International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 4, June - 2012

Iris Recognition for Biometric Identification using Wavelet Packet Decomposition

Sunita Lokhande
Sinhgad College of Engineering Pune

Vishram . N. Bapat
GITM Jhajjar, Haryana

Abstract

In this paper, iris recognition system using wavelet packet is presented. Computational complexity of Daubechies wavelet is less as compared to Gabor wavelets. As Gabor wavelet based iris recognition system is patented this limits the further development. In this paper, we propose a novel multi-resolution approach based on Wavelet Packet Transform (WPT) for iris texture analysis and recognition. The development of this approach is motivated by the observation that dominant frequencies of iris texture are located in the low and middle frequency channels. The features of the new iris pattern are compared against the stored pattern after computing the signature of new iris pattern and identification is performed. It specifically uses the multiresolution decomposition of 2-D discrete wavelet packet transform for extracting the unique features from the acquired iris image. We have showed that the proposed method for human iris recognition gave a way of representing iris patterns in an efficient manner and thus had advantages of saving both time and space.

Keywords : Biometrics, Iris recognition, wavelet, Iris segmentation, Iris normalisation

1 Introduction

Biometrics is automated method of identifying a person or verifying the identity of a person based on physiological or behavioral characteristic. Examples of physiological characteristics include hand or fingers images, facial characteristic and iris recognition. Behavioral characteristics are learned or acquired. Dynamic signature verification, speaker verification, and keystroke dynamics are examples of behavioral characteristics.

Iris recognition is regarded as the most reliable and accurate biometric identification system available. The human iris is an annular part between the pupil (generally appearing black in image) and white sclera has an extraordinary structure. The iris begins to form in the third month of gestation and structures creating its pattern are largely complete by the eight months, although pigment accretion can continue in the first postnatal years. Its complex pattern can contain many distinctive features such arching ligaments, furrows, ridges, crypts, rings corona, freckles and zigzag collarette [1]. These visible characteristics, which are generally called the texture of the iris, are unique to each subject [2], [3]. But as a new technology, iris recognition still has many difficulties., Need to solve. For example, the affection of eyelashes and eyelids, iris non-elastics deformation as the pupil changes the size, and head tilt. To test the proposed work, data set of Chinese Academy of Sciences-Institute of Automation (CASIA) is used.

1.1 **Overview of the Iris Recognition system**

Image processing techniques can be employed to extract the unique iris pattern from a digitized image of the eye and encode it into the biometric template, which can be stored in database. This biometric template contains an objective mathematical representation of the unique information stored in the iris, and allows the comparisons made between templates. When a person wishes to be identified by an iris recognition system, their eye is first photographed and then template is created for their iris region. This template is then compared with the template stored in a database, until either a matching template is found and a subject is identified, or no match is found and subject remains unidentified.

Human iris recognition process is basically divided into four steps.

i) Localization: Inner and outer boundaries of the iris are extracted.
ii) Normalization: Iris of different people may be of different size. For the same person, the size may vary because of changes in the illumination and other factors. So, normalization is performed to get all the images in a standard form suitable for the processing.
iii) Feature extraction: Iris provides abundant texture information; a feature vector is formed which consists of the ordered sequence of features extracted from the various representations of the iris images.
iv) Matching: Feature vectors are classified through euclidean Distance.

Texture is an important characteristic for analysis of much type of iris images. Texture can be defined as local statistical pattern of texture primitives in observer domain of interest. Two major issues are critical for iris texture classification: the texture classification algorithm and texture feature extraction algorithm. The Iris is complex enough to be used as a biometric signature. Therefore, in order to use iris pattern for identification, it is important to define a representation that is well adapted for extracting the iris information content from images of the human eyes. distance classifier. Performance of the proposed work has been compared for various values of the filter parameters and different shifts of iris. Figure 1 shows the flow of the proposed work wavelet packet for feature extraction. It uses euclidean distance for classification.

2. Preprocessing of Iris Image

An eye image from CASIA database is taken as input from which iris is detected. Our preprocessing operates in the following steps.

