Hand Gesture Recognition as Password to Open The Door With Camera and Convexity Defect Method

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***Abstract*—Computer Vision is one of reasearch that gets a lot of attention with many applications. One of the application is the hand gesture recognition system. By using EmguCV, will be obtained camera images from webcam camera. The Pictures will be disegmented by using skin detection method for decrease noises in order to obtain the information needed. The final project of this system is to implement the convexity defect method for extracting images and recognize patterns of hand gesture that represent the characters A, B, C, D, and E. The parameters used in pattern recognition of hand gesture is the number and length of the line connecting the hull and defects derived from the pattern of hand gesture.**

Keywords—EmguCV, image processing, skin detection, convexity defect, hand gesture recognition.

I. INTRODUCTION

Security is a condition where humans or animals feel avoid the danger that threatens or disturbing, furthermore, will pose a feeling of calm and comfortable. Security can be obtained in several ways, one of them is by applying technology. Application of technology security now have a very advanced ranging from conventional method to high-tech. In terms of security, it requires a key method for validation. 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 who uses a figure letters, fingerprints, face, some even used the retina of the eye as password. In this study will be made a system that uses motion of hands as the password.

Motion of hands 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].

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

The use of camera as censors usually relating to the field of computer vision such as used in the application of robotics, and control [4, 5, 6]. The application of computer vision said succeed if the system using a right methods ofimage processing. Many techniques used in 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].

II. METHODS

A. Obtain A Digital Image

At this stage, we will get RGB image realtime from the camera. The program will be built by using C# with Visual Studio 2013 compiler and supported by libraries emguCV. The Image Realtime captured by default which the resolution size is 640 x 480 pixels. In general, the camera has a resolution size is 640 x 480 pixels. However, there are some high end camera capable of capturing a larger resolution. in this system will be used a camera that has a resolution size is 640 x 480 pixels. As shown Figure 1. For cameras and computers that are used can be seen in figure 2 and figure 3.

Fig.1 Example of Digital Image

Fig. 2 The Camera

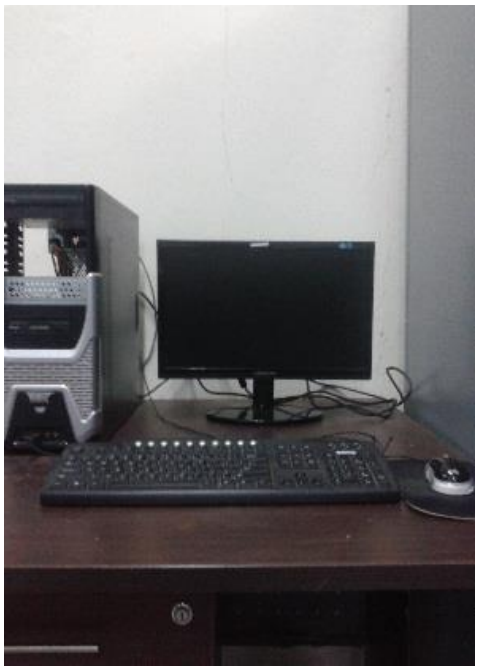

Fig. 3 The Computer

B. Image Segmentation

At this stage, the digital image obtained from the previous stage and after that it will be filtered in order to filter the pixels that have the information needed [10,11]. There are two processes that will be used in this stage, namely skin detection and thresholding. The first is the skin detection process where the process will be sought the pixels that have a color corresponding to the color of the skin where skin color ranges had been specify before by us . To be able to detect the skin color with good pixel, The RGB pixels are converted into HSV [11,12,13]. By using the following equation, it will be obtained HSV values of each pixels.

$V = max\ (\ R/255,\ G/255,\ B,255\ )$

$$S = \begin{cases} 0, & V = 0 \\ \dfrac{(V - \min(rgb))}{V} & V <> 0 \end{cases}$$

$$H = \begin{cases} 0, & S = 0 \\ 60\dfrac{(g-b)}{SV}, & V = r \\ 60\left[2 + \dfrac{(b-r)}{SV}\right], & V = g \\ 60\left[4 + \dfrac{(r-g)}{SV}\right], & V = b \end{cases} \quad (1)$$

RGB value of each pixel is converted into HSV values where if the HSV values of each pixel are located in the range of pixel values is given then skin color detected. Next, come to the thressholding process where skin color pixels has been detected change into white and the other will be changed to black or just called a binary image.

Fig. 4 Binary Image

C. Convexity Defect

At this stage, the binary image obtained in the previous process where the value of characters will be extracted by using the convexity defect. From the study of literature is read [14,15,16,17] this method can be used to extract the value of an image. This method has several stages for the solutions:

1. Obtain the largest contour of the binary image.
2. Save the pixel position from contour that formed and determine the pixel contour at the left most.
3. Sorting of the pixels and searching of hull defect.
4. Determine the distance of each hull length and defect.

