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Hough Transform Method for Iris Recognition-A Biometric Approach

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*Abstract— **Iris recognition is most accurate and reliable biometric identification system available in the current scenario. Iris recognition system captures an image of an individual's eye, the iris in the image is then meant for segmentation and normalized for feature extraction process. The performance of iris recognition systems highly depends on the segmentation process. Segmentation is used for the localization of the correct iris region in an eye and it should be done accurately and correctly to remove the eyelids, eyelashes, reflection and pupil noises present in iris region. In our paper we are using Hough Transform segmentation method for Iris Recognition. Iris images are selected from the CASIA Database, then the iris and pupil boundary are detected from rest of the eye image, removing the noises. The segmented iris region was normalized to minimize the dimensional inconsistencies between iris regions by using Daugman's Rubber Sheet Model. Then for the features of the iris were encoded by convolving the normalized iris region with 1D Log-Gabor filters and phase quantizing the output in order to produce a bit-wise biometric template. The Hamming distance was chosen as a matching metric, which gave the measure of how many bits disagreed between the templates of the iris.***

Index Terms— **Daugman's Rubber Sheet Model, Hough Transform, Iris Recognition, segmentation.**

I. INTRODUCTION

Imagine how convenient it would be to activate the security alarm at your home with the touch of a finger, or to enter your home by just placing your hand on the door handle. How would you like to walk up to a nearby ATM which will scan your iris so you can withdraw money without ever inserting a card or entering a PIN You will basically be able to gain access to everything you are authorized to, by presenting yourself as your identity. This scenario might not be as far off as we might expect. In the near future, we may no longer use passwords and PIN numbers to authenticate ourselves. These methods have proven to be in secure and unsafe time and time again. Technology has introduced a much smarter solution to us: Biometrics. Biometric authentication will help in enhancing the security infrastructure against some of these threats. After all, physical characteristics are not something that can be lost, forgotten or passed from one person to another. They are extremely hard to forge and a would-be criminal would think twice before committing a crime involving biometrics. The concept of Iris Recognition was first proposed by Dr. Frank Burch in 1939.It was first implemented in 1990 when Dr. John Daugman created the algorithms for it. These algorithms employ methods of pattern recognition and some mathematical calculations for iris recognition. Iris recognition is a method of biometric authentication that uses pattern-recognition techniques based on high-resolution images of the irises of an individual's eyes. Iris is a muscle within the eye that regulates the size of pupil, controlling the amount of light that controls the eye.

II. FEATURES OF IRIS

It is the colored portion (brown or blue) of the eye that regulates the size of the pupil. The coloration and structure of two irises is genetically linked but the details of patterns are not. They have stable and distinctive features for personal identification. They are stable with age. Extremely data rich physical structure having large number of features. Its inherent isolation and protection from the external environment. The impossibility of surgically modifying it without unacceptable risk to vision.

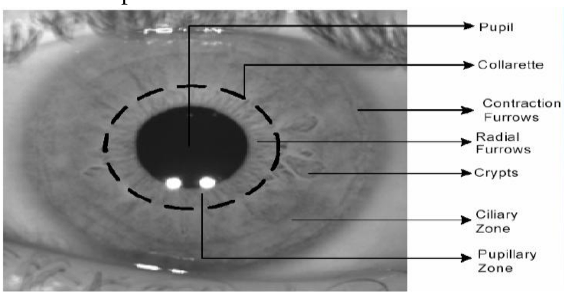

Fig 1.Front View of the Eye.

III. IRIS RECOGNITION SYSTEM

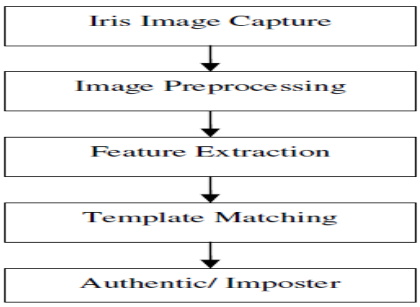

Fig 2 Block Diagram of Stages in Iris Recognition

A. Image Acquisition

It deals with capturing of a high quality image of the iris. Concerns on the image acquisition rigs, Obtain images with sufficient resolution and sharpness. Good contrast in the iris pattern with proper illumination. Well centered without unduly constraining the operator. Distance up to 3 meter. Near-infrared camera or LED

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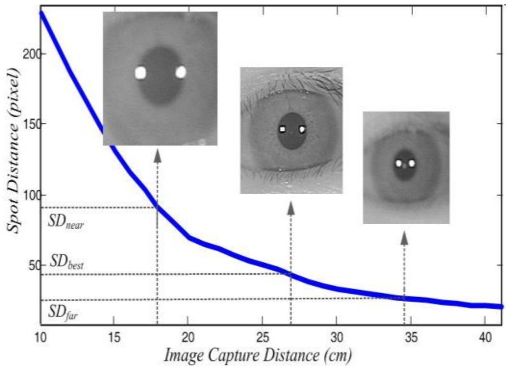

Fig 3: Graph Showing Proper Capture Of Image.

