher which tested has 16-bit block length. The value of l_i of the sequence s is determined by selecting 4-bit from 16-bit ciphertext of the cipher and converting it to a decimal value $0, 1 \ldots, 15$. This process is essentially using symbolic dynamic method [3, 12]. Next, each decimal value in the sequence is mapped to an integer value $1, 2, \ldots, 16$. So, the sequence is now ready for using as the input of the chaos game algorithm.

C. *Randomness Analysis*

In the analysis, this paper uses dynamical system 7 for l_n is a term of a random sequence generated by 1st, 2nd, 3rd and 4th-bit of the chipertext an SPN-network block cipher with $Nr = 3$ number of rounds. The chosen encryption key is $K = 00010100000010101001001010000110$. The initial data of block cipher is randomly chosen.

The measure concept will be used to analyze the characteristic of the generated set of points. Let $\mu(B_1), \mu(B_2), \ldots, \mu(B_{25})$ denotes measures of balls $B_1, B_2, \ldots, B_25$ from bottom left to upper right. In this case, *measure* can be presented as a vector $\vec{\mu}$ whose 25 number of components. The generated set of points and the areas which will be measured are shown in figure 4.

These are some added concepts related to measure. They will be used to analyze the output of the chaos game algorithm.

Definition 9. *Let $\mu_{exp}(B)$ denotes the measure value whenever the set of points generated by chaos game algorithm is equivalent with the attractor of the*

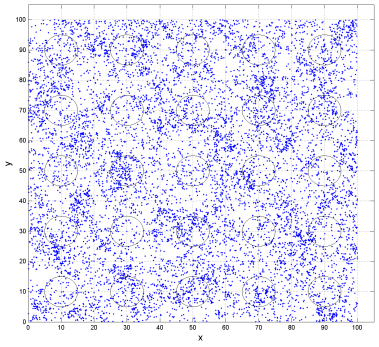

Figure 4 Set of points generated by chaos game algorithm which used an SPN-network block cipher whose 3 rounds.

corresponding IFS. Bias *and* normalized bias *will be defined as follows:*

$$\begin{aligned} \textit{bias}\,(B) &= \mu\,(B) - \mu_{exp}\,(B) \\ \textit{normalized bias}\,(B) &= \frac{\textit{bias}\,(B)}{\mu_{exp}\,(B)} \end{aligned} \tag{8}$$

In this case, bias and normalized bias is presented in a vector form . We also assign an *root mean square* (RMS) value to normalized bias vector:

$$RMS\left(\vec{\text{normalized bias}}\right) = \sqrt{\left(\frac{\vec{\text{normalized bias}}^{\,T} \cdot \vec{\text{normalized bias}}}{\text{number of components of the vector}}\right)} \tag{9}$$

The previous analysis results $RMS\left(\vec{bias_{norm}}\right) = 0.2393$.

Next, we will compare the randomness of the same kind of cipher with four and three number of rounds. For each cipher, the analysis is performed by picking ten initial data randomly as samples. Iteration of these ciphers with each initial data will be used to generate sets of points by using chaos game algorithm. Then, the s$RMS\left(\vec{\text{normalized bias}}\right)$ will be calculated for each iteration with corresponding initial conditions. This analysis uses encryption key $K = 00010100000010101001001010000110$, ten inital data and 1000 number of iterations for each initial data. The analysis results:

$$RMS\left(\vec{\text{normalized bias}}\right)_{\text{3 rounds}} = \begin{bmatrix} 0.4666 \\ 0.4846 \\ 0.4395 \\ 0.4708 \\ 0.4598 \\ 0.4336 \\ 0.4563 \\ 0.3947 \\ 0.4395 \\ 0.4481 \end{bmatrix}$$

$$RMS\left(\vec{\text{normalized bias}}\right)_{\text{4 rounds}} = \begin{bmatrix} 0.3822 \\ 0.3572 \\ 0.3595 \\ 0.4073 \\ 0.3575 \\ 0.3542 \\ 0.3761 \\ 0.3371 \\ 0.3688 \\ 0.3170 \end{bmatrix}$$

A smaller $RMS\left(\vec{\text{normalized bias}}\right)$ indicates that the sequence s has a higher randomness level. The analysis shoes that the block cipher with greater number of rounds will produce a sequence s whose higher randomness level. Because each $RMS\left(\vec{\text{normalized bias}}\right)$ in the analysis is calculated by picking random initial data, then a statistical test (such as one-way anova) may be used to distinguish the two different sets of data, $RMS\left(\vec{\text{normalized bias}}\right)_{\text{3 ronde}}$ and $RMS\left(\vec{\text{normalized bias}}\right)_{\text{4 ronde}}$.

V. Conclusions

In this paper, the analysis toward block cipher is performed by iterating the block cipher and then generating a random sequence based on several bits chosen from the ciphertext block of the cipher. Next, the randomness of the sequence is analyzed using the chaos game method and based on this analysis the complexities of the cipher (example: number of rounds) can be concluded.

An experiment in this paper has been shown that the method can distinguish ciphers with different number of rounds. The experiment shows that block cipher whose four rounds can generate random sequences with higher randomness level than the one generated by block cipher whose three rounds. It can be verified statistically that the normalized bias produced by the four-rounds block cipher is much lower than the one produced by three-rounds block cipher.

This capability of the method to distinguish SPN-network block ciphers with different number of rounds from each other may be explored further to develop an attack method towards the cipher. Further research is also needed to investigate the applicability of the chaos game method for analyzing standard block cipher algorithm which usually has very good confusion and difussion in each round. How

computing power requirement for executing the chaos game method is related to a block cipher complexities is also very a important matter to be investigated further.

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Derivation of An Existing Symmetric Watermarking Technique into Its Asymmetric Version. Case Study: Wang Algorithm

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***Abstract*—This paper presents an asymmetric watermarking technique derived from Wang Algorithm, a symmetric watermarking technique. This asymmetric version uses secret watermark as private key and public watermark as public key. The public watermark has a normal distribution and the private watermark is a linear combination of the public watermark and a secret sequence. The detection process is implemented by correlation test between the public watermark and the received image. Experiments show that the asymmetric technique was proved as robust as its symmtric version againts some typical image processings.**

***Index Terms*—asymmetric watermarking, Wang Algorithm, derivation, correlation.**

I. INTRODUCTION

Digital watermarking has been used widely as a tool for protecting copyright of digital multimedia data (e.g images) [1, 2]. Many digital watermarking techniques for still images have been proposed [1-3]. The particular problem with the state-of-the-art watermarking techniques is that the majority of these schemes are symmetric: watermark embedding and detection use the same key. The symmetric watermarking scheme has a security problem. Because the watermarking algorithm is published, once attacker knows the secret key, the watermark not only can be detected, but it can be easily estimated and removed from the multimedia data compeletely without making any degradation and thereby defeat the goal of copyright protection.

A solution to solve the problem is the *asymmetric watermarki*ng scheme, in which different key(s) are used for watermark embedding and detection. An asymmetric watermarking system uses the *private key* to embed a watermark and another key – it is called the *public key* – to verify the watermark. Anybody who knows the public key could detect the watermark, but the private key cannot be deduced from the public key. Also, knowing the public key does not enable an attacker to remove the watermark [3]. Review of several existing asymmetric watermarking techniques can be found in [4].

We need intensive effort and time if we design a new asymmetric watermarking technique. Thus we think to derive a symmetric watermarking technique into its asymmetric version. Key of this transformation is based on process of generating the private key and the public key. In this paper, we choose an existing symmetric watermarking technique achieving very good results in robustess. We choose Wang Algorithm [5] because the algorithm achieve very good results in imperceptibility and robustness. We will compare performance between the symmetric watermarking and its asymmetric version.

II. WATERMARKING IN DCT DOMAIN

Current image watermarking methods can be grouped into spatial domain methods and transform domain methods. In spatial domain, we embed the watermark by directly modifyng the pixel values of the original image. In transform domain, a transformation is first applied to the original image before embedding watermark. Then, the transform coefficients are modified to embed the watermark and finally the inverse transform is applied to obtain the watermarked image. Since the watermark embedded in the transform domain is irregularly distributed over the image after the inverse transform, the method make it more difficult for an attacker to read or modify the watermark [7]. Futhermore, embedding the watermark into the transform-domain can increase the robustness, when the watermarked image are tested after having been subjected to common image processings.

There are three main transform methods generally used, i.e Fourier transform (DFT), discrete cosine transform (DCT), and wavelet transform (DWT). In this paper we use DCT method. The DCT can be applied to transform the whole image or image blocks (8×8 pixel). By referring to JPEG compression, watermarking that operates on 8×8-DCT blocks yields better robustness than that on the whole image [6].

The DCT allows an image to be divided into different frequency subbands: low, middle, and high frequency. Embedding the watermark into the low-frequency

subbands can degrade the image quality, whereas high frequency components are easily discarded after low pass filterring or JPEG compression. Therefore, for balancing between image fidelity and robustness, most watermarking techniques embed the watermark into the middle-frequency subbands.

III. WANG ALGORITHM

Wang [5] proposed a novel blind detection method for multiplicative robust watermarking. Given an image with size $M \times N$; the image is divided into 8×8 blocks, then the DCT is applied to every sub-image. In order to satisfy the balance between the robustness and imperceptibility, the middle frequency coefficients are selected to embed the watermark by the zigzag scan in every sub-image. The watermark is a sequence that has Gaussian distributionn with mean 0 and variance 1. There are 1000 randomly watermarks generated and one of 1000 watermarks is chosen randomly to embed the original image. The multiplicative embedding rule is defined as

$$I' = I(1 + \alpha W) \tag{1}$$

where I' are the watermarked transform coefficients correponding to the original tranform coefficients I, α is the watermark strength and W is the watermark. The watermarked image is obtained after transforming the watermaked transform coefficients. Fig. 1 shows the embedding process.

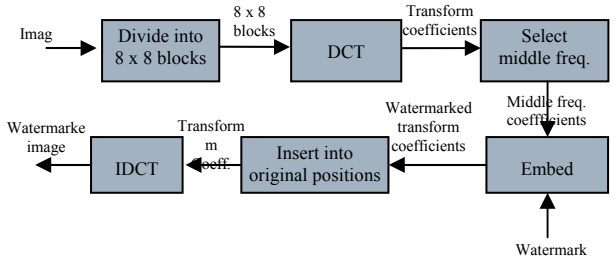


Fig. 1. Embedding process

Watermark detection is realized by computing correlation between the transform coefficient and watermark. The middle frequency coefficients are selected by the same rule mentioned above. The correlation c is defined as

$$c = \frac{1}{N}\sum_{i=1}^{N} |I'_i| W_i \tag{2}$$

According to Eq. (2), wheter a given watermark is present or not in the received image can be determined by comparing c with a specified threshold T:

$$\text{decision} = \begin{cases} 1 & , c \geq T \\ 0 & , c < T \end{cases}$$

Decision = 1 indicates that the watermark is present in the received image, or decision = 0 if the received image don't contain the watermark. Fig. 2 shows the detection process.

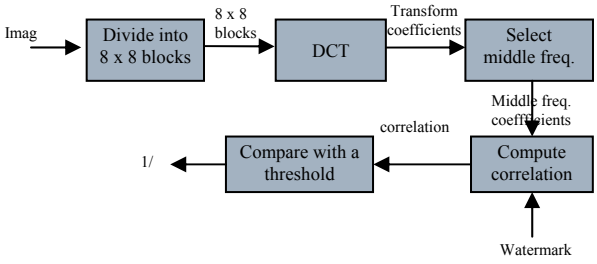


Fig. 2. Detection process

IV. ASYMMETRIC VERSION

We derive an asymmetric technique from Wang Algorithm. Key of this transformation is based on process of generating the private key and the public key. The public key should have a correlation with the private key. The private watermark is embedded into the image. User can perform an asymmetric detection using a correlation test between the public watermark and the received image.

In Wang Algorithm, the secret key is the watermark itself where it has normal distribution. In asymmetric version of Wang Algorithm, the private key and the public key is referred as the private watermark and the public watermark. We want the two watermarks to have normal distribution.

There exist numerous methods to generate the private watermark that are different but have a fixed correlation with the public watermark and both watermarks have normal distribution. One of them is by using statistics approach. In statistics, if we add two or more random variables as a linear combination where each of them has normal distribution, then the result has normal distribution too. Let X be a sequence with mean μ_1 and variance σ_1^2 and Y be sequence that independent from X with mean μ_2 and variance σ_2^2. A combination linear of X and Y is defines as

$$Z = aX + bY \tag{3}$$

where a and b is parameters. Sequence Z has the mean

$$\mu_3 = a\mu_1 + b\mu_2 \tag{4}$$

and variance

$$\sigma_3^2 = a^2\sigma_1^2 + b^2\sigma_2^2 \tag{5}$$

In generating the watermarks we have to ensure that the combination linear is secure. It means that the private watermark cannot be deduced from the public watermark. Also, knowing the public watermark does not enable an

user to remove the embedded watermark from the watermarked image. This characteristic is realized by adding the public watermark with a secret sequence. Security of this asymmetric version depend on the secret sequence. Let W_p be the public watermark and R be the secret sequence, the private watermark can be obtained by adding W_p and R as

$$W_s = \beta W_p + (1 - \beta)\, R \tag{6}$$

where β is a parameter in [0, 1] to control the compromise between the two sequences. In order to make the sequence R is more secure, we encrypt R by a random permutation before adding with W_p. Thus, eq. (6) can be written as

$$W_s = \beta W_p + (1 - \beta)\, \widetilde{R} \tag{7}$$

where $\widetilde{R}$ is encrypted version of R. Fig. 3 shows process of generating the public and the private watermak.

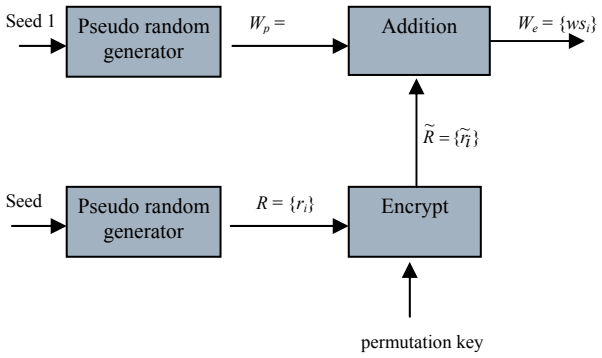


Fig. 3. Generating of the public and the private watermark

The private watermark is embedded into the image according to eq. (1) by replacing W with W_S:

$$I' = I(1 + \alpha W_s) \tag{8}$$

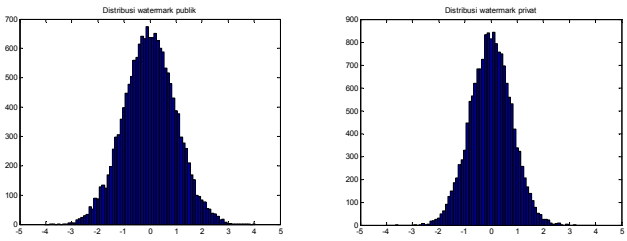
In the detector side, both the original image and the private watermark are not needed. Using the public watermark, W_p, the following correlatin is computed:

$$c = \frac{1}{N} \sum_{i=1}^{N} |I'_i| W_{p_i} \tag{9}$$

After we set the threshold T, the watermark detection is finished by the comparison between c and the threshold.

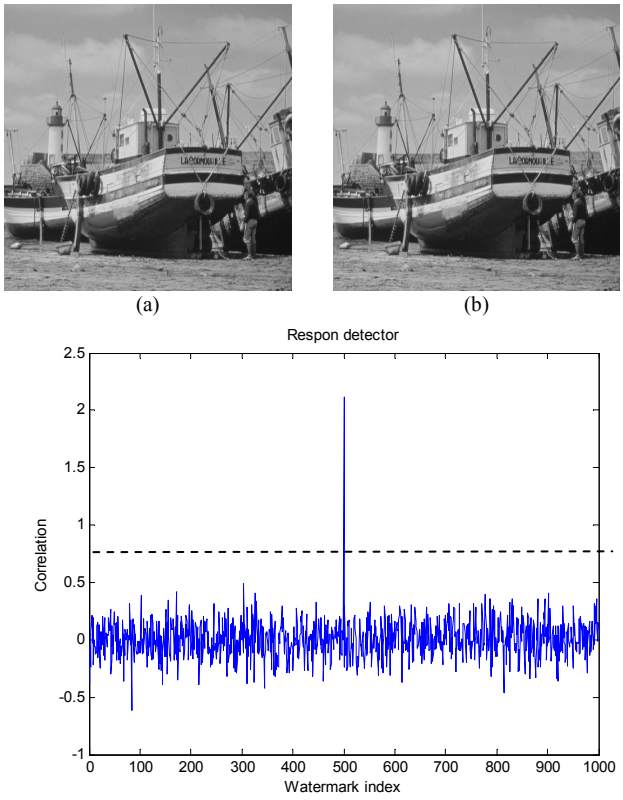
V. Experiment and Results

We apply our method to image watermarking by using MATLAB as programming tool. The test image is a 512 × 512 gray image 'Boat'. The public watermark is a 128 × 128 real matrix that has a normal distribution with *mean* = 0 and *variance* = 1. The embedding strength α is equal to 0.3 and parameter β is equal to 0.75. Distribution of the public watermark and the private watermark is shown in Fig. 4. From Fig. 4(b) we observe that shape of distribution graphics of the private watermark is like a bell as common normal distributions.



(a) (b)

Fig. 4. Distribution of (a) the public watermark and (b) the private watermark



(a) (b)

(c)

Fig. 5. (a) Original image. (b) Watermarked image. (c) Detection threshold experimently. T is set to be 0.75.

Figure 5(a) shows the original image and Figure 5(b) shows the watermarked image (*PSNR* = 47.1454). Next, we derive the detection threshold empirically. Figure 5(c) shows the detection threshold of 1000 random public watermarks studied, and only one public watermark, which has a correlation with the secret watermark, has a significantly higher correlation output than the others. The threshold T is set to be 0.75 in this graph (dashed

line). In case no attack done, the detector results c = 2.1148. This value is greater than the T, it means that the received image contains the watermark. As comparison, if we detect by using the private watermark, it results correlation c = 1.7324.

If the received image does not contain the watermark (in this experiment we use an unwatermarked 'Boat' image as input to detector), we get c = 0.0093 and there is not a significantly higher correlation output than the others (Fig. 6). We conclude that the image does not contain the watermark.

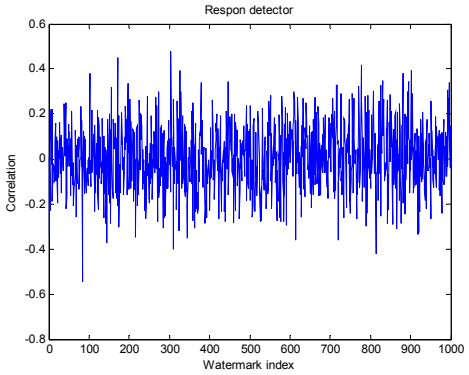


Fig.6. There is not a significanty higher correlation output than the others. The test image does not contain the watermark.

We have tested robustness of our method againts various attacks using common image processings (JPEG compression, cropping, resizing, etc). We use *Jasc Paint Shop version 6.01* as image processing software. For every attack, we set different thresholds, depend on the experiment to derive the threshold empirically. The experiments and results are explained as follows.

V.1. Experiment 1: JPEG Compression

We tested the robustness against JPEG compression with various extreme compression qualities: 0% and 5%. For compression quality 5%, the watermark can be detected well (c = 0.8660) and surprisingly for compression quality 0% the watermark still can be detected (c = 0.4290, T = 0.7). In the two experiments, the detector shows a significantly higher correlation than random watermarks, see Fig. 7 and 8 for details.

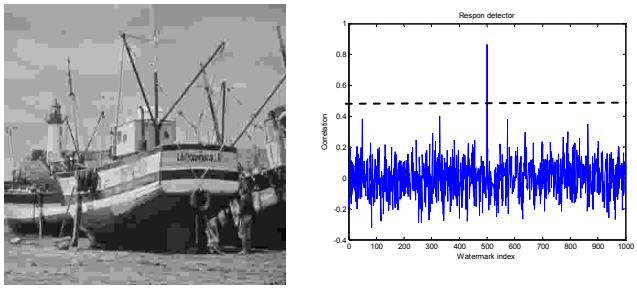


Fig 7. JPEG compression with compression quality 5%. The watermark can be detected

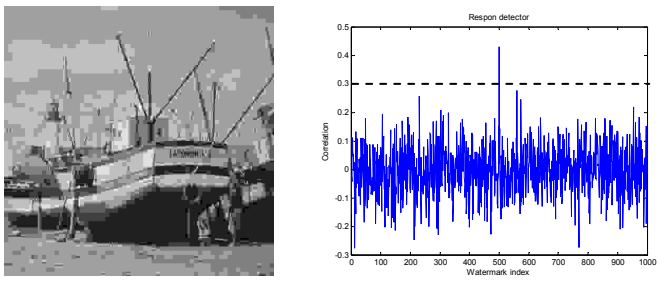
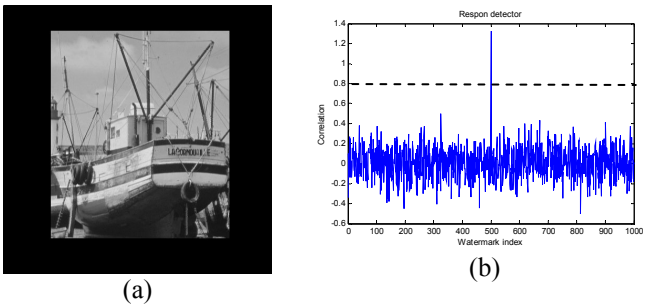


Fig 8. JPEG compression with compression quality 0%. The watermark still can be detected

V.2. Experiment 2: Image Cropping

Image cropping will remove some watermark information. In our simulation, we cut unimportant part from the watermarked image, the missing part of the image is replaced with black pixels (see Figure 9(a)). In fact, we can always corectly detect the watermark because the correlation value (c = 1.3266) is still greater than T. In this case, we set T = 0.8 from the experiment (see Figure 9(b)).

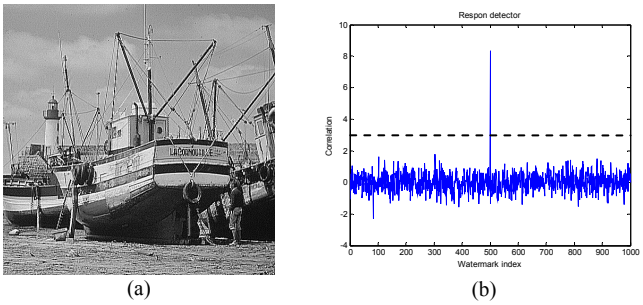


(a) (b)

Fig. 9. (a) Image cropping. (b) Detector response. The watermark still can be detected (we set T = 0.8).

IV.3 Experiment 3: Sharpening and Adding Noise

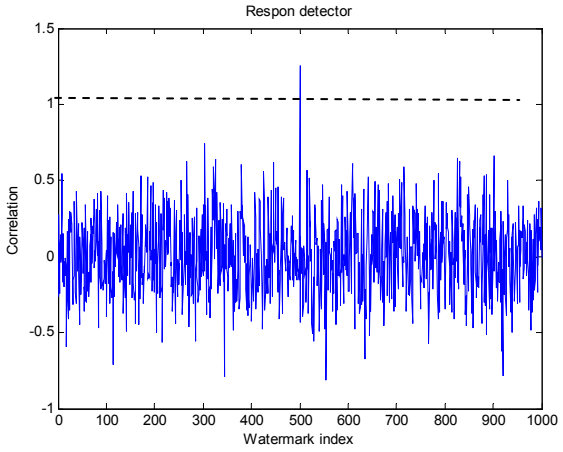
The watermarked image is sharpened several times (high-pass filtering operation) until their edges look sharper than the original version. We still detect the presence of the watermark (see Fig. 10, in this case we set T = 3.0 and c = 8.3470). We also add some noises like salt and peppers of 15%. The results show that the watermark can be detected (see Fig. 11, in this case we set T = 1.0 and c = 1.2519).



(a) (b)

Fig. 10. (a) Image sharpening. (b) Detector response.

(a)

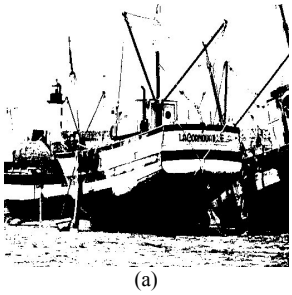


(b)

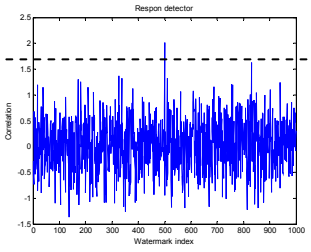
Fig. 11. (a) Adding noise. (b) Detector response

IV.4 Experiment 4: Dithering

We convert the watermarked image to a binary image by dithering operation. It means plenty of gray-level information lost. It is shown in Fig. 12 that the watermark still can be detected. The response to the right watermark is largest among the response to all the watermarks.



(a)

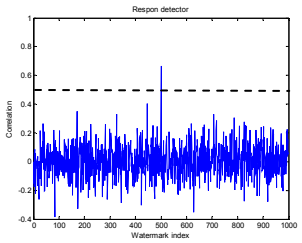


(b)

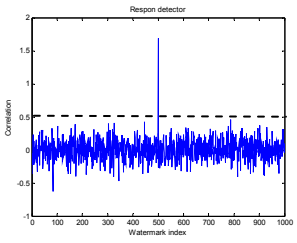
Fig. 12. (a) Dithering. (b) Detector response

IV.5. Experiment 5: Resizing

The image watermarked is resized until 50% of the original size. To detect the watermark, the smaller image must be returned to original size (else the watermark can not be detected). We found that $c = 0.6656$ (we set $T = 0.7$) and this experiment shows that the watermark still can be detected (see Fig. 13(a)). For resizing up to 200% of the original image, the watermark still can be detected well (we found that $c = 1.6862$ and set $T = 0.5$) (see Fig. 13(b)).



(a)



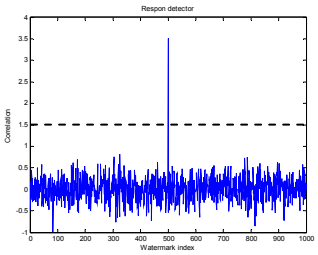
(b)

Fig. 13. Image resizing (a) 50% and (b) 200%.

IV.6. Experiment 6: Histogram Equalization

The watermarked image is adjusted so that distribution of gray-level is uniform by using histogram equalization operation (a typical low-pass filtering operation). Experiment shows that the watermark can be detected where $c = 3.5115$ and $T = 1.5$ (see Fig. 14).

(a)



(b)

Fig. 14. (a) Histogram equalization. (b) Detector response

VI. SECURITY ANALYSIS

If an attacker want to remove the watermark from the watermaked image, he (or she) must find $\tilde{R}$ in order to get W_s according to equation (7). Once W_s is calculated, the original image can be extracted by manipulation of equation (8) as follows:

$$I = \frac{I'}{(1+\alpha W_s)} \tag{10}$$

The attacker knows W_p, α and β but he (or she) doesn't know $\tilde{R}$. Because $\tilde{R}$ is encrypted version of R, the

attacker hard to find it. Let the attacker knows R, next he (or she) need know a random permutation used to encrypt R. Because cardinality of R is n, the attacker must try C(n, n) = n! permutation to find the right permutation. Remember that n is large enough, it is about 25% of original image size, so that finding the right permutation needs O(n!) computation. For n = 10000 as example, there are 10000! computation! We conclude it is impossible for attacker to deduce the private watermark from these public information.

V. CONCLUSION

In this paper an asymmetric watermarking technique for still images derived from its symmetric version has been proposed. This technique uses two watermarks; the first watermark is a public watermark used to public detection, and the second watermark is a private watermark that has a correlation to the public watermark. The private watermark is a linear combination of the public watermark and a encrypted version of a secret sequence. Security of this asymmetric technique is based on the difficulty of finding the secret sequence where it needs $O(n!)$ computation. Simulation have confirmed that this asymmetric technique is as robust as its symmetric version.

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Proper Noun Adaptation for Improving a Spoken Query-based Indonesian Information Retrieval System

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***Abstract*—Proper noun recognition is one of the challenging problems in the automatic speech recognition. In many languages, proper nouns pronunciation often does not follow general grapheme-to-phone conversion rules. Our experimental work reported in this paper shows that proper noun recognition in the Indonesian LVCSR (Large Vocabulary Continuous Speech Recognition) system is also more difficult than other regular words such as verbs and adjectives. However, in most of the information retrieval (IR) systems, proper nouns are usually keywords of the queries. Thus, high proper noun recognition error significantly decreases the performance of the IR. In order to increase the proper noun recognition accuracy, we propose a proper noun adaptation method based on the MLLR (Maximum Likelihood Linear Regression) approach. This technique reduces the recognition error rate by 2.38%, and gains 1.96% improvement of the IR MAP (mean average precision) score and 2.43% improvement of the IR MRR (mean reciprocal rank) score comparing to our baseline system.**

***Index Terms*—Indonesian Spoken Query, Information Retrieval, LVCSR, MLLR Adaptation.**

I. INTRODUCTION

The widespread access to the Internet has made information resources easily accessible from everywhere. However, there are cases where it is impossible or not convenient to use keyboard as the input device, such as for car drivers, and blind or partially-sighted users. In addition, a very large part of the world population does not have access to computers or Internet, e.g. in the rural area, in which the only available or the most convenient communication mean can be a telephone or a mobile phone. In all of these cases, if we want to let users take advantage of the large amount of information stored in digital repositories, it is necessary to enable voice access to the system as the query input rather than by using the text input. However, sometimes a high error rate of the speech recognition system severely decreases the information retrieval (IR) system's effectiveness. When the spoken terms are incorrectly recognized, a number of relevant documents containing the correct terms cannot be retrieved, while a number of irrelevant documents containing the wrong terms are retrieved. The larger the number of misrecognition terms becomes in the transcribed query, the lower the ranking of the retrieved documents becomes. In most of the information retrieval systems, the proper nouns are usually keywords of the queries. However, the proper noun recognition in the Indonesian LVCSR (Large Vocabulary Continuous Speech Recognition) system is more difficult comparing to other regular words. Thus, the high proper noun recognition error significantly drops the IR performance.

Several different automated methods, such as Boltzmann machines [1,2] and Decision Trees [3] have been proposed to reduce the proper noun error rate, however they have not yet achieved an acceptable error rate. In this paper we propose a proper noun adaptation method based on the MLLR (Maximum Likelihood Linear Regression) approach to reduce the proper noun error of Indonesian spoken queries.

II. INDONESIAN LANGUAGE

The Indonesian national language called Bahasa Indonesia is a variant of Malay language and categorized as the Austronesian or the Malayo-Polynesian language. Indonesian language is written using the Latin alphabet consisting of 26 characters from A to Z. The space symbol is used to separate words and some punctuation symbols e.g. ".", ",", "!", and "?", are used to separate sentences as in English. The correspondence between sounds and their written forms is generally regular. However there are some exceptions in proper nouns especially for old written style proper nouns or proper nouns that came from regional languages. The Indonesian standard phoneme set as described by Darjowidjojo [4] can be seen in Appendix 1. Indonesian language has borrowed many words from many languages, including Sanskrit, Arabic, Persian, Portuguese, Dutch, Chinese and many other languages, including other Austronesian languages. The basic word order in Indonesian sentences is Subject-Verb-Object. The adjective, demonstrative pronoun and possessive pronoun are written to follow the modified noun.