1) Determine the distance of each hull length and defect

At this stage, contour will be made by image that had been detected by skin color . Contour will be used for searching the position of the outermost from skin color pixels that are detected. Making contour of image that has been segmented

into the skin detection will be described in pseudocode as shown in Figure 5.

inda

```
x integer
For (i = 0; i < citra.width-1; i++)
For (j = 0; j < citra.height-1; j++)
        If (citra[i, j] != skincolor & citra[i+1, j+1] == skincolor)
then
                drawcontour[i+1, j+1]
                contour[x] = citra[i+1, j+1]
                x++
        End If
        Else If (citra[i, j] == skincolor & citra[i+1, j+1] !=
skincolor) then
                drawcontour[i, j]
                contour[x] = citra[i, j]
                x++
        End If
End For
End For
```

Fig. 5 Countour's Pseudocode

By using the algorithm as shown in figure 5 it will get skin contour detection from image as shown in Figure 6.

Fig. 6 Contour from skin detection had been detected

2) Save the pixel position from contour that formed and determine the pixel contour at the left most

At this stage, the position of the pixel on the contour will be stored into an array. The pixel will be compared and searched pixels that have the leftmost position, or in other words, pixels that have x values which is the smallest one. After obtained the leftmost pixel, the pixel index was changed to the first index. To more clearly be described with a flowchart as shown in Figure 7.

```
temp integer
indexMostleft integer
pixelMostleft point
pixelMostleft = contourX[0]
For (i = 0; i < jumlahcontourpixel - 1; i++)
        If (contourX[i] < contourX[i+1]) then
                indexMostleft = i
        End if
End for

temp = contour[indexMostleft]
contour[indexMostleft] = contour[0]
contour[0] = temp
```

Fig. 7 Pseudocode find the leftmost pixel

By using the algorithm, as shown Figure 7 are obtained leftmost pixel of contour skin detection as shown in Figure 8.

Fig. 8 Leftmost pixel of contour

3) Sorting of the pixels and searching of hull defect

After the leftmost pixel acquired at a later stage, on this stage each pixel will be sorted the index opponent based on clockwise direction (CCW). After we get the leftmost pixel, we only search of performed by 180 degrees starting from the bottom (0 degrees) and then to top (180 degrees). After the pixel sequentially based on clockwise direction and search hull and defect. The following equations are used in finding pointX that rotates 180 degrees counter-clockwise. However for PointY value will increase by 1 for angles which less than 90 degrees and will be reduced 1 to angle for more than 90 degrees.

For example, the image will be shown in figure 8 it will be visualized line from 0 to 180 degrees.

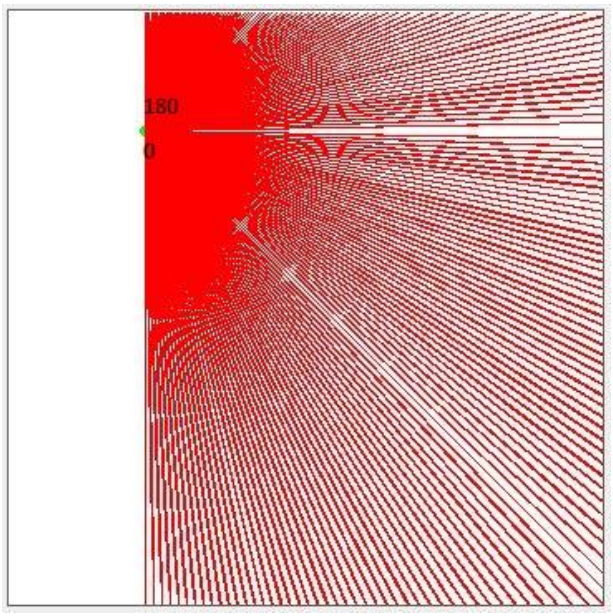

Fig. 8 The lines from 0 to 180 degrees

4) Determine the distance of each hull length and defect

By using library EmguCV, we get the hull and defects from the skin color contour that has been detected. Figure 9 is an example of hull and defects acquired.

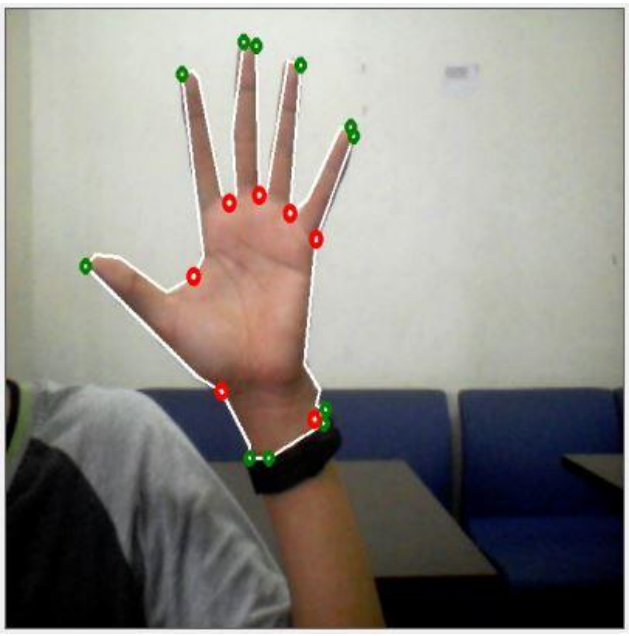

Fig.9 Hull and Defects

Next stage is to find the distance between the hull and the defect where the distance is what will represent the value of image pattern. The pattern that has pairs of hull and defect less than 10 then it will be added pair with distance value is 0. By using the Pythagorean formula, we will get distance hull and defects as shown in the following equation.

$$Length = end\_defectpointX - start\_defectpointX$$
$$Height = end\_defectpointY - start\_defectpointY$$
$$Slant = \sqrt{(Length2) + (Height2)} \quad (2)$$

By using the equations obtained distance of each hull and defects on each pattern as shown in Table I.

