Enhancement The Dry Fingerprint Image

Abdelwahed Motwakel1)  Rahmat Syam2)  Mochamad Hariadi3)
1) Department of Computer Science, Faculty of Science and Technology
Omdurman Islamic University Khartoum Sudan 384, email: motwakel@elect-eng.its.ac.id
2) Department of Mathematic, UNM Makassar Indonesia 90200, email: rahmatsyam@elect-eng.its.ac.id
3) Department of Electrical Engineering, ITS Surabaya Indonesia 60111, email: mochar@ee.its.ac.id

Abstract— The quality of the fingerprint images greatly affects the performance of the minutiae extraction. Dry fingerprint images are poor quality, which his ridges are scratchy locally and there are many white pixels in the ridges. In order to improve the quality of the fingerprint image, many researchers have been made efforts on the image enhancement algorithms. If the preprocessing is applied for the dry fingerprint image enhancement step, the quality gets would be more robust. In this paper, used the preprocessing method improve image quality appropriately, by applies several steps on the dry fingerprint image, smoothing, skeltonization, dilation, and the union of black pixels in the original image and dilated image. Experimental results indicate that the preprocessing method improves the quality of the dry fingerprint images significantly.

Keywords—Biometrics; fingerprint identification; fingerprint image quality; Image enhancement;

I. INTRODUCTION

Fingerprint identification is one of the most popular biometric technologies which 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 images[1]. Acquisition of good quality images is very important, but due to some environment factors or user’s body condition, a significant percentage of acquired images is of poor quality in practice [2]. From the poor quality images many spurious minutiae may be created and many genuine minutiae may be ignored. Therefore an image enhancement algorithm is necessary to increase the performance of the minutiae extraction algorithm.

Many researchers have been making efforts in the investigation of fingerprint image quality, most of the quality checks have been used as a criterion, which determines image rejection, or a performance measurement of image enhancement algorithm. In this case, only images are filtered uniformly. If the proposed method is performed through the dry fingerprint images, images can be enhanced more effectively.

This paper used the preprocessing method to improve quality appropriately. The preprocessing is performed for dry fingerprint image, which it has broken ridges and there are many white pixels in the ridges. We applied the preprocessing method to produce good quality images on private database collected with careful consideration image quality from ITS – Electrical Engineering Department. Which it called DB_ITS_2009.

II. FINGERPRINT IMAGE

Fingerprints have been used for over a century and are the most widely used form of biometric identification. Fingerprint identification is commonly employed in forensic science to support criminal investigations, and in biometric systems such as civilian and commercial identification devices.

The fingerprint of an individual is unique and remains unchanged over a lifetime. A fingerprint is formed from an impression of the pattern of ridges on a finger. A ridge is defined as a single curved segment, and a valley is the region between two adjacent ridges [4]. The minutiae, which are the local discontinuities in the ridge flow pattern, provide the features that are used for identification [6].

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. 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.

B. Ridges of fingerprint image

Fingerprint representation relies on ridges structure which it referred to as minutiae, which is ridge ending and ridge bifurcations; provide the details of the ridges and valley structures [6]. Where Ridge endings are the points where the ridge curve terminates, and bifurcations are the ridge splits from a single path to two paths at a Y-junction. Figure 4. Shown the fingerprint minutiae or ridges.

C. Dry fingerprint image

Fingerprints are the marks left behind when someone touches an object with their fingerer [4]. And there are three types of fingerprints that can be left behind.

- An impression left in something soft such as butter, putter, putty, soap or wet paint.
- A print left by a finger that is covered in something that is left behind such as dirt, blood, paint or ink.
- An invisible deposit left by secretions from the skin. Everyone's fingers have small amounts of oil and perspiration which come out of microscopic pores on the tiny ridges of the fingerprints. These secretions also come out of different parts of the body too.

Condition of skin greatly effective on fingerprint, such as dry skin tends to case inconsistent contact of the finger ridges with the scanner's platen surface, causing broken ridges and there are many white pixels replacing ridge structure.

D. Enhancement fingerprint image

Fingerprint images are rarely of perfect quality. They may be degraded and corrupted with elements of noise due to many factors including variations in skin and impression conditions. This degradation can result in a
significant number of spurious minutiae being created and genuine minutiae being ignored.

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. Figure 1 and 4 shows neutral/dry images, respectively.

- Neutral image: in general, it has no special properties such as dry. It does not have to be filtered.
- Dry image: The ridges are scratchy locally and there are many white pixels in the ridges.

To solve such problems, propose preprocessing method that is suitable for dry fingerprint, and provides sufficiently high identification accuracy. The propose method enhances dry fingerprints by extracts center lines of ridges and removes white pixels in ridges and maintains the structure of the fingerprint.

