Partial Palm Multibiostatistics for Personal Authentication

GAYATHRI.R.NAYAR[#1]

[#]Sarabhai Institute of Science and Technology, CUSAT, Vellanad, Kerala, India

[1]gayathrirnayar@yahoo.co.in

***Abstract*: In order to meet the growing needs of security, several researches are done in order to provide more privacy to the user. Nowadays, multiple biometric traits are combined together to form a recognition system so that the advantages of both the traits can be concatenated in order to provide more accuracy. In this paper, partial palm features are used for personal verification. Here, partial palmprint and partial palmvein are combined for identification of an individual. Partial palmprint matching is done by recursive adjoint minutiae matching method where a coarse to fine matching technique is used. Ahighest curvature method is used for extracting the vein pattern. The binarised patterns thus formed are used as templates. Further matching is done using Hamming distance.**

Keywords: partial palm, partial palm vein, Hamming distance, highest curvature method.

I.INTRODUCTION

The increasing need of security has led to more researches in the area of biometrics. Biometrics or biostatistics refers to identifying an individual based on his/her physiological and behavioural traits. Biometrics can be classified into extrinsic and intrinsic. Extrinsic biometric traits include palmprint, fingerprint, signature, gait etc.Examples of intrinsic biometric traits are vascular pattern, vessel structures etc [1]. Use of extrinsic biometric traits for identification is more popular due to its non -intrusive nature.But the problems associated with these traits are spoof attacks. A high quality image can be used instead of original trait. In order to deal with such attacks multiple biometric traits are combined so as to provide increased efficiency and accuracy.

In this paper, partial palmprint is combined with partial palm vein for individual identification. Partial implies taking a small portion of the full image i.e., thenar and hypothenar or interdigital areas. Palmprint is a better biometric trait than fingerprint due to its large size. Partial palmprint matching is done using the repeated adjoining minutiae method [2]. After finding the identity of the individual using partial palmprint matching, verification is done with the help of partial palmvein matching. Palmvein images are extracted using infra-red illumination of the palm. The deoxidised haemoglobin present in veins absorbs the infra-red illumination and the images of vein are obtained. Partial palmvein pattern are obtained using highest curvature method. The significant features within the image are encoded and then used as template for matching.

After finding the vein pattern, there may be missing links within the pattern. Several methods can be used to connect the missing links. A missing link method can be used which takes the region properties into account and plots the missing links if the distance between the two patterns is less than a particular threshold. Also, bresenham method can be used in which the 2 points where line needs to be drawn can be specified manually. But the problem associated with these methods is that it may draw lines between points where a vein is not present.

In any system, there are three stages: Registration stage, Training stage and Matching stage. In the registration stage, the full images are stored in the database and their features are extracted. The training stage applies particular algorithm to the input and trains them to get a set of features. Finally, in the matching stage a query image (partial image) is taken, it undergoes the same processes as in registration stage and then matching procedure is initiated to obtain the final result [2].

II.BLOCK DIAGRAM

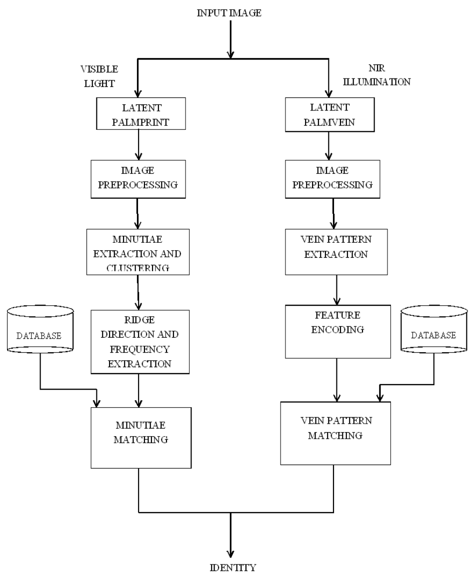


Fig.1. Block diagram

Fig.1 shows the block diagram of the multibiostatistics system. Input image is taken under two conditions which can be divided into 2 stages: visible light and infra-red illumination. Visible light illumination provides us with partial palmprint image whereas infra-red illumination provides partial palm vein image. Both the images then undergo various pre-processing steps before pattern extraction. In the first stage, minutiae are extracted which are then clustered to form templates for matching. Simultaneously, in the second stage partial palmvein image undergoes vein pattern extraction, their significant features encoding and finally, matching. The outputs of both the stages are then compared to give the final identity.

