AN APPROACH TOWARDS IRIS LOCALIZATION FOR NON COOPERATIVE IMAGES: A STUDY

Thesis submitted in partial fulfillment of the requirements for the award of the degree

Of

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CERTIFICATE

This is to certify that the work in this Thesis Report entitled "An Approach Towards Iris Localization For Non Cooperative Images: A Study" by Priyanka Kaushal has been carried out under my supervision in partial fulfillment of the requirements for the degree of Bachelor of Technology, in Computer Science during session 2009 - 2010 in the Department of Computer Science and Engineering, National Institute of Technology Rourkela, and this work has not been submitted elsewhere for a degree.

PLACE : Rourkela

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I express my satisfaction on the completion of this final year project and thesis report submission as a part of the curriculum for the degree of Bachelor of Technology, Computer Science.

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SYMBOLS AND ABBREVIATIONS

CHT	Circular Hough Transform
R	Red component of an image
G	Green component of an image
B	Blue component of an image
θ	Greek symbol, measure of degree of angle

Problem statement

Iris recognition systems are the most reliable biometric system since iris patterns are unique to each individual and do not change with time. A variety of methods were developed to handle eye data in biometric systems after J. Daugman developed the first commercial system. Eye images used in iris recognition systems require images to be taken under rigid constraints. To obtain a good quality image, subjects cooperation is required like the subject must look straight into camera, still and there should be proper illumination .

These causes inconvenience to the user and is also time consuming. Moreover in cases like criminal investigations images can be taken at any moment of time and thus require unconstrained conditions. In some other cases it is possible that pictures are shot without the knowledge of subject. So images taken under such situations are often "non cooperative" in nature. Conventional techniques require subjects' cooperation for the accuracy of results. Any unwanted data present in iris images may give false results leading to the rejection of images. Serious noise effects are present in iris images taken under unconstrained condition. A very well known existing technique, the Circular Hough Transform has been implemented for detection of iris and pupil boundaries[7]. Traditional segmentation techniques do not give accurate results with images containing noise. The main objective of this thesis is to introduce a novel approach towards iris segmentation techniques which may overcome users cooperation constraints.

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Abstract

Iris localization is the most important part of iris recognition which involves the detection of iris boundaries in an image. A very important need of this effective security system is to overcome the rigid constraints necessitated by the practical implementation of such a system. There are a few existing techniques for iris segmentation in which iris detection using Circular Hough Transform is the most reliable and popular and it has been implemented in this project. But there is a shortcoming in this technique. It does not perform well and does not gives high accuracy with images containing noise or occlusions caused by eyelids. Such kind of images constitute non cooperative data for iris recognition. To provide acceptable measures of accuracy, it is critical for an iris recognition system to overcome various noise effects introduced in images captured under different environment such as occlusions due to eyelids. This report discusses an approach towards less constraint iris recognition using occluded images. The Circular Hough Transform is implemented for few images and a novel approach towards iris localization and eyelids detection is studied..

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Every individual is recognized by a set of features unique to that individual. No two different individuals posses same set of physical and behavioral characteristics. This uniqueness of an individual can be preserved and deployed to identify and recognize an individual. The field of biometrics does the same. Biometrics is a field which deals with identifying and recognizing an individual based on some measurable physical and behavioral characteristics[11]. The term biometric represents some measurable life characteristics[10]. Current technologies use biometrics to provide authentication and authorization to a person in an organization for security purposes.

Any physical or behavioral characteristics of an individual can be used as a biometric data in biometric systems provided it fulfills the following criteria[11,10]:

1. *Universality*: Every person should posses the characteristic,
2. *Uniqueness*: No two individuals should be the same in terms of the characteristic,
3. *Permanence*: Characteristic should not change with time
4. C*ollectability*: Characteristic should be measured quantitatively

Based on the above criteria a wide variety of human characteristics are used as a biometric data. Each biometric characteristics has its own strengths and limitations. Either a single biometric can be used or a combination of two or more can be used depending upon the requirements of an application. The commonly used biometric characteristics are[10]:

1. Voice
2. Face
3. Fingerprints
4. Iris
5. Ear

6. Gait
7. DNA
8. Signature

The problem of resolving identity of a person can be categorized into two types[] i.e.

1. Verification

2. Recognition

Verification deals with confirming or denying ones claimed identity based on the set of unique features provided by him. *Recognition* deals with establishing a person's identity from a set of identities. In verification a person provides input sample data and this data is checked against the feature data of the same individual stored in a database for that person. Depending upon the extent of similarity the person's identity can be confirmed or denied. In recognition technique, the input feature data is checked against all the data stored in the database. If it matches, an identity is established for the person[10,11].

1.2 GENERAL BIOMETRIC SYSTEM

Any biometric system is composed of the following components:

1. Sensor: This component captures data of a subject which is used for further analysis. An example of a sensor is digital cameras capturing the image of an iris.

