Eyelids, Eyelashes Detection Algorithm and Hough Transform Method for Noise Removal in Iris Recognition

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ABSTRACT
The biometric system is based on human's behavioral and physical characteristics. Among all of these, iris has unique structure, higher accuracy and it can remain stable over a person's life. Iris recognition is the method by which system recognize a person by their unique identical feature found in the eye. Iris recognition technology includes four subsections as, capturing of the iris image, segmentation, extraction of the needed features and matching. This paper is a detail description of eyelids, eyelashes detection technique and Hough transform method applied on iris image.

Generally, eyelids and eyelashes are noise factors in the iris image. To increase the accuracy of the system we must have to remove these factors from the iris image. Eyelashes detection algorithm can be used for detecting eyelids and eyelashes. To improve the overall performance of the iris recognition system, we can use canny edge detection algorithm [12]. Then, Hough Transform can be applied on these images to identify the circles of specific radii and lines on iris image [14].

General Terms
Image Processing, Iris Recognition, Eyelids and Eyelashes Detection Algorithm.

Keywords
Iris, IIT Delhi Iris Database, Noise Removal, Canny Edge Detection, Hough Transform.

1. INTRODUCTION
In recent years, the technology which is based on biometric identification got an instant development. Due to its high reliability, noncontact and some other advantages, iris recognition technology has widely acceptable [7]. Iris recognition is a method of biometric authentication, based on extracted features of the iris of an individual's eyes [1], [7], [4]. Every individual has its unique and stable iris features. Iris recognition technology is based on unique pattern which is found in human eye [2], [3], [5]. Iris can be combination of crypts, corona, filaments, and furrows etc [2], [4], [7], [10]. Iris recognition system is the fastest system as compare to the other biometric recognition system. It is having number of different characteristics. Iris recognition system can be used for authentication purpose.

2. RELATED WORK
Idea of the iris recognition system is very old and it is firstly proposed by Frank. Among the all algorithms, most well-known algorithm is proposed by Daughman [1]. He has produced improved result. M. Monro et al has proposed eyelashes removal method for human iris recognition [5]. Criteria based eyelashes detection model for Iris Segmentation is proposed by Wai-Kin Kong et al [6]. B. Kang et al proposed method of robust eyelashes detection based on iris focus assessment [11]. Many researchers also concentrate on the accuracy of the iris recognition system [1], [3], [5]. Also many of them focused on the iris feature extraction and recognition systems. Noise factors affect the accuracy of the iris recognition system, so recently many researchers doing work on the noise removing techniques for iris image [2].

3. OUTLINE OF WORK
An Iris recognition system uses a small and high-quality gray scale camera to capture an image of the iris. Then it uses eyelid, eyelashes detection algorithm to detect the eyelids and eyelashes in the iris image. Eyelids and eyelashes are the noise factors in the iris image. And we must have to remove these noise factors from the iris image. For this Canny edge detection technique can be used [12]. To detect the pupil and boundaries in the iris image, we can use Hough transform method. Hough transforms method works on the basis of parametric equations [14], [15]. Hough Transform method can find geometric shapes such as circles, or lines within an image [14]. In Fig 1, iris recognition system is made up of number of subsystems. Our paper is based on the first two part of this system i.e. capturing of the iris image and pre-processing.

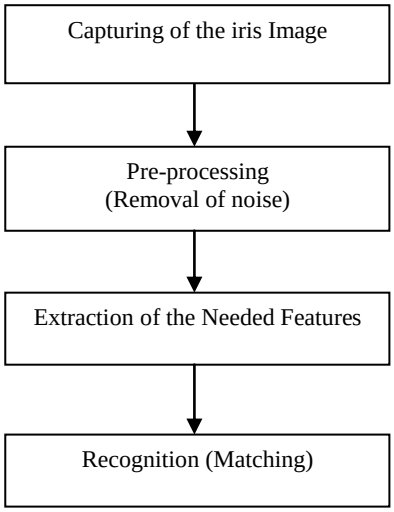

Figure 1: Iris recognition system block diagram [2].

3.1 Image Capturing
The iris image can be taken by a gray-scale camera in specific distance from the camera. [7], [9], [12]. When eye is properly stable then, iris image can be taken from this camera. This camera captures number of images and these images can be used for further use. We used IIT Delhi iris database for this purpose. Numbers of images are available in the IIT Delhi iris database. We have taken number of these iris images for sampling purpose.

