Design Concept of Convexity Defect Method on Hand Gestures as Password Door Lock

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ABSTRACT

In this paper we propose several steps to implement security for door locking are using hand gestures. The methods considered as preprocessing image, skin detection and Convexity Defection. The main components of the system are Camera, Personal Computer (PC), Microcontroller and Motor (Lock). Bluetooth communication is applied to communicate the PC and microcontroller to open and lock the door used commands character such as "O" and "C". The results showed that the hand gestures can be measured, identified and quantified consistently.

Keywords: Bluetooth, Camera, Convexity Defect, Design Concept, Hand Gesture.

1. INTRODUCTION

Security can be obtained in several ways; one of them is by applying technology. Applications of security technology now days are a very advanced from conventional to high-technology. In security, it requires a key to validate. These Keys will later be referred to a password.

A password is codes to open or access a system. In practice there is a lot of passwords used, one uses a figure letters, fingerprints, face, some even used retina of the eye as password. In this study, the system uses motion of hands as the password.

Hands motion commonly used in daily life to communicate, as in greeting someone or as an auxiliary apparatus to communicate with a person who experienced deficient in verbal language [1]. Often occurring in communicating motion of hands can help clarify remarks someone, besides motion of hands can also presented a letter [2, 3].

Motions of hands are understandable by human who have studied it. To convict hand movement, it was required good eyesight, at the time when the hand gestures are stored in memory and adapted to data stored in the brain. It will then be processed as an action. With this thought many researchers use camera as a substitute for the human eye, while microprocessor as substitute for human brain.

The use of camera as censors usually relate to the field of computer vision such as used in the application of robotics, and control [4, 5, 6]. The application of computer vision will succeed if the system using a right methods of image processing. Many techniques are available image processing, one of them is convexity defection.

Convexity defection is a technique in which the image digitally can recognize an object [7,8,9,10].

2. METHODS

2.1. Citra Digital

Image is another name of picture, usually used in the field of scientific image processing. There are two forms of functions f (x, y) in image processing x and y. These are coordinates of a point in an image. A digital image is changing from analog to digital form to make easier to process an image [11].

Digital image has some pixels to make it up. The pixels are 2-dimensional matrix of columns and rows. The more pixels in an image, the higher the resolution. It measures the number of points for each of length. The resolution also describes the details of an image [11].

2.2. Grayscale

Grayscale is an image where each pixel only contains intensity of color. This image has only one base color, that is gray, but the intensity of color is different [11]. In 8 bits digital image, every colors in one pixel are red, green, and blue with the similar value [11].

The difference between the pixel and the other one is the intensity, where for a lighter color (white) the valuesapproaching 255 and the darker color is close to 0. (Figure 1.)

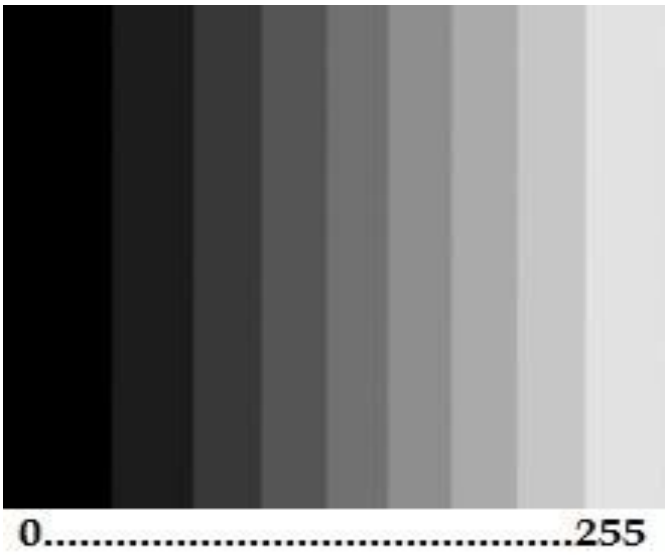

Fig 1. Degrees of gray scale in 8 bit.