2. Feature extractors: This component uses the captured data and performs some preprocessing steps to convert the data to a form which is suitable for a specific application.

3. Matching module: The already processed data is fed to the matching module for comparison with the with the stored templates or data to perform a verification or identification.

4. Database: The database acts like a repository in a biometric system which stores all the data of the registered users required during the matching process of the captured and processed data.

Prior to verification or identification the user's biometric measurements are captured. This data is in raw form, so the information required is extracted out of it by the feature extractor and this information is stored in database. This process is termed as enrollment[10]. After enrollment follows either the identification mode or the verification mode which is described in Section 1.1

The designing of biometrics-based identification systems involves few challenges. Described below are some of the research issues involved in biometrics based identification systems[10]:

1. Data acquisition. One of the critical need of a biometric system is acquiring relevant information from the input raw data. This step is critical since the quality of data extracted from raw input determines the performance of the entire system to a large extent. Two of the related issues are :

a. Assessment of quality: The quality and relevance of data is assessed to determine its suitability for the application
b. Seperation: Seperating the relevant data from the whole chunk of information to obtain the object of interest. Careful selection of data further helps improve the performance of the system and avoiding undesirable measurements.

2. REPRESENTATION: To detect the machine-readable representations completely capture the invariant and discriminatory information in the input measurements is the most challenging problem in representing biometric data. This representation issue constitutes the essence of system design and has far reaching implications on the design of the rest of the system.

3. FEATURE EXTRACTION: Given raw input measurements, automatically extracting the given representation is an extremely difficult problem, especially where input measurements are noisy.

4. MATCHING: The crux of a matcher is a similarity function which quantifies the intuition of similarity between two representations of the biometric measurements. Determining an appropriate similarity metric is a very difficult problem since it should be able to discriminate between the representations of two different identities despite noise, structural and statistical variations in the input signals, aging, and artifacts of the feature extraction module.

1.3 PERFORMANCE MEASURES OF A BIOMETRIC SYSTEM

The following parameters are generally used to measure the efficiency of a biometric system[10]:

1. False Acceptance Rate (FAR)

The FAR is the frequency that a non authorized person is accepted as authorized. Because a false acceptance can often lead to damages, FAR is generally a security relevant measure. FAR is a non-stationary statistical quantity which does not only show a personal correlation, it can even be determined for each individual biometric characteristic (called personal FAR).

2. False Rejection Rate (FRR)

The FRR is the frequency that an authorized person is rejected access. FRR is generally thought of as a comfort criteria, because a false rejection is most of all annoying. FRR is a non-stationary statistical quantity which does not only show a strong personal correlation, it can even be determined for each individual biometric characteristic (called personal FRR).

3. Failure To Enroll rate (FTE, also FER)

The FER is the proportion of people who fail to be enrolled successfully. FER is a non-stationary statistical quantity which does not only show a strong personal correlation, it can even be determined for each individual biometric characteristic (called personal FER). Those who are enroled yet but are mistakenly rejected after many verification/identification attempts count for the Failure To Acquire (FTA) rate. FTA can originate through temporarily not measurable features ("bandage", non-sufficient sensor image quality, etc.). The FTA usually is considered within the FRR and need not be calculated separately, see also FNMR and FMR.

4. False Identification Rate (FIR)

The False Identification Rate is the probability in an identification that the biometric features are falsely assigned to a reference. The exact definition depends on the assignment strategy; namely, after feature comparison, often more than one reference will exceed the decision threshold.

1.4 Thesis Layout

The rest of the thesis is organized as follows: Rest of the Chapter 1 deals with the basics of iris recognition and the steps involved. Chapter 2 comprises of literature review and motivation. Chapter 3 includes study of Circular Hough Transform, a new technique for iris localization and the use of linear Hough Transform for eyelid detection. Chapter 4 deals with experimental results and in Chapter 5 we have a discussion towards the end of thesis we have references.

1.5 IRIS AS A BIOMETRIC DATA

The complex texture of iris of both the eyes constitute the most distinct and numerous characteristic which can be used as a biometric data. Figure 1.1 depicts the human eye and its components.

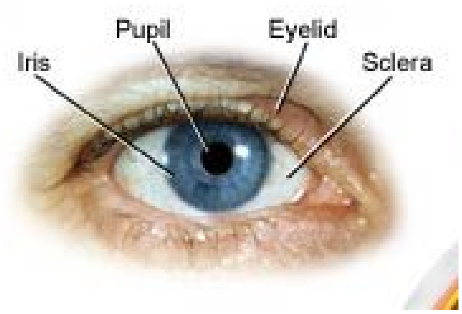

Fig 1.1 Eye image indicating various parts

Iris is the annular region between sclera and the pupil and it is generally heavily pigmented[7]. This iris contains some minute patterns which are unique to each individual. Even twins do not have same iris patterns[4]. Iris texture do not change with time. This distinctiveness and permanence of iris patterns makes it a popular and robust biometric data.

