Multifeature Palmprint Recognitionusing Feature Level Fusion

R.Gayathri*, P.Ramamoorthy**

*(Research Scholar in Anna University College Of Technology Coimbatore & Head, Department of Electronics and Communication Engineering, Vel Tech Dr.RR & Dr.SR Technical University, Chennai)

** (Dean Academic, Department of Electronics and Communication Engineering, Sri Shakthi Institute of Engineering Technology, Coimbatore)

Abstract

Palmprint verification is an important tool for authentication of an individual and it can be of significant value in security and e- commerce applications. Palmprint identification has gained high impact over the other biometric modalities due to its reliability and high user acceptance. This paper presents a palmprint based identification approach which uses the Gabor wavelet to extract multiple features available on the palmprint, by employing a feature level fusion and classified using nearest neighbor approach. Here, we extract the features using wavelet entropy consist of contrast, correlation, energy, and homogeneity. The features are fused at feature levels. Palmprint matching is then performed by using nearest neighbor classifier. We selected 25 individuals' left hand palm images every person is 5 and total is 125.Then we get every persons each palm images as a template (total 25).The remaining 100 are as the training samples. The experimental results achieve recognition accuracy for Gabor real part of 98.4%, FRR is 0.8% and FAR is 1.6%.And Recognition accuracy obtained for Gabor imaginary part of 97.63%, FRR is 0.8% and FAR is 2.4% on the publicly available database of Hong Kong Polytechnic University. Experimental evaluation using palmprint image databases clearly demonstrates the efficient recognition performance of the proposed algorithm compared with the conventional palmprint recognition algorithms.

Keywords- Feature level fusion, FRR, FAR, Grey co-occurrence matrix, palmprint, recognition, Multifeature.

I. Introduction

Based on the intrinsic features of a human being, biometrics authentication has a unique merit: people may lose their cards, or forget their passwords or PINs, but biometric "keys" or "passwords" are always available for quick identification. Biometric use a variety of techniques for measuring and recognizing the identity of a person with certain physiological or behavioral characteristics [1] & [2].Biometrics characteristics, including fingerprint, facial voice signature, palmprint are now widely used in security application. These characteristics include fingerprints [3] & [4], facial features [5], retina and iris patterns [6], speech patterns [7], hand geometry [8] & [9] and palmprint [10]-[16]. While a good biometric system should be reliable, low cost, require small amounts of data; no single biometric technique has yet met all of these prerequisites. Fingerprint identification [3] & [4] is the most well-known and widespread biometric method. It is very reliable, but finger-print capturing devices are expensive and the stored data is large. Furthermore, it can be difficult to extract some minutia features from some hands, for example from the hands of manual laborers and elderly people, whose fingers are heavily worn down. In some applications, several other methods may be better than fingerprints, since they require fewer data signatures, are less expensive and less intrusive, and avoid the stigma of fingerprinting, which makes people feel like criminals. In recent years, iris-based verification has been successfully developed [6], but it suffers from the discomfort of iris picture capturing that requires users to put their eyes before a camera. Thus, there is a demand for a new automatic personal identification system.

Recently, palmprint recognition has received more attention. Compared to other available biometric features, palmprint recognition has several advantages (i) palmprint contain rich information than hand geometry and fingerprints.(ii) All the features are combined to build a more accurate and robust multimodal biometric system;(iii) User acceptability is high.(iv)Even with a low resolution device palmprint are easily captured.

In the field of biometric authentication system, single modality is not enough to find the similarity between the train image and input test image. Two or more feature can be extracted from the image and can be used for training. The feature can be fused and form a single vector. These vectors become the training data for the images. These systems can significantly improve the recognition performance of a biometric system besides improving population coverage, deterring spoof attacks, increasing the degrees-of-freedom, and reducing the failure-to-enroll rate. Feature level fusion requires the extraction of different features from the source data before features are merged together.