III. IMAGE ACQUISITION

The partial palmprint as well as partial palm vein images are acquired under different conditions. Partial palmprint images are obtained under normal lighting conditions using a scanner. For obtaining a partial palm vein image, two methods are there: Transmission method and Reflection method. Transmission method is one in which infra-red light illuminates the back of hand and the veins absorbs the light and their image is captured by a scanner placed below palm. In this paper, Reflection method is used for obtaining palm vein image. In this method, the infra-red sensor as well as scanner is integrated into a single device. When a person places his/her palm on the scanner, the infra-red sensor illuminates the palm and the image is then formed on the scanner.

IV. IMAGE PRE-PROCESSING

Partial palmprint image is first filtered to remove any noise inherent in the image. It then undergoes edging operation to detect the ridges present in the palmprint. Edge detection is done using a canny operator. The image then undergoes thinning operation which converts the thick ridges into thin lines which are essential for minutiae extraction. Minutiae are the minute details within the image. In this paper, minutiae refer to ridge endings and ridge bifurcation.

In the second stage, partial palm vein image are to be processed since the original image doesn't show the veins clearly. A combination of Contrast Limited Adaptive Histogram Equalisation (CLAHE) and median filtering removes the noise without affecting the edges [3]. In CLAHE, the entire image is divided into several regions and then histogram equalisation is applied to each of the regions. This makes the invisible veins appear as this operation evens out the used gray level distributions [4].

V. PARTIAL PALMPRINT MATCHING

A. Minutiae Extraction and Clustering

Minutiae are extracted using window method. By using a 3X3 window it is checked whether the centre pixel has one dark pixel neighbour or three. If it is has one dark pixel neighbour then it will be marked as ridge ending and for three dark pixel neighbour, it will be marked as ridge bifurcation.

These minutiae are then clustered using a local orientation sampling structure. By choosing a minutia as the reference, a number of circles are taken around it. On each circle, several sampling points are taken. These clusters are then used as template for matching [5].

B.Ridge Orientation and Ridge Period Extraction

Local ridge orientation and ridge period are extracted from the sample points in the local orientation sampling structure. The ridge period is taken as the number of minutiae within each cluster. The local ridge orientation is taken as the difference between ridge orientation at the sample point and the ridge orientation of the central reference minutiae. Given a ridge orientation descriptor of partial palmprint, it can be associated with a cluster whose centroid has the smallest distance to the descriptor. Distance between two orientation descriptors o_d and o_d' are given by

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

wheren is the total number of sample points taken.

C. Matching

Matching is done by recursive adjoint minutiae method. Here the matching is done in a similar way as how forensic experts do it. First step is to form initial matching minutiae pairs. This is done as a step by step process where we first calculate ridge orientation and ridge period as well was minutiae structure similarity. The following equations give the similarity measures.

$$S_{o_d} = \frac{1}{N_v}\sum_{i\in V} exp\left(-\frac{\Delta o_{d_i}}{\mu_o}\right) \quad (2)$$

$$S_{r_d} = \frac{1}{N_v}\sum_{i\in V} exp\left(-\frac{\Delta r_{d_i}}{\mu_r}\right) \quad (3)$$

where V is the set of all valid sample points and Nv is the number of valid points ,$\Delta o_{di}=\min\{|o_{d_i}-o_{d_i}'|, 180-|o_{d_i}'-o_{d_i}''|\}$, $\Delta r_{di}=|r_{di}-r_{di}'|$, and μo and μr are predefined thresholds.In order to find the structural minutiae similarity measure, a tessellation structure is made use of . The region around reference minutiae is divided into several sectors so that a minutiae within a particular sector in partial palmprint template needs to be searched in the full palmprint only in the same corresponding sector.

$$S_m = \frac{1}{M}\sum_{i=1}^{M} s_i \frac{M}{N_t + N_q}\frac{M}{M + M_0} Q(D_{qe})Q(D_{te}) \quad (4)$$

where M is the number of matched local minutiae and M_o is a predefined threshold value, N_t and N_q are the number of minutiae in query and template structures. Q(x) is a quality measure function and D_{qe} and D_{te} are the Euclidean distances from the reference minutiae.

First two minutiae are taken (one from query and another from template) and their ridge orientation as well as ridge period similarities are multiplied. Then another minutia from both the lists are taken and their similarity measures are multiplied and the list is updated with the minutiae pair that has the largest fused similarity measure. After obtaining such a list with minutiae pairs having highest similarity measure, further filtering operation is done by fusing the minutiae structural similarity measure with ridge orientation and ridge period similarities. By multiplying three similarity measures, a list of minutiae pairs is found which gives the initial matched minutiae pairs within each cluster.

This initial matched minutiae pair list can now be used as reference for further matching. The next step is recursive checking of the adjoint minutiae as to whether it can be now used as the reference. This process continues until no neighbouring minutiae are left. The output would be minutiae correspondence list.