2.1 Segmentation

The first stage in iris recognition is the detection

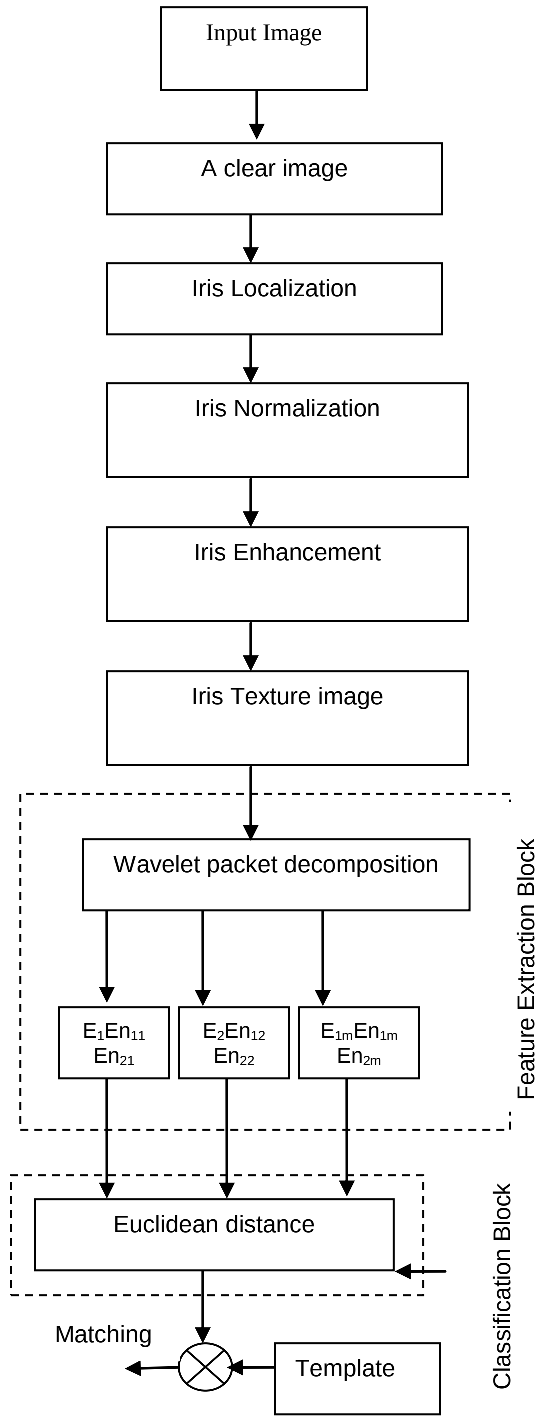

Figure 1. Flow of Iris recognition system

of pupil and Iris boundaries from the input eye images. Circular Hough transform is used to detect pupil and iris boundaries. This involves first employing Canny edge detection to generate an edge boundaries [1].

Also eyelids, eyelashes and reflection areas if any, need to isolate. Eyelids can be isolated by using linear Hough transform. Threshold can be employed for isolating eyelashes and reflections. Figure 2 b shows the segmented Iris.

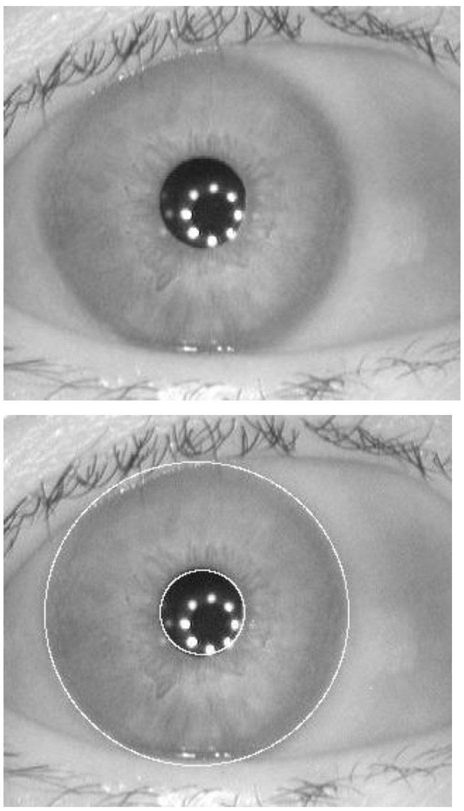

Figure 2.a) Original Image b) Segmented Iris

In general a typical iris recognition system is based on the texture analysis. The scheme composed of wavelet packet feature extractor and euclidean distance for recognition. The proposed work focuses on the last issue using wavelet packet for iris includes iris acquisition, iris liveness detection,

2.2. Iris Normalization

Irises from different people may be captured in different size and even for irises from the same eye; size may change due to illumination variations and other factors. Such elastic deformation in iris texture will affect the result of Iris matching. Image processing of the eye image is computationally expensive as the area of interest is of donut shape grabbing the pixels in this region require repeated rectangular to polar conversion[3]. This problem can be solved by projecting the original iris in a Cartesian co-ordinate system into doubly dimensionless pseudo polar co-ordinate system. This method normalizes iris of different sizes to the same size.

