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Personal Identification Using Palmprint Biometrics Based on Line Approach

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***Abstract*- Palmprint is the one of the important biometrics characteristic with higher user acceptance. In palmprint, palm-lines are more important features for personal verification. In this paper, in preprocessing a Gaussian filter is used to smooth the image and next ROI is extracted based on valley points. The morphological bottom-hat operation is proposed to extract principal line features. The 8-connected component labeling is used to remove unwanted lines. And templates are generated by dividing the image into blocks. In which block lines are present, based on this matching is done. The accuracy of this proposed model is 86%**.

***Keywords*— Palmprint verification, Palm-line extraction, Biometrics, Image preprocessing**

I. INTRODUCTION

Automatic personal authentication using biometric information is playing an important role in 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, has several advantages compared with other currently available characteristics. The palmprints contain 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 characteristic 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 only can be extracted from the fine-resolution images. Principal lines and wrinkles, called line features, are the most clearly observable feature in low-resolution palmprint images.

The De-Shuang Huang, Wei Jia and David Zhang proposed a novel palmprint verification 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 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.

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 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 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 these surveys, new method is proposed for extracting principal lines. In this paper principal lines are extracted using bottom-hat operation in four different directions and merged all. The matching is done by dividing the image into block and set '1' in which block lines are present.

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 morphological bottom–hat operation is used for extracting the line features for personal verification in the proposed approach.

A. Morphological Operation

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size.

The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the *structuring element* used to process the image.

Mathematically, dilation is defined in terms of set operations [13]. The dilation of A by B, is defined as

$$A \oplus B = \{z \mid (B)_z \cap A \neq \emptyset\} \quad (1)$$

Where Ø is the empty set and B is the structuring element and A is input image.

The erosion of A by B, is defined as

$$A \Theta B = \{z \mid (B)_z \cap A^c \neq \emptyset\} \quad (2)$$

The morphological closing of A by B, denoted A•B, is a dilation followed by erosion:

$$A \bullet B = (A \oplus B) \Theta B \quad (3)$$

The Bottom-hat morphological operator subtracts the input image A from the result of morphological closing on the input image.

$$H = (A \bullet B) - A \quad (4)$$

The flow chart for the proposed approach is shown in fig.1. And it consists of five modules. Each module is described in subsequent different sections.

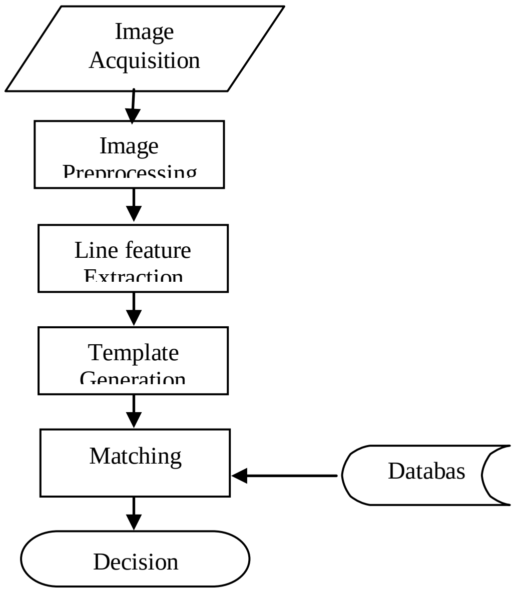


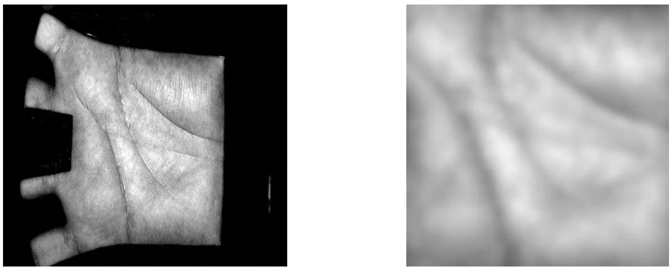
Fig.1 Flow Chart for the Proposed Approach

B. Image Acquisition

For the proposed approach images are taken from Hong Kong Poly technique University (Poly_U) database. The database consists of 7752 grayscale 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 preprocessing procedure. In preprocessing for extracting the sub-image or ROI, first images are smoothed using Gaussian filter. Then the blurred image is obtained and this is converted into binary image by thersholding. In the binary image, the mid point between fore finger and ring finger is found to obtain the sub-image from the centre of the palm. Because the center of the palm contain more information. Based on this mid point the region of interest (ROI) or sub-image of size 180 × 180 is cropped.



(a) (b)

Fig. 2 (a) Original Image and (b) 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 bottom-hat morphological operation is applied in four different directions (i.e. 0, 45, 90 and 135 degree). And the 8-connected component labeling is used to remove unwanted short lines. In 8-connected component labeling, connected lines are labeled and count the number of pixels of the line. If number of pixels of the line is less than threshold, those lines are considered as unwanted lines and removed. The lines extracted in four different directions are merged and final principal lines are obtained as shown in Fig.3.

Fig. 3 Extracted Principal Lines

E. Template Generation

The principal lines extracted images are further divided into 9×9 blocks of size 20×20. In which block line present, set those block as ‘1’ and remaining block as ‘0’.

