DEVELOPMENT OF ARTIFICIAL NEURAL NETWORK ARCHITECTURE FORFACE RECOGNITION IN REAL TIME

Julian Supardi,AlviSyahriniUtami

***Abstracts*-- Face has a biological structurethat is not simple. Nevertheless, research shows that some elements of the face have the geometric characteristics that can be measured. These characteristics are called face anthropometric. The existence of face anthropometric has provided significant clues for researchers to reduce the complexity of face recognition by computer. Although various methods have been developed to face recognition, but generally the system developed accepts input from a file.This condition is a one of face recognition system causes that hasnot been widely applied in real world. This paperpresentsa system that recognizes faces in real time. Artificial Neural Networks chosen as a tool for classification,to improve recognition accuracy. In this research, there are two Neural Networksused,radial basis neural network and Back-propagation neural network.The results obtained in this research shows that the accuracy of the ANN architecture that developed is still not well, which is 80%, but the Neural Network achieves convergence in 8-9 time of repetitions.**

I. BACKGROUND

The face has a biological structure that is not simple. Physically, the main elements contained in the faces are the nose, eyebrows, eyes, ears, mouth, teeth, tongue, cheeks, chin, neck, hair, and other accessories. These elements make the difference between the face and others. Besides the physical elements, there are other factors that affect the face, such as: the nerves and blood vessels, physical trauma and the result of surgery, expression, tears and sweat, pain and fatigue, gender and race, as well as growth and age. Nevertheless, research shows that some elements of the face have the geometric characteristics that can be measured [1]. These characteristics are called anthropometric facial.

The existence of anthropometric facial has provided significant clues for researchers in reducing the complexity of face recognition by computers. Accordingly, several methods have been applied, for instance, by statistics descriptive [2], cascade Face Verification Modules [3], PCA and LDA [4], Gabor and neural network [5], Artificial Neural Network[7].

Although the methods that developed for face recognition has been quite a lot, but generally the system that developed accepts input from a file, either a stationary image file (photo) or moving image files (video). Research on facial recognition using input directly or real time has not been developed. Though the implementation of facial recognition systems in the real system is requires inputs in real time. This condition is one of the causes of face recognition system has not been widely applied in the real world.

Basically, the face is one of the biometric omponents that have a huge potential to be applied to a variety of real-world systems, such as the PC login, database security, access control, e-bank, the card / passport, driver's license, and a security system in immigration [8].

Artificial neural network is a processing model that simulate the working principles of the nervous system of the human brain. This method uses the calculation of non-linear elements called interconnected neurons, so it can support the learning process. This condition allows the system to have the knowledge, so it can be used to solve problems related to pattern recognition, optimization, forecasting, and so forth. Weight adjustment process that dynamically has enabled the neural network can be applied to solving dynamic problems.

II. BIOMETRICS

Biometrics comes from the word bios, which means life and metron means measure. Biometrics is a certain physical state or behavior that is unique in a person. Biometrics has given many contributions toward the life. Biometrics can be utilized in the identification system or modern recognition. A biometric system is essentially a pattern recognition system that operates using biometric data from an individual, extracting a feature set from the data obtained and compare with the features that stick in the database [9].

III. FACE

The face has a biological structure that is not simple. Physically, the main elements that can be found on the face such as the nose, eyebrows, eyes, ears, mouth, teeth, tongue, cheeks, chin, neck, hair, and other accessories. These elements make the difference between the face one another. In addition to the physical elements there are other factors that affect the face, namely: the nerves and blood vessels, physical trauma and the result of surgery, expression because of vascular, tears and sweat, pain and fatigue, gender and race, as well as growth and age. Research shows that some elements of the face have the geometric characteristics that can be measured [1]. These characteristics called anthropometric of the face. Examples of anthropometric face can be seen in Figure 3.1 below

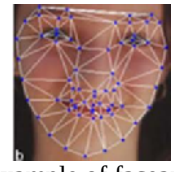

Figure 3.1: Example of faceanthropometric

According to [1] the nature of geometric can be obtained the information that becomes unique characteristic of overall face. In face recognition th
such as the situation of

position of face, face expression, and size of face (or head). A factor that helps in face recognition is symmetry characteristic. Humans recognize faces by relying on knowledge holistically and information obtained from the local characteristic of face [11]

IV. FACE RECOGNITION SYSTEM

Humans have used body characteristics such as face, voice and behavior for hundreds of years to recognize one another [9]. Developments in computing decades ago allow a computer or a machine to recognize a person as humans do [12]. Major progress in the last fifteen years has pushed face recognition system to be a topic that captivated in the researchers world [13]. This is because the face recognition system can be used as a verification and identification [14].

