COMPARISON OF DIFFERENT TECHNIQUES OF IRIS RECOGNITION

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بسم الله الرحمن الرحيم

In the name of Almighty Allah,

The most Beneficent, the most Merciful.

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Final Approval

It is certified that we have read the thesis, titled **"COMPARISON OF DIFFERENT TECHNIQUES OF IRIS RECOGNITION"** submitted by **Miss Urooj Zunash** Reg. No. **355-FAS/MSCS/F07**. It is our judgment that this thesis is of sufficient standard to warrant its acceptance by the International Islamic University, Islamabad, for the Degree of **Master of Science**.

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For the award of the degree of

Master of Science in Computer Sciences

Dedicated To

My MOM

The most courageous lady I have ever seen in my life

My DAD

Who taught me the things I would never have otherwise

Declaration

We hereby declare that this research, neither in part nor in full, has been copied from any source, except where cited; hence, acknowledged. It is further declared that this research, in its entirety, is a product of our personal efforts, under the sincere guidance of our supervisor. No portion of the work being presented herein, has been submitted to any other university, institute, or seat of learning, in support to any piece of writing for bestowment of any other degree of qualification.

Urooj Zunash

355-FAS/MSCS/F07

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UROOJ ZUNASH

Project in Brief

Project Title:	Comparison Of Different Technique Of Iris Recognition
Undertaken By:	Urooj Zunash
Supervised By:	DR. Syed Afaq Hussain & Mr. Muhammad Nadeem
Tool Used:	MATLAB© 7.0
System Used:	Toshiba satellite Pro
Operating System Used:	Windows Vista

Abstract

Iris recognition is used for security purposes along with fingerprint, face recognition and other biometrics. It is used at high security places for access control is mostly an authentication technique. The process of iris recognition is a httle bit complex. It is different from finger print or face recognition where the finger print may be distorted and face may be transformed due to makeup, but the iris pattern cannot be transformed or changed. The eye of a person in contact with the iris scanner is scanned and the segmented iris is compared with a copy of the iris stored in the data base for authentication.

The main objective of research was to implement some existing iris recognition techniques and give a comparative analysis with respect to some criteria. Existing techniques using Global features with Gabor filter and local features with log Gabor filter were analyzed. It has been found that Global features alone cannot represent iris well and Gabor filter allows dc components to pass. To overcome these limitations of the existing techniques, a new method has been proposed that uses Localized Log Gabor Filter.

In the end a comparative analysis of the 3 techniques on the same set of 10 images for 10 subjects has been described which shows the superiority of the proposed technique. Performance measure shows that Localized Log Gabor filter gives enhanced and stable results as compared to existing compared techniques with an accuracy of 92.8%.

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CHAPTER 1

INTRODUCTION

1 Introduction

Iris recognition is not a newly introduced inspiration. It has been used since last 10 or 15 years. But it was not practically used. It was just a theoretical concept which was used in movies. But john Daugman is the pioneer of the iris recognition. He breaks new grounds for iris recognition. It is basically used for security purposes and it is most authentic technique. The process of recognition is a little bit complex. It starts by scanning a person eye with camera. Person looks in camera for two or three second then his template is captured. Now there are a lot of techniques [3], [7], [12] used for recognizing human by iris. But different techniques including [7], [17] and proposed method are compared.

1.1 Biometric Technology

The word Biometric can be defined as life measure. Biometric technology is used for authentication and security of human being on the basis of some physical attributes [1]. Biometrics is a method which uniquely defines a human being based on one or more inherent physical or behavioral attributes in a systematic way (figure 1.1). It is also used to identify a human among many people.

Today e-security is a critical problem because even security through PIN (personal identity no) and password, the frauds through computers are increasing e.g. hacking. Biometric technology solves that problem because biometric characteristics of humans are unique and they cannot be copied, stolen or forgotten [2].

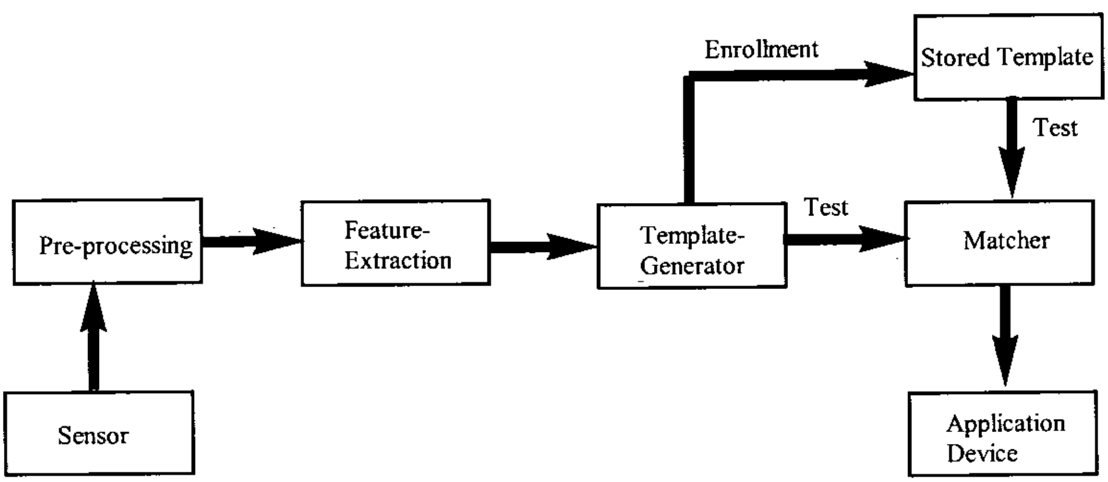


Figure1.1: Biometric system

1.2 Biometric characteristics

Biometric characteristics can be divided into two types, (figure 1.2)

- Physiological

  It is related to the shape of body e.g. Fingerprint, face recognition, DNA and iris recognition, hand and palm recognition etc.

- Behavioral

  This type is related to behavior of a person e.g. voice, typing rhythm etc [3].

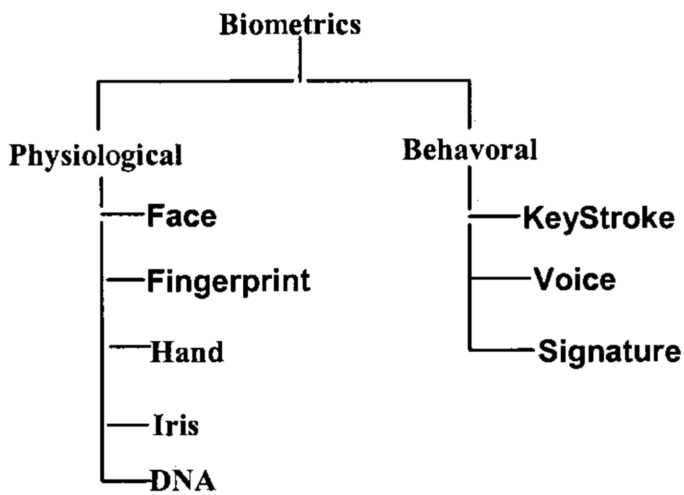


Figure 1.2: Types of Biometric Technology

1.2.1 Facial Recognition

Facial Recognition is a physiological type of biometric technology which is used mostly for commercial applications. It is also used in automobiles with sensors to detect risky states such as sleep, to avoid accidents.

1.2.2 Fingerprint Recognition

Fingerprint is a physiological type of biometric technology (figure 1.3). It is one of the oldest technologies which are used to identify person in criminal cases. Now a day's fingerprint recognition is done through software. In early days it was done through human eye. It is a very cheap technology. Fingerprint recognition is also used in electronic fund transfer in credit cards [4].

Figure 1.3: Fingerprint image

1.2.3 Palm Recognition

Palm recognition physiological type of biometric technology. It is a very secure method for recognition because it depends on blood veins and each person even identical twins has unique blood veins pattern. The person palm is exposed to infra red machine then its palm image is taken.

1.2.4 Iris Recognition

Iris recognition is a physiological type of biometric technology which is recently used On airports and very sensitive and high security organizations. It is most authentic among all techniques [4].

1.2.5 DNA recognition

DNA recognition is physiological type of biometric technology. Each person has 23 pair of chromosomes in his body and one comes from mother and other comes from father in each person 0.10 percent genome are unique.[5]

1.2.6 Signature Recognition

It is a behavioral type of biometric technology. Although this technique has worked for some years but it was very advantageous for budget department of organizations. Pen speed and pressure and stroke order increase the accuracy of signature recognition.[4]

1.2.7 Voice Recognition

It is behavioral type of biometric technology. Human voice is also unique to each person even in identical twins. Voice is combination of behavioral and physiological components which is unique. It is impossible to reproduce a person voice exactly. Voice recognition system can recognize very similar voice even twins voice. It is mostly used in telephone based systems, health care centers; call centers etc [5].

1.2.8 Biometric functions

Biometric system provides two functions:

- Verification

It provides authentication of user using some user name, ID no or smart card [3]. In smart card the private key of the user is stored on the card and users can be identified by using this smart card. In case of finger print recognition, the biometric uses two approaches:

- One is that finger print template is stored on the smart card. The user show his identification by providing a matched template
- The second method is overall all the characteristics are used to verify a person [6]

This system provides authentication by comparing some captured template of user with already stored card or id no in data base. If both templates matched then it will allow the person [3].

- Identification

It provides user authentication through biometric characteristics without the help of some ID no or smart card. The biometric template is compared with already stored record with in database and it returns close match result [3].Biometric include finger print, DNA, voice, thermo gram, facial, hand and iris. Among all these technique iris recognition is very reliable and emerging technique because it has many advantages i.e. speed, simplicity, accuracy as compared to other techniques [2].

1.2.9 Benefits of Biometric Technology

- Uniqueness

It is based on the unique properties of persons. Two people cannot have

Same biometric characteristic that's why it is secure.

- Non shareable

  Biometric is an inherent property of a human being. It cannot be shared with some other person.

- Cannot be copied

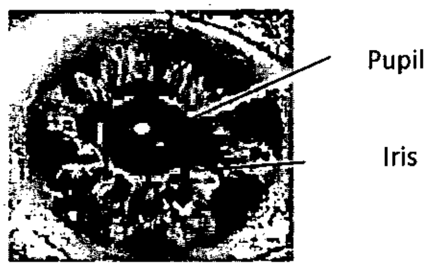
  New technologies including biometric has the property that person should be alive. So these properties cannot be mimic.

- Cannot be lost

  It is intrinsic property and cannot be lost but in case of some severe accident a person can lost it [5].

1.3 Iris Recognition

Human iris (1.4a & b) is a colored part of the eye at the back of eyelid and in front of eye lens .Iris is the only internal part of human eye which is visible with naked eye [2].



