FEATURE EXTRACTION FROM FUSION OF IRIS AND PALMPRINT BIOMETRIC IMAGES FOR RECOGNITION

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ABSTRACT

This paper presents fusion of two biometric traits, i.e., iris and palmprint, at feature level fusion that combines the information from iris and palmprint biometric which can achieve better performance, which may not be possible using a single biometric technology. The features are extracted from the pre-processed images of iris and palmprint. This system extracts Gabor texture from the pre-processed iris and palmprint images. The feature vectors attained from different methods are in different sizes and the features from equivalent image may be correlated, hence wavelet-based fusion technique is used to fuse both images. Finally the feature vector is matched with database template using Euclidean distance formula.The system is authenticated for their accuracy on Poly U palm print database fused with IITK iris database of 125 users. The experimental results demonstrated that the proposed multimodal biometric system achieves recognition accuracy of 99.2% and with false rejection rate (FRR) of 1.6% and false acceptance rate (FAR) of 6.3%.

INTRODUCTION

Biometrics refers to the use of physiological or biological characteristics to measure the identity of an individual. The access to the secured area can be made by the use of ID numbers or password which amounts to knowledge based security. But such information can easily be accessed by intruders and they can break the doors of security. Single modal biometric systems repeatedly face significant restrictions due to noise in sensed data, spoof attacks, data quality, no universality, and other factors. Thus to overcome the above mentioned issue multibiometric traits are used. A biometric system is essentially a pattern recognition system which makes a personal identification by determining the authenticity of a specific physiological or behavioural characteristic possessed by the user. Biometric technologies are thus defined as the automated methods of identifying or authenticating the identity of a living person based on a physiological or behavioural characteristic.

Multimodal biometric system employs two or more individual modalities, namely, gait, face, iris and fingerprint, to enhance the recognition accuracy of conventional unimodal methods [3]. The multimodal based authentication can aid the system in improving the security and effectiveness in comparison of unimodal biometric authentication, and it might become challenging for an adversary to spoof the system owing to two individual biometrics traits.

In this paper we use feature level fusion that combines the information to investigate whether the integration of palm print and iris biometric can achieve performance that may not be possible using a single biometric technology. This system extracts Gabor texture from the preprocessed palm print and iris images. The feature vectors attained from different methods are in different sizes and the features from equivalent image may be correlated. Therefore, we proposed wavelet-based fusion techniques. Finally the feature vector is matched with stored template using Euclidean distance. The proposed approach is authenticated for their accuracy on Poly U palm print database fused with IITK iris database of 125 users. The experimental results demonstrated that the proposed multimodal biometric system achieves recognition accuracy of 99.2% and with false rejection rate (FRR) of 1.6%.

A palm print contains distinctive features such as principal lines, wrinkles, ridges and valleys on the surface of the palm. Palm print has abundant lines and ridge structure, which can be used for matching [1] – [5].To localize the iris image [6] proposed intergro-differential operator (IDO), and [7] used Hough transform technique. For example, [8] estimated the pupil position [9] implemented an edge detection method for iris boundary extraction.[7] deployed a wavelet transform to locate the iris inner boundary, and used Daugman's IDO for the outer boundaryapplied mixtures of three Gaussian distributions. To improve the Hough transform resultused some heuristics. Therefore, in order to increase the performance of the automated system, it is advisable to go for multimodal biometrics. Multimodal biometric techniques have attracted much attention as the additional information between different biometric could get better recognition performance.

The important aspect in multimodal biometric is the fusion or the combination of modalities at the score level decision level match level or feature level [6].There are four levels for information fusion [7]: pixel level fusion, feature level fusion, match score level fusion and decision level fusion. Many studies in biometrics fusion have been done at match score level and decision level [8].Since feature level fusion contains richer information of the multibiometrics than match score level fusion and decision level fusion, it is able to obtain a better performance.

The paper is organized as follows; in section II, Multimodal biometric recognition system is described with biometric traits are iris and palm print. In section III, methodology used in Multimodal biometric recognition system is described. In section IV, the result and performance of proposed method is discussed. And section V is conclusion.

