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Fingerprint Matching Using Two Methods

Mrs. Hemlata Patel*, Pallavi Asrodia**
*(Computer Science & Engineering Department 'Jawaharlal Institute of Technology Borawan, Khargone, India)
** (Computer Science & Engineering Department, Jawaharlal Institute of Technology Borawan, Khargone, India)

ABSTRACT
In recent years, fingerprint recognition technique is the dominant technology in the biometric market. A number of recognition methods have been used to perform fingerprint matching. The Straightforward matching between the fingerprint pattern to be identified and many already known patterns would not serve well due to its high sensitivity to errors (e.g. various noises, damaged fingerprint areas, or the finger being placed in different areas of fingerprint scanner window and with different orientation angles, finger deformation during the scanning procedure etc.).In this paper, we proposed effective fingerprint matching based on two methods I. e. method 1(pattern-based), Method 2(minutia-based). This paper presents extra patterns and features of fingerprint and show the matching between two fingerprints

Keywords-**fingerprint matching; pattern-based method; minutiae-based method;**

I. INTRODUCTION

In an increasingly digital world, reliable personal authentication has become an important human computer interface activity. Fingerprint recognition is a complex pattern recognition problem. It is difficult to design accurate algorithms capable of extracting salient features and matching them in a robust way, especially in poor quality fingerprint images and when low-cost acquisition devices with small area are adopted. There is a popular misconception that automatic fingerprint recognition is a fully solved problem since it was one of the first applications of machine pattern recognition. On the contrary, fingerprint recognition is still a challenging and important pattern recognition problem.The patterns, which are aggregate characteristics of ridges, and minutia points, which are unique features found within the patterns. There are several methods of pattern recognition [1].

This paper provides extra patterns and based on those pattern minutiae features are calculated and show matching between fingerprints. Minutiae-based systems generally rely on finding correspondences between the minutia points present in "first" and "copy of first" fingerprint images. These systems normally perform well with high quality fingerprint images and a sufficient fingerprint surface area. This effect is even more marked on intrinsically poor quality fingers, where only a subset of the minutiae can be extracted and used with sufficient reliability.

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II. RELATED WORK

Biometrics is an automated method that recognizes people based on their physical and action characteristics, and is a field that used to authenticate a certain individual's characteristics, recognize a person's character, or study a person's measurable characteristics [2, 3]. Among the different biometrics, like face, hand, iris, voice and many others, fingerprints is the most dominant biometric technology in commercial applications due to their distinctiveness, persistence, accuracy, throughput, size and cost of readers.[4.]

Fingerprint–based identification is popular for individual identification because it will not change by age. It is unique to individuals and with the new technologies it is easy and low cost to implement [5, 6, 7, 8, and 9]

Human fingerprints have been discovered on a large number of archaeological artifacts and historical items in 1684, the English plant morphologist, Nehemiah Grew, published the first scientific paper reporting his systematic study on the ridge, furrow, and pore structure. In 1788, a detailed description of the anatomical formations of fingerprints was made by Mayer. In 1823, Purkinji proposed the first fingerprint classification, which classified into nine categories [10]

People have unique fingerprints that do not change, and fingerprints consist of ridge and furrow parts of a finger's surface. Fingerprints can be categorized according to many key patterns that include loops, whirl pools and arches [11, 12].

The minutia based algorithm is widely used for fingerprint authentication. It focuses on the endings of ridges and bifurcations. Consequently the central area in fingerprint image is very important and this algorithm keenly relies on the quality of the input images [5, 6].

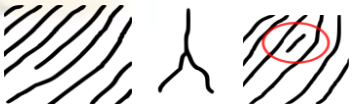

Figure 1: Example of ridge ending, bifurcation, short ridge

The published approaches define the few patterns for fingerprint matching [13]. Our work presented the core and delta points on the different patterns and find the minutiae points. This paper describes an extra feature short ridge.

III. UNIQUE FEATURES OF FINGERPRINT

There are a number of different strategies through which fingerprint identification can be done, among which verification through minutia points is the most simple and easy[13][14].