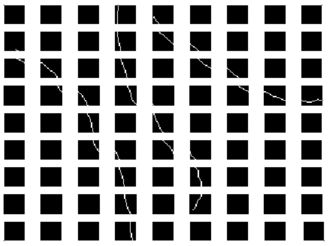


Fig. 4. Divided into Blocks

F. Matching

For matching test sample blocks are compared with blocks of the enrolled templates. And checked with which template maximum similarity is obtained by taking the average for similarity of all samples of particular user. Next check whether this average similarity is greater than the threshold value. Based on this matching decision is done.

For verification let 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.

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

$$E = \begin{pmatrix} e_{1,1}\ e_{1,2}\ \ldots\ldots\ e_{1,m} \\ e_{2,1}\ e_{2,2}\ \ldots\ldots e_{2,m} \\ - \\ - \\ - \\ e_{n,1}\ e_{n,2}\ \ldots\ldots\ e_{n,m} \end{pmatrix}$$

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

$$D = \frac{\sum_{i=1}^{S}\sum_{j=1}^{m} t_{1,j} == e_{i,j}}{S} \qquad (5)$$

Where ‘S’ is the number samples of particular user.

$$Match = Max\ (D_n) > T \qquad (6)$$

Where ‘T’ is threshold value 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 verification, each of 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 I. False acceptance rate (FAR) is the percentage of invalid matches. FAR is defined as,

$$FAR = \frac{\text{Number of accepted imposter claims}}{\text{Total number of imposter accesses}} \times 100\% \quad (7)$$

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

$$GAR = \frac{\text{Number of accepted genuine claims}}{\text{Total number of genuine accesses}} \times 100\% \quad (8)$$

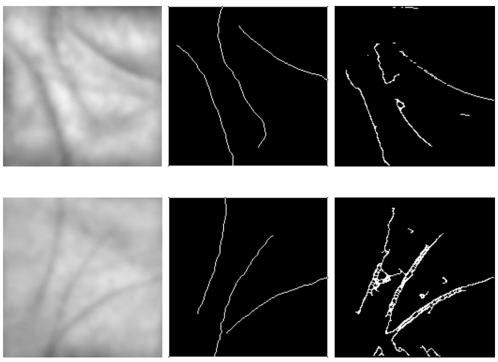
The False rejection rate (FRR) is percentage of genuine users rejected. FRR is same as **100-GAR** (%). The Accuracy of the proposed approach is evaluated using the equation (9).

$$Accuracy = (100 - (FRR + FAR) / 2) \quad (9)$$

TABLE I
THE FAR, FRR AND ACCURACY FOR THE PROPOSED APPROACH

Number of user	FAR	FRR	Accuracy
25	2	15	91.05
50	2	24	87.00
75	2	25.3	86.35
100	6.66	22	85.67

The figure shows some results obtained by the proposed approach and Canny Edge Detection algorithm. The fig5.a shows the original images, fig5.b shows the result of the proposed approach and fig 5.c shows the result of the Canny Edge Detection Algorithm.



(a) (b) (c)

Fig. 5 (a).Original image (b) Principal lines extracted using proposed approach (c) Principal lines extracted using Canny Edge Detection algorithm

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]. But the proposed approach has no this problem because it is based on the bottom-hat morphological operation. The comparison between the Canny Edge Detection algorithm and proposed approach is shown in Table II.

TABLE II
COMPARISON OF ACCURACY AND EXECUTION TIME OF DIFFERENT METHODS USED FOR EXTRACTING PRINCIPAL LINES

Methods	Accuracy	Execution time
Proposed Method	85.67%	270ms
Canny Edge Detection	80.65%	299ms

From this we can see that the performance of the proposed approach is better than the Canny Edge Detection algorithm.

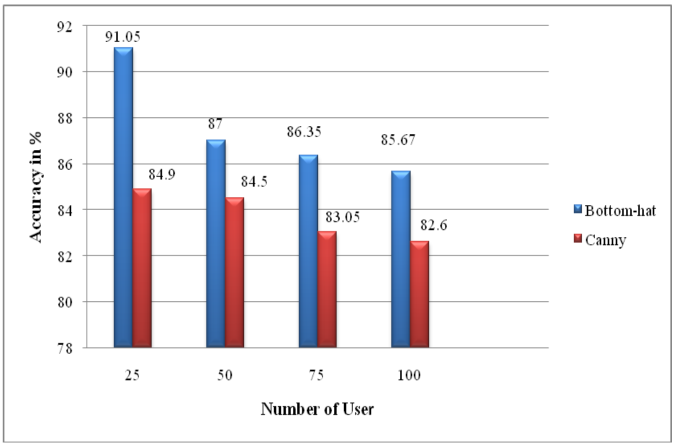


Fig. 6. Comparative results of Accuracy for proposed approach i.e. Bottom-hat and Canny Edge Detection Algorithm

IV. CONCLUSION

This paper presents the simple and efficient method to extract principal lines for personal verification. In preprocessing, images were smoothed and ROI was extracted. The bottom-hat morphological operation was applied in four different directions to extract principal line. The 8-connected component labeling was used to remove unwanted lines. The matching was done by dividing the image into blocks and comparing the blocks in which line present. 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 better than Canny Edge Detection algorithm.

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