III. LARGE VOCABULARY CONTINUOUS SPEECH RECOGNITION (LVCSR)

Automatic speech recognition is a technology that allows computers equipped with a device for sound input such as a microphone to transform human speech into a sequence of words. The system consists of three main components: an acoustic model, a language model and a decoder. The acoustic model represents how a given word or a phoneme ("phone") is pronounced. The language model predicts likelihood of a given word sequence appearing in the language. When the size of vocabulary that can be recognized is large (more than thousands of words), and they are spoken continuously, the task is referred to as large vocabulary continuous speech recognition or LVCSR.

The decoder estimates a word sequence $\hat{W}$ that generated a given acoustic observation sequence O. The speech recognition process can be formulated as a process of maximizing a posteriori probability of W given O, $P(W|O)$, as follows:

$$P\left(\hat{W} \mid O\right) = \max_{W} P\left(W \mid O\right) \tag{1}$$

By Bayes rule, the a posteriori probability can be converted into:

$$P\left(W \mid O\right) = \frac{P\left(O \mid W\right) P\left(W\right)}{P\left(O\right)} \tag{2}$$

Since $P(O)$ is independent of W, the recognition process becomes to:

$$\hat{W} = \arg\max_{W} P\left(O \mid W\right) P\left(W\right) \tag{3}$$

where $P(O|W)$ is a probability of producing O given W. It represents the probability of an acoustic observation sequence conditioned on the given word sequence. This probability is usually represented by Hidden Markov Models (HMMs). $P(W)$ is a language model which represents a probability of a word sequence observed in the language. Word n-gram models are generally used to estimate this probability.

A. Hidden Markov Models (HMMs)

In a HMM-based phone model, each phone is represented by an HMM. Each HMM phone model usually has a left-to-right topology and has five states. These states are an entry state, three emitting states, and an exit state. To produce a word, phone HMMs are combined together by joining the exit state of an HMM with the entry state of another HMM.

A basic principle of a Markov model is that it works as a finite state machine which changes the state once every time unit t. At each time t, a state j is entered and a speech vector O_t is generated based on a probability density $b_j(O_t)$. The transition from state i to state j is also probabilistic with a probability a_{ij}. In the generation process, only the observation sequence is known, and the underlying state sequence is hidden. This is why it is called a Hidden Markov Model. By summing the product of transition probabilities a_{ij} and output probabilities $b_j(O_t)$, a joint probability of a speech vector O_t and a state sequence X given a model M can be computed, and by considering only the most likely state sequence, the likelihood can be approximated as follows:

$$\hat{P}\left(O \mid M\right) = \max_{x} \left\{ a_{x(0)x(1)} \prod_{t=1}^{T} b_{x(t)}\left(O_t\right) a_{x(t)x(t+1)} \right\} \tag{4}$$

where $x(0)$ is the model entry state and $x(T+1)$ is the model exit state. Equation (4) assumes that the transition probabilities a_{ij} and the output probabilities $b_j(O_t)$ are trained for each model M_i. These parameters can be calculated by conducting a robust and efficient re-estimation procedure using a set of training examples corresponding to a particular model. Thus, to build an HMM-based model, a training set of acoustic utterances with its transcription is needed. Usually, the larger the available training data is, the higher the recognition accuracy.

To determine the parameters of each model M_i, it is necessary to make an initial model of what they might be until more accurate parameters in the sense of maximum-likelihood can be found. This can be achieved by applying Baum-Welch algorithm. This algorithm is based on an expectation maximization (EM) algorithm. It can compute maximum likelihood estimates and posterior model estimates for the parameters (transition and emission probabilities) of an HMM, even when only emissions are given as training data. Current LVCSR systems use mixtures of Gaussian distribution to represent each state in the HMM. Parameters of each Gaussian distribution are estimated from training data.

B. N-gram Models

In LVCSR systems, n-gram language models are used to provide the recognizer with an a priori likelihood $P(W)$ of a given word sequence W. It is usually derived from a large training text that shares the same language characteristics as expected input. N-gram language models rely on the likelihood of sequences of words, such as word pairs (in the case of bi-grams) or word triplets (in the case of tri-grams). If we assume that W is a sequence of words and q is the number of words in W, i.e., $W = \left(w_1, w_2, ..., w_q\right)$. The language model $P(W)$ can be generated as follows:

$$P\left(W\right) = P\left(w_1, w_2, ..., w_q\right) = \prod_{i=1}^{q} P\left(w_i \mid w_{i-n+1}, ..., w_{i-1}\right) \tag{5}$$

where n is the order of the Markov process. In particular, models with n = 2 and n =3 are widely used and are called bigrams and trigrams, respectively. In order to estimate the probability of $P(w_i \mid w_{i-2}, w_{i-1})$ in the trigram case, simple counts of each word-triplet in the training corpus are used as follows:

$$P(w_i \mid w_{i-2}, w_{i-1}) = \frac{N(w_{i-2}, w_{i-1}, w_i)}{N(w_{i-2}, w_{i-1})} \quad (6)$$

where $N(a, b)$ denotes the number of times one observes a and b continuously in the training data.

N-gram models have been popular because they yield simple and highly reasonable models. However, a problem arises when a word-pair or a triplet is not observed in the training text. It will give a 0 probability for the unseen word pair or triplet and, hence will make the probability of the entire sentence W to be 0. Due to data sparseness, this happens very often in practical situations, and it causes speech recognition errors. Another problem of n-gram is that an unreliable probability is assigned to infrequent words such as infrequent proper nouns. To avoid this problem, several smoothing techniques are usually applied. The fundamental idea of smoothing techniques is to subtract some small probability mass from the relative frequency estimates by Equation (6) for the probabilities of infrequent n-grams, and to redistribute this probability to unseen n-grams. There are several proposed smoothing techniques. These methods differ according to how much is subtracted out, called discounting, and how it is redistributed, called back-off. Some of the smoothing techniques that worked well in ASR systems include Linear interpolation proposed by Jelinek [5], Good-Turing discounting [6], Witten-Bell discounting [7], and Katz back-off [8].

C. MLLR Adaptation

The maximum likelihood linear regression (MLLR) method computes a set of linear transformations that reduce the mismatch between an initial model set and adaptation data. This technique estimates transformations for mean and covariance of Gaussian mixture HMMs so that they maximize the likelihood of the adaptation data. For speech recognition, this method was originally proposed by Leggetter et al. [9] and has been widely used.

IV. SPOKEN QUERY INFORMATION RETRIEVAL

Spoken query information retrieval refers to the IR which uses spoken queries to retrieve textual or spoken documents. The spoken query processing has a number of challenges compared with the text query processing. The most important ones are:

- Misrecognition of spoken query terms produced by the ASR. This may cause the terms to disappear from the query representation and also to be replaced by different terms. Thus, a large set of potentially relevant documents may not be retrieved.
- The additional time required to pre-process the query. A spoken query needs to be recognized and a transcript needs to be produced at the time the query is submitted. It has been observed that user satisfaction with an IR system also depends upon the time the user needs to wait for the system to display the results [10]. This includes the time to process the query.
- Spoken style queries tend to be longer than text queries and they frequently contain less important words, such as function words. Moreover they may also increase the searching confusion. Thus, they require some additional processing to remove words in the query that do not give important information for search.

Some studies show that the use of classical IR techniques for spoken query is quite robust to considerably high levels of WER (up to about 47%) [11]. However, there still exists the room for improvement. The tf-idf (term frequency – inverse document frequency) weighting method [12] is often used in IR. It is a statistical technique to evaluate how important a term is in a document. The importance increases proportionally to the number of times a word appears in the document but is offset by how common the word is in the document collection. There are many variations of the tf-idf formula depending on the way the tf and idf weights are computed [13]. In this experiment we used the most standard tf-idf formula as shown below:

$$tf(i, j) = \frac{n_{i,j}}{length_j} \quad (7)$$

$$idf(t_i) = \log \frac{N}{n_i} \quad (8)$$

where $n_{i,j}$ is the number of occurrences of a term t_i in a document d_j, $length_j$ is the number of words in the document d_j, N is the total number of documents in the collection, and n_i is the number of documents in which the term t_i occurs in the document collection.

The retrieval status value (RSV) is evaluated by applying the dot product to the document and query representations obtained using the tf-idf weighting schema. The score for each document is calculated by summing the tf-tdf weights of all query terms found in the document as shown below:

$$RSV(d_j, q) = \sum_{t_i \in q} idf(t_i) \cdot tf(i, j) \quad (9)$$

Some IR systems enable to perform Relevance Feedback (RF). The RF enables the system to reformulate the query after gaining some feedbacks. There are two kinds of the RF regarding the way it gains the feedback. The first one is the standard RF which enables a user to interactively express his information requirement by modifying his original query by explicitly confirm the relevance of some documents retrieved by the system. The second one is the Pseudo RF. In this method the system assumes that its top-ranked documents are relevant, and uses these documents in the RF algorithm. If RF performs well the final search should contain more relevant documents than the initial search.

The main IR evaluation measures are Recall and Precision. Recall is defined as the portion of all the relevant documents in the collection that has been retrieved. Precision is the portion of retrieved documents that is relevant to the query. To give more accurate measure, Average Precision is commonly used, defined as the average of 11 Precision values of the preset different levels of Recall. MAP is a mean of Average Precision scores for a group of queries. Another common IR evaluation measures is the mean reciprocal rank (MRR). The reciprocal rank is defined as the inverse of the rank of the first correct answer. The MRR is the average of the reciprocal ranks of results for a sample of queries Q as shown below:

$$MRR = \frac{1}{|Q|}\sum_{i=1}^{Q}\frac{1}{rank_i} \tag{10}$$

where $|Q|$ is the number of queries and $rank_i$ is the ranking of the first relevant document in the search list.

V. EXPERIMENTS

A. Baseline System

For the ASR, we employ the Bahasa Indonesia LVCSR system that we built previously [14]. For the acoustic model, context-dependent HMMs were trained using 32 Gaussian mixtures per state from a 14.5 hours Indonesian phonetically balanced-speech corpus recorded in our laboratory. For the language model, the bigrams and trigrams were trained using the ILPS corpus [15]. The articles in the corpus were taken from the two popular Indonesian newspaper [1] and magazine [2] sites. Both bigrams and trigrams were smoothed using the Good-Turing back off technique.

For building the dictionary, words that occur in the ILPS corpus for more than 3 times were selected. There were 2.65K words in the dictionary.

[1] http://www.kompas.com

[2] http://www.tempointeraktif.com

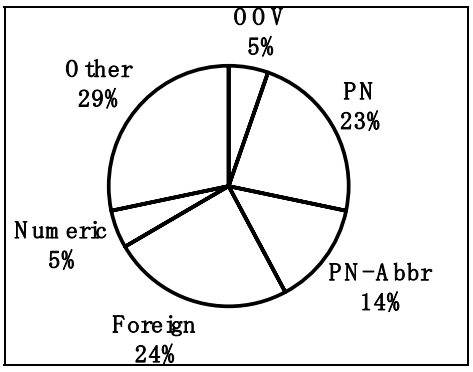

Figure 1. Error analysis of the transcribed queries for the baseline system (PN: proper nouns)

The spoken query was first transcribed using the Bahasa Indonesia LVCSR. We used Julius version 3.4[3] as the speech decoder. After removing the stop words in Bahasa Indonesia [16], the transcribed query with a speech recognition confidence score for each term in the query was fed into the IR system. We used the Lemur toolkit [4] provided by Carnegie Mellon University and the University of Massachusetts, Amherst, to build the Indonesian IR system.

B. Proper Noun Adaptation

From the baseline evaluation, we found that a majority of the misrecognized words was caused by proper nouns (23% error was regular proper nouns, and 14% error was abbreviated proper nouns) as shown in Figure 1. Assuming that the difficulties of recognizing proper nouns came from the acoustic variation, we tried to solve the problem by enhancing the acoustic model. To model the acoustic variations in uttering proper nouns by Indonesian speakers, an adaptation technique was used to create proper-noun specific acoustic models. We conducted supervised adaptation based on the MLLR technique using 8 regression classes. The adaptation data was proper noun utterances (14,840 words) extracted from the Indonesian speech corpus that was used to train the baseline acoustic model.

C. Evaluation

Since there is no standard evaluation corpus for spoken query IR in Bahasa Indonesia, we recorded spoken queries from 20 native Indonesian speakers (11 males, 9 females), each uttering 35 queries with different topics. The queries were derived from the Bahasa Indonesia IR collection developed by the ILPS [15]. There are 35 query topics available for the magazine corpus and the newspaper corpus in the ILPS corpus. In the experiment in this paper, we only used the corpus taken from the magazine. For each of the 35 topics of the query, we developed three kinds of spoken queries in terms of the

[3] http://julius.sourceforge.jp/index.php

[4] http://www.lemurproject.org

length: short query (2-4 words), medium-length query (4-8 words), and long query (8-16 words). There are 2100 Indonesian spoken queries in total. The document collection was taken from the portion of the Indonesian text corpus provided by ILPS that was not used in training the language model of Bahasa Indonesia LVCSR. The trigram language model had a test-set perplexity of 61.04 and an OOV (out of vocabulary) rate of 1.75% for this test set.

The average ASR accuracy of the baseline system was 80.66% and by applying the proper noun adaptation described above, the average accuracy increased 2.38% and became to 83.04%. The accuracy of each speaker can be seen in Figure 2.

Both transcribed queries from the baseline ASR and that using the proper-noun adapted acoustic models were input to the IR system. The text queries were also given into the IR to compare the results with that obtained using ASR. The average MRR score and MAP score for spoken queries using the ASR baseline system and the proper-noun adapted system, and using the text queries can be seen in Table I.

In addition, we applied a query expansion technique using the Pseudo-Relevance Feedback by choosing the top 5 documents in the search list and adding 5 most frequent words in those documents to expand each query. By doing this, we gained 2.7% improvement of the IR MAP score and 1.6% improvement of the IR MRR score.

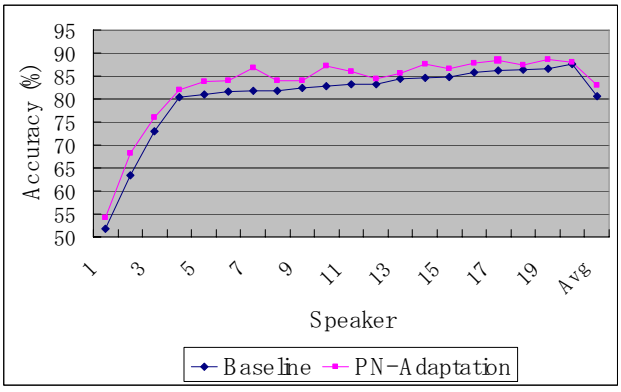

Figure 2. The ASR accuracy for the baseline system and the PN-adapted system for 20 speakers (sorted)

Table I

MRR and MAP score for spoken queries using baseline ASR, spoken queries using PN-adapted ASR, and the text queries

	MRR	MAP
ASR Baseline	0.6983	0.5127
PN-Adapted ASR	0.7226	0.5323
Text Query	0.8242	0.608

VI. CONCLUSION

In order to increase the proper noun recognition rate in the Indonesian LVCSR to increase the IR performance, we proposed a proper noun adaptation method based on the MLLR approach. This technique could reduce 2.38% of the recognition error rate of the spoken query, and gained 1.96% improvement of the IR MAP (mean average precision) score and 2.43% improvement of the IR MRR (mean reciprocal rank) score comparing to our baseline system.

As can be seen in Figure 1, there are several other sources of errors in the transcribed queries, such as foreign words (e.g. English words), numeric words, OOVs, and others. Since all foreign words that appear in the queries were misrecognized in our experiments, we are planning to improve the foreign word recognition performance as our future work.

APPENDIX

Phonetic Category	**Phoneme**	**Example**	
		Word	**Phoneme Sequence**
Vowels			
	/a/	saya	/s a y a/
	/e/	enak	/e n a k/
	/E/	kEmana	/k E m a n a/
	/i/	ingin	/i n g i n/
	/o/	orang	/o r a ng/
	/u/	untuk	/u n t u k/
Diphtongs			
	/ai/	sungai	/s u ng ai/
	/au/	danau	/d a n au/
	/oi/	amboi	/a m b oi/
Semi-vowels			
	/w/	wanita	/w a n i t a/
	/y/	saya	/s a y a/
Consonants			
Plosives	/b/	berapa	/b e r a p a/
	/p/	petani	/p e t a n i/
	/d/	dia	/d i a/
	/t/	teman	/t e m a n/
	/g/	giat	/g i a t/
	/k/	kamu	/k a m u/
	/kh/	khairul	/kh a i r u l/
Africates	/j/	juga	/j u g a/
	/c/	cinta	/c i n t a/
Fricatives	/v/	video	/v i d e o/
	/f/	maaf	/m a a f/
	/z/	jenazah	/j e n a z a h/
	/s/	saya	/s a y a/
	/sy/	syahdu	/sy a h d u/
	/h/	hujan	/h u j a n/
Liquids	/r/	ramai	/r a m a i/
	/l/	lambat	/l a m b a t/
Nasals	/m/	mana	/m a n a/
	/n/	mana	/m a n a/
	/ny/	nyanyian	/ny a ny i an/
	/ng/	lambang	/l a m b a ng/

Appendix 1. Indonesian phoneme set

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Text Document Split Pattern Browsing Based on Linguistic Knowledge of Writing Javanese Script using Natural Language Processing

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***Abstract*—Right now Javanese society write and read using Latin characters and not familiar using Javanese characters. Writing Javanese characters also not simple as Latin characters. How Javanese characters adapt to recent growth of treasury words? It is impossible to restrict the input of Latin characters that will be transliterated to Javanese characters. Beside that not all Latin characters having equivalance to existing Javanese characters. At this moment there were several rules in Javanese grammar are not relevant to do transliteration because of there are a lot of words in the worlds that not having equivalance in Javanese characters. The propose of this transliteration model is being able to used by all society and not only for Javanese society. The using of communication and information technology to build Latin to Javanese characters split pattern model using linguistic computation. The Context Free Recursive Descent Parser method with specific production rule can be used in checking and breaking Latin string to produce right Javanese pattern. From the testing it is seen that by using The Context-Free Recursive-Descent Parser algorithm, text document in Latin writing can be processed so that syllable split patterns can be produced correctly. Honestly this research has not come to the final result, it has only succeeded to produce syllable split patterns. The produced syllable split patterns are ready to be processed into the next step that is the process of converting syllable split patterns to be Javanese character and the mapping of their writing scheme.**

***Index Terms*—Javanese characters, linguistic computation, syllable split patterns, The Context-Free Recursive-Descent Parser**

I. INTRODUCTION

Latin to Javanese character transliteration machine is one of research field in linguistic computational. There is only few researchers who expert in Javanese grammar and has capability in digital tecnology [18]. At this moment there are already two Javanese character true type fonts. The fonts were made by Teguh Budi Sayoga [11] and Jason Glavy [4]. When using those fonts users have to remember several formats [18]. To use the fonts in writing Javanese characters users must have knowledge about how to read and write Javanese. The examples for showing the transliteration *tut wuri handayani*, the symbols has to type are *tutW|rianFyni.* None researchers have already developed algorithm to handle writing Javanese character for *x* and *q* Latin characters, aritmetic operand, special symbols (except period, coma and double quote), multiple consonant (more that two sequences consonant), can not write *q* and *x* Latin character into Javanese character also cannot handle roman numbering system [20].

Grammar or rule to write Javanese character in relevation with huge of words at this time need to be considered. The rules that are not relevant need to be revised by coordination with Javanese expert. The syllable *ca*, *wa*, *dha*, *ya* and *tha*, right now can not give *pasangan* and *pangkon sandhangan* because in Javanese language there are no words ended by those characters. The fact there are words ended by those characters. As a result it will make Javanese character be able to adapt in globalization era [19]. At formal language theory, every language has consistency and standard grammar. In fact, it is impossible to bind string that will be substituted to Javanese character [21]. So that a new rule is needed to revise some irrelevant rule. A character in input string, for example Latin consonant can have more than one possibility of alphabet in Javanese depending on character that follow that consonant. The period also has possibility as indication finishing sentences, decimal or abbreviation

so it will influence how that character build Latin string split pattern [19].

Choosing of parsing method and linguistic computation that will use depends on the problems that will be faced. If list of data model for building transliteration text document has been determined then Pattern Matching is used. This method needs some consideration such as, getting the correct Latin string pattern, sometimes backwards searching is needed in addition that to determine the first character at Latin string breaking searching process there are some methods depending on condition of characters around it. This situation can use method The Context-Free Recursive-Descent Parser. Sometimes parsing is not only used at source string but also on the result of processing string [18].

II. NATURAL LANGUAGE PROCESSING

Human Languages Technology is divided of two main groups, they are spoken Language System and Written Language System. At the second group, the activities done are such as developing of Optical Character Reader character recognition system [17], spell checker [21], grammar checker [14], hyphenation, information retrieval, the system which can conclude the narration [15], translator machine system [16] and transliteration system. Chomsky presented Language as collections of symbols and rules which arrange those symbols, it has opened opportunity for doing the processing of language symbol with computer technology, so it makes science of natural language processing [8]. The technology related to natural language processing is also known as natural language processing or computational linguistic [2]. Natural language processing analysis by using computer at speech and text still have many problem, one of them is ambiguity. Therefore, natural language processing is more difficult than interlingua [7].

Parsing is process for command extraction in natural language. There are 3 kinds of parsers, The State-Machine Parser, The Context-Free Recursive-Descent Parser and The Noise Diposal Parser. String matching, how to find all possibility of occurrence of *x* string with length of *m*, is often called pattern on other string *t* with *n* length called text [1]. String matching is process to find string characters form pattern in other strinf or text document content [10][12]. Pattern matching can be devided into two model, there are exact string matching and inexact string matching or fuzzy string matching [5]. Inexact string matching are divided into two model, first approximate string matching [3] and second phonetic string matching [5]. There are several string searching algorithm, for example are Brute Force Algorithm, Knuth Morris Pratt and Bayer Moore [13]. Each algorithm having their own advantage and disadvantage [10]. Brute Force algorithm comparing to the other is simple and strong [6]. Brute Force algorithm chosen on this research because degree of succesfull finding solution is 100% although having weakness on time process efficiency [9].

III. TEXT DOCUMENT SPLIT PATTERN BROWSING CONCEPT

Natural language processing component to make text document split pattern written on Latin character using The Context-Free Recursive-Descent Parser. This split pattern algorithm completed with ability to detect writing error possibility at the source text, text that will be syllable browse. So in general text source cultivation include:

a. File writing and reading process
b. Formatting process
c. Roman number checking process
d. Spell checker for filtering wrong words process
e. Latin string split pattern browsing process

A. Part I: File Writing and Reading Process

Text document written using Latin character. String which will be transliterated is sequence ASCII character in text document (not graphic document) so it is not necessary to train and learn in recognizing the shape of character [19]. Every source text written using text editor and saved in *.txt* format. Propose of this part is writing file to computer so can be processed.

B. Part II: Uppercase Characters Formatting

Propose of this part is selected and handled capital characters. Because of there none of string input will be reject or not be recognize of the syllable pattern so the text document that already checked before enter the split pattern browsing are write formatted [21]. A character in input string, for example Latin consonant can have more than one possibility of alphabet in Javanese depending on character that follow that consonant. The period also has possibility as indication finishing sentences, decimal or abbreviation so it will influence how that character build split Latin string pattern, does modification toward other characters and also represent what characters become the determiner of splitting of a sequence Latin character [19]. The rule of alphabet conversion according to its position is done for *murda* consonant and *swara* vowel [21].

C. Part III: Series of Characters Formatting

Propose of this part is converting group of characters element to character element. The character in string input is not only read or checked but also modified, changed or converted and inserted or added other characters in order to fulfill writing format requirement, even the decimal number must be firstly determined then the split pattern is browsed [21]. The equalization of alphabet *Q* or *q* with *kh*, equalization of alphabet *X* or *x* with *ks*.

Table 1: Latin string split models

Model	Pattern	Number of pattern	Explanation
1	Pattern of number character (decimal number)	10	
2		10	
3	Pattern of punctuation, special symbols and arithmetic operands	31	
4	Pattern of abbreviation	42	
5	Pattern of *swara* vowel	5	
6		15	
7	Pattern of 1 consonant prefix	26	
8		198	
9		264	
10		594	
11	Pattern of 2 consonants prefix	668	Produce 8 split patterns have the shape of 1 abjad (eventhough composed 2 characters) like result of 7th model plus 668 new split patterns have the shape of 2 abjad
12		5064	Produce 5064 new split patterns have the shape of 3 abjad and 48 split patterns have the shape of 2 abjad like result of 8th model
13		15140	Produce 15140 new split patterns have the shape of 4 abjad and 144 split patterns have the shape of 3 abjad like result of 10th model
14		6752	Produce 6752 new split patterns have the shape of 5 abjad and 64 split patterns have the shape of 4 abjad like result of 9th model
15	Pattern of 3 consonants as prefix	17186	Produce 17186 new split patterns have the shape of 3 abjad and 416 split patterns have the shape of 2 abjad like result of 11th model
16		24337	Produce 24337 new split patterns have the shape of 4 abjad and 780 split patterns have the shape of 3 abjad like result of 12th model
17		72954	Produce 72954 new split patterns have the shape of 5 abjad and 2340 split patterns have the shape of 4 abjad like result of 13th model
18		32446	Produce 32446 new split patterns have the shape of 6 abjad and 1040 split patterns have the shape of 5 abjad like result of 14th model
19	Pattern having more than 3 consonants as prefix	Unlimited	Depend on number of consonant group
20	Pattern having 1 consonant as prefix is followed by space and 1 consonant	8	Same as 11th model plus 8 new split patterns
21		1320	Same as 12th model plus 1320 new split patterns
22		3960	Same as 13th model plus 3960 new split patterns
23		1760	Same as 14th model plus 1760 new split patterns
24	Pattern having 1 consonant as prefix is followed by space and 2 consonants	780	Same as 16th model plus 780 new split patterns
25		2340	Same as 17th model plus 2340 new split patterns
26		1041	Same as 18th model plus 1041 new split patterns

D. Part IV: First Part of String Latin Split Pattern Browsing

Propose of this part is splitting every words to piece of element. To split a Latin string, although the Latin character checking has come to *n* position, sometimes it is needed to recheck (backwards browsing) the condition of previous characters, so that the requirement can be fulfill to take a Latin string split pattern [20]. Sometimes parsing is not only done at the source string but also done at the source string but also done at the source string result (for example the handling of roman number) [18]. If the first element is consonant and the next element is also consonant, the checking is repeated again and again to determine its Latin string split pattern. After every consonant is found, the number of consonants are noted down (after necessary equalization is done). The number of repeatitions can not be known for sure, but what is known is when the iterations are stopped. They are stopped if a character of non consonant is found after a consonant character. The Latin string split must

accomadate the handling of ambiguity problem [18]. This splitting will determine the structure of Latin string split pattern obtained. So it must be determined which character becomes the fundamental character, which character expresses *pasangan* character and so on [19].

E. Part V: Second Part of String Latin Split Pattern Browsing

Propose of this part is splitting every word to piece of element, including symbols handling.

F. Part VI: First Part of Roman Number Checking Process

Propose of this part is to check sequence of alphabets that build roman number and to check legal roman number that will be transliterated into *wilangan* number.

G. Part VII : Second Part of Roman Number Checking Process

Propose of part VII is to check sequence of alphabate that build roman number. Not valid roman number will not transliterated into *wilangan* number but will be split as non decimal characters.

H. Part VIII: First Part of Spell Checker Process

Propose of part VIII is spell checking process. Before Latin string split pattern are browsing, the state from every words must be known. Error checking possibility that happened on writing of the text source done by matching with dictionary. So the sensitivity or accuracy depend on the completeness of words list in the dictionary.

I. Part IX: Second Part of Spell Checker Process

Words searching in the dictionary are doing using Brute Force algorithm, every time found unmatching pattern with text the pattern shifted one character to right. This spell checker facility made to find word similarity to correct error spelling word. Words checking process consists two words checking, Indonesian language (consist 7962 words) and English (consist 29759 words). If words having similarity with Indonesian then words will be saved on temporary then checking doing on English. If there are not in the database then the words still can be replace by new input.

Production rules to Latin string split produce 26 Latin string split models that can be expended to produce more than 186.951 Latin string split patterns. First and second model are resulted by browsing of the number string Latin split pattern. Third model is resulted by browsing of the punctuation and symbols string Latin split pattern. Fourth model is resulted by browsing the dot and space

```
Bmx bicycle andle 1.9
Design photo Bank Monjali pas rampung.

Komple'ks E'xxon Xaveria dihari Jum'at.
Arnold Schwarzenegger mangan yogurt.
Postgresql, mysql And phsychology test.
Tiba-tiba hada Al-Toyib.

SMU Negeri VX
Perum Mulungan Wetan XV
S.M.P. N IX Yogya.

APPLYING OF THE CONTEXT FREE RECURSIVE DESCENT PARSER AND PATTERN MATCHING METHOD
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Graha Student Internet Center 3rd floor
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Telp/Fax: 0274 522443.

Rakhshanda Qeyrra.
Nafeeza Hakim.
Nathanael Jericho Andhika.
```

Figure 1: `document.txt`

```
bmks/bi/cy/cle/ha/n/dle/1/./9/
de/si/gnpho/to/Ba/nkmo/nja/li/pa/s ra/mpung/./

Ko/mple'/ks/he'/kskso/n ksa/ve/riya/di/ha/ri/ju/m/'/ha/t
Ar/no/ld/schwar/ze/ne/gger/ma/nga/n yo/gur/t/./
Po/st/gre/skhl/,/myskhl/A/nd/phsy/cho/lo/gy/te/st/./
Ti/ba/-/ti/ba/ha/da/A/l/-/to/yi/b/./

Smu/Ne/ge/ri/vks
Pe/ru/ma/ha/nmu/lu/nga/nwe/ta/n1/5/
S./m./p./N/9/yo/gya/./

A/pp/lying/O/f/the/co/nte/kst/fre/he re/cur/si/ve/de/sce/nt/Par/ser/A/nd/Pa/tter/nma/t/ching/me/tho/d
do/cto/ra/lPro/gra/mhi/nco/mpu/ter/Sci/he/nce/ho/fPo/st/gra/du/ha/te/s/cho/ho/lGa/djah/ma/da/U/ni/ver/si/ty
Gra/ha/Stu/de/nt/I/nter/ne/t/ce/nter/3/rd/flo/hor
fa/cu/lty/ho/fma/the/ma/ti/cha/nd/Na/tu/ra/lSci/he/nce/sGa/djah/ma/da/U/ni/ver/si/ty
Se/ki/pU/ta/ra/Bu/la/ksu/mur/yo/gya/kar/ta/./ /5/5/2/8/1/
Te/lp/fa/ks/:/ /0/2/7/4/ /5/2/2/4/4/3/./

ra/khsha/nda/khe/y/rra/./
Na/fe/he/za/ha/ki/m/./
Na/tha/na/he/lje/ri/cho/A/ndhi/ka/./
```

Figure 2: `document.tex`

character. Fifth and six model are resulted by browsing of the *swara* vowel string Latin split pattern. The browsing of *bunyi* vowel and consonant characters produce 20 string Latin split pattern models, seventh to twenty six.

IV. TESTING

Testing is done with hardware: processor AMD Atlon™ XP 2500+, RAM 256 MB and hardisk 40 GB, while the software which is used is GNU/Linux Debian 3.1 Sarge operating system and Perl. The testing of application is done by giving Latin text document input which contains:

a. The sequence of string that has character combination which is possible to be written in syllable of Javanese character.
b. The sequence of string Latin that has character combination which is not possible to be written in syllable of Javanese character and previously cannot be transliterated to Javanese character.

The system of text document split is tested by using based text file as shown in Figure 1. An example of a Latin text which has never been successfully transliterated, because this text contains character combination which is impossible to happen in Javanese.

