International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 3 Issue: 1 378 - 381

Advanced Partial Palmprint Matching Based on Repeated Adjoining Minutiae

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***Abstract*:** Nowadays, high resolution palmprint images are used for recognition. The features that can be extracted from a high resolution palmprint image include the minutiae points. In this paper, instead of full palmprints, partial palmprints are used for matching. Partial refers to a part of the palmprint such as the thenar and hypothenar or hypothenar and interdigital areas. The minutiae can be easily located from the thinned palmprint image by using a window. Since there are a large number of minutiae present within a palmprint image, the minutiae are grouped into several clusters. The extracted minutiae are clustered using Hough circles. In order to avoid spurious minutiae resulting from the presence of immutable creases, radon transform is made use of. By selecting initial minutiae pairs, the entire matching is done by using repeated adjoining minutiae matching. The algorithm is developed and successfully tested with palmprint database.

Keywords: *Palmprint, partial palmprint, minutiae, Hough circles, repeated adjoining minutiae matching.*

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I. INTRODUCTION

Automated human identification is a challenging task in order to meet the growing need of stringent security. Nowadays, biometrics are used extensively to identify an individual. Biometrics refers to the physical/behavioural characteristics of an individual. Biometrics can be divided into extrinsic and intrinsic. Extrinsic biometric features are those which are easily accessible such as fingerprint, palmprint, iris, etc. On the other hand, intrinsic biometric features are extremely difficult to acquire without the knowledge of an individual. Examples are DNA vessels, vein patterns, vessel structures etc [1]. Fingerprint is the most widely used biometric trait. But palmprint offers a much more secure solution by providing larger area for processing and more features. Live scan technology for palmprints was very costly hence, the existing systems used only low resolution palmprint images. But in recent years researches are being done in the area of designing automated high resolution palmprint images [2], [3]. The features that are mainly used in high resolution images are the minutiae points that are mainly used for fingerprint matching [4], [5]. The algorithms that are used for fingerprint matching cannot be used for palmprint since a palmprint covers a larger area and contains large number of creases [6] and also, due to flexibility of bones and skin in hands, a nonlinear distortion occurs in the images.

A computationally demanding step in any high resolution palmprint matching scheme is the pairwise minutiae similarity computation between query and template palmprints. If a minutiae pair is genuine, then its neighbouring minutiae should also match with high confidence. This makes it possible to propagate minutiae correspondences within the genuine palmprints.

II. BLOCK DIAGRAM

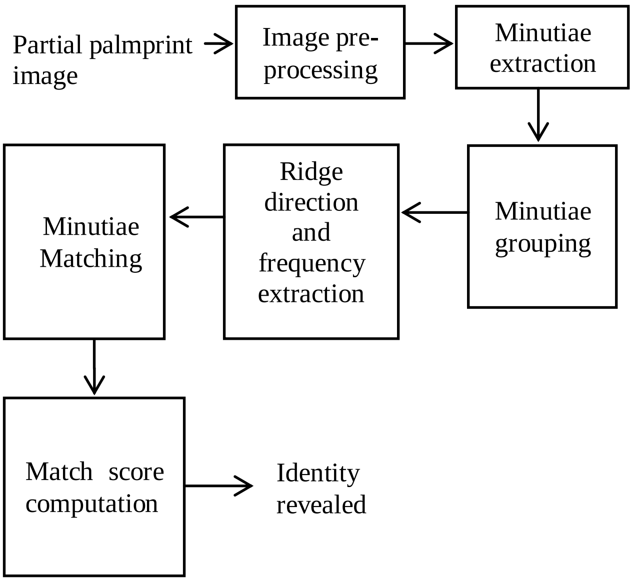

Fig.1. Block diagram of the proposed system

Fig.1 outlines the proposed system which specifically deals with challenges in partial palmprint matching such as large number of minutiae, nonlinear image distortion in palmprints and spurious minutiae. Here, an algorithm is applied to group minutiae into several groups according to their local properties. Starting with a small number of initial minutiae correspondences, a repeated adjoining minutiae matching algorithm is invoked to establish global minutiae correspondence. The final match score is based on the individual minutiae matching results.

III. IMAGE PREPROCESSING

The input image obtained first undergoes certain pre-processing operations. It is first filtered in order to remove any noise inherent in the image. A low pass gaussian filter is developed in which setting a suitable value for standard deviation reduces the noise. After removing the noise, the various lines in the palm needs to be detected. Edge detection is done so as to detect the various edges/lines present in the palm. Selecting a suitable operator and a suitable threshold value provides an image with all the edges in palm. After filtering and edge detection, the resulting binary image then undergoes morphological operations. Thinning is done in order to get the ridges present in the input image.