3.2 Pre-Processing

Iris image is captured from camera. This iris image may have some amount of noise. This noise can be eyelids, eyelashes, masked regions etc. These noise factors affect the accuracy and speed of the iris recognition system. Due to this noise, performance of the iris recognition system gets reduced. So, we have to remove these noise factors from the iris image. Preprocessing step helps us to remove iris image noise. Though performance of the system depends on this step, it plays important role in the iris recognition system. To remove these noise factors, we have used eyelids, eyelashes detection algorithm and circular, linear Hough transforms on the iris image.

3.3 Feature Extraction

This is also a very important step in iris recognition. This step can be used to get needed features of the iris image. Due to the memory problems, we need more small size iris data. In this step, needed features in the iris input image is chosen. These features can be used for further processing in matching step. With the help of these features, we can match one iris image with other iris image.

3.4 Recognition

Unique iris pattern is already stored in the iris pattern database. In this section, new iris pattern of the same individual is taken and matching of the already stored iris pattern and new iris pattern is takes place with the help of matching algorithm. We have not concentrated on this part in our paper.

4. EYELIDS AND EYELASHES DETECTION ALGORITHM

Eyelids and eyelashes are the noise factors in the iris image. And we must have to remove these noise factors from the iris image. To remove these eyelids and eyelashes from iris image we can use eyelids and eyelashes detection algorithm. This algorithm runs in four stages as follows:

4.1 Image Capturing

We have not captured iris images from the camera. Instead we have used already stored iris images from IIT Delhi iris database. There are two iris database available namely CASIA V1.0 and IIT Delhi Database. Various types of iris images are available in the IIT Delhi database. We used sample iris images from IIT Delhi Database. Iris images are collected from different students of the college. Iris images are captured from CMOS camera. The images of the databases are having same resolution, size and format. Figure 2 shows sample iris image from IIT Delhi iris database.

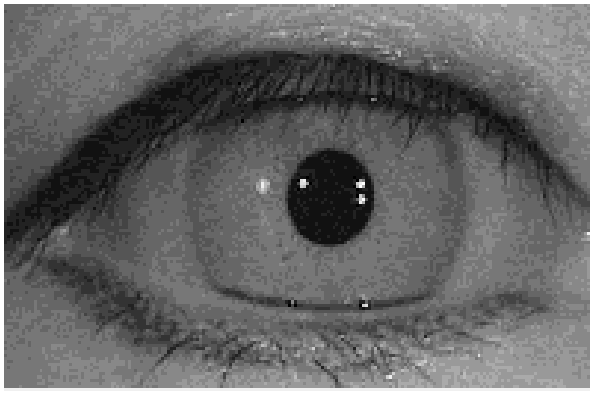

Fig 2: An original Iris image from IIT Delhi Iris Database.

4.2 Edge Detection using Canny Edge Detection Technique

Many techniques are available to detect edges in the iris image. But canny edge detection technique detects edges in perfect and robust manner. So we used canny edge detection technique to detect the edges in the iris image. We have taken iris image with sufficient iris information from IIT Delhi database. We can apply this canny edge detection technique on the sample iris image. Canny edge detection algorithm is proposed by canny [13]. This is very well known and popular edge detection algorithm. Canny edge detection algorithm runs in five stages as follow [13]:

4.2.1 Smoothing [13]

Smoothing is nothing but the blurring of the image. Generally, images taken from camera contain some amount of noise. This noise causes low performance of the system. So, we have to remove this noise. Blurring is the very powerful tool used in smoothing of image. Here, Gaussian filter is used for smoothing of the image. The kernel of a Gaussian filters with a standard deviation of σ = 1.4 is shown in equation (1)

$$B = {}^{1}/_{159}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} \quad \text{-------- (1)}$$

4.2.2 Finding gradient [13]

Gradient is the direction and steepness of that slope. We have to find the edges where the gray scale intensity is most. Sobel operator is a very powerful tool used to determine the gradient in image. Firstly we can approximate the gradient in the x- and y-direction respectively by applying the kernels shown in the Equation (2) and (3).

$$K_{GX} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad \text{-------- (2)}$$

$$K_{GY} = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad \text{-------- (3)}$$

The gradient magnitudes can be determined by a Euclidean distance and it can be measure by the law of Pythagoras as shown in following equation (4).

$$|\text{Gradient Magnitude}| = \sqrt{Gx^2 + Gy^2} \quad \text{----- (4)}$$

The edges should be marked only where the gradients of the image has large magnitudes.

