# IRIS SEGMENTATION AND RECOGNITION FOR HUMAN IDENTIFICATION

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***Abstract*: Iris based authentication system is a pattern recognition technique that makes the use of iris patterns, which are statistically unique. The richness and apparent stability of the iris texture make it a robust biometric trait for personal authentication. Iris is a unique part which does not change with respect to time and also every individual has unique and different pattern of iris for both the eyes. This helps to identify the person very accurately. This paper presents a survey of iris recognition systems that had been developed in literatures. Iris segmentation is very important for iris recognition system. If the iris region is not properly segmented, there would possibly exist noises in the segmented regions, which will result in poor recognition performance**.

***Index Terms:* Biometric, Iris, Iris Recognition, Iris Segmentation, Noise**

## I. INTRODUCTION

Popular biometric approaches with physiological characters like face, fingerprint, palm print, iris, retina, and voice. Among these approaches, the iris has some advantages over the others and has received a lot of attention in the last two decades. The human iris, an annular region located around the pupil and covered by the cornea, can provide independent and unique information of a person. The Iris Pattern is so unique that, no two persons can have the same Iris structure, not even the same person's two eyes have the same structure of iris. As an internal organ, iris is well protected from the external environment. Furthermore, the iris is highly stable with age, and it is difficult to fake the iris under the protection of the cornea. The main objective of this analysis is to implement a system that can identify fake identification and deal with noisy images. Iris recognition is the extraction of iris from an image of eye. Iris segmentation is the main method in iris recognition system. The iris recognition method uses either a colour, black and white, or infrared camera to take images. The quality of the acquired images is a major factor in the success of the iris recognition.

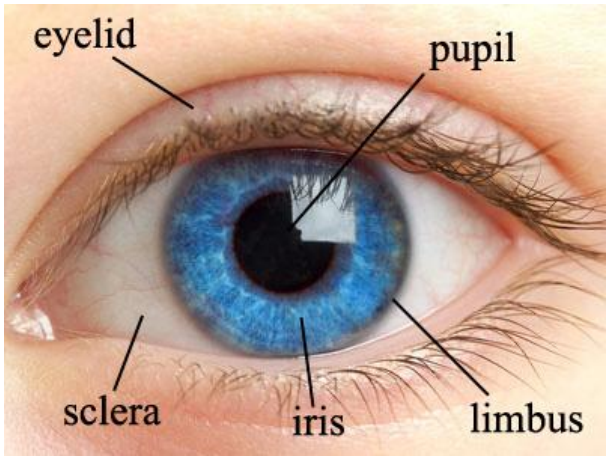



Figure 1: Eye Image

### 1.1. Iris Recognition Procedure

Fig-2 shows block diagram for a biometric system of iris recognition in unconstrained environments in which each block's function is briefly discussed below:

1. Image acquisition: in this stage, a photo is taken from iris.
2. Pre-processing: edge detection, contrast adjustment and multiplier is done in this stage.
3. Segmentation: localization of iris inner and outer boundaries and localization of boundary between iris and eyelids are done in segmentation.
4. Normalization: transformation from polar to Cartesian coordinates and normalization of iris image.
5. Feature extraction: noise removal from iris image and generating iris code.
6. Classification and matching: comparing and matching of iris code with the codes already saved in database.

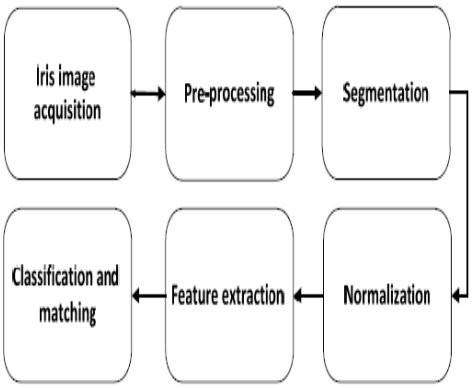



Figure 2: Block Diagram of an iris recognition system

## II. IMAGE ACQUISITION

Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. There are various databases which are available for verification of performance of iris recognition system. CASIA is the most widely used iris database which have different versions up to 4. The other one is MMU: Images from this database have few noise factors and their characteristics are also very identical.

Another database which can be used is BATH: images from this database are quite similar to the images of MMU. They have similar characteristics and few noise factors, almost exclusively related with small eyelid or eyelashes obstructions.

