IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727,
PP 10-17
www.iosrjournals.org

Development of an Iris Feature Extraction system by using Wavelet

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Abstract: *Biometric system is used for Identification as well as verification purpose. This paper presents the comparative of feature extraction of Iris. Iris Biometric system has image Acquisition, Image preprocessing, Feature extraction and matching. The features are extracted from the pre-processed images of iris images by using Gaussian filter as well as by using Gabor wavelet. The quality measures of the images are calculated. The Gabor wavelet improves the performance of the system.*
Keywords: *Feature Extraction, pre-processing, pupil, LDA*

I. Introduction

Iris recognition is a method of biometric authentication that uses various techniques like pattern recognition, texture base recognition [1]. The human iris, circular part between the pupil and the white sclera. These characteristics are visible and, called the texture of an iris. It is unique part.

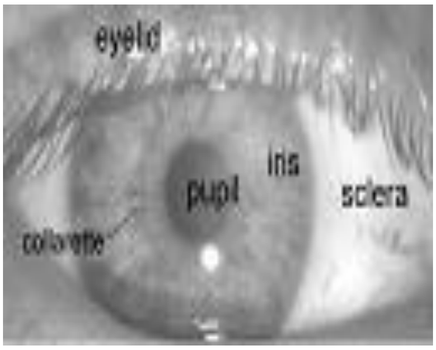


Figure 1: View of Human EYE

The whole iris recognition process is basically divided into four steps [2]:
1) Iris Image acquisition
2) Iris image pre processing
3) Iris feature extraction
4) Matching
5) Decision making

1.1 IRIS Image Acquisition

The iris image acquisition includes the position of the system, and the physical capture system (Wields, 1997). The iris recognition includes pre processing, Feature Extraction and Matching. During iris image acquisition, the iris image must be clear and sharp. Good clarity images improve the accuracy and the iris boundary and pupil detection is improved the quality[3].

1.2 Iris Pre-processing

The original eye image must be pre processed in order to extract iris features from an eye image. The pre processing involves localization and normalization of the iris image. The popular approach for iris is localization by using Daugman's integro-differential operator (IDO) and normalized with the help of Daugman's rubber sheet model. The Iris preprocessing and Iris feature extraction provides the feature vector for matching purpose [4].

1.3 Feature Extraction

There are various techniques which are used for feature extraction. The techniques are LDA, LPCC, Corner detection based iris encoding, HAAR Wavelet, Gabor wavelet, Gaussian filter etc. Iris feature extraction provides the feature vector for matching purpose.

II. Literature Review

Various techniques are used for iris feature Extraction.

1) In corner detection based iris encoding; the authors presented an iris recognition algorithm using corner detection. In this technique the polynomial, line is used for the detection of circle. In this method authors used Sobel Filter [5].
2) In LPCC and LDA based Iris feature extraction, the author presented iris recognition algorithm based on LPCC and LDA .The Author used rare combination of LPCC and LDA to extract the feature vector of iris images [6].
3) In Feature Extraction Using HAAR wavelet HAAR Wavelet is used to extract the feature from the iris images. The comparison with other wavelet HAAR Wavelet provides good results [7].
4) Feature Extraction Using DWT (Discrete Wavelet Transform), in this method the DWT analyses a signal based on its content in different frequency ranges.DWT is also used to remove the noise from the frequency domain. DWT provides the analysis of patterns. It is used to decompose the image. The author uses the low pass and high pass filter for the feature vector calculation [8].
5) Feature Extraction using Gabor Filter method extracts the features of the normalized iris by filtering the normalized iris region. This method uses the pair of Gabor filter which gives the information if noise. It forms the iris Code for the feature vector calculation [9].
6) In Statistical Pattern Recognition approach, the author used Fast Fourier transform to extract the features. In FFT high frequencies provide the important features of an image of iris .Higher frequencies are concentrated near to the boundary of the pupil. The high spectral bands are averaged for calculating the features. The spikes on the outer bands are largely due to the interfering eyelids [10].

Iris matching techniques are as follows.

