Iris Based Recognition System Using Wavelet Transform

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Abstract
Iris recognition is known as an inherently reliable technique for human identification. Feature extraction is a crucial step for iris recognition and important task. The extracted features are used for matching. Different wavelet transforms have been used by different researchers for feature extraction in iris recognition. Also many researchers extract features using different coefficient such has horizontal, vertical, diagonal or combination of them. In this work we have used SCOE-Iris v.1 database consisting of 2750 images, acquired in the signal processing laboratory at Sinhgad College of Engineering, Pune, India. In this work different basis wavelet are used for feature extraction and their performance is evaluated. The optimal wavelet transform is determined. Experimental results show that this algorithm are efficient and gives acceptable accuracy

Key words:
Iris recognition, wavelets, feature extraction, pattern matching and hamming distance.

1. Introduction

Identification of humans is a goal as ancient as humanity itself. As technology and services are advanced and developed there is a rapid need for personal identification is required. Examples include passport control, computer login control, bank automatic teller machines and other transactions authorization, premises access control, and security systems generally. All such identification efforts share the common goals of speed, reliability and automation.

Biometrics as form of unique identification is one of the subjects of researches that are growing more rapidly. The advantages of unique identification using biometrics features are numerous, such as fraud prevention and ease of use. Although the current state of art provides reliable automatic recognition of biometric features, the field is not completely researched. Different biometric feature offer different degrees of reliability and performance.

Human iris is an internal organ of the eye and as well protected from the external environment, yet it is easily visible from within one meter of distance makes it a perfect biometric for an identification system. Iris recognition is widely accepted as one of the best biometrics recognition methods [1] in the world because of its stability, uniqueness and noninvasiveness has the potential of applications in very wide areas.

Although the human eye is slightly asymmetrical and the pupil is slightly off the center for the most practical cases we think of the human eye is symmetrical with respect to line of sight. The colored part of the eye is called the iris. It controls light levels inside the eye similar to the aperture on a camera. The round opening in the center of the iris is called the pupil. The iris is embedded with tiny muscles that dilate and constrict the pupil size. .

Iris recognition relies on unique patterns of the human iris to identify or verify an individual which remains stable throughout life [2][3]. Thus iris recognition has received a extensive attention over last decade [2][3][4][5][6] and is reputed to be most reliable and accurate person identification system[7].

Various methods have been proposed by different researchers. In this paper first we try to find out the best combination of coefficients which can be used for creating the feature, also different wavelet transforms have been implemented for feature extraction and four bit quantization is used for encoding the feature vector. The remaining sections are organized as following: section 2 explains the iris recognition system. Section 3 deals with the feature extraction. Section 4 shows the experimental results; and section 5 is the conclusion.

2. Iris Recognition System

The iris recognition system consists of image acquisition, preprocessing, feature extraction and feature comparison.

2.1 Database

In practical applications of a workable system an image of the eye to be analyzed must be acquired first in digital form suitable for analysis. Her we use the images from SCOE-Iris v.1 database which were, acquired in the signal processing laboratory at Sinhgad College of Engineering, Pune, India. The image database collected here will be available to all the research community in Feb 2010. This database is acquired using ISGlightwise 1.3 M camera. The database consists of total 2750 images of resolution 320x280 acquired from 275 subjects. The images are

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acquired in different light intensity varying from 50 to 200 lux. Few sample images from the database are shown in fig.1.

Fig. 1. Sample eye images from SCOE-Iris v.1 database.

The acquired image of eye does not contain only iris but it contains iris as a part of large image, which also contains data, derived from the surrounding eye region. Therefore, prior to performing iris matching it is very important to localize the iris in the acquired image. The main objective here is to determine the pupil boundary and iris boundary and also non-useful information, namely the pupil segment and the part outside the iris.

The iris search greatly constrains the pupil search; concentricity of these boundaries cannot be assumed [3]. Very often the pupil center is nasal and inferior, to the iris center. In iris edge detection the pupillary and limbus boundaries are detected as shown in fig. 2. Here we make use of an integrodifferential operator for locating the outer circular region of iris[2][3].

