International Journal of Advanced and Innovative Research (2278-844)/

Volume 7 Issue 11

Human IRIS as a Biometric for Identity Verification

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***Abstract*—The use of human biometrics for automatic identity verification has become widespread. Mostly used human biometrics are face, fingerprint, iris, gait, retina, voice, hand geometry etc. Among them iris is an externally visible, yet protected organ whose unique epigenetic pattern remains stable throughout one's whole life. These characteristics make it very attractive to use as a biometric for identifying individuals. This paper presents a detailed study of iris recognition technique. It encompasses an analysis of the reliability and the accuracy of iris as a biometric of person identification. The main phases of iris recognition are segmentation, normalization, feature encoding and matching. In this work automatic segmentation is performed using circular Hough transform method. Daugman's rubber sheet model is used in normalization process. Four level phase quantization based 1D Log-Gabor filters are used to encode the unique features of iris into binary template. And finally the Hamming distance is considered to examine the affinity of two templates in matching stage. We have experimented a better recognition result for CASIA-iris-v4 database.**

Keywords— Biometric Identification, Iris Recognition, Pattern Recognition, 1D-Log Gabor Filter.

A. INTRODUCTION

Biometric identification is a very popular trend for identity verification due to its higher accuracy and flexibility nowadays. Different biometric recognition techniques like facial recognition, iris scanning, retina scanning, fingerprint scanning, voice verification, gait recognition, hand geometry and hand writing recognition etc. have already been developed by the researchers [1] and they are being used extensively in practical life to verify an individual. This paper is explaining an iris recognition process which is one of the most reliable and secure biometric recognition technique and shows higher accuracy compared to other biometric techniques [2]. The iris pattern contains huge amount of unique features and even two eyes of an individual and identical twins also possess uncorrelated iris patters [3]. A frontal view of the human eye is shown in Fig. 1. The average diameter of human iris is about 12 mm and pupil size varies from 10% to 80% of iris diameter [4]. The externally visible surface of the multi-layered iris often varies in color and appears as a zigzag pattern [3]. The pattern of human iris remains stable throughout the whole lifetime of a person and so it is more secure to use iris features as identification metrics. Besides there are more other properties of iris as an identifier; some of which are listed below.

Properties of the Iris as an Identifier

- Random pattern of great complexity & uniqueness
- Stable features from age three to whole life
- Highly protected, internal organ of the eye
- Externally visible, from distance up to some meters
- The two eyes of an individual contain completely independent iris patterns
- Identical twins possess uncorrelated iris patterns

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At first the French ophthalmologist Alphonse Bertillon proposed to use iris patterns as a basis for personal identification [5] but Cambridge Researcher, John Daugman implemented a working automated iris recognition system for the first time [2]. Though the Daugman system is the most successful and popular, some other systems have also been developed including Wildes et al. [6], Lim et al. [7], Boles and Boashash [8]. Daugman [9] used Integro-differential operator for pupil detection, Li.Ma et al., [13] used Hough transformation and extracted features using spatial filter. Wildes et al., [14] uses Hough transform and gradient edge detection for pupil detection and Laplacian pyramid for analysis of the Iris images. Boles and Boashash [8] uses zero-crossing method with dissimilarity functions of matching. Lim et al., [7] 2D Haar Transform for feature extraction and a new winner selection method designed for iris recognition. A. Poursaberi and H. N. Araabi [15] use wavelet Daubechies for feature extraction. A different iris recognition approach based on human-interpretable features was proposed by Jinaxu Chen et al. [16]. About each system faces the challenge of recognizing noisy iris images. Some issues and challenges in designing iris recognitions system were reviewed in paper [17]. The basic steps of iris recognition are almost same in all developed methods. Our experiment consist of five major steps, graphically shown in fig. 2 and they are; iris image acquisition, segmentation, normalization, feature encoding and matching. The performance of iris recognition is highly dependent on the earlier stage; segmentation where the iris region of an eye image is located.

