ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2, Issue 7, July 2013

Personal Identification Using Palmprint Biometrics Based on Principal Line Approach

Sumangala Biradar

Abstract— **Palmprint is the one of the important biometrics characteristics with higher user acceptance. In palmprint, palm-lines are more important features for personal identification. In this paper, in preprocessing a Gaussian filter is used to smooth the image and next ROI is extracted based on valley points. The Canny edge detection operation is proposed to extract principal line features. The edge direction and gradient strength of each pixel in the preprocessed image are found using Sobel masks. Then edges are traced using that information. Finally, non-maximum edges are suppressed by finding parallel edges and eliminating those with weaker gradient strengths. In this way principal lines are extracted and resultant image is obtained. The matching is done by dividing the resultant image into 9 X 9 blocks. The blocks are traced to create feature vector. While generating a template the feature vector bit is set if the concerned block contains the line. Personal identification is done based on the distance matching between the stored templates and the test palmprint image. Experiments show that the proposed method using PolyU palmprint database offer the accuracy of 86% personal identification.**

Index Terms— **Biometrics, Image preprocessing Palmprint identification, Palm-line extraction**

I. INTRODUCTION

Automatic personal authentication using biometric information is playing an important role in the applications of public security, access control, forensic, e-banking, etc. Many kinds of biometric authentication techniques have been developed based on different biometric characteristics, including Physiological-based (such as fingerprint, face, iris, palmprint, hand shape, etc.) and behavioral-based (such as signature, voice, gait, etc.) characteristics. The palmprint is a relatively new biometric feature; it has several advantages compared with other currently available characteristics. The palmprint contains more information than fingerprint, so they are more distinctive. And also palmprint capture devices are much cheaper than iris devices. Palmprint is one of the important biometrics characteristics with higher user acceptance.

The palmprint is the most important characteristic because of its uniqueness and stableness. A palmprint image contains various features, including geometrical features, line features, delta and minutiae points, etc. However, geometrical features, such as the width of the palm, can be faked easily by making a model of a hand. Delta points and minutiae can be extracted only from the fine-resolution images. Principal lines and wrinkles, called line features, are the most clearly observable features in low-resolution palmprint images.

Several research works on palmprint biometrics have been reported. The De-Shuang Huang, Wei Jia and David Zhang, proposed a novel palmprint recognition approach based on principal lines [1]. In this approach the principle lines are extracted by using the modified finite radon transform. When the transformation is applied, lines in Cartesian coordinate are converted to lines in energy and direction. The energies and directions are used to detect the differences between principle lines and wrinkles. After that, those differences are finally used to verify people.

The Leqing Zhu, Sanyuan Zhang, Rui Xing and Yin Zhang, proposed a method [2] for personal recognition, which is based on PFI and Fuzzy logic. In this the grayscale image is smoothed with an 8-neighbourhood mean filter. Canny edge detector and locally self-adaptive threshold binarization method are combined to extract the principal lines. The Probability Feature Image (PFI) was used in order to suppress random noises in feature image. The fuzzy logic was employed in matching.

The Leqing Zhu and Rui Xing, proposed a new hierarchical palmprint recognition method [3]. First the gradient images along the four directions are computed. Then these four gradient images are overlapped and de-noised. Edges are detected with Canny detector and merged with the de-noised gradient image with AND operation. The result is then dilated and blurred with a probable template to get the major line features. The bidirectional method is used for matching.

The Wei Jia, Yi-Hai Zhu, Ling-Feng Liu and De-Shuang Huang, proposed the palmprint retrieval based on principal lines for palmprint recognition [4]. In this principal lines are extracted using modified finite radon transform method. Then key points of principal lines are detected. And direction, position and energy of these are stored in the table. During matching palmprint is retrieved using this table.