2.3.Thresholding

Thresholding is a simple technique of segmentation. This technique can divide the image into two colors, usually black and white is [8]. To use this technique grayscale techniques are required in advance, meaning that when the original image has been transformed into a grayscale image, it will pull in a point which is the value of grayscale intensity [8]. For example, the intensity value taken is 100, then the grayscale intensity values above 100 will be assigned to 255 and a value below 100 will be assigned to 0. So 100 being the midpoint and called the threshold value (figure 2).

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Threshold value can be determined and calibrated so that the color distribution of objects in the image can be divided according to what we need.

Fig 2. Conversion of the original image into a grayscale image and also to binary image with the threshold value of 150 in 8 bits.

2.4. Skin Detection

Skin detection is an object segmentation techniques such as thresholding. In this case the human skin as its object. Alvise Lastra et al, [12] and Michael J,J and Rehg JM [13] conducted research using skin detection techniques to split the objects in the image. This technique can be well applied in detecting human skin.

2.5. Convexity Defection

Tankus, et.al. [14] used the convexity defection technique to detect human faces. By combining the technique of Y-Phase to recognize part of the eye and hair. David W J has also done research using this techniques to distinguish between curved or wavy lines with straight lines on a digital image [15]. This technique was able to distinguish the line curved (convex) and a straight line as shown in figure 3.

System will be made using the method to retrieve the value of convexity defects characteristic of the pattern of hand (figure 4). Then these values will be processed to determine the decision using the Euclidean distance.

2.6. ATMega16

The microcontroller (figure 5) will be used to regulate the dc motor that will be the key to the door. Microcontroller will be connected to a computer through a serial connection. This microcontroller can receive and send data by serial connection (USART)[17]. As has been done by Chauhan JS and Semwal S, they used ATMega16 as controller with useful set speed DC motor which was connected to the computer via a serial connection (USART) [18]. Ahn JH had also to use a microcontroller to control the robot using a serial connection [19].

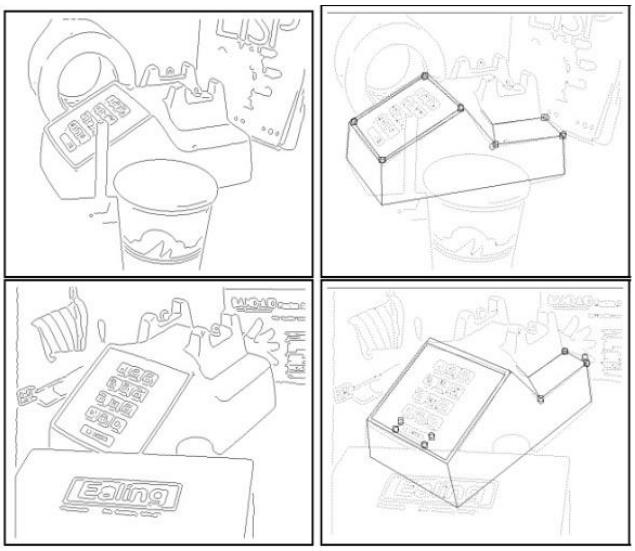

Fig 3. Grouping straight and curved lines using convexity defects technique [15].

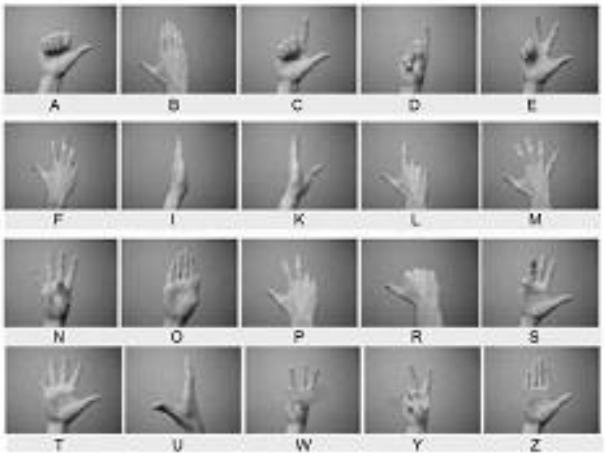

Fig 4. Shape hand patterns that represent letters [16].