IV. MINUTIAE EXTRACTION

Minutiae extraction is the most important step in this matching process since in a high resolution image based palmprint matching, the feature used is minutiae. Minutiae refer to minute details such as ridge endings and ridge bifurcations. Locating minutiae in a thinned image is relatively easy. A count of number of ones at a particular region of the image in a 3X3 window is suitable for this purpose. A ridge end point has only one neighbour in the window and thus in the resulting matrix a value of 2 indicates the position of a ridge point. On the other hand, a ridge bifurcation has atleast three neighbours, so a matrix element of 4 indicates a ridge bifurcation.

V. MINUTIAE GROUPING

Local ridge direction and ridge frequency are used for characterizing the minutiae. Minutiae are clustered using the well-known Hough circles. A local orientation sampling structure is used to extract local features of the minutiae [7]. For a reference minutia m, L circles with radii r_i, i=1,2,…L are considered as its local neighbourhood. On each circle, there are n_i,i=1,2,…L sample points equally distributed, starting from the projection location of minutiae. The value of ridge direction descriptor is set as the difference between the direction of minutiae in sample point and central minutiae direction, whereas the ridge frequency descriptor is set as the ridge frequency value at that particular sampling point. For minutiae near the boundary of palmprint, some of the sample points of circles lies outside the region and are not available. In order to make it available for grouping, their values are predicted by

$$d = \frac{1}{2}\tan^{-1}\left(\frac{\sum_{i\in V}\sin 2d_i}{\sum_{i\in V}\cos 2d_i}\right) \quad (1)$$

$$w = \frac{1}{n_v}\sum_{i\in V} w_i \quad (2)$$

where $\tan^{-1}$ is a four-quadrant arctangent function, V is the set of valid nearest sample points with n_v points in the structure, and d and w are the predicted ridge direction and ridge frequency values.

The distance, D, between two direction descriptors is given by,

$$D = \sqrt{\sum_{i=1}^{n}[(\cos 2d_i - \cos 2d_i')^2 + (\sin 2d_i - \sin 2d_i')^2]} \quad (3)$$

where n is the total number of sample points on L circles(in this paper it is taken to be 79), d_i and d_i' are 2 direction descriptors.

VI. LOCAL RIDGE DIRECTION AND RIDGE FREQUENCY EXTRACTION

Hough circle is formed for grouping the extracted ridge direction and ridge frequency descriptors. Forming concentric circles helps in grouping minutiae with similar descriptors. Grouping minutiae leads to the formation of template which forms the basis for matching. The template consists of several concentric circles each having a particular centroid value. The centroids thus formed can be used for matching. Given a query minutia, if the distance between the descriptor of query image and the centroid of any cluster is minimum, then it can be associated to that cluster.

VII. MINUTIAE MATCHING

Here, matching is based on the logic that if a minutiae pair is of true correspondence, then its neighbouring minutiae should also match. By using these mated neighbouring minutiae as reference, the whole palm can be searched recursively until no neighbours exist [8].

A. Minutiae similarity measure

For matching, three types of similarities based on ridge direction, ridge frequency and minutiae structure are computed. The ridge direction and ridge frequency similarity is given by

$$S_d = \frac{1}{N_v}\sum_{i\in V} exp\left(-\frac{\Delta d_i}{\mu_o}\right) \quad (4)$$

$$S_r = \frac{1}{N_v}\sum_{i\in V} exp\left(-\frac{\Delta w_i}{\mu_r}\right) \quad (5)$$

where V is the set of sample points valid in both descriptors, N_v is the number of valid sample points,$\Delta d_i=\min\{|d_i-d_i'|, 180-|d_i-d_i'|\}$, $\Delta w_i=|w_i-w_i'|$, and μ_o and μ_r are predefined thresholds.

The minutiae similarity measure is based on local minutiae structure. By tessellating the area around reference minutiae, the minutiae structural similarity can be found by computing their local polar coordinate values within each corresponding sectors. Then these values are checked with predefined thresholds to form the similarity given by

$$S_m = \frac{1}{M}\sum_{i=1}^{M} s_i \frac{M}{N_t + N_q}\frac{M}{M + M_0} Q(D_q)Q(D_t) \quad (6)$$

where M is the number of matched local minutiae, M_0 is a predefined value, N_q and N_t are number of minutiae in query and template local structures respectively, and s_i is the similarity of the i^{th} local minutiae pair, Q(x) is a minutiae quality measure function and D_q and D_t are the average Euclidean distances of three nearest minutiae to reference minutiae in query and template structures respectively.