4.2.3 Non maximum suppression [13]

This step converts blurred edges in the image of the gradient to sharp edges. This can be done by selecting all local maxima in the image and suppressing all non-maximums. This step keeps all local maxima which is having high gradient magnitude.

4.2.4 Thresholding [13]

After the non-maximum suppression, thresholding can be applied to iris image. This is used to determine only potential edges. Thresholding is nonlinear operation that converts gray-scale image into binary image. Figure 3 shows thresholding result on iris sample image.

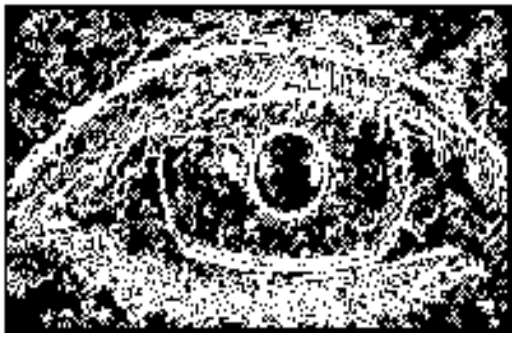

Figure 3: Result of Thresholding.

4.2.5 Edge tracking by using hysteresis [13]

In this step, strong edges can be selected as certain edges and these edges are included as final edges. Here, If any weak edge is connected to strong edge then only it is included. This can be done through BLOB (Binary Large Objects) analysis. Figure 4 shows result of canny edge detection algorithms.

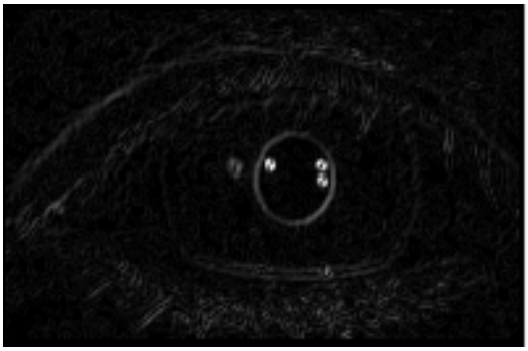

Figure 4: Result of Canny edge detection algorithms.

4.3 Applying Hough Transform

We can find geometric shapes, such as circles, or lines within an image with the help of Hough transform technique [14], [15]. This technique works on the basis of parametric equations [15]. After applying canny edge detection technique, we can get canny edge detected image. Then, the Hough algorithm can be applied to the canny edge detected image. This method is very efficient for the task of finding the iris from an image [14]. Because it works even when noise is present in the image and performs well even when a large amount of the circle is hidden [14].

In this paper, we introduce a detection strategy based on circular Hough transform and linear Hough transform methods. We firstly detect the inner and outer boundaries of the pupil in iris image [14], [15]. Then we have applied linear Hough transform to detect noise factor i.e. eyelids and eyelashes in the iris image [15]. The Standard Hough Transform (SHT) proposed by Duda and Hart (Duda and Hart, 1972) is widely applied for line extraction in natural scenes [14]. Circle and line can be defined in parameter space [15]. So, we have used circle and line for transfer to parameter space.

The equation of the circle is [15]:

$$(x-a)^2 + (y-b)^2 = r^2 \quad \text{-------- (5)}$$

As it can be seen the circle to get three parameter r, a & b, where a & b are the center of the circle in the direction x & y respectively and r is the radius. [15].

The parametric representation of the circle is [15]:

$$x = a + r\cos\theta \quad \text{-------- (6)}$$

$$y = b + r\sin\theta \quad \text{-------- (7)}$$

The equation of the line is [14], [15]:

$$r = x\cos\theta + y\sin\theta \quad \text{-------- (8)}$$

Where,

r = distance between line and the origin

Θ = angle of the vector

Then we can get an n dimensional parameter space (three dimensional spaces for a circle and line) [14], [15]. Figure 5 shows Result after applying Hough Transform to iris image.