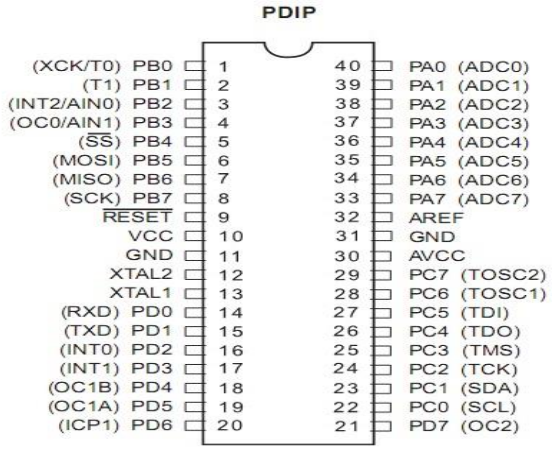

Fig 5. Microcontroller ATMega16 [17].

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3. RESULT AND DISCUSSION

3.1. Getting digital image

At this stage a digital image was obtained from a webcam. The image obtained is a dynamic image or real time image. Program of image capture will be made using C # language with the help of EmguCV library. Figure 6 is a simplified block diagram of a real-time image capture system.

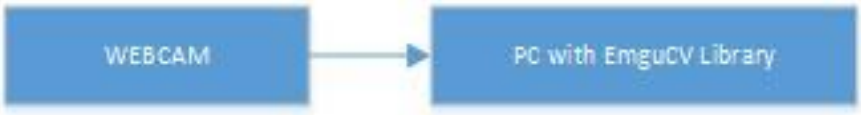

Fig 6. A block diagram of the real time image capture.

At beginning of the experiment some real time images can be captured and converted into an image as shown in the figure 7.

Fig 7. Some real time images where converted into an image.

3.2. Image Segmentation

At this step it will be used two methods, which are skin detection and thresholding. Skin detection is useful to detect skin color.The dectected Image will be converted to binary image with thresholding method.

Both methods where used to divide the pixels which have information of the hand shape and no information of the hand shape. Block diagram of the real time image to a binary image using skin detection method and thresholding is shown in figure 8.

At this stage it will produce a binary image where the color of the skin will be made of white and other colors will be made of black. This was done to simplify the process of its programming. Figure 9 is the result of an experiment using two methods.

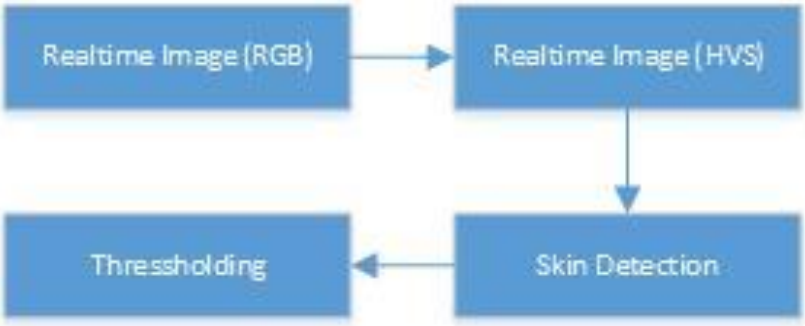

Fig 8. A block diagram of the real time image to thresholding image.

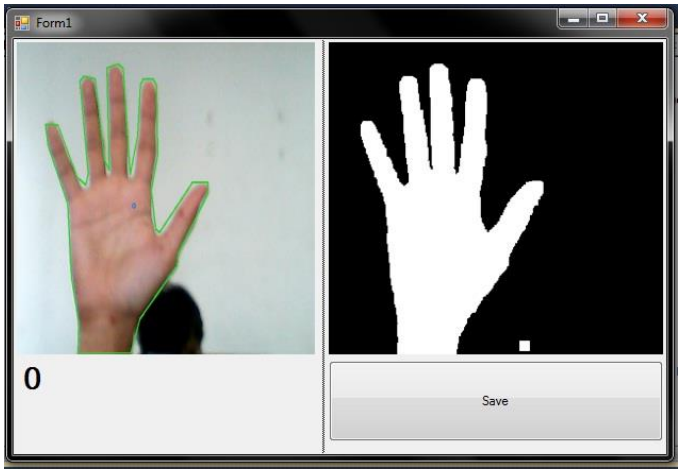

Fig 9. Sample image using skin detection and thresholding method.