Corrected text document is saved as *document_rev.txt* by system and this system can produce the pattern of Latin string split and by the system it is saved the file *.tex*., show on Figure 2.

The result of the testing shows that the model of syllable browsing can form split pattern which has been in a line with the existing linguistic knowledge. The program has some capabilities:

a. Able to find the word similarity to correct the word spelling mistakes.
b. Able to read, modify, and insert other characters into the character of input string in order to fulfill writing format requirement.
c. Able to handle the writing of Latin characters which have no equalization in Javanese alphabets.
d. Able to handle the writing of diftong (multiple vowel characters).
e. Able to handle the writing of roman numbering systems.
f. Able to handle the writing of punctuation, special symbols and arithmetic operands.
g. Able to accomodate period to avoid ambiguity because period also has possibility as indication finishing sentences, decimal or abbreviation so it will influence how that character build split Latin string pattern.
h. Able to handle ambiguity the using of dash symbol, to word repetition or mark of person name.
i. Able to accomodate space to avoid ambiguity, because Javanese character does not recognize space to divide words.
j. Able to accomodate acute accent to avoid ambiguity.
k. Able to handle the writing of more than three multiple consonant characters.

V. CONCLUSION

The algorithm of Latin text document split based on linguistic knowledge of writing Javanese script using The Context-Free Recursive-Descent Parser algorithm consists of: file writing and reading process, formatting process, Roman number checking process, spell checker for filtering wrong words process, and Latin string split pattern browsing process. Every process has own production rule. By building a set complex of rule, Latin string sequence which is written in Latin character can be processed so that syllable split patterns can be produced correctly. Ambiguity problem can be avoided by handling of space character and be expected to solve complex problem without any problems. This Latin text document splits are ready to be processed into the next step that is the process of converting syllable split patterns to be Javanese character and the mapping of their writing scheme.

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SIDoBI: Indonesian Language Document Summarization System

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***Abstract*—The phenomenon of information excess that has turned into the typical characteristic of modern society today causes good and user friendly automatic text summarization system a must. Indonesian Language Document Summarization System (SIDoBI) is the first web based application that creates summary automatically for documents written in Indonesian language. The application was developed by BPPT on top of MEAD, a Free/Open Source Software (FOSS) tool to generate automatic summary. In principle, the enhancements added by SIDoBI on MEAD are, the development of Indonesian IDF dictionary, MeadPHP interface, and web based GUI. The IDF dictionary was generated using the Indonesian language corpus which contains around 2.5 millions of sentences taken from online news sites on the internet. MeadPHP interface is used to connect MEAD in operating system to PHP application in web server. Finally, the web GUI becomes the front-end for the end user.**

***Index Terms*—automatic summarizer, FOSS, Indonesian language, web based.**

I. INTRODUCTION

Today we are flooded with a lot of information from various sources noticeably internet. Up to now people have tried to bring order into this huge volume of information by various techniques such as information retrieval, data mining and automatic text summarization. Information retrieval technique searches for good algorithms to retrieve a specific information, while data mining technique tries to find important patterns that occur inside the data. On the other hand, automatic text summarization technique summarizes a long document into the short one containing the most important content.

Automatic text summarization could be divided into two camps. First is abstraction method which tries to understand the document and create the summary using natural language processing method. The second is extraction method which selects most important sentences from the document and output them as summary. Abstraction summarization is usually used by human experts but still remains as difficult problem for computer. Hence, extraction summarization is the most popular choice in the field of automatic text summarization.

MEAD[1][2] which is used as the summarization machine in this work, falls into extraction summarization. It uses centroid method to determine the importance of each sentence in documents. To outline, first documents are clustered into similar content, each cluster will have a centroid which is the collection of most important words in the cluster. Next, each sentence is compared to the centroid and sentences more similar to the centroid are considered more important. Then the summary will be constructed using the most important sentences.

In this paper we present our work on automatic text summarization called SIDoBI which stands for Sistem Ikhtisar Dokumen untuk Bahasa Indonesia (Indonesian Language Document Summarization System). Chapter II will outline previous works on automatic text summarization. Our works will be explained in chapter III – V, that is Indonesian IDF dictionary in chapter III, MeadPHP interface in chapter IV and SIDoBI web GUI in chapter V. Then, chapter VI will explain our experiments with SIDoBI, and chapter VII is conclusion. Chapter VIII will contain acknowledgment.

II. PREVIOUS WORKS

Although there were many researches on automatic text summarization, there were only a few ones conducted in Indonesian language.

In 2004, Radev et. al.[1] developed MEAD, a platform for multidocument multilingual text summarization. MEAD's architecture consists of four stages. First, documents are clustered based content similarity. Then, a number of features are extracted for each sentence in the cluster. And, classifier combines these features into a composite score for each sentence. Finally, reranker will further refines these scores after considering possible cross-sentence dependencies (e.g., repeated sentences, chronological ordering, source preferences, etc.).

Gregorius et. al.[3] in 2007 attempted to build an Indonesian automatic text summarization using a virtual graph concept, weight of sentence and of relation among sentences, Deductive – Inductive method in Indonesian Language, and Exhaustive Shortest Path Algorithm to provide a sumarization path from the first sentence to the

last sentence on every paragraph in an article. He concluded that the quality of summarization result depends on the type and the structure of the article. System will produce a good summary if the type of the article is an argumentation type and the article's structure has many paragraphs in which each paragraph has more than two sentences.

III. INDONESIAN IDF DICTIONARY

As shown in Figure 1, SIDoBI is constructed by a) MEAD with Indonesian IDF dictionary in operating system, b) MeadPHP interface and c) web GUI in web server. Users could input the document in three ways, textarea, file or URL from web browser, and the output summary will be presented back in the browser. SIDoBI is now publicly available as open source at SourceForge[4] and could be demonstrated online at [5].

We have replaced the English IDF dictionary of MEAD with our own Indonesian IDF dictionary. The dictionary is generated from Indonesian language corpus and contains more than 280 thousands of Indonesian words.

A. Indonesian Language Corpus

To create IDF dictionary, we used corpus that consists of Indonesian sentences downloaded from website of major Indonesian magazines and daily newspapers such as *Kompas* (http://www.kompas.com), *Surabaya Post* (http://www.surabayapost.co.id), *Pos Kota* (http://www.poskota.co.id), *Pikiran Rakyat* (http://www.pikiran-rakyat.com), *Tempo* (http://www.tempo.co.id), etc for 5 years (1999 – 2003). The corpus consists of 42,911,469 words in 2,542,080 sentences and it contains articles on various topics such as politics, economics, sports, crimes, cultures, and so on. The corpus also records informal language such as conversations. The following table gives the data about the corpus.

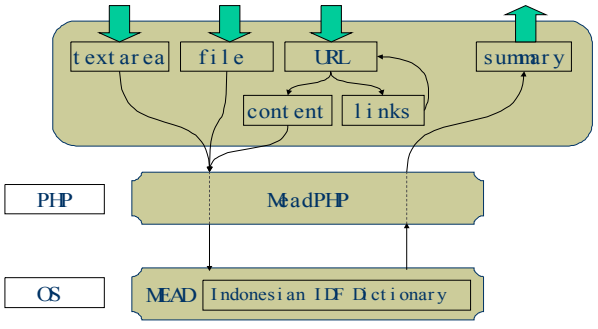

Figure 1. SIDoBI system

Number of articles	108,509
Number of Sentences	2,542,080
Number of Unique Sentences	2,534,552
Number of Words	42,911,469
Number of Unique Words	432,568

Table 1. Data of Corpus

Unique words in table 1 include derivations, but do not include words that consist of numbers only.

We built a tool written in Perl programming language to strip HTML tags and create a corpus with a sentence in each line. The corpus was then edited manually to fix grammatical and mistype errors. The errors in the corpus were as follows:

- Incomplete headlines
  JAKSA AGUNG BERIKAN CERAMAH DI DEPARTEMEN KEUANGAN
- Continued texts
  Sambungan hal (1)
  BELUM ... BERSAMBUNG 000110M8900458BUS HALTE JEMBATAN PENYEBERANGAN DPRD DKI 289-01-1190-05-18000812 *BUS HALTE JEMBATAN PENYEBERANGAN DPRD DKI 2*
  SAMBUNGAN (1) Belum lama ini pihak Perumtel juga mengeluh tentang sering terjadi "pengorekan" uang koin pada telepon umum oleh tangan jahil di beberapa tempat di Jakarta.
- Various news codes
  Khusus untuk koordinasi rayon tengah (C), koordinatornya langsung dijabat oleh Koesnadi.u/diy 003/diy&3.24/E&9-01-02-14:21.BDI
  000119M8900430PSSI SEMINAR ORGANISASI MANAJER TIM T1989 89-01-1190-05-18003224 *PSSI SEMINAR ORGANISASI MANAJER TIM T1989 *
- Splitting a sentence without continuation
  Pemanggilan di wilayah-wilayah lain akan terus dilakukan seperti yang…….
  000107M8900503PENYELUNDUPAN ROTAN KASUS GAGALKAN BC PRIOK 89-01-1190-05-18003171 *PENYELUNDUPAN ROTAN KASUS GAGALKAN BC PRIOK *
  BC PRIOK GAGALKAN PENYELUNDUPAN ROTAN ASALAN BERDALIH KERANJANG
- Explanations in a bracket that were written in a foreign language
  Pekanbaru & Pangab (Chief of the General Staff) Singapura Letjen Winston W. L. Choo menyatakan terima kasihnya kepada Pemerintah Indonesia, khususnya Pemerintah Daerah Riau, yang telah menyediakan lahan untuk dibangun sebagai daerah Latihan Penembakan Udara (Air Weapon Range - AWR) di Siabu, dekat Pekanbaru, di mana Angkatan Udara Singapura bisa memanfaatkannya.
- Mistype errors
  Walaupun demikian, pihak Pemda Jakarta Utara tidak akan lepas ta ngan. Bantuan seperlunya akan diberikan kepada semua warga yang terkena musibah, demikian Pakpahan.
  pungutan- pungutan
- Mistakes on splitting words
  Sedangkan pars anggota terdiri atas Kusno Sudjarwadi, Moh.
  Sadikin Natadipura, H. Sjachroni, Djun Saptohadi,

F.E.S. Tarigan, S. K. Samsuri, H. Misbach Yusa Biran, Eros Djarot, Zakaria Rasyid, Drs. H.Faesal Tamin, dan H.Johardin.

- Place names in the beginning of a sentence
  Jakarta, 1&- Menteri Kehutanan Ir. Hasjrul Harahap mengungkapkan, sampai akhir 1987 sudah tercatat 540 perusahaan yang diberikan Hak Pengusahaan Hutan (HPH) dengan nilai investasi hampir mencapai Rp. 20-triliun.
- Numbers are replaced by an ampersand
  Hasil pemasaran ke luar negeri tahun&988 meningkat 45 persen dari tahun&985 menjadi 7.468.636 dolar AS.
- Tables
  Susunan kabinet itu ialah: Perdana Menteri : Solomon Mamaloni. Menteri Dalam Negeri dan Deputi Perdana Menteri: Danny Philip. Menteri Keuangan dan Perencanaan Ekonomi : Christopher Colombus Abe.
  Perincian harga jual minyak Indonesia dan harga jual resmi OPEC (OPEC OSP) dalam dolar AS per barel adalah sebagai berikut: Janis Minyak Juni Mei Harga jual resmi OPEC
  (OSP).
  Duri 16,39 16,99 16,10.
  Cinta 17,82 18,41 17,20.
  Walio 17,87 18,44 17,86.
  Udang 17,72 18,29 17,21.
  Jatibarang 17,06 7,63 16,55.
  Bunyu 17,77 18,34 17,26.
  Arun Kondensat 8,43 19.00 18,35

B. IDF Dictionary

Inverse Document Frequency (IDF) dictionary is used to calculate the importance of words in document. In principle, it assigns the IDF value to each word in the language corpus, such as the more important a word the higher its IDF value. Intuitively, the less frequent a word appears in the corpus, it is considered more important hence higher IDF value and vice versa.

The IDF value can be calculated using the formula below:

$$\mathrm{idf_i} = \log \frac{|D|}{|\{d_j : t_i \in d_j\}|}$$

$\mathrm{idf_i}$: IDF value of word t_i
$|D|$: number of all documents in corpus
$|\{d_j : t_i \; E \; d_j\}|$: number of documents which contains word t_i

In the calculation to determine importance of word, IDF value is combined with TF (term frequency) value. In principle, TF value measures the importance of word in a document, and on the contrary of IDF, the less frequent a word in the document, it is considered less important hence lower TF value and vice versa. Usually TF value is simply the number of occurrences of word in the document.

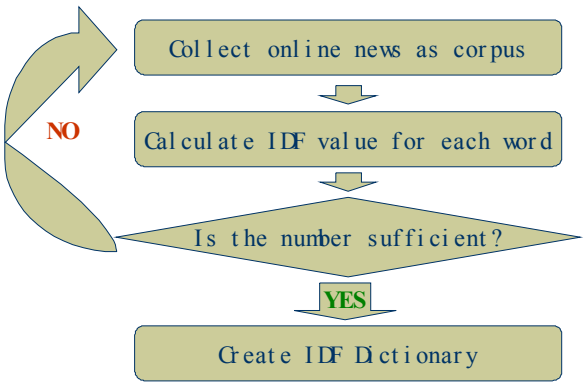

Figure 2. Creation of IDF Dictionary

The importance (also known as *tf-idf* value) of a word in document is calculated by the formula:

$$imp_i = tf_i \times idf_i$$

imp_i: importance of word t_i
tf_i: TF value of word t_i
idf_i: IDF value of word t_i

IV. MEADPHP INTERFACE

The document summarization machine, MEAD, is written in Perl and runs on operating system. Whereas, web based user interface, SIDoBI, is written in PHP and runs on web server. To connect SIDoBI in PHP to MEAD in operating system, we created MeadPHP interface.

MeadPHP is a simple PHP class which could be easily used by any PHP application in an object oriented way. MeadPHP is designed to include as many as MEAD functionality while keeping its easy of use. Moreover, MeadPHP also includes various document converter tool to convert document from several format to text.

Basically, before using it in PHP application user needs to edit the configuration file which determines environment variables and paths to various sources such as MEAD program itself, data directory, and other helper programs. Then, MeadPHP could be used as easily as:

```
require_once('meadphp.php');
$summarizer = new MEADPHP(array(
        'is_file'=>$is_file,
        'filetype'=>$ext,
        'text'=>($is_file?$_FILES['userfile']['tm
p_name']:stripslashes($_POST['text'])),
        'compression'=>$_POST['compression'],
        'percentage'=>$_POST['percentage'],
        'absolute'=>$_POST['absolute'],
        'basis'=>$_POST['basis']));
$summarizer->summarize();
$summary = $summarizer->getSummary();
```

Generally, MeadPHP could be used by any application written in PHP, given that the summarization machine MEAD is already installed properly in the system. Hence, any PHP application such as many CMS (content management system) open sources could take benefit from the summarization machine MEAD.

V. SIDOBI WEB GUI

The web user interface in SIDoBI as shown in figure 3, is written in PHP to take input from user and print output from MEAD using browser. The functionality includes document input (text box, file upload or URL link) and MEAD adjustment (summary length). In the heart of SIDoBI there is the interface MeadPHP as explained above.

SIDoBI is designed to be as user friendly as possible while maximizing usage of MEAD functionality. Since all MEAD functionality is already provided in MeadPHP, the GUI development could be focused in user friendly aspect.

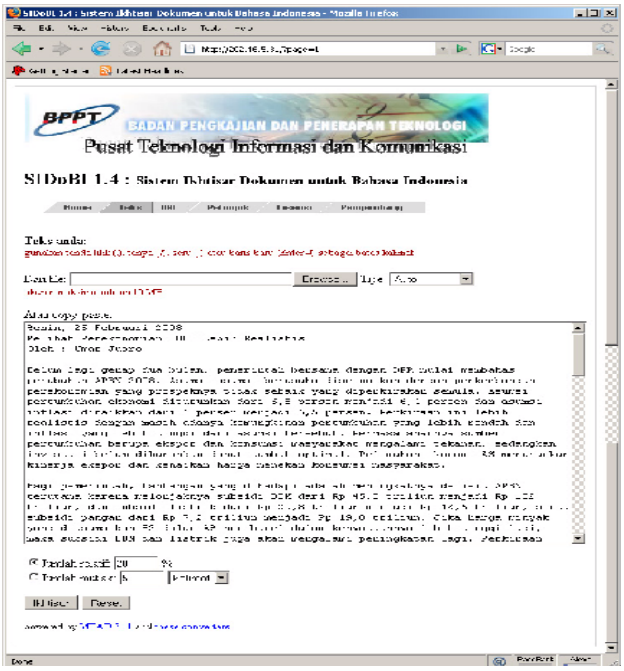

Figure 3. Web GUI

Document input functionality in SIDoBI includes:

a. Tex box: could be copy-pasted from any sources.
b. File upload: supports several format, text file, MS Doc, Adobe PDF and OpenOffice.
c. URL link: fetch content of a website as input, then harness the links to be the next input.

MEAD adjustment functionality includes adjustment of:

a. compression basis, either sentence or word,
b. summary length, either absolute number (of sentences or words), or relative percentage (of sentences)

VI. EXPERIMENTS

In this experiment we will learn the effect of summary length and IDF dictionary in the summarization accuracy. We used 8 articles from online news sites, and perform automatic summarization of length 10% and 25% each using English and Indonesian IDF dictionary.

As references, 4 humans performed the same summarization, and each automatic summary is scored against each human summary and then averaged. We used evaluation tool called ROUGE[6][7] in this experiments, and as recommended in [8] we choosed to use ROUGE-1 as the metric.

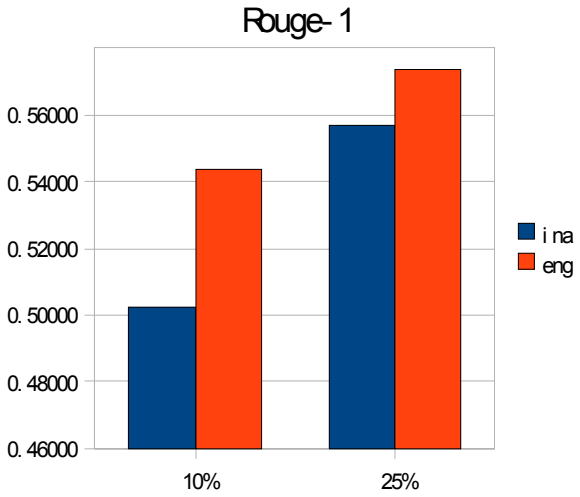

Figure 4. F-measure of ROUGE-1

The result is shown in figure 4. Here we used F-measure value since the summary length of machine and human is different. From the result we know that:

a. Longer summary produces more accurate results.
b. English IDF dictionary produces more accurate results than Indonesian.

Result a) is in accordance to our expectation because longer summary includes more information from original document, therefore the probability that system summary will match human is higher.

However, result b) is against our expectation that for Indonesian documents Indonesian IDF dictionary should give better results than English one since it provides more accurate IDF value for Indonesian words.

Neverthless, result b) could be explained from the scoring algorithm used by MEAD in determining sentence importance. By default MEAD combines three features, e.g. centroid (C), position (P), and length (L), to do scoring as below:

$S = C + P$ if $L >= 9$
$S = 0$ otherwise

Here, only centroid makes use of IDF dictionary when sentence length more than or equal to 9, therefore short sentences will be ignored regardless its centroid value. We suspect this is the main reason behind this result, together with the internal algorithm of centroid calculation. By adjusting the scoring's weight and refining the centroid calculation, it migth be possible to increase the effect of IDF dictionary.

VII. CONCLUSION

In this paper we presented SIDoBI, an Indonesian Language Document Summarization System. SIDoBI has contributed to automatic text summarization field in three important aspects: Indonesian IDF dictionary, MeadPHP interface, and SIDoBI web GUI which are released to public as open source project.

Publicly available Indonesian IDF dictionary is expected to stimulate academic research in Indonesia which need it. And MeadPHP interface will greatly reduce the effort to use MEAD summarization machine in PHP, and in turn may encourage research in this field. Lastly, SIDoBI web GUI which is designed as user friendly as possible may help to spread the word about automatic text summarization to as large as common audiences.

In the future we plan to:

a. investigate why Indonesian IDF dictionary did not have positive effect to the result,
b. enhance MeadPHP to include more functions available in MEAD,
c. and consequently upgrade the web GUI to use the functions as well.

VIII. ACKNOWLEDGMENT

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Part-Of-Speech Tagger as a Language Tools Supporting Rural Need

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***Abstract*—Part-of-speech tagging is a corner stone for most natural language processing, for example in machine translation and cross language information retrieval. These language tools can help rural people with limited language proficiency when searching information on the Internet. This paper describes our work in developing part-of-speech tagger for Indonesian language. We studied the adaptation and application of Brill's transformation-based error-driven learning tagger to the Indonesian language. The patterns available in the software provided by Brill are effective on the English language. In this work, in the view of the rich morphology and original syntax of the Indonesian language, we want to evaluate the appropriateness of the original and test alternative patterns and setting. We present the results of the comparative performance evaluation of the different combinations of lexical and contextual patterns and of the different settings of Brills tagger. Under the best settings, we obtain an accuracy of 91 %.**

***Index Terms*— part-of-speech tagger, Brill's tagger.**

I. INTRODUCTION

Nowadays internet has experienced a rapid growth. Internet is used for searching and exchanging information. Unfortunately, there are still many Indonesians have not get benefit yet from this technology although the infrastructure has been better provided. One caused this is language barrier. Information provided on Internet is mostly in English, but English proficiency among Indonesians, particularly who living in rural areas and small towns is very low. Language tools should have been developed to help such people searching information on the Internet. Machine translation and Cross language information system are the example of these language tools.

In this paper we explain our research about part-of-speech tagging for Indonesian language. Part-of-speech tagging is a corner stone for most natural language processing tasks including not only word sense disambiguation, parsing, question answering but also those tasks involving supporting the processing of language in machine translation and cross language information retrieval. Part-of-speech tagging is the process of assigning tags to words in a document a tag that indicates their lexical category. Lexical categories are usually defined as a combination of morphological, syntactical and semantic features of the words and their usage. Efficient automatic part-of-speech tagging can be achieved by looking at morphological and syntactical features alone.

Transformation-based error-driven learning, Hidden Markov Model, Maximum Entropy and Conditional Random Field are some of the popular and effective methods that have been proposed for automatic supervised part-of-speech tagging. Several research publications report the performance evaluation of the application of these methods to the part-of-speech tagging of several languages. For example, applications of Brill's transformation-based error-driven learning tagger to the part-of-speech tagging of English [3], German [9] and Swedish [7] have been documented. Maximum Entropy and Hidden Markov Model and Conditional Random Field have been applied to part-of-speech tagging of English [5], Hindi [8] and Amharic languages [1] among others.

Gerold Schneider and Martin Volk [9] developed part-of-speech tagger for German using rule-based Brill-Tagger. They showed that the tagging performance improved if the size of the corpus increased. To reduce the tagging errors they used external lexicon to decrease the unknown words. They also added rules manually which helped the errors reduced.

Beáta Megyesi [6] found that for Hungarian, Brill-Tagger was not as accurate as English because the structure of the languages was different. The tagger had difficulties in assigning part-of-speech belonging to open classes because of the Hungarian complicated morphological structure. The open classes were nouns, adjectives, verbs and adverbs, whereas the closed classes were determiners, pronouns, prepositions, conjunctions, auxiliaries and modals. Hungarian nouns might be analyzed as a stem followed by three positions in which inflectional suffixes (for number, possessor and case) could occur. Additionally, derivational suffixes, which changed the part-of-speech of a word, were very common and productive. Thus, a stem could get one or more derivational and several inflectional suffixes. The

accuracy of the tagger increased from 82.45% to 97% by changing the rule generating mechanisms, namely the lexical templates, in the lexical training module.

Klas Prütz [7] did a study on Brill-Tagger for Swedish. In his study, the performance of the tagger was not satisfactory if it only used a very small training corpus. The accuracy of the tagger was 89% using a complete tag set and 91.5% using limited tag set. However, when the lexicon was extended so that the number of unknown words decreased, the accuracy of the tagger increased to 95.7%.

In this work we would like to develop part-of-speech tagger for Indonesian Language using Brill-tagger. The patterns available in the software provided by Brill are effective on the English, we tried to find the appropriateness of the original and test alternative patterns and setting in Indonesian Language. We compare Brill's tagger with different and new patterns in lexical and contextual learning.

II. Part-of-Speech in Indonesian Language

Indonesian Language is the official language of Indonesia with its inhabitants more than 240 million people [10]. Even though Indonesian Language is spoken by most of the people in the country, the availability of language tools and resources for research related to Indonesian Language are still limited. One of language tools that is not available for Indonesian Language is Part-of-Speech Tagger.

Since a standardized Indonesian annotated corpus is not available, we explore Indonesian grammar [2] to define tag set for Indonesian Language to be used for annotating Indonesian corpus. Indonesian Language has 5 main part of speech: kata kerja (verb), kata sifat (adjective), kata keterangan (adverb), kata benda (noun), and kata tugas (function words). Noun can be further divided into subcategories, such as personal pronouns, determiner, questioner, numeral, and classifier. Function words can be further divided into subcategories, such as preposition, conjunction, interjection, article, and particle.

The above description of Indonesian language is far from complete and only highlights some of the major characteristics of Indonesian Language. Based on the above description we define 26 tags for Indonesian words including punctuation. The tag set is shown in Table 1.

III. Brill-Tagger

Brill's Part-of-Speech tagger was proposed by Eric Brill in 1992 for English. Brill's tagger was a supervised learning tagger. The tagger produces lexicon, lexical rules, and contextual rules based on the annotated training corpus. The produced lexicon and the rules are used to tag un-annotated corpus.

Table 1. Indonesian Tag Set

Tag	Description	Definition
,	Comma	Punctuation mark that indicates the separation of elements
:	Mid-sentence punctuation	Punctuation marks that mark the middle of the sentences
(	Left parenthesis	Punctuation marks that start the insertion of information into a text
)	Right parenthesis	Punctuation marks that end the insertion of information into a text
“	Left quote	Punctuation marks that start the enclosed text that indicates saying, statement, quote, etc.
”	Right quote	Punctuation marks that end the enclosed text that indicates saying, statement, quote, etc.
•	Bullets	Punctuation marks that list the items
.	Sentence-final punctuation	Punctuation marks that end the sentences
$	Dollar	Dollar currency symbols
Rp	Rupiah	Rupiah currency symbols
SYM	Symbols	Other symbols
VB	Verbs	Words that mainly serve as the predicate of a sentence and denote an action, a process or a state, which is neither quality nor behavior
JJ	Adjectives	Words that give additional information about noun (modify noun) and can be a predicate in a sentence
RB	Adverbs	Words that modify a verb, an adjective, or another adverb
NN	Nouns	Words that refer to human, animals, things, concepts and meanings and usually is placed as subject or object or complement in a sentence
PPN	Personal Pronouns	Words that refer to persons
DPN	Determiner Pronouns	Words that refer to something or information or place that is talked about
QPN	Questioner Pronouns	Words that indicate questions
NUM	Numerals	Words that are used to count nouns
CLS	Noun classifiers	Words that classify the nouns into certain category
IN	Prepositions	Words that indicate various semantic connection between the constituent before and the constituent after
CJ	Conjunctions	Words that connect two language constructs of equal level: word and word, phrase and phrase, or clause and clause
IJ	Interjections	Words that reflect the emotion of the speaker
AR	Articles	Words that: (1) denote title (e.g. sang, sri, hang, dang), (2) denote collective meaning/grouping (e.g. para), or (3) are used to convert a word into noun/noun phrase (e.g. si)
PC	Particles	Words that emphasize the previous word
FW	Foreign words	Words that are not Indonesian words

A. Training Phase

In training phase (also known as learning phase), Brill-Tagger uses transformation-based error-driven learning technique [4] to correct the errors that are produced by the tagger. The errors will be corrected using the transformation rules through the following steps:

1. Un-annotated text is passed through an initial-state annotator producing annotated text.
2. The annotated text that is done automatically is compared to manually annotated text.
3. From manually annotated text, the tagger will produce the transformation rule based on lexical and contextual features.
4. Comparing the annotated text and the manually annotated text may produce the errors. The errors will be corrected by doing transformation using lexical rules and contextual rules.

Brill-Tagger creates lexicon based on the training corpus. The lexicon is a list of words from the training corpus and their word class. Table 2 shows the example of English lexicon from Brill-Tagger and its tag, Table 3 shows some Indonesian lexicon from Indonesian corpus and its tag. Initially, Brill-Tagger assigns each word with its most likely tag from the lexicon. The most likely tag (first tag) is the tag that appears most frequently in the training corpus for a word. For unknown word, the word that doesn't exist in lexicon, Brill-Tagger assigns a proper noun if it starts with capitalized letter or noun otherwise.

Table 2. Example of English Lexicon from Brill-Tagger

English Lexicon	meaning of tag
expressing VBG Laurance NNP founding NN VBG JJ competency NN Cabbage NNP NN interactive JJ rankles VBZ happily RB tamp VB enflamed VBN overlooked VBN VBD among IN whether IN CC	VB = verb, base form VBG = verb gerund or present participle VBG = verb, gerund or present participle VBZ = verb, 3rd person singular present VBN = verb, past participle VBD = verb, past tense NNP = proper noun, singular NN = noun, singular or mass JJ = adjective RB = adverb IN = preposition CC = coordinating conjuction

To revise the tagger of unknown words, Brill-Tagger uses lexical rules and contextual rules. Lexical rule is the lexical category of a word based on its morphology. Brill tagger creates lexical rules by examining one to four character(s) in front of a word and at the end of a word. Contextual rule is the information of a word based on its context in the sentence, such as the information about one to three word(s) that comes before and after a tagged word. Table 4a shows the example of lexical rule and contextual rule in Brill Tagger for English and the explanation.

Table 3. Example of Indonesian Lexicon from annotated Indonesian corpus

Indonesian Lexicon	meaning of tag
Lemhannas NN berminat VB Utara NN kendaraan NN ditaati VB penuh JJ RB tanpa IN kapasitas NN	NN = noun singular or mass VB = verb (any form) JJ = adjective RB = adverb IN = preposition

These lexical rules and contextual rules are generated using rule templates. Brill-Tagger uses 8 rule templates for lexical rules and 14 rule templates for contextual rules. Table 4b shows an example of lexical rule template and Table 4c shows an example of the contextual rule template.

Table 4a. Example of Lexicon rule and Contextual rule

LEXICAL RULE:	`NN s fhassuf 1 NNS`
Meaning :	Change the tag from NN (noun) to NNS (noun, plural) if the last character of the word is 's'
Example word :	cars/NN (from initial tagging)
The result tag:	cars/**NNS**
Reason:	Because the last character of noun word is 's' so it must be plural noun

CONTEXTUAL RULE :	`NN VB PREVTAG TO`
Meaning :	Change the tag from NN (noun) to VB (verb base) if the previous tag is TO
Example :	to/TO eat/**NN** (from initial tagging)
The result tag:	to/TO **eat/VB**
Reason:	Because word after "TO" must be verb base.