Figure 3 a) Noise array after normalisation

b) Polar array after normalization

The remapping of the iris region from (x,y) Cartesian coordinates to the normalized Non-concentric polar representation is modeled as

$I(x(r,\theta), y(r,\theta))$ ------- $I(r,\theta)$

With

$$x(r,\theta) = (1-r)\, x_p(\theta) + r\, x_i(\theta)$$

$$y(r,\theta) = (1-r)\, y_p(\theta) + r\, y_i(\theta)$$

$I(x,y)$= iris image

(x,y) = original cartesian coordinates

(r,θ) = normalised coordinates

(x_p, y_p)= pupil coordinates

(x_i, y_i)= iris coordinates along θ direction.

2.3 Feature Extraction using wavelet

Feature extraction of iris is the key of recognition. It is crucial to choose the suitable filter for feature extraction. We proposed a algorithm based on Wavelet packet.

Fourier-based analysis is based on the sinusoidal functions of various frequencies, whereas wavelet analysis on the other hand is founded on basis functions formed by dilation and translation of a prototype functions known as mother wavelet (Daubechies, 1988)[4].The main advantages of wavelet is that they have a varying window size, being wide for slow frequencies, and narrow for the fast ones, thus leading to an optimal time-frequency resolution in all the frequency ranges.

Wavelet Packet transforms (WPT)

Wavelet transform provides flexible time frequency resolution properties; one possible drawback is that frequency resolution is rather poor in the high frequency region. Wavelet packets, a generalization of a wavelet bases, are alternative bases that are formed by taking linear combination of usual wavelet functions.

There are bases inherit properties such as orthonormality and time-frequency localization from their corresponding wavelet functions. Wavelet decomposition can be regarded as a continuous time wavelet decomposition sampled at different frequencies at every level or scale. Wavelet packet analysis is an extension of the discrete wavelet transform (DWT) and it turns out that the DWT is only one of the many possible decomposition that could be performed on the signal. The advantage of wavelet packet analysis is that it is possible to combine the different levels of decomposition in order to achieve the optimum time-frequency representation of the original. Thus wavelet packet are used for the purpose of feature extraction.

For wavelet packet decomposition of the iris ,the tree structure is used as a binary tree of depth m=2. Wavelet packet decomposition is applied to iris images using Daubechies-2 wavelet packets filters with energy [15]. Energy of each channel is computed by

$$E(iris) = \frac{1}{MN} \sum_x \sum_y |f(x,y)| \qquad (1)$$

f(x,y) indicates iris pixel at position(x,y).
M= No. of rows
N=No. of columns.

We integrate the energy values of each subband of the wavelet packet decomposed iris image.

3, Template Matching

For template matching different measures are there like Euclidean distance, hamming distance. Euclidean distance is defined as a measure of dissimilarity between two features. Performs its measurement with the following equation:

$$\text{Euclidean distance} = \sqrt{\sum_{i=1}^{L} (y_i - p_i)^2} \qquad (2)$$

Being L the dimensions of the feature vector.
y_i the i^{th} component of the sample feature vector and p_i the i^{th} component of the template feature vector.

3,1 Data Analysis

The proposed algorithm is tested on CASIA iris image database CASIA-IrisV3 developed by the Chinese Academy of sciences-Institute of Automation. The CASIA database includes 22051 iris image sequences from 700 subjects. This is largest image database available in public domain. The captured iris images are 8-bit gray level images with a resolution of 320 x 280. In general the diameter of the iris in images from this database is greater than 200 pixels. This makes sure that there is enough texture information for reliable recognition.

The CASIA database consists of clear images, motion blurred images, occluded images and defocused images in different numbers.

The proposed iris recognition algorithm is tested in two modes-

1. Identification (i.e. one-to-many matching)
2. Verification (i.e. one-to-one matching)

In identification mode, algorithm is measured by correct Recognition Rate (CRR), the ratio of the number of the samples being correctly classified to the total number of the test samples .

In verification mode, FRR (False Rejection Rate) and FAR (False Acceptance Rate) will be used for measure of accuracy process and shows the overall performance of an algorithm. FRR measures the probability of an enrolled individual not being identified by the system. FAR measure the probability of an enrolled individual being wrongly identified as another individual. The false accept and and false reject rates can be calculated by the amount of overlap between two distributions.