## III. IMAGE PRE-PROCESSING

Initially, in order to improve later processing, a primary processing is performed on iris images. Pre-processing basically include different edge detection techniques. This step also consists of localizing the iris from an iris image. The obtained image has to be pre-processed to detect the iris, which is an annular portion between the pupil and sclera. Comparison of Edge Detection Operator is shown below:

| **Operator** | **Advantages** | **Disadvantages** |
|---|---|---|
| Classical (Sobel, Prewitt, Kirsch) | Simplicity, Detection of edges and their orientations | Sensitivity to noise, Inaccurate |
| Zero Crossing(Laplacian, Second directional derivative) | Detection of edges and their orientation. Having fixed characteristics in all directions | Responding to some of the existing edges, Sensitivity to noise |
| Laplacian of Gaussian(LoG)(Marr-Hildreth) | Finding the correct places of edges, Testing wider area around the pixel | Malfunctioning at the corners, curves and where the gray level intensity function varies. Not finding the orientation of edge because of using the Laplacian filter |
| Guassian(Canny, Shen-Castan) | Using probability for finding error rate, Localization and response. Improving signal to noise ratio, Better detection in specially in noise conditions | Complex Computations, Time consuming |

Canny's edge detection algorithm is computationally more expensive compared to Sobel, Prewitt and Robert's operator. However, the Canny's edge detection algorithm performs better than all these operators under almost all scenarios. Results after image acquisition and pre-processing are shown in Figure 3.

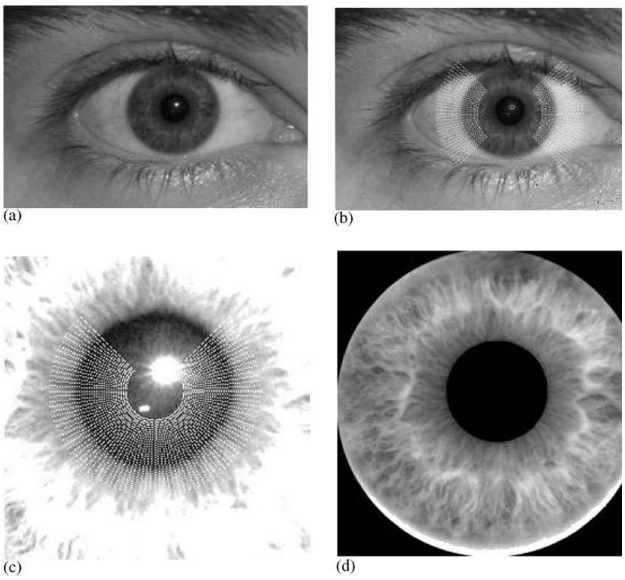



Figure 3: Image acquisition and preprocessing (a) Photograph taken; (b) Outer boundary detection; (c) Inner boundary detection; (d) Isolated iris image

## IV. IMAGE SEGMENTATION

Accurate iris image segmentation plays an important role in an iris recognition system since success of the system in next stages is directly dependent on the precision of segmentation stage. The main purpose of iris segmentation stage is to localize the valid part of iris for iris biometrics, including finding the papillary and limbic boundaries of the iris, localizing its upper and lower eyelids if they occlude and detecting occlusion of eyelashes, shadows or reflections. Different iris segmentation techniques are shown below.

### 4.1. Iris Segmentation using Daugman's method:

Daugman presented the first approach to compute iris recognition, including iris localization. An integro-differential operator is proposed for locating the inner and outer boundaries of an iris. The operator assumes that pupil and limbus are circular contours and performs as a circular edge detector. Detecting the upper and lower eyelids is also performed using the Integro-differential operator by adjusting the contour search from circular to a designed accurate. But, from this method we cannot judge whether pupil and eyelash noises are considered in his method or not.

### 4.2. Iris Segmentation using Localization:

In this method, segmentation stage includes three following steps:

1. Localization of iris inner boundary (the boundary between pupil and iris).
2. Localization of iris outer boundary (the limbic border between sclera and iris).
3. Localization of boundary between eyelids and iris.

Figure 4 shows block diagram of segmentation.