IRIS RECOGNITION

Iris patterns are used in the recognition of individuals. Iris recognition is the technique of establishing a personal identification and verification of an individual based on his/her iris patterns[11]. Due to its uniqueness iris recognition is carried out for applications requiring high security concerns.

STAGES OF IRIS RECOGNITION

Iris recognition is a stepwise procedure. The first step is the image capture. Then images are brought to appropriate forms in order to perform some preprocessing steps. Then the iris is localized and segmented for further processing. The texture of the iris is extracted then using appropriate techniques. Finally texture matching is done to validate identification process. The major steps can be summarized as[4].:

1. **Image Capture**: Image is captured under proper illumination, distance and other factors affecting image quality are taken into consideration. This step is crucial because image quality plays a important role in iris localization.

2. Image preprocessing: The image captured is converted to some form suitable for rest of processing like conversion of gray scale to binary image.

3. **Image localization**: This step uses the output image from the previous step and detects the outer and inner iris boundaries. There are various techniques to detect boundaries like Circular Hough Transform.

4. Feature extraction: The portion of interest i.e. iris patterns are extracted from the localized iris using techniques like Haar wavelets.

5. **Pattern matching**: The extracted patterns are mapped onto the patterns already extracted and stored in database. The degree of similarity decides whether the identification is to be established or not

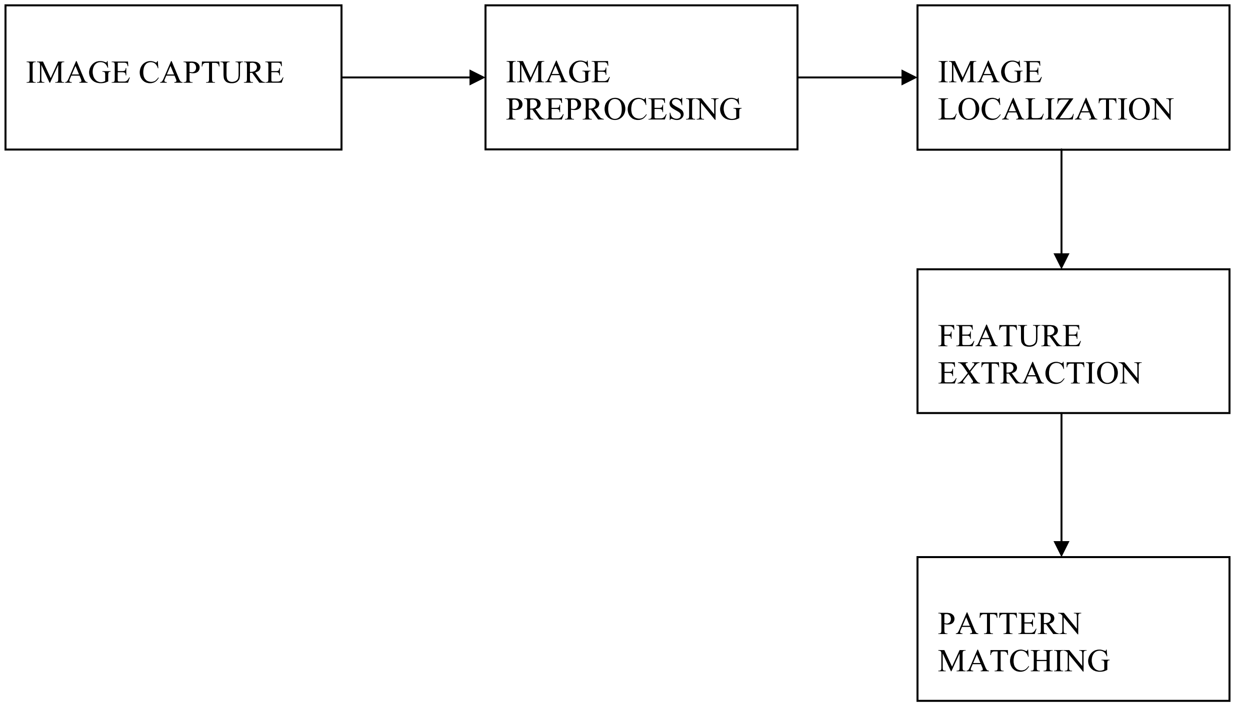

Fig.1.2 Block diagram of the stages of iris recognition system

1.6 CONCLUSION

The subproblem of iris localization is a step involved in iris recognition.This step becomes critical in case of dealing with noisy images and images with eyelids interference. Since images having more of irrelevant information imposes problems and gives inaccurate results while iris localization. So, it is important to develop new efficient methodologies of iris localization which gives accurate results.