Table 4b. Example of lexical rule template

Lexical Rule Template :	
Rules :	Deleting the prefix x, x is any string of length 1 to 4, results in a word (deletepref / fdeletepref)
Example :	un deletepref 2 JJ x Change the tag from any tag to JJ (adjective) if its first 2 letters are "un" and removing them results in a word that exists in the corpus. **unusual** → if '**usual**' exists in the lexicon → **unusual**/JJ

Table 4c. Example of contextual rule template

Contextual Rule Template :	
Rules :	The preceding / following word is tagged with Z (PREVTAG / NEXTTAG)
Example :	NN VB PREVTAG PP Change the tag from NN (noun) to VB (verb base) if the previous tag is PPN (Personal Pronoun). ❖ I/PP read/NN → I/PP read/VB

B. Tagging Process

In the tagging process, the tagger uses the lexicon, lexical rules, and contextual rules that have been produced in the training phase. The initial tag that is assigned to a word is the most likely tag. This initial tag is then corrected according to the learned lexical and contextual rules. These lexical and contextual rules are used to transform the incorrect tag (the errors in initial tagging) into a new tag. As an example for the tagging process using the sentence below:

Nah, kita akan berangkat sekarang.
(Well, we are leaving now.)

In this example, it is assumed that all the words in the sentence are in the lexicon except word "Nah" (Well), then at initial tagging appeared in the sentence as follow:

Nah/NN ,/, kita/PPN akan/RB berangkat/VB ./.

After initial tagging, the tagging process continues using lexical rules. Since there are no lexical rules that match the word "Nah" (Well), then the tag for "Nah" (Well) does not change.

The tagging process continues using contextual rules. In the contextual rule, there is a rule:

NN IJ RBIGRAM Nah ,

This rule allows to change NN (noun) to IJ (interjection) if the current word is 'Nah' and the following/right word is ','. This rule matches the initial tagging so the tag for word "Nah" is changed from NN to IJ as follow:

Nah/IJ ,/, kita/PPN akan/RB berangkat/VB ./.

IV. EXPERIMENT

In this study we use Indonesian newspaper articles that are annotated manually. The articles contain 9 topics such as: economic, health, education, life style, international, national, family, metropolitan, and sports. The corpus contains 17,119 tokens (including punctuation marks). We use 805 annotated sentences (12,901 words) as the training set and 241 sentences (4,218 words) as the testing set. The training set is used to train the Brill tagger resulting lexicon, lexical rules, and contextual rules for Indonesian Language. We modified Brill algorithm and tried some settings on producing lexical rule and contextual rule during training phase.

The evaluation of result is done by comparing the manual tagging and the automatic tagging based on Brill's tagger.

V. RESULT

The result of our study on Brill's tagger for Indonesian Language shows that apply lexicon and modified lexical learning (0-3 characters in front of and at the end of the words) gives 87% - 91% accuracy (Table 5). Then if we apply lexicon and modified contextual learning (0-3 words before and after the word) the tagger has 86% - 90% accuracy (Table 6).

Table 5. Result of Brill's tagger for Indonesian Language with different setting on producing lexical rule

No	Experiment	Result (%)
1	Lexical (0,1)	87.84
2	Lexical (0,2)	87.44
3	Lexical (0,3)	89.17
4	Lexical (1,0)	90.23
5	Lexical (1,1)	90.23
6	Lexical (1,2)	90.02
7	Lexical (1,3)	90.16
8	Lexical (2,0)	90.92
9	Lexical (2,1)	90.92
10	Lexical (2,2)	90.66
11	Lexical (2,3)	90.87
12	Lexical (3,0)	91.28
13	Lexical (3,1)	91.28
14	Lexical (3,2)	90.92
15	Lexical (3,3)	91.16

Table 6. Result of Brill's tagger for Indonesian Language with different setting on producing contextual rule

No	Experiment	Result (%)
1	Contextual (0,1)	87.17
2	Contextual (0,2)	86.94
3	Contextual (0,3)	86.94
4	Contextual (1,0)	89.89
5	Contextual (1,1)	90.02
6	Contextual (1,2)	89.83
7	Contextual (1,3)	89.88
8	Contextual (2,0)	89.65
9	Contextual (2,1)	89.83
10	Contextual (2,2)	89.66
11	Contextual (2,3)	89.59
12	Contextual (3,0)	89.60
13	Contextual (3,1)	89.69
14	Contextual (3,2)	89.59
15	Contextual (3,3)	89.62

In our study, lexical rules that give the best result are from pattern (3,0) and (3,1). These results mean that in Indonesian Language most prefix are three characters and most suffix are only one character. And contextual rules that give the best result is from pattern (1,1). This means in Indonesian Language context is not really important. Indonesian Language only needs one word before and after to decide contextual rule.

VI. CONCLUSION

Indonesian Language has limited language tools and resources, for example there is no available part-of-speech tagger for Indonesian Language yet. Our study in developing part of speech tagger for Indonesian Language based on Brill's tagger showed the special pattern in lexical property and contextual property for Indonesian Language.

In the future we will study part of speech tagger further using a bigger corpus to learn if the lexical rules and contextual rules can perform better for Indonesian Language.

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Compressive Sampling with Known Spectral Energy Density

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Abstract—**A method to improve l_1 performance of the CS (Compressive Sampling) for signals with known spectral energy density is proposed. Instead of random sampling, the proposed method selects the location of samples to follow the distribution of the spectral energy. Samples collected from three different measurement methods; the uniform sampling, random sampling, and energy equipartition sampling, are used to reconstruct a given UWB (Ultra Wide Band) signal whose spectral energy density is known. Objective performance evaluation in term of PSNR (Peak Signal to Noise Ratio) indicates that the CS reconstruction of random sampling outperform the uniform sampling, while the energy equipartition sampling outperforms both of them. These results suggest that similar performance improvement can be achieved for CS-based devices, such as the compressive SFCW (Stepped Frequency Continuous Wave) radar and the compressive VLBI (Very Large Baseline Interferometry) imaging, allowing even higher acquisition speed or better reconstruction results.**

Keywords—Compressive Sensing, Compressive Sampling, Equipartition of Energy, Non Uniform Sampling, SFCW, UWB, VLBI

I. INTRODUCTION

Compressive sampling (CS) is an emerging method with various practical applications [1], [2]. In contrast to the Shannon sampling theorem that put a minimum limit at $2\Delta\omega$ sampling rate for a $\Delta\omega$ bandlimited signal, the CS capable to reconstruct the signal exacly based on much lower rate or fewer number of samples.

Currently, there have been efforts to improve the performance of CS by incorporating prior knowledge. Paper [3] proposes a method for sparse signal recovery that outperforms standard l_1 in term of fewer number of required samples. The algorithm solves a sequence of l_1 minimization problem where the weights used for the next iteration are computed from the value of the current solution. Related to this method, the authors of paper [4] propose an algorithm to recover sparse signal from system of underdetermined linear equations when there is prior information about the probability of each entry of the unknown signal being nonzero. While in [5], a method of modifying CS for problem with partially known support is presented.

This method is closely related to CS with partially known support described in [5]. Whereas the known support in [5] is located in the sparsity domain Ψ, the measurement is conducted in the projection domain Φ. In parctice the user is more interrested to know how the modification of his/her measurement protocol improves the performance. This paper shows that a simple method to select the location of the samples in the projection domain significantly improve the objective performance for a given sample number.

The problem can be formulated as follows: given the spectral energy distribution of a signal and a restricted budget on the number of measurements, how to select a set of samples that best represents the signal in the sense of CS? This problem occurs in CS applications, such as in the compressive SFCW (Stepped-Frequency Continuous Wave) radar [6] and compressive VLBI (Very large Base Line Interferometry) imaging [7], [8]. It should be noted that the knowledge on absolute values of the signal's Fourier coefficients defining the spectral energy density cannot be used directly to recover the signal without any knowledge on their phase values.

In an SFCW radar, an impulse is not-directly transmitted in time-domain. Instead, the Fourier coefficients representing the signal is collected by measuring the responds of the observed objects on a range of frequency. The A-scan, which is reflections of the attenuated and shifted impulses, usually can be represented as derivative of Gaussian function. Since shifting in time domain is equivalent to shifting the phase of the Fourier coefficients in frequency domain, the magnitude of the signal spectrum will almost remain the same. Therefore, the information of the signal's spectral energy density can be used as a prior knowledge in the reconstruction. If the number of required samples can be reduced by the proposed method, the acquisition speed of the compressive SFCW radar can be increased significantly.

In the VLBI imaging, one can assume that the spatial distribution of intensity of the radio galaxies are elongated Gaussians. This prior can also be obtained by estimating the actual (spatial) spectral energy density using direct measurements. Then, similar to the SFCW radar case, one can use the magnitude spectrum to improve the reconstruction performance. Additionally, for a given configuration of observers (antenna) and the position of the object, the location of the samples in the *uv*-plane (spatial-frequency/ Fourier domain) is well defined. When prediction of the best measurement procedure can be made, the performance of the compressive VLBI imaging system can also be greatly improved.

In this paper, one dimensional UWB (Ultra Wide Band) signal consisting of shifted and attenuated monocycles as a case, which can be generalized into higher dimensions is used. The objective performance of l_1 reconstruction for three different sampling schemes, namely, the random sampling, the frequency equipartion

sampling (FES), and the energy equipartition sampling (EES) are compared. It has been shown in [9] and [10] that the EES performs better for direct FFT inversion representing the l_2 reconstruction, compared to the uniform sampling scheme. The proposed method is actually the l_1 extension of this scheme.

The rest of the papers is organized as follows. Section II explains briefly the principle of the standard CS and the modified CS when prior is known. In Section III, an algorithm to select a set of best samples in frequency domain for a given spectral energy density is derived. Experiments and analysis is given in Section IV and Section V concludes the paper.

II. Theory of CS and Modified-CS with Prior

In the CS, reconstruction of a signal $\vec{s}$ that is sparse in a bases system Ψ requires just a small number of measured samples $\vec{S}$. This subsampling process can be represented as a projection by an $M \times N$ measurement matrix $\mathbf{\Phi}$, where $M << N$. Therefore, the observable $\hat{S}$, which is a subset of $\vec{S}$, can be expressed as follows

$$\hat{S} = \Phi \cdot \Psi \cdot \vec{s} = \Delta \cdot \vec{s} \tag{1}$$

The newly defined matrix $\Delta \equiv \Phi\Psi$ represents an over-complete basis.

Equation (1) expresses an *underdetermined* system of linear equations where the number of unknown is larger than the number of the equations whose coefficients are listed in Δ, therefore the solution will be non-unique. To solve this equation, CS assumes that the signal is sparse, which means that the number of the Ψ-domain coefficients, i.e.

$$\left\|\vec{s}\right\|_0 \equiv \sum_{n=1}^{N} \left|s_n\right|^0 \tag{2}$$

is the smallest one. Actually, minimization of (2) is a combinatorial problem that computationally intractable. When the signal is highly sparse, the solution of (2) for L_0 is identical to the solution of a more tractable L_1 problem [7], [8], by minimizing

$$\left\|\vec{s}\right\|_1 \equiv \sum_{n=1}^{N} \left|s_n\right|^1 \tag{3}$$

In fact, minimization of (3) can be recast as a convex programming problem [11], [12], whose solvers are widely available, such as the Interior Point Method.

An important issue regarding this solution is that $\mathbf{\Phi}$ and $\mathbf{\Psi}$ should be sufficiently incoherent. The measure of coherence between two bases $\mu(\Phi,\Psi)$ is defined as [13]:

$$\mu(\Phi,\Psi) = \max_{\phi\in\Phi,\psi\in\Psi} \left|\langle \phi,\psi \rangle\right| \tag{4}$$

where ϕ and ψ are column (row) vectors of $\mathbf{\Phi}$ and $\mathbf{\Psi}$, respectively.

It has been shown that a general random basis has a high degree of incoherence with any basis, including the identity or spike bases **I**. Therefore, one can choose a random matrix as the projection bases Φ. In such a bases, the number of required sample K is [13]

$$K \geq C \cdot \mu^2(\Phi,\Psi) \cdot F \cdot log\,(N) \tag{5}$$

where C is a small constant, F denotes the degree-of-freedom of the signal or the number of non-zero coefficient of the signal when represented in the sparsity bases Ψ.

For a suitable number of measured data K given by (5), CS guarantees to recover perfectly the time domain signal through optimization

$$\min_{\vec{s}\in R^N} \left\|\vec{s}\right\|_1 \; s.t.\; \hat{S}_k = \left\langle \vec{\varphi}_k, \Psi\vec{s} \right\rangle,\; \forall k \in \{1,2,...,K\} \tag{6}$$

where $\vec{\varphi}_k$ is a row vector of Φ. In brief, the CS principle states that for a small, but sufficient, number of observations, it is possible to recover a sparse signal $\vec{s}$ from its subsamples $\hat{S}$ through L_1 optimization given by (6).

The performance of CS can be improved when there is (are) prior information of the signal. In [4] and [5], weights are elaborated into the formulation of the optimization, i.e., equation (6) is modified into

$$\min_{\vec{s}\in R^N} \left\|W\vec{s}\right\|_1 \; s.t.\; \hat{S}_k = \left\langle \vec{\varphi}_k, \Psi\vec{s} \right\rangle,\; \forall k \in \{1,2,...,K\} \tag{7}$$

where **W** is a diagonal matrix of positive weights. On the other hand, when the support T of the signal is known, one can also improve the performance as suggested in [5] by reformulating (6) into

$$\min_{\vec{s}\in R^N} \left\|(\vec{s})_{T^C}\right\|_1 \; s.t.\; \hat{S}_k = \left\langle \vec{\varphi}_k, \Psi\vec{s} \right\rangle,\; \forall k \in \{1,2,...,K\} \tag{8}$$

where T^C denotes the complement of T.

Compared to the (re-) weighted and the known-support modified CS, the proposed method uses the prior in a slightly different manner. When the absolute of the spectrum or the distribution of signal energy in frequency domain is known, the method selects only particular samples that follow the distribution of the spectral energy density. The detail scheme is described in the following Section.

III. Frequency Domain Sampling and The Principles of Equipartition

In uniform sampling, the frequency band is divided into N sub-bands uniformly, i.e,

$$\Delta\Omega_1 = ... = \Delta\Omega_i = ... = \Delta\Omega_N \tag{9}$$

Such a trivial scheme will be named as the frequency equipartition sampling (FES). In this method, a different approach to get a better time-domain reconstruction results is proposed; i.e., by proportionally counting the

contribution of the spectral energy in each frequency sub-bands, which is illustrated in Fig.1. The left part of Fig.1 shows a time-domain impulse $s(t)$, a monocycle for example, while the right part is its spectral energy density $|S(\Omega)|$ obtained from the Fourier transform of $s(t)$.

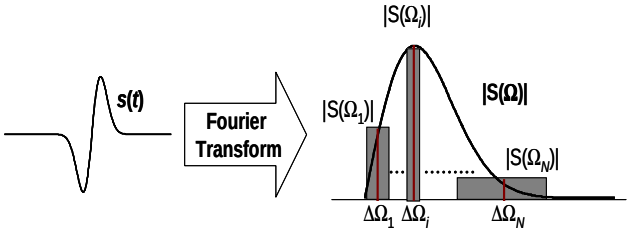


Fig.1 Non uniform frequency spacing scheme based on equipartition of the spectral energy

The main idea in the new scheme is to select sub-bands of frequencies and its range $\left[\Omega_i - \Delta\Omega_i/2, \Omega_i + \Delta\Omega_i/2\right)$, so that the energies in the $\Delta\Omega_i$ intervals are identical. It is shown in the figure as dashed bars that have identical areas. The centre of the sub bands $\{\Omega_i\}$ will become the location of selected samples in frequency domain.

To determine each frequency range, first note the following Parseval's relation

$$E = \int_{-\infty}^{\infty} |s(t)|^2 dt = \int_{-\infty}^{\infty} |S(\Omega)|^2 d\Omega \tag{10}$$

which guarantee that the amount of energy in time domain will be equal to the amount of the energy in the frequency domain. In the proposed scheme, instead of the $|S(\Omega)|^2$ described in [9] and [10], its square root or absolute value of the spectrum $|S(\Omega)|$ is used.

The EES Algorithm

1. For a given spectral energy distribution |S(Ω)|, define the frequency range [Ω_L, Ω_U] and the number of sample N.
2. Calculate the total sum of spectral energy $\hat{E} = \int_{\Omega_L}^{\Omega_U} |S(\Omega)| d\Omega$ and the average energy in the subband $\varepsilon \equiv \hat{E}/N$.
3. Starting from the lowest to the highest frequency:
   a. Integrate $E(\Omega)$ over an interval $\Delta\Omega$ such that the total energy in the interval equal to ε. The middle of the interval is the location of selected sample.
   b. Repeat Step 3.a until all of the sampling points in the set $\{\Omega_i | i=1, \ldots, N\}$ are found.

Fig.2 The EES Algorithm to select sampling points

For a given working frequency band bounded by Ω_L, and Ω_U, approximation of the energy in each dashed area, ε, is given by:

$$\varepsilon \equiv \frac{\hat{E}}{N}, \text{ where } \hat{E} = \int_{\Omega_L}^{\Omega_U} |S(\Omega)| d\Omega \tag{11}$$

The energy of a given frequency interval is directly related to the equal amount of energy contribution in the time domain. Accordingly, the following relation is obtained:

$$\begin{aligned} \Delta\Omega_1 |S(\Omega_1)| = \ldots = \Delta\Omega_i |S(\Omega_i)| \\ = \ldots = \Delta\Omega_N |S(\Omega_N)| \end{aligned} \tag{12}$$

This new scheme will be called the equipartition of the energy sampling (EES). Consequently, the i-th frequency Ω_i is obtained, corresponding range of frequency

$$\left(\Omega_L + \sum_{k=1}^{i} \Delta\Omega_k - \frac{\Delta\Omega_i}{2}\right) \le \Omega_i < \left(\Omega_L + \sum_{k=1}^{i} \Delta\Omega_k + \frac{\Delta\Omega_i}{2}\right) \tag{13}$$

and the width of the i-th subband

$$\Delta\Omega_i = \varepsilon / |S(\Omega_i)| \tag{14}$$

According to (13) and (14), to determine the set of frequencies $\{\Omega_{i,}\}$ one needs the spectral energy density |S(Ω)| and the number of sample N. A simple algorithm to determine the sample locations in frequency domain according to energy equipartition sampling (EES) can be immediately formulated. Figure 2 displays the EES algorithm.

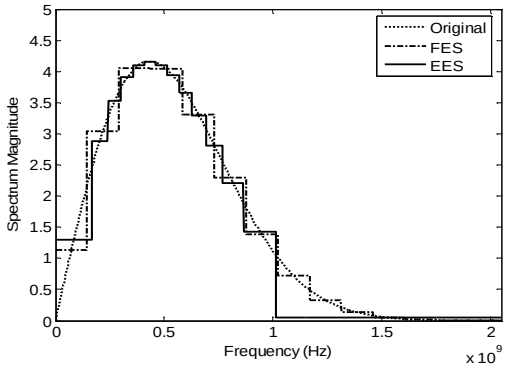


Fig.3. Comparison of EES with FES for a 14 samples

An illustration of EES compared to the FES for a 2GHz impulse of monocycle signal divided into 14 sub-bands is presented in Fig.3. The selected sample is located in the centre of each subband for corresponding method. The figure shows that the subband becomes wider when the spectral energy density is lower, yields non-uniformly distributed frequency-domain sample positions.

IV. EXPERIMENTS AND ANALYSIS

In the experiment, a 256 length discrete time signal representing a 2 GHz monocycle signal of the GPR A-scan is generated. The A-scan will consisting of shifted and attenuated monocycle impulses, depending on the number of reflections and their range or distance from the antenna. In CS terminology, the number of the impulse defines the DoF (Degree of Freedom) or the sparsity of the signal. Therefore, minimum number of required samples given in (5) will change according to the value of DoF. For the present case, one and three random reflections are simulaetd.

Figure 4 shows the reconstruction results of monocycle signal based on 14 samples selected by three sampling methods. The top part shows the original signal, while the next ones are reconstructed signal based on samples obtained by the EES, random sampling, and the FES, subsequently. The PSNR values of reconstructed signal for the present case by the FES method is -12.9 dB, random sampling gives -6.2 dB, and the EES yields 19.6 dB. Therefore, the EES gives the best results compared to both of the random sampling and the FES.

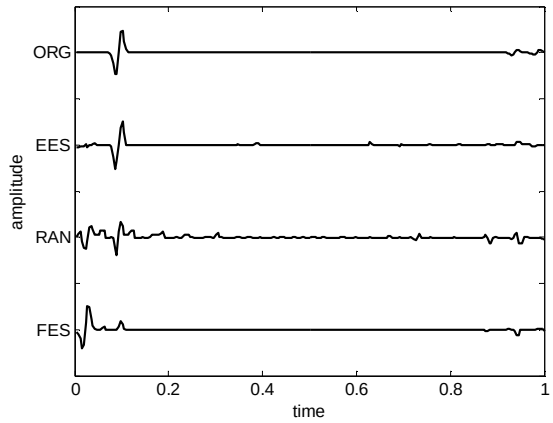


Fig.4 Simulation results for a 14 samples for three sampling schemes: EES, random sampling, and FES

Figure 5 shows the spectrum of original signal and the reconstructed ones. The spectrum also shows that the reconstructed signal from EES best fits the original magnitude spectrum.

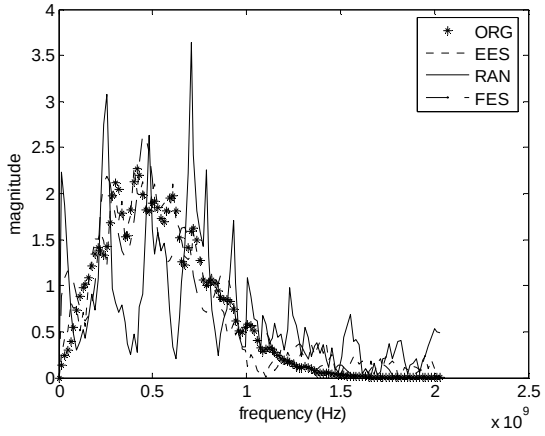
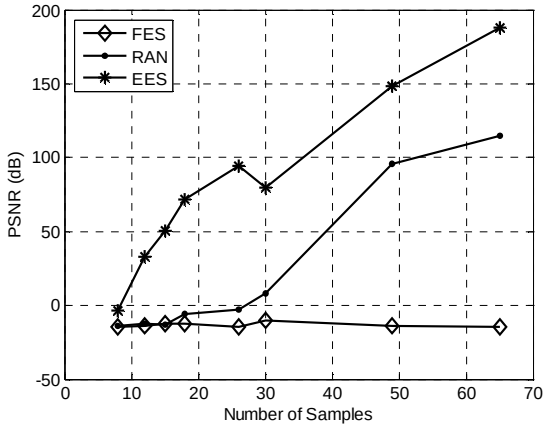
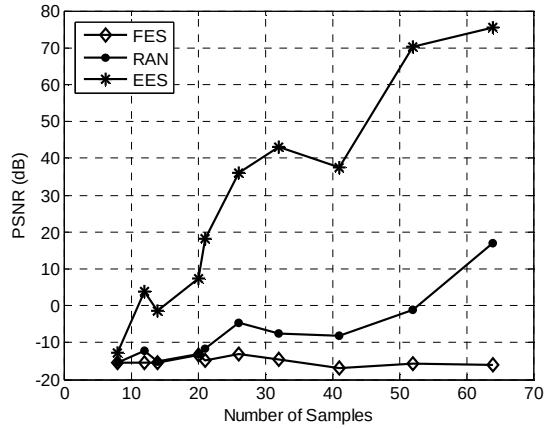


Fig.5 The spectrum of the original and reconstructed signals

Figure 6 shows PSNR performance of various numbers of samples with (a) one and (b) three DoF (attenuated and shifted monocycles). Each data point is an average of seven times signal generation, sampling, and reconstruction. This figure shows that the EES consistently outperforms both of the FES and random sampling in term of PSNR and demonstrates that higher DoF requires more sample to achieve the same PSNR as the lower one.



(a)



(b)

Fig.6 The l_1 reconstruction performance in term of PSNR for various number of samples with three sampling methods: frequency equipartition sampling (FES), random sampling (RAN), and energy equpartition sampling (EES). Figure (a) shows the performance of a signal with one monocycle, and (b) with three shifted and attenuated monocycles

V. CONCLUSIONS

A new method to improve l_1 reconstruction in CS with known spectral energy density is described. Performance of three sampling schemes, i.e, the FES, random sampling, and EES are compared an analized. It is shown that the EES outperforms both of the random sampling and FES. This result enables a possibility of CS imaging with much fewer number of samples, hence higher acquisition speed, than suggested by random sampling in the standard CS method.

ACKNOWLEDGEMENT

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Adaptive Regularized Newton Algorithm for Image Reconstruction in Electrical Impedance Tomography

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***Abstract*—Electrical Impedance Tomography (EIT) is a computerized tomographic imaging technique which is able to reconstruct an image of the distribution of electrical impedance such as resistivity from knowledge of the boundary voltage and current on the object. EIT offers a possibility of realizing a low cost and safe imaging system, because it uses non-ionizing radiation and requires relatively simple hardware. Almost all EIT image reconstruction problems are ill-posed. The matrix to be inverted in the equation for calculating the update resistivity distribution is ill-conditioned. This leads to solution of that equation may not exist, or although a solution does exist, it does not stable. We adopt the well-known Tikhonov regularization technique to solve the ill-posed problem. We introduce a stabilizing function with a regularization parameter to the objective function. By minimizing the objective function we obtain a regularized resistivity update equation. The problem is how to select a proper regularization parameter in order to find the solution. In this study, an algorithm for selecting the regularization parameter is proposed. This parameter is adaptively determined based on the objective function in each iteration. To illustrate the proposed method, we present numerically the image reconstruction using artificially generated data.**

***Keywords*—Electrical Impedance Tomography, Finite Element Model, Regularized Newton Method, Adaptive Regularization Parameter**

I. INTRODUCTION

Electrical Impedance Tomography (EIT) is a computerized tomographic imaging technique which is able to reconstruct an image of the distribution of electrical impedance such as resistivity from knowledge of the boundary voltage and current on the object. Some promising fields of this technique are biomedical engineering, geophysics, non-destructive test, industrial process, humanitarian determining etc.

The EIT is feasible in biological object and suitable for imaging the internal of human body. The knowledge of internal electrical properties would be useful for detecting such as brain function [4], lung and ventilation [6], necrotic tissue inside the body [12][13], and cancers [11][14][15][16]. Furthermore, detecting the internal of human body from an image of electrical properties would have a number of advantages over the other techniques. There is no radiation from such as x-ray and radioactive materials. It could be done with a relatively simple and inexpensive electrical system.

Almost all EIT image reconstruction problems are ill-posed. We adopt the well-known Tikhonov regularization technique to solve the ill-posed problem. We introduce a stabilizing function with a regularization parameter to the objective function. By minimizing the objective function we obtain a regularized resistivity update equation. The problem is how to select a proper regularization parameter in order to find the solution. Some works have performed how to choose the regularization parameter for solving the ill-posed problem [2][3][7][10]. They obtained relatively good results, but it is still left open to investigate an alternative method. In this paper, a method for determining the regularization parameter is described. The parameter should be selected properly. When the parameter is too large, the solution will significantly deviated from the correct solution, while the parameter is too small, it does not significantly relax the ill-posed problem. This study proposed a selection rule of parameter adaptively based on two steps previous value of the objective function in each iteration. To illustrate the proposed method, we present numerically the image reconstruction using artificially generated data.

The present paper is arranged as follows, section 2 describes the EIT image reconstruction method. Section 3 describes the ill-posed problem and regularization method. Section 4 discuses the numerical simulation and results Section 5 describes the conclusions of this study.

II. EIT IMAGE RECONSTRUCTION

The present EIT system consists of a number of electrodes, current generator, voltage measurement unit and a computer for image reconstruction. A set of electrodes is placed on the periphery of an object. The current generator provides a.c. currents to the electrodes then voltage measurement unit measures the boundary voltage induced. The data of injected current and boundary voltage are sent to the computer for reconstructing the distribution of resistivity. Fig. 1 shows the outline of the EIT system.

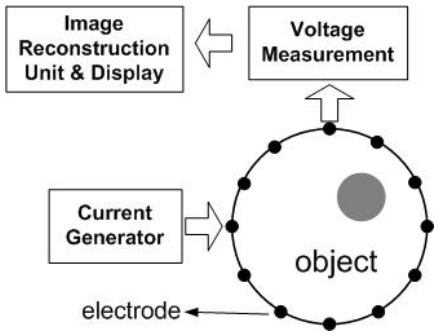


Fig. 1. Outline of the EIT system

Several image reconstruction algorithms have been developed where most of them are derived from the Laplace equation. They can be grouped into two categories. The first are based on linear approximations or direct reconstruction methods. Examples of linear methods are the back projection method, one step Newton method, moment method etc. The seconds are model based iterative methods. Examples are double constraint method, Iterative Newton method etc.

In model based iterative reconstruction algorithm the problem is broken into a forward and an inverse problem. The forward problem involves finding the potential distribution given the resistivity distribution and certain boundary condition. The inverse problem calculates the resistivity distribution given measured potential and current density distribution. In this study, the Finite Element Method (FEM) is used to solve the forward problem, and the Newton method to the inverse solution where it minimizes, iteratively, an objective function to obtain the update resistivity distribution equation.

A. Finite Element Modeling

For a given resistivity distribution and boundary condition, i.e., the potential and current density on the boundary, the potential distribution inside the object obeys the following governing equation,

$$\nabla \cdot \frac{1}{\rho} \nabla \Phi = 0 \tag{1}$$

The boundary conditions is defined as follows

$$\Phi = \Phi_0$$
$$\frac{1}{\rho} \frac{\partial \Phi}{\partial \eta} = \mathbf{J}_0 \tag{3}$$

where, Φ is the potential distribution within the medium, Φ_0 is the boundary potential and $\mathbf{J}_0$ is the boundary current density, and η denotes normal unit vector pointed outward on the boundary. The FEM is employed for solving the governing equation. The region is discretized using triangular element, under assumption that the electrical properties are homogeneous and isotropic. The FEM yields a system of linear algebraic equations:

$$\mathbf{Yv} = \mathbf{i} \tag{4}$$

where $\mathbf{Y}$ is the admittance matrix, $\mathbf{v}$ is a voltage distribution vector, and $\mathbf{i}$ is current vector. The boundary potential data of the model can be calculated as follows,

$$v_e(\rho) = \mathbf{T}_r \cdot vec(\mathbf{v}) \tag{5}$$

where $\mathbf{T}_r$ denotes a transformation matrix. The value of $v_e(\rho)$ will be compared with the voltage measurement data in the reconstruction algorithm.

B. Calculation of Resistivity Distribution

To calculate the internal resistivity distribution of an object from boundary potential and current data, we evaluate iteratively an objective function that describes the error between the voltage response of the real object and that of the model. The objective function is defined as

$$\Pi(\rho^k) = \frac{1}{2}\left(v_e(\rho^k) - v_0\right)^T \left(v_e(\rho^k) - v_0\right) \tag{6}$$

where v_0 is the potential vector measured from the boundary object, $v_e(\rho)$ is the potential vector calculated from the model of resistivity distribution. In order to minimize the objective function $\Pi(\rho^k)$, we take the Taylor series expansion of the derivative of the objective function at point ρ^k then keep the linear terms. We obtain the impedance update equation as follows

$$\rho^{k+1} = \rho^k + \Delta\rho^k \tag{7}$$

$$\Delta\rho^k = -\left[\left(v_e'(\rho^k)\right)^T \left(v_e'(\rho^k)\right)\right]^{-1} \left(v_e'(\rho^k)\right)^T \left(v_e(\rho^k) - v_0\right) \tag{8}$$

where,
k = iteration number
(2)

This algorithm is known as the iterative Newton reconstruction algorithm.

In the beginning, we guess an initial distribution of resistivity, and obtain voltage response on the Finite Element (FE) model. We calculate the value of objective function. If it is less than a certain limit, the calculated distribution of resistivity is considered as a solution. If it is greater than the limit, the resistivity distribution is further updated by using equation (7) and (8).