1) Hamming Distance: After the extraction process, the iris code matching task is performed by pairing the iris code extracted from the input and the template iris images. Hamming distance calculate the similarity measurs. The distance between the two featured vector are calculated by

$$D(Fc,Fci),i = 1,N \qquad (1)$$

Where
Fc = Feature of the input pattern
Fci = Feature of the ith pattern from the database
N = Number of patterns in the database

In such a process, there is a most similar pattern which is assigned as i* , to the database pattern. i* is the pattern which has a minimum distance value of Di*

$$Di^* = \min D(Fc,Fci),i = 1,N \qquad (2)$$

This enables the comparison of two iris patterns based on the idea that the greater the Hamming Distance among the two feature vectors, greater the variation between them. If the distance between two iris feature vectors is similar then the match is found between the images. If the distance between the two feature vector of two iris images is greater than zero then there is no match found in two images of iris.

The Hamming Distance was used for identification and rectification of errors in Iris Biometric system. Hamming distance gives the difference between two bits. The Hamming Distance between the two Boolean vectors is given by

$$HD = \frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B(j) \qquad (3)$$

where CA and CB are the coefficients of the two iris images and N is the size of the feature vector and the Boolean operator that gives a binary 1 if the bit sat position j in CA and CB are different and 0 if they are similar. The minimum distance determines the input pattern which is the most similar to the database pattern [11].

2) Neural Network based model:
In this approach, the normalized and enhanced iris image is represented by a two-dimensional array. This array contains the grayscale values of the texture of the iris pattern. These values are input signals for the neural network. NN is used for the classification [12].Various Neural network techniques like back propagation, feed forward N. N. are used for the classification purpose.

III. Proposed System

Basic steps of Iris recognition system is shown in the following figure.

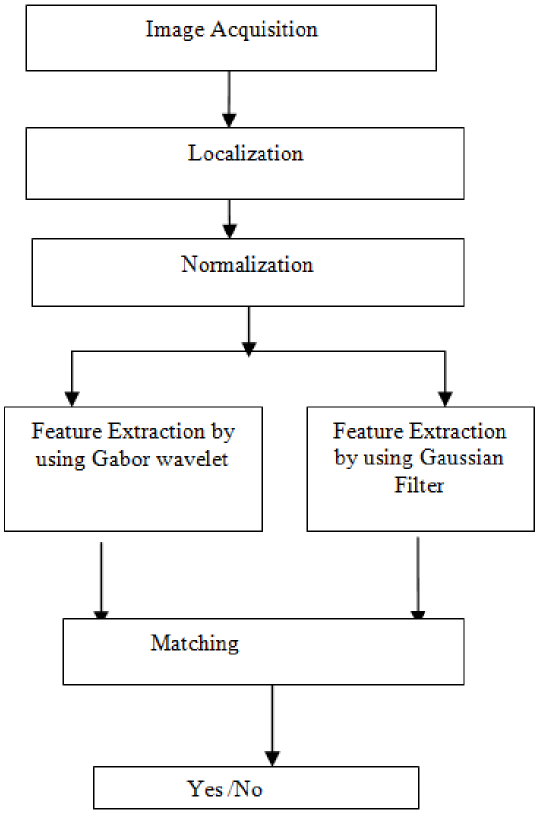


Fig 2: Proposed System

3.1. Image acquisition

In Image acquisition module the iris images are captured through the camera or other devices. The image will then be resized and corrected geometrically and it will remove the background and scene which are not related to the face so that it is suitable for recognition as well as verification For our experiment we consider the MMU database. For our experiment we consider 5 left eye images and 5 right eye images of 20 persons.

3.2 Iris Localization

We use circular Hough transform for detecting the iris and pupil boundaries. This involves first employing canny edge detection to generate an edge map. Gradients were partial in the vertical direction for the outer iris/sclera boundary, as suggested by Wildes et al. [13]. Vertical and horizontal gradients were weighted equally for the inner iris/pupil boundary [14].

3.3 Iris Normalization

For normalization of iris recognition system we used Daugman's rubber sheet model [33] shown in the following figure.