D. False Minutiae Avoidance

Presence of false minutiae leads to incorrect results. The immutable creases present in the partial palm causes false minutiae. In order to remove such false minutiae, modified finite radon transform can be used. By extracting the crease information using radon transform, false minutiae can be avoided using the assumption that minutiae that lie near to creases are false and hence needs to be removed [6].

VI. PARTIAL PALMVEIN MATCHING

A. Partial Palmvein Pattern Extraction

Highest curvature of the image profile is the method used for vein pattern extraction. This method will try to extract the centre positions of veins. This can be done by calculating highest curvature in the cross-sectional profile of the palm vein image. This method is not affected by varying brightness as well as width of palm veins [7].

This method involves three steps for extracting the palm vein pattern. First step is extracting the centre position of veins. This can be found by making use of the fact that the brightness profile of a vein shows a valley. This happens because the vein is brighter than the surroundings. The centre points are found by calculating the local minimum curvature in the profile. Second step is to connect these centre positions by a filtering operation. A horizontal line is drawn through a pixel, say(x, y), if the pixels to the right and left of(x, y) are having high value. A line with a gap will be drawn if the left and right pixels have small value. Third step is to binarize the vein pattern thus obtained. A pixel will be a part of the background if it has a value less than a threshold otherwise it will be a vein pixel [8].

B. Encoding

Only the significant features in a particular image needs to be used for matching. So after obtaining the vein pattern, significant features are encoded. In this paper, encoding is done by convolving the vein pattern with 1-D log Gabor wavelets [9]. The 2-D image s broken into two 1-D parts and then convolution is done. A noise mask is also formed by this step. The noise mask indicates the positions where the image may be corrupted. The output of encoding would be a bit wise template. Use of 1-D log Gabor wavelets for feature encoding reduces the encoding time. The frequency response of 1-D log Gabor filter is given by:

$$G(f) = \exp\left(\frac{-\left(log\left(\frac{f}{f_o}\right)\right)^2}{2\left(log\left(\frac{\sigma}{f_o}\right)\right)^2}\right) \qquad (5)$$

wheref_o is the centre frequency and σ is the bandwidth of the filter.

C. Matching

The next step would be to match the bit wise templates of both the query as well as the full image. Bit-wise matching is best done using hamming distance [9]. It is used to determine how many bits are same between the two bit patterns being compared. The advantage of using the hamming distance is that there would be more gap between the genuine and imposter score distribution. The hamming distance is found out using the formula:

$$H_D = \frac{1}{N - \sum_{i=1}^{N} X_{n_i}(OR)Y_{n_i}} \sum_{k=1}^{N} X_k\,(XOR)Y_k(AND)Xn'_k(AND)Yn'_k \qquad (6)$$

where$X_k$and Y_k are two bit wise templates to be compared. X_{ni} and Y_{ni} are the corresponding noise masks and N is the number of bits in each template.If 2 bit patterns are completely independent, then the hamming distance would be 0.5.

VII. AUTHENTICATION

After obtaining the output of partial palmprint matching and partial palm vein matching, both are compared in order to authenticate the identity. A genuine match gives the same result.

VIII. INTEGRATION OF TEMPLATES

In order to save the storage space the templates of partial palmprint and partial palm vein are integrated. This results in one template for one image.

P_{P1}	P_{p2}
P_{v1}	P_{v2}

Fig 2. Integration of templates

Here P_{p1} and P_{p2}refers to templates of partial palmprints and P_{v1} and P_{v2} refers to templates of partial palm veins of one image.

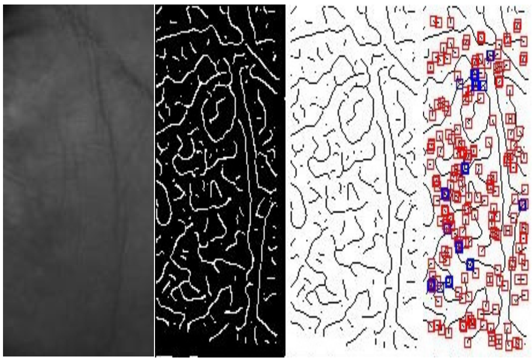
IX. RESULTS AND DISCUSSION

A. Database

In this paper, CASIA Multispectral palmprint database [10] is used. This provides both the visible and infra-red illuminated images. Of the various images available, images taken under 640 nm and 940 nm are taken.

B .Evaluation

In the image pre-processing step for partial palmprints, an important step is the selection of edge and filter threshold and also the edging operator. A range of values starting from 0.01 to 0.2 was tested with an interval of 0.001. The best filter threshold was then chosen as 0.1. The edging operation was done using both the canny as well as sobel operator. But the canny operator gave an accurate result when compared to sobel operator. The edge threshold value was also tested from 0.001 to 0.1 and the chosen value is 0.01.