CHAPTER 2

LITERATURE STUDY

1.1 IRIS SEGMENTATION METHODOLOGIES

Many advancements have been made in the field of iris segmentation techniques. In 1993, J.G Daugman proposed an approach for iris segmentation. In the segmentation stage, this author introduced an integrodifferential operator to find both the iris inner and outer borders. The methodology used by him is most popular amongst all iris recognition techniques. In this paper, Daugman assumed the iris and pupil to be circular and introduced an operator for edge detection. This operator searches over the image domain (x, y) for the maximum in the blurred derivative with respect to increasing radius r, of the normalized contour integral of I(x, y) along a circular arc ds of radius r and center (X_0 , Y_0)[12,13].

A methodology was proposed by Wildes in 1997 in which the intensity values of the image is converted into a binary edge map. The edge map is constructed through the Canny edge detector. In order to incorporate directional tuning, the image intensity derivatives are weighted to favour ranges of orientation. Then the well-known Circular Hough Transform is used to obtain the boundaries. The accuracy of this methodology. Is dependent on the edge detection algorithm[12,14]. In 2004, J. Huang proposed an approach which would work for iris images having noise. This method involved rough localization and normalization, edge information extraction and the fusion of edge and region information[11].

In a paper by P.Gupta et al(2006), Circular Hough Transform was used for detection of outer iris and inner iris boundaries. The procedure first finds the intensity image gradient at all the locations in the given image by convolving with the sobel filters. The absolute value of the gradient images along the vertical and horizontal direction is obtained to form an absolute gradient image. The absolute gradient image is used to find edges[6]

1.2 Motivation

The proposed methodologies as discussed in Sec 1.1 performed well with the good images. However, each methodology has one or more drawbacks. The main disadvantage with the mentioned techniques is they do not give good results with occluded images or images containing some noise due to eyelids, eyelashes, reflections etc. We were motivated to study and implement a technique which works with almost all kind of noisy images. The work is related to an approach to address the subproblem of iris localization which deals with localizing the iris and pupil boundaries to produce data which can be used in the subsequent steps of iris recognition. Since iris is a robust and unique biometric data, researchers have developed many techniques to deploy its uniqueness to generate a biometric system which is reliable and accurate. However the iris images are not tolerant to noise the presence of which causes problems while localizing iris boundaries with the conventional techniques, we implement a technique of iris localization which gives better results with non cooperative images.

CHAPTER 3

IMPLEMENTATION OF A NEW APPROACH

3.1 INTRODUCTION

P. Gupta et al (2006) used Circular Hough Transform to detect iris and pupil boundaries. In the initial stages of this project this technique was thoroughly studied and simulated for different stages.

3.2 HOUGH TRANSFORM

Any object can be described by mathematical functions that define the boundaries of that object. The **Hough transform** is a technique used in digital image processing to isolate features of a particular shape within an image. This technique finds objects with a particular shape within a certain class of shapes. It uses parameters that describe any shape, creates a mesh of those parameters and then follows a voting procedure to cast votes in the mesh cells in some accumulator space[15].

In digital image processing, often detecting some basic shapes like lines, circles, ellipses etc may be a requirement. In most of the cases Hough Transform requires some kind of edge detection of the objects prior to performing transform. Due to various kind of noises in the image, the detected edges may not be in a perfect shape. Hough Transform performs shape detection by grouping these edge points using a voting procedure in an accumulator space. A basic form of Hough Transform detects straight line in any image[15].

3.3 Circular Hough Transform(CHT)

Circular Hough Transform is used to detect the presence of circular shapes in any image. For example detection of number of circular discs in an image. Another well known application of Circular Hough Transform is the detection of number of coconuts in an image[2]. Circular Hough Transform uses the parameterized equation of circle for this purpose .

The equation of circle can be written as

$$(x-a)^2 + (y-b)^2 = r^2 \qquad (1)$$

Where x, y are the points on the circumference of the circle, a, b is the centre of circle and r is the radius of the circle.

The equation of circle can be written as

$$\begin{aligned} X &= a + r^* \cos(\theta) \\ Y &= b + r^* \sin(\theta) \end{aligned} \qquad (2)$$

Circular Hough Transform uses these equations to compute the CHT of a circle and detect the presence of circular objects in an image.

3.4 ALGORITHM (Circular Hough Transform)

The algorithm for CHT is[3]:

1. Read an image file.

2. Find edges in the image.

3. Define a range of radius to be used.

4. For each edge point
   a. Draw a circle with that edge point as the centre and a radius r and increment the number of votes by 1 for all the coordinates that coincide with the circumference of the circle drawn,in the accumulator space.
   b. Find circles for an edge point for all the radius in the range.