B. Iris Localization

Iris localization is a process to isolate the iris region from the rest of the acquired image. Iris can be approximated by two circles, one for iris/sclera boundary and another for iris/pupil boundary.

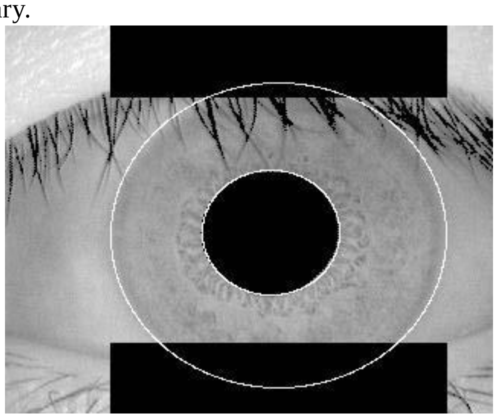

Fig 4: Localization of iris and pupil boundary.

C. Feature Extraction

Feature encoding was implemented by convolving the normalized iris pattern with 1D Log-Gaber wavelet.2D normalized patterns are broken up into a number of 1D signal. Each row corresponds to a circular ring on the iris region. The angular direction is taken rather than the radial one, which corresponds to columns of normalized pattern. The features are extracted in codes of 0 and 1.

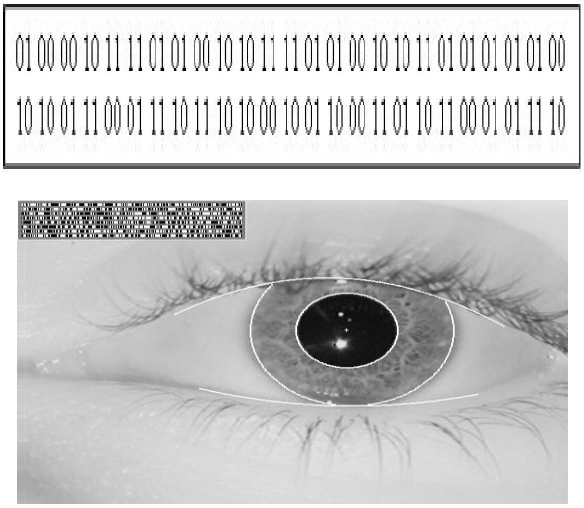

Fig 5: Extraction of Features of Iris in Form of Codes

D. Template Matching

For matching, the Hamming distance was chosen as a metric for recognition. The result of this computation is then used as the goodness of match, with smaller values indicating better matches. If two patterns are derived from same iris, the hamming distance between them will be close to 0 due to high correlation.

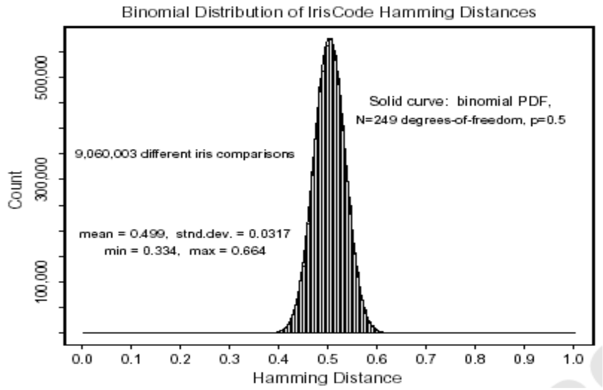

Fig 6: Binomial Distribution of iris code Hamming Distances

IV. DATABASE (CASIA-CHINESE ACADEMY OF SCIENCES INSTITUTE OF AUTOMATION)

The Chinese Academy of Sciences - Institute of Automation (CASIA) eye image database contains 756 grayscale eye images with 108 unique eyes or classes and 7 different images of each unique eye. Images from each class are taken from two sessions with one month interval between sessions. The images were captured especially for iris recognition research using specialized digital optics developed by the National Laboratory of Pattern Recognition, China. The eye images are mainly from persons of Asian descent, whose eyes are characterized by irises that are densely pigmented, and with dark eyelashes. Due to specialized imaging conditions using near infra-red light, features in the iris region are highly visible and there is good contrast between pupil, iris and sclera regions.