(a)(b) (c)(d)

Fig. 3.Results of pre-processing as well as minutiae extraction steps. (a) Partial palmprint image (Query image) (b) After filtering and edge detection (c) Thinning operation (d) Extracted minutiae. Red squares indicate ridge endings and blue squares indicate ridge bifurcations

After extracting the minutiae, they need to be clustered so as to form the templates. The clustering or grouping is done using a sampling structure. The number of circles to be taken in each cluster is fixed to 4 with radii r_i =5,10,15,20. The number of clusters also needs to be fixed. A large number of clusters may sometimes miss out true correspondences and accumulate unwanted minutiae. In this paper, the number of clusters is set as 10 for partial palmprints and 20 for the corresponding full palmprint. These clusters are then stored as templates. The total number of sample points was taken to be 79. . In (2), μ_o is taken as 4 and in (3) μ_r is taken as 2.

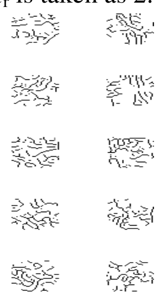
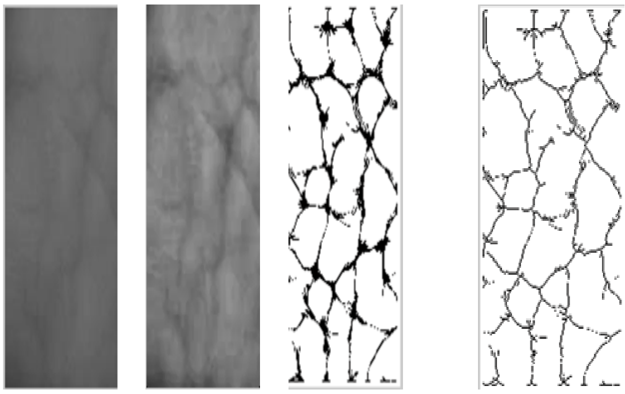


Fig. 4. Template formed from partial palmprint

In partial palm vein matching, before vein pattern extraction, the value for sigma needs to be found out to be used in the highest curvature method. A range of values from 3 to 10 with an interval of 0.5 was tested. Sigma value was chosen as 7 since it gave the correct vein pattern and also avoided inclusion of unwanted details. After obtaining the vein pattern, thinning operation is performed.



(a) (b) (c) (d)

Fig.5. Partial palmvein image pre-processing and vein pattern extraction results. (a) Input partial palmvein image. (b) Image after histogram equalisation and median filtering. (c) Vein pattern extracted by highest curvature method. (d) Thinned image of vein pattern.

The thinned image is then feature encoded using Log Gabor filter. The number of filters used for each process is set as 1. The wavelength of the basis filter is set to 18 and also the ratio of standard deviation of the gaussian describing the log Gabor filter's transfer function in the frequency domain to the filters centre frequency is set as 0.5. The encoding process gives bitwise templates.

The matching is done using hamming distance where a hamming distance of value less than 0.2 indicates a perfect match. If the value is greater than 0.4 then, it would be an imposter pair.

X. CONCLUSION

In this paper, two biostatistics traits are combined so as to provide improved accuracy and security . The use of a clustering of minutiae in partial palmprint leads to narrowing down the search space and thus increasing the speed. Also, integrating the templates helps in reducing the size of the database.

This method can be used in civilian applications. It is easy to use especially for old age people, since there is no restriction for placement of palm to obtain the image.

REFERENCE

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

[2]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.

[3] M.Rajalakshmi,R.Rengaraj, "*Biometric* Authentication using near infra-red images of hand dorsal vein pattern" IJAET/Vol.II/ Issue IV/October-December, 2011/384-389.

[4] S.D.Raut, V.T.Humbe, "*Analysis of Multispectral Palm vein Image using Enhancement Operations*" , IJCSE, Vol. 5 No.07 July 2013

[5] 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.

[6] 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

[7]Naoto Miura, Akio Nagasaka, TakafumiMiyatake*, "Extraction of Finger-Vein Patterns Using Maximum CurvaturePoints in Image Profiles"* , IAPR Conference on Machine Vision Applications, May 16-18, 2005 Tsukuba Science City, Japan.

[8] Wan NourulAkmalAb Aziz, KamaruzzamanSeman, Ismail Abdullah, M. Norazizi Sham Mohd*, "Finger Vein Minutiae Points Extraction based on Maximum Curvature Points in ImageProfile and Finger Print Application Methods" ,* Australian Journal of Basic and Applied Sciences, 7(8): 751-756, 2013.

[9] Libor Masek, Peter Kovesi. "*Biometric Identification System Based on Iris Patterns*". The School of Computer Science and Software Engineering, The University of Western Australia. 2003.

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