III. ILL-POSED PROBLEM

A. Regularization Technique

Equation (8) can be rewritten as a simple algebraic equation as follows;

$$\mathbf{Ax} = \mathbf{y} \tag{9}$$

where

$$\mathbf{A} = \left(v_e'\left(\rho^k\right)\right)^T \left(v_e'\left(\rho^k\right)\right) \tag{10}$$

$$\mathbf{x} = \Delta\rho^k \tag{11}$$

$$\mathbf{y} = -\left(v_e'\left(\rho^k\right)\right)^T \left(v_e\left(\rho^k\right) - v_0\right) \tag{12}$$

We consider that the vector **x** is an unknown function in a space **X**, and a vector **y** is in a space **Y**. To solve the linear equation, we need to calculate the inverse of **A** that contains the Jacobian matrix. The Jacobian matrix is a function of the resistivity distribution, the injected current, the geometry object, and the boundary potential. Since, the limitation of that information for **y**, we can not obtain the approximate solution from inverting the matrix **A**. This is because, mathematically, the operator **A** may not belong to the mapping of **X**-**Y**, then **x** may not exists, or although **x** does exist, it does not stable, that is a small perturbation on the data, i.e., the boundary potential measurement data v_0, will cause a large changes in the solution of update resistivity distribution. Consequently, the problem is ill-posed, or the matrix **A** is ill-conditioned, namely the ratio between the maximum eigenvalue and the minimum one is very large. We adopt the well-known Tikhonov regularization method to solve the ill-posed problem. Here, a smoothing function $\Lambda\left(\rho^k\right)$ is introduced to the objective function, then the objective function in equation (6) turns into:

$$\Pi\left(\rho^k\right) = \frac{1}{2}\left(v_e\left(\rho^k\right) - v_0\right)^T \left(v_e\left(\rho^k\right) - v_0\right) + \alpha\Lambda\left(\rho^k\right) \tag{13}$$

where $\Lambda\left(\rho^k\right)$ provides the information of resistivity distribution to the objective function as prior information, α is a regularization parameter which is a positive number. We define the smoothing function as a function of the update resistivity distribution as follows,

$$\Lambda\left(\rho^k\right) = \left(\Delta\rho^k\right)^T \Sigma\left(\rho^k\right) \tag{14}$$

where Σ is a positive definite matrix. By minimizing the new objective function, we obtain the following resistivity update equation.

$$\Delta\rho^k = -\left[\left(v_e'\left(\rho^k\right)\right)^T \left(v_e'\left(\rho^k\right)\right) + 2\alpha\Sigma\right]^{-1} \left(v_e'\left(\rho^k\right)\right)^T \left(v_e\left(\rho^k\right) - v_0\right) \tag{15}$$

Observe that the equation (8) differs to (15) in term of $2\alpha\Sigma$. The matrix in equation (15) is better condition as α is a positive number and Σ is a positive definite matrix.

B. Parameter Selection Rule

The problem in the regularization technique is to determine the regularization parameter α. Here, we select an initial value by trial and error. Then we modify the α by a rule as shown in the following algorithm. α is determined based on two steps previous value of the objective function. The change of α is calculated by two control parameters γ_1 and γ_2, where they should be greater than 1.0.

SET $\alpha > 0$; $\gamma_1 > \gamma_2 > 1.0$

IF $\Pi\left(\rho^{k+1}\right) < \Pi\left(\rho^k\right)$ AND $\Pi\left(\rho^k\right) \geq \Pi\left(\rho^{k-1}\right)$ THEN

$$\alpha^{k+1} = \alpha^k / \gamma_2$$

ELSEIF $\Pi\left(\rho^{k+1}\right) < \Pi\left(\rho^k\right)$ AND $\Pi\left(\rho^k\right) < \Pi\left(\rho^{k-1}\right)$ THEN

$$\alpha^{k+1} = \alpha^k / \gamma_1$$

ELSEIF $\Pi\left(\rho^{k+1}\right) \geq \Pi\left(\rho^k\right)$ AND $\Pi\left(\rho^k\right) \geq \Pi\left(\rho^{k-1}\right)$ THEN

$$\alpha^{k+1} = \alpha^k * \gamma_1$$

ELSEIF $\Pi\left(\rho^{k+1}\right) \geq \Pi\left(\rho^k\right)$ AND $\Pi\left(\rho^k\right) < \Pi\left(\rho^{k-1}\right)$ THEN

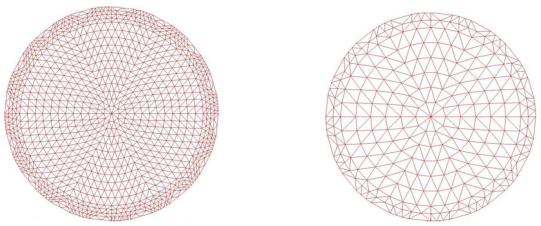
$$\alpha^{k+1} = \alpha^k * \gamma_2$$

ENDIF

In the algorithm, if the value of objective function converges to the small value, the regularization parameter also converges to zero and the regularized update equation becomes the original equation.

IV. NUMERICAL SIMULATION

As the illustration, some numerical results obtained from a simulation are shown. We employ the EIDORS 2D EIT software developed by Vauhkonen [9]. Here, two FE models for cross sectional of object were considered, one was a 'real' object to be identified in solving the forward problem and the other was used as a model by which the 'real' object was to be reconstructed in solving the inverse problem. The FE models used for this study are shown in Fig. 2. The first model has 492 elements and the second one has 279 elements.



a. FE Model for Object b. FE Model for Image

Fig. 2. FE Model

As an example, we considered a circular object as a representative of the cross sectional of an object with a medium where resistivity distribution was known. An anomaly object with higher resistivity was put in it and it is shown in Fig. 3.

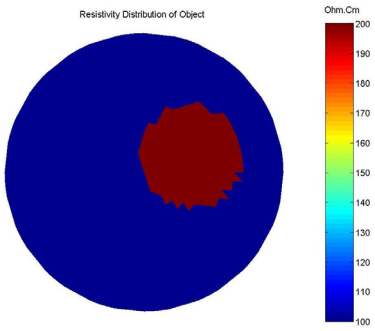


Fig. 3. Simulated object

In this numerical simulation, 16 electrodes are put on the periphery of object and to be provided with the a.c current with 1.0 mA amplitude. The reconstruction algorithm was performed in 12 steps. First, the regularization parameter is constant, then in the second simulation the algorithm was performed with the initial regularization parameter α equal 0.1. γ_1 and γ_2 are 1.8 and 1.3 respectively.

Fig. 4 shows two objective functions with adaptive regularization paremeter and fixed paremeter. From this figure, it can be seen that by using the adaptive paremeter, the objective function converge to the small value, while by using the fixed parameter, the objective function is still relatively large and flat. This fact shows that an appropriate regularization parameter will give a better result in the reconstructed image.

Fig. 5 shows the regularization parameter in each iteration. In adaptive algorithm, the regularization parameter converges to a small value. This indicates that the regularized image reconstruction equation (eq. 15) approached the original equation (eq. 8).

The reconstructed images in12 steps of iteration are shown in Fig. 6. The results show that the resistivity distribution of the object can be depicted in the reconstructed images. The region of in-homogeneity in the object is approximately located.

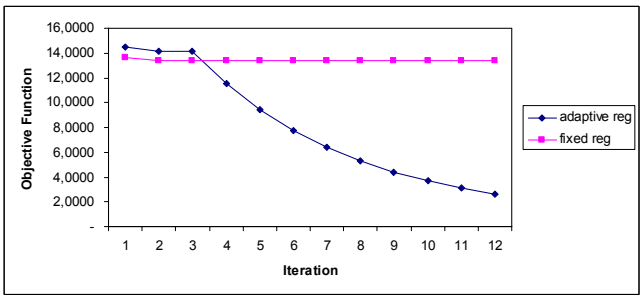


Fig. 4. Objective Function vs Iteration

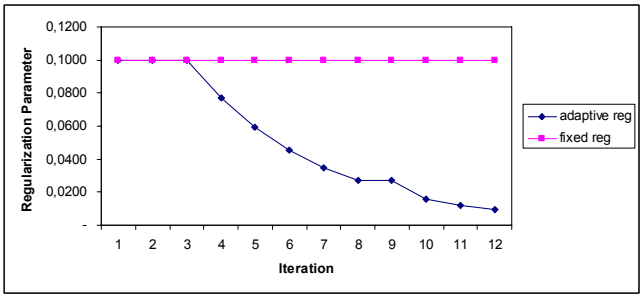


Fig. 5. Regularization Parameter in each Iteration

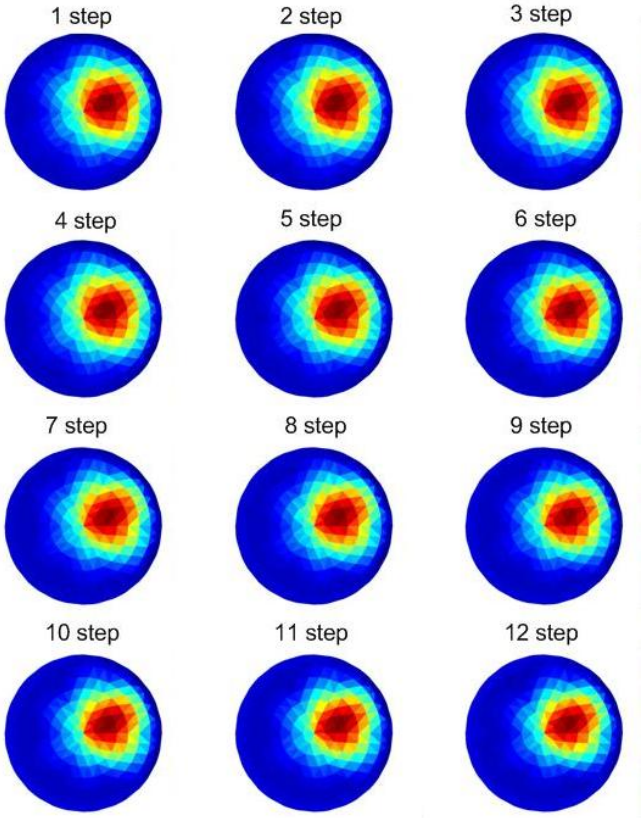


Fig. 6. Reconstructed Images

Fig. 7 shows the reconstructed images of 12th steps iteration obtained from adaptive and fixed regularization parameters. Although these two images are relatively similar, the image obtained from adaptive regularization parameter is better. It is shown by the small value of objective function and its resistivity distribution close to the resistivity distribution of the 'real object'.

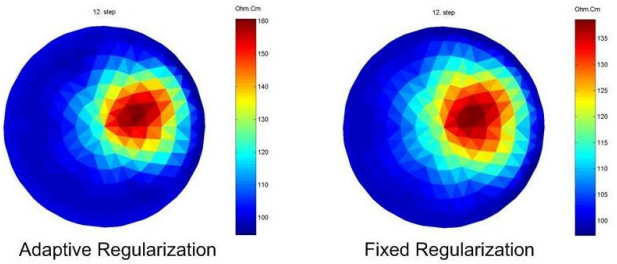


Fig. 7. Reconstructed Images for 12th Steps from Adaptive and Fixed Regularizations

V. CONCLUSIONS

From this study, an adaptive regularized Newton method was applied to reconstruct the resistivity distribution of a 2-D circular object. We conclude that the regularization parameter selection rule performed well for our test case. The objective function converged to the small value and the region of inhomogeneity of the object was approximately located, and the calculated resistivity distribution close to its 'real object'. In the further study, the image reconstruction for the real data measurement should be perfomed, where there are some problems related to the measurement error and other hardware problem.

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Precisely Iris Location Based on Point Hough Transform

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***Abstract*—Face Recognition is a technology for person authentication by using the digitized facial features. For the past two decades, it has become one of the most challenging research topics in the field of image processing, pattern recognition and computer vision. Automatic Face Recognition has been intensively investigated by researchers and many useful algorithms have been developed. Since faces of different subjects are often similar while face images from the same person often differ quite significantly due to pose, expression variations and lighting conditions, current face recognition systems cannot meet the requirements of many practical applications. This thesis focuses on the research of human eye localization. The eyes are the most important facial landmarks on human face. The positions of two eyes are commonly used for the geometry normalization of a face image. Eye location is thus a very crucial step for the establishment of a Face Recognition system. In particular, this thesis makes one main contributions detailed below. A proposed method for the localization of human eyes is presented. The method is based on the character that eyes have higher degrees of complexity. Firstly, a search area of the eyes is determined by using the result of horizontal projection of grayscale. Secondly, a lesser area is determined by using the distribution character of eye grayscale. Finally, a Point Hough transform is applied to location the eyes precisely. We implement the algorithms and experiment in my face testing set. The results show that the method for the localization of human eyes is easy to realize and has illumination robust.**

***Keywords*—face recognition, skin color, eye location, image processing; facial feature detection.**

I. INTRODUCTION

With the social development and technological progress, it is a growing demand for fast, efficient and effective identification technology. Traditional methods like the password, stamp, ID card is easy to forget, easily forged and lost so that brings the inconvenience to the People's life and social management. So, in recent years, biometric technology has gradually infiltrated into the daily life and work. Fingerprints, Iris, genetic and other biological identification system, as in comparison to face identifications system more direct and friendly, no psychological barriers, and the face of the expression Profile Analysis, but also to other identification systems to some of the information.

Obviously, the users' to the extent that a product of the application and market prospects. Although people face recognition of the current performance is not better than fingerprint identification, however, face features are likely to be the most commonly used in the future biological identifiers [1]. Face Recognition System can be applied to other biological identification systems used the occasion, could also be used without the user deliberately with video surveillance, video streams of automatic editing, the perpetrators brought to justice, video search is widely used in the future.

Face recognition can be described as to be static or dynamic images of some of them face database to confirm that the image of one or more persons. The research includes the following five aspects: face detection, face representation, face identification, facial expression analysis and physical classification.

Eyes are the most important features of human face. Eye states detection has received a great deal of attention. There are many applications of the robust eye states extraction. For example, the eye states provide important information for recognizing facial expression, human-computer interface systems and driver fatigue monitoring system.

Iris is gaining lots of attention due to its accuracy, reliability and simplicity as compared to other biometric traits. The human iris is an annular region between the pupil (generally darkest portion of the eye) and sclera. It has many interlacing minute characteristics such as freckles, coronas, stripes, furrows, crypts and so on. These minute patterns in the iris are unique to each individual and are not invasive to their users.

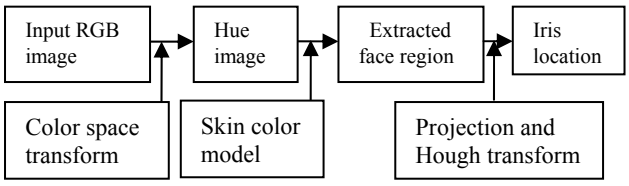


Fig.1 Flow chart of iris localization in images

Eye localization methods proposed in this paper first extract face region based on hue image in transformed color space, and then locate eye center by thresholds setting, Integral projection and Hough transform. The flowchart of the algorithm is illustrated in Figure 1.

II. FACE RECOGNITION BASED ON IMAGE GRAY-SCALE INFORMATION

Skin color is the important information of human face. It is not dependent on the details of facial features. Under normal conditions in the light, face skin color gathered in the color space in a particular region. Through the establishment of a color sampling distribution function or color distribution of the search for suitable threshold. It can be extracted a skin color region. [2 , 3].

In the color face segmentation algorithm, in order to separate from the face from complex context, its need to use for different light conditions of reliable color models. Research shows that, despite different nationalities, age or gender the face skin color looks different, but this is mainly concentrated in the brightness, in some color spaces which brightness to be removed, the different face skin color distribution is consistent and focused on smaller regions. However, most of the color video recorders, digital cameras, and some image acquisition devices are used to indicate the RGB color model, but the expression of RGB color space, color information and brightness information is mixed together. As the surrounding environment changes, the facial monitoring may become more complicated because of the brightness, making the results of color segmentation unreliable. Therefore, must convert RGB color space in order to achieve that color and brightness information separated.

This article got 60 uniform illumination human photos, and cut out them to 100 un-overlapping skin areas, total 292039 skin pixels. Convert these skin images to HSV color space and HIS color space for analyze the distribution of skin color, and then fix the range of skin color distribution.

Therefore, for every pixel in image, when the corresponding R,G,B value and converted H,S,I and H,S,V value meets the following relations, the pixel as to identify the skin color:

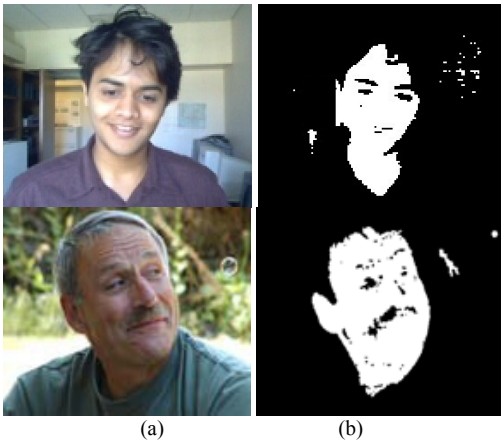
$0.52 \le hue \le 0.63$
$0.10 \le saturation \le 0.40$
$1.0 \le R/G \le 1.3$

or

$0.03 \le H \le 0.128$
$0.10 \le S \le 0.40$
$1.0 \le R/G \le 1.3$

Use self-adaptive region merged algorithm [4] to get the region of face. After threshold, the threshold within the scope of pixels is set to 1, and the remaining pixels set to 0, get the binary image. We can see the Fig. 2.

Above is through mixing (RGB+HSI) and mixed (RGB+HSV) combination of methods for different types of facial image test. That is, under the ordinary light, laboratory (low light), natural light and special light effect. Experiments have proven that the face detection method which combined three types of color space has the better skin color recognition(Fig.2).However, when a background light is too bright, the face of a widespread high light district, or the skin color and background color contrast is not strong, identify ineffective. Moreover for different skin color need to adjust the threshold.



(a) (b)

Fig.2 (a)original image; (b)binary image

III. EYE LOCATION BASED ON IMAGE GRAYSCALE INFORMATION

In the face positive image recognition, the change of face direction has the obvious impact for the recognition results, so before feature extraction needs to preprocess the face image. The distance between eyes is not easily influenced by the change of the light or expression, so the precise positioning is very important. Common eye location algorithm has Hough transform [5], Deformable template [6, 7], Edge feature analysis and symmetric transformation [8, 9], etc.

In this paper, first of all, eye location based on image grayscale information use of the images gray-level projection to determine the region of eyes in images, and then use the ratio of eyes gray distribution to determine the smaller eyes region, that is, for the first eyes location. On this basis, use the Hough transform to find at the eyes center.

A. Location Eye Search Region

In general, for children, eyes located in the half of head, with age, the proportion which the distance between eyes to the chin in the entire length of the head will increase until be adult. Although persons have a variety of face shapes, consider the impact of the neck and collar, the lower border of an eye search region defined in the one-third height of the face.

Find the upper border of the eye search region is using the horizontal gray integral projection. As we know that the eyes locate in the upper part of the face and that the pixels near the eye are more changeful in value comparing with the other parts of face, it is obvious that the peak of this horizontal projection in the upper part can give us the horizontal position, therefore we can easily line out a horizontal region in which the eyes location. The horizontal gray level integral projection can be defined respectively as [10]:

$$H(y) = \frac{1}{x_2 - x_1} \sum_{x_1}^{x_2} I(x, y)$$

where I(x,y) is the intensity of a pixel at location (x,y), H(y) is the horizontal gray integral projection between [x1,x2].

B. Locate Eye Region

Above has been defined the eye search region, now is searching for the region to find the location of the eyes.

In the eyes of the search area, eyes and eyebrows gray value is the minimum, we can usually take advantage of this feature of the eye to narrow the search area. However, the experiment found that sometimes the eyes and eyebrows will stick together, this change in the face expression, particularly, when angry is more, resulting in the eyes and eyebrows will be very difficult to distinguish. Meantime, eyes to the precise positioning of the increase in the number of invalid data, greatly affected the positioning accuracy of the eye and increased targeting of computing time. Therefore, I am under the eyes of regional significant changes in the characteristics of gray to distinguish between the eyes and eyebrows, to achieve the purpose of the regional division of the eye.

Under normal circumstances, white part of the eyeball is the largest part of average gray value in the search area, but the iris part is the smallest. Therefore, the ratio of the gray value of iris and the sclera is the smallest that is in all adjacent pixels in the average gray value of the eye search area. The table lists the Horizontal direction gray-scale changes which from the random sample of 10 face images in an image library. That is the gray value ratio of iris and sclera, the ratio of skin and sclera, the ratio of iris and skin, the ratio of eyebrows and skin (all values are average value).

Table I. Gray value ratio data

No.	iris/ sclera	skin/ sclera	iris/ skin	eyebrows/ skin
1	0.206	0.798	0.322	0.589
2	0.261	0.732	0.358	0.672
3	0.269	0.695	0.307	0.654
4	0.234	0.829	0.385	0.571
5	0.214	0.753	0.318	0.576
6	0.425	0.881	0.552	0.669
7	0.181	0.821	0.295	0.657
8	0.433	0.736	0.356	0.664
9	0.187	0.695	0.381	0.683
10	0.236	0.801	0.318	0.603

Table I shows that the ratio of the gray value of iris and the sclera is less than others. According to this characteristic, the eye location implementation steps like follows:

1. Set the threshold (lim). After the gray distribution of eye searches regional in a number of different light conditions showed that light have significant impact on thresholds. So it is difficult to determine the threshold. In order to not affect the accuracy of the threshold under the premise of minimizing the amount of the relevant calculation.
2. When the eyes of the search area in order to meet the search of adjacent pixels gray value ratio is less than the lim. Remove the ones which from the vertical direction with other pixels of the distance more than 2 pixels.(Exclude the impact of individual pixels which is in the eyebrow region). Then find the largest and smallest pixels from the ordinate and separately defined as the max and min.
   Because of the eyelid blocked the white of the eye's part is more than iris, so that the actual distribution of the eyes range is bigger than max and min, defined the upper limit of actual areas where the eyes as max+2, the inferior limit as min-2.
3. Use vertical integral projection to locate the area between min-2 and max+2. Through the vertical integral projection curve analysis can be found there will be two peaks in the location of the eyes. Thus use of these two peaks will be easy to locate the horizontal position of the eyes. The vertical integral projection can be defined respectively as:
   $$V(x) = \frac{1}{y_2 - y_1} \sum_{y_1}^{y_2} I(x, y)$$
   where I(x,y) is the intensity of a pixel at location (x,y), V(y) is the vertical integral projection between [y1,y2].

At the basis of eyes regional location, the precise positioning of the eyes to the specific implementation steps is as follows:

1. Use the eight-direction Sobel algorithm for boundary tracking.
2. Border Image Binarization.
3. Use the Point Hough transform for exactly iris location.

IV. EXPERIMENTAL RESULTS

The final location result is shown in Fig. 3. The black rectangle represents the eye region and the white cross means the center of eyeball.

There are lots of existing algorithms to locate eyes, such as template matching method, neural network and so on, their common disadvantage is the complexity of algorithms, large computation, locating system itself is very difficult to achieve.

The criterion of [11] is used to judge the quality of eye detection, which is a relative error measure based on the distances between the detected and the accurate central points of the eyes. Let Cl and Cr be the manually extracted left and right eye positions, Cl' and Cr' be the detected positions, dl be the Euclidean distance between

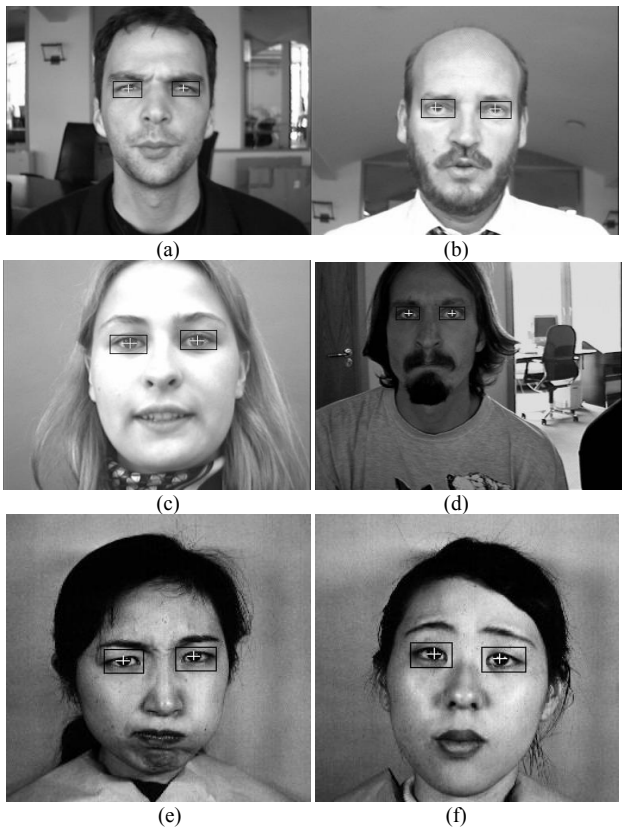


Fig.3 Final location results

Cl and Cl', dr be the Euclidean distance between Cl' and Cr'. Then the relative error of this detection is defined as:

$$err = \frac{\max(d_l, d_r)}{d_{lr}}$$

If err < 0.25, the detection is considered to be correct. Note that err = 0.25 means the bigger one of dl and dr roughly equals half an eye width. Thus, for a face database comprising N images, the detection rate is defined as:

$$rate = \sum_{\substack{i=1 \\ err_i<0.25}}^{N} 1/N \times 100\%$$

where err_i is err on the i-th image. According to Eq.(4), a detection is regarded as an erroneous one if the distance between the detected central point and the manually extracted central point is bigger than half an eye width.

We conducted our experiment with BioID face database and JAFFE face database are consists 1734 face images and other images which are captured from CCD camera under the varying condition of illumination, pose of head and expression of face.

Table II. A comparison result of detection rate

Method	Detection Rate	False Detection Rate
IPF	95.18%	4.81%
VPF	95.79%	4.21%
Proposed method	97.36%	2.64%

V. CONCLUSION

Eye location is an important step between face detection and face recognition. A procedure for locating eye features has been introduced in this paper. The proposed method can locate eyes exactly and rapidly. The successful detection rate is 97.36%. Experiments show that the performance of this system is robust against the variations of face poses, accessories and illuminations.

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A New Curvature Based Detection of Cerebral Aneurysm from 3D Medical Images

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***Abstract*—A new scale invariant curvature shape index based on local principal curvatures of the arterial wall vasculature has been proposed. The new shape index is feasible to differentiate between cerebral aneurysm shapes from other arterial segments. The shape index I is defined as $I = (K_1+K_2)/ K_1$ where K_1 and K_2 are the maximum and the minimum curvature, respectively and $|K_1| \geq |K_2|$. This shape index is non-dimensional and not depending on the size of the object. The shape index value vary from zero to two where near zero index characterize the saddle shape which will represent the junction or the inner bend of the artery, near one shape index characterize the normal/straight artery, and near two shape index characterize the sphere or ellipsoid shape which will represent the aneurysm dome or the outer bend of the artery. The value 0.75 and 1.25 was chosen rigorously to give a better differentiating scenario. Shape index ranging in between 0.75 and 1.25 represented normal/straight artery while shape index lower and higher than that range represented junction or inner bend and aneurysm or outer bend, respectively. Results showed that the aneurysm shapes clearly differentiated from the normal artery. Additional smoothing technique based on moving average algorithm was added to improve the result. A curvature based display system using this shape index calculation can be integrated into 3D medical image processing package to help to detect aneurysm shapes especially small aneurysms that are prone to be overlooked in routine readings.**

***Keywords*—Scale invariant, Curvature analysis, Cerebral aneurysm, Medical image**

I. INTRODUCTION

Cerebral aneurysm is a cerebrovascular disorder in which weakening and thinning of arterial blood vessel causes a localized dilation or ballooning of the artery. Cerebral aneurysm occurs primarily near the arteries at the base of the brain, known as the Circle of Willis [1-3]. About 70-90% of cerebral aneurysms are less than 10 mm in size. Cerebral aneurysms larger than 25 mm are rarely to be found [4-6]. Cerebral aneurysm may stable and unruptured or grow under unpredictable speed. The growth of cerebral aneurysm can go as fast as 2 mm per year [7]. Ruptured cerebral aneurysms are very dangerous. If it ruptured, the blood will fill the intracranial space to cause the subarachnoid hemorrhage (SAH).

In United State of America, the case of cerebral aneurysm was found quite often. Study showed that the risk of cerebral aneurysm can reach 8.1% of the population [8, 9] but only about 3% lead to rupture [4]. The recovery cost of the aneurysm rupture is quite significant. It is estimated about 513.1 million US$ had been spent to cover the cost for recovery during the year of 1979 to 1989. During the same period there had been a potential lost of income of 827.1 million US$ from the patient who suffered from the cerebral aneurysm rupture. This could happen because most patients with ruptured cerebral aneurysm were in their productive age, between 45 to 64 years old [10].

Early detection of cerebral aneurysm can reduce their risk of rupture. Detection can be performed, for example, by monitoring the blood flow sound [11] or by reviewing the medical images of the brain [12, 13]. New development in the medical imaging technology increases the scanning resolution. High resolution images permit the capture of small arteries therefore it is now possible to detect the presence of cerebral aneurysms either from 2D medical images (angiograph) or 3D medical images (CT or MRI). Faster image segmentation technique together with faster computing allowing for almost instant result of aneurysm detection. Those results are critical for the medical team in order to develop the best medical intervention to cure the patient.

Cerebral aneurysms are in the form of saccular or fusiform (see Fig. 1). The saccular cerebral aneurysms occur near the apex of the bifurcation or curved arteries and account for about 90% of the aneurysms [14]. The fusiform type can occur at a straight segment such as basilar artery. Most saccular cerebral aneurysm can be characterized as a simple pear shape [15]. The risk of rupture of cerebral aneurysm can be determined based on its shape or size [16, 17]. Fig. 1 showed the schematic shape of the aneurysm and its surrounding vasculature.

Hayashi proposed a curvature based enhanced display system for detecting the cerebral aneurysm [18]. He used the colour system based on the shape index defined as $S=1/2-1/\pi*\arctan[(K_1+K_2)/(K_1-K_2)]$ and the curveness defined as $R=1/2*\sqrt{(K_1^2+K_2^2)}$ for displaying the vasculature. The aneurysm displayed in contrast colour for easy identification.

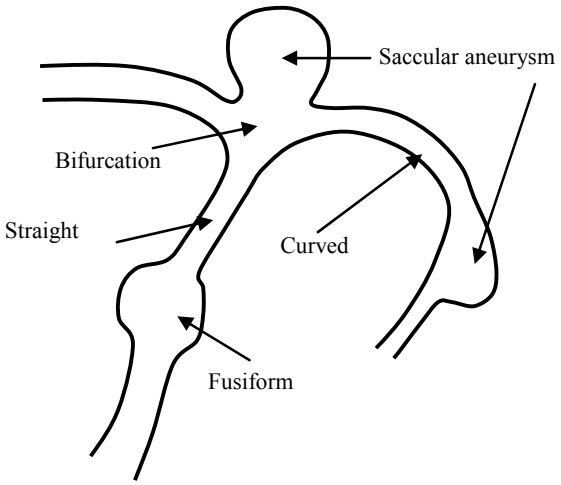

Fig. 1. Schematic shape of cerebral aneurysms and its surrounding vasculature.