4.Experimental Results-.

The accuracy of recognition with this

distributions can be determined by calculating their false accept rates (FAR) and false reject rates (FRR) with different threshold[3]

$$FAR = {}_0\sum^{k} ED / {}_0\sum^{max} ED \quad (3)$$

$$FRR = {}_k\sum^{max} ED / {}_0\sum^{max} ED \quad (4)$$

Where k is the separation point (threshold) between intra-class and inter-class.

Once optimum parameters have been found, the performance of this optimal configuration will be measured by calculating FAR and FRR. .

To evaluate the performance of the proposed work following experiments are carried out.

Experiment 1:
Performance of iris recognition using feature vectors of energies only

In this feature vectors are created by applying Wavelet packets. Table 1 shows FAR and FRR and Correct recognition rate (CRR) for different values of threshold.

In this equal error rate is 11% , corresponding to this correct recognition rate is 79%. Figure 4 shows variation of FAR and FRR for different threshold. Figure 4 shows variation of FAR and FRR for different threshold.

Table 1 FAR and FRR for different threshold. (Energy only)

Threshold	FRR (%)	FAR (%)	CRR(%)
2	68	0	30
4	47	2.77	34
6	30	5.09	44
8	19	9.7	55
10	16	10	66
12	14	12	75
14	11	11	79
16	9.7	24	86
18	6.9	27	90
20	6.9	30	91

Experiment 2:
Performance of iris recognition using feature vectors of only standard deviation.

In this features are created by applying Wavelet packets. Table 2 shows FAR and FRR and Correct recognition rate (CRR) for different values of threshold.

Table 2 FAR and FRR for different threshold. (standard deviation only)

Threshold	FRR (%)	FAR (%)	CRR
2	34	0	50
4	20	0	65
6	18	1.38	79
8	13.8	1.38	81
10	12.5	2.77	86
12	11.11	4.16	87
14	8	5.55	88
16	6.9	6.9	91
18	5	12	93

In this equal error rate(EER) is 6.9% , corresponding to this correct recognition rate is 91%. Figure 5 shows variation of FAR and FRR for different threshold.

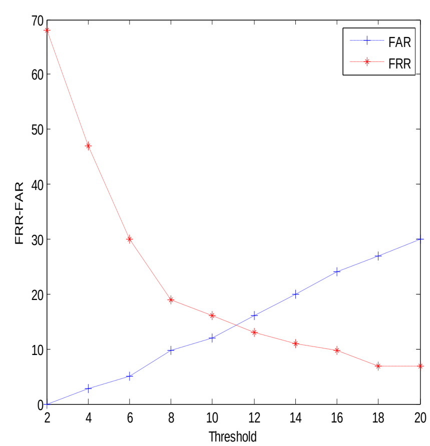

Figure 4. FAR-FRR for different threshold (energy only)

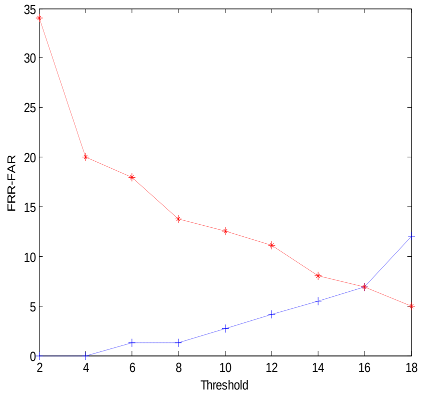

Figure 5. FAR-FRR for different threshold

(Standard deviation)

Experiment 3

Performance of iris recognition using feature vectors of energies and standard deviations.

In this features are created by applying Wavelet packets. Table 6 shows FAR and FRR and Correct recognition rate (CRR) for different values of threshold.

Energy and standard deviation together gives equal error rate is 6%, corresponding to this correct recognition rate is 93%. In this performance is improved. Figure 4 shows variation of FAR and FRR for different threshold.