To make a detailed comparison between two images, it is advantageous to establish a precise correspondence between characteristic structures across the pair. The system under discussion compensate for image shift, scaling, and rotation. Given the systems' ability to aid operators in accurate self-positioning, these have proven to be the key degrees of freedom that required compensation. Shift accounts for offsets of the eye in the plane parallel to the camera's sensor array. Scale accounts for offsets along the camera's optical axis.

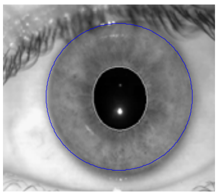

Fig. 2: Iris localized Image

Rotation accounts for deviation in angular position about the optical axis. Iris localization is charged with isolating an iris in a larger acquired image and thereby essentially accomplishes alignment for image shift.

The zones of analysis are established on the iris in a doubly dimensionless projected polar co-ordinate system. Its purpose is to maintain reference to the same region of iris tissue regardless both of pupillary constriction and overall image size, and hence regardless of distance to the eye and video zoom factor. This pseudo polar co-ordinate system is not necessarily concentric, since for most eyes the pupil is not central in the iris.

A pair of dimensionless real co-ordinates (r, θ) where 'r' lies in the unit interval [0,1] and 'θ' is the usual angular quantity that is cyclic over $[0,2\pi]$. The remaping of the iris image I(x,y) from raw co-ordinates (x,y) to the doubly dimensionless non concentric polar co-ordinate system (r,θ) as explained in [7]. The normalized image generated is of size 512 x 64 as shown in fig. 3.

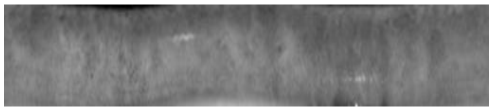

Fig. 3. Normalized Image

The details of feature extraction, encoding and matching are described in next section.

3. Proposed Approach

Many iris recognition algorithms are based on ground work of Daugman [1][2] which is based on gabor wavelets, Boles[4] algorithm is based on zerocrossing of wavelet transform and Lim [6] algorithm is based on 2D Haar wavelet transform.

The standard discrete wavelet transform (DWT) is a very powerful tool used successfully to solve various problems in signal and image processing. The DWT breaks an image down into four sub-sampled, or images. The results consist of one image that has been high pass in the horizontal and vertical directions(HH), one that has been low passed in the vertical and high passed in the horizontal(LH), one that has been high passed in the vertical and low passed in the horizontal(HL) and last that has been low pass filtered in both directions(LL) Where, H and L mean the high pass and low pass filter, respectively. While HH means that the high pass filter is applied to signals of both directions, represent diagonal features of the image, HL correspond to horizontal structures, LH results vertical information and LL is used for further processing.

Jafar [9] uses Haar wavelet, decomposes up to fifth level then creates a feature vector by combining [LH5 HL5 HH5] for feature extraction. Similarly [10] uses Haar wavelet, decomposes up to fourth level then creates a feature vector by using HH4.

Poursaberi [11] uses daubechies db2 wavelet, decomposes up to fourth level then creates a feature vector by combining [LH4 HL4] for feature extraction. Similarly [12] uses daubechies db2 wavelet, decomposes up to third level then creates a feature vector by using [LH3 HL3]. Moukhtar [13] creates a feature vector using three different wavelets daubechies db2, db4 and Haar.

Ajay Kumar[14], decompose the image five times using Haar wavelet, the feature vector consist only HH components. Daouk[15] In this approach, the enhanced images are decomposed into 5 levels by the Haar wavelets [11]. Next the vertical, horizontal and diagonal coefficients of fourth and fifth level were employed. The coefficients of first three levels were almost the same as those of the fourth level were ignored. The fifth level decomposition offered the most discriminative information and therefore all the coefficients from this decomposition were employed.

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In this work we use different mother wavelet: Haar, Daubechies, Coiflet, Symlet and Biorthogonal. We have decomposed the normalized image using fifth level decomposition, as shown in fig. 4. In order to create the feature vector we tried different combinations of HH5, HL5, and LH5. The results obtained from different combinations are compared to find the best.