In this work a new technique to detect the presence of the aneurysm shape, based on curvature analysis of the 3D geometric model of vasculature segmented from the medical images, was proposed. With this new technique different arterial segments can be characterized as curved, straight, junction or aneurysm shape. Different segments will be coloured differently for easy visual observation. Additional smoothing technique was added to improve the result.

II. Curvature

Local curvatures provide information about the local behaviour of the surface in vicinity of a given point, and so play an important role when working with surfaces. For any given point on a surface in 3-dimensional space there exist two principal curvatures K_1 and K_2 defined the maximum and minimum curvature at a point on surface. Other curvatures were derived from those principal curvatures. For example, the Gaussian curvature, defined as $G=K_1*K_2$, gives information about the location of the surface with the tangent plane at the considered point; a positive value means that the surface is locally either a peak or a valley; a negative value means that the surface is locally a saddle; a null value means the surface is locally flat in at least one direction (planar or cylindrical).

The Mean curvature, defined as $H=(K_1+K_2)/2$, is an extrinsic measure of curvature that locally describes the curvature of an embedded surface in 3-dimensional space. A minimal surface is a surface which has zero mean curvature at all points such as surfaces of minimum area subject to various constraints.

The Gaussian and Mean curvatures are non-scale invariant curvatures meaning that the curvatures are depending on the size of the object. Rugis suggested a scale invariant curvature called similarity curvature defined as $K_3=\min(|K_1|, |K_2|)/\max(|K_1|, |K_2|)$ [19]. It is a non-dimensional number and not depending on the size of the object.

In this work we introduce a new shape index curvature defined as follow:

$$I = (K_1+K_2) / K_1 \qquad (1)$$

This shape index curvature can characterize different vascular geometry such as straight artery, curved artery, junction, as well as the aneurysmal geometries. This shape index is also a non-dimensional number and scale invariant. For any given point where $|K_1| \geq |K_2|$, the shape index value will be in between zero and two where near zero value characterize the saddle or junction artery, near two value characterize the sphere and ellipsoid and near one value characterize a cylinder or straight artery. This shape index curvature is a very convenient tool to characterize the different shape of vascular geometries and capable of distinguishing the aneurysm from its surrounding normal vasculatures.

Fig. 2 showed the plot of Gaussian, Mean and Shape Index curvature for various primitive geometries. We can immediately see that the shape index is able to characterize different geometry better than Gaussian and Mean curvatures.

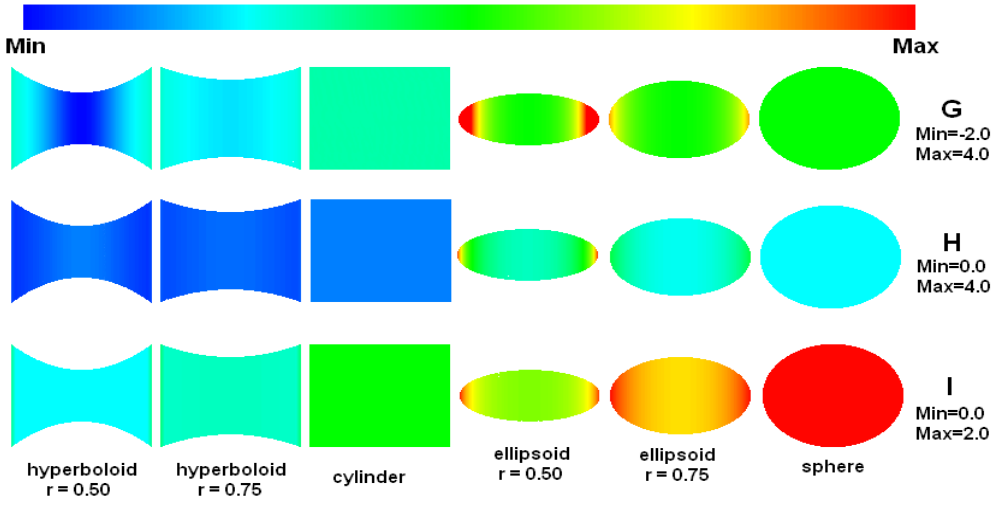

Fig. 2. Curvature of several primitive geometries showing colour evolution

The computation of local curvatures is a necessary step in many applications such as shape analysis and surface segmentation. Unfortunately local curvatures are only defined for smooth surfaces, and when dealing with surface triangle meshes the curvature value can only be estimated. Over the last decade, many estimators have been proposed in the literature [20]. In this study, we adopted the method developed by Rusinkiewicz to calculate the principal curvature of the 3D vasculature segmented from medical images represented by triangle surface patches [21].

III. Methods

A. Vasculature Geometry

Three dimensional vasculatures were segmented from CT images using threshold method. Only specific part of the vasculature that included the aneurysm geometry considered in this work. The remaining vasculature was disregarded. Fig. 3 showed three different vasculatures from different location of the Circle of Willis. The sizes of the aneurysms were 5.6 mm, 4.9 mm and 5.2 mm for ACom, Basilar and ICA aneurysms, respectively. Each model consisted of about 2000 vertex points and 4000 triangle patches. The size of individual patch was about 0.5 mm.

B. Curvature Calculation

The principal curvatures K_1 and K_2 were calculated based on the method developed by Rusinkiewicz [21]. The method was based on a finite-differences approach that estimates curvatures on irregular triangle meshes. The method was an extension of a common method for estimating per-vertex normals. The source code is available online. The calculation of shape index $I=(K_1+K_2)/K_1$ was then added to the source.

C. Geometry Classification

The shape index curvature bounded between zero and two. The value 0.75 and 1.25 was chosen rigorously for the classification purpose. Surface with shape index curvature ranging in between 0.75 and 1.25 classified as normal arteries while shape index lower and higher than that range represented junction or inner bend and aneurysm or outer bend, respectively.

D. Smoothing Technique

The smoothing technique was used to reduce the scattered shape index value and improved the viewing. The smoothing technique was calculated based on moving average algorithm define as follow:

$$\bar{I}_j = \frac{1}{n+1}\left(\sum_{k=1..n} I_k + I_j\right) \quad (2)$$

where j is the vertex point where the smoothed value will be calculated, k is the neighbouring vertex point and n is the total neighbouring vertex point. The smoothing algorithm can be applied several times depending on the degree of smoothness needed.

IV. Results

Fig. 4 showed the plot of Gaussian, Mean and shape index curvature of the three aneurysm model in this study. The Gaussian and Mean curvature cannot clearly differentiate between normal arteries and aneurysm shapes. The shape index curvature was able to differentiate between aneurysm and normal arteries better. The aneurysm showed in near red colour (shape index near two) while other arteries showed in near blue and green colours for shape index near zero and near one, respectively.

Fig. 5 showed the shape index plot using geometry classification outlined before. The shape index below 0.75 were coloured with the solid blue representing the arterial junction or the inner side of the curved arteries. The shape index higher than 1.25 were coloured with the solid red representing the aneurysm shapes or the outer side of the curved arteries. The shape index in between 0.75 and 1.25 were coloured with the solid green representing the straight arteries. Fig. 4 also showed the shape index plot without smoothing (left) and with 5 times smoothing (right). The smoothing reduced the scattered shape index values and improved the classification.

Although the aneurysm shape and the outer bend were using the same colour, it can be easily differentiated using visual observation (manual).

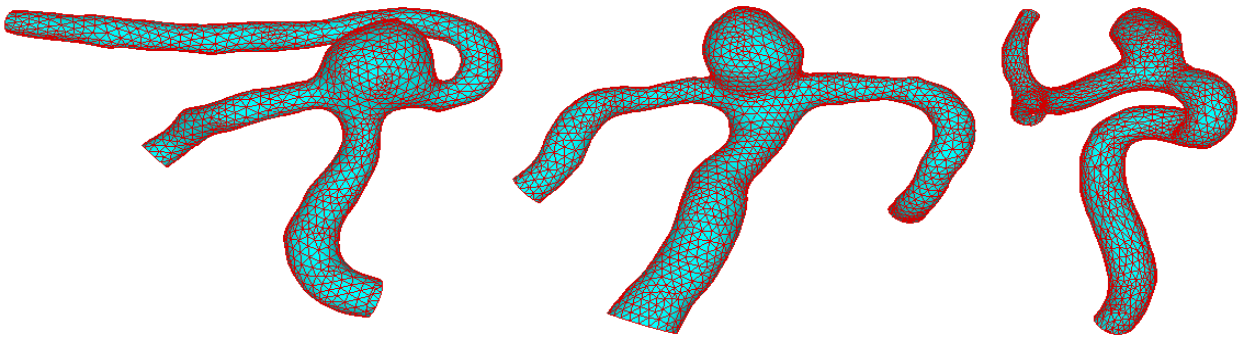

Fig. 3. Aneurysm geometry. (a) ACom aneurysm; (b) Basilar aneurysm; (c) ICA aneurysm.

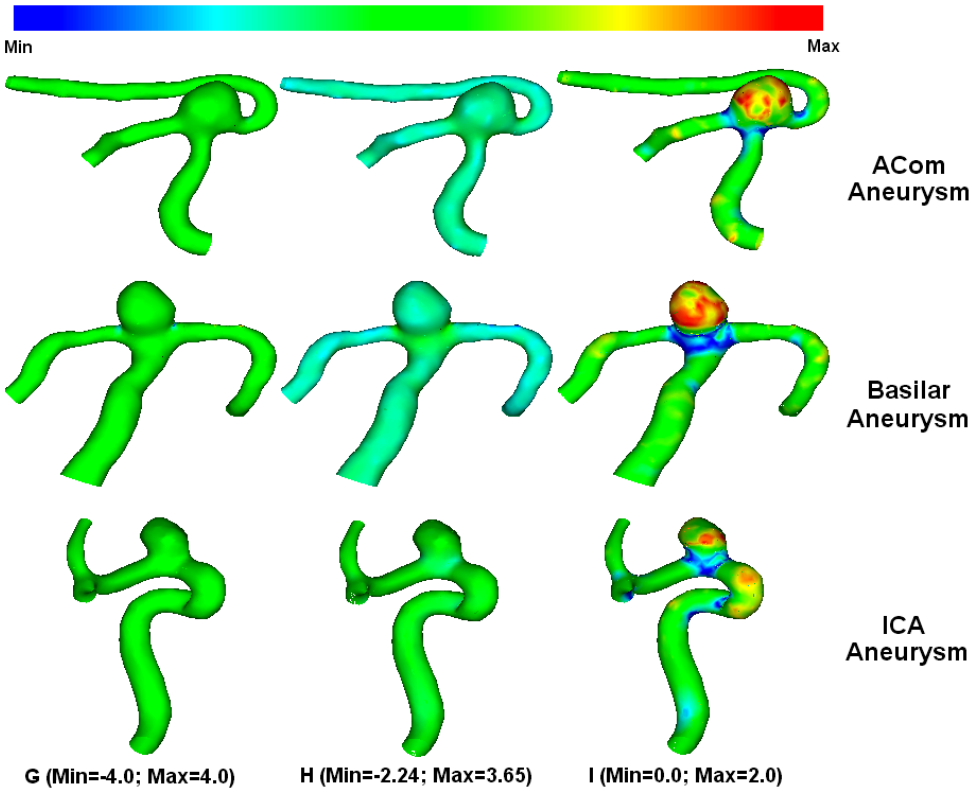

Fig. 4. Plot of curvature for three aneurysm models in this study. Showed Gaussian curvature (left), Mean curvature (middle) and shape index curvature (right).

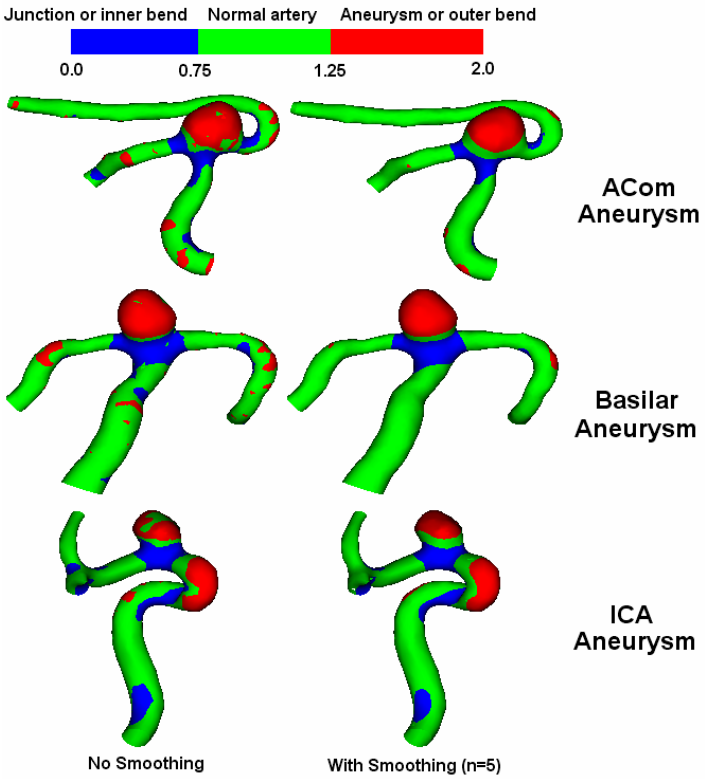

Fig. 5. Segments classification based on shape index curvature. Showed junction or inner bend segment (blue), straight segment (green), and aneurysm or outer bend segment (red). Also showed the shape index plot after smoothing (right).

V. DISCUSSIONS

Non-scale invariant curvature such as Gaussian and Mean curvatures will have dependency on the size of the object. The Gaussian and Mean curvature have the unit of 1/length^2 and 1/length, respectively. For the case of aneurysm geometry the extreme curvature usually occurred near the aneurysm neck. Fig. 6 showed the curvature plot zoomed near the aneurysm neck where the extreme Gaussian and Mean curvatures can be seen.

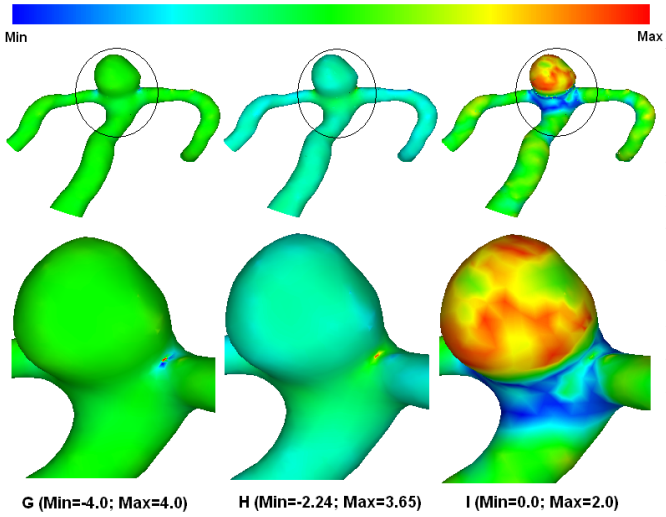

Fig. 6. Plot of curvature for the basilar aneurysm model zoomed around the aneurysm. Showed Gaussian curvature (left), Mean curvature (middle) and shape index curvature (right).The extreme values of Gaussian and Mean curvature occurred locally near the neck.

We introduce a new shape index curvature that has the scale invariant property. Using the shape index curvature extreme values can be avoided and it also independent of the size of the object. The shape index value varies between zero and two. Near zero, one and two value characterizes the saddle or junction artery, a cylinder or straight artery, and a sphere or ellipsoid, respectively. Therefore, this shape index curvature can characterize different vascular geometry such as straight artery, curved artery, junction, as well as the aneurysmal geometries. This shape index curvature is capable to characterize the different shape of vascular geometries and capable of distinguishing the aneurysm from its surrounding normal vasculatures.

This study suggested a robust arterial segment classification base on the shape index value. We selected the shape index values of 0.75 and 1.25 as the limiting number. Surface with shape index curvature ranging in between 0.75 and 1.25 classified as normal arteries while shape index lower and higher than that range represented junction or inner bend and aneurysm or outer bend, respectively. The limiting number was chosen rigorously just for the classification purpose. Using that classification we can differentiate the aneurysm from other arterial vasculatures. The outer side of the curved artery in this case was also classified as the aneurysm. This curved geometry cannot be differentiated from the aneurysm by using only the shape index curvature. Therefore, we rely on the visual observation to differentiate between those two types.

To reduce the scattered value of the shape index we used a smoothing technique base on the moving average algorithm. The smoothing algorithm replaced the local curvature with an average of its surrounding curvature (see equation 2). The algorithm can be applied many times to achieve the smoothness level as desired. For each time the algorithm applied, the new curvature was promoted from the local curvature to a more global one. In this study we found that 5 times smoothing was enough to reduce the scatter and improved the segment classification. The five times smoothing meant that each vertex curvature was affected by up to 5 rings of its neighbours where the inner neighbour points would weight more than the outer neighbour points. Assuming that the patch size was about 0.5 mm the radius of influence was about 2.5 mm which was about the size of the aneurysm itself (the aneurysm diameter in this study was about 5mm). This gives the idea on how many times the smoothing can be applied so that the shape index curvature does not loss its local curvature meaning.

The classification algorithm based on the shape index curvature can be integrated to the 3D reconstruction of medical image processing package. A curvature based display system using this shape index calculation can help the physician to detect aneurysm shapes more accurately especially small aneurysms that are prone to be overlooked in routine readings.

The same classification algorithm has the potential to detect other arterial lesions such as the abdominal aortic aneurysm or the atherosclerosis plague. For other lesion type, the limiting shape index value may be different from the value suggested in this study.

VI. CONCLUSIONS

A new curvature shape index based on local principal curvatures has been proposed. The new shape index is feasible to differentiate between aneurysm shapes from other arterial segments. A curvature based display system using this shape index calculation can be integrated into 3D medical image processing package to help to detect aneurysm shapes especially small aneurysms that are prone to be overlooked in routine readings.

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Face Tracking System with Haar Method and Pre-Study Face Recognition with Histogram Comparison

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***Abstract*—Face detection and recognition research rises with assumption identity, feature and character information of someone have extracted from images. Although commercial application for face detection and recognition have implemented, this technology not perfect yet, it need to develop for best result. Based on the background, problem can be pointed how to design and make automatic identification system with new method of face tracking and recognition. Haar algorithm has used in the research to face tracking and histogram comparison for face recognition. Microsoft Visual C++ 6.0 compiler, C++ language, and image processing library OpenCV from Intel have used in this research too. Face tracking have specialized for frontal face not the others. The result gives 80 percent success for face tracking and recognition without changing light and structural component. Lightening factor and face expression haven't influence face tracking, since camera can capture face. Structural component haven't influence either, since tracking process hasn't lose the feature and vice versa. The size of tracking image depends on the distance of the object and camera, so much longer so much the smaller. Recognition process depends on lightening because it use histogram algorithm which get image intensity value. System can be used for every lightening condition if it has stagnant lightening for capture and database image. Face recognition can be used for every background according skin face histogram from tracking image.**

***Index Terms*—haar algorithm, face tracking, face recognition, histogram comparison.**

I. INTRODUCTION

Face recognition technology and the others biometrics technology (iris scanning, retina scanning, sound recognition, finger print, hand and fingers geometrics, signature verifications, walk style, ears or the others part of body). Whereas it is still strange, but it will develop dramatically as mention in MIT Technology Review [1], biometrics will be top ten emerging technologies that will change the world".

This method developing was supported by computer technology, especially computer processor and video, makes implementation of face recognition will be large, and it is not impossible will growth as urgent application on every system that needs it [2], Face computing model is active research area since 1980 because this area not only in theory domain but also practice application in face recognition, such as crime identification, safety system, image and film processing, human-computer interaction and the others thing. Whereas computing model developing for face recognition is difficult, because of complex, multi dimension, and dynamics of face.

Research about face recognition raise with assumption that information about identity, status and character of everyone can be extracted from images. The other assumption is computer that has reaction as their image vision. Topics of face recognition and expression interested researchers. Now, whereas commercial application of face recognition have implemented [3], but this technology is not perfect yet [1] so this research still need to be developed, one of the research is face tracking system with haar method and pre-study face recognition with histogram comparison.

II. FACE TRACKING

Face tracking is detection and tracking face features with camera and marked as tracked image as output, in this step system recognize pattern as face or not. The process will be did by compiler Microsoft Visual C++ 6.0 and image processing library OpenCV from Intel and Haar method with statistics approximation [4].

Training of Haar statistics model use positive sample which have face features and negative sample without it, both of these are trained together and the difference is used as face classification parameter. This information is saved and compressed as statistics model parameter which mentioned as "a cascade of boosted tree classifier". This process was known as haar training algorithm that had result file xml as statistics model parameter.

This research used haar training parameter "haarcascade_frontalface_alt.xml" that was especially for front face tracking. Process of face tracking with classifier file xml was shown at Fig. 1 and Interface of face tracking software can be seen at Fig. 2.

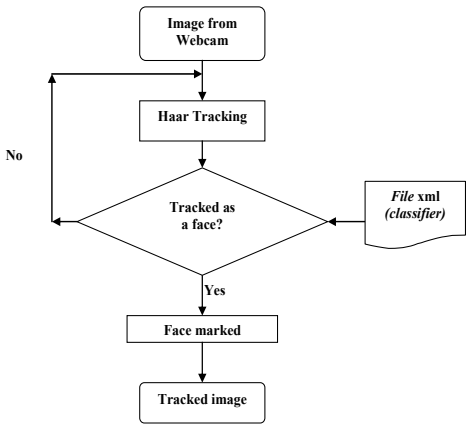

Fig. 1. *Flowchart* of face tracking algorithm with *classifier file* xml

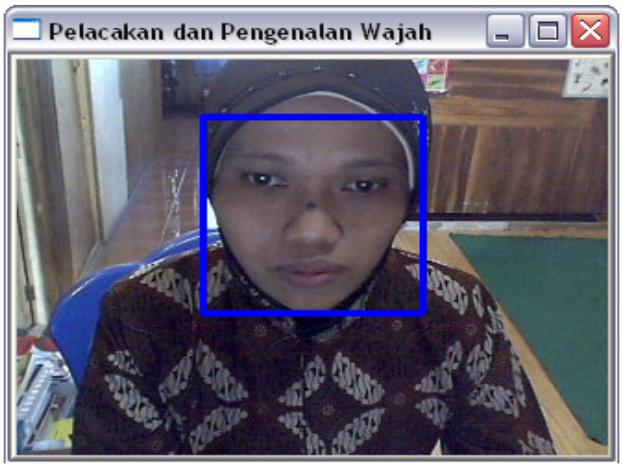

Fig. 2. Interface of face tracking software

III. FACE RECOGNITION

Pre processing was did to limited tracked image with value of back projection of face skin image histogram (sample image was taken by selection of mouse), If value was included to the criteria, image which was shown is the original pixel value. On the other hand, value was not included to the criteria, image was shown is black (pixel value = 0). This pre processing can be shown at Fig. 3 and interface of face tracking application can be seen at Fig. 5 to Fig. 8.

Face recognition is face identification process based on face image that was saved in data base, this step system give output whose is this face? Or face not recognize (face not exist in data base). Method which is used is histogram comparison. This process found face image histogram first, that grayscale histogram. It compared with grayscale histogram from images in data base used three method comparison such as correlation, Chi-square, and intersection method (Open Source Computer Vision Library – Reference Manual, 2001), all of this value used as conditional of face recognition with were ranged before. Flowchart of face recognition with histogram comparison algorithm can be seen at Fig. 4.

Before images which were compared its histogram, would be pre processed with eliminated the background of tracked face images.

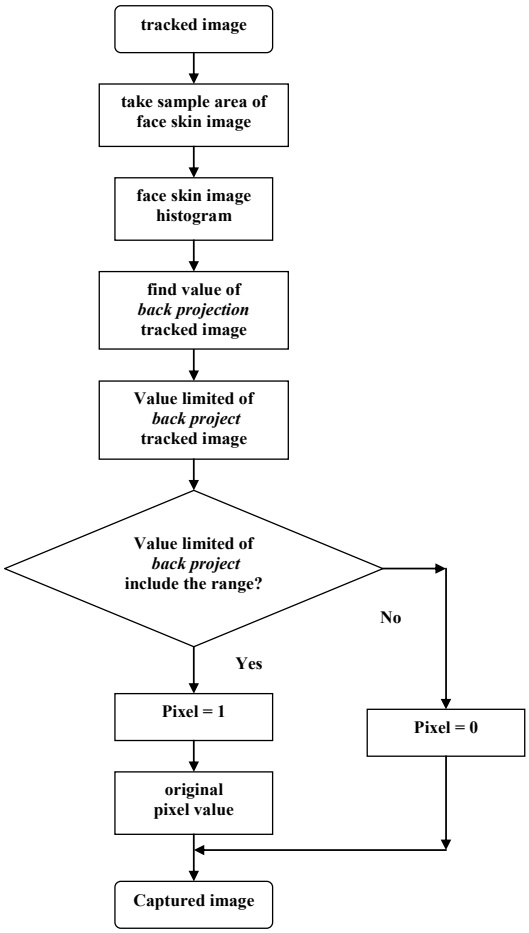

Fig. 3. Flowchart of face image pre processing algorithm

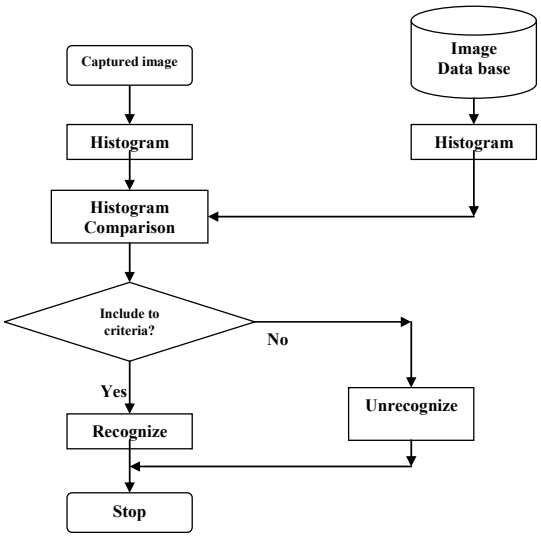

Fig. 4. Flowchart of process of face recognition with histogram comparison

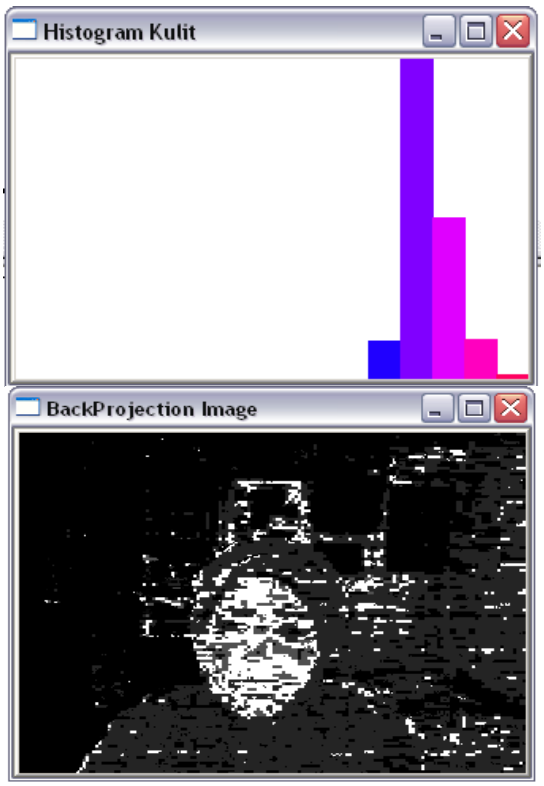

Fig. 5. Sampled skin color histogram and Back projection image

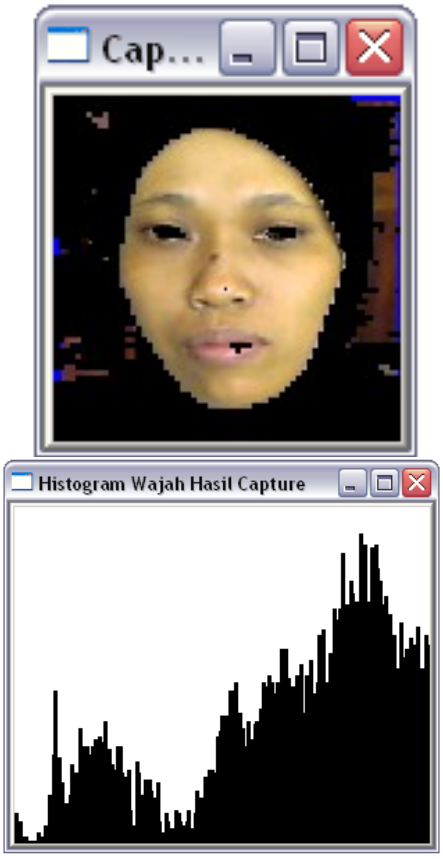

Fig. 6. Captured image as result of face tracking and its histogram

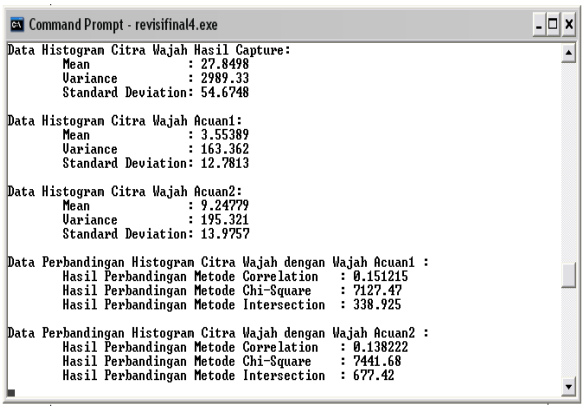

Fig. 7. Image histogram data and its comparison result

Fig. 8. Face recognition result

IV. EXPERIMENT RESULT

A. Experiment of Face Tracking Process

Experiment of face tracking was did by face tracking process with different condition of face position, lighting, image size that was influenced with face distance from camera, structural component factor, and face expression, so will be known achievement of experiment results and how far the face tracking process can be done. In this experiment was taken 10 to 15 samples in each condition, for false positive and false negative was done by all of samples of experiment was about 70 samples. The achievement of this process can be seen at Table. I.

Based on experiment results with criteria of frontal face position and non frontal face position, such as left diagonal, right diagonal, up face, down face and the other position the achievement result was 0.7. It indicate that this process is specified to face image with frontal face position to the camera. It can be proved that file xml was set up to 0.6 for x axis rotation, 0 for y axis rotation, and 0.3 for z axis rotation [5].

The results of lighting factor to the face tracking process show that this criteria was not significant to influence the process with value of achievement was 1 or without error from 10 samples, but its quality still be influenced with camera catch. This achievement was supported by training factor that ignored color and image limited [5].

The criteria of tracked image size or object (face) distance from camera can be analyzed that this tracking

TABLE I
ACHIEVEMENT OF RESULTS OF FACE TRACKING EXPERIMENT

No	Criteria	Condition	Number of Samples	Achievement	Error
1	Face Position		10	0.3	0.7
2	Lighting	Good	10	1	0
		Dark	10	1	0
3	Image Size		10	0.8	0.2
4	Structural Component		15	0.67	0.33
5	Face Expression		10	1	0
6	*False Positive*		70	0.714	0.286
7	*False Negative*		70	0.8	0.2

have minimum and maximum distance, the minimum distance is the shortest length interval object to camera which camera can not track the object and the maximum is the most far length interval of it. The minimum distance is not be significant because of dependent to camera specification, for this research use Logitech 5000 that the minimum distance is about 15 centimeters and maximum distance is about 150 centimeters from the camera. It also can be proved that this system was trained with minimum image size was 20x20 pixel and maximum size was 200x200 pixel [5].

Structural components which used in this experiment were glasses, face make up, moustache, beard, and veil or the other object that blocked the face. The structural components which were not lost recognize feature was not influence tracking process in this experiment for instance glasses. It can happen for the other structural components.

