Fingerprint Identification Using the Hybrid Thresholding and Edge detection for the Room Security

Sumijan Sumijan, Syafri Arlis, Pradani Ayu Widya Purnama

Universitas Putra Indonesia YPTK, Padang, Indonesia

Abstract – **Biometric technology is an electronic device that scans body parts for security systems using passwords, thus making the biometric system a better choice of a secret room security system. This study combines the hybrid thresholding method and Edge detection to identify fingerprint self-image, to determine the level of similarity of fingerprint images in the database with the fingerprint image of the test. Hybrid thresholding Laplacian of Gaussian and Otsu to get the result of separation between background and object, to identify the fingerprint canny method, the percentage of fingerprint identification results of an average similarity level: 87.94%. The calculation results show a very high degree of accuracy.**

Keywords – **Fingerprints, Secret rooms, Laplacian of Gaussian and Otsu, Canny, Identification.**

1. Introduction

Image processing is an information technology whose orientation is to improve the used images regarding their quality and identity of an image so that it becomes better, and these images can be identified as objects. Image processing can use certain techniques and is easier for computers to interpret. Current image processing technology has been automated, one of which is to identify and verify identity using biometric features [1], [2].

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One part of biometrics is fingerprints. Fingerprints are lines in the skin of a person's fingertips, in identification we use finger's biometrics, and they have been used in America by E. Henry in 1902. The system discovered by Henry uses a ridge pattern, especially the index finger, the back of the groove on the skin centered on the finger pattern. In general, physical characteristics that is widely used as a basis for identification of a person is the geometry of the hand, because the characteristics are different in each person and will not change (stable) often with age. Hand geometry provides a wider area compared to fingerprints, so that more unique features can be generated to improve the performance of recognition systems [3], [4], [5].

Biometrics is a method used to recognize human identity based on one or more unique physical features or unique behavior. The reason for using biometrics has to do with the limitations of humans verifying based on objects. This biometric technology uses one part of the human body that has characteristics (unique) and remains like fingerprints, eyes and face. Types of biometric systems are fingerprint recognition; face recognition, eye recognition, palm recognition, and voice recognition. One of the modern edge detection algorithms is edge detection using the canny method. Canny edge detection was found by Marr and Hildreth who examined the modeling of human visual perception. There are several criterion for the canny method, namely detecting it well, localizing it well, clear responses. Laplacian of Gaussian is one of the edge detection operators developed from the second derivative [3]. Thresholding can use the Otsu method; the Otsu method is very good for getting good threshold values. [6], so that the merger between Laplacian of Gaussian and Otsu can add accuracy to determine image identification [2],[7].

Image is another term for image as one of the multimedia components that plays a very important role as a form of visual information. The image has characteristics that are not owned by text data, namely the image is rich with information. Literally, an image is an image in a two-dimensional (two-dimensional) plane. From a mathematical point of

view, image is a continuous function of the intensity of light in the aerospace field [8]. There are three types of images that are commonly used in image processing. First, the color image is each scale on a color image representing the color which is a combination of three basic colors (RGB = Red Green Blue). Grayscale images are digital images that have only one channel value per pixel. In other words, the value of the RGB part with the color that is owned is black, gray, and white. Binary imagery is an image where each pixel is only represented by a value, namely zero or one [9], [10].

2. Material and Method

The image acquisition process is carried out perpendicular to the object using a Logitech c920 camera with a resolution of 480x640 pixels. The camera is mounted on a closed system under stable conditions with lighting using a 3watt LED light. The system is made closed so that the lighting when shooting can be stable, and not affected by outside lighting. The camera will take the image perpendicular to the object and will be stored on a Personal Computer (PC) [11],[12]. The distance between the camera and the object in the image acquisition process is 30 cm. The image acquisition process is carried out on 3 people using the left hand, with each person taken 1 hand image for the database and 1 hand image for the test data. During the image acquisition process, the position of the hand has to be straight and slightly tenuous and the position of the middle finger has to be right in the middle because it will be used as a reference point during the tracking process, see Fig. 1.
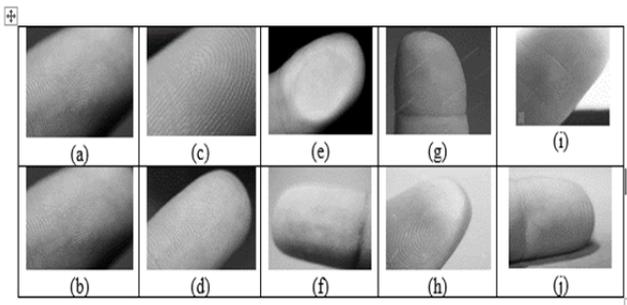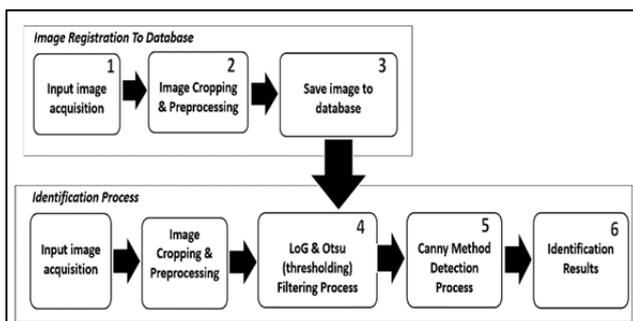

