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Research of Fingerprint Recognition

Chunfeng Jiang, Yulan Zhao, Wei Xu,
School of Information Engineering
Jilin Agricultural Science & Technology College
Jilin, China
llbird@126.com

Xiangping Meng
School of Electrical & Information Technology
Changchun Institute of Technology
Changchun, China

Abstract—**A new method of fingerprint recognition was proposed. After image gathered from scanner, it was enhanced and binarized, the ridges of fingerprint image were thinned, then used freeman chain code derivation to describe the extracted fingerprint ridge, matching based on fingerprint ridge contour, and this method has the translation and rotation invariance. The algorithm was programmed with C and VC++ on PC, the AFIS implemented on single-chip microcomputer.**

Keywords-fingerprint recognition; fingerprint image process; ridge contour; freeman chain code; feature matching

I. INTRODUCTION

Fingerprint recognition was the most popular areas of biology recognition. Compared with other biology recognition technology- palm prints, iris, cornea, face, voice, and DNA-fingerprint recognition was a better identification because of its universal and permanent uniqueness. Based on the fingerprint recognition technology, the AFIS could substitute conventional system based on password and certificate. Therefore, it was significant widely and deeply to study fingerprint recognition technology[1].

This paper introduced an effective fingerprint recognition algorithm composed of fingerprint image preprocessing, extraction of ridge contour and fingerprint matching. The directional graph of point was calculated by discrete direction measure during fingerprint image pretreatment[2]. Then, it used histogram to process directional graph deeply, and fingerprint image was binarized. After binarization, the fingerprint image was thinned layer by layer. In the fingerprint matching process, the freeman chain code derivation was used to expree texture and match ridge.

II. FINGERPRINT RECOGNITION ALGORITHM

This paper proposed a kind of simplified algorithm withdraws the characteristic point of the fingerprint. This text's system, the same as most others, used end point and branching point which FBI proposed to process fingerprint image[3,4]. In the extracting ridge countour, the translation and rotation invariance of freeman 8 chain code derivation avoided the interference from false characteristic points.

A. Enhancing Fingerprint Image

1) Acquisition and processing of the directional diagram

There were quite clear directivity in fingerprint image,and image intensification effect was decided directly by the accuracy of the point directional diagram. For evaluating point directional diagram, fingerprint ridge trend was divided into 8 directions. In order to reduce the impact of noise and ensure the accuracy of the evaluated direction, the image was divided into small $w \times w$ image block and computed each small piece histogram and the peak direction of histogram was the direction of the image texture. Such procedure would create the direction incoherence between the adjacent blocks. In dealing with the process of discovery, the direction of the histogram method was used as the direction of a point when used a common block approach to treat the direction maps. Thus, the retention capability of the latter binarization direction was stronger.

B. Binarization

The each pixel direction was got from above method and then the binary image was computed based on the point direction graph received. If the ridge direction of the pixels was i, we used the method of estimating point direction maps to calculate the direction i of this pixel and the mean gray at the vertical direction $iGm=(i+4) \bmod 8$. And then calculated the binary pixel as followed:

$$iGm = \begin{cases} 1 & if \quad Gmean[i] \geq Gmean[iVar] \\ 0 & otherwise \end{cases} \tag{1}$$

And iGm expressed the value of this pixel in binary images picture, 1 was the gray scale of background and valley, 0 was the grayscale of the ridge in the binary image.

C. Fingerprint image refinement

The iterative algorithm was used to refine layer of layer in this paper. The first iteration of the algorithm was to be divided into two scanning and refined from neighboring layers to the center layer of layer during the process of refinement and refinement result was put to the axis of the original image.

D. Feature extracted

This paper used derivation of Freeman 8 chain code to describe ridge and valley. The chain code of line in Fig. 1 was 123120000766543, its derivation was 111112000770777.

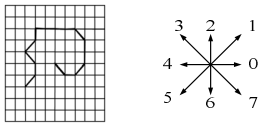

Figure 1. Line and 8 points

We used 30×30 grid to cover the fingerprint image, the contour-tracing method to extract the ridge, and the chain code derivation to represent each line with parameters starting point coordinate, terminal point coordinate, chain code length and chain code derivation. For example, the chain code of line A was $\{ a_1, a_2, a_3, \ldots \ldots, a_N \}$, its terminal discription was

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$\{ x_0, y_0, a_1', a_2', a_3', \ldots \ldots, a_N', x_n, y_n, L_n \}$, which,$\{ a_1', a_2', a_3', \ldots \ldots, a_N' \}$was chain code derivation of A.