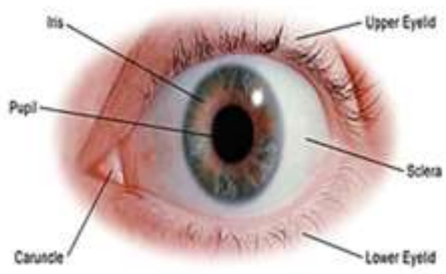

Fig. 1.Front view of a human eye

The rest stages are normalization means converting the extracted iris area into constant rectangular dimension, and feature encoding which means creating a bit-wise template containing only the most discriminating features of iris. The input of the system is an eye image and the output is a template consisting of zero and one. And only these templates are considered in matching stage to classify an individual either as genuine or imposter.

II. IRIS SEGMENTATION

The first stage if iris recognition technique is isolating iris area from an input eye image. The interior image portion of two circles is identified as iris region where one circle defines the

Eyelids detection

The Parabolic Hough transform is used to detect the eyelids by approximating the upper and lower eyelids with parabolic arcs which are represented as

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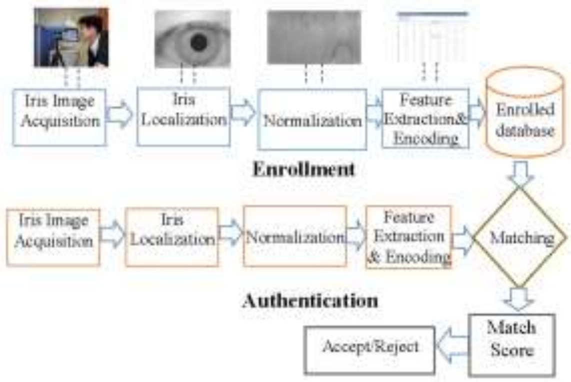


Eye image may contains specular reflection and since the intensity values at specular region are normally higher than any other regions in eye image it can be easily detected by thresholding. Sometimes eyelashes may cover some pixels of iris region described in the method presented by Kong and Zhang [9]. It can be detected by convoluting separable eyelashes with Gaussian smoothing.

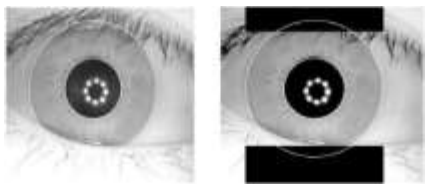
B. Iris and Pupil Localization

Accurate localization of iris and pupil in an eye image is very important for successful person identification. Hough transform is widely used for this purpose. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes et al. [6], Kong and Zhang [11]. At first, the eye image is smoothed to reduce noise using Gaussian filtering and after that gradient of intensity values is calculated both in vertical and horizontal direction. The local maxima in gradient values are suppressed and finally candidate edge pixels

III. NORMALIZATION

After proper segmentation of iris region, the next step is to normalize it into a constant rectangular block to prevent its spatial inconsistency which may occur for several reasons like as iris stretching caused by dilation of pupil for illumination variation, imaging distance variation, rotation of the camera, head angle, eye rotation etc. [18]. Besides the pupil region is not always concentric within the iris region, and is usually slightly displaced [4]. So normalization is performed to minimize all of these problems. All the pixels in iris region are remapped to polar coordinates (r,) using homogenous rubber sheet model invented by Daugman [10] where r is the interval between [0,1] and is between angle [0,2π].

are isolated by thresholding process. Considering each edge					
pixel as a center of circle with certain radius value voting is					
performed in Hough space satisfying following circle equation				Fig. 4. Daugman's rubber sheet model.	
where x_c and y_c are center coordinates and radius is r.				The iris region from (x,y) Cartesian coordinates is remapped	
(−)	(−) −	= 0.	(1)	to the normalized polar representation using following formula	
				when pupils are not concentric.	



A maximum voted point in Hough space is considered as the best positioned center coordinate and the radius for which,the point became maximum is considered as the radius of iris boundary circle. Similar procedure is applied to calculate the center coordinates and radius of pupil.