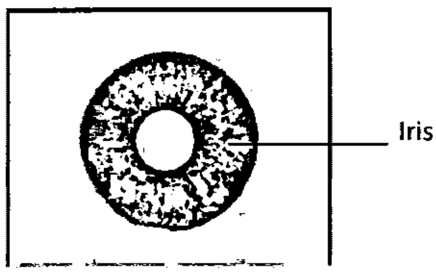


Figure 1.4(a): Eye image (b): Iris image

Iris recognition is a technology that authenticate user by capturing template of the iris. Iris recognition is a category of biometric technology or biometric security. Iris recognition technology is used at high security places i.e. airports, government buildings and research laboratories. This technology capture the iris templates and record it, so it confirms the identity of a person by capturing image of his iris and then compare it with database. It takes few seconds. Glasses or contact lenses do not affect the operation of iris recognition. Iris recognition is very reliable because iris has very important future that it remains same throughout the life time of an individual but face or voice can be changed to some extent

[7]. Iris recognition gains a lot of attention because it has many advantages over other biometric technologies like greater speed, simple and accuracy [2].Iris recognition process is shown below in (figure 1.5)

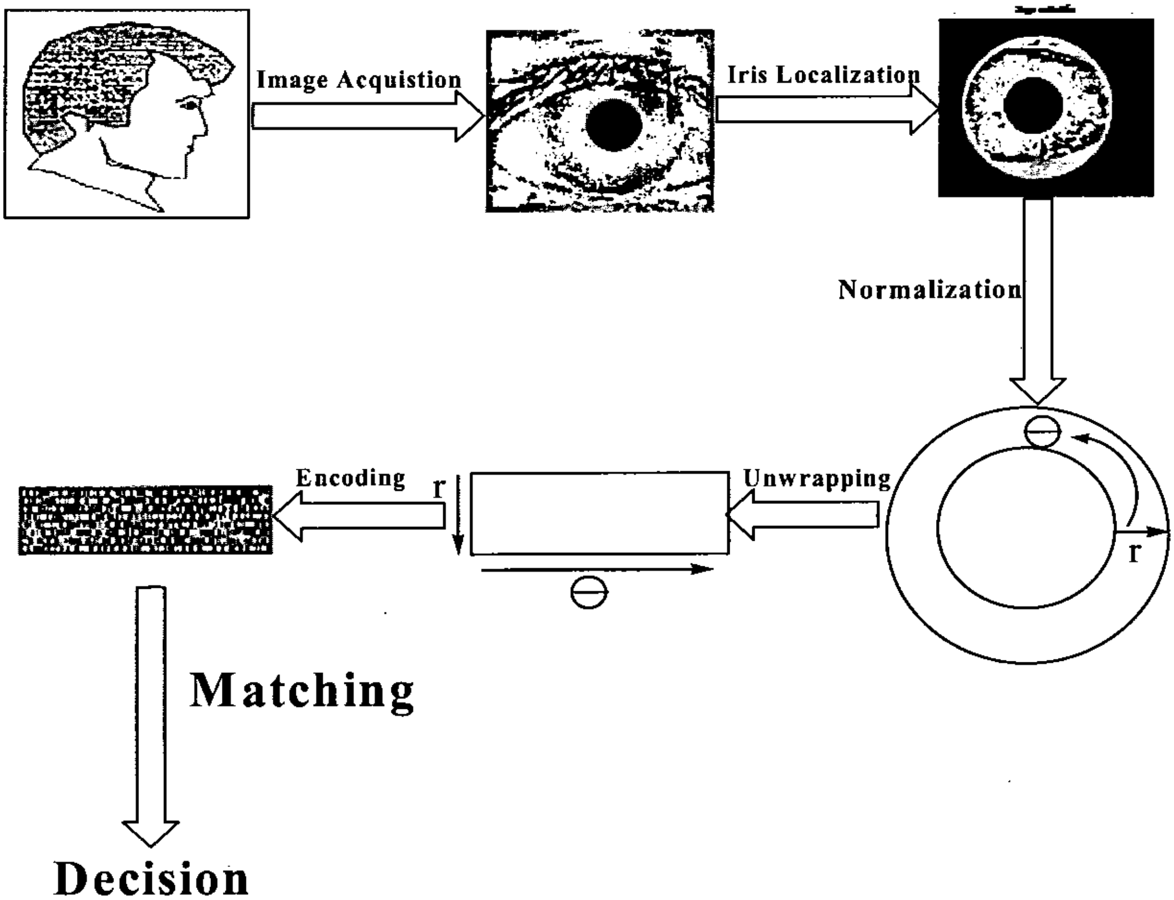


Figure 1.5: Iris Recognition Process

1.3.1 Image acquisition

To capture a high feature iris image is one of the major defy of iris recognition. The first phase of iris recognition is to apply preprocessing of already captured iris image.

1.3.2 Iris localization

In order to extract iris region, detection of iris as well as pupil edge detection takes place.

1.3.3 Normalization

Normalization is used to convert the iris region in to fixed size in order to remove dimensional irregularities between eye images. This is due to enlargement of iris caused by pupil dilation from unstable level of illumination.

1.3.4 Unwrapping:

The normalized iris image is unwrapped into a rectangular state. In the last, all the discerning features of the iris are taken out to compare the different iris template. To construct the iris code, the resultant iris region is encoded using wavelets. A decision can be taken for matching.

1.3.5 Importance of Iris Recognition

Personal identification has attracted the attention of many researchers in the field of pattern recognition and machine learning due to the increasing demand for a high security. Several biometric identification technologies that are fingerprint recognition, facial recognition, iris recognition and voice recognition meet those tasks. Iris of a human child develops in the third month of gestation, and after the iris pattern has been developed, it becomes consistent in few years. Moreover, the iris pattern does not associated with genetic determination it depends on the initial stage of the embryo, which leads to the fact that the iris of same human are not identical even the twins. In fact the iris is isolated and sheltered from exterior atmosphere. Also it is not possible to change iris surgically without having a risk to eye sight. In conclusion, the physiological reaction to light provides one of several natural tests against artifice [8]. Due to its distinctive and enriched properties, iris recognition plays the leading role in biometric identification for human identification. Face itself is a 3D object that varies depending on the angle, pose, illumination and age so facial recognition faces many problems [9].

1.3.6 History of Iris Recognition:

Efforts for the reliable and authentic way for biometric personal identification have a long and bright history. The inspiration of using iris recognition for personal identification was originally proposed in 1936 by ophthalmologist Frank Burch, MD. In the 1980's the idea was used in science fiction movies. Till 1987, it was just an idea of two American ophthalmologists, Leonard Flom and Aran Safir patented Burch but they were not capable to develop such a process. So they gave idea to John Daugman to develop actual algorithms for iris recognition. The developed algorithm of Daugman is now base for all iris recognition research. That algorithm was developed in 1994.

1.3.7 Organization of Thesis

Chapter 2 is "Literature survey". Different research papers describing iris recognition techniques. After summarizing these research papers, the problem in the area of iris recognition is identified.

Chapter 3 is "Research Methodology" .This chapter explains different techniques for iris recognition.

Chapter 4 is "Experimental results"; different sets of medical images are tested on implemented techniques. These images are taken from CASIA database.

Chapter 5 is "Conclusion and future work" and References are given at the end.

CHAPTER 2
LITRATURE REVIEW

2. Literature Review:

Many research papers have been studied on iris recognition and few of them are given below.

2.1 Iris Recognition Based On Multi Channel Gabor Filtering

Li et al, [7] have described the following steps for iris recognition.

- Image preprocessing
    - Iris localization
    - Iris normalization
    - Iris image enhancement & de- noising
- Iris feature extraction
- Classifier design

A captured iris image not only contains area of interest but also some redundant adjacent information so preprocessing steps should be applied on iris image. For iris localization the inner and outer boundary of iris is taken as circle, Hough transform, edge detection and filtering have been used. Iris from different eyes is obtained in different sizes, even for two eyes of the same person. This is due to camera variation, illumination and other factors. For normalization the iris ring is mapped to a rectangular block in counter clock- wise direction. After normalization iris image is still low contrast due to non uniform illumination. This may affect results and matching process. So to remove high frequency noise, low pass Gaussian and histogram equalization are used and each sub image is processed separately.

For feature extraction the iris image is divided in to eight sub images using Gabor filter, they have used central frequencies of 2, 4, 8, 16, and 32. Cycle /degree and filtering is performed at angles of 0, 45, 90,135 degrees respectively. So Gabor filter are used in different directions and frequencies. When each sub image is filtered by all these Gabor filters, it gives a total of 160 output images. Gabor filter is used to extract feature values from each sub image using the equation given below.

$$G(x,y;\theta,f) = exp\left\{-\frac{1}{2}\left[\frac{x'^2}{\delta^2_{x'}}+\frac{y'^2}{\delta^2_{y'}}\right]\right\}\cos(2\pi f x')$$

Where (2.1)

$$x' = x\cos\theta + y\sin\theta$$

$$y' = y\cos\theta - x\sin\theta$$

f is frequency of the sinusoidal plane wave along the direction of □ from x-axis, $\delta^2_{x'}$ and $\delta^2_{y'}$ are space constant of Gaussian envelop along x' and y' axis respectively.

Feature vector is a collection of all features f(x, y) extracted from each sub image and their variance is taken as V given by;

$$V = -\frac{1}{N}\left(\sum_N |f(x,y) - m|\right) \quad (2.2)$$

Where, N is the no of pixel in the image, m is the mean of image and f(x, y) is the value at point(x, y). The Average Absolute Deviation of each filtered output image composes the components of feature vector. It will return feature vector of 160 lengths for each input image. Iris matching is based on Weighted Euclidean Distance between the corresponding feature vectors. WED is defined as

$$WED(k) = \sqrt{\sum_{i=1}^{BN} A_i \sum_{j=1}^{N}(f(f^{k}_{(i,j)} - f_{(i,j)})^{\wedge}2} \quad (2.3)$$

Where, A_i represent the ith weighting coefficient, BN and N are the number of sub images and the total number of feature take out from each sub image correspondingly, $f_{(i,j)}$ and $f^k_{(i,j)}$ indicate the jth feature component of the ith sub image of unknown iris. That iris is indexed by k. Weighted coefficient is A_i for different feature set, take out from different sub images. These coefficients are determined from experimental results. The nearest neighbor classifier is used in algorithm. The unknown iris is compared with all irises in database. The iris is identified when Weighted Euclidean Distance is matched. The image should be scale, rotation and translation invariant to get acceptable results which are achieved through normalization [7].

2.2 Iris Recognition using Gabor Wavelets

Daugman [8], has used Gabor wavelet technique for iris recognition. He detects iris using XOR and then remove the noise through NOT. Preprocessing is divided in to two steps:

- Localization
- Normalization

This algorithm is based on the iris code. For preprocessing, inner and outer boundaries of the iris was located. Integro-differential operator was used to detect the center and diameter of iris. After conversion from Cartesian to polar coordinates, rectangular representation of required data was used. Feature extraction algorithm used the modified complex valued 2-D Gabor wavelets [10]. For matching Hamming distance has been calculated by using simple Boolean Exclusive –OR operator [2]. It is sensitive to illumination and uses deformable model [3].

2.3 Iris Recognition by modified Log Gabor Filter

Peng Yao et al, [11] performed Iris recognition through modified Log- Gabor filter because of the limitations of Gabor filter. Log-Gabor filter has the advantage that it is strictly band pass filter while Gabor filter is not strictly band pass. Gabor filter is used for extracting phase information and band pass makes the Log-Gabor filter more suitable for extracting the phase information of iris. 2-D Log-Gabor filter can be analyzed as band pass on radial coordinates and low pass on angular coordinates. Before feature extraction, preprocessing is needed so that features are translated easily but this paper proposes such algorithm which encodes the IRIS phase information which is different from complex 2-D Gabor filter. All preprocessing steps are omitted and feature is extracted through integral differential operator. After feature extraction the iris code is matched through Hamming distance. In first experiment they applied Gabor filter and in second experiment Modified Log-Gabor filter is applied [11].