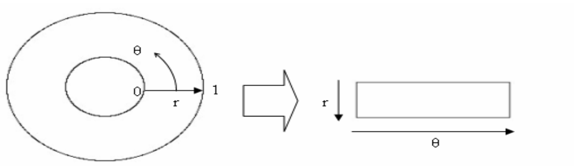


Figure.3: Daugman's rubber sheet model

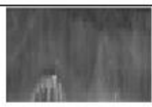
Each point within the iris region to a pair of polar coordinates (r, θ) where r is on the interval [0, 1] and θ is angle [0,2π]. The remapping of the iris region from (x, y) Cartesian coordinates to the normalized non-concentric polar representation is modeled as

$I(x(r,\Theta),y(r,\Theta)) \longrightarrow I(r, \Theta)$ (4)

With

$X(r, \Theta) = (1- r)xp(\Theta) + rx1(\Theta)$ $X(r,\Theta) = (1- r)Yp(\Theta) + rY1(\Theta)$ Where I(x, y) is the iris region image, (x, y) are the original Cartesian coordinates, (r, θ) are the corresponding normalized polar coordinates, and Xp and Yp are the pupil coordinates and the direction is θ . This method defines the angular resolution in which the number of radial lines going in the region of the iris area. Since rescaling is required for this process [15].

Table 1: Iris preprocessing and feature extraction

Sr. No.	circular Hough transform	Daugman's rubber sheet model	Iris feature Extraction by using Gabor Wavelet.
1.			
2.			
3.			
4.			
5.			

3.4 Iris Feature extraction

For Iris feature extraction we used Gabor wavelet feature extraction method. Feature encoding was done by using Gabor wavelet. The two dimensional normalized pattern is divided into the one dimensional signals. For two dimensions each row is consider to a circular loop on the iris region. The maximum direction is considered according to the normalized pattern [16].The feature extraction is shown in following table. The encoding method creates the template containing a number of bits of information, and a corresponding noise mask. It defines to corrupt areas of iris pattern and marks these patterns as corrupted. So that it provides the feature encoding for the process by using filters. The following table shows the circle detection of iris by using Hough man transform, Iris normalisation by using Daugman's rubber sheet model and Iris feature extraction we used Gabor wavelet.

For Iris feature extraction we used Gaussian filter and Gabor wavelet. The following table 1 and 2 shows the quality measures of Gaussian filter as well as the Gabor wavelet.

Sr. No.	M.S.E.	P.S.N.R.	MNCC	Structural contents	Max Diff.	Normalized Absolute Error
Image 1	8.1357 e+03	9.0268	1.3399	0.4061	240	0.7903
Image 2	7.4258 e+03	9.4234	1.2604	0.4632	243	0.7265
Image 3	6.2583 e+03	10.1662	1.3726	0.4301	87	0.6666
Image 4	6.6094 e+03	9.9292	1.3655	0.4241	231	0.6965
Image 5	7.1000 e+03	9.6182	1.2304	0.4696	251	0.7405

Table 2: statistical analysis for Iris Biometric system by using Gabor wavelet.

The graphical representation is as follows.