Manuscript received June, 2013.
***Sumangala Biradar**, Information Science and engg, department, B.L.D.E.A'S College of Engg,, Bijapur, India, 9964156753*

The Wei Li, Lei Zhang, David Zhang and Jingqi Yan, proposed the principal line based ICP Alignment for Palmprint Verification [5]. First the modified finite Radon transform (MFRAT) is used to extract principal line. The iterative closest point (ICP) alignment algorithm is used to compute the shifting, rotation and scaling between the ROI images, and then presented an efficient way to combine the alignment result with the competitive code for palmprint recognition.

The Cong Li, Fu Liu and Yongzhong zhang, proposed a method to extract the principal lines based on their cartelistic of roof edges [6].In this at first gray adjustment and median filtering are used to enhance contrast and weaken noise. Then, palm-lines are detected based on diversity and contrast. And an improved Hilditch algorithm is used to do thinning, an edge tracking approach is applied to get rid of twigs and short lines, and then, the broken lines are connected. Finally, the single pixel principal palm-line image is obtained.

The Patprapa Tunkpien, Sasipa Panduwadeethorn and Suphakant Phimoltares, proposed a simple and fast method to extract the principle lines of palmprint by using consecutive filtering operations related to gradient and morphological operators [7]. A gradient masks and closing operator are used to detect the lines.

The Feng Yue, Wangmeng Zuo and David Zhang, proposed the iterative closest point (ICP) algorithm [8] for palmprint alignment before matching. The palm-lines are extracted using steerable filter. However, due to nonlinear deformation and inconsistency of extracted palm line feature, the ICP algorithm using only position information would fail to obtain optimal alignment parameters. To improve its accuracy orientation feature is used, which is more consistent than palm line, to make ICP registration more robust against noise.

Although palmprint based authentication approaches have shown promising results. Efforts are still required to achieve higher performance for their use in high security applications. Based on the summarization of related work, instead of extracting principal lines based on both direction and energy, here in this paper we focus on extracting principal lines based on direction only.

In this work, canny edge detection operation is proposed to extract principal lines. For extracting principal lines the edge direction and gradient strength of each pixel in the preprocessed image are found using Sobel masks. Then edges are traced using that information. Finally, non-maximum edges ar suppressed by finding parallel edges and eliminating those with weaker gradient strengths. In this way principal lines are extracted and resultant image is obtained.. The matching is done by dividing the resultant image into 9 X 9 blocks. The blocks are traced to create feature vector. While generating a template the feature vector bit is set if the concerned block contain the line. Personal identification is done based on distance matching between stored templates and test palmprint image.The rest of this paper is organized as follows: Section 2 presents proposed approach; Section 3 presents the experimental results and Section 4 gives the conclusion.

II. PROPOSED APPROACH

The canny edge detection algorithm is used for extracting the principal line features for personal identification in the proposed approach.

A. Canny Edge Detection Algorithm

Edge detection is important in image processing programs because it allows object separation and shape detection. The Canny edge detector is regarded as one of the best edge detectors currently in use.

***The canny edge detection algorithm runs in 5 separate steps*:**

1. **Smoothing:** Blurring of the image to remove noise.
2. **Finding gradients:** The edges should be marked where the gradients of the image has large magnitudes.
3. **Non-maximum suppression:** Only local maxima should be marked as edges.
4. **Double thresholding:** Potential edges are determined by thresholding.
5. **Edge tracking by hysteresis:** Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.

The flow chart for the proposed approach is shown in Fig 1. It consists of five modules such as image acquisition, image pre-processing, line feature extraction, template generation, matching for legitimate person identification.