B. Initial Mated Minutiae Pair Generation

By using the similarity measures computed previously, the initial mated minutiae pairs can be generated. For each minutiae in template and query minutiae list, weak similarity and strong similarity are calculated. Weak similarity multiplies the direction and ridge frequency similarities, i.e., S_dXS_r whereas strong similarity multiplies ridge direction, ridge frequency, and local minutiae structure similarities, i.e. , $Sd_oXS_rXS_m$. Computation of strong similarity gives the initial mated minutiae pairs. These initial mated minutiae pairs serve as seeds for minutiae matching.

C. Repeated Adjoining Minutiae Matching

The initial mated minutiae obtained serve as reference for matching. Adjoining minutiae matching is done by taking the initial pair of mated minutiae and then finding their rigid transformation parameters. Then another minutiae pair is selected from the query and template minutiae list, which is a neighbour of the initial minutiae. Their strong similarity is computed, Sim_{orm} , and also their rigid transformation parameters. Two constraints are imposed here in order to remove the problems associated with partial palmprint matching. It is checked whether the strong similarity computed here Sim_{orm} is less than a predefined threshold. This constraint ensures that newly found minutiae have sufficiently high similarity so as to avoid any false correspondences. Taking the difference between the rigid transformation parameters of initial as well as newly found minutiae controls the amount of distortion.

VIII. MATCH SCORE GENERATION

In order to get the match score, three types of similarities are computed and fused together as in [7]. They are orientation field similarity, ridge density map similarity and average minutiae similarity. The global orientation similarity is computed by:

$$Sc_d = \frac{1}{N}\sum_{i=1}^{N} exp\left(-\frac{\Delta d_i}{\mu_o}\right) X \frac{N_0}{N_0 + 900} \qquad (7)$$

where N is the total number of blocks in the overlapped region, Δd_i is the difference in ridge direction in i^{th}block, μ_o is a predefined threshold, same as in (4) N_0 is the number of blocks with average ridge direction less than a particular predefined value. Similarly, ridge density map similarity is computed by,

$$Sc_f = \frac{1}{N}\sum_{i=1}^{N} exp\left(-\frac{\Delta r_i}{\mu_r}\right) X \frac{N_r}{N_r + 900} \qquad (8)$$

where Δr_i is the difference in the ridge frequency in the i^{th} block, N_r is the number of blocks with average ridge frequency difference less than a predefined value, μ_r is the same value in (5). The average minutiae similarity is formed by using the similarity of minutiae correspondence found in adjoining minutiae matching.

$$Sc_m = \sum_{i=1}^{M} Sim^i_{orm} \qquad (9)$$

where Sim^i_{orm} is the strong similarity that is computed in adjoint minutiae matching.

The similarities are fused together as:

$$Score = Sc_d X Sc_f X Sc_m \qquad (10)$$

The final match score helps to identify the person, if it exceeds a particular threshold value.

IX. SPURIOUS MINUTIAE REMOVAL

Spurious minutiae remain one of the most challenging problems in partial palmprint matching. Spurious minutiae may arise due to immutable creases present in palmprint as well as unavoidable image acquisition conditions. One of the methods for spurious minutiae removal is to extract the crease information. After extracting the crease information, spurious minutiae are simply avoided using the assumption that the minutia that lies near to creases is definitely a spurious one. The creases can be extracted efficiently using the modified finite radon transform [9].

X. RESULTS AND DISCUSSION

Here multispectral palmprint image database from CASIA is being used [10].The number of minutiae groups is an important factor in palmprint matching. A large number of groups sometimes may miss out any true minutiae correspondences. So here, the number of groups is set to 10 for a partial print and 20 for a full palmprint. These groups or clusters are further stored as templates which comes handy in matching process. In order to form these clusters, a local orientation sampling structure is formed with L circles, where L=4 and their radii r_i=5, 10, 15, 20. The total number of sample points in these clusters is taken to be 79. In (4), μ_o is taken as 4 and in (5) μ_r is taken as 2.