In this paper we will extract four feature of the image. The feature extraction is obtained using wavelet entropy technique. The wavelet entropy is used for feature extraction of image. The features are: Energy, Contrast, Homogeneity and Correlation. These feature have same vector hence can be fused together. The extraction process starts after the texture analysis of the image.

II.GABOR FILTER

The Gabor functions proposed by Daugman are local spatial bandpass filters that achieve the theoretical limit for conjoint resolution of information in the 2D spatial and 2D Fourier domains. Gabor functions first proposed by Dennis Gabor as a tool for signal detection in noise. Gabor showed that there exists a "quantum principle" for information; the conjoint time-frequency domain for 1D signal must necessarily be quantized so that no signal or filter can occupy less than certain minimal area in it. However, there is a tradeoff between time resolution and frequency resolution. Gabor discovered that Gaussian modulated complex exponentials provide the best trade off. For such a case, the original Gabor elementary functions are generated with a fixed Gaussian, while the frequency of the modulating wave varies.

Gabor filters, rediscovered and generalized to 2D, are now being used extensively in various computer vision applications. Daugman generalized the Gabor function to the following 2D form in order to model the receptive fields of the orientation selective simple cells:

The Gabor representation of a palmprint image X(x, y) can be obtained by convolving the image with the family of Gabor filters eqn (1) as follows:

$$W_{m,n}(x, y) = \iint X(x, y)\, g^{*}_{mn}(x - x_0, y - y_0)\, dx_0 dy_0 \qquad (1)$$

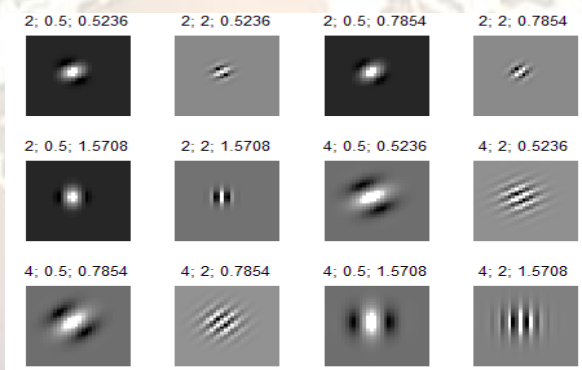


Fig 1. Representation of Gabor Wavelets (Magnitudes for Spatial frequency (s) =3 and Orientation (k) = 4)

Where $W_{m,n}(x, y)$ denotes the result corresponding to the Gabor filter at scale S and orientation K and * indicate the complex conjugate.

Figure 1 represents the Gabor Wavelets three spatial frequencies and four orientations .shows the magnitude of the convolution result of a random palmprint image with 32 Gabor filters with $U_l = 0.05$ and $U_h = 0.4$, in which three scales and four orientations have been used to generate a series of Gabor responses involving a trade filter bandwidth against the size of the scaling factor between frequencies of the successive filters, as well obtaining a broad and uniform coverage of the spectrum. As a result, a palmprint image can be represented by a set of Gabor wavelet coefficients $W_{m,n}(x, y), m = 0, \ldots, 2; n = 0, \ldots, 3$. The magnitude of each coefficient $W_{m,n}(x, y)$ is normalized to zero mean, unit variance and at each scale level the coefficients are resampled by a factor of $\left(\frac{1}{2}\right)^{s-1}$ giving a dimensionality that is $\left(\frac{1}{4}\right)^{th}$ of the previous level. This overcomes the dimensionality explosion relating to using a filter-bank with different scales and orientations. Finally, the coefficients are converted into a vector X_{mn} by concatenating the rows. A discriminative feature vector x can be derived to represent the image $I(x, y)$ using equation (2) as follows:

$$X = \left[X_{0,0}^{T} X_{0,1}^{T} \ \ldots\ldots \ X_{3,7}^{T}\right] \quad (2)$$