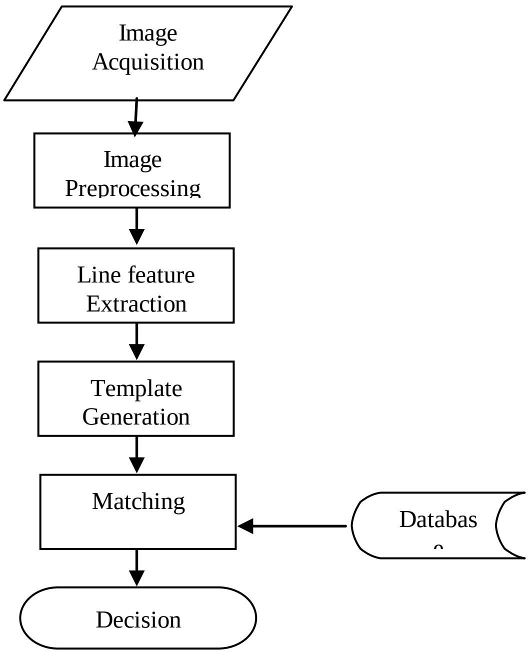


Fig.1 Flow Chart for the Proposed Approach

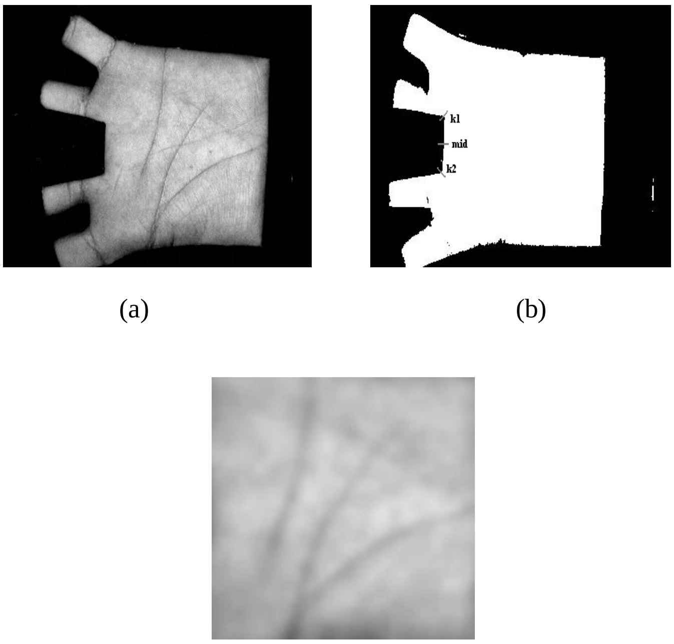
B. Image Acquisition

Image acquisition is the first step in a palmprint biometrics system. The proposed system uses the palmprint images from Poly_U palmprint database. The Poly_U database is prepared by Biometric Research Centre of Hong Kong Poly technique

University. The database consists of 7752 greyscale images from 193 users corresponding to 386 different palms in BMP image format. Around twenty samples from each of these palms were collected in two sessions. The images are captured by an online CCD-camera-based device.

C. Image Preprocessing

It is necessary to obtain sub-image from the captured palmprint image, and to eliminate the variations caused by rotation and translation. Hence after the image acquisition, the acquired image is subjected to pre-processing procedure. In pre-processing for extracting the sub-image or ROI, first images are rotated in uniform direction and they are smoothed using Gaussian filter. Then the smoothened image is blurred so that the image is prepared to extract palm lines effectively. The blurred palmprint image is binarized i.e. converted into black & white, in order to derive a single pixel wide palm lines of the palmprint image. To obtain a binary image from Gray level image Otsu's auto-thresholding method [14] is used. From the binary image, the mid point between fore finger and ring finger is found using 8-neighbourhood to obtain the sub-image from the centre of the palm. For that consider the number of pixels of an image in row wise ('X') and find the mid point by dividing the number of pixels by two (X/2). From the middle point scan towards right to get the point 'I' [B(x, y+1) =1].Move the pointer up from 'I' to get the corner point 'k1' and move the pointer down from 'I' to get another corner point 'k2'.Then find the middle point 'mid' between the corner points 'k1' and 'k2'.Move the pointer from the point 'mid' with the fixed number of pixels towards centre of the palm and position the fixed sized square to crop the image. As the centre of the palm contains more information the region of interest (ROI) or sub-image of size 160 × 160 is cropped from the centre of the palm.