V. METHODOLOGY

A. Segmentation

1. Hough Transform

The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes. Firstly, an edge map is generated by calculating the first derivatives of intensity values in an eye image and then threshold the result. From the edge map, votes are cast in Hough space for the parameters of circles passing through each edge point. These parameters are the centre coordinates x_c and y_c, and the

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radius *r*, which are able to define any circle according to the equation. A maximum point in the Hough space will correspond to the radius and centre coordinates of the circle best defined by the edge points. Wildes et al. and Kong and Zhang also make use of the parabolic Hough transform to detect the eyelids, approximating the upper and lower eyelids with parabolic arcs, which are represented as to performing the preceding edge detection step, Wildes et al. bias the derivatives in the horizontal direction for detecting the eyelids, and in the vertical direction for detecting the outer circular boundary of the iris. The motivation for this is that the eyelids are usually horizontally aligned, and also the eyelid edge map will corrupt the circular iris boundary edge map if using all gradient data. Taking only the vertical gradients for locating the iris boundary will reduce influence of the eyelids when performing circular Hough transform, and not all of the edge pixels defining the circle are required for successful localization. Not only does this make circle localization more accurate, it also makes it more efficient, since there are less edge points to cast votes in the Hough space.

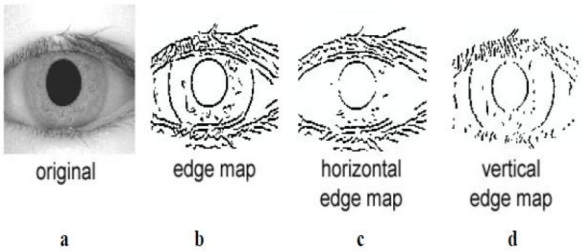

Fig 7: Showing the Edge Map Formation

There are a number of problems with the Hough transform method. First of all, it requires threshold values to be chosen for edge detection, and this may result in critical edge points being removed, resulting in failure to detect circles/arcs. Secondly, the Hough transform is computationally intensive due to its 'brute-force' approach, and thus may not be suitable for real time applications.

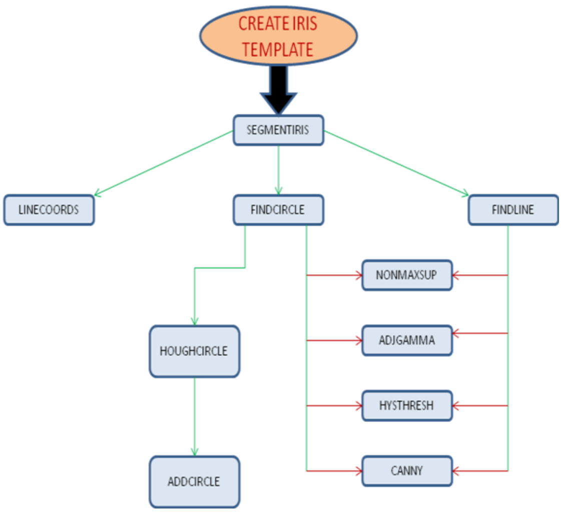

Fig 8: Flow diagram of Hough Transform

SEGMENTIRIS- Performs automatic segmentation of the iris region from an eye image. Also isolates noise areas such as occluding eyelids and eyelashes. **FINDCIRCLE** - Returns the coordinates of a circle in an image using the Hough transform and Canny edge detection to create the edge map. **LINECOORDS** - Returns the x y coordinates of positions along a line. **FINDLINE** - Returns the coordinates of a line in an image using the linear Hough transform and Canny edge detection to create the edge map. **HOUGHCIRCLE** - Takes an edge map image, and performs the Hough transform for finding circles in the image.

ADDCIRCLE - A circle generator for adding (drawing) weights into a Hough accumulator array. **NONMAXUP** - Function for performing non-maxima suppression on an image using an orientation image. It is assumed that the orientation image gives feature normal orientation angles in degrees (0-180). **AJDGAMMA** – Adjust image gamma. Image gamma value in the range 0-1 enhance contrast of bright regions, values > 1 enhance contrast in dark regions. **HYSTHRESH** - Function performs hysteresis threshold of an image.