Figure 1. Input Image 10 different Fingerprints

Figure 2. Stage of process in the research

Pre - processing

Pre-processing is a supporting stage of this research. This stage functions to process the input image before the segmentation process is carried out. The image produced in this stage is very crucial in determining the final image quality produced. Cropping process aims to eliminate unnecessary noise outside the research object, determine the image of the research object to be analyzed and processed, and reduce the size of the original brain image so that it can be easily processed and analyzed [13],[14].

Database Registration Process

The registration process is the most important process in an identification system. In this process the image processing result data will be stored in a database which will then be used as a reference in the identification process. This database will be called back during the matching process in the identification process, because it is used as a comparison to determine the identity of the object. In this registration process there are three stages, namely: (1) Image Acquisition of Inputs, (2) Image Cropping and Pre-processing, and (3) Storage to Database. Image processing performed in the registration process is the same as image processing performed in the identification system. The first thing done in image processing is to convert from grayscale images to binary images. Image conversion is done to separate the area of the hand from the background, as well as unnecessary areas. Binary process is the process of converting from an RGB image into a binary image (0 and 1) using a threshold value that is done by trial and error [15],[16],[17].

Fingerprint Identification Process

In the registration process, in addition to acquiring input images, Image cropping also applies filtering using the LoG and Otsu methods to separate objects and non-objects, so the identification process can be carried out. In the identification process there are 5 stages, namely: (1) Image Acquisition of Inputs, (2) Image Cropping and Pre-processing, (3) Filtering process using LoG and Otsu methods, (4) Detection process with the canny method, and (5) Identification Results. The initial segmentation process is then used to perform the edge detection process. Edge detection has the aim to increase the appearance of edges or a boundary of an object. This edge detection process uses a second derivative operator (Laplacian). This edge image has to be processed further to produce more useful information that can be used in detecting a form. One of the advanced processes of edge detection that can provide information is to use

contour extraction. Contour is a series of edge pixels that make up the region boundary. The representation of the contour can be in the form of an edge list or in a curve. Matching processes for identification systems use Euclidean Distance. Euclidean distance is a matching process by calculating the closest distance between input feature vectors and database feature vectors [3], [18].

Filtering and Determining Fingerprint threshold

The next stage is to determine the best threshold. This threshold serves to identify the boundary line (boundary) of an object contained in the image. In this study, determining the threshold used is the second derivative operator (Laplacian of Gaussian) which can determine the threshold more accurately, especially on steep objects because it has zero crossing. Laplacian of Gaussian is formed from the Gaussian process which serves to reduce noise, and it is followed by Laplace operations that function to minimize the possibility of edge detection errors. The Laplacian of Gaussian operator in a 3x3 matrix for 4-neighborhoods and 8-neighborhoods is defined as follows,

$$h = \begin{matrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{matrix} \qquad (1)$$

$$h = \begin{matrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{matrix} \qquad (2)$$

In the Canny method, each pixel in the smoothed image J (i, j), the gradient Jx and Jy is calculated. Then we estimate the edge strength using the following formula:

$$es_{i,j} = J2 \\ x_{i,j} + J2 \\ y_{i,j} \qquad (3)$$

Next estimate the direction of the normal edge vector with:

$$eo_{i,j} = arctan \\ Jx \\ Jy \qquad (4)$$

The output is in the form of an image of strengthening the ice is formed from:

Es (i, j) and the direction image Eo (i, j).   (5)

Otsu method published by Nobuyuki Otsu in 1979 [10]. This method determines the threshold value by differentiating the two groups, objects and backgrounds, which has a part overlapping, based on the histogram (see Figure 3.)
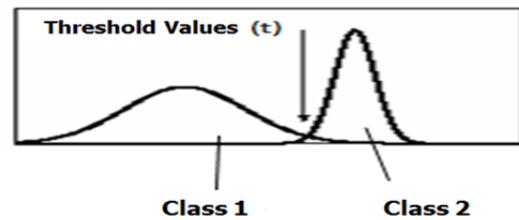

Figure 3. Determination Threshold Value To Obtain Optimal Results [16]

The principle of Otsu method is described below. First of all, the probability of the value of the intensity i in the histogram calculated by the following formula:

$$p(i) = \frac{ni}{N}, \; p(i) \geq 0, \sum_{1}^{256} p(i) = 1 \qquad (6)$$

In this research an identification system has been made by using finger biometrics. The design of this system consists of the process of image acquisition, then the results of the image segmentation process, the process of matching training data with test data and identification results based on finger biometrics.

