Iris Recognition System Based on Feature Level Fusion

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Abstract – Multibiometric systems utilize the evidence presented by multiple biometric sources (e.g., face and fingerprint, multiple fingers of a single user, multiple matchers, etc.) in order to determine or verify the identity of an individual. Information from multiple sources can be consolidated in several distinct levels. But fusion of two different biometric traits is difficult due to (i) the feature sets of multiple modalities may be incompatible (e.g., minutiae set of fingerprints and eigen-coefficients of face); (ii) the relationship between the feature spaces of different biometric systems may not be known; (iii) concatenating two feature vectors may result in a feature vector with very large dimensionality leading to the “curse of dimensionality” problem; huge storage space and different processing algorithm. Also if we use multiple images of single biometric trait, then it doesn’t show much variations. So in this paper, we present a efficient technique of feature-based fusion in a multimodal system where left eye and right eye are used as input. Iris recognition basically contains iris location, feature extraction, and identification. This algorithm uses canny edge detection to identify inner and outer boundary of iris. Then this image is feed to Gabor wavelet transform to extract the feature and finally matching is done by using indexing algorithm. The results from the analysis of works indicate that the proposed technique can lead to substantial improvement in performance.

Keywords – Biometrics, Gabor Wavelet, Indexing Algorithm, Feature Level Fusion, FAR (False Accept Rate), FRR (False Rejection Rate)

I. INTRODUCTION

The biometric recognition means it measures the characteristics of human being. The characteristics which remain constant throughout the life are called as Physiological Biometrics, for e.g. fingerprint, eye etc. Characteristics which may vary according to age, behavior of person, or mood are called as Behavioral Biometrics, for e.g. signature, keystroke, etc. The biometric recognition operated in two different modes as per the need of application such as (i) Verification Mode (where one to one matching is provided between query template and stored template) (ii) Identification Mode (where one to many matching is provided between query template and stored template) in both cases if the comparison is nearer to the predefined threshold value then the person is identified or else rejected. The biometric systems are very much essential in applications like Home Security, Airport, Checking, Voting machine, etc. Iris recognition is considered to be a highly accurate and consistently reliable method for personal identification. The iris, being found to be very stable, highly unique and easy to capture. It is consider as one of the promising biometric identifiers [1,2]. Human iris possesses genetic independence and contains extremely information-rich physical structure and unique texture pattern which makes it highly acceptable. Thus, iris has given high performance in biometric requirement like universality, distinctiveness, permanence, acceptability and performance [3]. The general biometric system has data acquisition section, preprocessing section, feature extraction section and matching section. The function of data acquisition section is to collect the number of sample of biometrics in different conditions. In preprocessing section the images are normalized by color converting, cropping and resizing. The features are extracted from normalized image in feature extraction section. The final results are obtained from matching the extracted features of query image with database templates by using the distance formulas. Biometric systems operating on a single biometric feature have many limitations. They are inherently varied because of the existence of background noise, signal distortion, biometric feature changes and environment variations. As a result recognition system may not be sufficiently robust and it has a limited ability to overcome spoofing attack. Multibiometric systems are a recent approach developed to overcome these problems. Multibiometric system means I use two or more biometric traits to identify the person and these traits are fuse with each other at different levels. The fusion can be done at five different levels, which are (i) sensor level (ii) feature extraction level; (iii) match score level; (iv) decision level (v) rank level. We have chosen the feature level since the feature set contain much richer information about the raw biometric data than the matching score or decision level. But the fusion at this level is difficult because of the following reasons (i) the feature sets of multiple modalities may be incompatible (e.g., minutiae set of fingerprints and eigen-coefficients of face); (ii) the relationship between the feature spaces of different biometric systems may not be known; and (iii) concatenating two feature vectors may result in a feature vector with very large dimensionality leading to the “curse of dimensionality” problem [1]. To overcome these incompatibility problems, we have chosen multiple instance of the same trait (left eye and right eye).

The rest of this paper is organized as follows; Section 2 briefly reviews the previous work on iris recognition techniques, Section 3 highlights the iris recognition steps, Section 4 introduces the proposed template fusion process and Section 5 presents the experimental work, Section 6 gives the conclusion.