CANNY - Function to perform canny edge detection.

B. Upper and Lower Eyelid Detection

Similar to iris outer boundary localization, the proposed method selects two search regions to detect upper and lower eyelids. The upper and lower search regions are labeled as in Figure. The pupil centre, iris inner and outer boundaries are used as reference to select the two search regions. The search regions are confined within the inner and outer boundaries of the iris. The width of the two search regions is same with diameter of the pupil. Sobel edge detection is applied to the search regions to detect the eyelids. In order to reduce the false edges detection caused by eyelashes, Sobel kernel is tuned to the horizontal direction.

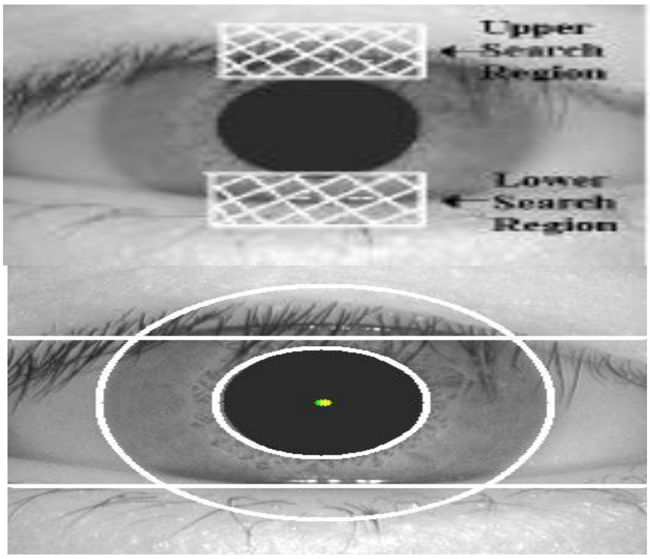

Fig 9 (A) Upper and Lower Search Regions of the Iris Image. (B) Upper and Lower Eyelids Detection.

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After edge detection step, the edge image is generated. The eyelids are detected using linear Hough Transform method. The method calculates total number of edge points in every horizontal row inside the search regions. The horizontal row with maximum number of edge points is selected as eyelid boundary. If the maximum number of edge points is less than a predefined threshold, it is assumed that eyelid is not present in the search regions. The eyelids detection process is illustrated in Figure. In the proposed method, the eyelid boundaries are approximately modeled as straight lines. Edge detection cannot identify all pixels along the eyelid boundaries. The eyelid boundaries are normally occluded by the eyelashes. Therefore, eyelid boundaries are modeled with straight lines approximation.

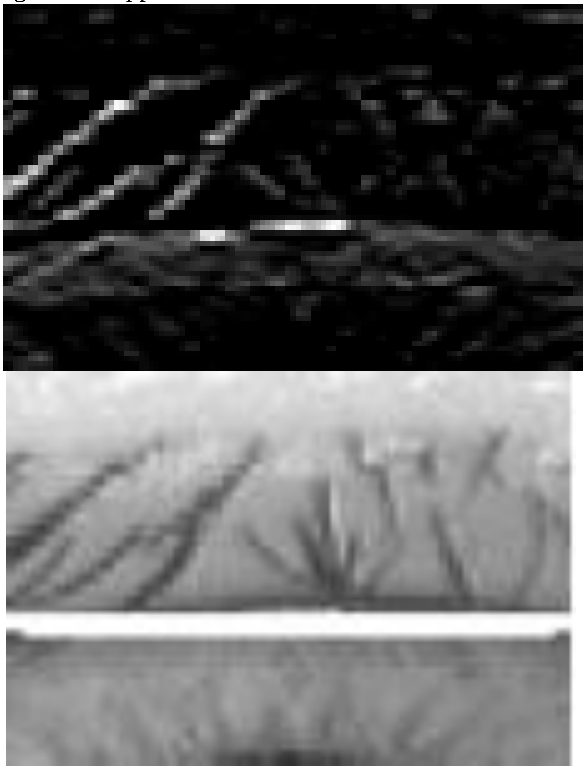

Fig 10: Removal of Eyelid Noises

C. Normalization:-

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket. The normalisation process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location. Another point of note is that the pupil region is not always concentric within the iris region, and is usually slightly nasal. This must be taken into account if trying to normalise the 'doughnut' shaped iris region to have constant radius. Some methods of normalisation are discussed below.