Table 3 FAR and FRR for different threshold. (standard deviation and energy only)

Threshold	FRR (%)	FAR (%)	CRR
2	36	0	52
4	22	0	69
6	15	1	80
8	13	2	83
10	12	2	86
12	8	4	88
14	6	5	90
16	6	6	93
18	6	8	93
20	4	9	95

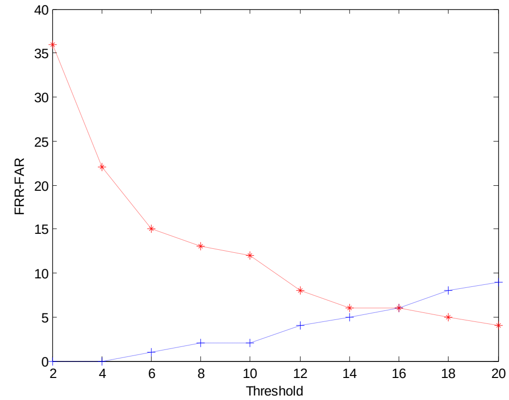

Figure 6. FAR-FRR for different threshold

(**Energy and standard deviation)**

Comparison With existing methods

The methods proposed by Daugman [3], Wilds [2], Boles [8] are the best known among the existing schemes for iris recognition. Therefore we choose to compare our algorithm with theirs.

Table 4 Comparison With existing methods (CRR)

Methods	CRR (%)	EER(%)
Daugman	100	0.08
Boles	92.64	8.13
Proposed	93	6

Table1 5 Comparison With existing methods (Time)

Methods	Feature xtraction time (ms)	Matching time
Daugman	200 msec	430 ư sec
Proposed method	54 msec	47 ư sec

Conclusion

In this paper, iris recognition system using wavelet packet is presented. In this paper, we propose a novel multi-resolution approach based on Wavelet Packet Transform (WPT) for iris texture analysis and recognition. The signature of the new iris pattern is compared against the stored pattern after computing the signature of new iris pattern and identification is performed. It specifically uses the multiresolution decomposition of 2-D discrete wavelet packet transform for extracting the unique features from the acquired iris image. We have showed that the proposed method for human iris recognition gave a way of representing iris patterns in an efficient manner and thus had advantages of saving both time and space. An energy measure is used to identify the particular packets that carries discriminating information about the iris texture. The experimental results show 93% correct classifications when applying the algorithm on an iris image database.

References

1) John Daugman , "How iris recognition works" IEEE Transction on Circuits and Systems for Video Technology, Volume no. 1,PP.21-30, 2004

2) Richard P. Wildes , "Iris recognition :An Emerging Biometric Technology ," Proc. IEEE ,Vol. 85, PP 1348-1363, 1997

3) 3. John Daugman , " Biometric Personal Identification System based on Iris Analysis " United State Patent , no. 5291560 , 1994.

4) Daubenchies " The Wavelet Transform , time frequency localization and Signal Analysis ," IEEE Trancation Information Theory , Vol. 36, PP. 961-1005 , 1990

5) Arivazhagan S. and Ganesan L. "Texture Classification Using Wavelet Transform , " Pattern recognition letters ,24, 1513-1521 , 2003

6) Users M . . "Texture Classification and Segmentation using wavelet frames " IEEE Tranction on inages processing , 4(11), 1995 PP. 1549-1560.

7) Turkoglu I. , Arslan A. ,and Ilkay E, " An intelligent System for Diagnosis of Heart Value diseases with Wavelet Packet Neural Networks" Computer in Biology and Medicine .33(4), 319-331.

8) Boles and Boashash, "A Human Identification Technique Using Images of the Iris and the Wavelet Transform", IEEE Transactions on Signal Processing, 1998.

9) Li Ma, Tieniu Tan, Yunhong Wang, and Dexin Zhang, "Efficient Iris Recognition by Characterizing Key Local Variations", IEEE Transactions on Image Processing, Vol 13, No. 6, June 2004.

10) Tisse et al., "Person Identification Technique using Human Iris Recognition", Proc. of Vision Interface, 2002.

11) Tan – Personal identification based on Iris texture analysis

12) Li Ma, Tieniu Tan, Yunhong Wang, and Dexin Zhang, "Personal Identification Based on Iris Texture Analysis", IEEE Transactions on Pattern Analysis and Machine Intelligence,Vol. 25, No. 12, December 2003.

13) D.Field "Relations between the statistics of natural images and response properties of cortical cells" ,Journal of optical society of America, 1987.

14) Ricard Yew Fatt Ng, Yong Haur tay, Kai Ming Mok "A review of Iris Recognition Algorithms" ,IEEE Trans.

15) Abdualkadir Sengur , Ibrahim Turkoglu and M. Cevdet Ince Expert systems with Applications 32 (2007) 527-533. Wavelet packet neural networks for texture classification ScienceDirect Expert systems with Applications 32 (2007) 527-533.