(a) (b)

(c)

Fig. 2 (a) Original Image and (b) image with pixels k1,k2 and mid and (c) Region of Interest (ROI) of palmprint

D. Line Feature Extraction

After pre-processing, to extract line features i.e. principal lines from the sub-image or ROI the canny edge detection algorithm is used .First, a Gaussian blur is applied to the image to reduce noise. Thresholding can also be used if the objects of interest are significantly contrasted from the background and detailed textures are irrelevant. Next, the edge direction and gradients at each pixel in the smoothed image are determined by applying the Sobel-operator. For that first the gradient in the x- and y-direction is found respectively by applying the kernels is shown below.

$$K_{Gx} = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

$$K_{Gy} = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$$

The gradient magnitudes (also known as the edge strengths) is then determined as an Euclidean distance measure by applying the law of Pythagoras as shown in Equation (1). It is sometimes simplified by applying Manhattan distance measure as shown in Equation (2) to reduce the computational complexity.

$$|G| = \sqrt{G_x^2 + G_y^2} \quad (1)$$

$$|G| = |G_x| + |G_y| \quad (2)$$

where: G_x and G_y are the gradients in the x- and y-directions respectively.

However, the edges are typically broad and thus do not indicate exactly where the edges are. To make it possible to determine this, the direction of the edges must be determined and stored as shown in Equation (3).

$$\theta = \arctan\left(\frac{|G_y|}{|G_x|}\right) \quad (3)$$

Then edges are traced using that information. And the "blurred" edges in the image of the gradient magnitudes is converted to "sharp" edges by preserving all local maxima in the gradient image, and deleting everything else. Next double thresholding is done by marking the edge pixels stronger than the high threshold as strong and edge pixels weaker than the low threshold are suppressed and edge pixels between the two thresholds as weak. Finally, in this way parallel edges (principal lines) are extracted and those with weaker gradient strengths are eliminated. The extracted principal line and strong wrinkles shown in fig.3 are corresponds two parallel edges in Canny Edge Detection algorithm. This is because that

Canny Edge Detection algorithm is based on magnitude maximums of the gradient image.

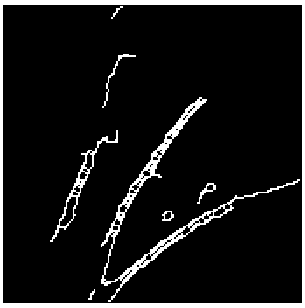


Fig. 3. The extracted principal lines and strong wrinkles

E. Template Generation

The principal lines extracted images are further divided into 9×9 blocks of size 20×20. The blocks are traced to create feature vector. While generating a template the feature vector bit is set to '1'if the concerned block contain the line else the feature vector bit is set to '0'.

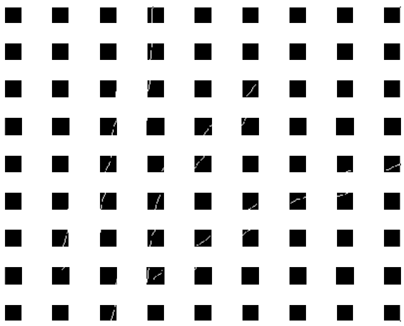


Fig. 4. The resultant image is divided into Blocks

F. Matching

For matching test sample feature vector is compared with feature vector of the enrolled templates, and checked with that template from which maximum similarity is obtained by taking the average similarity of all samples of particular user. Next matching is successful if the average similarity is greater than the threshold value otherwise unsuccessful match.