Face recognition system is an application on a computer that allows identifying or verifying a person using a digital image or a video frame. One of methods used is by comparing facial features in a digital image toward facial features in database.

V. ARTIFICIAL NEURAL NETWORK

Artificial neural networks or commonly abbreviated as ANN is an information processing model was developed based on the working principle of the nervous system of the human brain [14][16]. ANN will be able to solve problems when the knowledge relating to this issue has existed [15]: In order to gain the knowledge, there are several methods that can be used, and one of them is the backpropagation algorithm given as follows [6][16].

Initialize of weights to small random numbers

While (kondisi berhenti salah){
For (each of training pattern){
for (i= 1 to n){
Set semua x_i
}
for (j=1,2, . . ,p){

$$z_{in_j} = \sum_{i=1}^{n} x_i v_{ij}$$

$$z_j = f(z_{in_j})$$

}

for (k=1,2,.., m){

$$y_{in_k} = \sum_{j=0}^{p} z_j w_{jk}$$

$$y_k = f(y_{in_k})$$

}

$$\delta_k = (t_k - y_k) f'(y_{in_k})$$

$$\nabla w_{jk} = \alpha \delta_k z_j$$

$$\nabla v_{ij} = \alpha \delta_j x_i$$

$$\delta_j = f'(z_{in}) \sum_{k=1}^{m} \delta_k w_{jk}$$

$$w_{jk}(baru) = w_{jk}(lama) + \nabla w_{jk}$$

$$v_{ij}(baru) = v_{ij}(lama) + \nabla v_{ij}$$

}/*end for*/
}/* end while

Once the learning phase is complete, the ANN is ready to use. The use of ANN is called the testing. Backpropagation algorithm for testing stages is as follows [6][16]:

Initializethe weights v and w from training algorithm

for (setiapvektormasukan) {

for (i=1 to n) { Set semua x_i }

for (j=1 to p) {

$$z_{in_j} = \sum_{i=1}^{n} x_i v_{ij}$$

$$z_j = f(z_{in_j})$$

}

for (k=1 to m) {

$$y_{in_k} = \sum_{j=0}^{p} z_j W_{jk}$$

$$y_k = f(y_{in_k})$$

}
} /*end for */

Besides backpropagation algorithm mentioned above, another commonly used algorithm is the radial basis function neural network. The steps of the algorithm for the learning phase are as follows:

1. Initialize center of normalize matrix data input and center of calculation result
2. Initialize spread value that will be used to Gaussian matrix calculations.
3. Determine the input signal to the hidden layer and calculate the value of the activation function of each hidden layer using the formula below:

$$\varphi(|X_m - t_j|) = e^{\frac{|x_m - t_j|}{\sigma^2}} \quad (4.1)$$

With the provisions:

- m = 1,2,3,... according the number of training ;
- j = 1,2,3… according the number of hidden unit;
- X : input vector ;
- and t : data vector as a center.

4. Compute new weight(W) by multiplying pseudoinverse of G matrix with target(d) vector from training databy using formula in equation:

$$W = G^{+} d$$
$$= (G^{t} G)^{-1} G^{t} d$$

5. Compute neural output value Y(n)

$$Y(x) = \sum_{n=1}^{\infty} (wG(||x - ti) + b ,$$

where

6. Save the value of training

VI. ARTIFICIAL NEURAL NETWORK

In general, the mechanisms that occur in Real-time Face Recognition System can be described by the block diagram in Figure 6.1. below.