Figure 4. Thresholding Results Laplacian of Gaussian & Otsu methods

Fingerprint Edge Detection using the Canny Method

Identification system when using detection use the canny method which can identify a person based on finger biometrics. The testing process is done with several images with different cameras and with different methods. It is like using a cellphone camera with different brands of pixel differences on the camera.

Figure 5. Results Identification of the canny method

3. Result and Discussion

After the image acquisition process is carried out, the position of the acquired hand image has to be rotated first by 180˚ so that it faces downward. Image conversion is done to divide the hand image into several areas of the object or to separate the object from its background. The process of image conversion begins with changing the RGB image (Red, Green, and Blue) to an image with a greyscale (greyscale). In this method, segmentation begins with determining the threshold value first. This threshold value is obtained by means of error and error. From the experimental results or trial and error, it is found that the appropriate threshold value for segmentation is 150. After going through the segmentation process using thresholding, the image results from the segmentation process have not produced a perfect value. The desired result in this segmentation process is the number 0 or black on the object, and number 1 or white in the background, but from the results of segmentation in the background area there are still small gaps or holes in black. In other words there is still noise in the image, so the operation Laplacian of Gaussian and Otsu are to improve image results.

Algorithm: Calculates the number of white pixels of the reference and process images
% Calculate Number of Reference Image Pixels
1. Start
2. Calculate the image size Temp [m, n, o] = size (temp)
3. Set count = 0
4. Check the line of each object to m,
5. Check the column of each object to n,
6. If temp (column, row) = 1
      Count = count + 1
      If not, repeat step 5
7. Check the line of each object to n,
10. Check the column of each object to m,
11. Check the number of pixel reference = count
13. Show final result (pixel reference)
% Calculate the Number of Image Pixels to Be Processed
14. Calculate the size of the processed image [m, n, o] = size (d)
15. Set count = 0
16. Check the line of each object to m,
17. Check the columns of each object to n,
18. If temp (column, row) = 1
        Count = count + 1
        If not, repeat step 17
19. Check the line of each object to n,
20. Check the column of each object to m,
21. Check the number of pixel process = count
23. Show final results (pixel process)
24. Finish

Table 1. Test Image Test Results, Database Image and Identification Results

No. Image	Test Image (Pixel)	Database Image (Pixel)	Accuracy (%)	Errors (%)	Identification Results
1	620	610	98.39	1.61	matching
2	584	460	78.77	21.23	matching
3	663	568	85.67	14.33	matching
4	640	632	98.75	1.25	matching
5	700	512	73.14	26.86	not matching
6	255	245	96.08	3.92	matching
7	640	562	87.81	12.19	matching
8	620	442	71.29	28.71	not matching
9	750	715	95.33	4.67	matching
10	800	753	94.13	5.88	matching
Rata-rata			87.94%		

Table 1. The created algorithm calculates the number of white pixels of the reference and process images can identify fingerprints in the database compared to the results of scanning with segmentation methods and count the number of pixels of the image between the database image and the image of the scanning result. The minimum number of pixels for fingerprint images in the database is 245 pixels, while the maximum number of pixels is 753 pixels. For fingerprint test images the minimum pixel count is 255 pixels and the maximum pixel count is 800 pixels. Percentage of fingerprint identification results of an average similarity level: 87.94%, the results of this study indicate a very high degree of accuracy. From the results of 10 test images, 8 were identified and 2 were not identified according to the results of the calculations produced in Table 4.1, so this study produced a fingerprint identification process with an accuracy level of: 8: 2 * 100 = 80%.

Figure 6. Test Image Test Results, Database Image and Identification Results

Figure 5 and Table 1 shows the process of calculating the number of white pixels, so we will get the number of white pixels. If the number of white pixels of the image, which is to be processed, is more than the number of white pixels of the reference image, the cell is said to be incompatible. If the number of white pixels of the image that isto be processed, is the same as the number of white pixels of the reference image, then the fingerprint is matched (identified).

4. Conclusion

From the results of the identification of fingerprints that have been carried out by pixel results from the process of Laplacian of Gaussian and Otsu methods and the resulting Canny method is used to measure the degree of similarity of fingerprint images by comparing the fingerprints of test images and database images. The Laplacian of Gaussian and Otsu methods are used to determine thresholding and the canny method used to detect edges. The results of research calculations produce an average value of 87.94%. The Laplacian of Gaussian and Otsu methods combined with the Canny method get an 80% accuracy rate using 10 fingerprint test images, 8 identified and 2 unidentified.

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