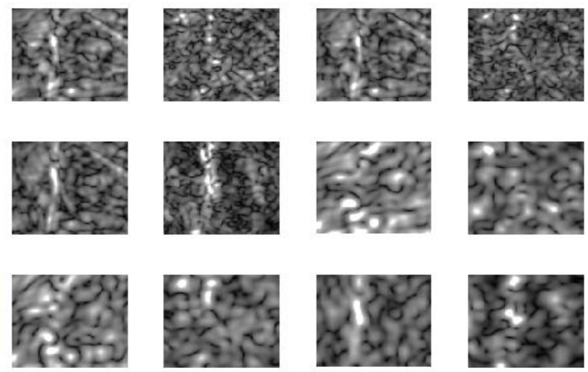


Fig 2. Gabor Magnitude Response of the palmprint image

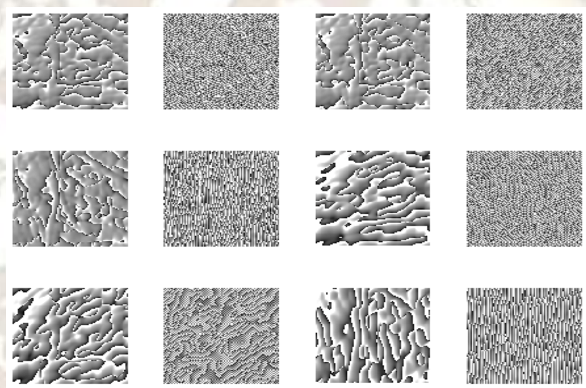


Fig 3. Gabor Phase Response of the Palmprint image

The dimension of the derived feature vector still too high for an efficient classification process since it requires a large memory space and a high computational effort.

An image can be represented by the Gabor wavelet by allowing the description of both the spatial frequency and orientation relation. By convoluting the palm image with complex Gabor filter with 3 spatial frequency and 4 orientation captures the whole frequency spectrum both amplitude and phase as shown in the figure 2 and figure3 respectively.

III.Extraction of Entropy Feature Based on GLCM:

A co-occurrence matrix or co-occurrence distribution is a matrix or distribution that is defined over an image to be the distribution of co-occurring values at a given offset. Gray scale values of the image or various dimensions of color, the co-occurrence matrix can measure the texture of the image. Mathematically, a co-occurrence matrix C is defined over an n x m image I, parameterized by an offset (Δx,Δy), given in (3) as:

$$C_{\Delta x,\Delta y}(i,j) = \sum_{p=1}^{n} \sum_{q=1}^{m} \begin{cases} 1, if I(p,q) = i \ and \ I(p+\Delta x, q+\Delta y) = j \\ 0 \quad\quad otherwise \end{cases} \quad (3)$$

Consider image is a function of $f(x,y)$ then the gray level co-occurrence matrix, the probability for gray scale *i* and *j and* occur at two pixels separated by distance δ and direction θ (or by displacement Δ*x* and Δ*y*).

$$P(i,j,\delta,\theta) = P(i,j,\Delta x,\Delta y) = P\{f(x,y) = i \ and \ f(x+\Delta x, y+\Delta y) = j \quad (4)$$

ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 2,Mar-Apr 2012, pp.1048-1054

Once the co-occurrence matrix eqn(4) has been formed, texture feature can be computed. The average features can be obtained for texture classification. Entropy feature of gray scale co-occurrence matrix is one of the features having the best discriminatory power which is given in eqn (5).

$$f_2 = \sum\sum P(i,j,\delta,\theta)\ log_2 P(i,j,\delta,\theta) \quad (5)$$

IV. Proposed Design

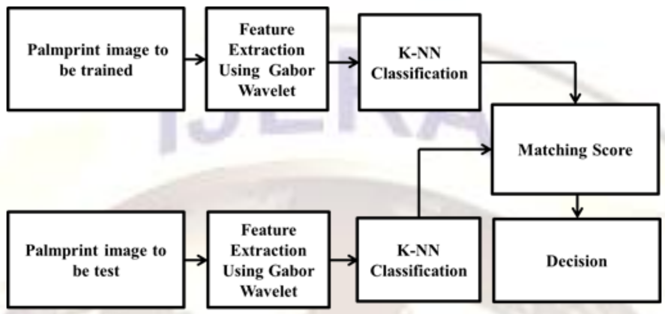


Figure 4: Proposed Palmprint Authentication using Feature Level Fusion

Fig. 4 shows overall framework of the proposed Palmprint authentication using feature level fusion. From figure 4, it can be seen that the features are extracted by Gabor wavelet entropy. Here the features extracted are contrast, homogeneity, energy and correlation. Classified using K- nearest neighborhood classification.Descision is taken based on the matching score