TABLE 1
THE DISTANCE LENGTH OF HULL AND DEFECTS

LENGTH OF LINE	DATA SAMPLE				
	A	B	C	D	E
INDEX 0	42.8	269.0	115.3	99.86	212.2
INDEX 1	174.8	237.5	278.4	161.8	202.2
INDEX 2	213.4	169.7	241.9	218	286.4
INDEX 3	134.4	148.9	219.8	255	246.4
INDEX 4	95.2	57.06	187.5	263.6	138.4
INDEX 5	72.1	40.9	1.53	15.06	119.3
INDEX 6	46.8	111.1	0	0	1.77
INDEX 7	40.7	80.02	0	0	0
INDEX 8	38.5	0	0	0	0
INDEX 9	5.13	0	0	0	0

D. Decision Making

At this stage, the distances obtained for each hull and defects on each pattern will be calculated of similarity by using equation dimensional Euclidean distance 1 dimension as shown in the following equation

$$\sqrt{(x-y)^2} = |x-y|. \quad (3)$$

E. Controls

On this stage, the pattern detected will verified by a pattern that has been stored in the database. If the pattern is correct then the computer will give orders to the microcontroller to unlock the keywords that have been installed. The shipping is sequent by serial with Bluetooth wireless media where the serial connection has a pretty good speed, and easy to apply on a microcontroller.

The microcontroller use the Atmel ATmega 16 which has a feature that supports serial USART serial connection [18, 19, 20].

III. RESULT AND DISCUSSION

In order to obtain training data for each pattern, so that the experiments performed 200 times to get initial data for each pattern as shown in Table II.

The data that will be compared with the realtime data obtained. Every each index value of the data to be searched by using the smallest Euclidean distance equation. Realtime data is shown in Table III.

In the test, the value of each index pattern similarity can be seen in Table IV.

Patterns that have the most value similarity is pattern detected. The red column is the index that has the smallest similitary value. As shown in Table IV for each - one for each

pattern similarity number is A = 6, B = 3, C = 0, D = 0, and E = 1. From these data it can be seen that the detected pattern is a pattern A.

TABLE II
DATA FROM EACH PATTERN

LENGTH OF LINE	DATA LATIH (y)				
	A	B	C	D	E
INDEX 0	55.375	150.83	144.6	23.805	107.465
INDEX 1	38.015	118.10	101.48	24.23	67.535
INDEX 2	23.845	60.79	76.455	58.53	42.53
INDEX 3	27.965	81.62	118.18	55.245	125.87
INDEX 4	31.56	41.865	124.70	59.79	123.15
INDEX 5	28.675	18.585	0	46.985	86.925
INDEX 6	28.075	38.4	0	62.045	79.895
INDEX 7	31.37	48.085	0	48.35	0
INDEX 8	29.95	0	0	29.835	0
INDEX 9	23.4	0	0	6.695	0

TABLE III
REALTIME DATA

LENGTH OF LINE	DATA REALTIME(x)
INDEX 0	154
INDEX 1	33
INDEX 2	63
INDEX 3	16
INDEX 4	14
INDEX 5	135
INDEX 6	36
INDEX 7	31
INDEX 8	41
INDEX 9	54

TABLE IV
SIMILARITY VALUE IN WHOLE INDEX

LENGTH OF LINE	$\sqrt{(x-y)^2} = \lvert x-y \rvert.$				
	A	B	C	D	E
INDEX 0	98.6	3.1	9.4	130.1	46.5
INDEX 1	5	85.1	68.4	8.7	34.5
INDEX 2	39.1	2.2	13.4	4.47	20.4
INDEX 3	11.9	65.6	102.1	39.2	109.8
INDEX 4	17.5	27.8	110.7	45.7	109.1
INDEX 5	106.3	116.4	135	88	48
INDEX 6	7.9	2.4	36	26	43.8
INDEX 7	0.3	17	31	17.3	31
INDEX 8	11	41	41	11.1	41
INDEX 9	30.6	54	54	47.3	54

IV. CONCLUSION

According to the results and discussion, the system can detect the human hand gesture which are alphabet of A,B,C,D,and E. The system then sends the data code to the door lock

ACKNOWLEDGMENT

The authors thank the University of Sriwijaya, Department of Computer Engineering for The Competitive Grant No.0662/UN9.1.9/KP/2014, and also for Research members of Lab. Automation Industry, for their support of our research

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