International Journal of Engineering Research & Technology (IJERT)
NCAEM-2013 Conference Proceedings
ISBN: 978-93-83758-09-8

Fingerprint Recognition Using Minutiae Feature Points Matching

[1]Kamiya Guglani, [2]Priya Dhingra
[1,2] Mtech Scholar, Geeta Engineering college, Naultha(Panipat)

[1]guglani.kamya@gmail.com,[2] pdpriya9@gmail.com

ABSTRACT— Fingerprints are the most widely used biometric feature for identification and verification in the field of biometrics. This paper implements an algorithm for minutiae extraction based on tracing the thin ridge line, expressing the type of current point and the states of its 8-neighborhood pixels by 8-neighbour coding, which can effectively extract ridge endings and ridge bifurcations in thinned fingerprint image. The experimental results show that the algorithm can not only improve the speed of feature extraction, but also accurately eliminate pseudo minutiae, so the follow-up time of the image processing is shortened, and it can satisfy the need in the practical application.

Keywords-fingerprint identification, CN value, feature extraction, minutiae.

I. INTRODUCTION

Fingerprint identification system has been widely used in many kinds of fields such as public security, enterprise, bank and so on. And the correctness of the feature extraction directly affects the reliability of the system. The principle of automatic fingerprint identification system is shown in figure 1. The process of fingerprint identification system mainly includes the following steps: the first step is the fingerprint acquisition, collecting fingerprints using the acquisition device and converting them to images; The second step is the fingerprint image preprocessing, pre-treating the original fingerprint image, which can reduce noise, and make the fingerprint image become a clear point-line chart, in order to lay the foundation for the fingerprint feature extraction followed. The third step is the extraction of feature points, which is mainly based on fingerprint form and minutiae feature. The final step is the feature points matching, comparing the input fingerprint with the template fingerprint, and judging whether they are the same. The accuracy of feature point extraction, that plays an important role in the fingerprint identification system, directly affects the precision of the result of fingerprint matching. This paper focuses on how to correctly extract fingerprint feature points.

II. FEATURES OF FINGERPRINTS

A fingerprint is comprised of ridges and valleys, the ridges are the dark area of the fingerprint and valleys are the white area that exists between the ridges. Feature selection is one of the most important problem in the pattern recognition system, and the feature is the only data which can reflect the nature of the input object, so the difference of feature not only affects the extraction process, but also directly influences the design and performance of classifier. In order to extend its application in personal identification system, the fingerprint should have the following properties:

1)Fingerprint should be unique;
2)Matching is simple and easy to carry out;

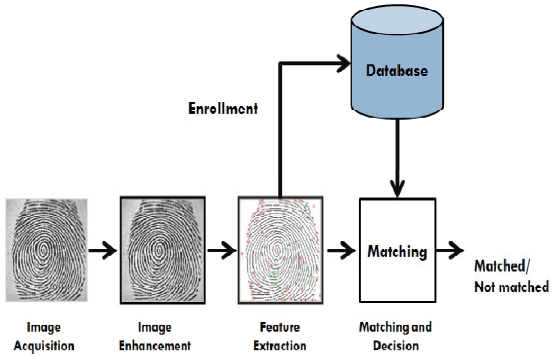


Figure-1: Functional block diagram of automatic fingerprint identification system

3)Fingerprint must have the stability, on which rotation, nonlinear distortion and transition only have small effects;
4) Fingerprint must be robust. Its robustness is mainly against the noise, and can distinguish incomplete fingerprint.

ISBN: 978-93-83758-09-8

The fingerprint is commonly described by grain structure feature, according to the range of description, which can be classified as global feature and local feature.

(1) Global feature: it describes the grain structure feature in the fingerprint global scope, and is also known as Henry feature.

(2) Local feature: each line of the fingerprint not only has the beginning and the end, but also has the junction and the bifurcation point. These four kinds of points are usually referred to as Galton feature points.