3.3. Draw Hull

After the binary image was obtained, the next step is to form the hull of the contour shape of the hand. The Melkman algorithm will be used in this process. Hull will be determined by line and column [20,21]. After that points will be compared based on their position, then the outermost points will be selected. Hull will be established from the point where the direction of the hull can be clockwise (CW) or counter – clockwise (CCW) as shown in figure 10.

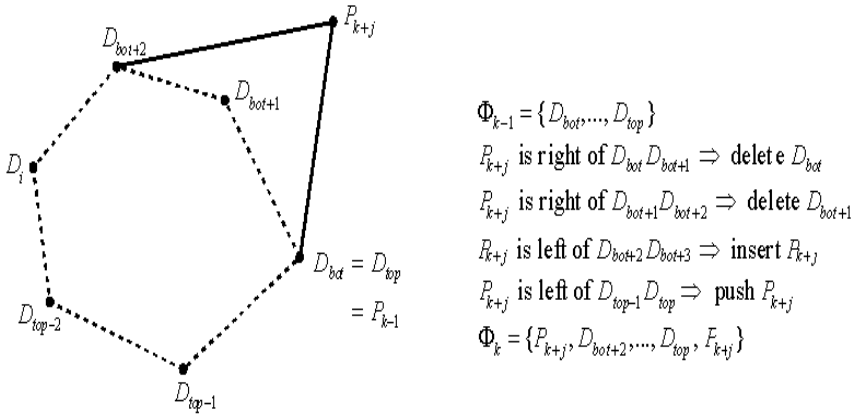

Fig 10. Example of counter – clockwise hull [20].

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At the beginning of the experiment, assisted by Emgucv, formed hull can be seen in figure 11.

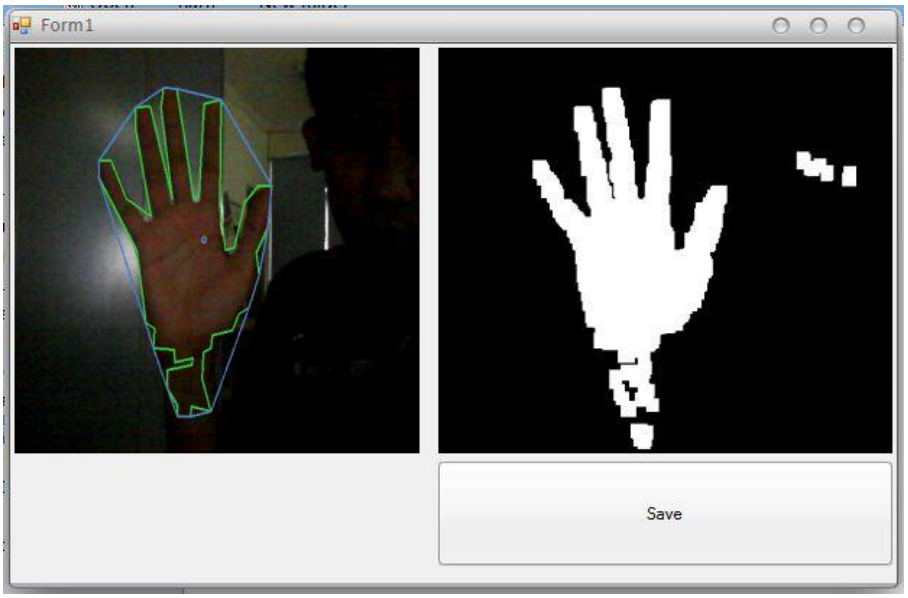

Fig 11. Hull formed from the hand contour.