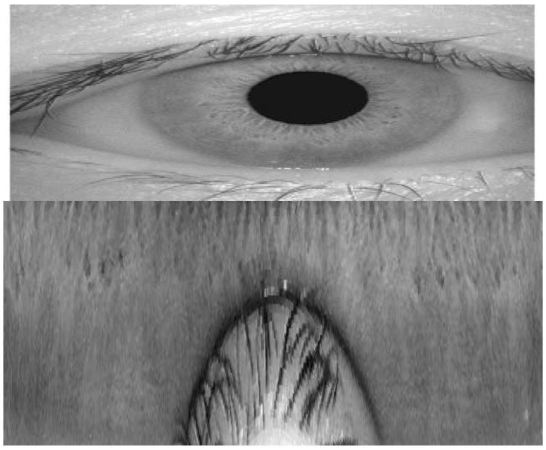

Fig 11 (a): Input eye image (b): Normalised eye image

VI. RESULTS & DISCUSSION

The automatic segmentation model using Hough transform proved to be successful. The CASIA database provided good segmentation, since those eye images had been taken specifically for iris recognition research and boundaries of iris pupil and sclera were clearly distinguished. For the CASIA database, the Hough transform based segmentation technique managed to correctly segment the iris region from 3 out of 4 eye images, which corresponds to a success rate of around 83% as compared to the Hough transform based segmentation technique that managed to correctly segment the iris region from 3 out of 4 eye images, which corresponds to a success rate of around 87%. Using Hough transforms methods on locating the pupil and limbus assumes that the boundaries are perfect circles. Although the approaches are different, all these methods consider pupil and limbus as circular curves. It has been noticed that the circular assumption of the contours can lead to inappropriate boundary detection. The above method of segmentation resulted in false detection due to noises such as strong boundaries of upper and lower eyelids. The strong eyelid boundaries and presence of eyelashes affected the limbus localization significantly. We also implemented eyelashes and eyelids detection for the above two methods. The eyelid detection system proved quite successful, and managed to isolate most occluding eyelid regions. One problem was that it would sometimes isolate too much of the iris region which could make the recognition process les accurate, since there is less iris information. However, this is preferred over including too much of the iris region, if there is a high chance it would also include undetected eyelash and eyelid regions The eyelash detection system implemented for the CASIA database also proved to be successful in isolating most of the eyelashes occurring within the iris region as shown in. A slight problem was that areas where the eyelashes were light, such as at the tips were not detected. However, these undetected areas were small when compared with the size of the iris region.