The extraction of the fingerprint features generally means extracting the local features in the fingerprint images, or minutiae features.

I. MINUTIAE OF FINGERPRINTS

A. The classification of fingerprint minutiae

The fingerprint minutiae belong to local features, which primarily refers to the ridge endings and the ridge bifurcations, as shown in figure 2. The ridge ending is where the ridge comes to a sudden end, and the ridge bifurcation is where the ridge is splitted into two. Previous studies have concluded that these two kinds of minutiae are enough to illustrate the uniqueness of the fingerprint.

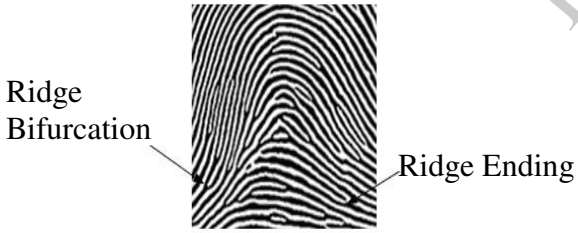


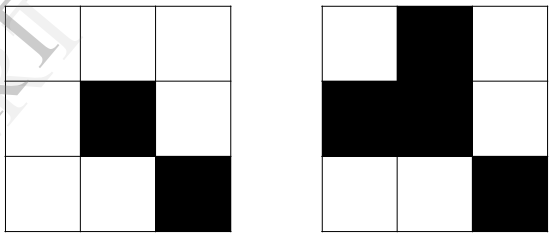
Figure-2: The diagram of fingerprint minutiae

The performance of automatic fingerprint identification system depends greatly on the accuracy of the feature extraction. The feature points in the fingerprint image belong to ridge endings or ridge bifurcations that can be calculated and judged by feature extraction algorithm.

B. The characteristics of the fingerprint minutiae

The extraction of fingerprint minutiae features is an important step in automatic fingerprint identification system. The ridge endings and ridge bifurcations of fingerprint features are commonly used in the process of minutiae extraction. In the thinning image, if "1" is used to represent the ridge points, correspondingly,"0" is used to represent the other parts, then the value of feature point can be obtained by calculating crossing number (CN). The pixels of the ridge are correspondingly divided into ridge endings, ridge bifurcations and non-feature points when CN takes different values.

First, we analyze the characteristics of the two minutiae feature points before extracting features. In the 8 neighborhood pixel graph shown in figure 3, around the ridge ending, it has only one black spot in 8 adjacent domains, namely it has only one pixel whose gray value is 1, with other pixels whose gray values are 0; correspondingly, around the ridge bifurcation, it has three black spots in 8 adjacent domains, namely it has 3 pixels whose gray values are 1. In this way, when the gray values of 8 pixels vary in a certain order, may be from 1 to 0 ,or from 0 to 1, the times of variation are different. According to the above, it is known that it changes 2 times around the ridge ending, and it changes 6 times around the ridge bifurcation, these information can be as the main basis for judging and extracting fingerprint minutiae features.



(a) ridge ending (b) ridge bifurcation

Figure-3: 8 neighborhood pixel graph of minutiae feature points

II. FINGERPRINT FEATURE EXTRACTION BASED ON MINUTIAE

The algorithm of fingerprint minutiae feature extraction is as follows: First, a detection template of a 3 3 grid (shown in figure 4) will be applied to the thinned fingerprint image, by which the types and positions of fingerprint minutiae feature points will be detected. In figure 4, M is checkpoint, N1, N2,... , N8 are neighboring points nearby M, which are arranged in anti-clockwise direction, and the gray values of which are 1 or 0.

N3	N2	N1
N4	M	N8
N5	N6	N7

Figure-4: the diagram of minutiae detection template

ISBN: 978-93-83758-09-8

If the value of M equals to 1, M is one point along the fingerprint ridge. In order to judge the type of M, we need to calculate the CN value, by which we can identify whether it is ridge ending or ridge bifurcation.

(1)If its neighboring points satisfy the following formula, M is ridge ending.