3.4. Extraction Information

At this step the binary image was obtained from the previous process will be extracted to obtain values of its information. The extraction information convexity defect method will be used at this point.

The image will give the lines where the lines represent the distance between defect and hull. An example can be seen in Figure 12.

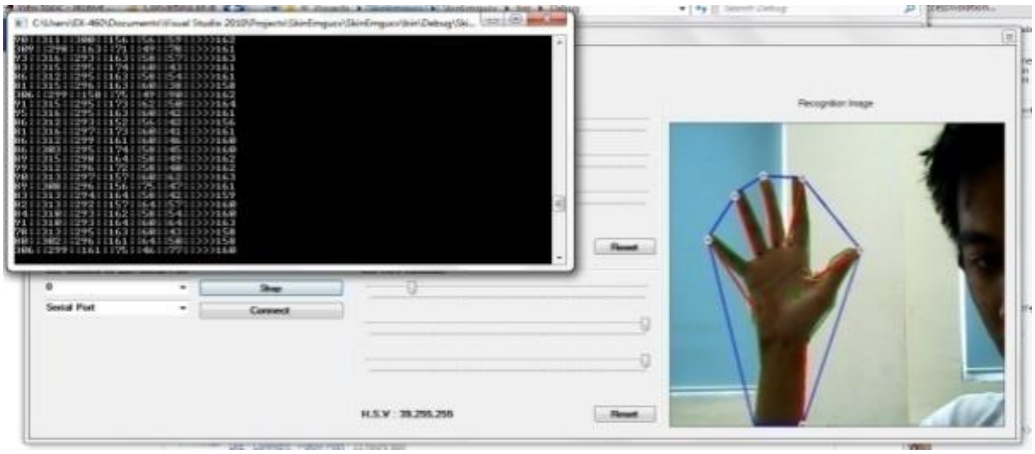

Fig 12. Examples of information extraction on hand pattern that represents the distance between the defect and the hull using the convexity defect.

The experimental results obtained for each hand gesture A, B, C, D and E the lines can formed as seen in the figure 13.

The table I is the value of a length lines on each hand gesture. Each of the values where obtained from an average of 200 times in realtime and sequential experiments.

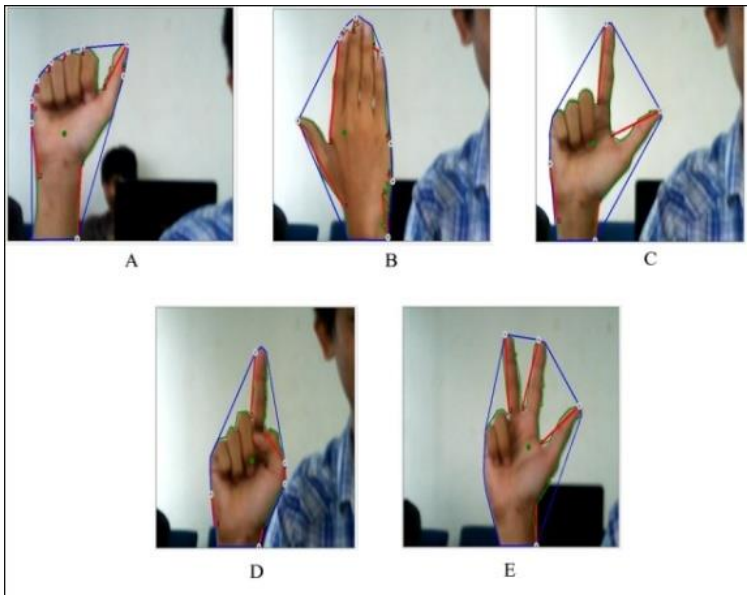

Fig 13. Shape and length of lines for each hand gesture.