MULTIMODAL BIOMETRIC RECOGNITION SYSTEM

Fig. 1 Typical Block Diagram of a Multimodal Biometrics

A generic biometric system operates in two stages one is the capture and storage of enrolment biometric samples and the capture of new biometric samples and their comparison with corresponding reference samples. The proposed Multimodal Biometric Authentication system works in a six-stage process that consists of the following stages. Fig. 1 shows the following stages.

- Image Capture
- Image Pre-processing
- Feature Extraction Gabor filter
- Wavelet based Fusion
- Matching by Euclidean Distance formula
- Decision / Result

METHODOLOGY

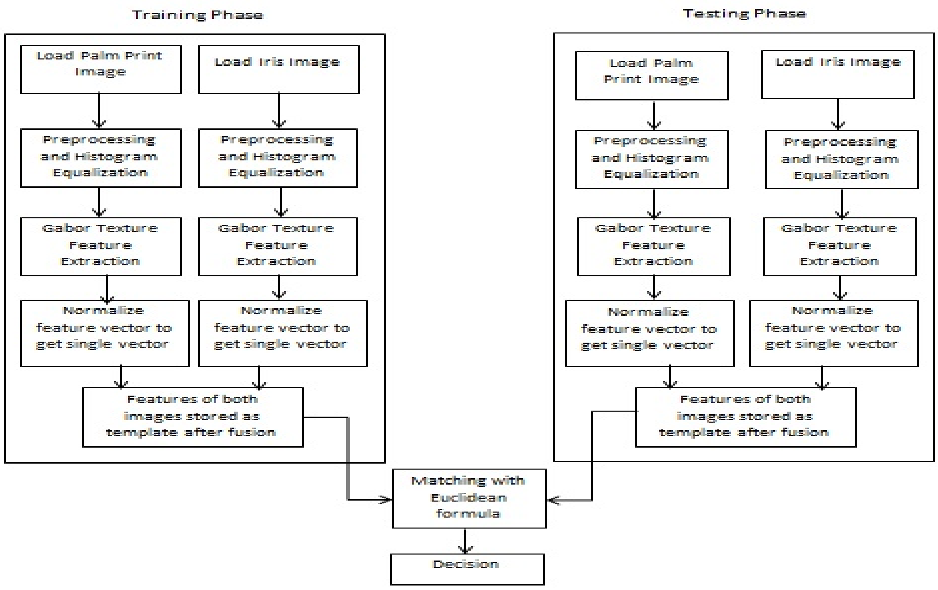

Fig.2. Proposed Multimodal Biometric Recognition System

Our methodology for testing multimodal biometric systems focuses on the feature level fusion. This methodology has the benefit of exploiting more amount of information from each biometric. Figure 3 comprises of feature extraction of palm print and iris using Gabor texture feature. These features are fused and stored as a parameter for finding the matched image from the database. The feature vectors are extracted independently from the pre-processed images of palm print and iris. The feature vectors are extracted independently from the pre-processed images of palm print and fingerprint. The feature vectors of input images are then compared with the templates of the database to produce the output. Combining more than one biometric modality progresses the recognition accuracy, reduces FAR and FRR. The proposed multimodal biometric system overcomes the limitations of individual biometric systems and also meets the accuracy requirements

GABOR FILTER

Dennis Gabor proposed the famous "Window" Fourier Transform (also known as short-time Fourier transform, STFT) in the paper "Theory of Communication" in 1946, which was later called Gabor, transforms. The Gabor transform function f (t) is defined in Eqn. (1).

$$G_f(\omega,\tau) = \int_{-\infty}^{\infty} f(t)g(t-\tau)e^{-j\omega t}\,dt \qquad (1)$$