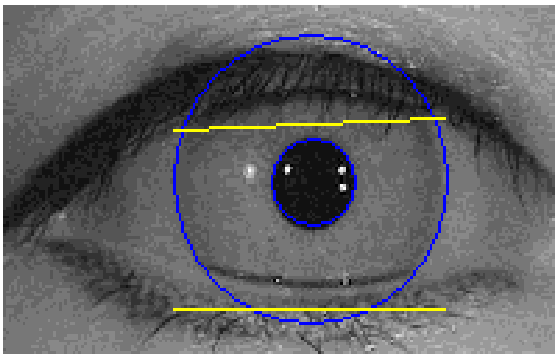

Figure 5: Result of Hough Transform.

4.4 Removal of Noise

Eyelids and Eyelashes are the main noise factor in the iris image. These noise factors can affect the accuracy of the iris recognition system. After applying circular Hough transform to iris, we can get circle detected noise region in the iris image. Then we can apply linear Hough transform and we get line detected noise region in the iris image. We have to remove these detected eyelids and eyelashes from the iris image. Then, the iris image can be available for future use. Figure 6 shows Result of removal of noise from original iris image.

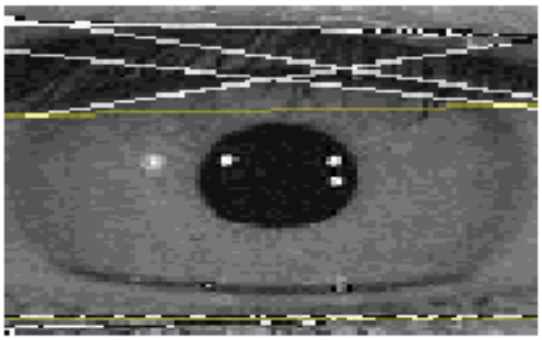

Figure 6: Result of removal of noise from original iris image.

5. RESULTS

In the paper, we have proposed eyelids, eyelashes detection method. All of the iris images are taken from IIT Delhi Iris Database. Our aim is to reduce the noise in iris images. With the help of eyelids and eyelashes detection algorithm, we have removed most of the noise in iris sample images. Circular Hough transforms and linear Hough transform gives better results. Using this technique we can remove most of the noise in the iris image. This will helps in increasing of performance of the iris recognition system.

As shown in figure 7, we have given two iris images namely (a) and (c) as sample images taken from IIT Delhi database. In this figure, (b) and (d) are the results of our proposed eyelid and eyelashes detection algorithm. Result shows, most of the noise in the iris image is removed by this method.

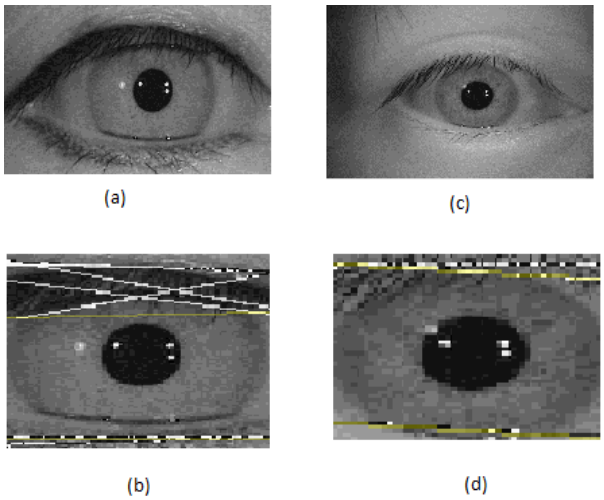

Figure 7: Result of eyelids, eyelashes detection algorithm. (a) And (c) are the original iris images taken from IIT Delhi Iris Database. (b) And (d) are the eyelids, eyelashes detection algorithm result of (a) and (c) respectively.

6. CONCLUSION AND FUTURE SCOPE

Iris recognition is one of the biometric technology and has higher accuracy and greater security. A new approach for iris segmentation is provided in this paper. In this paper, we have discussed on eyelid, eyelashes detection technique and Hough transforms method to remove noise in iris image.

A new eyelid and eyelashes detection method is discussed with reduced noise. Eyelids and eyelashes detection method is more accurate. This system will reduce the time for detecting the inner and outer edges of the iris with the help of linear Hough transform and circular Hough transform.

6.1 Future Scope

Iris recognition system can be used in many applications such as banking, secure access to individual's property and government systems. It provides security and stability to the applications. Generally noise factor in the iris image affect the performance of the iris recognition system. So, by removing these noise factors we can improve the performance of the system.

Further, this work can be enhanced to get real time application of iris recognition system. Processing speed and accuracy can be improved in future.

7. ACKNOWLEDGMENTS

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8. REFERENCE

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