The feature are extracted from the normalize GLCM. Features are

a. Contrast: It is the measure of the intensity contrast between a pixel and its neighbor over the whole image. Calculated using eqn(6)

$$\sum_{i,j=0} |i-j|^2 p(i,j) \quad (6)$$

b. Homogeneity: a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Range = [0 1] Homogeneity is 1 for a diagonal GLCM.Calculated using eqn(7)

$$\sum_{i,j=0} \frac{p(i,j)}{1+|i-j|} \quad (7)$$

c. Energy: It is the measure of the sum of squared elements in the GLCM. Range=[0 1] Energy is 1 for a constant image. Calculated using eqn(8)

$$\sum_{i,j=0} p(i,j)^2 \quad (8)$$

d. Correlation: measure of how correlated a pixel is to its neighbor over the whole image. Calculated using eqn(9)

$$\sum_{i,j=0} \frac{(i-\mu i)(j-\mu j)\, p(i,j)}{\sigma_i \sigma_j}. \quad (9)$$

Range = [-1 1] Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is NONE for a constant image.
P (i,j) = Element (i, j) of the normalized symmetrical GLCM

V. Experimental Results and Discussion

To evaluate the effectiveness of our proposed Multifeature palmprint recognition using feature level fusion scheme, a database containing palmprint samples is required. For our research, we use PolyU Palmprint Database, collected by the Biometric Research Center at The Hong Kong Polytechnic University, which is a widely used database in palmprint research. The database contains 7,752 greyscale images, corresponding to 386 different palms with 20 -21 samples for each in bit- map image format. We selected 25 individuals' left- hand palm images; every person has 6 and totaling up to 150. We then get every person's palm images as a template (totaling 25).The remaining 125 are used as training samples. The experiments are conducted in MATLAB with image processing Toolbox and on a machine with an Intel core 2 Duo CPU processor. The test database has 25 different untrained images that undergo the same algorithm as trained image, and we compare this to the original trained image.

TABLE 1.ACCURACY MEASURE

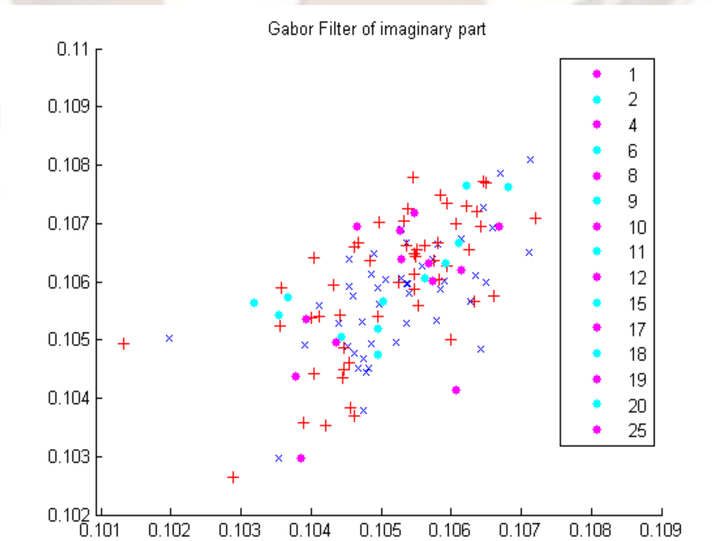
No. of Samples	Gabor real part accuracy			Gabor Imaginary part accuracy		
	FRR	FAR	Accuracy	FRR	FAR	Accuracy
125	0.8	1.6	98.4	0.8	2.4	97.63

From the above output we analyzed that the image not found are considered as false rejected and the classified class is mismatched with the respective class are considered as false accepted.
Table 1 shows the accuracy measure. We come to conclusion that Gabor real part filter value is more accurate compare to Gabor imaginary part filter.