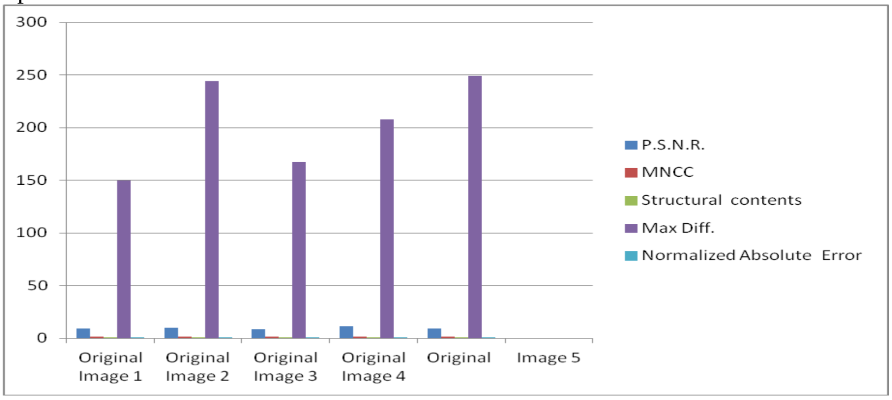


Figure 4: Statistical Analysis

Table 3: statistical analysis for Iris Biometric system for Gaussian Filter

Sr. No.	M.S.E.	P.S.N.R.	MNCC	Structural contents	Max Diff.	Normalized Absolute Error
Image 1	7.7796 e^{+03}	9.2212	1.6617	0.2895	150	0.8808
Image 2	7.1794 e+03	9.5688	1.5184	0.3361	244	0.8368
Image 3	6.0900 e+03	8.6368	1.6726	0.2447	167	0.8730
Image 4	5.0680 e+03	11.0824	1.3844	0.4338	208	0.6271
Image 5	6.4905 e+03	8.8415	1.6019	0.3188	249	0.8607

The above table shows that the Gabor wavelet improves the accuracy so we used Gabor wavelet feature extractor.
The following figure shows the graphical representation of statistical data.

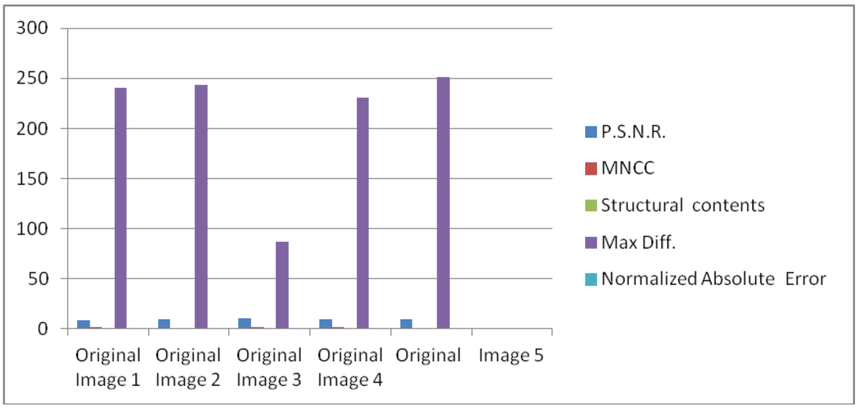


Figure 5: Statistical Analysis

3.5 Matching

For matching, the Hamming distance was chosen as a metric for recognition, since bit-wise comparisons were necessary. If the distance between two iris feature vectors is similar then the match is found between the images. If the distance between the two feature vector of two iris images is greater than zero then there is no match found in two images of iris. The Hamming Distance was used for identification and rectification of errors in Iris Biometric system. Hamming distance gives the difference between two bits.

IV. Experimental Results

The performance of the iris recognition system as a whole is examined. Tests were carried out to find the best separation, so that the false match and false accept rate is minimized, and to confirm that iris recognition can perform accurately as a biometric for recognition of individuals. Multimodal Biometric system is used for iris recognition. In this experiment MMU database is used. Where multi instance samples of iris are used. For left eye 5 samples are considered and for right eye 5 samples are selected for the experiment. i.e. 10 samples of one person like 20 persons database are used. The recognition rate is increased with this system. The recognition rate is increased with this system. Hamming distance matcher is used for recognition.

4.1 Iris Pre-processing, normalisation and Feature Extraction by using Gaussian filter

The following figure shows the iris Localisation by using Daugman's Integro-differential Operator, Normalization by using Cartesian co ordinate system and feature extraction by using Gaussian Filter .