The binary feature vector is generated by quantizing the feature vector obtained by different combinations of HH5, HL5 and LH5. The binary feature vector is encoded by using two level quantization[1][2][6][8][9][11][12][13].

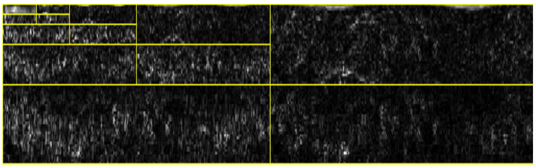

Fig. 4: Decomposition of normalized image using Haar transform at level 4

To improve the recognition rate, the coefficients are quantized by using four level quantization [16]. The coefficients greater than 0.5 are set to value 11, coefficients less than 0.5 are set to 10. Similarly the feature vector values in-between 0 to -0.5 are set to 01and smaller than -0.5 are set to 00.

The last module of an iris recognition system is used for matching two iris templates. Its purpose is to measure how similar/different templates are and to decide whether they belong to the same individual or not. An appropriate match metric can be based on direct point-wise comparisons between the phase codes. The test of matching is implemented by the simple Boolean Exclusive-OR operator (XOR) applied to the encode feature vector of any two iris patterns. The XOR operator detects disagreement between any corresponding pair of bits. This system quantifies this matter by computing the percentage of mismatched bits between a pair of iris representations, i.e., the normalized Hamming distance. Let A and B be two iris representations to be compared and N be total number of bits, this quantity can be calculated as

$$HD = \frac{1}{N}\sum_{j=1}^{N} A_j \oplus B_j \qquad (1)$$

In order to avoid rotation inconsistencies which occur due head tilts, the iris template is shifted right and left by 4 bits. It may be easily shown that scrolling the template in polar coordinates is equivalent to iris rotation in Cartesian coordinates. This algorithm performs matching of two templates several times while shifting one of them to four different locations. The smallest HD value amongst all this values is selected, which gives the matching.

4. Results

As shown in Table no. 1 experiments were performed using different combinations of HH5, HL5, and LH5. The results obtained from different combinations are compared to find the best. The feature vector is created by concatenating LH5 and HL5.

The performance was evaluated as shown in Table no.2 using different mother wavelets: Haar, Daubechies, Coiflet, Symlet and Biorthogonal. The Haar wavelet is selected for feature extraction as it gives better result for minimum feature vector length.

Table 1: Comparison of different feature vectors using Haar wavelet on SCOE-Iris v.1 database.

Feature Vector	Accuracy in %	Feature vector length
D	89.68	64
H	83.65	64
HD	94.92	128
HV	95.56	128
HVD	97.62	192
V	92.54	64
VD	97.3	128

5. Conclusion

The experimental results clearly demonstrate that the feature vector consisting of concatenating LH5 and HH5 gives better results. On the other hand, the Haar wavelet is particularly suitable for implementing high-accuracy iris verification/identification systems, as feature vector is at the least with respect to other wavelets. The db9 wavelet gives a accuracy of 99.98% but the feature vector length is 18 times as compared to Haar wavelet.

Table 2: Performance of feature vector using different mother wavelet on SCOE-Iris v.1 database.

Feature Vector	Accuracy in %	Feature vector length	Feature Vector	Accuracy in %	Feature vector length
Haar	97.3	128	sym6	99.68	1248
db1	97.1	128	sym7	98.57	1568
db2	95.87	288	sym8	95.4	1920
db3	97.62	480	sym9	98.57	2304
db4	96.03	704	sym10	97.78	2720
db5	96.83	960	coif1	95.56	480
db6	97.94	1248	coif2	95.87	1248
db7	96.68	1568	coif3	99.84	2304
db8	99.52	1920	coif4	96.83	3648
db9	99.98	2304	coif5	98.25	5280
db10	99.52	2720	bior1.3	97.3	480
db11	97.78	3168	bior1.5	90	960
sym2	95.87	288	bior2.2	97.46	480
sym3	97.62	480	bior2.4	95.56	960
sym4	95.56	704	bior2.6	96.35	1568
sym5	97.74	960	bior3.3	92.7	704

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