A Novel Palm Line Extraction and Matching For Personal Identification

HosseinSalimi,SaiedFazli

***Abstract*—Palmprint-based personal identification is regarded as an effective method for automatically recognizing a person's identify. It is well-known for several advantages such as stable line feature, low-resolution imaging, low-cost capturing device, and user friendly. This paper presents a novel approach to palm line matching used in personal authentication. In theproposed method, images are resized then compared to the dataset for best match.In this paper, after cropping region of interest (ROI) palm-line is extracted from the ROI, using gradient magnitude, gradient direction and morphological operation. In the matching stage, test and train images are resized to smaller size to calculate the similarity between two palmprintsresulting in better robustness even with slight rotations and translations. Experimental results for identification on IITD (Indian Institute of Technology Delhi) palmprintdatabase show effectiveness of the proposed method. Accuracy of 97.3 percent is obtained which is 1.64 percent above the method applied in [2].**

***Index Terms*—Biometric, ROI extraction, principle line, line extraction, line matching**

I. INTRODUCTION

Biometric is the science of measuring human's characteristics for the purpose of authenticating or identifying the identity of an individual based on specific physiological or behavioral characteristics. Several types of physiological characteristics used in biometric are appearance of face, hand geometry, fingerprint, iris and palm print. The most widely used biometric feature is the finger print and the most reliable feature is the iris. However it is very difficult to extract small unique features such as minutiae from unclear finger prints and the iris input devices are very expensive [1]. Other biometric features, such as the face and the voice, are as yet not sufficiently accurate. Compared with all of these, the palm print, a relatively new biometric feature, has several advantages [3]. Palm prints contain more information than fingerprints, so they are more distinctive. Palm print capture devices are much cheaper than iris devices. Further, palm prints contain additional distinctive features such as principal lines and wrinkles, which can be extracted from low-resolution images by combining all the features of palms, such as palm geometry, ridge and valley features, and principal lines and wrinkles, it is possible to build a highly accurate biometrics system[2].

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Zhang et al. used two-dimensional (2-D) Gabor filters to extract texture features from low-resolution palm print images captured using a charge-coupled device (CCD) camera and employed these features to implement a highly accurate online palm print recognition system[4].

Huang et al. proposed a two-level modified finite radon transform and a dynamic threshold to extract major wrinkles and principal lines. Two binary edge maps are compared based on a matching scheme called pixel-to-area comparison [5].

Wu et al. designed two masks to compute the vertical first-order derivative and the second-order derivative of palm print images. The directional first-order and second-order derivatives can be obtained by rotating the two standard marks. They use the zero-crossings of the first-order derivatives to identify the edge points and corresponding directions. The magnitude of the corresponding second-order derivative is considered as the magnitude of the lines. They retain only the positive magnitude because palm lines are valleys. The weighted sum of the local directional magnitude is regarded as an element in the feature vector. This feature is normalized by its maximum and minimum components. Euclidean distance is used for matching [6].

Leung et al. employ Sobel masks to extract palm lines and line segment Hausdorff distance to compare two palm prints [7]. Rafael Diaz et al. use Sobel masks and morphologic operator as two separated feature extractors to obtain the gradient of the images [8]. These feature values are classifiedby neural networks.Han et al. proposed using Sobel and morphological operations to extract the line like features from palm print images obtained using a scanner [9].

Pedro et al. employ Sobel masks to enhance edge information and the statistical information in the processed images is used to estimate an optimal threshold for extracting the edges. The authors then utilize a thinning algorithm to further process the edges. Several descriptors of the edges are computed as features for matching [10].

In this paper main purpose is to increase accuracy by resizing images to smaller size in the palm matching. Reducing the size of image remove noises and robust it to vibrations.

The rest of paper is organized as follows. Section II discusses proposed method including preprocessing, line extraction and palmprint matching. SectionIII contain experimental result. Section IV we talk about conclusion.

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II. Proposed Method

In Fig.1 the block diagram of implemention of proposedmethod is shown.