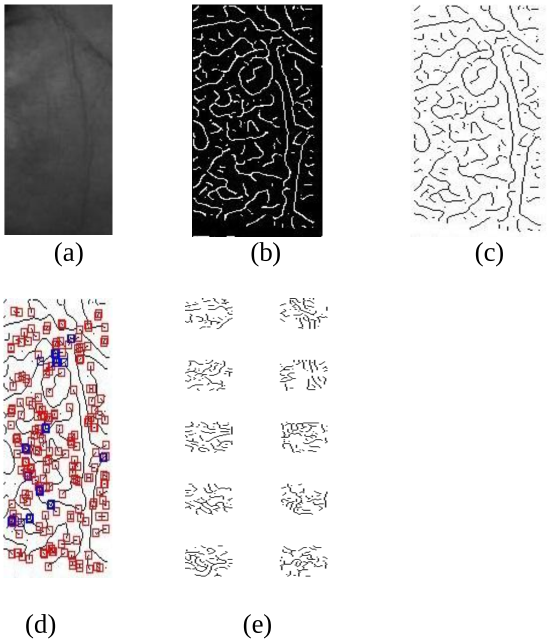

Fig 2. Results of pre-processing and minutiae extraction stages. (a) Input image (b) Image after filtering and edge detection (c) Image after thinning operation (d) Thinned image showing minutiae, red squares shows ridge endings and blue squares indicate ridge bifurcations, (e) The clusters that are formed by using the local orientation sampling structure.

In adjoining minutiae matching, Sim_{orm} was set to 0.02 so that the newly found minutiae have high similarity in order to avoid any false minutiae correspondences. In match score computation, N_O was chosen as the number of blocks having a ridge direction less than 22.5 degrees and N_r as the number of blocks having a ridge frequency difference of less than 2 pixels.

XI. CONCLUSION AND FUTURE SCOPE

In this paper, an algorithm is developed to group the minutiae into several groups. Hough circles helps to group the extracted minutiae easily. These clusters narrow down the search space leading to reduction in computation time. The repeated adjoining minutiae matching procedure ensures local compatibility so as to reject any false minutiae correspondences.

In order to provide more privacy and security to the user, partial palmprint matching can be combined with palm vein matching. Palm vein being an intrinsic biometric trait cannot be acquired without the knowledge of the user. Hence, it provides a greater sense of security to the user. Also, a partial palm vein matching scheme can be developed which can be further fused with partial palmprint so as to reduce storage space.

REFERENCES

[1] Yingbo Zhou and Ajay Kumar, "*Human Identification using PalmVein Images*",IEEE Trans.Information Forensics and Security,vol.6,no.4, pp.1239-1274,December 2011.

[2] A.Jain and J.Feng, "*Latent Palmprint Matching*" IEEE Trans. Pattern Analysis and Machine Intelligence, vol.31, no.6, pp.1032-1047, June 2009.

[3] J .Funada, N.OhtaM.Mizoguchi, T.Temma, K.Nakanishi, A.Murai, T.Sugiuchi, T.Wakabayashi, and Y.Yamada ," *Feature Extraction Method for Palmprint Considering Elimination of Creases*", Proc. 14th Int'l Conf. Pattern Recognition, vol.2, pp.1849-1854, 1998.

[4] D. Maltoni, D. Maio, A. Jain, and S. Prabhakar, *Handbook of Fingerprint Recognition*, second ed. Springer-Verlag, 2009.

[5] A. Jain, L. Hong, and R. Bolle, "*On-Line Fingerprint Verification*," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 19, no. 4, pp. 302-314, Apr. 1997.

[6] D.Ashbaugh,*Quantitative-Qualitative Friction Ridge Analysis:An Introduction to Basic and Advanced Ridgeology*,CRC,1999.

[7] M.Tico and P.Kuosmanen, "*Fingerprint Matching Using an Orientation-Based Minutia Descriptor*", IEEE Trans. Pattern Analysis and Machine Intelligence, vol.25, no.8, pp.1009-1014, Aug. 2003.

[8] Eryun Liu, Anil.K.Jain and JieTian, " *A Coarse to Fine Minutiae based Latent Palmprint Matching*" IEEE Trans. Pattern Analysis and Machine Intelligence, vol.35, no.10, pp.2307-2321, Oct.2013.

[9] J.Dai and J.Zhou, "*Multifeature-Based High-Resolution Palmprint Recognition*," IEEE Trans. Pattern Analysis and Machine Intelligence,vol.33,no.5,pp.945-957, May 2011.

[10] CASIA-MS-PalmprintV1,http://biometrics.idealtest.org/