Face expression didn't face tracking in this system, it can be proved in the experiment with various expression. Expression experiment got 10 samples and 100% can be tracked, although in discrepancy of expression. It was caused by training for the system that was used a lot of face image [5]. Meanwhile, this experiment must fulfill the rule frontal face position.

False positive is error that can happen in face tracking while the system detected a non face object as a face, and false positive is vice versa, while the system can not detected a face object as a face. It occurred commonly in every method of face tracking included haar method in this research. False positive was caused by there was the similarity of haar features in tracked image and face image was trained, and false negative was caused by technical factors of face tracking such as face position, structural components and size of tracked images.

B. Experiment of Face Recognition Process

Face recognition experiment process with face tracking in condition the exist of face images in data base, lighting, discrepancy of tracked image size (object distance to camera), structural components, and the difference of expression, can be its results in Table. II.

Firstly, achievement value in criteria of the exist of images in data base was caused by the difference of histogram itself. Histogram is shown the spread of intensity of image pixel [6]. The difference of histogram will have result histogram comparison value which have different value too, and face recognition was depended on these.

The second criteria was the level of lighting, in this experiment the lighting was not measured with a device but with estimated condition of lighting, for good

TABLE II
ACHIEVEMENT OF RESULTS OF FACE RECOGNITION EXPERIMENT

No	Criteria	Condition	Number of Samples	Error	Achievement
1	*Face image file exist in data base*	exist	25	0.16	0.84
		Not exist	25	0.08	0.92
2	Lighting	Good	25	0.16	0.84
		Medium	25	0.20	0.80
		Dark	25	0.28	0.72
3	Image size	Larger	25	0.04	0.96
		Smaller	25	0.12	0.88
4	Structural components		25	0.20	0.80
5	Face expression		40	0.025	0.975

condition was sampled room condition in afternoon time (lighting is good), medium condition was in night time but with good lighting from lamp, and the worse condition was in night time and with bad lighting from the lamp.

Result of face recognition which was tested by lighting of face image, the more similar lighting condition in reference image and tracked image was, the higher its achievement value was in experiment.

The difference of image size also was tested with two condition, which were tracked image was smaller than reference image, and tracked image was larger than reference image.

Based on data of the result can be concluded that the difference of size of tracked and reference image had influence to the face recognition while it was not too significant. It was caused by face tracking process itself which must adapt with location of object. If the distance of object to camera was near, the image size that was saved had smaller size. On the other hand, the distance of object to camera was far, the image size that was saved had larger size. It could happen because the face tracking image was set with minimum size of tracked image was 20x20 pixel and maximum size was 200x200 pixel [5], so the system will adapt to the size of the object.

Structural component was influenced to face tracked image, but if it still could be tolerated by haar algorithm, face will be tracked. Structural component including glasses, face make up, moustache, and beard, but structural component that could be tolerated by haar algorithm, face will not be tracked which is the veil that blocked haar features on face. Recognition system can not run if tracking system didn't happen.

Face expression had influence to the face recognition but not really significant because face expression didn't make in histogram change. In this experiment used four condition of face expression namely, happy, sad, angry and surprise, and face images samples which were taken 10 times every expression were given result that high achievement. It was supported by [7] that histogram can developed by features for increasing quality to object recognition.

C. Benefits and Drawbacks of System

This face tracking and recognition with its experiment result that was did in this research have some benefits and drawbacks. These can used for adaptation to system application. The benefits there are:

a. Face tracking with haar algorithm has good achievement 80% as a result.
b. Face recognition with histogram comparison have simple algorithm and computation caused the process can run more quickly.
c. System can used in every background condition because the face recognition use tracked face image with background elimination.
d. Face recognition was adapted to the color skin face histogram.
e. System can used in every lighting condition but both of lighting condition in tracked face image and data base image mat be same.

The drawback of system are:

a. Because of histogram comparison algorithm, face recognition depend on image intensity.
b. System available only in the specific room with stagnant lighting condition.
c. Color skin face image selection depend on an operator.

V. CONCLUSION

Based on design, build, and test face tracking and recognition system, could be conclude that are face tracking process specific for frontal face position, the same lighting condition in tacked image and data base image must needed because system uses histogram comparison algorithm, structural components on face, image size and face expression are not influenced the recognition since it do not lost haar features and system can used in every background condition because the face recognition use tracked face image with background elimination.

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Dual Tree Complex Wavelet Transform for Face Image Identification

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***Abstract*—In this paper, we propose a novel method for face feature extraction using the directional multi resolution decomposition offered by the dual tree complex wavelet transform. Complex approximately analytic wavelets provide a local multi scale description of images with good directional selectivity and invariant to shifts and in plane rotations. Similar to eigenface they are insensitive to illumination variations and facial expression changes. The dual tree complex wavelet transform is however less redundant and computationally efficient. In this paper we construct dual-tree complex wavelet transform (DT-CWT) using approximately analytic wavelets, which posses Eigenface and discrete wavelet transform characteristics for the face recognition problem. We then investigate and conduct experiments using standard databases. The resulting complex wavelet based feature vectors are as discriminating as the Eigenface derived features and at the same time are of lower dimension when compared with that of eigenface. In all experiments using ORL databases, the proposed complex wavelets recognition rate equaled or surpassed the performance of eigenface (PCA). These findings indicate that complex wavelets can provide a successful alternative to Eigenface for face recognition.**

***Index Terms*—dual tree complex wavelet transform, Eigenface, face recognition, principal component analysis.**

I. INTRODUCTION

Face recognition has always been a hot research topic within the last several years. It has a wide range of applications such as security systems, credit card verification, scene surveillance including commercial and law enforcement applications [1]. Numbers of algorithms have been proposed. However, reliable techniques have proven elusive because their performances vary due to image variations caused by illumination conditions, facial expressions, poses or perspectives and other factors. In this paper, we propose an efficient face recognition method based on dual-tree complex wavelet transform (DT-CWT) [4], [6], using five images per person for training and five image per person for testing on ORL face database. In our method, a DT-CWT decomposition structure is achieved by performing complex wavelet decomposition on face. This decomposition structure was applied to every face image for facial features extraction in training and testing stage. The magnitudes of different wavelet subbands coefficients are used for feature representation. It is important that the representation of face images have the following desirable properties. 1) it should require minimum or no manual annotations, so that the face recognition task can be performed automatically; 2) representation should not be redundant. In other words the feature vector representing the face image should contain critical amount of information in order to make sure that the dimensionality of the representation is minimal; 3) the representation should cope satisfactorily with the non-ideal effects such as illumination variations, pose, aging, facial expression, partial occlusions etc.; 4) invariance to shifts, in-plane rotations; 5) directional selectivity in many scales; 6) low computational complexity. Furthermore, it is also desirable that the representation derives its roots in some form from the principles of human visual processing.

Many techniques have been proposed in the literature for representing face images. Some of these include principal components analysis [9]-[11], discrete wavelet transform [12], [13] and discrete cosine transform [14].

In this paper we proposed a systematically dual tree complex wavelet transform for the face recognition problem with improved shift invariance and directional selectivity properties. Decomposition transforms of the representations encompass 4 levels and 6 directions. PCA is employed to further reduce the dimensionality of the derived feature vectors. Finally similarity measure was used for identification. Results of experiments carried out on ORL databases indicate that complex wavelets indeed constitute an excellent alternative to Discrete wavelets transform and Eigenface in face image representation and recognition.

The rest of the paper is organized as follows: section 2 briefly give an overview of 2D discrete wavelets transform and Eigenface, and section 3 briefly give an overview of DT-CWT. Section 4 describes the proposed method for feature extraction of face image for face recognition and section 5 discusses the simulation results.

II. REVIEW EIGENFACES AND 2D-DWT

Extracting features of a face image is one of the key procedures for face recognition. In pattern recognition and in image processing, feature extraction is a special form of dimensionality reduction.

When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called *features extraction*. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation.

Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. When performing analysis of complex data one of the major problems stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power or a classification algorithm which overfits the training sample and generalizes poorly to new samples. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy.

Eigenfaces

In mathematical terms, this is equivalent to finding the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images, treating an image as a point (or vector) in a very high dimensional space [8], [10]. The eigenvectors are ordered, each one accounting for a different amount of the variation among the face images.

These eigenvectors can be thought of as a set of features which together characterize the variation among face images. Each image contributes some amount to each eigenvector, so that each eigenvector formed from an ensemble of face images appears as a sort of ghostly face image, referred to as an *eigenface*. Examples of these faces are shown in Figure 1. Each eigenface deviates from uniform grey where some facial feature differs among the set of training faces; collectively, they map of the variations between faces.

Figure 1. Eigenface from the three input images.

Each individual face image can be represented exactly in terms of a linear combination of the eigenfaces. Each face can also be approximated using only the "best" eigenfaces –those that have the largest eigenvalues, and which therefore account for the most variation within the set of face images. The best M eigenfaces span an M-dimensional subspace—"face space"—of the space of all possible images.

Because eigenfaces will be an orthonormal vector set, the projection of a face image into "face space" is analogous to the well-known Fourier transform (FT). In the FT, an image or signal is projected onto an orthonormal basis set of sinusoids at varying frequencies and phase, as depicted in Figure 2(a). Each location of the transformed signal represents the projection onto a particular sinusoid. The original signal or image can be reconstructed exactly by a linear combination of the basis set of signals, weighted by the corresponding component of the transformed signal. If the components of the transform are modified, the reconstruction will be approximate and will correspond to linearly filtering the original signal.

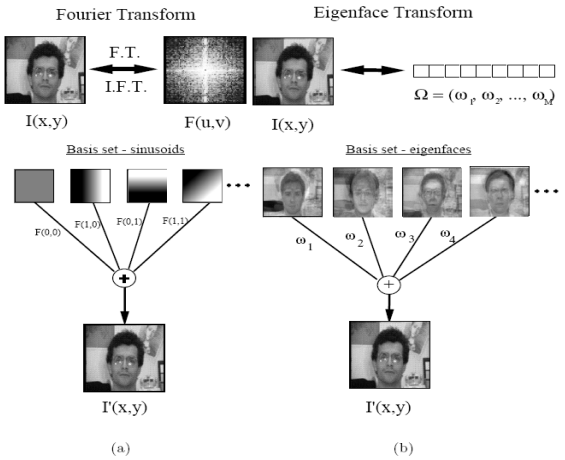

Figure 2. Transformation and reconstruction of images with (a) the Fourier transform, and (b) the Eigenface transform.

Figure 2(b) shows the analogy to the "Eigenface transform". This transform is non-invertible, in the sense that the basis set is small and can reconstruct only a limited range of images. The transformation will be adequate for recognition to the degree that the "face space" spanned by the eigenfaces can account for a sufficient range of faces.

Let the training set of face images be $\varphi_1, \varphi_2, \varphi_3, \ldots \varphi_M$. The average face of the set is defined by $\Psi = \frac{1}{M}\sum_{n=1}^{M}\phi_n$. Eachs face differs from the average by the vector $\Phi_i = \varphi_i - \Psi$. This set of very large vectors is then subject to principal component analysis, which seeks a set of (M-1) orthonormal vectors, $\mathbf{u}_n$, which best describes the distribution of the data. The k^{th} vector, $\mathbf{u}_k$, is chosen such that:

$$\lambda_k = \frac{1}{M}\sum_{n=1}^{M}(U_k^t \Phi_n)^2 \qquad (1)$$

is a maximum, subject to:

$$U_l^t U_k = \delta_{lk} = \begin{cases} 1, & \text{if } l=k \\ 0, & \text{otherwise} \end{cases} \qquad (2)$$

for $l < k$, which constrains the vectors to be orthogonal. The vectors $\mathbf{u}_k$ and scalars λ_k are the significant M eigenvectors and eigenvalues, respectively, of the covariance matrix:

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n\Phi_n^t = AA^t \quad (3)$$

where the matrix $A = [\ \Phi_1\ \Phi_2\ ...\ \Phi_M\ ]$. The matrix C, however, is N^2 by N^2, and determining the N^2 eigenvectors and eigenvalues is an intractable task for typical image sizes. We need a computationally feasible method to find these eigenvectors $\mathbf{u}_i$ of C:

$$AA\mathrm{u}_i = \lambda_i \mathrm{u}_i \quad (4)$$

If the number of data points in the image space is less than the dimension of the space ($M < N^2$), there will be only $M - 1$, rather than N^2, meaningful eigenvectors. (The remaining eigenvectors will have associated eigenvalues of zero.) Fortunately we can solve for the N^2-dimensional eigenvectors in this case by first solving for the eigenvectors of an M by M matrix — e.g. solving a 16x16 matrix rather than a 16,384 by 16,384 matrix — and then taking appropriate linear combinations of the face images Φ_i. Consider the eigenvectors $\mathbf{v}_i$ of A^tA such that

$$A^tA\mathrm{v}_i = \mu_i \mathrm{v}_i \quad (5)$$

Premultiplying both sides by A, we have:

$$AA^tA\mathrm{v}_i = \mu_i A\mathrm{v}_i \quad (6)$$

or

$$AA^t(A\mathrm{v}_i) = \mu_i(A\mathrm{v}_i) \quad (7)$$

and comparing with Equation (4) we see that $A\mathrm{v}_i$ are the eigenvectors of $C = AA^t$.

To achieve dimensionality reduction, let us construct matrix $U = [\vec{u}_1 \quad \vec{u}_2 \quad ....\vec{u}_D]$, containing D eigenvectors of C with largest corresponding eigenvalues. Here, $D < N_P$ (number of training vector). A feature vector $\vec{x}$ of dimensionality D is then derived from a face vector $\vec{f}$ using:

$$\vec{x} = U^T\left(\vec{f} - \vec{f}_\mu\right) \quad (8)$$

i.e., face vector $\vec{f}$ decomposed in terms of D eigenvectors, known as “eigenfaces”.

2D-DWT Multilevel 2-D wavelet decomposition Calculating the wavelet coefficients at every possible scale generates a lot of awful data. If scales and positions based on powers of 2 –called dyadic scales and positions- are chosen then analysis become more efficient and accurate. Such as analysis obtained from the discrete wavelet transform (DWT). The analysis start from signal s and results in the coefficients C(a,b).

$$C(a,b) = C(j,k) = \sum_{n\in Z} s(n)g_{j,k}(n) \quad (9)$$

For many signals, the low frequency content is the most important part. It identifies the signal. The high frequency content has less importance.

Feature extraction is done as follows. Given a signal s of length N, the DWT consists of $\log_2 N$ stages at most. Starting from s, the first step produces two sets of coefficients: approximation coefficients cA_1, and detail coefficients cD_1. These vectors are obtained by convolving s with the low-pass filter Lo_D for approximation, and with the high-pass filter Hi_D for detail, followed by dyadic decimation. More precisely, the first step is in Figure 3.

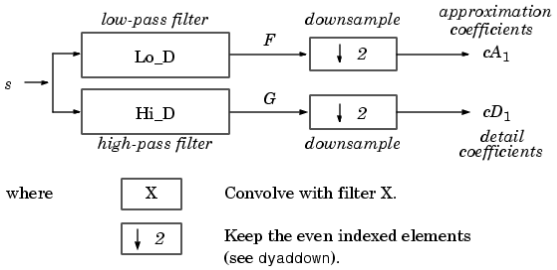

Figure 3. Filterbank 1 D-DWT decomposition.

For images, a similar algorithm is possible for two-dimensional wavelets and scaling functions obtained from one-dimensional wavelets by tensorial product.

This kind of two-dimensional DWT leads to a decomposition of approximation coefficients at level j in four components: the approximation at level $j + 1$ and the details in three orientations (horizontal, vertical, and diagonal). The following charts describe the basic decomposition and reconstruction steps for images.

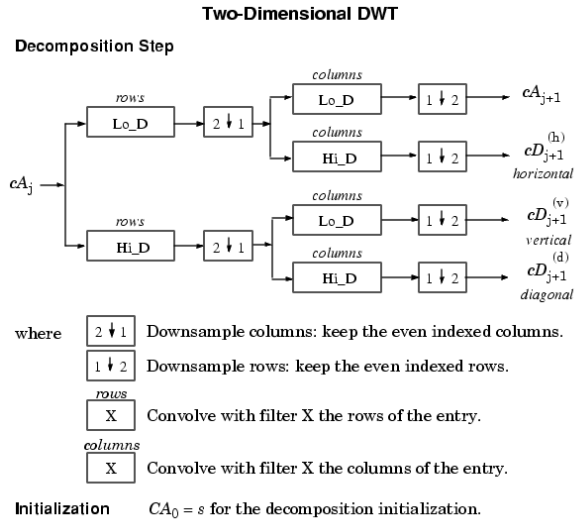

Figure 4. Filterbank 2 D-DWT decomposition.

Feature vector for one image consist of wavelet coefficient filterbank at level j decomposition:

$$\vec{x} = \left[cA_j, \quad cD_j, \quad ...., \quad cD_1\right] \quad (10)$$

D_k stands for $[D_k^{(h)}, D_k^{(v)}, D_k^{(d)}]$, the horizontal, vertical, and diagonal details at level *k*.

III. Dual Tree Complex Wavelet Transform

DT-CWT, introduced by Kingsbury [4], leads to another avenue for feature extraction. It gives good directional selectivity for two and higher dimensions and is nearly shift-invariant. DT-CWT wavelet functions are isotropic since their spectrum supports are square. With the good directionality and shift invariance properties, DT-CWT has been successfully used in many applications such as image coding [5] and facial feature extraction [6].

In DT-CWT, two real discrete wavelets transform (DWT) $\psi_h(t)$ and $\psi_g(t)$ are employed in parallel to generate the real and imaginary parts of complex wavelet $\psi(t) := \psi_h(t) + j\psi_g(t)$ separately. Note that $\psi(t)$ is approximately analytic and $\psi_g(t)$ is approximately the Hilbert transform of $\psi_g(t) \approx \mathrm{H}(\psi_h(t))$ equivalently. In 2-D scenario, DT-CWT shows its great potential for feature representation thanks to the following properties [4], [7]. Firstly, DT-CWT introduces orientations for image representation, with 6 subbands orienting at $\pm 15^0$; $\pm 45^0$; $\pm 75^0$ respectively. It achieves this with a redundancy factor of only 4:1, or 2:1 if taking magnitudes only. Secondly, it is nearly shift invariant, in the sense that small translations do not affect the magnitudes of the complex coefficients. Thus, the magnitudes information of coefficients is much more stable.

Thirdly, DT-CWT can be implemented with lifting scheme, which is much faster.

IV. Face recognition using DT-CWT

In this section, we propose an efficient face recognition method which is based on DT-CWT. **T**he directional multiscales decomposition of the gray level face image is performed up to level 4. The DT-CWT feature vector *X* is formed by concatenating the results of the multiscale representation (magnitude of wavelet coefficients). Given an image $I(x,y)$ and a wavelet $\psi_{\mu,v}(x,y)$, of level μ and direction v , vector *X* can be form by:

$$X = \begin{pmatrix} O_{0,0} & O_{0,1} & .... & O_{3,5} \end{pmatrix}^t \qquad (11)$$

where $O_{\mu,v}(x,y) = I(x,y) * \psi_{\mu,v}(x,y)$ and $O_{\mu,v}$, μ=0,..,3 , v=0,1,..,5 is formed by concatenating the rows or columns of $O_{\mu,v}(x,y)$. Here * and *t* denote, the convolution and transpose operators respectively. This representation encompasses different scales, spatial location and 6 fixed orientations similar to Gabor [2], [3] representation.

The size of such a feature vector for a 112x92 face image is 20748 pixels which is much smaller than the corresponding 2D-DWT feature vector where the size is 59294. In order to reduce the dimensionality of the feature vector to manageable sizes. For the complex wavelets due to the intrinsic downsampling of the multiscale transform, we employed an extra dyadic downsampling strategy to further reduce the size of the feature vector. The feature vectors even after downsampling are of very high dimension and therefore not very convenient to be used directly for recognition. To reduce the dimensionality of the feature vector space we employed PCA on DT-CWT, 2D-DWT and Eigenface.

Classification using modified coefficients.

Coefficients on different subbands representing different frequency scales and orientations have different affects on feature extraction, and thus on face recognition. First, coefficients on each subband are normalized to take magnitude of complex coefficients to balance the effects of different subbands, especially, the low and high frequencies. Second, those subbands providing more discriminant information for recognition should be emphasized. For all of images, the DT-CWT features are aligned to be a vector, and taking principal component for classification.

V. Experimental results

In this section, we will evaluate the performance of our proposed method, the DT-CWT-based face recognition method, on ORL face database from AT&T Laboratories Cambridge [15].

ORL face databases consist of 400 image of 40 person. There are ten different images of each of 40 distinct subjects. For some subjects, the images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses). All the images were taken against a dark homogeneous background with the subjects in an upright, frontal position (with tolerance for some side movement). A preview image of the Database of Faces is Figure 5.

Figure 5. Sample image of ORL Database.

The files are in PGM format, and can conveniently be viewed on UNIX (TM) systems using the 'xv' program. The size of each image is 92x112 pixels, with 256 grey levels per pixel. The images are organised in 40 directories (one for each subject), which have names of the form sX, where X indicates the subject number

(between 1 and 40). In each of these directories, there are ten different images of that subject, which have names of the form Y.pgm, where Y is the image number for that subject (between 1 and 10).

We are divided manually into two groups of 5 images per person for training and 5 images per person for testing. We are conducted an experiment and compare the performance of our method with other methods such as (Eigenface PCA, 2D-DWT PCA). We tabulate the result of identification for these experiments in Table 1.

Table 1. Face Identification result.

Method	Identification rate (%)
Eigenface PCA	70
2D DWT PCA	75
DT CWT PCA	91

Figure 6 show some example error of identification using Eigenface PCA and 2D-DWT, and was correctly identify using our method DT-CWT PCA.

Figure 6. Example of error identification using Eigenface and 2D-DWT.

Figure 7 show some example true of identification using DT-CWT PCA.

Figure 7. Examples of true identification using DT-CWT.

To conclude, DT-CWT-based method can achieve a best performance. On the one hand, the obtained decomposition structure gives a good representation for face images. On the other hand, normalization using magnitude of coefficients eliminate the effects caused by varying conditions at best efforts resulting a robust good performance.

In most cases shown above, 2D-DWT-based method gives the secondary performances. 2D-DWT-based methods perform not as good as DT-CWT-based methods. Although they both inhibit directionality selection and shift invariance properties, they are not powerful for face images in terms of feature extraction due to their rigid decomposition.

VI. CONCLUSIONS

In this paper, we have proposed a novel DT-CWT-based method for face recognition. In our method, DT-CWT, decomposition structure is determined by scale of j=4 and 6 directional, is applied to extract feature from each face image. By normalization (taking magnitude of complex coefficients) wavelet subbands coefficients and then classifying using the PCA classifier, good face recognition performance could be achieved (91 %).

Compared to the traditional 2D-DWT-based methods, the DT-CWT-based method not only performs better, but also inherits low computational complexity.

For the future works, better directionality selectivity and shift invariance, and conduct an experiment using others database like FERET and VidTIMIT are under investigation.

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An Application of Handwriting Recognition System for Recognizing Student's ID and Score on the Examination Paper Using WebCam

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***Abstract*—This paper presents an automatic data entry system which is used to read and recognize the student's ID and score on the examination paper automatically. The system uses a Webcam to capture the image and a numeral handwriting recognition technique to recognize the student's ID and score. A simple effective image projection technique is employed to localize the student's ID and score from an image, followed by the classsification technique using vector distance and box-method for classifying the numeral chartacters. The experimental results show that the algorithm works properly in finding and extracting student's and score from the examination paper. Further, the classification technique shows a good result in classifying numeral handwriting characters.**

***Index Terms*—automatic data entry, handwriting recognition, image projection, vector distance, box-method.**

I. INTRODUCTION

Recently, most of educational institutions have implemented the academic information sytem which provides the information of academic matters to the students easily and in short time. One key feature in this system is the application of computer and networking systems to store, process, and produce the data, resuts a paperless system. It requires that the data should be available (or converted) in digital format. Unfortunately, in several cases this requirement creates some burdens for implementation of a fully efficient academic information system. One of such problem is to convert or digitalize the student's ID and score on the examination paper. It is well known that for engineering programs, most of examination given to students should be answered by handwriting on the paper. In this case, a data entry process is needed to enter the score and the corresponding student's ID into computer that needs extra time and works, also facing the accuration problem due to the human error.

In this research, we propose an automatic data entry system to solve the above problems. The proposed system utilizes the handwriting recognition technique to recognize the student's ID and score written on the examination paper.

Handwriting recognition techniques have been implemented in several areas such as for automatic data entry of passport [1], to extract and recognize handwritten characters from application forms [2], to recognize handwritten postal codes for automatic sorting of mails [3]. In those applications, the characters are extracted from a whole document automatically, before they are recognized by the recognition system. Since the character extractions play an important process in the handwritten recognition system, they are also investigated intensively by researchers. In [4], they proposed a method by a syntactical structure of the numerical field to extract zip codes, phone numbers and customer codes from handwritten incoming mail documents. A robust connected component based character locating method is proposed in [5] for locating characters in scene image taken from digital camera.

The appplications of character recognition described above require the high performance of the accuracy and speed. The problems of handwritten character recognition are more complex than the machine printed characters, due to the different writing styles. Many approaches have been proposed to recognize the handwritten characters [6]. In [6], they compared several popular classification techniques for handwritten character recognition, i.e. the k-nearest neighbor classifier, neural classifiers, learning vector quantization classifier, and support vector classifiers. They concluded that all the classifiers give high recognition accuracies. Furthermore, they noted that the feature extraction is primarily important to the performance of character recognition. An innovative approach for feature extration called box-method is proposed by [7] to deal with the variability of writing styles. In [7], both fuzzy logic and neural network are used for character recognition.

The approaches for characters extraction described above are application dependent. It is difficult to find a general method to extract characters for all scenarios. In our research, we propose a method to extract student's ID and score written on the examination paper. The proposed method utilizes the characteristics of examinee identification box printed on the examination paper to

localize and extract the student's ID and score. The simple and effective vertical and horizontal projections are employed for extraction process.

To recognize the numeral handwriting characters, we propose to modify the handwritten recognition method used in [7]. The method [7] uses the skeleton of a character to extract the feature. This skeleton is obtained by a thinning algorithm which is rather complicated. In our research, to simplify the process we do not used the skeleten of a character, but uses a blob (binary image) of the character instead.

The paper is organized as below. Section 2 presents the proposed handwriting recognition system. The characters extraction is described in section 3. In section 4, the characters recognition is described. The experimental results and discussions are covered in section 5. Finally, the conclusion is presented in section 6.

II. PROPOSED HANDWRITING RECOGNITION SYSTEM

The proposed system is depicted in Fig. 1. A Webcam is used to capture the image of examination papers where student's ID and score to be recognized. The Webcam is used instead of the scanner, because of the low cost, fast reading, and easy installation. However, those benefits should be paid with the following problems: the captured image is affected by the lighting changes, the appearance of characters on the paper may degrade due to the improper position of the paper, eg. not in flat position, folded, etc. Since our objective is to find and recognize the numeral characters, i.e. the student's ID and score of the examination, not the whole handwriting texts, the problems become less difficult.

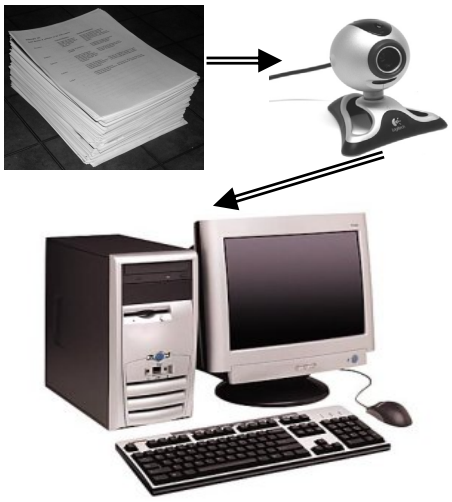


Figure 1. Hardware configuration of the proposed system.

In the research, the student's ID and score to be recognized are captured from the examination paper used in National Institute of Technology (ITN), Malang, with the specific format as depicted in Fig. 2. A box contains the fields of name, student's ID, course, etc., is printed on the top-right corner of the examination paper. There is no field for score on that box, but usually examiner/lecturer writes the score on the left side of that box as depicted in Fig. 2.

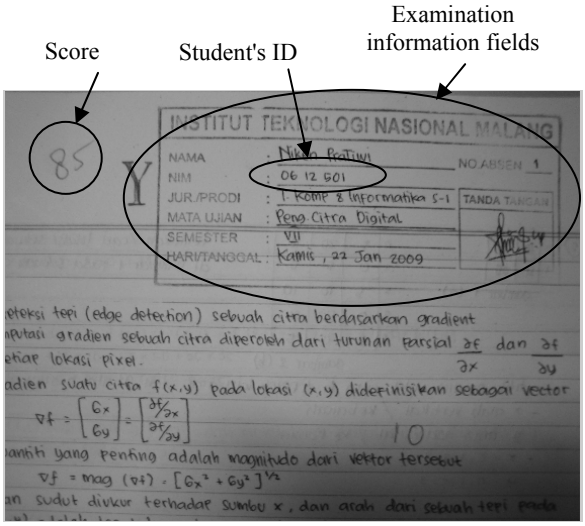


Figure 2. Example of examination paper.

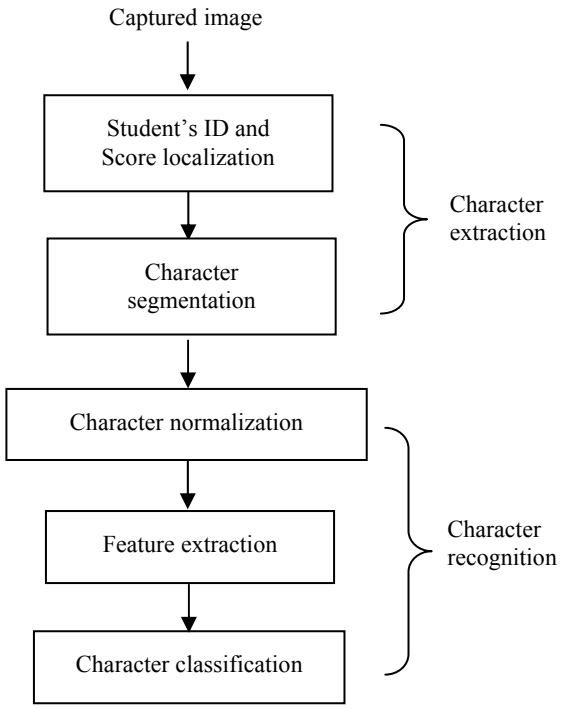


Figure 3. Block diagram of student's ID and score recognition system.

The process for recognizing student's ID and score is depicted in Fig. 3. The recognition process is divided into two stages: character extraction and character recognition. First step in the character extraction stage is the localization of student's ID and score that finds the locations of student's ID and score in the image. The

locations are defined by the bounding boxes of the digits of student's ID (seven digits) and score (one to three digits). Then the character segmentation step will separate the individual digit of student's ID and score. After each character is extracted, they will be classified in the recognition stage.

The extracted characters obtained in previous stage are scale varying and sometimes contain noise. Thus, the character normalization is required in the recognition stage. It resizes the characters in a standard size, and eliminates the outlier noise. After character is normalized, the feacture extraction using the box-method [7] is employed to extract the feature of each character. Finally, the character classification process is used to classify the character (represented by its feature) into the reference numeral characters, i.e. "0" to "9". The details processes will be described in the following sections.