5. Find the maximum number of in the accumulator space.

6. Plot the circle with parameters (r, a, b) corresponding to the maximum in the accumulator space.

7. The circle obtained is the desired circle with (r, a, b) as the radius and center of circle respectively.

3.5 Canny edge detection

Edges are the regions of high intensity contrasts i.e. a significant difference in intensity from one pixel to another. Extracting these edges out of an image filters out important data about the shape and size of objects present in an image. In this work, Canny operator in MATLAB was used .This operator works on the canny edge detection algorithm. The detected edges consisted of boundaries of iris, pupil and to some extent eyelashes.

3.6 Application of CHT

With the edge detected image, an appropriate range of radius was chosen. Now for every edge point in the image the circles of radius in the range chosen were drawn with that edge point as centre of circle. The circles were drawn in the parameter space which is 3 dimensional , where the coordinates of the centre of circle and the radius represented the three perpendicular axes[3].

3.7 Accumulator Space

AN accumulator array was taken which consists of three parameters: x coordinate(x) and y coordinate(y) of centre of circle , radius of circle(r) drawn. with each circle drawn for each pixel point the elements of accumulator matrix were incremented corresponding to all the points passed by the circumference of circle. The maximum value in the array was found out. Those values corresponded to the radius of iris and centre of iris. Now a circle with determined radius was superimposed on the original image[3,6].

A NEW APPROACH

3.8 IRIS LOCALIZATION

Y. Chen et al(2010), proposed a novel approach towards iris localization which deals with non cooperative images[1]. The main focus of the project work is the implementation of this technique. The procedure is described in subsequent sections.

3.8.1 INTRODUCTION

The Circular Hough Transform is quite tolerant to noise but it gives good results with images taken under constrained conditions. It does not performs well with images suffering from eyelids and eyelashes occlusions. As already mentioned, good iris images require rigid constraints which impose an inconvenience to the subject. This section describes a novel approach which gives considerable good results with non cooperative images as well[1].

3.8.2 AN OVERVIEW

Basic idea behind this approach proposed by Y. Chen et al(2010) is to allow some preprocessing steps to be performed prior to iris and pupil detection so that the we get a more defined area for the detection of iris. Subsequent steps involve detection of eyelids since a considerable part of the iris is covered by eyelids and eyelashes which may lead to faulty detection of center and ultimately rejection of image.

The whole process is divided into 3 steps[1]:

1. Detection of sclera region

2. Localization of iris and pupil boundaries

3. Eyelids detection

3.8.3 DETECTION OF SCLERA

Iris images are taken from different distances. Thus different images of same person may show different sizes and location of iris depending upon factors like distance and illumination[1]. Sclera region is the white part of the eye between upper and lower eyelids and excluding iris region. Iris is contained within sclera region. The proposed method suggests localization of this sclera region[1] as a preprocessing step. Since the iris may lie anywhere in the image, this step helps in locating the approximate region where iris lies.

It further consists of two steps[1]:

a. Detection of sclera region

b. Defining a region for iris

3.8.4 Detection of sclera region

Sclera part is lightly pigmented as compared to iris and pupil. In some cases where the color of iris is darker, the pupil is not easily distinguishable from iris[1]. Sclera region can be easily distinguished from the rest of eye parts.

HSI Color Model

The colors perceived by humans is dependent on certain characteristics. The HSI model represents colors through 3 attributes: Hue, Saturation, Intensity.
Hue depicts the amount of color present i.e. describes a pure color itself. *Saturation* depicts the amount of whiteness added to a pure color. *Intensity* represents the gray scale level of any image [8].

The HSI model decouples the intensity component from color component and thus the saturation of any image is more tolerant to noise[8]. So the saturation component of the image was separately calculated in the proposed method. The range of Saturation component is [0, 1]. In this model when the Saturation value is 0, the value of Hue does not carry any meaning since the pixel is white. Similarly when Saturation is 1, the Hue value represents pure color(e.g. Blue, yellow etc).

For the detection of sclera area, which will have saturation values close to 0, the saturation component of each pixel can be calculated using the equation[1,8]:

$$S = 1 - \frac{3}{(R+G+B)}[\min(R, G, B)] \qquad (3)$$

A threshold value was then determined from the histogram of saturation values of all the pixels close to zero which represents saturation of pixels of sclera region[1].

The saturation value of all the pixels was compared with the threshold value. The pixels having saturation less than or equal to the threshold were considered as pixels belonging to sclera part and pixels with saturation above threshold were not considered as part of sclera. So the sclera portion which was white was easily delineated from the rest of the eye[1].

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3.8.5 Localization of region for iris

This step involves defining an area based on the previous step where iris can be located. This step is performed since location of iris varies for different images and this will provide a target area that is adaptive for different images. Locating an area where iris can most probably be found provides a clear demarcation for iris and the required area of interest and separates it from rest of the unwanted eye area. The extracted sclera obtained from the previous step as can be seen, contains some white spots .This points are not required while defining a target rectangle and are removed to obtain a binary map of the eye image where the iris is located[1].