VI. EXPERIMENTAL RESULTS

In this work CASIA-Iris-Interval Version 4 database has been used where there are 1565 8 bit gray-level JPEG images of both left and right eyes of 249 different individuals [20]. The rate of success of automatic segmentation using Hough transform has become 91.56% which is better than some previous result shown in Table 1.Only the successfully segmented irises have

TABLE 1. AUTOMATIC IRIS SEGMENTATION RESULT

Methods	**Segmentation rate (%)**
Libor Masek[21]	83.00
Proposed Work	91.56

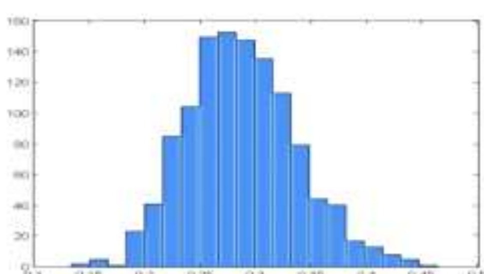


Fig. 7 Intra-Class Hamming distance distribution

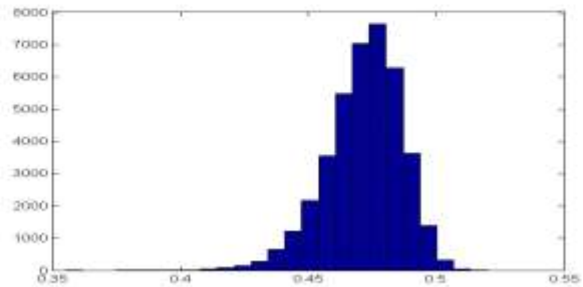


Fig. 8. Inter-Class Hamming distance distribution

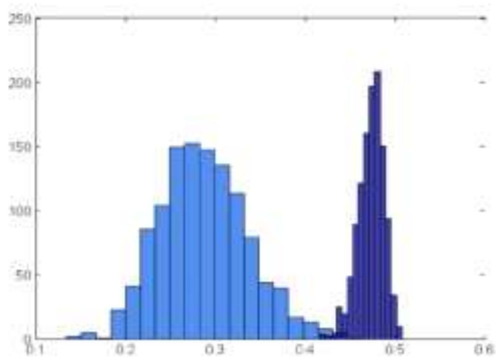


Fig. 9. Intra-Class & Inter-Class Hamming distance distribution

A. Intra-Class Comparisons

Component Comparison between images of an identical eye taken by sensor camera from different angles is termed as intra-class comparison. In this work 1160 intra-class comparisons of iris templates were successfully performed and their hamming distance distribution is shown in Fig. 7.

B. Inter-Class Comparisons

Inter -Class comparison is defined as the comparison between two images of different eyes. Total 40,000 intra-class comparisons were executed successfully for this work and the histogram of distribution is shown in Fig. 8. Among all the results of intra- class comparisons and inter-class comparisons very few values were seen to overlap. Their combined hamming distance distribution for 1164 comparisons is shown in Fig. 9.

C. False Accept and False Reject Rates

Some of our experimented false accept rates (FAR) and false reject rates (FRR) for different threshold value have been shown in table 2. The value of FAR and FRR has become optimal for the threshold value 0.42 for the CASIA database.

We have also experimented the recognition accuracy of iris considering 200 images as training set and another 200 images as testing set. And we have derived a better recognition accuracy than some previous result shown in table 3.

TABLE 2. FAR & FRR OF CASIA-IRIS-V4 DATABASE

Threshold	FAR (%)	FRR (%)
0.20	0.000	97.337
0.30	0.000	37.801
0.38	0.000	3.952
0.40	0.000	1.890
0.42	0.172	0.945
0.44	3.090	0.258
0.48	69.785	0.000
0.50	99.142	0.000

TABLE 3. IRIS RECOGNITION ACCURACY COMPARISON

Features	Methods	Recognition Rate (%)
Iris Features	Boles et al., [8]	92.64
	Daugman[22]	98.60
	Masek et al.,[23]	94.91
	Proposed Method	99.17

VII. CONCLUSION

Nowadays the access to most of the highly secured places are controlled by human iris based verification technique because of its higher accuracy and robustness. Our experiment of Hough transformed based iris recognition technique also strongly supports the claim about its higher accuracy and reliability. This research work was conducted using CASIA –iris-version 4.0 database with the experimented parameters provided by L. Masek [18] for CASIA-version 1.0. The experimental result for updated database showed better result both in segmentation and recognition. It was also observed that correct segmentation is the most vital phase of iris recognition technique. So special concern need to be given on iris image acquisition and segmentation. Finally it can be clarified that the significance of human iris as a person identification is highly acceptable and appreciable. Though the experiment was conducted in constrained database we are optimistic to consider more dynamic dataset for future work to evaluate its global performance.

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