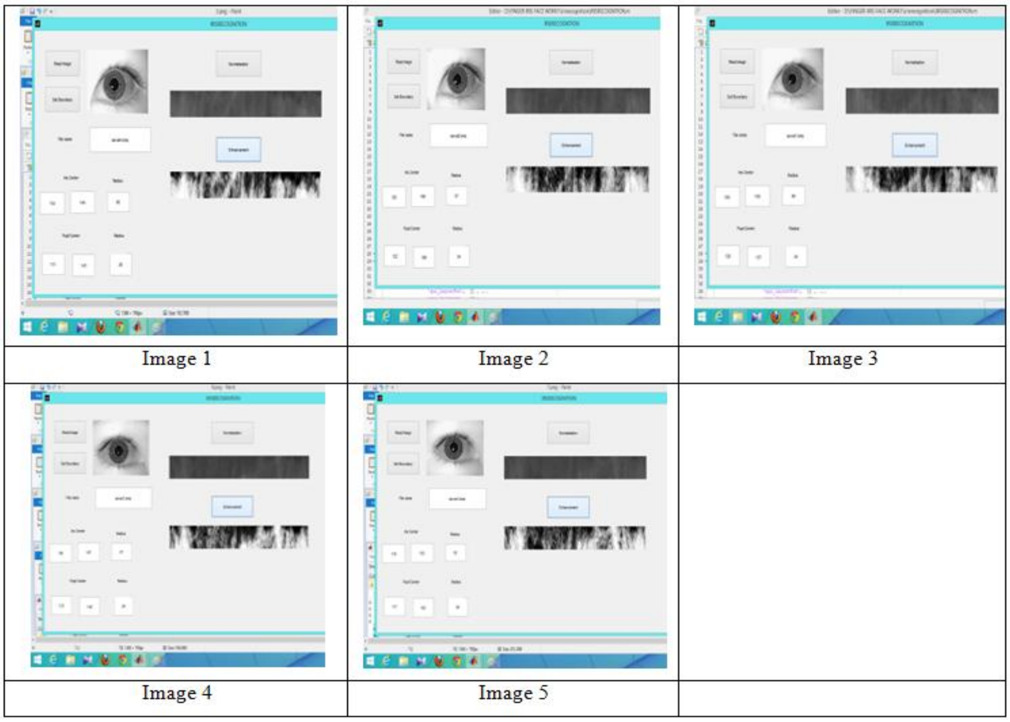


Figure 6: Iris pre-processing, normalisation and feature extraction technique by using Gaussian filter.

4.2 Iris Pre-processing, normalisation by using rubber sheet model and Feature Extraction by using Gabor wavelet

The following figure shows iris localization by using Houghman transform and normalization by using rubber sheet model and Feature Extraction by using Gabor wavelet.

Iris preprocessing and feature Extraction as well as normalization is shown in the following figure.

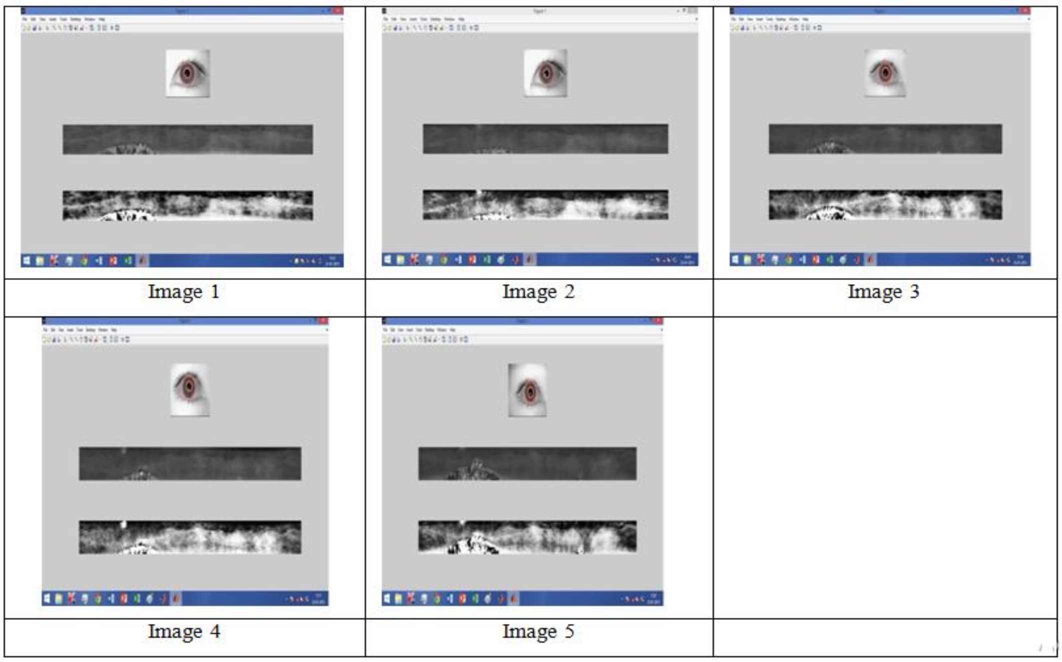


Figure 7: Iris pre-processing, normalisation and feature extraction technique by using Gabor wavelet.