E. Fingerprint feature matching

Fingerprint feature matching was the most important part in AFIS. Fistly, the valid ridges were extracted. Then the matching degree between two ridges was caculated. Finally, it was determined whether the two fingerprints matched according to matching degree.

The fingerprint image in library was as the template image, the fingerprint image gathered from scanner called the pending matching image. The matching process was as followed:

1) Chain code derivation: For the ridge A in template image and the line B in pending matching image, each expressed as chain code derivation:

$A: \{ x_0, y_0, a_1', a_2', a_3', \ldots \ldots, a_N', x_n, y_n, L_n \}$

$B: \{ x_0, y_0, b_1', b_2', b_3', \ldots \ldots, b_M', x_m, y_m, L_m \}$

2) Matching fragment: Fragment α from A and fragment β from B were obtained, their length n was greater than 2/3 of A and B, which α began in the ridge edge point k of A, β started on the ridge edge point l of B, then the matching between α and β was defined as:

$$D_{kl}^{n} = \frac{1}{n}\sum_{j=0}^{n-1} \cos\frac{\pi}{4}\left(a_{k+j}^{'} - b_{l+j}^{'}\right) \tag{2}$$

Which $a_{k+j}^{'} = a_{k+i} - \frac{1}{n}\sum_{j=0}^{n-1} a_{k+j}$, $b_{l+j}^{'} = b_{l+i} - \frac{1}{n}\sum_{j=0}^{n-1} b_{l+j}$, $0 \le i < n$

3) Caculating the best matching of length n:

$$D_{kn\ln}^{n} = \arg\max_{k,l}\left(D_{kl}^{n}\right) \tag{3}$$

4) Caculating the maximum of n:

$$N = \max\left\{n \mid D_{kn\ln}^{n} > D\right\} \tag{4}$$

Where D was the threshold of matching.

5) Looping 1-4.

6) Counted the number of matching as M_N.

7) Calculation of two fingerprint images matching degree:

$$m = \frac{M_N}{M} \tag{5}$$

Which M_N was the number of matching, M was the number of all lines in template image. If m was greater than the threshold T_M,($T_M \ge 0.95$), it was determined that two images were matched.

III. SYSTEM IMPLEMENTATION

The AFIS of the paper was composed of PC and the fingerprint-gathering-recognition-meter.

The fingerprint-gathering-recognition-meter was composed of AT89S52 single-chip microcomputer, fingerprint processing module, RAM, flash memory, LCD, keyboard, acoustic-optic alarm circuit e.t. as in Fig. 2. In order to ensure the system could be used normally without the city power supply, a sealed chargeable storage battery was used as backup power.

The fingerprint-gathering-recognition-meter could work

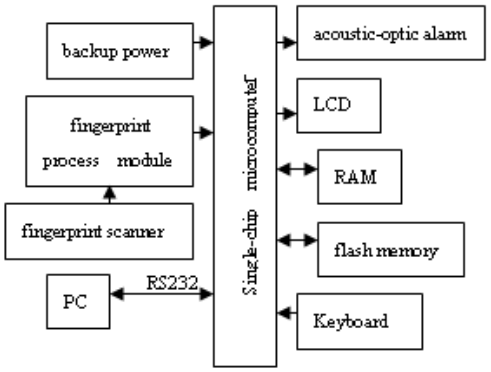

Figure 2. AFIS hardware structure diagram

independently and accomplished the function of fingerprint gathering, enrollment, check and serial communication with PC(RS-232 standard interface). Many fingerprint gathered compiled a user fingerprint database and the database was downloaded to many fingerprint gathering recognition meter in order to convenient to confirms the user status on the spot. So the question of serial communication from the fingerprint gathering recognition meter to the PC must be solved.

The algorithm was programmed with C++, and was debugged under of VC++ 6.0 in Windows XP operating system.

IV. CONCLUSION

The fingerprint algorithm of the article could withdraw the ridge and the valley line branching point information of fingerprint image more accurately and could omit the false characteristic point caused by extraction end point. The ridge and valley branch point was used to match fingerprint in the matching process. This method had already been applied in the teller status fingerprint confirmation system and the effect was good. The fingerprint algorithm validity of this article has further been confirmed.

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