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Palm Print Feature Extraction and Authentication Using 2-D Gabor Filter

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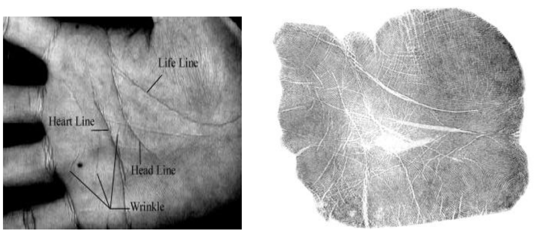
Abstract: A new technique of biometric technology is palm print identification which is based on feature extraction from palm used for personal identification. In this paper the feature extraction are carried out by using technique of texture based feature extraction. For low quality images powerful feature extraction method is necessary. So, 2D Gabor filter used to get texture information. This is very useful and advantageous technique for security purpose.

Keywords: Palm print, Authentication, Gabor, Feature Extraction.

I. INTRODUCTION

Palm print is becoming most essential and relatively large biometric identifier as compared to other biometric traits such as fingerprint, iris, face, retina, signature and DNA. Palm print identification has various advantages (1) low resolution imaging (2) stable line feature (3) high user acceptance. Earlier techniques like fingerprint identification and iris and retina reorganization requires high accuracy but there are some problems with these prior technologies. In palm print feature extraction considered geometrical features are wrinkles, ridges and principle lines singular point, textures etc. Palm print authentication can be done in a two way i.e. Online and offline. Fig 1 (a) and (b) shows offline and online methods.



(a) (b)

Fig.1 online and offline palm print scanning

In offline palm print verification system, all samples are inked on paper and through digital scanner transmitted to computer. It requires high resolution where lines, datum points and singular points can be extracted. In online palm print verification system samples directly obtained by palm prints canner. It is low resolution technique. In this image size is reduced comparable with fingerprint images. Online identification used for many real time applications. Palm print identification system consist of five models, (1) palm print acquisition (2) pre-processing (3) feature extraction (4) matching (5) storage.

The five modules are described below:

1) Palm print Acquisition: A palm print image is captured by our palm print scanner and then the AC signal is converted into a digital signal, which is transmitted to a computer for further processing.
2) Pre-processing: A coordinate system is set up on basis of the boundaries of fingers so as to extract a central part of a palm print for feature extraction.
3) Textured Feature Extraction: We apply a 2-D Gabor filter to extract textural information from the central part.
4) Matching: A distance measure is used to measure the similarity of two palm prints.
5) Database: It is used to store the templates obtained from the enrolment phase. Palm print authentication operates in two modes, (1) enrolment and (2) verification.

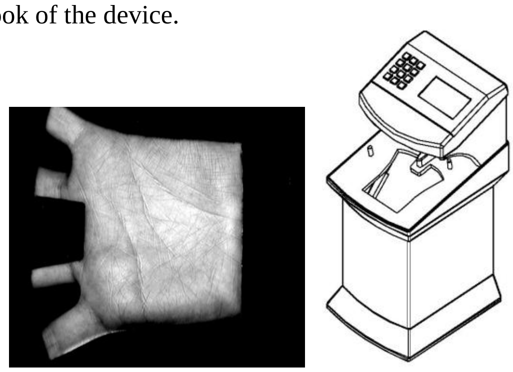
In this paper we are using 2D Gabor filter to obtain texture information and the textural extraction method is used for personal authentication. The experimental result illustrates the effectiveness of this method.

II. METHODOLOGY

Following is the methodology that we follow during palm print recognition.

A. Palm print Acquisition

Recently, a CCD based palm print capture device has been developed by us [25]. Fig. 2(a) shows a palm print image captured by our palm print scanner and Fig. 2(b) shows the outlook of the device.



(a) (b)

Fig.2 a) palm print image captured b) outlook of device

Note that a low-resolution technique (75 dpi) is adopted to reduce the image size, which is comparable with

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fingerprint images even though a palm is much larger than a fingerprint. It is evident that on-line identification is more important for many real-time applications, so that it draws our attention to investigate.

B. Palm print Image Pre processing

In an image pre-processing, it is necessary to obtain a sub-image from the captured palm print image and to eliminate the variations caused by rotation and translation. The five main steps of palm print image pre-processing are as shown in fig.3.