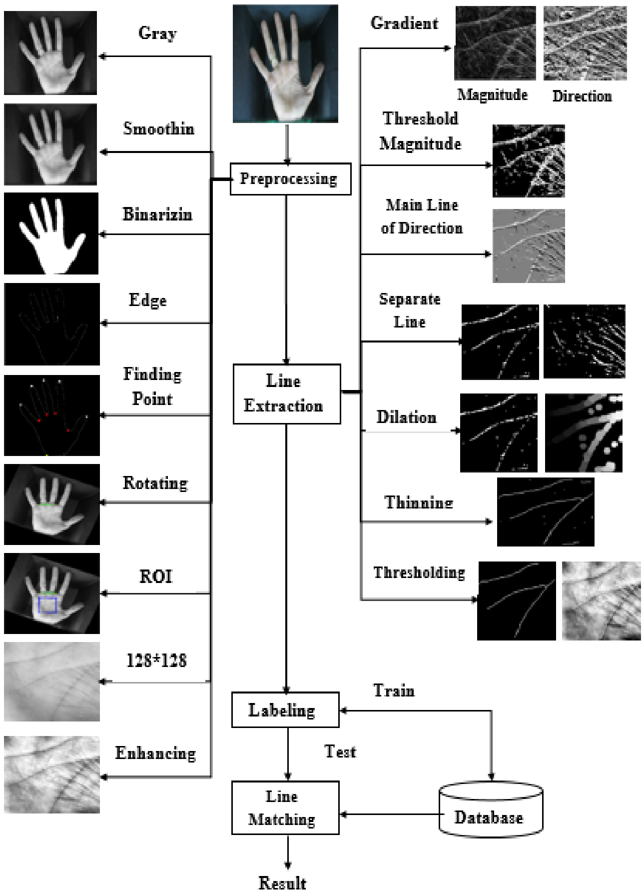

Figure 1: Block diagram of the proposed method

A. *Preprocessing*

When palmprint images are captured by a device, a little displacement and rotation of hand are caused to meet different palms. Thus, it is necessary to align the original image. On the other hand, a central area of the palmprint image has enough information to represent palmprint features.

First, image is converted to gray and is smoothed by way of Gaussian filterto remove noise in the border of hand region. Thenistransformed into a binary image and canny edge detector is appliedtobinaryimage, to extract boundary of thehand. Result of this process is shown in Fig.2.

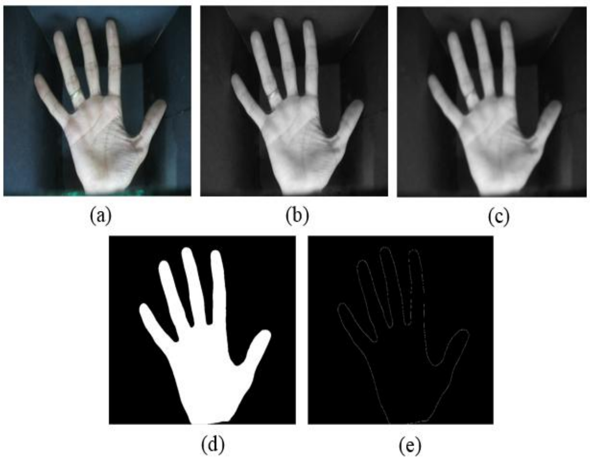

Figure 2:(a). Original image (b). Convert to gray (c). Smoothing (d). Binary image (e). Edge detection

Next step is finding the reference point.The reference point consists of valley point, finger tip [11].We considered a point at the wrist boundary as a stable reference point because the points of the wrist boundary are the least affected by the rotation of the hands.To find Peak and valley point coordinates,contour of the hand boundery is extracted and then distance of all extracted point, are calculated relative to the reference point by using Euclidian distance (eq.1).

$$Eq = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (1)$$

(x_1,y_1) and (x_2,y_2) are the coordinate of two point.