(a) Normalized Iris Region

(b) Iris codes obtained by real part of complex 2D Gabor filter

(c) Iris codes obtained by imaginary part of complex 2D Gabor filter

(d) Iriscodes obtained by the real part of modified 2D Log-Gabor filters

(e) Iris codes obtained by imaginary part of modified 2D Log-Gabor Filters

Figure 2.1

2.4 Efficient Iris Recognition Through 1 D Wavelet Transform

Qazi et al, [12] have presented their model of Iris recognition dividing the process in to the following four steps:

- Image acquisition
- Iris localization
- Iris normalization
- Matching

In the first step, eye image is obtained using a CCD camera. The image should be of good resolution. This is a very important step. For best results author recommended using CASIA data base. In the second step, iris area (area between pupil and sclera) is separated from the eye image. The author observed after experiments that integro-differential operator which is used by Daugman as a circular edge detector, fails when there is noise in image. So Hough transform is used. For good localization vertical gradient and difference recursive filter is used. Through this maximum edge point is chosen.

$$x^2 + y^2 - r^2 = c^2 \tag{2.4}$$

Where, R is radius and x & y are centre coordinates. Once an Iris is segmented from an eye image, the next step is normalization. Normalization is done through Rubber sheet model. In this iris region is transformed from Cartesian to polar coordinates. In Rubber sheet model each point in the iris region is remapped to the polar coordinates (r, θ). R is an interval [0, 1] and θ is angle [0, 2θ]. Mapping is done by equation.

$$\mathbf{I(x(r,\theta), Y(r,\theta)) \rightarrow I(r,\theta)}$$

$$\mathbf{x(r,\theta) = ((1-r) * x_p(\theta)) + rx_i(\theta)} \tag{2.5}$$

$$\mathbf{Y(r,\theta) = ((1-r) * y_p(\theta)) + ry_i(\theta)}$$

Where, I(x, y) is the iris region image, (x, y) are the original Cartesian coordinates. (R, θ) are corresponding normalized polar coordinates. x_p, y_p, x_i, y_i are the coordinates of the pupil and iris boundaries along θ direction. Low contrast and unequal illumination can be eliminated through histogram equalization. For the purpose of recognizing an individual; most selective features of iris are needed, Daugman used 2-D Gabor filter for this purpose but disadvantage of this method is DC component when bandwidth is larger than one octave. So 1D log-Gabor filter is used. The equation is

$$\mathbf{G(f) = exp\left[\frac{-\log\left(\frac{f}{f_0}\right)}{2\left(\log\left(\frac{\sigma}{f_0}\right)\right)}\right]} \tag{2.6}$$

Where, f_0 represent central frequency and σ gives the bandwidth of the filter. The final step is matching. In this paper matching is done through Hamming Distance. In this method real time iris code is matched with already stored iris code. The expected value of Hamming Distance is 0.5. The formula is

$$\mathbf{HD = 1/N \sum_{j=1}^{N}(Aj\ XOR\ Bj)} \tag{2.7}$$

Where, N is total number of bits, A is the first iris code and B is second iris code [12].

2.5 Iris Recognition by Cross Correlation

Kumar et al,[13] has used standard segmentation as a preprocessing step and locate the inner and outer boundaries of the iris. After detecting the inner and outer boundaries the image I(X, Y) is mapped on the polar coordinates I (p, θ). Image is normalized during the segmentation process. An image correlation filter has been used for the purpose of iris recognition. Cross-correlation is obtained between the given image and the stored images. If the resulting correlation plane should contain peak then it is authentic image and if no peak is found then it is different image. Cross-correlation is quite robust to noise.

Disadvantage:

Method has serious drawbacks however, in case images are from distinct sources [13].

2.6 Iris Data Parameterization by Hermite Projection Method 2007

S.Krylov et al. [14] have used Hermite Projection Method for iris recognition. To draw out iris from an eye image first they localize iris. First they find approximate pupil center using rough criteria.

$$X_{cent} = \arg\ \min_x\ \sum_y I(x,y)$$

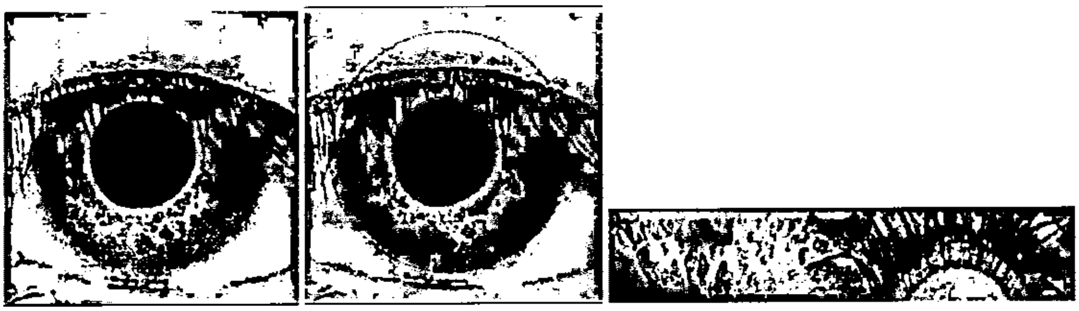
$$Y_{cent} = \arg\ \min_y\ \sum_y I(x,y) \tag{2.8}$$

After finding pupil center, they use that center and localize inner and outer boundaries of iris using following modification of criterion.

$$\max_{r,x_0,y_0} \left| \frac{\partial}{\partial r} G_\sigma(r) * \oint_{r,x_0,y_0} \frac{I(x,y)}{2\pi r} ds \right| \tag{2.9}$$

Where * denotes convolution, G_σ is Gaussian of scale σ, (x_0, y_0) are possible coordinates of center of the pupil. R θ $[r_{min}, r_{max}]$ is the radius of boundary.

After localization of iris, now in order to normalize iris, iris is mapped from pseudo polar coordinates to 514 x 64 rectangular images. In order to omit eyelashes, eyelid, they only use 3/5 part of iris.



(a): Original image (b) iris localization (c): iris normalization

Figure 2.2

Region of interest is upper left corner of the normalized image. Because right corner contain eyelashes and eyelids. Before applying Hierarchical Hermite Projection Method, two halves of upper left corner is selected. If level of hierarchy is k then m= 2^{k-1} [14].

2.7 Iris Recognition Using Haar Wavelets

Daouk et al. [15], captured iris image through CCD camera with a resolution of 640 x 580.After image acquisition iris image is converted from RGB to gray image. Iris is localized through Canny and Hough transform. For detecting outer circle of iris first image is down sampled and use default threshold value of canny and then use circular summation of all intensities of circle. The circle with highest value of summation and larger radius match with outer circle. For inner circle threshold of canny depends on intensities of iris, then to localize inner circle is little bit difficult due to different color of iris. If the iris color is light then localization of inner circle is easy and threshold will be higher. But if the iris is dark like black color then localization is difficult and will be low. The range of pupil radius is between 0.8 and 0.1. Now iris ring is mapped on new image. The next step is mapping. Sometimes pupil dilates and appears in different size in different images. To overcome this, the lower iris (180 to 360 angles) ring is mapped to rectangle box of size 100 x 402 pixels. Coordinate system is changed from polar to Cartesian.

Using Haar wavelets mapped image of size 100 x402 is divided in to five levels. These levels include some vertical coefficients, horizontal coefficients and others are diagonal. Then gather up the coefficients which are important in iris pattern .To reduce the redundancy, all unimportant and redundant data is omitted. This will result in six matrixes. Now all these matrixes are mingled and feature vector is constructed. As the size of mapped image is fixed so that the vector size will be the same. Feature vector is reduced to 702 features instead of Daugman's 1024 features vector. This is an efficient technique. Conversation of feature vector in to binary code is very essential because analysis of two binary codes is easy as compared to multiple values. The minimum value of feature vector is less than 0 and maximum value is greater than 0 like 0.35.

Hamming Distance is a statistical test for comparing two binary codes. If the images are same then these fail in test. But it is proved that two different images pass in that test. The formula of Hamming Distance in (2.7)

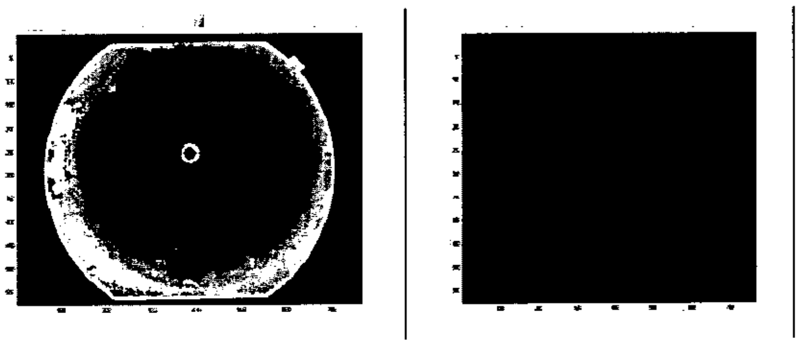
Where, N is total no of bits, A is the first iris code and B is second iris code.

ADVANTAGE

- The computation cost and time is low
- Give better result as compare to other wavelet transform [15]

2.8 Iris Recognition Using Neural Network

Leila et al, [16] canny edge detection is used for capturing the iris edges that are transformed through covariance matrix of discrete wavelet and then iris is recognized through neural network. Iris recognition through neural networks satisfies noisy class ship.



(a): Original image (b): Edge detection through canny

Figure2.3

Learning vector quantization is a type of neural network which is used . The working of neural network is

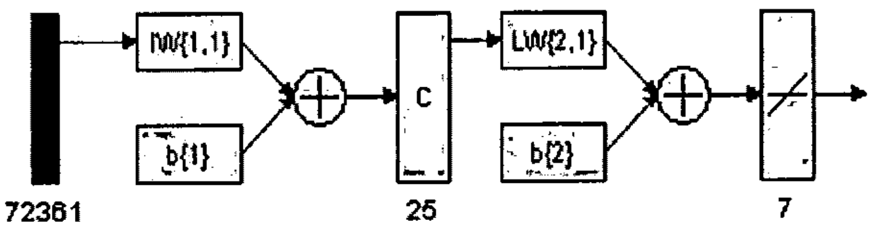


Figure 2.4: Neural Network

Basically through this neural network we can classify a noisy image for iris recognition [16].

2.9 Recognition of human iris pattern by Liber Mask

Liber Mask et al, [17] Iris recognition has been divided into the following steps:

2.9.1 Image Preprocessing:

To capture a high feature iris image is one of the major defy of iris recognition. The first phase of iris recognition is to apply preprocessing of already captured iris image.

2.9.2 Iris localization:

In order to extract iris region, detection of iris as well as pupil edge detection takes place. Iris is localized through canny detection and Hough transform.