TABLE I
VALUES OF LENGTH LINES ON EACH HAND GESTURE

LENGTH OF LINE	DATA TEST	DATA SAMPLE				
		A	B	C	D	E
INDEX 0	43	42.8	269.0	115.3	99.86	212.2
INDEX 1	187	174.8	237.5	278.4	161.8	202.2
INDEX 2	211	213.4	169.7	241.9	218	286.4
INDEX 3	147	134.4	148.9	219.8	255	246.4
INDEX 4	29	95.2	57.06	187.5	263.6	138.4
INDEX 5	70	72.1	40.9	1.53	15.06	119.3
INDEX 6	55	46.8	111.1	0	0	1.77
INDEX 7	67	40.7	80.02	0	0	0
INDEX 8	21	38.5	0	0	0	0
INDEX 9	2	5.13	0	0	0	0
AVERAGE	83.2	86.4	111.4	104.4	101.3	120.7

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3.5. Decision-making

Length of the lines in the previous process will be compared with test data. By applying the euclidean distance algorithm smallest error will be obtained, where each index are compared one by one with sample data.

Each length of the test lines will be compared with each of sample line in each gesture according to its index. Test lines that has the smallest error will be stored in an array in which the contents of the array is the sum of each lines that has the smallest error on a gesture.

Next step sample data values are averaged and then compared to the test values which are also averaged, so that will be 11 values to compare. The table II is explained how the process of decision making was done with 11 values.

TABLE II
VALUES OF ERROR EACH INDEX

LENGTH OF LINE	$\sqrt{(x-y)^2} = \lvert x-y \rvert.$				
	A	B	C	D	E
INDEX 0	0.14	226.01	72.315	56.86	169.27
INDEX 1	12.16	50.58	91.435	25.115	15.245
INDEX 2	2.46	41.25	30.905	7.02	75.495
INDEX 3	12.535	1.92	72.855	108.035	99.74
INDEX 4	66.25	28.065	158.595	234.605	109.425
INDEX 5	2.175	29.01	68.47	54.935	49.33
INDEX 6	8.105	56.125	55	55	53.23
INDEX 7	26.295	13.02	67	67	67
INDEX 8	17.535	21	21	21	21
INDEX 9	3.13	2	2	2	2
AVERAGE	3.2315	28.246	21.2635	18.147	37.5275

That table II shows that values of error that obtained using Euclidean distance algorithm for one dimension where x is line length of each hand gesture and y is data test. After finding minimum value from each index then count every minimum values of each hand gesture as shown in table III.

From the table III data “A” has the minimum value, it means that the data test is closer to hand gesture “A”. in the program the password that have been saved in database was compared with data that has just been recognized, if password and data are the same then it will open the lock of door by turning the motor dc.

TABLE III
SUM OF MINIMUM VALUE

LENGTH OF LINE	COUNT MINIMUM VALUES				
	A	B	C	D	E
INDEX 0	0.14	226.01	72.315	56.86	169.27
INDEX 1	12.16	50.58	91.435	25.115	15.245
INDEX 2	2.46	41.25	30.905	7.02	75.495
INDEX 3	12.535	1.92	72.855	108.035	99.74
INDEX 4	66.25	28.065	158.595	234.605	109.425
INDEX 5	2.175	29.01	68.47	54.935	49.33
INDEX 6	8.105	56.125	55	55	53.23
INDEX 7	26.295	13.02	67	67	67
INDEX 8	17.535	21	21	21	21
INDEX 9	3.13	2	2	2	2
AVERAGE	3.2315	28.246	21.2635	18.147	37.5275
SUM OF MINIMUM VALUE	7	3	1	1	1

3.6. Controlling Motor

Using Bluetooth communication between PC and microcontroller, the open and lock commands will be sent. Command is a character such as “O” for open and “C” for close the lock.

4. CONCLUSION

Recognition of the hand pattern using the convexity defect method worked as expected. Systems can only recognize five letters (A-E) where for each letters A, B, and C were quite satisfactory and for D and E patterns were error. Error that occurred cannot be separated from the influence of light when becoming a major problem in digital image processing system. The distance between the webcam and the object when taking the current test data are also very influential on an error.

To overcome the error system, it is necessary to make a specific provision of light and distance. Webcam should be in black box where the light is only obtained from the LED light webcam. The retrieval of data should be done with these conditions by entering the hand into the box from the bottom so that the distance between the object and the webcam can be stable.

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