For identification, let us assume, T and E is the matrix of test palmprint sample and enrolled palmprint database. The images are partitioned into m sub-blocks respectively as.

$$T = t_{1,1}\ t_{1,2}\ t_{1,3,}\ldots\ldots t_{1,m}$$

$$e_{1,1}\ e_{1,2}\ \ldots\ldots\ e_{1,m}$$
$$e_{2,1}\ e_{2,2}\ \ldots\ldots e_{2,m}$$

$$E = \quad -$$
$$-$$
$$e_{n,1}\ e_{n,2}\ \ldots\ldots\ e_{n,m}$$

Where 'n' be the number of enrolled templates in database. The test sample palmprint T is assumed to be matched with enrolled template 'e' if the maximum similarity is obtained by taking average similarity of all samples of particular user. The matching is successful if the average similarity is greater than the threshold value otherwise unsuccessful.

If (Max (D_n) > H)) then
  Successful match
Else
  Unsuccessful match

Where 'Dn' is the average similarity and 'H' is threshold value, whose value is set based on trials.

III EXPERIMENTAL RESULTS

The proposed model of this paper is tested on palmprint database collected by the Biometric Research Centre of Hong Kong Polytechnic University from 100 individuals (10 images for each person). Among them, seven samples are used for training and remaining three samples are used for testing. For identification, each of the palmprint images was matched with all of the other palmprint images in the public database.

The performance of the proposed approach is evaluated using performance metrics i.e. FAR, GAR, FRR and Accuracy are shown in Table 1. False acceptance rate (FAR) is the percentage of invalid matches. FAR is defined as,

$$FAR = \frac{\text{Number of accepted imposter claims}}{\text{Total number of imposter accesses}} \times 100\%$$

(4)

The Genuine acceptance rate (GAR) is the percentage of genuine matches. The GAR is defined as,

$$GAR = \frac{\text{Number of accepted genuine claims}}{\text{Total number of genuine accesses}} \times 100\%$$

(5)

The False rejection rate (FRR) is percentage of genuine users rejected. The FRR is defined as,

$$FRR = 100\text{-}GAR\ (\%).$$
(6)

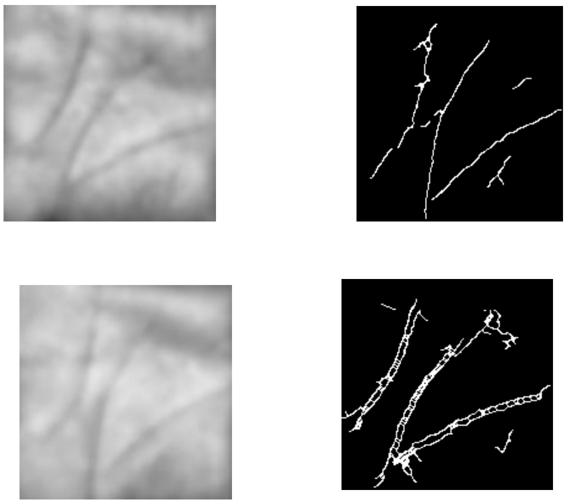
The Accuracy of the proposed approach is evaluated using the equation given below,

Accuracy = (100 – (FRR + FAR) / 2) (7)

Table.1. The FAR, FRR and Accuracy for the proposed approach

Number of users	FAR(%)	FRR(%)	Accuracy(%)
50	2	24	87
75	2	25.3	86.35
100	6.6	22	85.67

The below figure shows some results obtained by the proposed approach.



(a) (b)

Fig.5. (a).Original image (b) Principal lines extracted using proposed approach

From Fig.5, each palm-line corresponds to two parallel edges in Canny Edge Detection algorithm. This is because that Canny Edge Detection algorithm is based on magnitude maximums of the gradient image [9].The comparison of execution time between the Canny Edge Detection algorithm, Modified Finite Radon transform (MFRAT) is shown in Table 2.

Table.2. Comparison of execution time of different methods used for extracting principal lines

Methods	Execution tume	Accuracy(%)
The proposed method	270ms	85.67
MFRAT	410ms	95.00

From this we can see that the proposed approach is faster than the MFRAT.