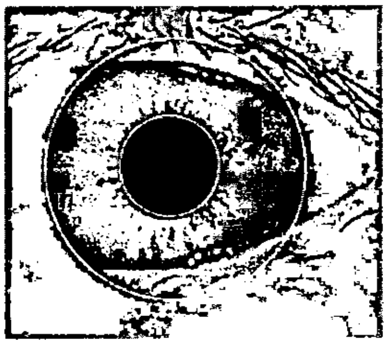
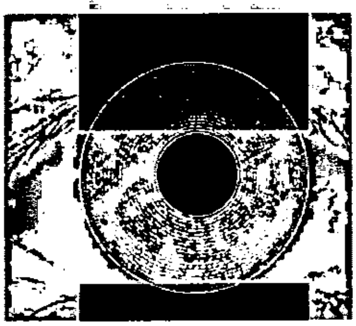


Figure 2.5(a): Localized iris

2.9.3 Normalization:

Normalization is used to convert the iris region in to fixed size in order to remove dimensional irregularities between eye images. This is due to enlargement of iris caused by pupil dilation from unstable level of illumination. Daugman rubber sheet model Normalized and unwrap the image.



(b): Normalized iris

2.9.4 Unwrapping:

The normalized iris image is unwrapped into a rectangular state

(c): Unwrap iris

2.9.5 Feature Extraction:

To recognize an individual perfectly, iris feature extracted absolutely. To extract iris feature Log Gabor filter is used.

(d) Feature extraction

In the last, all the discerning features of the iris are taken out to compare the different iris template. To construct the iris code, the resultant iris region is encoded using wavelets.

2.9.6 Matching:

A decision can be taken for matching on the basis of that iris code. Matching is done through Hamming distance.

2.10 Problem Identification:

On the basis of the above described methods for Iris recognition, It is noticed that results depend on image acquisition, their preprocessing for making the system RTS(Rotation, Translation and Scale) invariant, proper segmentation of the Iris and the classifier. Each method has its pros and cons but no quantitative analysis is available for evaluating or comparing them. There is also room for devising an accurate and efficient iris recognition algorithm.

CHAPTER 3

RESEARCH METHODOLOGY

3. Research Methodology

Methods are implemented and results of different techniques of iris recognition are compared. Then a new technique is proposed on the basis of some modifications in the existing algorithms and the results are compared with implemented methods. Qualitative and quantitative research methodologies are used.

On the basis of analysis two methods are selected and implemented which are given below.

- Iris Recognition Based On Multi Channel Gabor filtering by Li Ma.[7]
- Recognition of human iris pattern for Biometric identification by Liber Mask.[17]

3.1 Iris Recognition Based On Multi Channel Gabor filtering

3.1.1 Image Pre-processing

A captured iris image not only have iris region but also have some other extra information. It has also variation in size to distance between camera and face. It also loses some useful information due to brightness. To capture useful information some preprocessing is applied on captured iris image and get required one. There are some preprocessing steps:

3.1.1.1 Iris Localization

Inner and outer boundaries of the iris are taken as circle and iris is localized. For iris localization, filtering, edge detection and Hough transform is used. It is a very efficient method of localization.

3.1.1.2 Iris Normalization

Iris of different people may be captured in different sizes and even same person may have iris images of different sizes and colors due to change in illumination and view distance, etc. Normalization is used to convert the iris region in to fixed size in order to remove dimensional irregularities between eye images. Results of iris matching may be affected by such deformation in iris texture. It is crucial to remove such deformations to attain the perfect results. We normalized our image and unwrap it through Daugman Rubber sheet model using equation (2.5).

3.1.1.3 Iris Image Enhancement and De-noising

Normalized iris texture has non-uniform illumination due to light and also has low contrast. Due to this type of noise, the results may be affected. To get accurate results, image is enhanced through low pass Gaussian and local histogram equalization. To acquire good and well-distributed results, all eight sub images are processed separately.

3.1.2 Iris Feature Extractions

Iris has copious texture information and remarkable structure. It is advantageous to discover such a method which extracts global and local iris information. Paper presents a new representation which can obtain global and local information of iris. It divides the rectangular iris ring in to eight sub images and then evaluates it. Feature vector is a structured series of local features which are extracted from eight sub images of iris. Global feature is calculated through local features. Gabor filter is a renowned technique which is used to attain useful information in a particular band pass channel and also decomposes the information in biorthogonal components. Each sub image is filtered with different frequencies and different angles. A feature vector is the compilation of all features which are extracted through eight sub images. The technique which is widely used for texture analysis is Gabor filter. For feature extraction the iris image is divided in to eight sub image through Gabor filter, paper use central frequencies are 2, 4, 8, 16, and 32. Cycle /degree and filtering performed on angle of θ =0, 45, 90,135. So 20 Gabor filter are used in different direction and frequencies. When each sub image is filtered by all these Gabor filters then it gives total 160 output images. Gabor filter is used to extract features value from each sub image using equation (2.1).

3.1.3 Feature Vector

Feature vector is collection of all features extracted from each sub image. Feature vector value is Average Absolute Deviation for each resultant image using equation no (2.2).

3.1.4 Classifier Design

Iris matching is based on Weighted Euclidean Distance between the corresponding feature vectors. WED is applied using equation (2.3).

The nearest neighbor classifier is used in algorithm. The unknown iris is compared with all irises in database. It is advantageous that image should be scale, rotation and variance invariant.(Figure 3.1) [7]

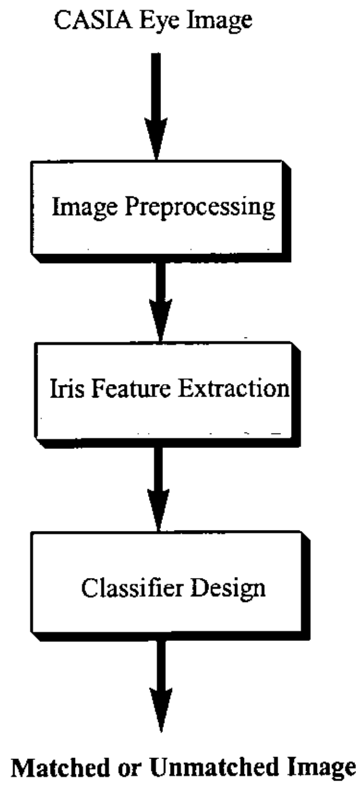


Figure 3.1: Flow Chart of Iris Recognition Algorithm by Li Ma

3.2 Recognition of human iris pattern for Biometric identification by Liber Mask

The work has been divided into following steps:

3.2.1. Image Preprocessing

To capture a high feature iris image is one of the major defy of iris recognition. The first phase of iris recognition is to apply preprocessing of already captured iris image. A captured iris image not only have iris region but also have some other extra information. It has also variation in size to distance between camera and face. It also loses some useful information due to brightness. To capture useful information some preprocessing is applied on captured iris image and get required one. There are some preprocessing steps:

- Iris localization
- Iris normalization
- Iris image enhancement and de-noising

3.2.1.1 Iris Localization

In order to extract iris region, detection of iris as well as pupil edge is required. Iris is localized after taking the inner and outer boundaries of the iris as a circle. Canny edge detection and Hough transformation have been used for iris localization.

3.2.1.2 Iris Normalization

Different people's iris may be captured in different sizes and due to change in illumination and view distance even same person may have iris images of different sizes. In order to remove dimensional irregularities between eye images normalization is used to convert the iris region in to fixed size. Due to deformation in iris texture, results of Iris matching may be affected. It is vital to remove such deformations to achieve the perfect results. Through Daugman rubber sheet model using equation no (2.5) image is normalized and unwrapped.

3.2.1.3 Unwrapping

The normalized iris image is unwrapped into a rectangular state. Iris ring is converted in to 20x240 rectangular blocks.

3.2.2 Iris Feature Extractions

Iris has abundant texture information and extraordinary structure. To recognize an individual perfectly, iris feature should be extracted absolutely. To extract iris features, Log Gabor filter has been used using equation (2.6).Finally; all the discerning features of the iris are taken out to compare with the different iris templates. To construct the iris code, the resultant iris region is encoded using wavelets.

3.2.3 Matching

The final step is matching. A decision can be taken for matching on the basis of the iris code. Matching is performed using Hamming Distance. Real time iris code is matched with already stored iris code. The expected value of Hamming Distance taken as 0.4. The formula for Hamming Distance is applied using equation (2.7). (Figure 3.2). [17]

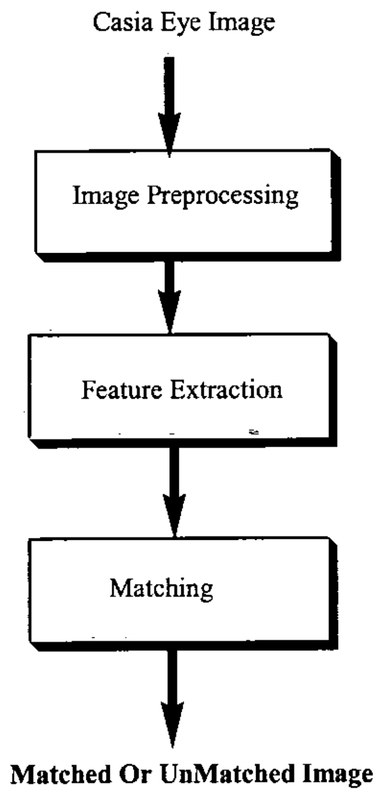


Figure 3.2: Flow Chart of Iris Recognition Algorithm by Liber Mask

3.3 Localized Log Gabor filter for iris recognition

Proposed method for Iris recognition is Localized Log Gabor Filter. Proposed method is more efficient than existing compared techniques in terms of accuracy.

3.3.1 Image Preprocessing

A segmented iris template not only have iris region but also have some other additional information. Due to distance between camera and face, iris template has also deviation in size. It also loses some valuable information due to brightness. To capture constructive data some preprocessing is applied on captured iris image and gets necessary data. The pre-processing steps employed are described below.

3.3.1.1 Iris Localization

The internal and external boundaries of the iris are captured as circular for iris localization. Filters are used for edge detection and Hough transform. This method localizes iris efficiently.

3.3.1.2 Iris Normalization

Due to change in illumination and other factors even same person's iris may be of different in size. Iris matching results may be affected by such variation in iris texture. It is crucial to remove such deformations to attain the perfect results. Iris ring is mapped anti-clockwise direction on a 64x512 rectangular block and then divide the block into eight smaller blocks of 64x64.

3.3.1.3 Iris Image Enhancement and De-noising

Normalized iris texture has non-uniform light and has low contrast. The results may be affected by this type of noise. To obtain perfect results image is improved through low pass Gaussian and local histogram equalization to remove the noise and enhance the contrast. To acquire good and well-distributed results, all eight sub images are processed separately.

3.3.2 Iris Feature Extractions

Iris has profuse texture information and significant structure. It is beneficial to ascertain a method which extracts global and local iris information. New technique is presented which can attain global and local information of iris. It splits the rectangular iris in to eight sub images and then evaluates it. Feature vector is a structured sequence of local features which are taken out from eight sub images of iris. Global feature vector is computed through local features. Log Gabor filter is used instead Gabor filter because some limitations of Gabor filter that are removed in Log Gabor filter and it also gives better results as compared to Gabor filter. Each sub-image is processed with Log Gabor filter. Feature vector is a list of features that is extracted through the eight sub images. Gabor filter is used to extract features value from each sub image using equation (2.6).