Step 1: Apply a low-pass filter to the original image. Then use a threshold, *Tp*, to convert this original image into a binary image as shown in Fig. 3(b). Mathematically, this Transformation can be represented as

$$B(x,y)=1 \text{ if } O(x,y)*L(x,y)\geq T_p \qquad (1)$$

$$B(x,y)=0 \text{ if } O(x,y)*L(x,y)<T_p \qquad (2)$$

Where *B(x,y)* and *O(x,y)* are the binary image and the original image, respectively; *L(x,y)* is a low pass filter, such as Gaussian, and “□” represents an operator of convolution.

Step 2: Extract the boundaries of the holes, ($F_i x_j, F_i y_j$),(i=1.2), between fingers using a Boundary-tracking algorithm. The start points, (Sx_i, Sy_i), and end points (Ex_i, Ey_i), of the holes are then marked in the process as shown in Fig. 3(c).

Step 3: Compute the centre of gravity (Cx_i, Cy_i), of each hole with the following equations:

$$Cx_i = \frac{\sum_{j=0}^{M(i)} F_i x_j}{M(i)} \qquad (3)$$

$$Cy_i = \frac{\sum_{j=0}^{M(i)} F_i y_j}{M(i)} \qquad (4)$$

Where *M(i)* represents the number of boundary points in the hole, *i*. Then construct a line that passes through (Cx_i, Cy_i)and the midpoint of(Sx_i, Sy_i)and (Ex_i, Ey_i).

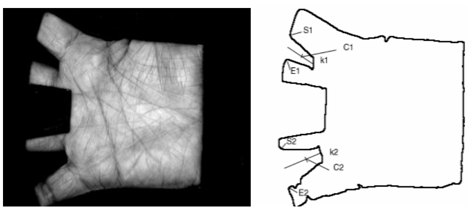
The line equation is defined as

$$y=x\frac{(Cy_i - My_i)}{(Cx_i - Mx_i)}+\frac{My_i\, Cx_i - Mx_i\, Cy_i}{Cx_i - Mx_i} \qquad (5)$$

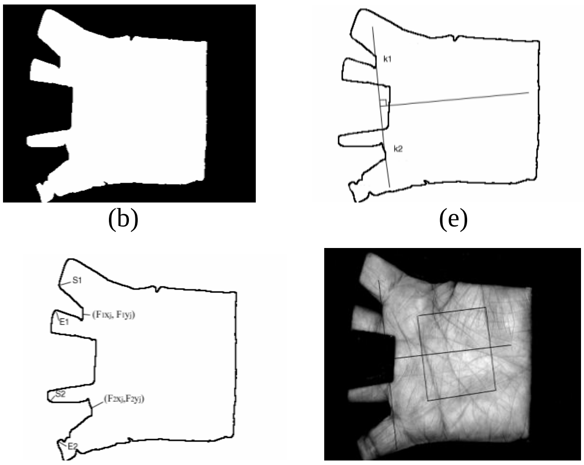
Where (Mx_i, My_i) is the midpoint of (Sx_i, Sy_i)and (Ex_i, Ey_i). Based on these lines, two key points, *(k1, k2)*, can easily be detected (see Fig. 3(d)).

Step 4: Line up *k1* and *k2*to get the Y-axis of the palm print coordinate system and make a line through their mid-point which is perpendicular to the Y-axis, to determine the origin of the coordinate system (see Fig. 3(e)). This coordinate system can align different palm print images.

Step 5: Extract a sub-image with the fixed size on the basis of coordinate system, which is located at the certain part of the palm print for feature extraction (see Fig. 3(f)).



(a) (d)



(b) (e)

(c) (f)

Fig.3 five steps of palm print image processing

C. Palm print Feature Extraction By Texture Analysis

This defines our palm print feature extraction method, which includes filtering and matching.

C.1 Gabor Function

Gabor filter, Gabor filter bank, Gabor transform and Gabor wavelet are widely applied to image processing, computer vision and pattern recognition. This function can provide accurate time-frequency location governed by the “Uncertainty Principle”. A circular 2-D Gabor filter in the spatial domain has the following general form,

$$G(x,y,\theta,u,\sigma)=\frac{1}{2\pi\sigma^2}exp\left\{-\frac{x^2+y^2}{2\sigma^2}\right\}exp\{2\pi i(uxcos\,\theta+uysin\,\theta)\} \qquad (6)$$

Where $i=\sqrt{-1}$; *u* is the frequency of the sinusoidal wave; θcontrols the orientation of the function and σ is the standard deviation of the Gaussian envelope. Such Gabor filters have been widely used in various applications. In addition to accurate time-frequency location, they also provide robustness against varying brightness and contrast of images. Furthermore, the filters can model the receptive fields of a simple cell in the primary visual cortex. Based on these properties, in this paper, we try to apply a Gabor filter to palm print authentication.