Where (t) is a window function i.e., Gaussian function. Reports have suggested that the Gabor function is the solitary function to accomplish the lower bound of uncertainty relation which can accomplish the best localization in time-frequency domain at the same time. [20] Made Gabor function and expanded into two dimensional forms, and on this basis constructed a 2D Gabor filter. The general form of 2D Gabor filter basis functions is given in Eqn. (2).Were ω is oscillation frequency, α_0^{-m} is the scale factor, and K is the number of filters. In order to construct the filters in different scales and orientations we have to vary the value of mand n. An image can be represented by the Gabor wavelet by allowing the description of both the spatial frequency and orientation relation. Convoluting the palm image with complex Gabor filter with 3 spatial frequencies and 4 orientations captures the whole frequency spectrum both amplitude and phase. In Figure 3, magnitude and phase of the Gabor filter responses are shown.

$$\psi_{m\,n}(xy) = \alpha_0^{-m} \exp\left\{\frac{\alpha_0^{-2m}}{8}\left[4\left(x\cos\frac{n\pi}{K} + y\sin\frac{n\pi}{K}\right)^2 I\omega + \left(-x\sin\frac{n\pi}{K} + y\sin\frac{n\pi}{K}\right)^2\right]\right\} * \exp\left[I\omega\omega_0^{-m}\left(x\cos\frac{n\pi}{K} + y\sin\frac{n\pi}{K}\right)\right] \quad (2)$$