Because not use any pegs in IITD database, capturing image have different rotation and Translation. Therefore, before cropping images, full hand images is rotated at particular angle. For align images in same direction, we calculate angle between two valley point (valley of little and ring finger and valley of middle and index finger) and rotate the image with calculated angle.Result of this process is shown in Fig.3 (d, e).

for extract ROI, The distance between two valley points is calculated then new points in the 1/3 of calculated distance of two valley points (see Fig.3 (f)) is found.Extract the sub-image, based on coordinate system as shown in Fig.1(f). Then, fixed all extracted sub-images size to 128*128 (Fig.3 (g)).

As it can be seen,palmprint lines in the cropped images are blurry. It is not easy to distinguish them from background. Splits the image into small rectangular areas, and enhances the contrast of these areas by adjusting their local histograms. After image enhancement, the lines are clear and easy to recognize (Fig.3 (h)).

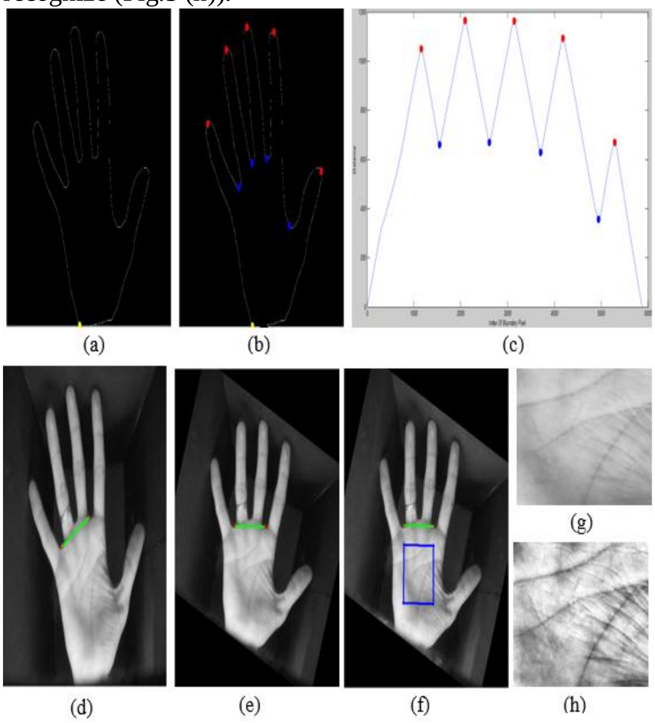

Figure 3:(a). Reference point (b). Finding peak and valley point (c). Distance plot (d). Find two valley point for calculate angle (e). Rotated image (f). Crop ROI (g). 128*128 cropped image (h). Enhanced image

B. *Palm Line Extraction*

It is well known that palm lines consist of wrinkles and principal lines. And principal lines can be treated as a separate feature to characterize a palm. Therefore, there are

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several reasons to carefully study principal lines based approaches. At first, principal lines based approaches can be jointly considered with the person’s habit. For instance, when humanbeings are comparing two palm-prints, they instinctively compare principal lines. Secondly, principal lines are generally more stable than wrinkles. The latter, is easily masked by bad illumination condition, compression, and noise. Finally, principal lines can act as an important component in multiple features based approaches. However, principal lines based approaches have not been studied adequately so far. The main reason is that it is very difficult to extract principal lines from complex palmprint images, which contain many strong and long wrinkles [5]. The following steps are designed to extract principle lines:

Firstly, 3x3 sobel mask is convolved tooriginal image intwo directions (0º and 90º)to find horizontal and vertical lines. Then gradient magnitude (G) and gradient direction (θ) iscalculated using (2) and (3), respectively. Fig.4 shows the steps of extracting gradient magnitude and direction.

$$|G| = \sqrt{I_x{}^2 + I_y{}^2} \tag{2}$$

$$\theta = \tan^{-1}\left(\frac{I_x}{I_y}\right) \tag{3}$$

Where $I_x$and I_y are convolved images in horizontal and vertical direction.