According to the current most widely used Galton -Henry system, the fingerprint is divided into five classifications [13] [14]:

- Arch: Fingerprint lines start from side of the finger and end at the other side, do not return and on the core points and delta point.
- Tented Arch: Like an arch fingerprint, but graphic Centre upward rise in the vertical direction, equivalent to a core and a delta on the same vertical line.
- Left Loop: Circular pattern that is fingerprint lines access from one direction then back from the same direction after a rotation around. To the left is Left Loop. There is a core and a delta at the lower left.
- Right Loop: To the right is Right Loop. There is a Core and a delta at the lower right.
- Whorl: At least one fingerprint stripe rotate into a closed curve around the centre, there are two core points in centre, a triangular point on each side when the cores are not in the same vertical line, here will form a double helix.

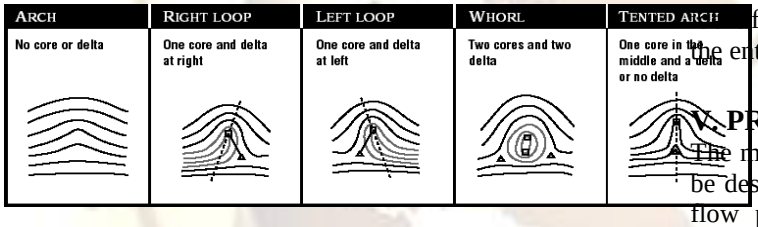

Figure 2: Example of fingerprint pattern.

The second set of features of a fingerprint is cores and deltas. The core is located by a square while the delta is located by a triangle as shown below diagram.

Core & Delta

Minutiae

IV. FINGERPRINT RECOGNITION SYSTEM

Fingerprint identification is perhaps the oldest of all the biometric techniques. Fingerprints have a long history of use in police forensic science. Because of this, the authentication by fingerprint is the most convenient biometric element to identify a person. A large variety of solutions are already available and the technology is mature. Fingerprint technology can be used to authenticate a person versus a pin code when entered for an ATM/online debit transaction or a signature for a credit card transaction.

A verification system authenticates a person's identity by comparing the captured biometric characteristic with her own biometric template pre-stored in the system. An identification system recognizes an individual by searching the entire template database for a match.

V. PROPOSED WORK

The main features of our approach for feature extraction can be described as followed. We view a fingerprint image as a flow pattern with a definite texture The SDK must be capable of processing fingerprint images supplied to the SDK in uncompressed raw 8-bit (one byte per pixel) greyscale format. Each image shall appear to have been captured in an upright position and approximately centred horizontally in the field of view. The image data shall appear to be the result of a scanning of a conventional inked impression of a fingerprint. Figure 1 illustrates the recording order for the scanned image. The origin is the upper left corner of the image. The x-coordinate (horizontal) position shall increase positively from the origin to the right side of the image. The y-coordinate (vertical) position shall increase positively from the origin to the bottom of the image.

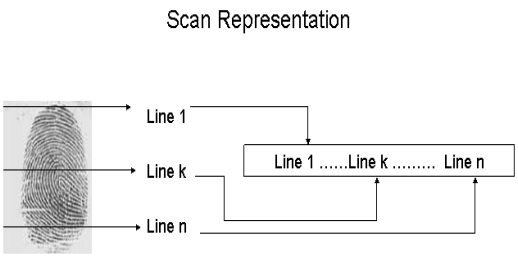

Figure 3. Order of scanned lines

P8	P7	P6
P1	P0	P5
P2	P3	P4

Raw 8-bit greyscale images are canonically encoded. The minimum value that will be assigned to a "black" pixel is zero. The maximum value that will be assigned to a "white" pixel is 255. Intermediate gray levels will have assigned values of 1- 254. The pixels are stored left to right, top to bottom, with one 8-bit byte per pixel. The number of bytes in an image is equal to its height multiplied by its width as measured in pixels; there is no header. The image height and width in pixels will be supplied to the SDK as supplemental information.