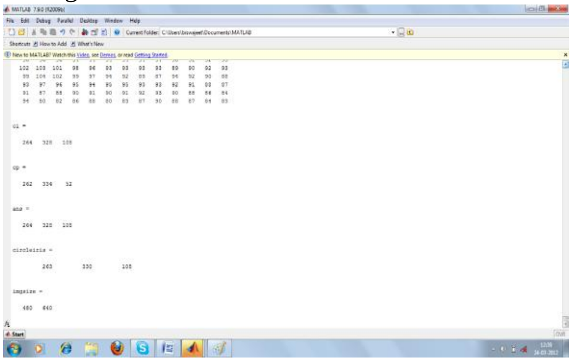

Fig 12: Output Displayed in command window

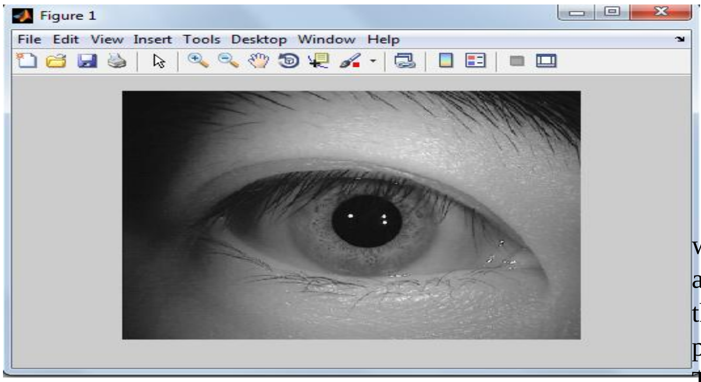

Fig 13: Input Image taken from Database

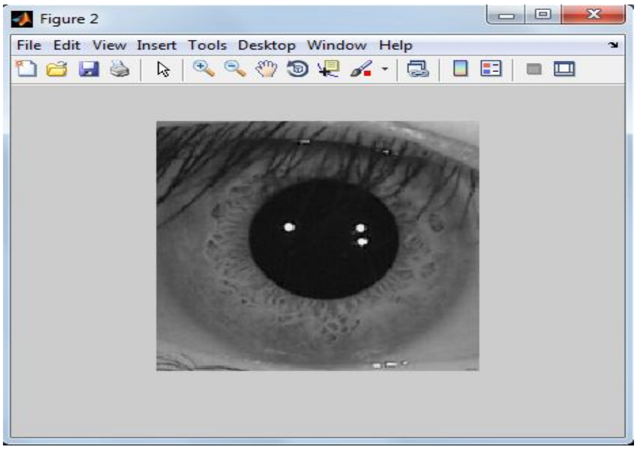

Fig 14: Resized image of the original iris image

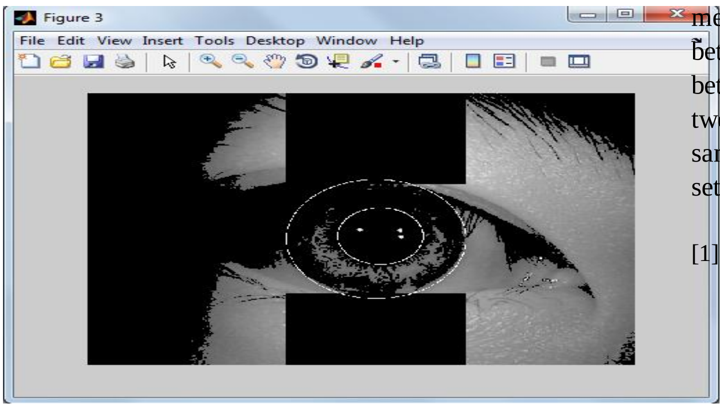

Fig 15: Presence of Noise in the eye

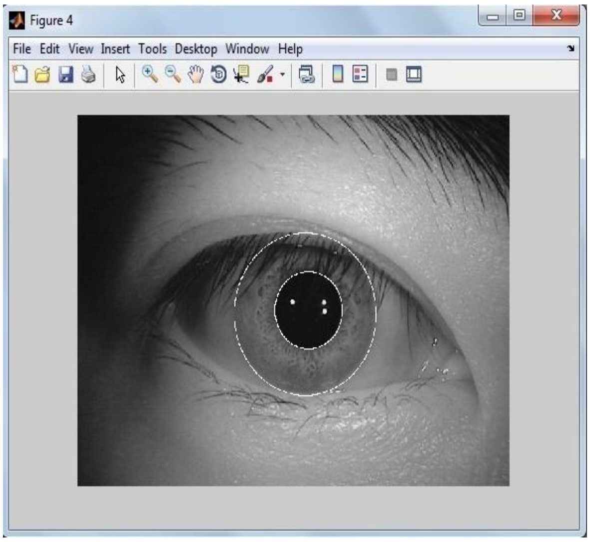

Fig 16: Circle showing the Segmented Iris and Pupil region

VII. CONCLUSION

This paper has presented an iris recognition system, in which Hough Transform segmentation stage is based on accuracy and higher efficiency rate. Hough was found to be the better method for the segmentation process. So the entire process of iris recognition was carried out using Hough Transform. Properly detecting the inner and outer boundaries of iris texture is important for all iris recognition systems. An automatic segmentation algorithm was presented, which would localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas. Threshold was also employed for isolating eyelashes and reflections of the image. Next, using Hough Transform the segmented iris region was normalized to eliminate the present dimensional inconsistencies between iris regions. This was achieved by implementing a version of Daugman's Rubber Sheet Model, where the iris is modeled as a flexible rubber sheet, which is unwrapped into a rectangular block with constant polar dimensions within the given region. Finally, features of the iris were encoded by convolving the normalized iris region with 1D Log-Gabor filters and phase quantizing the output in order to produce a bit-wise biometric template. The Hamming distance was chosen as a matching metric, which gave a measure of how many bits disagreed between two templates. A failure of statistical independence between two templates would result in a match, that is, the two templates were deemed to have been generated from the same iris if the Hamming distance produced was lower than a set Hamming distance.

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