The image obtained after the performed operation was used to find a target rectangle. The minimum and maximum coordinates of the uppermost and leftmost white pixel was determined and a rectangle with the obtained coordinates was superimposed on the original image[1].

3.9 DETECTION OF IRIS and PUPIL

After sclera detection is performed, the image is subjected to Circular Hough Transform for the detection of iris and pupil boundaries. The mechanism and methodology used in this technique has already been described in earlier sections. The image is cropped to the dimensions of the rectangle drawn and CHT technique is applied on the cropped image.

3.10 EYELIDS DETECTION

3.10.1 INTRODUCTION

Detection of eyelids is important in eye images taken under unconstrained conditions, because a considerable amount of obstruction is caused by these eyelids. These obstructions often lead to faulty iris boundary detection and subsequently error in later stages of iris recognition. So detecting the eyelids boundary is an important step in iris localization. The technique used to detect iris boundaries is Linear Hough Transform[1].

3.10.2 Linear Hough Transform

The main idea behind Hough Transform is explained in Section 2.2 Linear Hough Transform is the simplest case of Hough Transform. Linear Hough Transform is used to detect straight lines in any image. Like circular Hough Transform this also the uses the voting procedure over an accumulator space[5]. A straight line can be represented by the equation

$$y = mx + c \tag{4}$$

where x and y are the coordinates of a point in image, m and c are the slope of the line and intercept respectively.

Equation (5)[5] represents a straight line

$$x \cos(\theta) + y \sin(\theta) = r \qquad (5)$$

where x and y are the point coordinates, r represents the distance between the line and origin and θ represents the angle of vector from origin to the closest point. The above equation produces a sinusoidal curve in the (r, θ) plane. This curve is unique to a point. If two curves of two different points are superimposed then the point where they cross each other will correspond to the line that passes through both the points[5]. This equation is used for detection of straight lines.

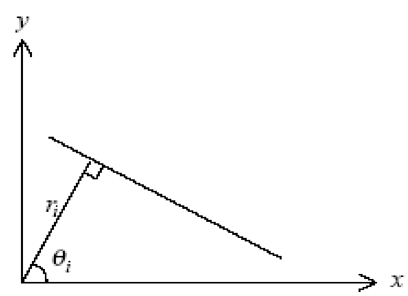


Fig. 3.1 Representation of straight line in (x,y) plane using (r_i, θ_i)[5]

r_i shows distance of origin from line, θ_i represents angle of the vector from origin to nearest point

3.10.3 Application of Linear Hough Transform in detecting eyelids

The eye image used for detection of eyelids is subjected to binarisation. The image is converted to binary image using an appropriate threshold. The resulting image is operated by an appropriate edge detector.

The edge detector used in this case was Sobel edge detector[1].Then Linear Hough transform is applied on the obtained edge points.

Linear Hough Transform uses an accumulator array where votes are casted for each cell(represented by values of (r, θ). For every edge point in the image and its neighbour pixel, the occurrence of a straight line is checked using the parameterized equation mentioned before. If a line exists between the two pixels then the votes in accumulator array corresponding to the values of (r, θ) for the pair of pixels are incremented by 1. After computing the equations for all pairs, the votes in the accumulator array are checked. corresponding to highest votes in the accumulator array, the appropriate lines are drawn[5].

3.11 CONCLUSION

The technique of Circular Hough Transform was applied on the images taken from UBIRIS database and few of the results are included in this thesis. Circular Hough Transform performs well with images and is quite tolerant to noise but in few cases gives error especially in highly occluded images, where the circle detected also includes eyelids and eyelashes. So we need to implement a technique which provides eyelids detection. The new technique for the detection of iris and pupil includes some preprocessing steps of sclera detection and defining a region for search of iris. These two preprocessing steps gives better result than directly applying CHT .This technique works for almost all kind of images.

CHAPTER 4

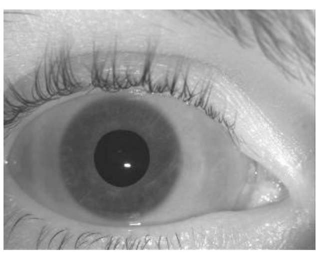
EXPERIMENTAL RESULTS

SIMULATION RESULTS

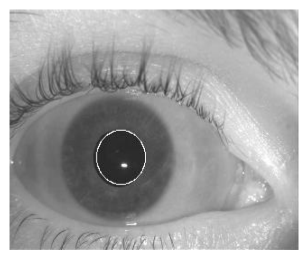
The technique of iris localization discussed in Chapter 3 was simulated and the results were derived for various images and few of them are included in this report. The codes were implemented in MATLAB using the images from UBIRIS database since it has noisy images which are suitable for our implementation.