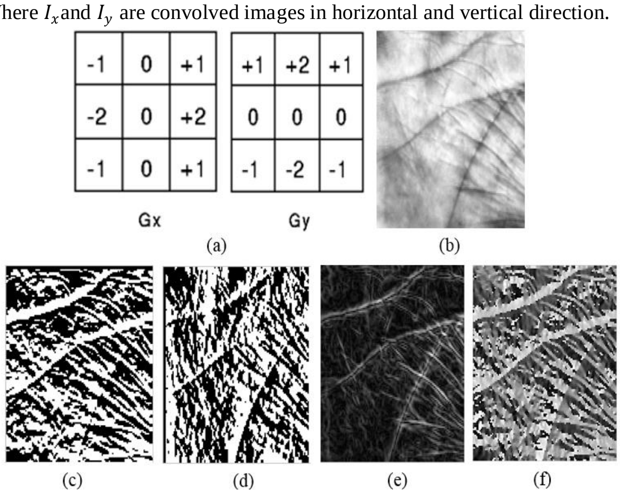

Figure 4:(a). 3*3 Sobel operator in (0, 90) direction (b). Original image (c, d). Sobel images in (0, 90) direction (e). Gradient Magnitude image (f). Gradient Direction image

After calculating of gradient magnitude image, an optimal thresholdis chosen using histogram to maintain strong edges (Fig.5 (a)). The gradient magnitude binary imageis multiplied to direction image, in order to maintain important line angles, related to direction image (Fig.5 (b)). Since, line image contain strong wrinkle we can remove them by direction criterion. Mostly, direction of most wrinkles differ from principal lines. For example if the directional principle lines belong to [0… 90), approximately, the directional of most wrinkles will be at [90… 180) approximately and vice versa [5]. In this article the principle lines was in (90… 180] rang (Fig.5 (c, d)).After extract principle lines approximately, dilation operator is applied to image to fill small holes (Fig.6 (b)).Finally,thinning processes isusedto erode the outer layers of pixel until no more layers can be removed (Fig.6 (c)). As it canbe seen in this figure, some wrinkles lines still exist in image. For removing them we choose a threshold. Fig.6 (d) showsextracted principle lines.

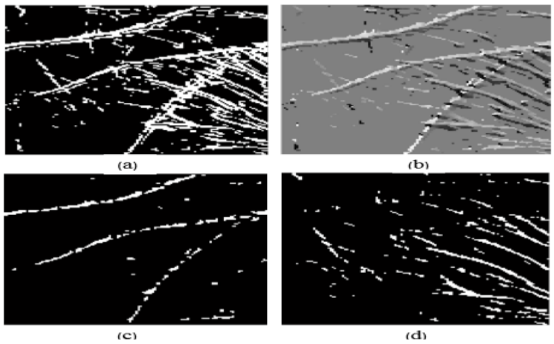

Figure 5: (a). Binaries Magnitude image (b). Direction image with important line angles (c). Principle Line angles in [90...180] range (d). Wrinkle Line angles in [0...90) range

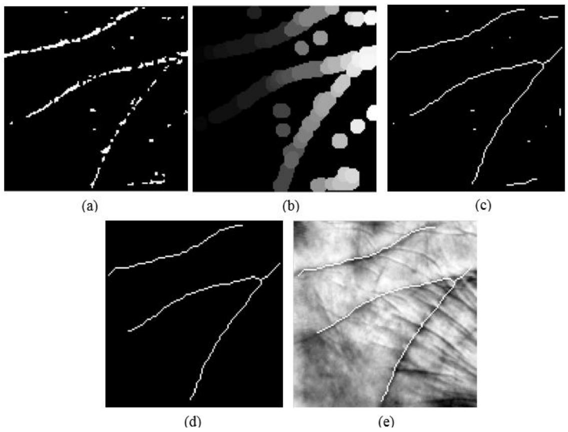

Figure 6: (a). Principle lines (b). Dilation image (c). Thinning image (d). Principle line (f). Draw line in original image

In Fig.7 is shown some principle lines for three person.