Using the detection template, we can take point-by-point detection for the ridge lines in the thinned fingerprint image, then all minutiae feature points in the fingerprint image, namely the ridge ending and ridge bifurcation, can be extracted out. The extraction result of fingerprint minutiae feature is as shown in figure 5.

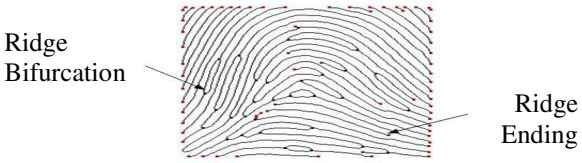


Figure-5: The extraction result of minutiae feature points

IV.FEATURE EXTRACTION POST-PROCESSING

In the process of fingerprint feature extraction, some false minutiae will inevitably creep in, therefore, it is also needed to validate whether these minutiae are true or not. When the false minutiae take a greater proportion in the minutiae, not only would the difficulty of the matching algorithm increase, but it would also have a tremendous negative impact on the accuracy of the identification results of the whole system. In order to eliminate false minutiae to the greatest extent, the fingerprint minutiae extracted must be further processed.

Considering the complexity of false minutiae, this paper will focus on three situations and make the corresponding processing.

a) Remove image edge effect

There are a lot of false minutiae feature points in the boundary of the fingerprint that is called the edge effect. In the process of eliminating the false minutiae, in order to reduce the influence of edge effect, we should try to eliminate the false minutiae in the boundary of foreground area.

b) Delete ridge breakpoints and adjacent ridge endings

The rupture often happens in the middle of continuous fingerprint ridge that is mainly caused by uneven finger pressure in the process of fingerprint acquisition, when the noise effect is great, the situation also may happen. As shown in figure 6, there are two false ridge endings, which will appear in feature extraction, and should be eliminated in some way. Because the two ridge endings are in the same part of ridge line, so they are in the same direction, and the distance between them is very short. According to these characteristics, we can assume that: if the distance between two ridge endings in the same direction is smaller than a certain threshold, the two ridge endings will be sentenced to be false minutiae.

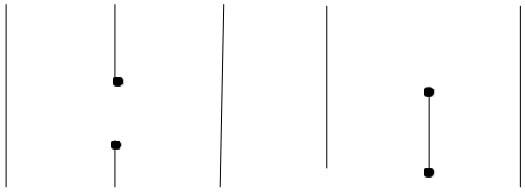


Figure-6: The diagram of false minutiae

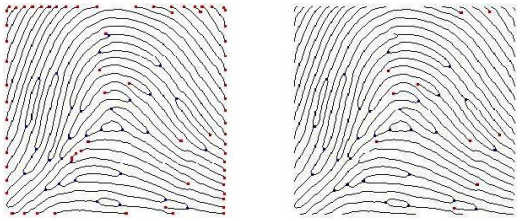
c) Delete false ridge bifurcation

The method to judge whether the ridge bifurcation is true or not is as shown in figure 7. Respectively along three ridge lines from a ridge bifurcation, if there is no other ridge ending or ridge bifurcation in the specified distance, the ridge bifurcation is identified as real ridge bifurcation. Otherwise, the ridge bifurcation will be identified as false ridge bifurcation, and needs to be eliminated.

(a) real ridge Bifurcation (b) false ridge Bifurcation

Figure-7: The diagram of real and false ridge bifurcation

In figure 8, it indicates the information of fingerprint minutiae after eliminating the false minutiae. By comparison between the two images, we can see that most of the false minutiae are eliminated after the above processing.