E. 2D - Wavelet Transform

The wavelet transform in particular has proven to be an effective tool for e.g. image processing and numerical analysis. Problems from these areas are typically large and the wavelet transforms can be very time-consuming although the algorithmic complexity is proportional to the problem size [16]. And Progressive transmission of an image can benefit from a 2D wavelet transform.

The wavelet process is conceptually really simple. Given an image, we will create 4 new sub-images to replace it. To create these four sub-images, we break the original image into 4 pixel blocks, 2 pixels to a side. If the original image has size \(2^n \times 2^n\), we should have \(2^{n-2}\) blocks. Now for each block, the top-right pixel will go directly into the top-right sub image. The bottom-left pixel goes directly into the bottom-left sub image. And the bottom-right pixel goes into the bottom-right sub image. So these 3 sub images will look like a coarse version of the original, containing 1/4 of the original pixels. Figure 5 shown the wavelet decomposition for fingerprint image.

The 2D-Wavelet Transform used to decomposition the fingerprint image into four decomposition, when the original image size is (208x154) and the first decomposition is (104 x 78), the second decomposition is (52 x 39), the third decomposition is (26 x 20), and the fourth decomposition is (13 x 10).

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 [13], [14].

III. PROPOSED METHOD

![Figure 6. System overview](image)

Figure 5 wavelet Decomposition

Figure 6. System overview
Figure 6 shows the whole method proposed in this paper. Image is enhanced by extracting their center lines and removing white noises using the center line image. By done the steps in figure 6, which is smoothing, skeletons, dilated and extracting the union of black pixels in an original image and the image after dilation, in this way ridge-enhanced image is obtained.

The first step as shown in Figure 7. Smoothing which is the conventional filtering method it remove the white pixels of ridges and also removes necessary ridges that are thinner than neighbor ridges.

Then, the skeleton image is obtained by applying Zhang and Suen skeletonizing algorithm to the filtered image. As shown in figure 8, the original image and the thinning image.

By dilating the thinning image, the center line image is made. Then by extracting the union of black pixels in the original image and the center line image, white pixels in the ridges are removed. In this way, the ridge-enhanced image is obtained, and maintaining the structure of ridges. As shown in figure 9. the steps of enhance image.

A. Smoothing: smoothing is one of the conventional filtering methods; it can remove the white pixels of ridges in dry fingerprint images and applied to the original image.
B. Thinning: Thinning is defined as process of reducing the width of pattern to just a single pixel. a thinned image is obtained for extraction of ridge structures.
C. Dilation: Dilation is the operation that "grows" or "thickens" image which the image is binary.
D. Extracting the union of black pixels in an original image and the image in C: white pixels in the ridges are removed. In this way, the ridge-enhanced image is obtained [4].

IV. EXPERIMENTAL RESULTS

The result at various stages of image enhancement is shown in figure 10. The enhanced image has fewer white pixels in ridges than the original image and ridges connect smoothly.

The proposed method is verified with private fingerprint database (called DB_ITS_2009) collected with the careful consideration image quality in the Electrical Engineering Department of Institute Technology Sepuluh Nopember, Surabaya. Database DB_ITS_2009 consists of 800 fingerprint images (image size is 208 x154) 100 of the finger. Each finger has 8 expression /position. And the images are gray-scale image.

To estimate the effectiveness of the proposed method used the learning vector quantization (LVQ) which it determine the image quality of the preprocessing method is more better, when the percentage of non identification for the enhanced images, and the original images are shown in table 1.
Table 1. Shown the non identification percentage of the original image and enhanced image according to 2D-wavlets Transform decomposition.

<table>
<thead>
<tr>
<th>Decomposition</th>
<th>Original image</th>
<th>Enhanced image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18.3%</td>
<td>13.3%</td>
</tr>
<tr>
<td>2</td>
<td>16.6%</td>
<td>11.6%</td>
</tr>
<tr>
<td>3</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>4</td>
<td>13.3%</td>
<td>8.3%</td>
</tr>
</tbody>
</table>

V. CONCLUSIONS

The performance of fingerprint identification system relies critically on the image quality. Hence, good quality images make the system performance more robust. However, it is always very difficult to obtain good quality images in practical use. To overcome this problem, image enhancement step is required.

In this paper, we have proposed image enhancement method for fingerprint identification system. The performance of the proposed method was evaluated using Learning Vector Quantization. Experimental results show that the proposed method is able to improve the images quality four times than original one.

VI. REFERENCES


[4]. Eun-Kyung Yun, Jin-Hyuk Hong and Sung-Bae Cho, Adaptive fingerprint image enhancement with fingerprint image quality analysis, Department of Computer Science, Biometrics Engineering Research Centre, Yonsei University, 134 Shinchon-dong, Sudaemoon-ku, Seoul 120-749, South Korea.

[6]. Raymond Thai, Fingerprint Image Enhancement and Minutiae Extraction, University of Western Australia, 2003.