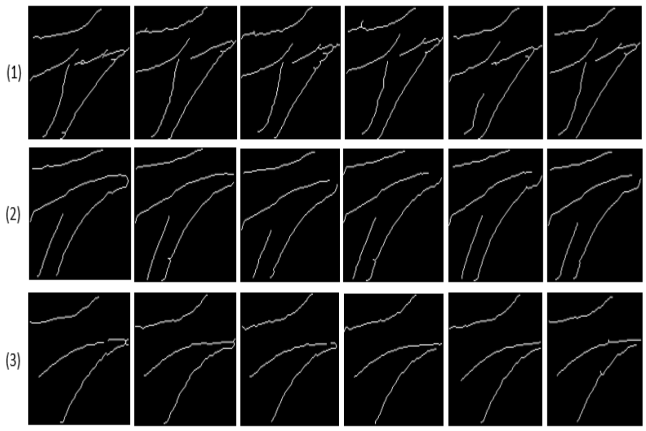

Figure 7:extracted principle line for three person with six different hand images

C. Palm Line Matching

In the palm matching, the main purpose is to find a good similarity between test and training images. This paper proposed a new method for palm line matching by resizing image to asmaller size. In this method, is used the pyramid theory as in [12]: "A common characteristic of images is that neighboring pixels are highly correlated. To represents the image directly in terms of the pixel values is therefore inefficient: most of the encoded information is redundant. The first task in designing an efficient, compressed code is to find a representation which, in effect, de-correlates the image pixels". Therefore, it can remove noises and berobust to vibrations. As it can be seen in Fig.8, with the higher pyramid, we can maintain the basic structure of principle

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lines and remove noises.

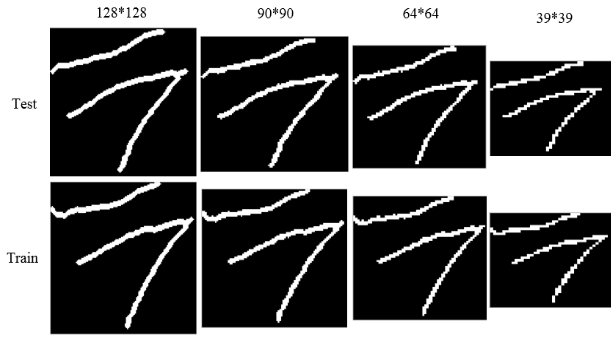

Figure 8: principle line with different size

For matching principle lines, test and train images is resized in smaller size. Usually after resizing operation, some sample of principle lines removed. Therefore, before resizing operation, images must be dilated with morphological operation (Fig.9). By the way, due to preprocessing, might occur a little translations in images. In order to overcome this problem, vertical and horizontal translation of train image is required, thentheresultingimageismatched withthetestimage. The vertical and horizontal translations are performed from (-2 to 2) pixel. Finally, the maximum value of accuracy is obtained from translated matching and is considerd as the final matching score. The matching score from L to C is defined as follows:

$$S(L,C) = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} L_{Dr} \cap C_{Dr}}{N_{L_{Dr}}} \quad (4)$$

Where $\cap$ is the logical "AND" operation, $N_{L_{Dr}}$ is the number of points on detected principle lines in dilated and resized test image, L_{Dr} and C_{Dr} are, dilated and resized test and train images respectively, and M*N is image size. By the way, index of D and r represents, dilation and resized respectively.