The above diagram 8 has improved quality then diagram 7. Gabor wavelet improves the accuracy so for our experiment we used Gabor wavelet for the experiments.

4.3 Matching

For matching, the Hamming distance was chosen .The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates. Now when taking the Hamming distance, only those bits in the iris pattern that corresponds to '0' bits in noise masks of both iris patterns will be used in the calculation.

4.4 FAR and FRR

The recognition performance is evaluated using the False Acceptance Rate (FAR) and False Rejection Rate (FRR), the false acceptance rate, or FAR, is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user. A system's FAR typically is stated as the ratio of the number of false acceptances divided by the number of identification attempts.The false rejection rate, or FRR, is the measure of the likelihood that the biometric security system will incorrectly reject an access attempt by an authorized user. A system's FRR typically is stated as the ratio of the number of false rejections divided by the number of identification attempts.
The FAR and FRR is shown in the following diagram.

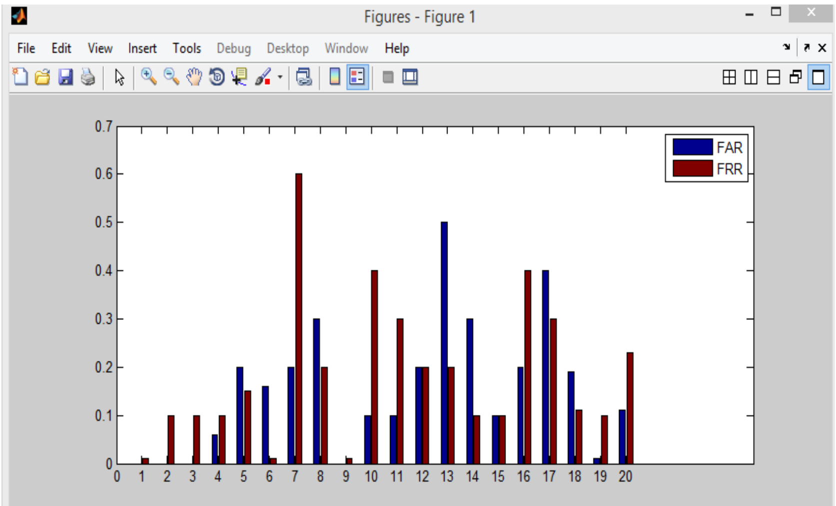


Figure 8: FAR and FRR by using Gabor wavelet

The following table shows the Individual accuracy with iris biometric system.

Table 4: Individual accuracy

Trait	Feature Extraction	Accuracy (%)	FAR (%)	FRR (%)
Iris	Gabor wavelet	99.4	0.2	0.25

The ROC curve for the Iris recognition system is as follows.

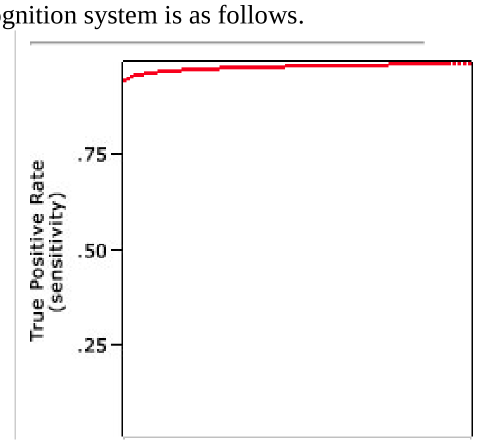


Figure 9: ROC curve for face recognition system

V. Conclusion And Futute Scope

In this paper, We used the Gabor wavelet feature extraction and hamming distance based matching. The results are improved in Gabor wavelet feature extraction than the Gaussian filter based feature extraction. The recognition rate is 99.4% by using Iris trait. The FAR is 0.2% and the FRR is 0.25%.

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