C.2 Filtering and Feature Extraction

Generally, principal lines and wrinkles can be observed from our captured palm print images (see Fig. 1(a)). Some algorithms such as the stack filter can obtain the principal lines. However, these lines do not contribute adequately to high accuracy because of their similarity amongst different palms. Fig. 4 shows six palm print images with similar principal lines. Thus, wrinkles play an important role in palm print authentication but accurately extracting them is still a difficult task. This motivates us to apply texture analysis to palm print authentication. In fact, a Gabor function, G(x, y, θ, u, σ) with a special set of parameters (σ, θ, u), is transformed into a discrete Gabor filter, G[x, y, θ, u, σ]. The parameters are chosen from 12sets of parameters listed in Table 1 based on the experimental results in the next section. In order to provide more robustness to brightness, the Gabor filter is turned to zero DC (direct current) with the application of the following formula:

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$$\breve{G}[x, y ,\theta,u,\sigma]=G[x, y ,\theta,u,\sigma] - \frac{\sum_{i=-n}^{n}\sum_{j=-n}^{n} G[i,j,\theta,u,\sigma]}{(2n+1)^2} \quad (7)$$

Where $(2n+1)^2$ is the size of the filter. In fact, the imaginary part of the Gabor filter automatically has zero DC because of odd symmetry. The sample point in the filtered image is coded to two bits, *(br, bi)*, by the following inequalities,

$$br=1 \text{ if } \mathrm{Re}[\tilde{G}[x, y ,\theta,u,\sigma]*I]\geq 0, \quad (8)$$

$$br=0 \text{ if } \mathrm{Re}[\tilde{G}[x, y ,\theta,u,\sigma]*I]<0, \quad (9)$$

$$bi=1 \text{ if } \mathrm{Im}[\tilde{G}[x, y ,\theta,u,\sigma]*I]\geq 0, \quad (10)$$

$$bi=0 \text{ if } \mathrm{Im}[\tilde{G}[x, y ,\theta,u,\sigma]*I]<0, \quad (11)$$

Where I is the sub-image of a palm print. Using this coding method, only the phase information in palm print images is stored in the feature vector. The size of the feature is 256 bytes.

C.3 Palm print Matching

In palm print matching process, each feature vector is considered as two 2-D feature matrices, real and imaginary. Palm print matching is based on a normalized hamming distance. Let P and Q be two palm print feature matrices. The normalized hamming distance can be defined as,

$$D_0 = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}(P_{R(i,j)}\otimes P_{I(i,j)}\otimes Q_{I(i,j)})}{2N^2} \quad (12)$$

where $P_R(Q_R)$ and $P_I(Q_I)$ are the real part and the imaginary part of P (Q), respectively; the Boolean operator, "⊗", is equal to zero if and only if the two bits, *PR(I)(i,j)* and *QR(I)(i,j)* are equal and the size of the feature matrices is $N\times N$. It is noted that *Do* is between 1 and 0. The hamming distance for perfect matching is zero. In order to provide translation invariance matching, Eq. (12) can be improved as

$$D_{min} = \frac{\sum_{i=\max(1,1+s)}^{\min(N,N+s)}\sum_{j=\max(1,1+t)}^{\min(N,N+t)}(P_R(i+s,j+t)\otimes)Q_R(i,j) + P_I(i+s,j+t)\otimes Q_I(i,j))}{2H(s)H(t)} \quad (13)$$

Where $S=2$ and $T=2$ control the range of horizontal and vertical translation of a feature in the matching process, respectively and

$$H(s)= \min(N,N+ s)- \max(1,1+ s) \quad (14)$$

The hamming distance, *Dmin*, can support translation matching; nevertheless, because of unstable pre-processing, it is not a rotational invariant matching. Therefore, in enrolment mode, the coordinate system is rotated by a few degrees and then the sub-images are extracted for feature extraction. Finally, combining the effect of pre-processing and rotated features, Eq. (13) can provide both approximately rotational and translation invariance matching.

III.EXPERIMENTAL RESULTS

A. Palm print Database

For this experiment, we have a palm print database which contains 4647 palm print images which are taken from 120 persons by using palm print scanner. This database contains 43 images of female, 111 of less than 30 years old, 2 of more than 50 years old. Each one gives10 images of their right palm and 10 images of left palm in each of two occasion.81 days' time difference are for first and second occasion. The minimum of 4 days and maximum of 162 days. These images are in two sizes that is 384×284 and 768× 568.Also the large images are resized to 384×284.For this experiment all the test images are of 384×284 with 75 dpi resolution. After this only the centre part of the test image is extracted having size of 128×128 called DBI. Now DBI is resized to 64×64 called DBII. Buying DBII also the low resolution palm print images can used for personal identification. Nine typical images from our database are shown in Fig (4).