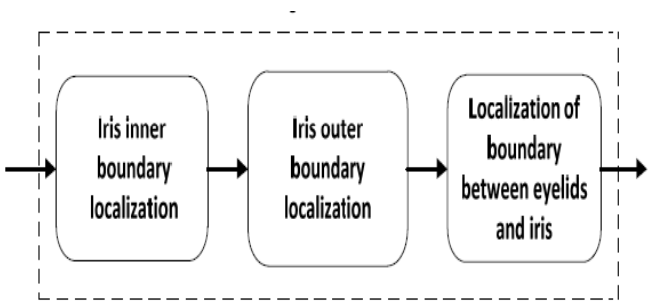


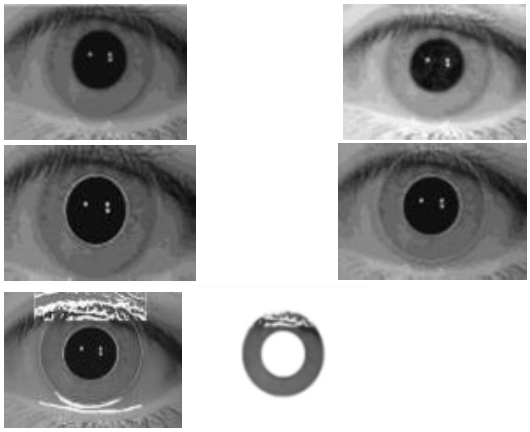

Figure 4: Block Diagram of Segmentation Stage

### 4.3. Iris Segmentation using Gaussian Filter:

Gaussian filter is used to smooth the image and it is also used for the noise removal. The one-dimensional Gaussian filter has an impulse response given by,

$$g(x) = \frac{1}{\sqrt{2\pi}\cdot\sigma}\cdot e^{-\frac{x^2}{2\sigma^2}} \quad \text{..... (1)}$$

Where, σ is the standard deviation of the distribution. For example, figure which is shown below represents the segmentation method of human eye with the use of Gaussian Filter. It represents a flow of the process which was proposed in the order: (a) Original eye image; (b) Gaussian filtering; (c) Pupil detection; (d) Limbic Boundary localization; (e) Eyelids and Eyelashes detection and (f) Segmented iris image.



(a) (b) (c)
(d) (e) (f)

Figure 5: Flowchart of iris image segmentation

4.4. Iris Segmentation using Wildes's method:

Wildes used edge detection and Hough transform to localize the iris. Edge detector is applied to a grey scale iris image to generate the edge map. Gaussian filter is applied to smooth the image and to select the proper scale of edge analysis. The voting procedure is realized using Hough transform in order to search for the desired contour from the edge map. The center co-ordinate and radius of the circle with maximum number of edge points is defined as the contour of interest. For eyelids detection, the contour is defined using parabolic curve parameter instead of the circle parameter.

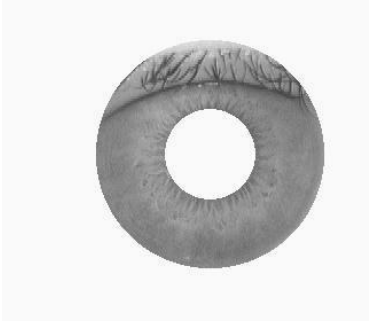
Original Edge map Horizontal Vertical

edge map edge map

Figure 6 : Hough Transform

## V. IRIS NORMALIZATION

In image processing, normalization is a process that changes the range of pixel intensity values. Normalization is sometimes called contrast stretching or histogram stretching. Normalization method generally converts colored images into gray level images in order to save computational cost and storage memory. Figure 7 shows transforming iris area from polar to Cartesian coordinates. Therefore, iris area is obtained as a normalized strip.



(a)

(b)

Figure 7: Normalization (a) Polar arrangement of Iris (b) Normalized arrangement of Iris

## VI. FEATURE EXTRACTION AND MATCHING

Feature extraction is generally considered the most important step for any recognition system. As many researchers used wavelet transform for feature extraction. But, Curvelets transform is an extension of wavelength transform which is very popular in image processing and scientific computing. Curvelets Transform returns on average 28000 co-efficient and we cannot pass such a large number of features directly to the classifier because of two reasons; 1) due to such a large number of features, classification time and memory consumption will be increased. Many of the classifiers may not support such a large number of features. 2) Most of the coefficients may not have much diverse information of the image and hence can lead to wrong classification. To avoid these problems, we reduce the dimensionality of the features and choose the best representational features for the images using Principal Component Analysis (PCA).

Classification and matching basically involves comparison and matching of iris code with the codes which are already saved in the database.A matching technique is required to match the template that is generated in the feature encoding process, which gives a measure of similarity between two iris templates. Daugman uses Hamming distance for matching two binary iris templates. Hamming Distance is calculated for different angular shifts and the final distance is the minimum of all calculated distances. Support Vector Machine (SVM) technique is also used for the matching purpose. support vector machines (SVMs) are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick.

## VII. CONCLUSION

In this paper, we study different methods for iris recognition system for human identification. There

are so many applications which use iris recognition method for the authentication purpose like ATM machines, anti-terrorism, National border controls, computer login, etc. This system is developed using six basic modules for iris recognition. We have seen different existing techniques and methods used in each stage. From this paper we can conclude that which technique is best and we can use that for the better performance and accuracy**.**

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