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Fingerprint and Palmprint Image Fusion System Based on C#

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Abstract: A system is based on the recognition of fingerprint and palmprint fusion in c# which is a accurate, convenient, humanized design. The rough matching method of fingerprint recognition is combined with node and the direction field and the rough matching method of getting palmprint recognition is based on multi resolution analysis. The final result is made by the two rough matching results using parallel fusion decision. After identifying the debugging results suggest that: The system is stable, good real-time, high recognition rate and it can achieve the expected goals. The system well meet the actual demand and has the widespread application prospect.

Key words: Palmprint recognition, fingerprint recognition, decision fusion

INTRODUCTION

With the improvement of living standards, digital and invisible trend of identity has become increasingly apparent. However, problem caused by the identity information which is divulged economic loss is becoming more and more serious. Therefore, how to identify the identity has become the focus of research (Li *et al*., 2013; Brunelli and Falavigna, 1995; Cappelli *et al*., 2012). ID class identification method because of its easy to counterfeit simple defects has been unable to meet the needs of human life. Therefore, identification method based on science and technology has become a hotspot (Yu *et al*., 2012). Single mode recognition technology has been unable to meet the needs of people's lives, emerge as the times require the identification of multi modal (Sun and Qiu, 2001). The palmprint and fingerprint is easy to accept, easy collection, good stability and other advantages (Jain *et al*., 2004). Using the two fusion matching not only can make without raising the technical difficulty of the situation but also get higher recognition rate. A convenient, fast, beautiful, practical based on palmprint and fingerprint matches emerge as the times demand recognition system.

FINGEEPRINT IDENTIFICATION ALOGRITHM BASED ON NODE AND BASED ON ORIENTATION FIELD

Get the fingerprint skeleton information after the image of the original fingerprint preprocessing. The fingerprint feature extraction basing on the fingerprint skeleton information. The fingerprint feature points have many, such as intersections, center points and end points. Around the white point there is only one whit point in 8×8 boxes for end points. Around the white point there are two white points in 8×8 boxes for intersections. But the center point must be calculated. Record the fingerprint feature pot should first get fingerprint core point. The center point formula is as follows:

$$\text{Poincare}(i,j)=\frac{1}{2\pi}\left\{\int_0^{2\pi}\frac{\partial}{\partial}O'(i+\tau\cos\eta, j+\tau\sin\eta)\,d\eta\right\} \quad (1)$$

among them:

$$\frac{\partial}{\partial}O'(i+\tau\cos\eta, j+\tau\sin\eta)=\begin{cases} d\varpi, |d\varpi|<\pi/2 \\ \pi+d\varpi, d\varpi\le-\pi/2 \\ \pi-d\varpi, \text{others}\end{cases} \quad (2)$$

$$d\varpi=\lim_{v\to\infty}\frac{M-W}{\phi} \quad (3)$$

among them:

$$M=O'(i+\tau\cos(\eta+\phi), j+\tau\sin(\eta+\phi)) \quad (4)$$

$$W=O'(i+\tau\cos\eta, j+\tau\sin\eta) \quad (5)$$

Then make center point as the origin and establish the relative coordinate system which is based on center point. Record the location, direction, frequency and feature point type of the end points and bifurcation points. Because the pseudo points exist the feature points

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in the pre extraction of the need to remove, after the estimation of feature point to pseudo point to get the real feature points . Pseudo feature points including caused by ridge fault point as well as the keyhole, burr and even the formation of the fork and the edge points.

Edge point: Edge point removal is relatively simple, only when the feature points can be collected from the collection of a certain numbers.

Pseudo feature points caused by line fault: For this kind of characteristic mainly consider the distance and direction of the relationship between detail points. First determine the feature of P1, if there is another feature of P2 makes the distance between two points is less than 5 (5 is threshold), namely pseudo point.

Because eyelet, burr, fork even the formation of pseudo point: There are there possible. The first one is that for any two ridge bifurcation point, if the distance between two points is less than 10 (10 is threshold) for small point. The second one is that For the same stripes on either end of the P1 and any bifurcation point as P2, if the distance between two points is less than 4 or the distance between two points is less than 8 at the same time angle and ridge direction two feature points of attachment and the abscissa of the angle of the absolute value of the difference is less than, burr point (4 and 8 are the threshold values). The last one is that For any bifurcation point, if the distance between two points is equal to about 4 at the same time angle and ridge direction two feature points of attachment and the abscissa of the angle of the absolute value of the difference is less than $\pi/4$, fork even point. Combine with the method of node and the orientation field of fingerprint to recognize the identification which has the position, gradient, direction, type and frequency of fingerprint feature information as the basis. The first step need make the two feature information rotational and translational in order to make them aligned. Calculate the direction in the range of allowable errors named OT(i, j). The OT(i, j) formula is as follows:

$$O(W^{Q}(i,j)) = \begin{cases} \beta, 0 \le x < k, 0 \le y < n, O(W^{Q}(\lfloor x/\alpha, y/\alpha \rfloor)) \ge 0 \\ -1, \text{others} \end{cases} \quad (6)$$

among them:

$$O(W^{Q}(\lfloor x/\alpha, y/\alpha \rfloor)) + \varpi_{r_1} - \varpi_{r_2} = k\pi + \beta \quad (7)$$

$$x = x_{r_2} + \eta \times \cos(\lambda - \varpi_{r_1} + \varpi_{r_2}) \quad (8)$$

$$y = y_{r_2} + \eta \times \sin(\lambda - \varpi_{r_1} + \varpi_{r_2}) \quad (9)$$

Calculate the transverse and longitudinal coordinate as new values according to the angle errors. Within the permissible range of the transverse and longitudinal coordinate errors and the feature points in the same type of conditions, find out the matching points in the 45 degree direction deviation range of the similar feature points. The similarities are accounted for in the original image feature point is the contrast or similarity ratio.

MULTI-RESOLUTION ANALYSIS BASED PALMPRINT RECOGNITION

Getting palmprint region of interest is the first step. The first one point need to find out the center point. The center point is the center location between the lowest point of index finger and middle finger and the lowest point of the ring finger and the little finger. According to center point as the origin of coordinates establish the Cartesian coordinate system. With the origin as the basis, find out the grid area whose area is 128×128 as palmprint region of interest.

Get palmprint region of interest after the palmprint image preprocessed. The obtained pretreatment of the region of interest decompose for J wavelet. The image of each decomposition image is divided into S×S disjoint blocks. According to the horizontal direction and the vertical direction of the two-dimensional wavelet decompose for one-dimensional wavelet. Then comprehensive calculation of energy of each block and forming an energy vector. The two-dimensional wavelet transform formula is as follow:

$$W_f(a;\lambda_1,\lambda_2) = \frac{1}{a}\iint f(x_1,x_2)\phi\left(\frac{x_1-x_2}{a}, \frac{x_2-\lambda_2}{a}\right)dx_1dx_2 \quad (10)$$

The one-dimensional wavelet transform formula is as follows:

$$Wf(b,a) = \int_{-\infty}^{+\infty} f(t)\frac{1}{\sqrt{a}}\phi\left(\frac{t-b}{a}\right)dt \quad (11)$$

The wavelet energy feature is obtained after the energy value of the vector normalization.

The wavelet energy feature is composed of all levels of the wavelet energy feature combination. Application the formula of weighted-distance to measure similarity between different wavelet energy features. The weighted-distance formula is as follows:

$$D(V,U)=\sum_{i=1}^{M}(c_i\sum_{j=1}^{3\times S\times S}\left|V_{(j)}^{i}-U_{(j)}^{i}\right|) \quad (12)$$

Weight is based on the ability to distinguish levels of wavelet energy feature of the palm to calculate: distinguish ability is stronger, the corresponding weight is greater; distinguish ability is weak, the corresponding weight is small.

FUSION MATCHING

Fusion matching is a process of integrated recognition based on the results of fingerprint and palmprint rough matching. This system adopts the method of parallel fusion to match. The flow chart is as shown in Fig. 1.

Through the application of fingerprint identification with node and based on orientation field, getting the data of matching is between stored within the database features and to identify the characteristics. At the same time getting the result of matching palmprint based on the feature used to be stored in the database and the characteristics which are need to identify ,which is apply for the technology of palmprint recognition of multi resolution analysis for palmprint matching. This system is calculated using the method of parallel fusion. The method of matching method of parallel is as follows:

$$W=\alpha\times W_p+(1-\alpha)\times W_f \quad (13)$$

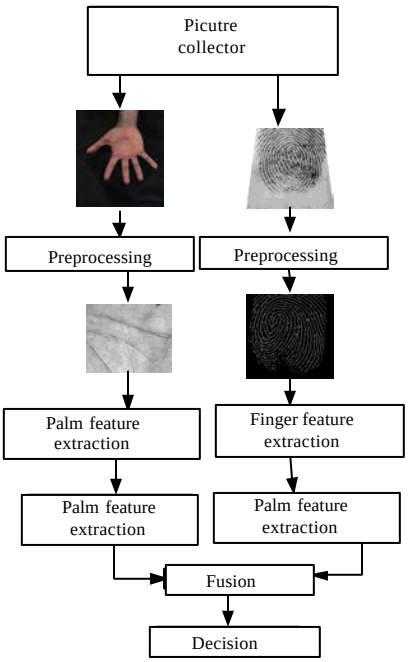

Fig. 1: Flow chart of fusion method

Using the matching scores of fingerprint recognition sub system matching scores named Wfand the palmprint recognition sub system matching scores as Wp to calculate the comprehensive result which is based on the linear fitting method. If the two coarse matching results are the same, it is the final result; otherwise the two coarse matching results are different, do them again by using the two results to calculate the data of the fingerprint and the palmprint from one result to another. Then calculate the two comprehensive results by using the matching method of parallel.

If the result of fusion matching is less than a threshold value, the result is right. Then the need result is the greater recognition results. Otherwise there is no result.

CONCLUSION

Through the application of fingerprint identification algorithm based on node and based on orientation field, getting the result of fingerprint coarse recognition. The fingerprint recognition effect diagram obtained as shown in Fig. 2. As you can see from Fig. 2, this method can extract and mark the fingerprint endpoint, bifurcation point and center point. The result of rough identification is recorded at background.

Before showing the conclusion of palmprint rough recognition, introduce the parameter of the wavelet energy feature's MTWR and weighted coefficient. The relation between MTER and weighted coefficient is as shown in Table 1.

Fig. 2: Fingerprint coarse recognition effect chart

Fig. 3: Palmprint matching effect chart

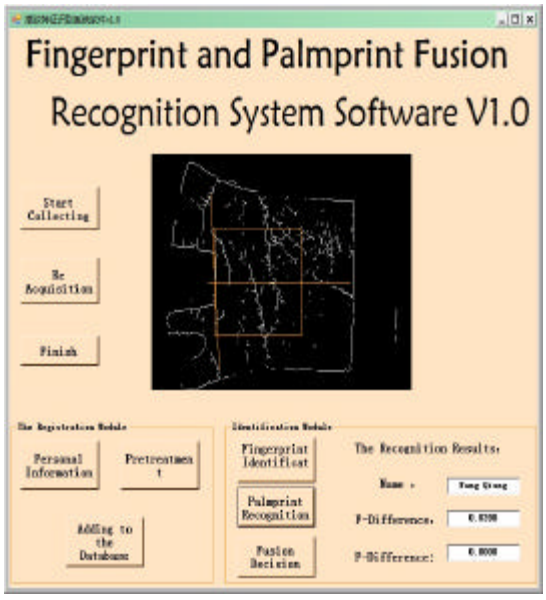

Fig. 4: Fusion decision map

Table 1: MTER and weighted coefficient of each level wavelet

Level No.	1	2	3	4	5
MTWR (R,%)	11.42	7.07	4.91	4.84	5.35
Weighted coefficient	0.11	0.17	0.25	0.25	0.23

This parameter is obtained by using Polyu-Online-Palmprint Database test performance ability of wavelet features. At this time, there are 3200 samples in the library, respectively from 320 palms. Each hand has 10 images. For each of the palm of the hand, in palmprint database choose 6 samples used for training and the remaining 4 to test. Select -Harr wavelet is the most simple to decompose the palmprint, total number of wavelet decomposition is 5. The calculation of WEF, each detail image is divided into blocks. The mean wavelet energy feature of each class of the training samples as the palmprint template class.

Through the application of palmprint recognition method based on multi resolution analysis, to get the coarse matching results of palmprint recognition. The palmprint recognition effect diagram is shown in Fig. 3. As you can see from Fig. 3, there are the more extraction of palmprint location of interest, clear and appropriated ridge feature points. The result of rough identification is recorded at background.

Basing on the results of the fingerprint coarse matching results and palmprint coarse matching, the final matching method calculated is based on parallel fusion. Fusion recognition effect is shown in Fig. 4. As you can see from Fig. 4, after making fusion decision, get the final recognition results as well as the fingerprint and palmprint difference.

CONCLUSION

The system through the application of fingerprint identification algorithm which is combined with the node and based on orientation field and the technology of palmprint recognition which is based on multi resolution analysis recognize the identification. The result of the identification through the method of parallel connection is more accurate results. This system can not improve the technical level, but to get higher recognition rate of recognition results. The running speed of the system faster, higher precision and beautiful, strong feasibility, also has practical application value to meet the research requirement. But the existence of center point positioning is not accurate and other issues to be improved.

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