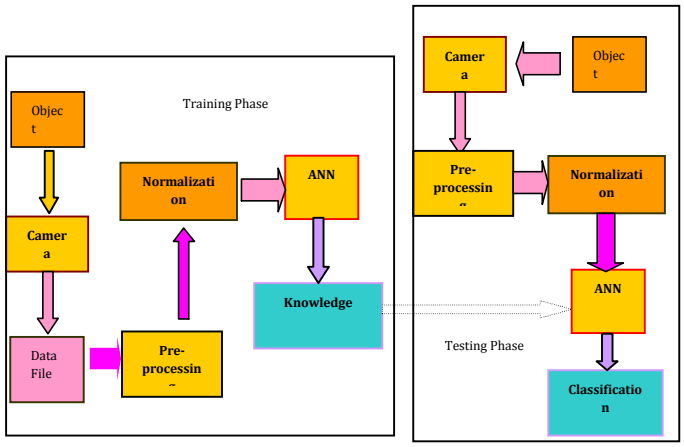

Figure 6. 1. Architecture of Face Recognition using ANN

VII. RESULT AND DISCUSSION

7.1. Architecture ofNeural Network

There are two types of Neural network architecture that developed in this study, namely architecture of Radial Basis Function Neural Network shown in Figure 7.1 and Backpropagation Neural Network is shown in Figure 7.2.

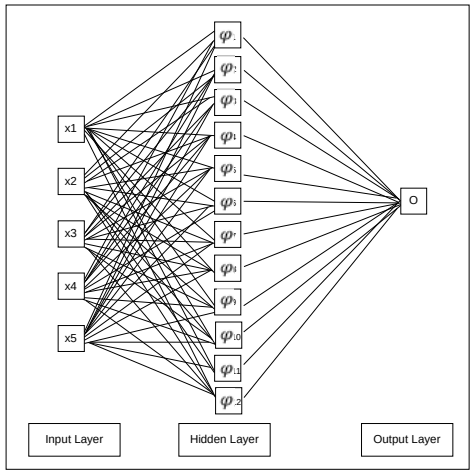

Figure 7.1. Architectureof Radial Basis Function Neural Network

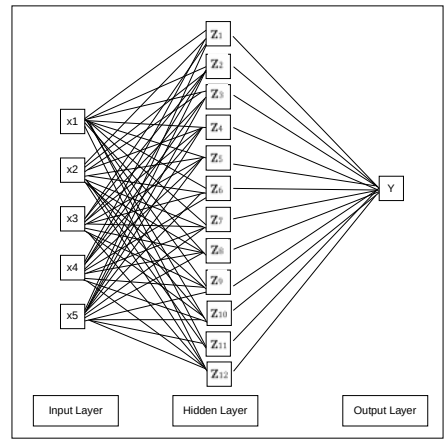

Figure7.2. Architecture of Backpropagation Neural Network

After training towardthe parameters have been given, then obtained the weights that resulting convergence for each of the neural network as shown in Figure 7.3.

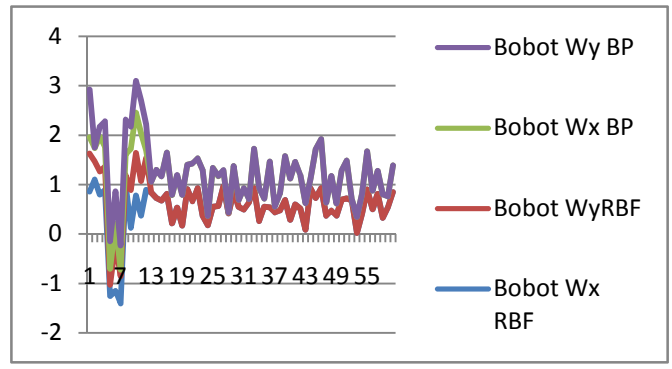

Figure7.3. Weights Comparisonof RBF NNand BP NN

7.2 Testing Result

Once the network achieve converges, conducted tests on Neural Network architecture that has been developed, the test results are shown in Figure 7.4. as follows:

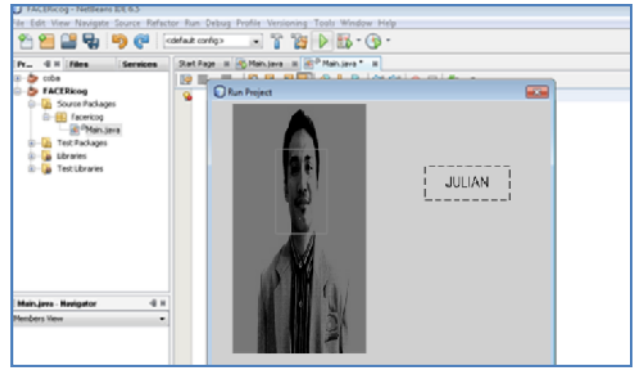

Figure7.4. Testing Result

Testing result of the software provides an accuracy level of the face recognition that still not good, from 5 test data given but unfortunately only 3 that successfully recognized (80)%.