Stages involved in Fingerprint Recognition:
The stages involved in fingerprint recognition are
Pre-processing:
(i) Histogram Equalization: To increase the contrast of the captured image histogram equalization is necessary. The histogram of a digital image with gray levels in the range (0, L-1) is a discrete function defined by

$$P(rk) = nk/n$$

Where,
Rk- Kth gray level
Nk- no. of pixels

(ii) Lowpass Filtering: To smooth the high frequency regions of the print low pass filtering is necessary. For this purpose *Weiner Lowpass Filtering* is used.

(iii) Binarization: Binarization is the process in which the gray scale image is converted into a binary image by thresholding and is defined as

$$\text{Binarized pixel value} = \begin{cases} 1 & \text{if pixel value} > \text{mean} \\ 0 & \text{otherwise} \end{cases}$$

Where, mean (μmn) is defined by
Where, μmn - mean of region (m x n) th sub-image
A, B - size of sub image
Gs (i, j) - original image

(iv) Thinning: To reduce the complexity in processing the binarized image, thinning is performed. It is a process of reducing the width of the ridges in the fingerprint image to one pixel wide (skeleton image) by morphological thinning Operation- Hilditch algorithm can be used.
-Based on spatial domain method, consider each pixel with its neighbors.
-By using some thinning rules, we can generate a one pixel wide skeleton image.

Post-processing:

Connectivity: To make the thinned image as a perfect single pixel width image with continuity in the ridge flow connectivity is performed. (i.e.) refining the skeleton, transforming the skeleton into a state from which valid minutia information can be extracted. Based on some neighborhood technique to remove any undesirable artifacts. Consider a 3 X 3 sub-image from thinned image with center pixel as the region of interest, the following operation is performed.

If p0 & p6 =1 then make p7 & p5=0
If p0 & p8 =1 then make p7 & p1=0

Feature Extraction: Extracting the minutiae - end points and branch points from the skelitonized image and storing it in a separate template for matching.

End point extraction: If the pixel considered has only one neighbor –considered as end point and stored in a template.
Branch point extraction: If the pixel considered has exact three neighbors' – considered as branch point and stored in the separate template.

● **Filtering:** Invalid end points, branch points and pores are removed from the templates by comparing it with the original image. Thus reducing the error rate.

VI. FINGERPRINT MATCHING

Fingerprint matching is the process used to determine whether two sets of fingerprint come from the same finger. One fingerprint is stored into the database and other is employee's current fingerprint.
Minutiae point refers to the topical characteristic at the end point of the ridge part. The best way to compare fingerprints is to compare all visual information on the fingerprints. However, this is realistically impossible. Comparing all visual information requires too much data, and this is inappropriate to making a commercialized system. Actual commercialized systems do not store the fingerprint itself, but characteristics of the fingerprints, and codes related to the position of these points of characteristics. Since only characteristics are stored, they cannot be revived as fingerprint visuals, and therefore cannot be used as evidence in legal facilities [2]

Figure 7: fingerprint matching

VII. CONCLUSIONS

In this paper, we have proposed a reliable method for feature extraction from fingerprint images. The flow direction of the ridges is computed viewing the fingerprint image as a texture image. The main contribution of the of this paper are (i) extra types of pattern (ii) finding minutiae points(iii) fingerprint verification (iv) fingerprint matching. The input image quality did not affect the performance of our technique.

In the preprocessing, the original fingerprint image is converted into the gray scale image and after that it is converted into the binary image.

In the post processing, make the thinned image as a perfect single pixel width image with continuity in the ridge flow connectivity is performed. (i.e.) refining the skeleton, transforming the skeleton into a state from which valid minutia information can be extracted. Based on some neighborhood technique to remove any undesirable artifacts. We are currently in the process of running the feature extraction algorithm (minex complaint algorithm). In order for the proposed method to be acceptable for the commercial use, the execution time of the algorithm must be substantially reduced and the accuracy will be improved.

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