4.1 RESULTS OF CIRCULAR HOUGH TRANSFORM

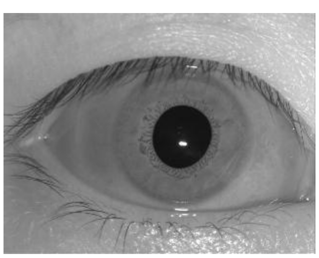
The technique of Circular Hough Transform discussed in Section 3.3 was implemented for finding the radius of iris and pupil and centre of iris. A gray scale eye image was taken and was converted into binary image using appropriate threshold. This step was done to remove some noise from image. Then edges were found using any edge detection technique. This step is required since Hough Transform requires edge points. There are various edge detectors like Canny, Sobel, Prewitt[2]. For our purpose Canny edge operator was used. A range of radius was chosen. In this case radius varied from 1 to 50. Figure 4.1 shows the results.



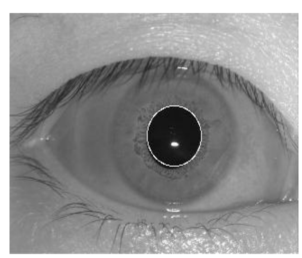
(a) Input image



(b) Detected pupil



(c) Input image



(b) Detected pupil

Fig. 4.1 Images showing the results of CHT

4.2 RESULTS OF DETECTION OF SCLERA REGION AND IRIS LOCALIZATION

A coloured image was taken from UBIRIS database and it was subjected to the procedure described in Section 3.8.4.The saturation values were calculated for each pixel and a histogram depicting the saturation values was obtained. Fig. 4.2 is a histogram of saturation values.

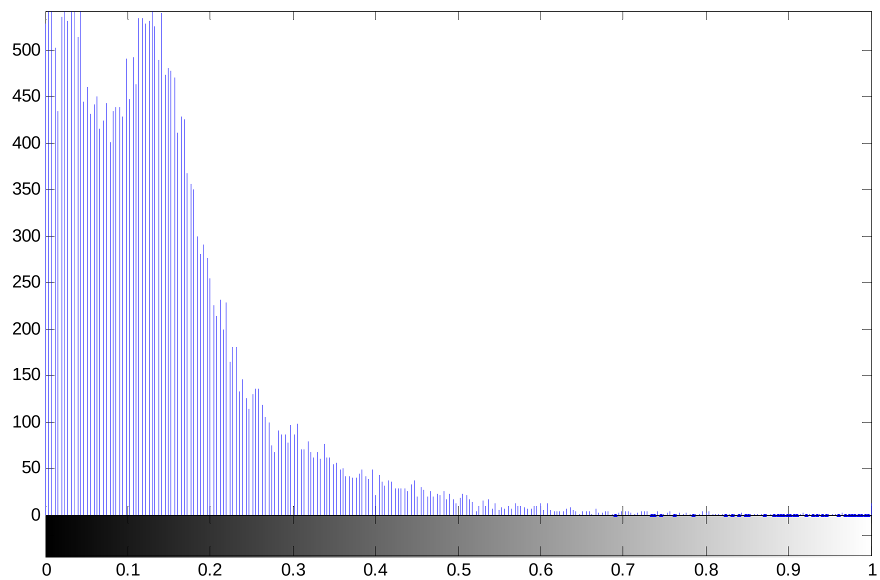
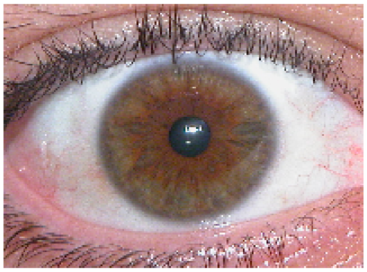
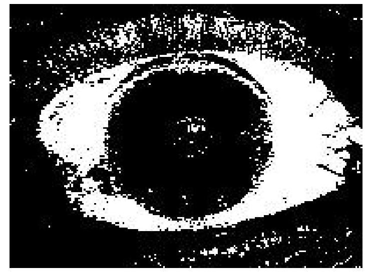


Fig. 4.2 Histogram of saturation values of input image

From the analysis of the histogram a threshold value was chosen for each input image saturation values of all pixels was compared with this threshold and an image containing the pixels of sclera was generated.



(a) Input image



(b) Detected sclera

Fig. 4.3 Images showing results of sclera extraction

The larger white portion extracted depicts the sclera region. Fig. 4.3 which is the resultant image shows presence of some noise points which can be seen in the dark region as white dots.

The unwanted pixels were removed by a function *bwareaopen()*. This function is available in MATLAB and is used to remove the connected components in a binary image which have fewer than a specified number of pixels P which is passed as an argument to the function giving another binary image[8]. The output binary image thus consisted of required pixels of interest.