3.3.3 Feature vector

Feature vector is a group of all features pull out from each sub image. Feature Vector Value (V) is Average Absolute Deviation for each resulting image and is given by equation (2.2).The Average Absolute Deviation of each filtered output image composes the parts of feature vector. It will return feature vector of 8 lengths for each input image.

3.3.4 Classifier Design

Iris comparison is based on Weighted Euclidean Distance between the resultant feature vectors. WED is defined as given in equation (2.3). The unidentified iris is compared with all irises in database. The iris is recognized when Weighted Euclidean Distance is matched. It is valuable that image should be scale, rotation and variance invariant. Algorithm is rotation, scale and variance invariant as normalization has been performed on iris image.(Figure 3.3)

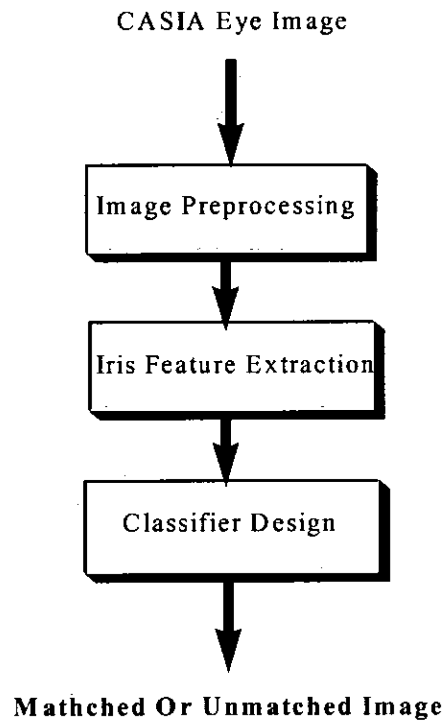


Figure 3.3: Flow Chart of Iris Recognition Algorithm of Localized Log Gabor filter

CHAPTER 4

RESULTS AND DICUSSION

4. Experimental Results:

CASIA database iris images are used. Some images are of same person but taken in different angle and some are of different persons. Two methodologies are implemented as given in the literature survey and compared. New techniques proposed based on the strengths of the above two techniques.

4.1 CASIA IMAGES:

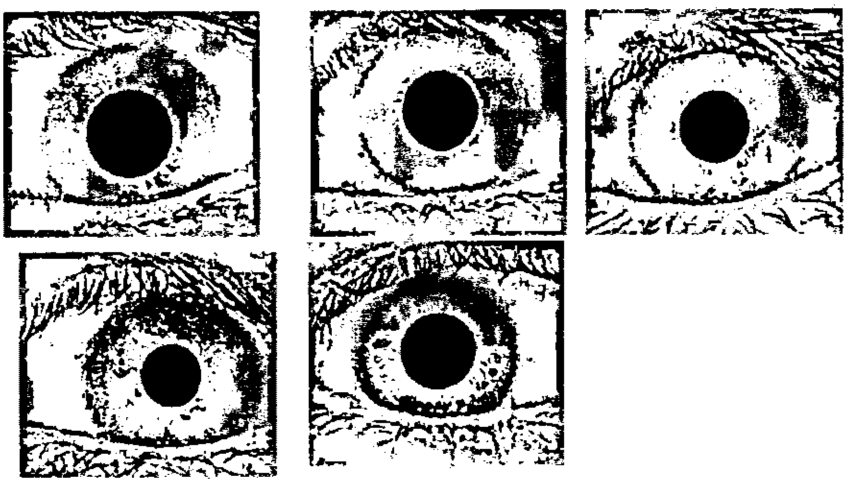


Figure 4.1: These are the images of five different persons from CASIA database

4.2 Results For Method 1 Gabor Filter:

Gabor filter is used for iris recognition

4.2.1 Test data

- Original image size =320 x 280
- Rectangular strip size is 64 x 512
- Sub image size= 64 x 64
- Data base =CASIA [16]
- No of subjects = 14

Sample 1 of Subject 1:

The original iris images for 5 subjects and their results for iris localization, iris segmentation, Mapping on rectangular grid, division into 8 sub parts, and the final Gabor Image is given below.

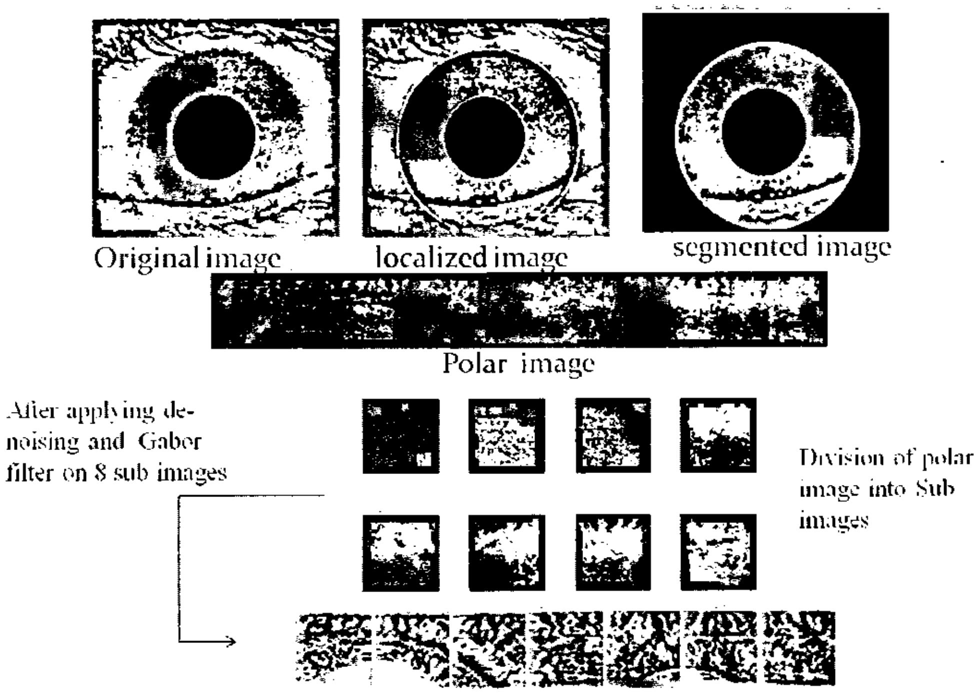


Figure 4.2: Different pre-processing steps apply and get final Gabor image

Sample one from Images of one person taken from CASIA database , then localizes & segmented iris. Segmented is converted into polar image. Polar image is divided in to eight sub images then on each sub image de-noising and Gabor filter is applied. At the end all sub images are combined in to one 64X512 image.

Sample 1 of Subject 2:

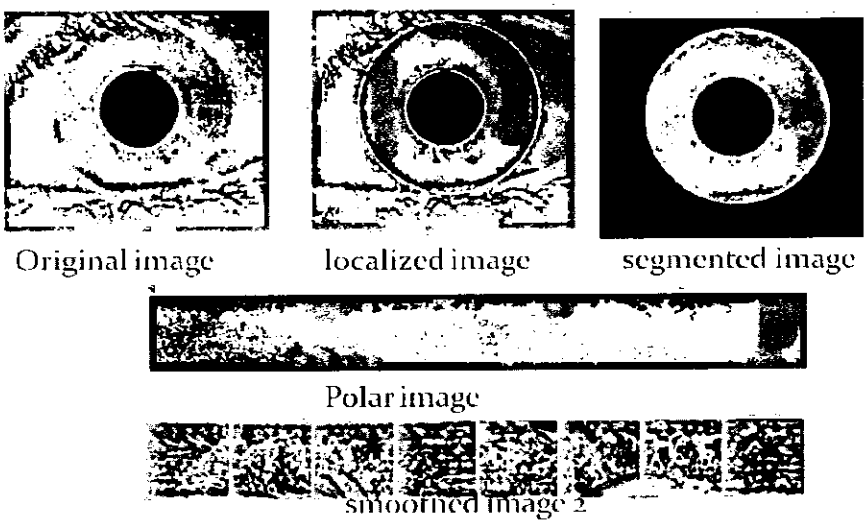


Figure 4.3: Steps applied on second person and calculate Euclidean distance

Sample one of subject 2 taken from CASIA database, then iris is segmented & localized. Segmented iris is converted into polar image. Polar image is divided in to eight sub images then de-noising and Gabor filter is applied on each sub image. At the end all sub images are combined in to one 64X512 image. Euclidean distance of subject one and subject 2 are calculate and compared. The Euclidean distance between 1st subject and 2nd subject is 4.3804.

Sample 1 of Subject 3:

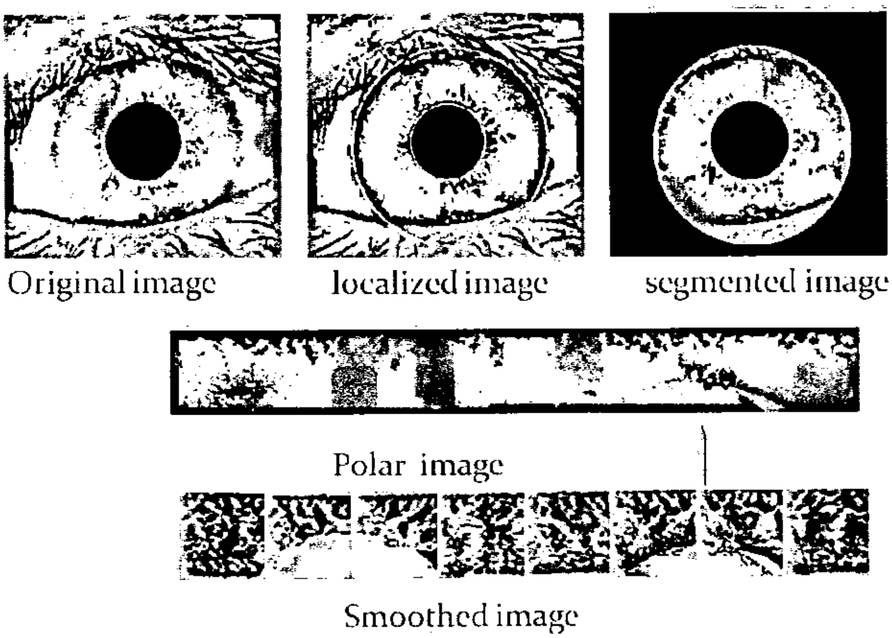


Figure 4.4 Iris recognition different steps applied on subject 3 and compare Distance

Sample one of subject 3 taken from CASIA database, all preprocessing steps are applied. After preprocessing, segmented iris is converted into polar image. Polar image is divided in to eight sub images then on each sub image de-noising and Gabor filter is applied. Then Euclidean distance of subject one and subject 2 are calculate & compared. The matching result is 4.1216

Sample 1 of Subject 4:

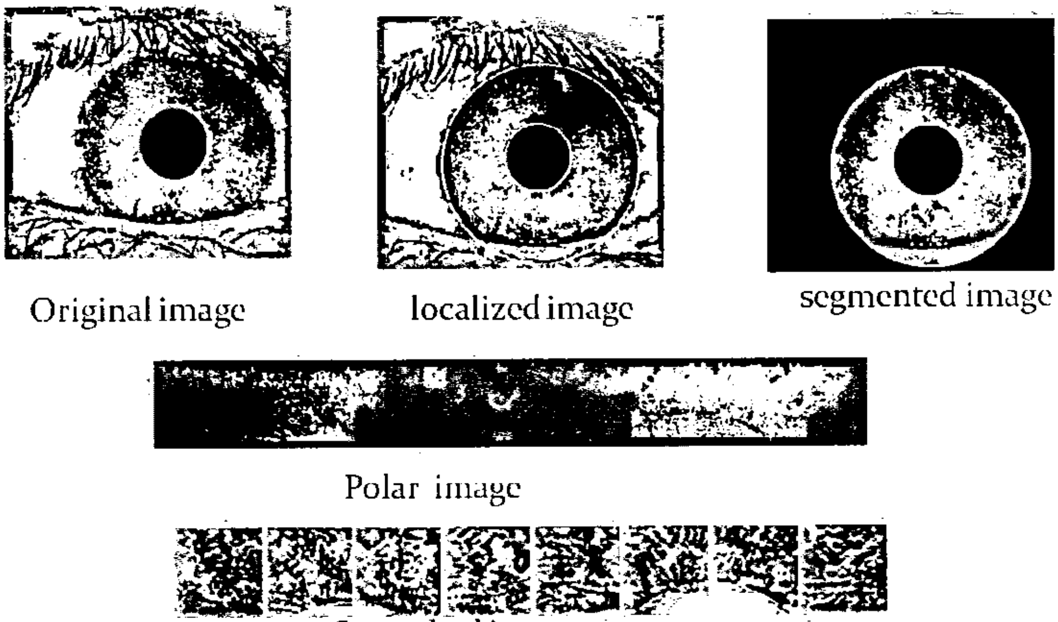
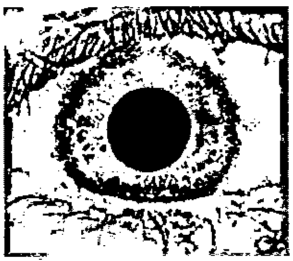
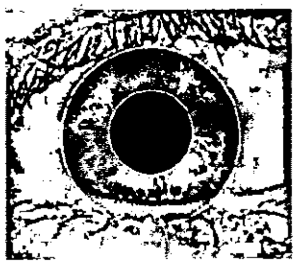


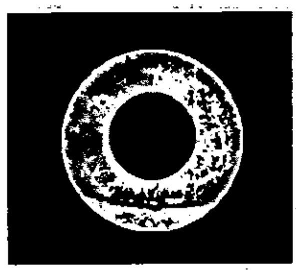
Figure 4.5: Iris Recognition steps applied on subject 4

Subject 4 & sample one is taken from CASIA database, then iris is localized & segmented. Cartesian coordinates are converted into polar coordinates. Polar image is divided in to eight sub images then on each sub image de-noising and Gabor filter is applied. At the end all sub images are combined in to one 64X512 image. Euclidean distance of subject one and subject 4 are calculated & compared. The Euclidean distance between 1^{st} subject and 4^{th} subject is 0.6719.

Sample 1 of Subject 5:

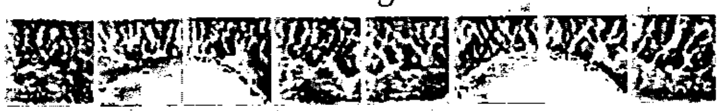






Original image localized image segmented image

Polar image



Smoothed image

Figure 4.6: Iris Recognition steps applied on subject 5

All preprocessing steps are applied on Sample one of subject 5 taken from CASIA database. Segmented is converted into polar image. Polar image is divided in to eight sub images then on each sub image de-noising and Gabor filter is applied. At the end all sub images are combined in to one 64X512 image. Euclidean distance of subject one and subject 5 are compared. The Euclidean distance between 1st subject and 5^{th} subject is 2.4438.

4.3 Results for Method 2: Log Gabor Filter:

4.3.1 Test data:

- Original image size =320 x 280
- Rectangular strip size is 20 x240
- Data base =CASIA.[16]
- Threshold for different person is 0.4
- Threshold for same person but different sample is 0.2

Sample 1 for Subject 1:

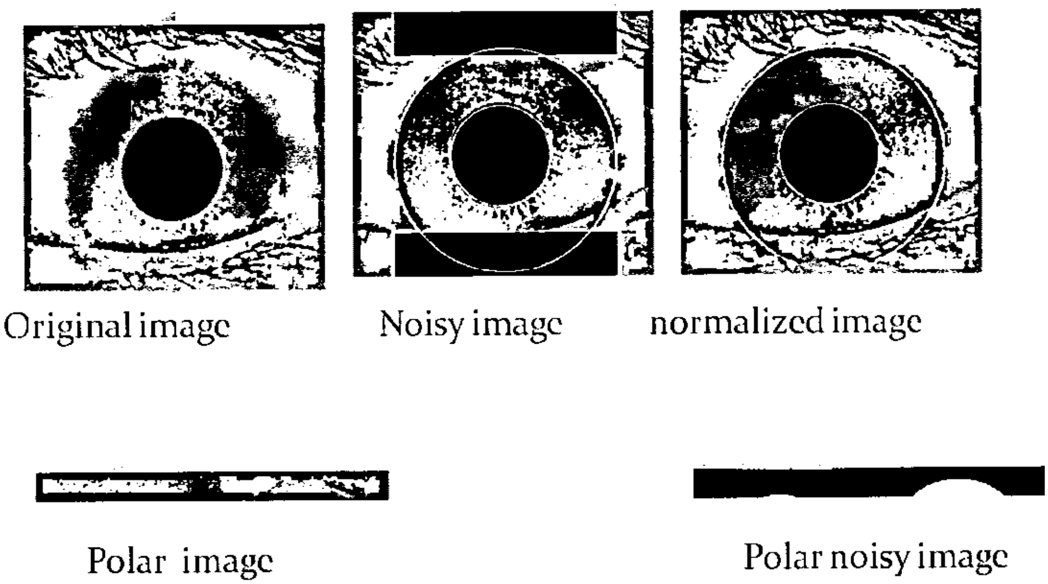
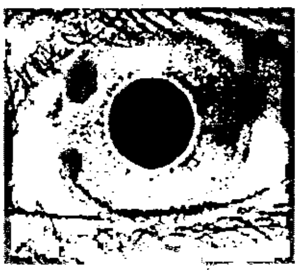
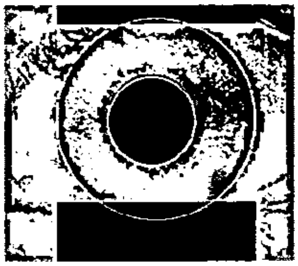
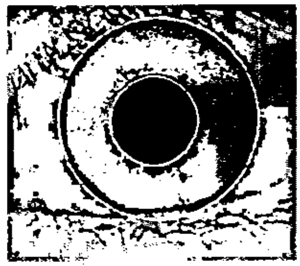


Figure 4.7: Method 2 is applied on 1^{st} sample of 1^{st} person& match it

Second method is applied on the 1^{st} sample of the 1^{st} person, detects the noise in the image then normalized the image and get polar image. Images are compared with Hamming Distance. It will authenticate the user.

Sample 1 of Subject 2:

Original image Noisy image segmented image

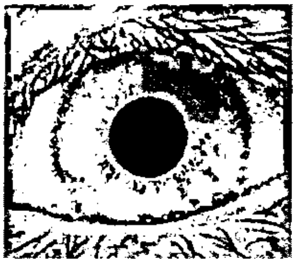
 

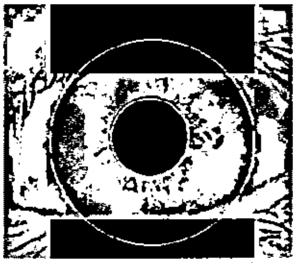
Polar image Polar noisy image

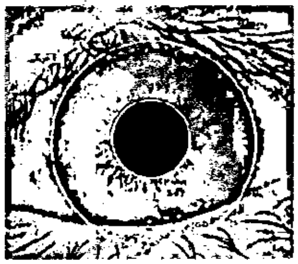
Figure 4.8: Method 2 is applied on 1st sample of 2nd person& match it

Second method is applied on the 1st sample of the 2nd subject taken from CASIA, normalized the image by detecting the noise in the image then and get polar image. 2nd subject is compared with 1st subject through Hamming Distance. HD= 0.4675 shows persons are different.

Sample1 of Subject 3:


Original image


Noisy image


segmented image


Polar image


Polar noisy image

Figure 4.9: Method 2 is applied on 1st sample of 3rd person& match it

Second method is applied on the 1st sample of the 3rd subject of CASIA database, it detects the noise in the image then normalized the image and get polar image. 3rd subject is compared with 1st subject through Hamming Distance. HD= 0.4740 shows that these are two different persons.

Sample 1 of Subject 4:

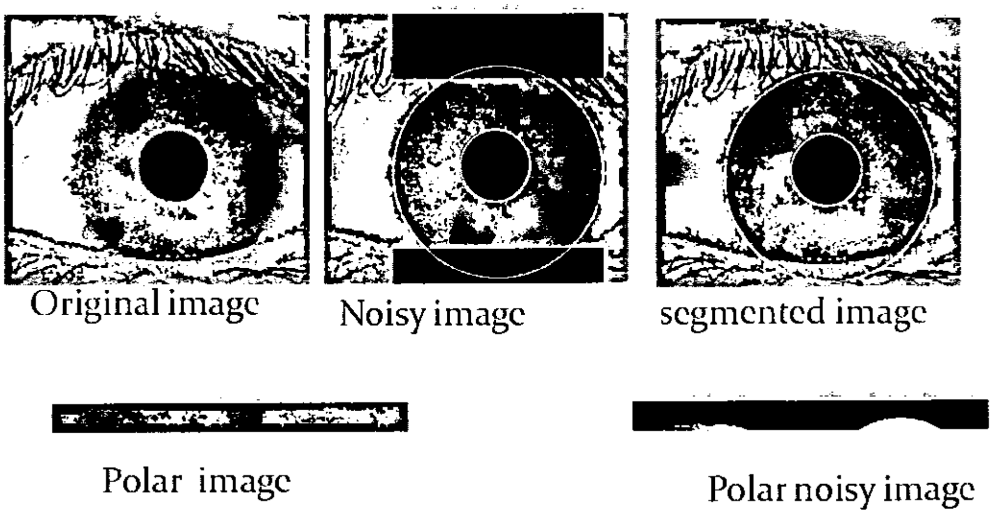


Figure 4.10: Method 2 is applied on 1st sample of 4th person& match it

Log Gabor Filter is applied on the 1st sample of the 4th subject, normalized the image enhancement by removing the noise from image and then get polar image. 4th subject is compared with 1st subject through Hamming Distance. HD= 0.4566 shows that these are two different persons.