VIII. CONCLUSION

The conclusions that can be given in this study are:

1. RBF and Backpropagation Neural Network Architecture that developed in this study have been successfully recognizing faces in real time.
2. The level of accuracy of the ANN architecture used is still relatively low, ranging from 80%.

REFERENCES

[1] DeCarlo,Douglas, Dimitris Metaxas, and Matthew Stone. 1998. An Anthropometric Face Model using Variational Techniques. SIGGRAPH

[2] Khera, V. 2003. Face Recognition using Feature Extraction based on Descriptive Statistics of a Face Image. Proceedings of the Eighth International Conference on Machine Learning and Cybernetics, Boading, USA

[3] Zhang, Ping. 2008. A Video-based Face Detection and Recognition System using cascade Face Verification Modules. IEEE, Alcorn State, USA

[4] Zhang, Hui. 2009. Face Recognition Based on PCA and LDA Combination Feature Extraction. IEEE, Beijing, China

[5] Latha, P., Ganesan, L. &Ramaraj, N. (2009) Gabor and Neural Based Face Recognition. International Journal of Recent Trends in Engineering, 2 (3), pp. 111-113

[6] Fausett, Laurence. 1994. *Foundamentals of Neural Networks* .EnglewoodsCliff : Prentice Hall.

[7] Anam, Sarawat, et al. 2009. *Face Recognition Using Genetic Algorithm and Back Propagation Neural Network.* Proceedings of the International Scientists 2009 VolI IMECSMultiConference of Engineers and Computer2009, March 18 - 20, 2009, Hong Kong

[8] Zhao, W., Chellappa, R., Phillips, P. J., and Rosenfeld, A., 2003. Face Recognition: A Literature survey, ACM Computing Surveys, Vol. 35, No. 4, December 2003, pp. 399–458.

[9] Jain, K. A. & Ross, Arun. 2004. An Intoduction to Biometric Recognition. IEEE Transactions on ciucuits and systems for video technology , Michigan State, USA

[10] Hykin,Simon. *1999.Neural Network : A Comprehensive Foundation.* Prentice-Hall,Inc, Ney Jersey.

[11] Lewis, Michael B andHadyn D Ellis.2003. How We Detect a Face: A Survey of Psychological Evidence. Journal of Imaging System Technology, vol. 13. Wiley Interscience, Research funded by EPSRC GR37777.

[12] Kirchberg,KlausJ. liverJesorsky,andFrischholz, RobertW.2002. Genetic Model Optimization for Hausdorff Distance-Based Face Localization.InProc. Workshopon Biometric Authentication, Springer, Lecture Notesin ComputerScience,LNCS-2359,pp.103.111,Copenhagen,Denmark,June, 2002.

[13] Chen,Yao-Jiunn and Lin,Yen-Chun. 2007. Simple Face-detection Algorithm Based on Minimum Facial Features.The 33rd Annual Conference of the IEEE Industrial Electronics Society (IECON) Nov.Taipei, Taiwan

[14] Tasaltin, Ramazan andTaylan, Osman. 2007. A Frontal Face Detection Algorithm Using Fuzzy Classifier.JKAU: Eng. Sci., Vol. 18 No. 1, pp: 37 - 53 (2007 A.D. /1428 A.H.)

[15] Jung, Insung and Wang, Gi-Nam. 2007. *Pattern Classification of Back-Propagation Algorithm Using Exclusive Connecting Network.* World Academy of Science, Engineering and Technology.

[16] Supardi, Julian, et al.2007. *SistemPengenalWajahManusiaDenganJaringanSyaraf Tiruan*.Prosiding SATEK Ke I Unila: LemlitUnila 2007

Julian Supardireceived his B.Sc. degree in Mathematics from Sriwijaya University, in 1997. He received his Magister Teknik in Software Engineering from Bandung Institute of Technology, in 2004. Now, he is a lecturer of Informatics Engineering Department of Computer Science Faculty of Sriwijaya University. His current research is Application of Dynamic Segmentation for Face Recognition Using Artificial Neural Networks

AlviSyahriniUtami received her B.Sc. in Mathematics from Sriwijaya University, in 2002. She received her Magister Komputer in Computer Science from GadjahMada University, in 2005. She has been working as a lecturer of Informatics Engineering Department of Computer Science Faculty ofSriwijaya University since 2006. Her research interests includes artificial intelligence, natural language processing, and image processing.