IV. Conclusion

This paper presents a simple and efficient method to extract principal lines for personal identification. In preprocessing, images are smoothed and ROI was extracted. The Canny edge detection operation is proposed to extract principal line features. The edge direction and gradient strength of each pixel in the preprocessed image are found using Sobel masks. Then edges are traced using that information. Finally, non-maximum edges are suppressed by finding parallel edges and eliminating those with weaker gradient strengths. In this way principal lines are extracted and resultant image is obtained. The matching is done by dividing the resultant image into 9 X 9 blocks. The blocks are traced to create feature vector. While generating a template the feature vector bit is set to'1' if the concerned block contains the line. Personal identification is done based on the distance matching between the stored templates and the test palmprint image

The personal verification was performed on the Poly_U Palmprint database with 1000 samples from 100 individuals (10 per palm). The experimental results showed that the proposed method is faster than MFRAT but the accuracy is less than MFRAT, it will be improved in future.

REFERENCES

[1] De. Shuang. Huang, Wei. Jia, and David. Zhang,. *Palmprint verification based on principal lines*, Pattern Recognition, vol. 41, pp. 1316-1328, April 2008.

[2] Leqing Zhu, S.Z., Rui Xing,Yin Zhang. *Palmprint Recognition Based on PFI and Fuzzy Logic*, in Fifth International Conference on Fuzzy Systems and Knowledge Discovery, 2008. FSKD '08. . 2008.

[3] Leqing Zhu, Rui Xing. *Hierarchical Palmprint Recognition Based on Major Line Feature and Dual Tree Complex Wavelet Texture Feature*, Proceedings of the Sixth International Conference on Fuzzy Systems and Knowledge Discovery,2009, pp.15-19.

[4] Wei Jia, Yi-Hai Zhu, Ling-Feng Liu, De-Shuang Huang. *Fast Palmprint Retrieval Using Principal Lines*, Proceedings of the 2009 IEEE International Conference on Systems, Man, and Cybernetics, San Antonio, TX, USA - October 2009.

[5] W. Li, L. Zhang, D. Zhang, J.Q. Yan. *Principal line based ICP alignment for palmprint verification*, in: Proceedings of the International Conference on Image Processing, 2009.

[6] Cong Li, Fu Liu and Yongzhong zhang. *A Principal Palm-line Extraction Method for Palmprint Images Based on Diversity and Contrast*, Third International Congress on Image and Signal Processing (CISP2010),2010.

[7] Patprapa Tunkpien, Sasipa Panduwadeethorn, Suphakant Phimoltares. *Compact Extraction of Principle Lines in Palmprint using Consecutive Filtering Operations*, Proceedings of the Second International Conference on Knowledge and Smart Technologies ,July,24-25,2010.

[8] Feng Yue, Wangmeng Zuo, David Zhang. *ICP Registration Using Principal line and Orientation features for Palmprint Alignment*, Proceedings of 2010 IEEE 17th International Conference on Image Processing September 26-29, 2010, Hong Kong.

[9] Xiangqian Wu, Kuanquan Wang and David Zhang. *A Novel Approach of Palm-line Extraction*, in Third International Conference on Image and Graphics, 2004.

[10] D. Zhang, W.K. Kong, J. You, M. Wong. *On-line palmprint identification*, IEEE Trans. Pattern Anal. Mach. Intell. 25(9): pp. 1041-1050, 2003.

[11] J.F. Canny. *A computational approach to edge detection*, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 8, no. 6, pp. 679-698, 1986.

[12] PolyU Palmprint Database, http://www.comp.polyu.edu.hk /~biometrics.

[13] R.C. Gonzalez, R.E. Woods and S.L. Eddins. *Digital Image Processing using MATLAB*, Prentice-Hall, New Jersey, 2002.

[14] J. R. Parker. *Algorithms for Image Processing and Computer Vision*, John Wiley & Sons, Inc., 1997.