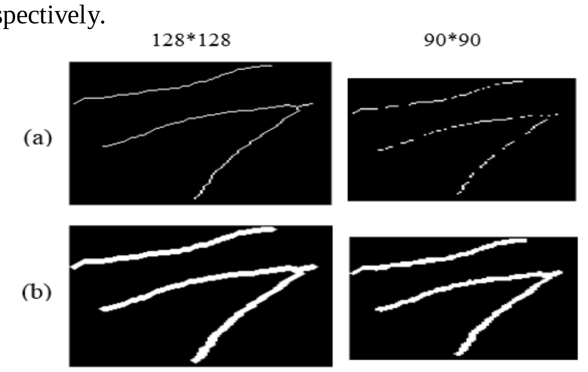

Figure 9: resize image (a). Without dilation (b). With dilation

III. Experimental Result

We use of IIT Delhi touchless palmprint database. This database consist of the hand images collected from the students and staff at IIT Delhi, India. This database contains left and right hand images from more than 230 subjects, using a very simple touchless imaging setup.468 right hand images corresponding to 78 different palmsarechosenforthisstudy.

Fig.10 shows the process of matching between different images of same hand. As it can be seen, when there is no any translating and resizing operation, the accuracy of matching is low. After translating train image and matching with test image (without resizing), the accuracy is improved. But best matching score is occurred when images are resized and translated.

In Table (1) we implement the methodin [2]. In this method test images first rotate in (-2, 2) angles, then all direction collected with "OR" logical operation and dilate forfill holes. In next step, train images translate vertically and horizontally in the range of (-5, 5) pixels (the step is 1 pixel).

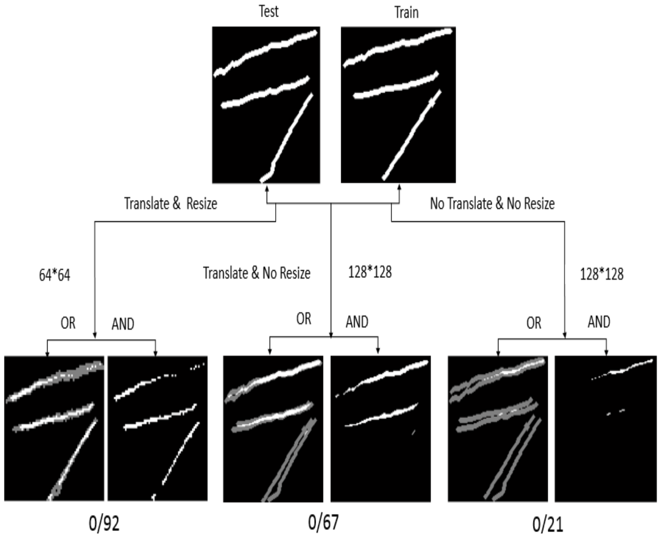

Figure 10: matchingwithdifferenttranslationandresizing

In Table 2 we proposed our method. Firstly, test image isdilated and resized. Then train image after dilation and resizing, is translated in the range of (-2, 2) pixels like method [2]. Accuracy for different size of images are calculated. It can be seenwhen the image is smaller, the accuracy of system increases, in the other word principle lines becomes more robust to noise and scale variation. Best result occurs when size of images are 39*39 pixels.

In addition of improved accuracy in proposed method, Number of translations state is reduced significantly compared method [2], too. In method [2] number of translation for each train image is 100 while in the proposed method this number is reduced to 25 for each train image.

Table 1: method in [2] with 3 Train and 3 Test

…............	**Dimension**	**Accuracy**
Method in[2]	128*128	95.66

Table 2: Proposed method with 3 Train and 3 Test

Resize Value	**Dimension**	**Accuracy**
Original Size	128*128	83.3
0.9	116*116	90
0.7	90*90	94.7
0.5	64*64	96
0.3	**39*39**	**97.3**
All size(0.9, 0.7, 0.5, 0.3)	………………………	96.67

IV. Conclusion

In this paper, we propose a novel approach to palm line matching for personal identification. Firstly 128*128 pixels ROI image is cropped, then the light condition is adjusted till the quality of the image is good enough for successful line extraction. Gradient direction, gradient magnitude, Dilation morphology and thinning operation are applied for line extraction. For palm line matching test and train images are resized and matched. Resized images are used in palm line matching based on pyramid theory. The experimental

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results, show a better accuracy rate compared to the previous work.

V. Reference

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