II. LITERATURE SURVEY

Wildes et al. [4] presented another iris recognition system. It constructs a Laplacian pyramid by iteratively applying a Gaussian lowpass filter and decimation operator to the iris image. Quantized differences between a level and its next lower resolution level yield the final representation. The similarity between new samples and stored templates are achieved using the normalized correlation. This method is reported to have good
performance. Daugman [5] method is developed first using the integro-differential operator for localizing iris regions along with removing possible eyelid noises. Tisse et al. [6] analyzed the iris characteristics using the analytic image constructed by the original image and its Hilbert transform. Emergent frequency functions for feature extraction were in essence samples of the phase gradient fields of the analytic image’s dominant components. Huang et al. [7] decomposed an iris image into four levels using 2-D Haar wavelet transform and quantized the fourth-level high-frequency information to form an 87-bit code. A modified competitive learning neural network was adopted for classification. Park et al. [8] uses directional filter banks to decompose iris image into directional subband outputs. We have extended the approach given in by using bi-orthogonal directional filters to improve the efficiency, scalability and flexibility of the system. Arun et al., [9] proposed the feature extraction techniques for three modalities viz. Fingerprint, iris and Face. The extracted information from each modality is stored as a template. The information are fused at the match score level using a density based score level fusion, Gaussian Mixture Model (GMM) followed by the Likelihood ratio test. Ngoc-Son Vu and Alice Caplier [10] invented a feature descriptor set called Patterns of Oriented Edge Magnitudes (POEM) for feature extraction by applying the self-similarity operator on accumulated edge magnitudes across different directions. Based on these Features, two feature descriptors are constructed. Carlos et al., [11] proposed an Active Shape Models (ASM) landmark selection scheme to improve the ASM performance in face recognition applications. The proposed scheme selects robust landmark points where relevant facial features are found and assigns higher weights to their corresponding features in the face classification stage. Xiaoni Liang and Weiqing Tong [12] presented an accurate and fast approach to estimate the pose of face in near-infrared images. The approach automatically extracts the feature points from a normalized face image. The pupils and nose tip are used to estimate the pose rotation of yaw and the pupils, nose tip and the center line of mouth is used to estimate the pose rotation of pitch.

III. IRIS RECOGNITION

A unique significant characteristics of the iris is that, no two irises are similar, even for identical twins, among the entire human population. To study the characteristics of the irises, we will use only the gray level profiles of iris images. Input images are processed to extract the portion containing the iris. Images contains not only the abundant texture information but also some useless parts such as eyelids, eyelashes, specular reflection etc. iris is present in between the pupil and sclera. To locate the iris part simple and efficient method is shown in fig a.

A. Segmentation

Segmentation process is the most important and difficult steps because the quality of image processing heavily depends on the quality of segmentation process. In this process, we applied canny edge detector. It partition an image into homogeneous regions and identify the boundaries which separate regions of different textures. The Canny operator is optimum even for noisy images as the method bridge the gap between strong and weak edges of the image. After detecting the edges hough transform is apply on it which is use to fill the gaps between edges (edge linking). The circle is simpler to represent in parameter space, compared to the line, since the parameter of the circle can be directly transfer to the parameter space. The given Eq. (1) shows circle

$$\left( (x-a)^2 + (y-b)^2 \right) = r^2$$

Where a & b are the centre of the circle in the direction x and y respectively and r is the radius.

B. Feature Extraction

Iris provides abundant texture information. A feature vector is formed which consist of order subsequent feature extracted from the various representation of iris image. The extraction of the whole information available in the iris signature done by applying a Gaussian wavelet transforms.

$$\varphi(x, y) = \frac{f^2}{\pi \eta} \exp \left( - \left( \frac{f^2}{\eta^2} x^2 + \frac{f^2}{\eta^2} y^2 \right) \right) (\exp(j2\pi fx, ) - K)$$

where f is the frequency of the modulating sinusoidal plane wave and \(\theta\) is the orientation of the major axis of the elliptical Gaussian.

C. Matching

It is a process to determine whether two iris templates are from the same individual or not. The indexing algorithm is divided into two parts: 1) feature extraction and database enrollment in which features are extracted from the gallery images and indexed using the Euler code; and 2) probe image identification in which features from the probe image are extracted and matched. Euler code is used to find the possible matches. For matching two iris indexing parameters (Euler codes) \(E_1(i)\) and \(E_2(i)\) (i=1,2,3,4) apply a thresholding scheme. Indexing parameters are said to be matched if \(E_1(i)-E_2(i)\) ≤ T, where T is the geometric tolerance constant. Indexing score \(S\) is computed using equ. (2),(3).