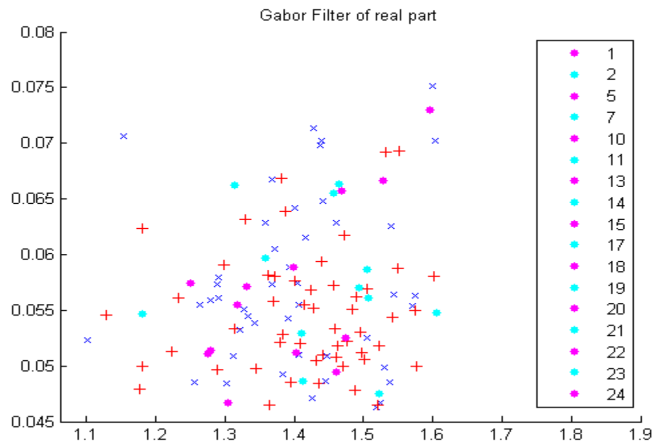
Table.2 Comparison

Methods	Database Size	Accuracy
Proposed Gabor real part	125/25	98.4
Proposed Gabor imaginary part	125/25	97.63
Canny FSIM[15]	400/100	97.322
Perwit FSIM[15]	400/100	94.712
Wavelet transform method(2006)[16]	100/50	96.3

Table 2 shows the comparison of the available algorithm that the proposed method gives the satisfactory experimental results when compare to the other algorithms.



(i)



(ii)

Fig.5 Result of KNN classification for the Palmprint images -Classification Output of 125 samples. (i)Gabor filter imaginary Part (ii) Gabor filter Real Part

VI. Conclusion

We proposed a Multifeature palmprint recognition system by using feature level fusion. This approach performs better than using single feature based palmprint identification.For the research we consider 125 samples of 25 different people having 5 similar images. We took twenty five untrained image belong to the same sample taken for the trained image i.e. similar to 25 sample but not the same image as the sample. Here we obtained recognition accuracy for Gabor real part accuracy as 98.4 percentages with false acceptance rate 1.6% and false rejection rate 0.8%.Gabor imaginary part accuracy as 97.63 percentages with false acceptance rate 2.4% and false rejection rate 0.8%. Experimental result shows that nearest neighbor classifier is one of the best algorithms for classification.

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Biographical notes

R.Gayathri received B.E degree in Electronics and Communication Engineering from Madras University and M. Tech. degree in Laser and Electro Optical Engineering from Anna University, College of Engineering Guindy, Chennai, India in 1999 and 2001 respectively and she is currently pursuing the Ph.D. degree in the department of Electronics and Communication Engineering at Anna University College of Technology, Coimbatore, India. She is currently working as an Assistant Professor and Head in the Department of Electronics and Communication Engineering, Vel Tech Dr.RR and Dr.SR Technical University, Chennai, India. Her research interest includes pattern recognition, computervision, machine learning, application to image recognition, network security. She has published more than 15 papers in international referred journals, National and International Conferences.

Dr. P.Ramamoorthy received B.E degree in Electronics and Communication Engineering and M.E degree in Electronics Engineering from PSG college of Technology, Coimbatore, India. He received Ph.D. degree in Electronics and Communication Engineering from Bharathiyar University. He is currently working as a Dean Academic in Sri Shakthi Institute of Engineering Technology, India. He has more than 36 years of experience in teaching and research in Government Institutions. He is guiding 14 research scholars under Anna University Coimbatore. His research areas in the area of Image Analysis, Image Compression, Biometric Application, Network Security, Mobile Communication, Adhoc Networks, etc. He has published more than 38 papers in referred international journals, National and International Conferences.