Sample 1 of Subject 5:

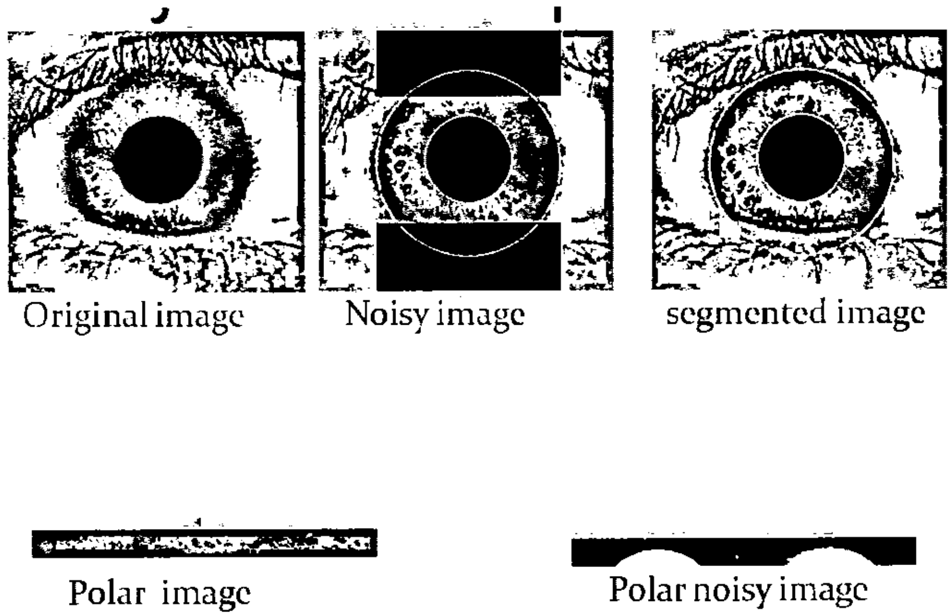


Figure 4.11: Method 2 is applied on 1st sample of 5th person& match it

Second method is applied on the 1st sample of the 5th subject, detects the noise in the image then normalized the image and get polar image. 5th subject is compared with 1st subject through Hamming Distance. HD=0.4532 shows that these are two different persons.

4.4 Comparison

Log Gabor filter is efficient than Gabor filter because Log Gabor filter collect the data on broad level .

Advantages of Method 1 Gabor filter

- Tolerant to illumination variations
- Process much more information as compared to other
- Algorithm capture both local and global details to obtain good results

Disadvantages of Method1

- Allow dc components .if the dc response is not removed, the filter will respond to the absolute intensity of the image
- Not efficient because of five frequencies and four angles

Advantages of Method 2 Log Gabor filter

- Log Gabor filter does not allow dc components
- It covers bandwidth limitation
- Log Gabor filter collect data on broad level

Disadvantage of Method 2

- Global features(mean and variance) alone cannot represent iris well [6]

4.5 Proposed Technique: Localized Log Gabor Filter

Log Gabor filter is used on eight sub images of polar strip. Two iris recognition techniques are compared . There are some limitations of existing compared methods. So we propose a new technique to combine the advantages of both techniques. Log Gabor filter gives us more accurate and stable results rather than Gabor filter
Because log Gabor stop zero frequencies. Minimum threshold for different person is 3.2.Maximum threshold for same person is 2.6.

Sample 1 of Subject 1:

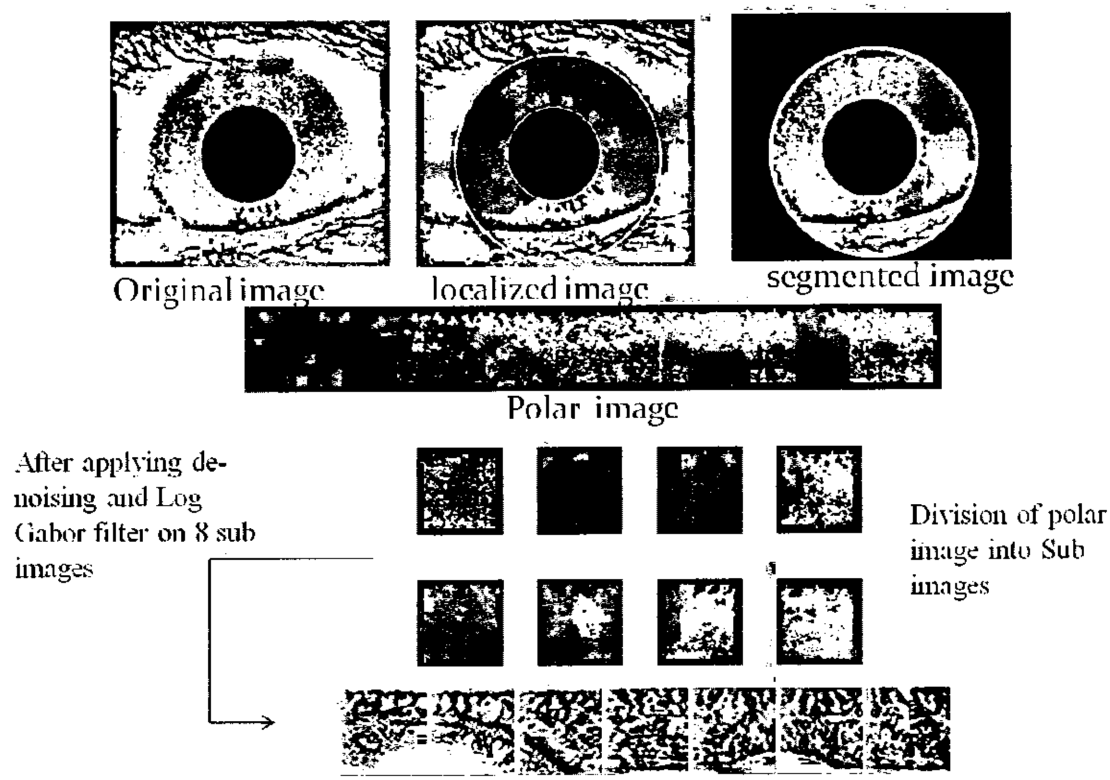


Figure 4.12: Proposed method applied on the subject one

Sample 1 of Subject 2:

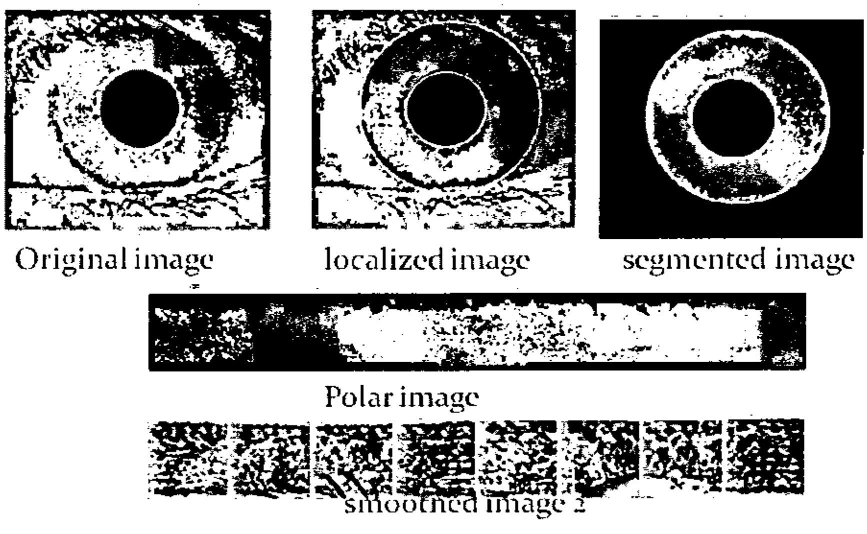


Figure 4.13: Proposed method applied on the 2nd subject &compare with 1st subject

All preprocessing steps are applied on eye image, iris is segmented . after the segmentation of iris Localized Log Gabor Filter is applied on it and then matched the iris using WED(weighted Euclidean Distance) . WED result for subject 1 and 2 is 7.3181.

Sample 1 of Subject 3:

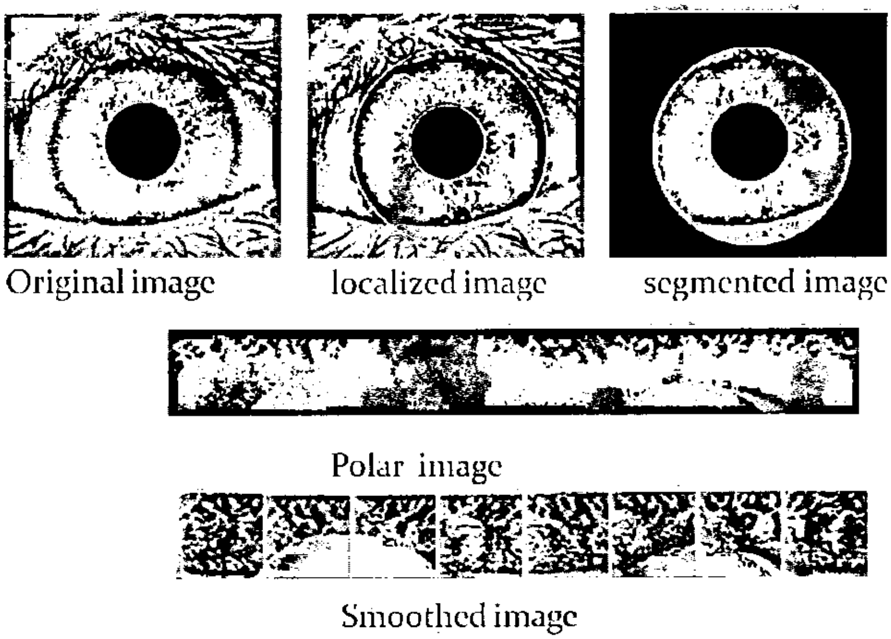


Figure 4.14: Proposed method applied on the 3rd subject &compare with 1st subject

Localized Log Gabor Filter is applied on the 1st sample of the 3rd subject, normalized the image enhancement by removing the noise from image and then get polar image. 4th subject is compared with 1st subject through Weighted Euclidean Distance. WED=18.7338 shows that these are two different persons

Sample 1 of Subject 4:

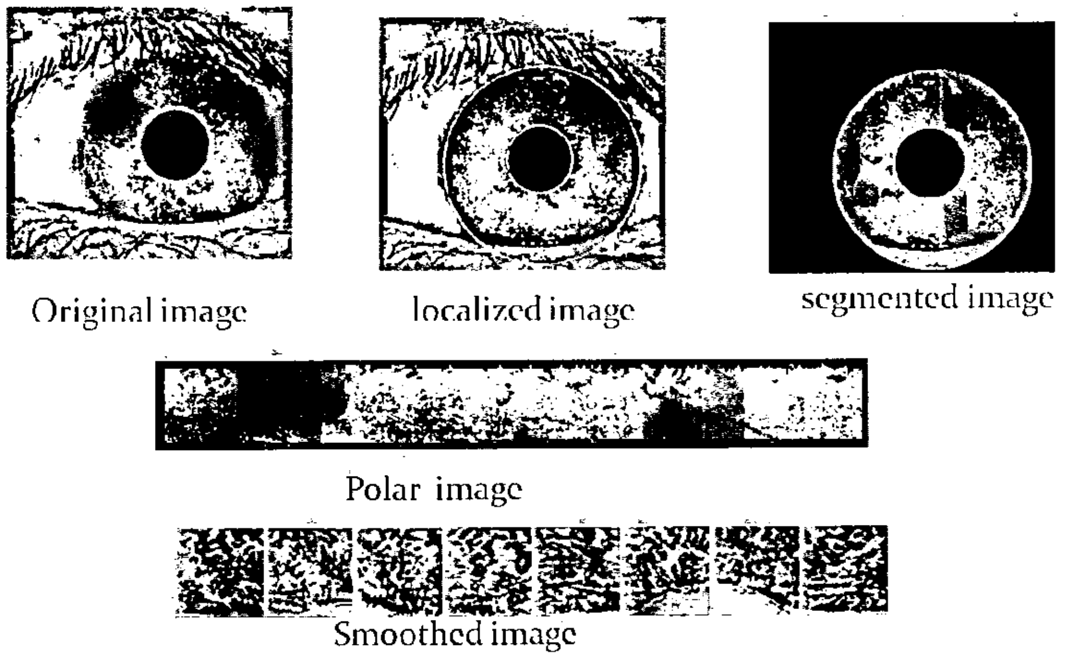


Figure 4.15: Proposed method applied on the 4th subject &compare with 1st subject