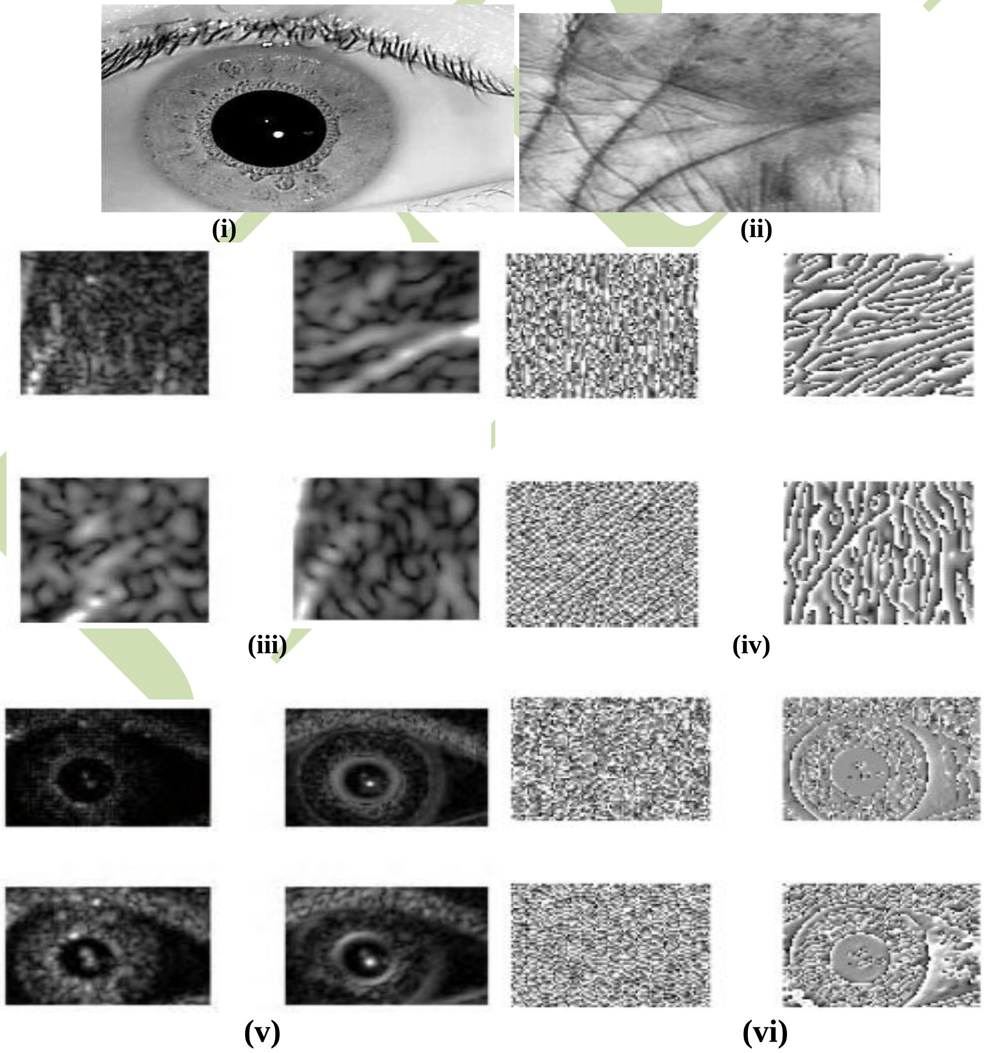

Fig. 3. Palmprint and Iris image response to above Gabor filter: (i) Iris image, (ii) Palmprint image, (iii) Gabor palmprint magnitude response, (iv) Gabor palm print phase response, (v) Gabor iris magnitude response and (vi) Gabor iris phase response

WAVELET FUSION

(i) (ii) (iii)

Fig. 4.Wavelet fusion of texture image (i) Gabor iris magnitude response (ii) Gabor palm print magnitude response (iii)Synthesized image(fused image)

To fuse two images using wavelet fusion the two images should be of same size and is should be associated with same color. Figure 4 explains the 2 level wavelet decomposition of iris and palm print image and the respective fused image of palm print and iris.

CLASSIFICATION

The classification is the combining of the cluster of images between the test image and train image. The mean distance between the centroid of the train image and the test image is computed. The closest point is chosen and plots the value which forms a cluster. The distance computation is based on Euclidean distance weight function. If the value is too extreme it is not considered. In 2-D, the Euclidean distance [20] between (x1, y1) and (x2, y2) is given by Eq.3:

$$\sqrt{(x1 - x2)^2 + (y1 - y2)^2} = c \quad (3)$$

Euclidean distance algorithm of classification is nonparametric as their classification is directly subject on the data. The objects are trained corresponding to the data and the test image can be classified using the same process as the object or image was trained.

EXPERIMENT AND RESULT

The effectiveness of our proposed multimodal biometric authentication scheme is evaluated on palm print database and iris database. In this work, we used PolyU palm print database, collected by the Biometric Research Center at The Hong Kong Polytechnic University, and iris database from IITK which is a widely used database in palm print and iris research. The database contains 7,752 grey-scale images correspondent's to 386 different palms with 20 to 21 samples for each, in bit-map image format. Totally 625 images of 125 individuals, 4 samples for each palm and iris are randomly selected to train in this research. Then we get every person's each palm and iris image as a template (total 125). The proposed algorithms have been evaluated on IITK iris database. The experiments are conducted in MATLAB with image processing Toolbox. Table 1 explains the accuracy and error rates obtained from the individual and combined system. The overall performance of the system has increased showing an accuracy of 96.04% with FAR of 1.58% and FRR of 6.34% respectively. Receiver Operating Characteristic (ROC) curve is plotted for Genuine Acceptance Rate (GAR) against False Acceptance Rate (FAR) for individual recognizers and combined system as shown in Figure 5 . From the plot it is clear that integrated system is giving highest GAR at lowest FAR.

Table 1. Figures showing individual and combined accuracy

Trait	Algorithm	Accuracy (%)	FAR (%)	FRR (%)
Iris	Haar Wavelet	94.36	4.85	6.43
Palmprint	Minutiae Matching	92.06	3.17	12.69
Fusion	**Haar + Minutiae**	**96.04**	**1.58**	**6.34**