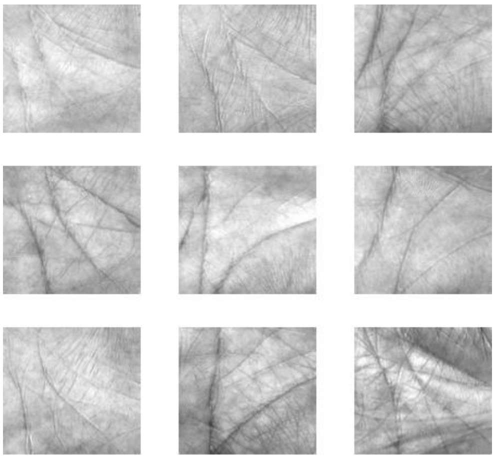

Fig.4 Nine typical images from DBI.

B. Verification Test

For verification each of the images in DBI (DBII) is matched with all other palm print images in the same database. A matching is counted as a correct matching if two palm print images are collected from the same palm; otherwise it is an incorrect matching. The total number of matchings for one verification test is 10,794,981. 43,660 of them are correct matchings and rest of them are incorrect matchings. There are 16 images are tested. Table 1 shows matching score and total time elapsed in second.

Table 1: Input Palm Print their matching scores and Time elapsed in seconds

Image Number	Matching Score	Total Time elapsed in second
1	94.5929	0.144616
2	98.8597	0.14411
3	62.2748	0.128504
4	99.4281	0.126648
5	86.2688	0.12814
6	61.1362	0.125711
7	69.5922	0.131949
8	82.2009	0.127965
9	101.451	0.123784
10	101.637	0.126795
11	63.9106	0.12675
12	102.032	0.14815
13	31.375	0.127188
14	24.2806	0.12635
15	29.0042	0.126761
16	19.1283	0.124324

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C. GUI Implementation

For personal authentication fig shows the GUI for authorised user identification and unauthorised user identification.

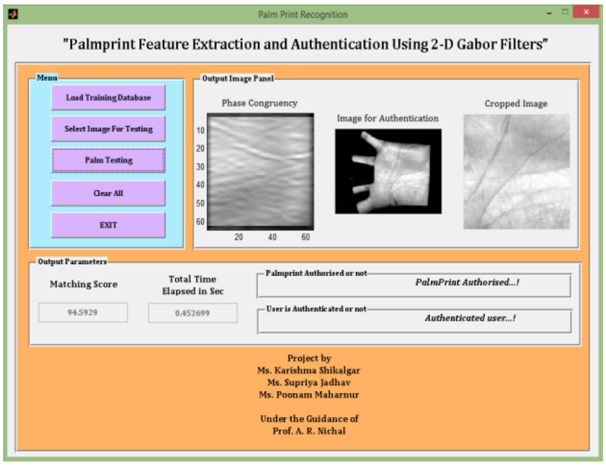

Fig.6 (a) GUI For authorised user.

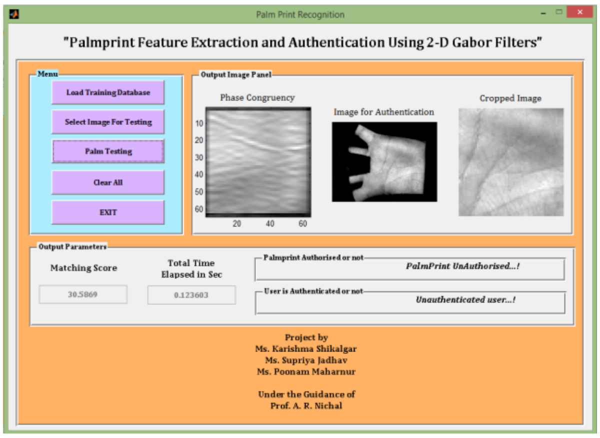

Fig.6(b) GUI For unauthorised user.

IV. CONCLUSION

This paper reports a textured-based feature extraction method using low-resolution palm print images for personal authentication. A palm print is considered as a texture image, so an adjusted Gabor filter is employed to capture the texture information on palm prints. Based on our tests, Filter 11 is the best of twelve filters in terms of accuracy. Combined with the effects of pre-processing and rotated pre-processed images, our matching process is translation and rotational invariance. Experimental results illustrate the effectiveness of the method.

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BIOGRAPHIES

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