Subject 4 & sample one is taken from CASIA database, then iris is localized & segmented. Cartesian coordinates are converted into polar coordinates. Polar image is divided in to eight sub images then on each sub image de-noising and Gabor filter is applied. At the end all sub images are combined in to one 64X512 image. Euclidean distance of subject one and subject 4 are calculated & compared. The Euclidean distance between 1st subject and 4th subject is 3.2856

Sample 1 of Subject 5:

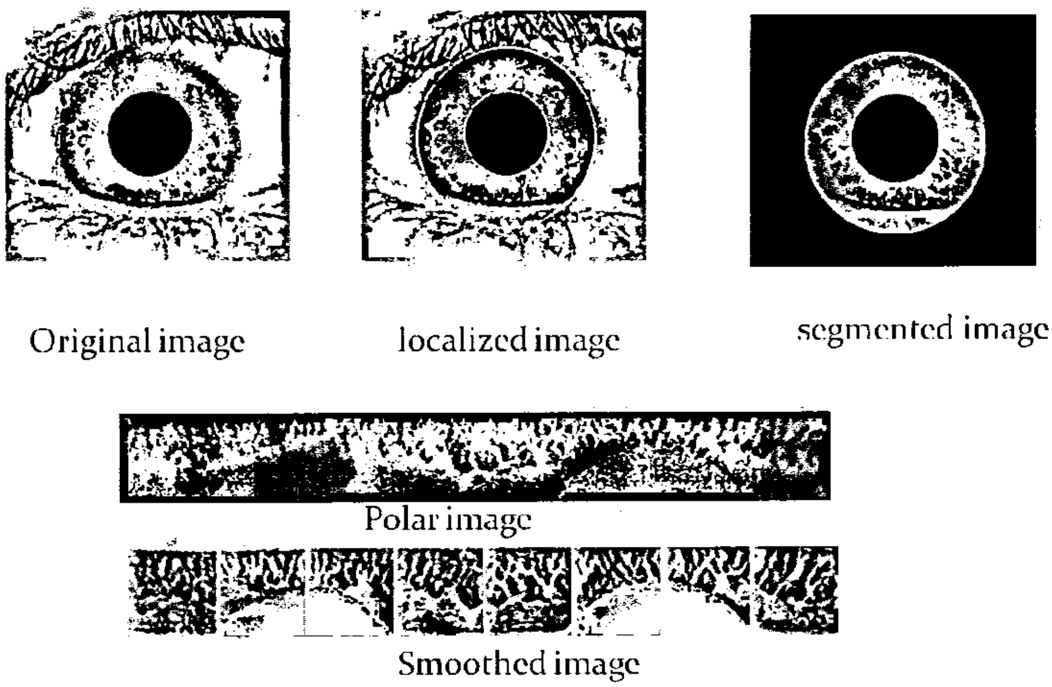


Figure 4.16: Proposed method applied on the 5^{th} subject &compare with 1^{st} subject

All preprocessing steps are applied on Sample one of subject 5 taken from CASIA database. Segmented is converted into polar image. Polar image is divided in to eight sub images then on each sub image de-noising and Gabor filter is applied. At the end all sub images are combined in to one 64X512 image. Euclidean distance of subject one and subject 5 are compared. The Euclidean distance between 1st subject and 5^{th} subject is 5.8237.

Table 4.1: Analysis of different techniques on different persons

Comparison of Different person images	Method 1(WED)	Method 2(HD)	Proposed method(WED)
Subject 1-subject 2	4.3804	0.4675	7.3181
Subject 1-Subject 3	4.1216	0.4855	18.7338
Subject 1-Subject 4	0.6719	0.4675	3.2856
Subject 1-Subject 5	2.4438	0.4740	5.8237
Subject 1-Subject 6	3.3301	0.4566	8.1387
Subject 1-Subject 7	1.7976	0.4535	6.6814
Subject 1-Subject 8	3.0974	0.4745	3.2665
Subject 1-Subject 9	3.1355	0.4581	15.0776
Subject 1-Subject 10	1.9407	0.4702	17.7818
Subject 1-Subject 11	1.3740	0.4726	5.4023
Subject 1-Subject 12	4.1956	0.4780	7.6326
Subject 1-Subject 13	1.7637	0.4740	12.3124
Subject 1-Subject 14	3.5061	0.4532	4.4457

Different iris recognition methods are applied on 14 different subjects of CASIA database. In above table, the values taken are on different scale.

Table 4.2: Analysis of distance of different samples of same persons

Comparison of same person image	Method 1 (WED)	Method 2(HD)	Proposed method(WED)
Subject 1-sample 1&2	38.0024	0.2260	1.7273
Subject 2-sample 1&2	3.2266	0.2715	0.1754
Subject 3-sample 1&2	0.7751	0.2239	1.4909
Subject 4-sample 1&2	0.1936	0.3318	2.2364
Subject 5-sample 1&2	1.5801	0.2657	2.6782
Subject 6-sample 1&2	1.6865	0.2496	0.2224
Subject 7-sample 1&2	0.8921	0.2521	1.3543
Subject 8-sample 1&2	37.2034	0.2380	1.7352
Subject 9-sample 1&2	2.7661	0.4663	1.3791
Subject 10-sample 1&2	1.0474	0.2881	2.3247
Subject 11-sample 1&2	0.6301	0.3103	1.2858
Subject 12-sample 1&2	0.3840	0.2713	1.2599
Subject 13-sample 1&2	1.0273	0.2348	5.7289
Subject 14-sample 1&2	0.0588	0.2576	10.3349

Different iris recognition methods are applied on different samples same Persons of 14 different subjects of CASIA database. In above table, the values taken are on different scale.

Table 4.3: Positive and Negative cases in results

Methods	True -ve	True +ve	False -ve	False +ve
Gabor filter	12	9	5	2
Log Gabor	14	11	3	0
Localized Log-Gabor(Proposed Method)	14	12	2	0

CHAPTER 5

CONCLUSION AND FUTURE WORK

Table 4.4: Performance Measure

Methods	Accuracy	Precision	Recall
Gabor filter	75.5 %	83.3%	66.6%
Log Gabor	89.2%	100%	80%
Localized Log Gabor(Proposed Method)	92.8%	100%	85.5%

In above mentioned table, different types of performance measures are used to calculate the Accuracy of proposed method

Table 4.5: Statistical evidence of different methods of iris recognition

Methods	Mean	Variance	Coefficient of variation
Gabor filter(different person)	0.583091	0.063839	43.33%
For same person	0.071429	0.122324	489.64%
Localized Log Gabor(Proposed Method) (different person)	0.441906	0.070231	59.97%
For same person	0.234527	0.060344	104.74%

Different statistical tools are used to authenticate proposed method in above mentioned table

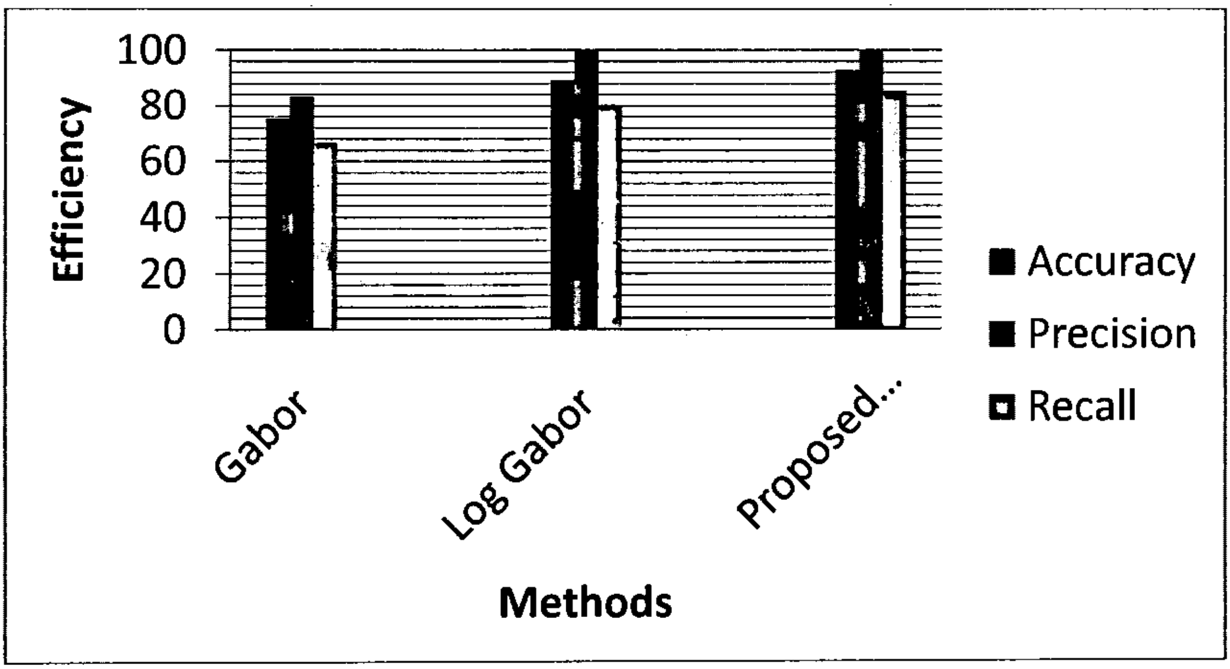


Figure 4.17: Graphical Representation of three methods

5. Conclusion and Future Work

Bases on the experimental results of proposed method, the conclusion are drawn in this section.

5.1 Conclusion:

Many techniques have been developed for iris recognition keeping in mind the importance of security issues. Many researchers compare different iris recognition techniques. But not any researcher works on techniques which are compared. The basic purpose of this research was to compare different techniques of iris recognition but at the end of comparison, new technique is proposed for iris recognition based on the advantages of the compared techniques. The proposed technique not only divide image in to sub images but also apply Log Gabor filter which has zero DC responses. It covers bandwidth limitation and collects the data on broad level. The proposed technique is very efficient and gives better, stable results and overcome the limitations of compared techniques.

5.2 Future work:

- The images of different camera's and different resolution can be compared
- Results can be evaluated for large database of iris images taken from different sources

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