$$s(i) = \begin{cases} 1 & \text{if } (E_1(i) - E_2(i)) \leq T \\ 0 & \text{otherwise} \end{cases} \quad \text{…….. (3)}$$

$$S = \frac{1}{4} \sum_{i=1}^{4} s(i) \quad \text{…………………. (4)}$$

Fig. a. Block Diagram of Iris Recognition System

IV. FEATURE LEVEL FUSION

In this section we summarize the feature level fusion. Let \(X = \{x_1, x_2, \ldots, x_m\}\) and \(Y = \{y_1, y_2, \ldots, y_n\}\) denote the feature vectors. It representing information extracted
from two different sources. In order to yield the new feature vector, vectors $X$ and $Y$ are augmented and then feature selection is performed on the resultant vector in order to reduce its dimensionality.

**D. Feature Normalization**

The individual feature values of the vectors $X$ and $Y$ may be significantly different in terms of their range and distribution. For example, the values of $x_i$’s may be in the range $[0,100]$ while $y_i$’s values may be in the range $[0,1]$. Therefore, feature normalization is performed to modify the mean and variance of the feature values in order to ensure the contribution of each feature vector is comparable. When two feature vectors $X'$ and $Y'$ are augmented, a new feature vector $Z' = \{x_1', x_2',..., x_m', y_1', y_2',..., y_n'\}$ is obtained. The curse of dimensionality dictates that the augmented vector might not result in an improved performance. Feature selection process is a dimensionality reduction scheme. Some feature values may be noisy compared to others. In the feature selection process, a minimal feature set of size $k < (m + n)$ is chosen such that classification performance on a training set of feature vectors is improved. The feature selection algorithm employed here is sequential forward floating selection technique. A new feature vector $Z = \{z_1, z_2,..., z_k\}$ is obtained when the feature selection algorithm is applied. By using this algorithm iris recognition system is modified as shown in fig b.

![Fusion Based Iris Recognition System](image)

Fig.b. Fusion Based Iris Recognition System

**V. EXPERIMENTAL RESULTS**

The reliability of the proposed multimodal biometric authentication system is described with the help of experimental results. The system has been tested using CASIA iris image database created by National Laboratory of pattern recognition, Institute of Automation, Chinese Academy of Science is used for obtaining iris images. From this dataset, 100 left and 100 right iris templates comparisons were made and the results were taken up for score level fusion later.

<table>
<thead>
<tr>
<th>Threshold</th>
<th>Left Eye FRR</th>
<th>Left Eye FAR</th>
<th>Right Eye FRR</th>
<th>Right Eye FAR</th>
<th>Fusion FRR</th>
<th>Fusion FAR</th>
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</thead>
<tbody>
<tr>
<td>0.05</td>
<td>97.4</td>
<td>0.4</td>
<td>96.2</td>
<td>0</td>
<td>98.4</td>
<td>0</td>
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<tr>
<td>0.11</td>
<td>9.8</td>
<td>5.2</td>
<td>9.4</td>
<td>5.8</td>
<td>3.6</td>
<td>2.6</td>
</tr>
<tr>
<td>0.20</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1: Comparison between Left Iris, Right Iris And Fusion Rule

The performance measures used in our analysis are False Acceptance Rate (FAR), False Rejection Rate (FRR). Table 2 shows the set of values obtained for different thresholds. Graphs are plotted for FAR and FRR by considering different threshold value as shown in Fig c and Fig d.

![Graph of FRR Vs Threshold](image)

Fig.c. Graph of FRR Vs Threshold

![Graph of FAR Vs Threshold](image)

Fig.d. Graph of FAR Vs Threshold

Thus the performance of multi-unit iris shows that there is a very good improvement in the recognition rate of multi unit system compared to the use of either left or right iris.

**VI. CONCLUSION**

Unimodal biometric systems fail in case of lack of proper biometric data for a particular trait. It is robust to use multiple biometrics for providing authentication. This paper proposed an efficient algorithm which helps to
improve the accuracy of recognition system. Feature encoding and matching are derived by log-Gabor wavelet and HD respectively. Feature fusion of left eye and right eye is used because features contain sufficient information to make genuine and impostor case distinguishable. They are relatively easy to obtain. The performance analysis is made using the publicly available CASIA database and the recognition rates are found to be 90.23% and 92.05% for left and right iris respectively. In order to improve the accuracy, a score level fusion of distances obtained from left and right irises is performed using weighted average rule method. This shows a very good enhancement in the recognition rate to 96.4%, compared to the usage of left or right iris alone.

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**REFERENCES**