III. CHARACTER EXTRACTION

A. Student's ID and Score Localization

Since student's ID is written in the provided box of the examination information fields, we first find the box in the image. The box is defined by the left border (**LB**), the right border (**RB**), the top border (**TB**), and bottom border (**BB**). **RB** is assigned as the right border of the paper, **TB** is assigned as the top border of the paper. While **LB** and **BB** are searched by analyzing the image projections as described in the following:

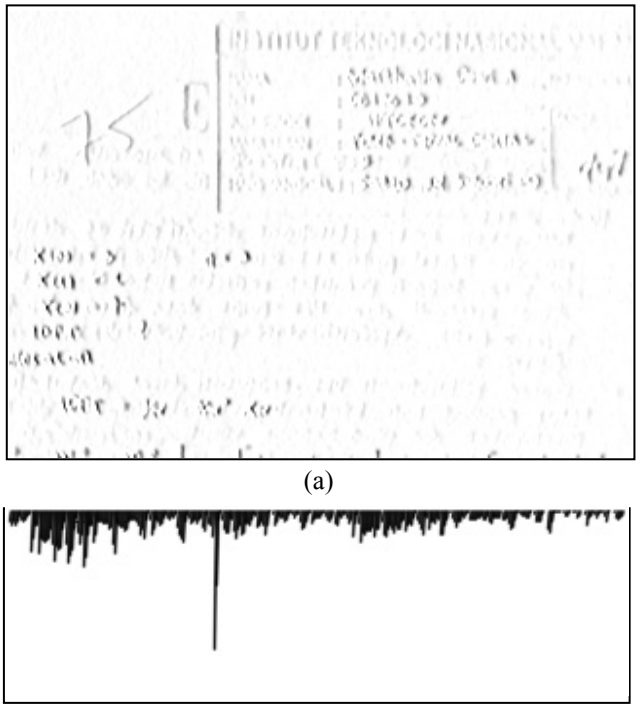
1. Convert the color image (captured image) into grayscale image.
2. Find the Sobel gradient image in the horizontal direction.
3. Compute the horizontal projection of the gradient image, and identify the column of the maximum peak as the left border of the box (**LB**).
4. Define the **left_image** as the sub-image of the gradient image bounded with a short distance in the left and right of **LB**.
5. Compute the vertical projection of the **left_image**, and perform a scanning from the top to the bottom to find the first transition from high peaks to zero indicating the bottom border of the box (**BB**).

After **LB,RB,TB** and **BB** are determined, the bounding box of student's ID is defined by geometric analysis as follows:

1. Define the **box_image** as the gradient image bounded by **LB, RB, TB** and **BB**.
2. Compute the vertical projection of the **box_image**, and perform a scanning from the top to the bottom to find the first peak. Identify the corresponding row as **line_up**. Then perform a scanning from the bottom to the top to find the first peak, and identify the corresponding row as **line_down**.
3. The left (**L**), right (**R**), top (**T**) and bottom (**B**) borders of the student's ID are obtained using the following formulas:

L=**LB**+33x(**line_up-line_down**)/40 (1)
R=**LB**+83x(**line_up-line_down**)/40 (2)
T=**line_down**+26x(**line_up-line_down**)/40 (3)
D=**line_down**+20x(**line_up-line_down**)/40 (4)

To localize the score, we search the area on the left side of the box of examination information fields. It is assumed that the area only contains the score. Therefore, the bounding box of the score could be determined by vertical and horizontal projection easily.



(a)

(b)

Figure 4. (a) The gradient image; (b) The horizontal projection of the gradient image.

Fig. 4(a) depitcs the gradient image obtained by Sobel operator in the horizontal direction. Since the examination paper uses the paper with horizontal lines printed on it, we could eliminate those horizontal lines by perform the gradient image only in the horizontal direction. The horizontal projection of the gradient image in Fig. 4(a) is depicted in Fig. 4(b). The peak in the figure corresponds with the left border of the box (**LB**).

Fig. 5 depicts the box_image and the corresponding vertical projection. From the figure, it is clear that the **line_up** corresponds with the first field of the examination information fields (see Fig. 2 for the details). The **line_down** corresponds with the last field. Hence, we could utilize the two parameters as the reference for locating the student's ID as defined by Eqs. (1)-(4).

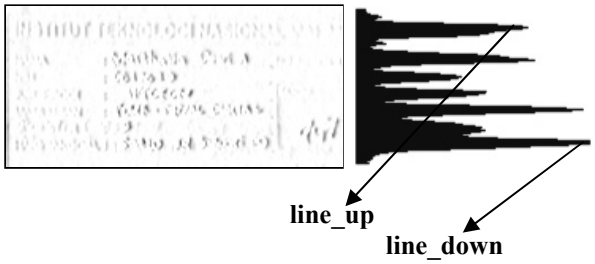


Figure 5. The **box_image** and the corresponding vertical projection.

B. Character Segmentation

The bounding box obtained in previous section defines the boundarie of all seven digits of the student's ID. To classify each digit or character, we should separate each digit individually. We employ a horizontal projection technique to separate them. Here, the projection is calculated from the binary image obtained by thresholding the grayscale image. To elimate the noise and connect the missing segment in the thresholded image, we perform the Gaussian smoothing and the morphological dilation operation.

The horizontal projection method peforms well when the gap between two adjacent digits is clear enough. Thus create a valley in the image projection. However, in some cases two digits often touch each other, and the valley is not exist. It results a wrong segmentation. To overcome such problem, we utilize the ratio of height and width of the character to verify the segmented results.

IV. CHARACTER RECOGNITON

A. Character Normalization

The examination information fields printed in the examination paper provides a specific field with a certain height for writing the student's ID. However due to the nature of handwriting, the size of characters written by the different students will be different. Furthermore, without the provided field, the size of score's characters written by the examiners will be totally different from one examiner to others. Therefore, the size normalization should be performed before classification.

In the research, the normalized size of the character is chosen as 42 x 32 pixels. For normalization we employ the method used in [7]:

$$x' = \left(\frac{p}{m}\right)x \tag{5}$$

$$y' = \left(\frac{q}{n}\right)y \tag{6}$$

where
x' is the x-coordinate of the normalized image,
y' is the y-coordinate of the normalized image,
x is the x-coordinate of the original image,
y is the y-coordinate of the original image,
p is the the height of the normalized image,
q is the width of the normalized image,
m is the height of the original image,
n is is the width of the original image.

When the normalized image is bigger than the original image, there will be pixels do not have corresponding pixels in the original image. In the case, we use the nearest neighbor interpolation to interpolate those pixels.

B. Feature Extraction and Classification

Feature extraction used in this research is the vector distance and box-method approached proposed by [7], [8]. The method divides a character image into 24 boxes of size 6 x 4 as depicted in Fig. 6(b), where a binary character of number "4" shown in Fig. 6(a) is superimposed on the partitioned image. By taking the bottom left corner as the origin (0,0), the vector disctance for kth pixel in bth box at location (i,j) is calcucalted as

$$d_k^b = (i^2 + j^2)^{1/2} \tag{6}$$

Then, a normalized vector distance is obatined by dividing the sum of distance of all '1' pixels in a box with the total number of pixels on the box, yields

$$\gamma_b = \frac{1}{n_b}\sum_{k=1}^{n_b} d_k^b, \quad b = 1,...,24, \tag{7}$$

where n_b is the the number of pixels in bth box. Fig. 6(c) depicts the extracted features for character "4", where the dot points denote the normalized vector distance for each box.

The original approach [7] used the thinned image (skeleton image) to extract the feature. It requires a special thinning algorithm [9] in pre-processing step to provide the thinned image. In the research, instead of using the thinned image, we treat the binary image directly. Since the calculation of vector distance expressed by Eq. (7) is normalized by total pixels in the box, it suggests that the non-thinned image might be used too. Further, the non-thinned image is less sensitive to the variation of character's style or shape compared to the thinned image.

After features of the characters are extracted, the classification process is performed by calculating the distance of feature vectors between target image and the references. The distance is calculated using the following formula:

$$dist = \sqrt{\left(\sum_{b=1}^{24}\left(\gamma_b^t - \gamma_b^r\right)^2\right)} \tag{8}$$

where γ_b^t is the normalized vector distance for bth box of the target image, and γ_b^r is the normalized vector distance for bth box of the reference image. Given a target image, we calculate the distance for all reference images (digit "0" to "9"), and classify the target image to the reference digit with the minimum distance.

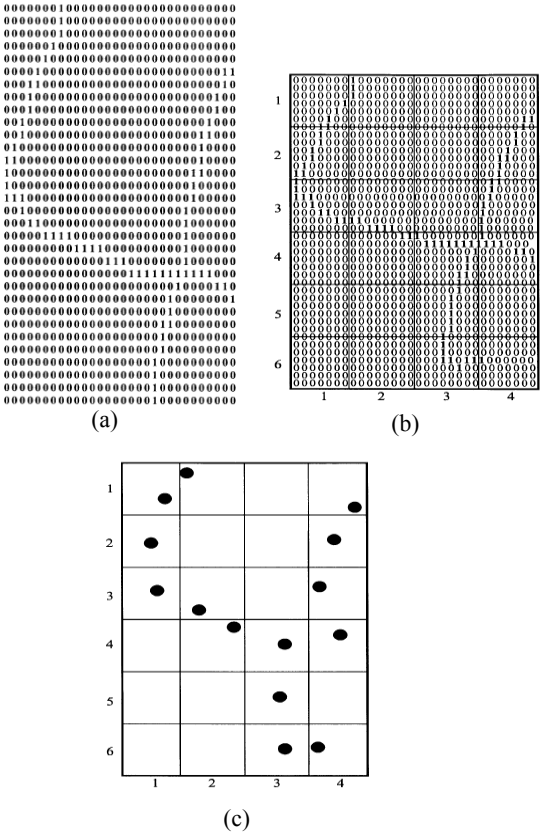


Figure 6. (a) A binary image of digit “4”; (b) Digit “4” enclosed in 6 x 4 boxes; (c) Pattern of digit “4” plotted using extracted features[7].

V. EXPERIMENTAL RESULTS AND DISCUSSIONS

To verify our proposed algorithm, we conducted the experiments using the examination paper images captured by 2.0 Megapixels Webcam. The algorithm was implemented using C++ and the OpenCV library.

We evaluated the characters extraction and classification stages separately. Twenty examination papers captured by Webcam are used for evaluating the character extraction process. Table 1 shows the results. From the table, we could see that the proposed algorithm is able to find the location of the student’s ID and score efficiently. However, the extraction rate of the student’s ID is low. From the observation, it is caused by the resolution of the Webcam which is relative low, hence the quality of captured image is poor, i.e. the characters of student’s ID are not clear enough. The score extraction rate is higher than the student’s ID because the character size of score is usually larger, more than three times of the student’s ID size.

Fig. 7 shows the typical extraction results. The box shown on the top right corner in Fig. 7(a) is the detected box of the examination information fields. The box shown on the middle in Fig. 7(b) is the bounding box of the student’s ID. The digit extraction of the student’s ID and score are shown in Fig. 7(c) and 7(d) respectively.

Table 1. Results of the characters extraction

Tested items	Number of successed images	%
1. Box localization	19	95%
2. Student’s ID localization	18	90%
3. Student’s ID extraction	9	45%
4. Score extraction	14	70%

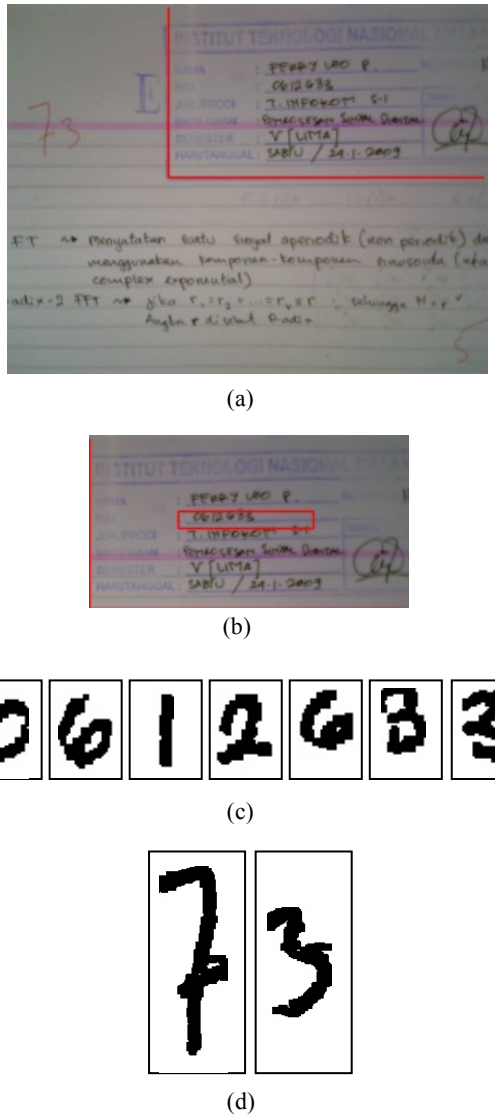


Figure 7. (a) Detected box of the examination information fields; (b) The bounding box of student’s ID;(c) Extracted student’s ID; (d) Extracted score.

The character classification algorithm was tested on two hundred images of the numeral characters collected from Internet, contain twenty images for each numeral character. The classification rate is shown in Table 2. It could be clearly understood that the classification rate of

numeral "1" is very high, because there are no many variations in the writing of number "1". Fig. 8 depitcs the samples of tested numeral character images.

Table 2. Results of the character classification

Numeral character	Classification rate
"0"	85%
"1"	100%
"2"	75%
"3"	90%
"4"	95%
"5"	60%
"6"	95%
"7"	90%
"8"	85%
"9"	80%
Overall	86%

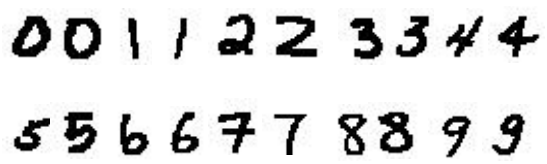


Figure 8. Some of the tested numeral character images.

VI. CONCLUSION

This paper presents the application of handwriting recognition technique to recognize student's ID and score written on the examination paper. The proposed technique using image projection for locating those characters and vectore distance calculated using box-method, shows a good results on a limited test images.

In future, we will investigate with the complex and a huge numbers of test images. Furthermore, the technique will be extended to deal with the general case of the examination paper.

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Adaptive Fingerprint Image Defect Detection and Classification Based on Fingerprint Image Quality Analysis

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***Abstract*—The knowledge about fingerprint images defect classification is very important to decide the method for the fingerprint image restoration. The accuracy of the fingerprint image matching is heavily dependent on the quality of the fingerprint images. Therefore, if the fingerprint defect classification can be performed adaptively, then the fingerprint image characteristics in the image enhancement step will become better, as a consequence, the system performance will be more robust. In this paper, we propose an adaptive fingerprint defect detection and classification method, which classify the defect of fingerprint images based upon the image quality by extracting six features from the fingerprint images and analyzing the image quality using the Learning Vector Quantization clustering method.**

***Keywords*—biometrics, fingerprint, identification, image quality, image enhancement.**

I. INTRODUCTION

Fingerprint identification is one of the most popular biometric technologies and is used in criminal investigations, commercial applications, and so on. The performance of a fingerprint image-matching algorithm depends heavily on the quality of the input fingerprint image [1]. It is very important to acquire good quality images but in practice a significant percentage of acquired images is of poor quality due to some environmental factors or user's body condition [2]. The poor quality images cause two problems: (1) many spurious minutiae may be created and (2) many genuine minutiae may be ignored.

There are some on-going and past efforts in the investigation of fingerprint image quality. Hong et al. [3] modeled the ridge and valley patterns as a sine wave, and computed the amplitude and frequency to decide the quality of the fingerprint image. They evaluated the performance of their image enhancement algorithm using goodness index based on minutiae and verification performance. But they used quality check only for the performance evaluation of image enhancement algorithm. Ratha et al. [4] proposed a method for image quality estimation from wavelet scalar quantization (WSQ) images. This is only for WSQ compressed format and it is not the case for general fingerprint images. Lim et al. [5] developed local and global quality measures and estimated the quality and validity of fingerprint images. In addition, Bolle et al. [6] used the ratio of directional area to other non-directional area as a quality measure. Shen et al. [7] applied Gabor filter to image sub-blocks and concluded that a good quality block can be identified by the outputs of Gabor filter bank.

This paper proposes an adaptive preprocessing method to improve image quality appropriately. The preprocessing is performed after distinguishing the fingerprint image quality according to its characteristics. It is an adaptive filtering according to oily/dry/neutral images instead of uniform filtering. In the first stage, several features are extracted for image quality analysis and they go into the clustering module. Then, the adaptive preprocessing is applied to produce good quality images. We test the proposed method on FVC 2004 DB2_A and a private DB collected with careful consideration of image quality at Electrical Engineering of Engineering Institute of Sepuluh Nopember Surabaya.

II. BASIC THEORY

A. Fingerprint Identification

Fingerprint identification is the technology that distinguishes between the user oneself and others using the unique information in fingerprint. Fingerprints are the oldest biometric signs of identity. The inside surfaces of the hands from fingertips to wrist contain minute ridges of skin, with furrows between each ridge. The ridges have pores along their entire length that exude perspiration [8]. A fingerprint is believed to be unique to each person. Fingerprint identification begins based on this uniqueness. As shown in Figure 1, a fingerprint image consists of ridges and valleys. A ridge is defined as a single curved segment and a valley is the region between two adjacent ridges. In general, black lines mean ridges and white lines mean valleys.

Fingerprint identification system consists of three main processes, which are acquisition, feature extraction, and matching as shown in Figure 2 [9]. Firstly, the system obtains the digitalized fingerprint images using a sensor.

Figure 1. Example Fingerprint Images

Since in image acquisition external factors influence the image quality, preprocessing module has to enhance the image quality. After that, feature extraction is performed. The most common representation used in fingerprint identification is Galton features [10], which are called as minutiae. There are many different minutiae types that are extended from the Galton features. In most of the automatic identification systems, the minutiae are restricted to two types: ridge endings and ridge bifurcations [2]. Spurious minutiae need to be removed because most of the images may not always have well defined ridge structures and they have some spurious minutiae. Using these extracted minutiae, matching module is performed. At the matching stage, the templates from the claimant fingerprint are compared against that of the enrollee fingerprint.

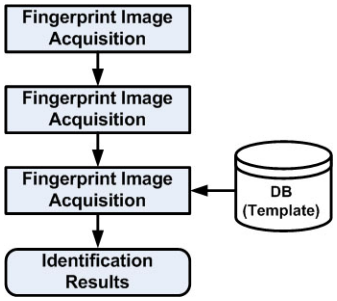

Figure 2. Architecture of a Fingerprint Identification System

As shown in Figure 3, image quality and filtering algorithm affect the performance of minutiae extraction. The left image is original one and the right image shows the extracted minutiae after the conventional filtering. There are many endings since the original image has many broken ridges.

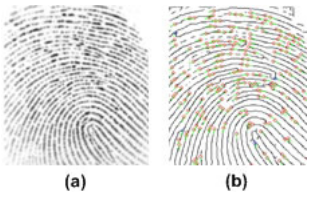

Figure 3. Image Quality (a) Original Image (b) Extracted Minutiae Image

In general, the fingerprint image quality relies on the clearness of separated ridges by valleys and the uniformity of the separation. A fingerprint image changes in many ways because of the changes in environmental conditions such as temperature, humidity and pressure. The overall quality of the fingerprint depends greatly on the condition of the skin [2]. Dry skin tends to cause inconsistent contact of the finger ridges with the scanner's platen surface, causing broken ridges and many white pixels replacing ridge structure. To the contrary, the valleys on the oily skin tend to fill up with moisture, causing them to appear black in the image similar to ridge structure. Figure 1 shows oily/neutral/dry images, respectively.

- Oily image: even though the separation of ridges and valleys is clear, some parts of valleys are filled up causing them to appear dark or adjacent ridges stand close to each other in many regions. Ridges tend to be very thick.
- Neutral image: in general, it has no special properties such as oily and dry. It does not have to be filtered.
- Dry image: the ridges are scratchy locally and there are many white pixels in the ridges.

B. Ridges of Fingerprint Image

Point minutiae is a shape poin make on the fingerprint. More types is minutiae or called ridge: ridge ending, ridge crossing, and ridge bifurcation [2]. The fingerprint minutiae shapes shown as Figure 4.

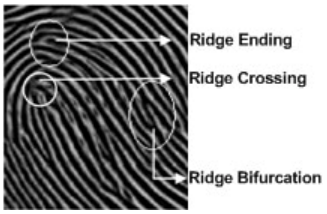

Figure 4. Ridge Shape of Fingerprint

C. Feature Extraction

In this paper, six features are used to grasp the image quality characteristics as shown in Table 1.

Table 1. Feature for Analysis of Image Quality

Feature	**Definition**	**Purpose**
Mean (R)	Mean of gray values	Measurement of whole gray level
Variance (v)	Variance of gray values	Uniformity of gray values
Block Directional Difference (p)	Mean of block directional difference	Distinctness between ridges and valleys
Ridge-valley Thicness Ratio (r)	Mean of block of ridge-valley thickness ratio	Measurement of ratio for ridge and valley thickness
Orientation Change (o)	Using block orientation, summation of orientation change along each horizontal row and each vertical column of the image block	Measurement of ridge continuity
Minutiae (m)	Minutiae number (ridge ending and bifurcation)	Compute minutiae number

The mean and variance of a gray-level fingerprint image are defined as equation (1) and (2).

$$Mean = \frac{1}{MN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} I(i,j) \quad (1)$$

$$Variance = \frac{1}{MN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(I(i,j) - Mean)^2 \quad (2)$$

The mean of gray values indicates the overall gray level of the image and the variance shows the uniformity of the gray values. *I(i,j)* represents the intensity of the pixel at the *i* th row and *j* th column and the image *I* is defined as an *NxM* matrix.

Fingerprint image is divided into a number of nonoverlapping blocks and block directional difference is computed [10]. Using the 9x9 mask, slit sum Si, i=1,..,8 is produced for center pixel C of the block.

$S_i = \sum_{j=1}^{5} P_{ij}$

block directional difference = $Sum(|S_{max} - S_{min}|)$

where

$S_{max} = Max\{S_i, i = 1,2,\ldots,8\}$ and

$S_{min} = Min\{S_i, i = 1,2,\ldots,8\}$

Pij denotes the gray-level value of the j-th pixel in the direction i. Smax and Smin appear in each valley (white) pixel and in each ridge (black) pixel, respectively. Therefore, the directional difference of image block has a large value for good quality image blocks. In other words, ridge structures are characterized as well separated. For bad quality image blocks, the directional difference of image block has a small value. Namely, ridge and valley are not distinguished in each other.

The ratio for ridge thickness to valley thickness is computed in each block [5]. Ridge thickness and valley thickness are obtained using gray level values for one image block in the direction normal to ridge flow. After that, the ratio of each block is computed and average value of the ratio is obtained over the whole image.

Orientation change is obtained by accumulating block orientation along each horizontal row and each vertical column of the image block. Orientation computation is as follows [12].

1. Divide I into blocks of size wxw.
2. Compute the gradients (x(i,j) and (y(i,j) at each pixel (i,j) with the Sobel operator.
3. Estimate the local orientation of each block centered at pixel (i,j) using the following equations [13]:

$$V_x(i,j) = \sum_{u=i-\frac{w}{2}}^{i+\frac{w}{2}}\sum_{v=j-\frac{w}{2}}^{j+\frac{w}{2}} 2\theta_x(u,v)\theta_y(u,v) \quad (3)$$

$$V_y(i,j) = \sum_{u=i-\frac{w}{2}}^{i+\frac{w}{2}}\sum_{v=j-\frac{w}{2}}^{j+\frac{w}{2}}(\theta_x^2(u,v)\theta_y^2(u,v)) \quad (4)$$

$$\theta(i,j) = \frac{1}{2}\tan^{-1}\left(\frac{V_x(i,j)}{V_y(i,j)}\right) \quad (5)$$

where θ(i,j) is the least square estimate of the local ridge orientation at the block centered at pixel (i,j). It represents the direction that is orthogonal to the direction of the Fourier spectrum of the wxw window. In this paper, we set w=16 and feature values are normalized between 0 and 1.

4. Measurement of ridge continuity.
5. Minutiae number.

D. Minutiae Extraction

Steps in minutiae exctraction, that is binarization, skeletonization, and minutiae detection. Image conversion at binarization process using thresholding operation, until object result as fingerprint sketch groove. Skeletonize aim to decrease of redundant area. Futhermore image skeletonized result of detected minutiae by compute that minutiae numbers computed based on the number of one-value of each 3x3 window: if the central is 1 and has only 1 one-value neighbor, then the central pixel is a termination. If the central is 1 and has 3 one-value neighbor, then the central pixel is a bifurcation. If the central is 1 and has 2 one-value neighbor, then the central pixel is a usual pixel.

E. Fingerprint Detectian and Classification

As mentioned before, fingerprint image quality is divided into three classes, dry/neutral/oily. In this paper, we cluster images according to their characteristics using six features defined before. Fingerprint images are clustered by Learning Vector Quantization clustering algorithm [14], [15].

F. Learning Vector Quantization

One of artificial neural network algorithm slender used on pattern recognition and classification are Learning Vector Quantization (LVQ). LVQ is a pattern classification method that each output unit represents a particular category or class (some units output should be used for each class). Weight vectors for a unit of output is often expressed as a vector referens. Assumed that a series of pattern classification with the training available with the initial distribution vector referens. After training, LVQ network classifying the input vectors assigned to the same class as the unit of output, while the vectors have referens classified as input vectors [14], [15].

III. METHODOLOGY

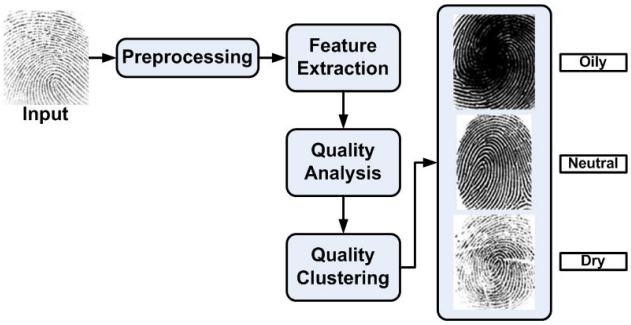

Figure 5. Overview

This paper proposes a method for detecting and classifying defects with the fingerprint image of both. In the first phase, conducted adaptive preprocessing fingerprint image data to produce images of good quality.

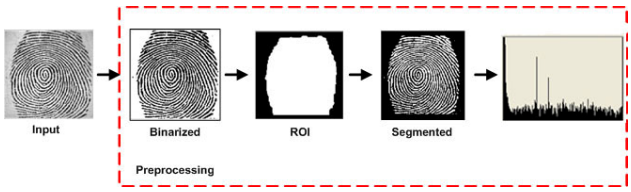

Figure 6. Preprocessing Steps Fingerprint Image

Some of the preprocessing phase are:

1. Edge detection, is done to improve penampakan line object to the fingerprint background. Edge detection method is used Sobel Detection.
2. Binerisasi, is the conversion process the image into binary image (the image that only has two gray-level values: black and white).
3. Morphology operation carried out for the region of interest (ROI) by making the process of closing (the dilasi followed by erosion).
   - Dilasi, is to change the size of an image without changing the form of essentially by adding the eight pixels around each other on the object.
   - Filter, is to eliminate noise that occur on the image. Filter used in the preprocessing stage is the adaptive filter, which can maintain high fringe frequency and the other's image, and adjust themselves with the image of local variants.
   - Erosion, is to change the size of an image without changing the essence of the eight pixels of each other around the object.
4. Segmentation, is used to segment pixels into object-pixel region that represents the object. In other words is separate the object image of the fingerprint background.

Six characteristics (as shown in Table 1) taken the next adaptive to analyze the image quality and added to the cluster module. Cluster module method used was the Learning Vector Quantization. The proposed method is verified using a fingerprint database FVC 2004 DB2_A and a private database collected with the careful consideration because the image quality in the Electrical Engineering Department of Sepuluh Nopember of Institute Technology, Surabaya.

IV. Experimental Results

The proposed method is verified with the database FVC 2004 DB2_A (called DB_1) and a private database (called DB_2) collected with the careful consideration because the image quality in the Electrical Engineering Department of Sepuluh Nopember of Institute Technology, Surabaya. Database DB_1 consists of 880 fingerprint images (image size is 328x364) 100 of the finger. Each finger has 8 expression/position. Database DB_2 consists of 308 fingerprint images (image size is 154x208) of the 28 fingers. Each finger has 11 expression. The second database: DB_1 and DB_2 is gray-scale image. Characteristics of fingerprint images analyzed using the results of clustering Learning Vector Quantization.

The experimental results are:

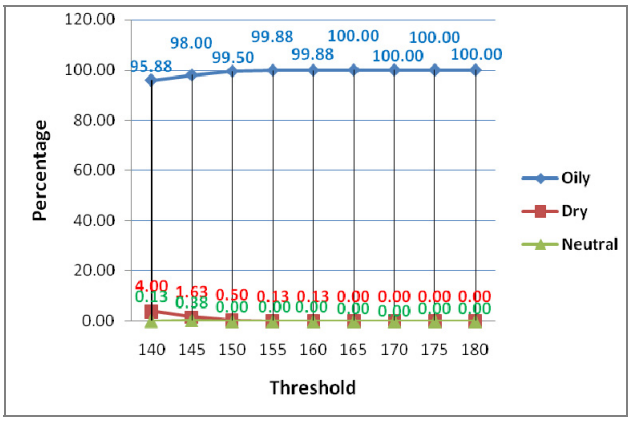

Figure7. Experimental Result of DB1

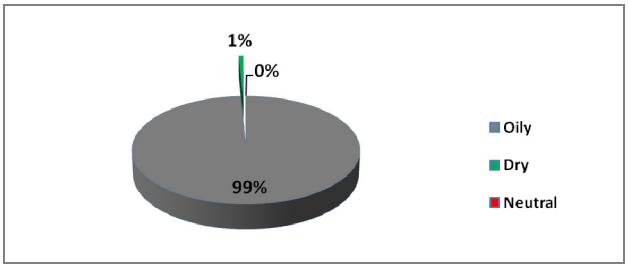

Figure 10. Detection and Classification Percentage Result of DB1

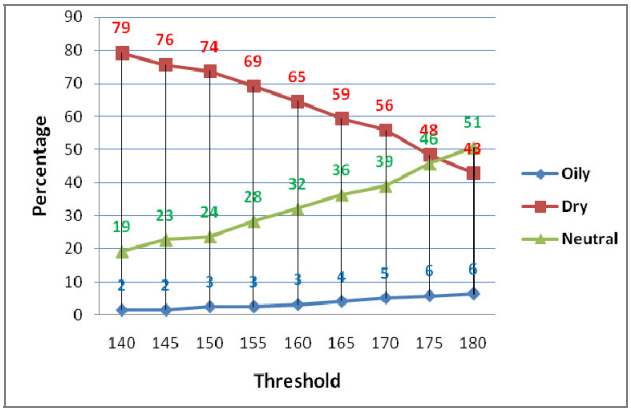

Figure 9. Experimental Result of DB2

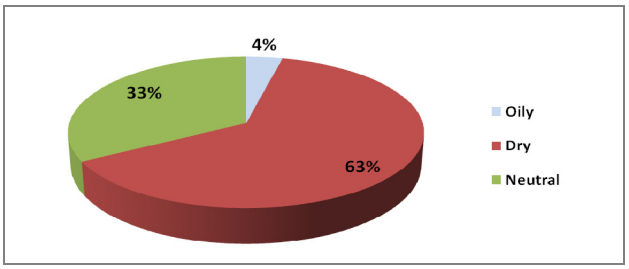

Figure 10. Detection and Classification Percentage Result of DB2

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