(a) before eliminating the false minutiae (b)after eliminating the false minutiae

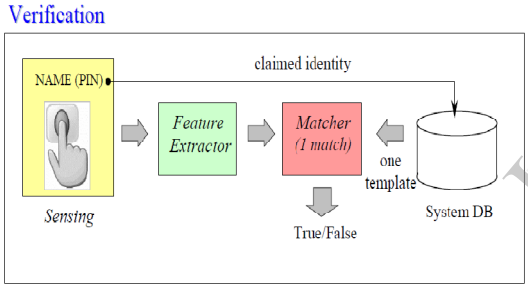
Figure-8: Comparison diagram of fingerprint minutiae

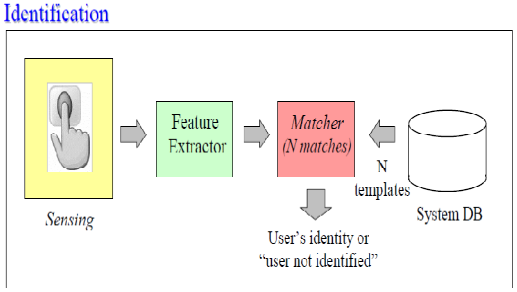
ISBN: 978-93-83758-09-8

By the processing of eliminating the false minutiae and the suppression of edge effect, most of the false minutiae are eliminated, so that the reliability of the extraction results would be further improved. It provides the necessary condition for the followed operations of fingerprint image, namely, matching and identifying.

III. FINGERPRINT RECOGNITION

Fingerprint recognition (also known as Dactyloscopy) is the process of comparing known fingerprint against another or template fingerprint to determine if the impressions are from the same finger or not. It includes two sub-domains: one is fingerprint verification and the other is fingerprint identification. Verification specify an individual fingerprint by comparing only one fingerprint template stored in the database, while identification specify comparing all the fingerprints stored in the database. Verification is one to one matching and identification is one to N (number of fingerprint templates available in database) matching. Verification is a fast process as compared to identification.





IV. CONCLUSION

This paper emphatically introduces the fingerprint feature extraction, using an algorithm for minutiae_ extraction based on tracing the thin ridge line, expressing the type of current point and the states of its 8-neighborhood pixels by 8-neighbour coding, and makes the further processing to the fingerprint minutiae extracted, namely, eliminating the false minutiae and retaining the real minutiae.

In this paper, only the minutiae feature is analyzed and discussed in the fingerprint feature extraction, but the texture feature and structural feature are not analyzed and researched. Unavoidably, while analyzing the information of fingerprint ridge line, it has a certain deviation from the actuality to describe fingerprint features using single minutiae feature. Based on such considerations, in the future, a variety of features may be combined with each other to form a whole, so that the information of fingerprint ridge line can be described more comprehensively and effectively.

REFERENCES

[1] K. Karu, A. K. Jain. Fingerprint Classification[J]. Pattern Recognition.1996,29(3).
[2] Shang Tao. Network Security System Based on Fingerprint Identification[J]. Computer Network World: No. 11, 2004.
[3] Yuan Weiqi,Bai Yun. Biological Characteristics Identification Technology[M]. Science Press, 2009.
[4] A.Senior. A Hidden Markov Model Fingerprint Classifier. Proceedings of the 31 st Asilomar conference on Signals[C]. Systems and Computers. 1996, pp.1587-1597

[5] Gu Ming. Ancient Identity Card, the Information Age Displays its Talent-a Story of "Fingerprint Identification"[J]. Computer Knowledge and Technology: Experience and Skills: No. 2, 2007
[6] Hao Junjie etc. an Improved Algorithm of Fingerprint Image Thinning and Feature Extraction [J]. Modern Computer: second edition. No. 4, 2008.
[7] Davide Maltoni, Dario Maio, A. K. Jain and Salil Prabhakar, *Handbook of Fingerprint Recognition*, Second Edition, Springer, 2009

[8] Feng XingKui etc. Direction-weighted Median Filtering Algorithm [J]. Journal of Image and Graphics: 2000, 5 (7).
[9] *L. C. Jain* et al., Intelligent Biometric Techniques in Fingerprint and Face Recognition, Boca Raton, FL: CRC Press, 1999.
[10] Xia Liangzheng. Digital Image Processing[M]. Nanjing: Southeast University Press. 1999.