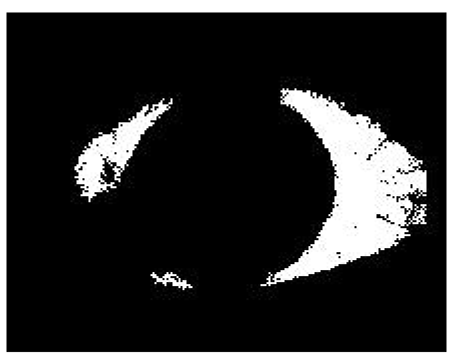


Fig. 4.4 Image showing final results of sclera detection

From fig, 4.4 the coordinates of the uppermost and leftmost pixels were taken and a target rectangle was drawn to minimize the area of occurrence of iris.

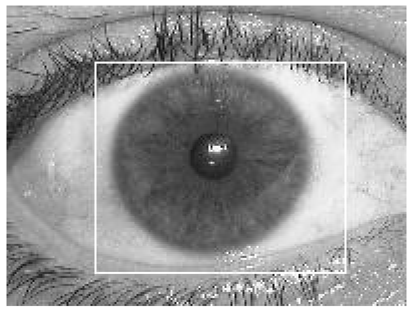
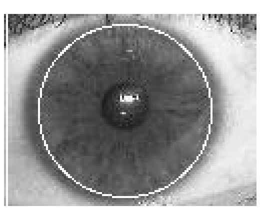


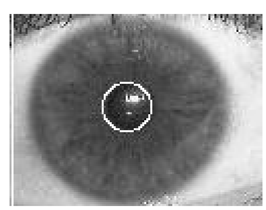
Fig. 4.5 Image depicting the target rectangle

The figure thus obtained has a rectangle which defines an approximate region for the occurrence of iris. This technique can be applied to a variety of non cooperative images to obtain approximate iris region.

The image obtained i.e. fig. 4.5 was cropped to the size of rectangle drawn and Circular Hough Transform was applied on the image for detection of iris and pupil.



(a) Detected iris

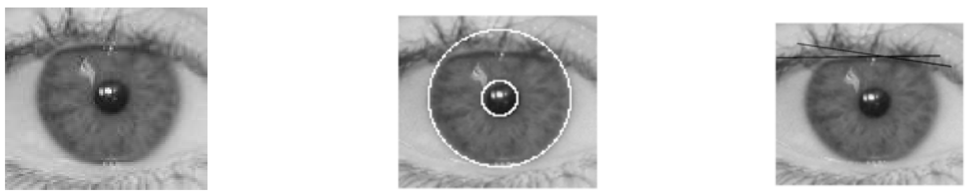


(b) Detected Pupil

Fig.4.6 Detected iris and pupil boundaries in an image

4.3 RESULTS OF EYELIDS DETECTION

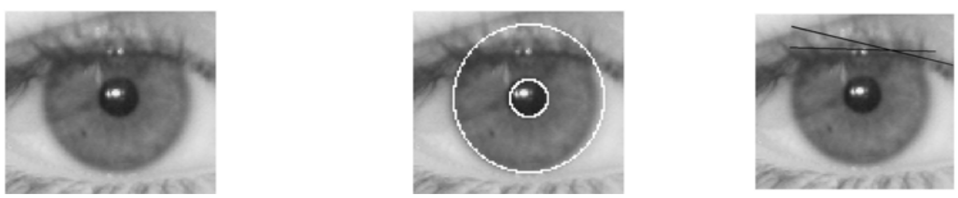
Linear Hough Transform was applied to the images obtained after application of CHT. The algorithm when simulated gave the images shown in fig. 4.7



(a) Input image

(b) Detected iris and pupil

(c)Detected eyelids



(d) Input image

(e) Detected iris and pupil

(f) Detected eyelids

Fig. 4.7 Results of eyelids detection. Black lines in (c) and (f) show eyelid's boundaries

4.4 CONCLUSION

The figure thus obtained were represented in this Chapter and the images reflect the simulation done in this project work..

CHAPTER 5

DISCUSSION

DISCUSSION

This thesis discusses a technique for iris localization of images which are not good. Application of Circular Hough Transform gives accurate results to a certain extent with images that show slight eyelid obstructions. But CHT cannot perform well for all kind of non cooperative data. In later parts of thesis a technique for detection of iris is discussed which shows good results with bad images, having some noise or occlusions caused due to eyelids. Linear Hough Transform then detects eyelids in an image. This technique worked well with images taken from UBIRIS database. So far this technique has performed well with the images that were chosen for the simulations of sclera detection, circle detection and line detection algorithms. The motive of this project was to improve or modify the discussed technique but due to time constraints we could not do it. The technique discussed in Chapter 3 can be extended to extract iris region with more accuracy, efficiency and a fast retrieval of data thereby removing various kinds of noise. This can also lead to better iris recognition and improvements in image sensing which is required in many fields like medical applications, military applications, criminal investigations and a lot more.

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