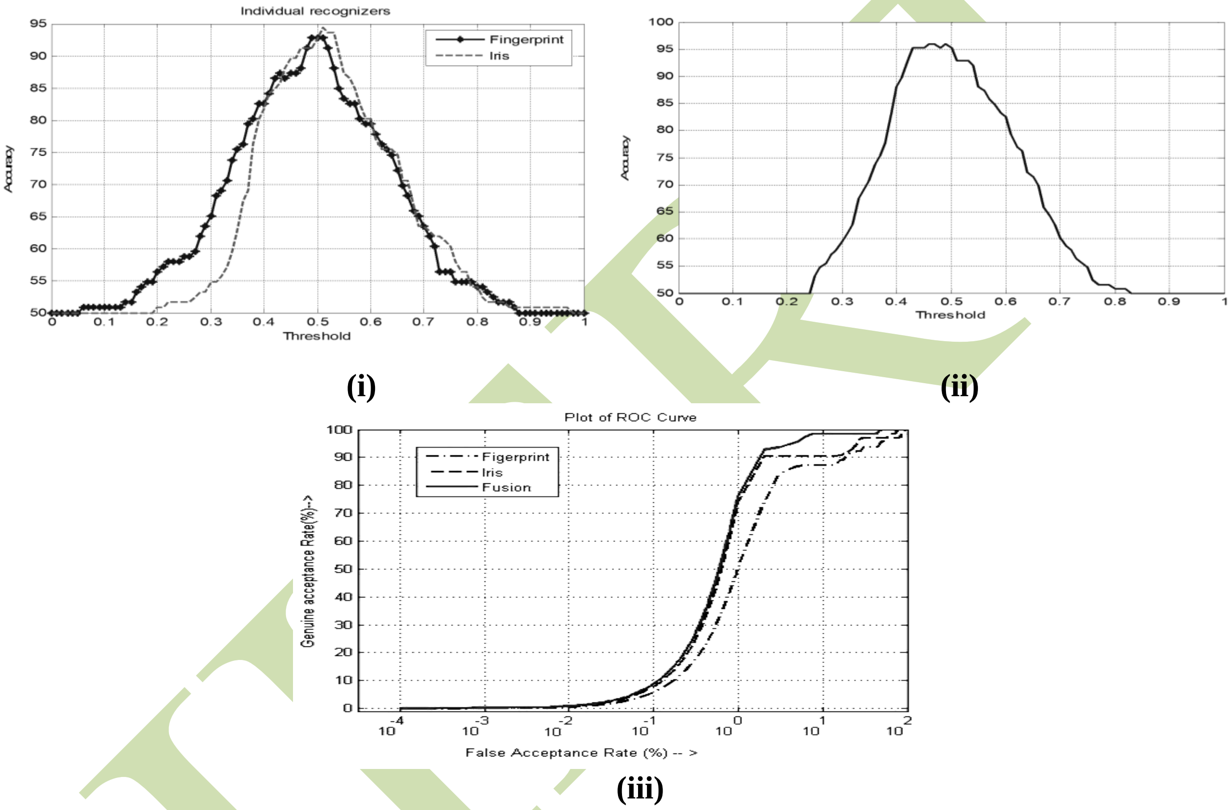

Fig. 5. Characteristics plot for (i) Accuracy plots of individual recognizers, (ii) Accuracy graph for combined classifier, (iii) ROC Curve for Palmprint, Iris and Fusion

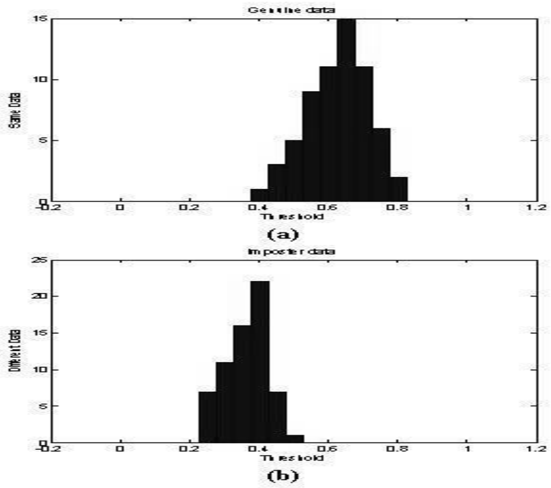

Fig. 6.Histogram for (a) genuine and (b) imposter scores

Histograms for genuine and imposter data are shown in Figure 6. The distribution of genuine and imposter data shows that at threshold of 0.5 the system would give minimum FAR and FRR rates with maximum accuracy of 96.04%.

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