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# Biometric Authentication Using Iris Recognition

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**Abstract:** Biometric is not only used for the security purpose but also it is useful to keep information of person secured as well as for access control. Palm printing, fingerprint, face recognition, lip pattern are several biometric approaches. Behavioral characteristics can also include in the biometric approach such as voice, odour and rhythm. Due to iris recognitions unique features, it become popular among all different types of biometric system. Variation in texture, accurate, unique and stable pattern are some important features of iris recognition. Most important point for iris biometric is that human iris remains unchanged throughout the person's life. This paper is proposed for the implementation of biometric authentication using iris.

**Keywords:** Authentication, Hamming Distance, Feature extraction.

## 1. Introduction

Priority for every person, educational system or any organization is that to keep the security of information to avoid crime or fraud. Nowadays biometric authentication using iris attain a more attention in various fields. Human iris has unique pattern, it contains lots of textural information and it poses high degree of randomness. These are some reasons for why iris recognition becoming more popular than any other biometric approaches. Due to such advantageous properties of biometric authentication using Iris is well grounded and precise for identifying human. Iris is easily captured, internally protected and externally visible organ. There is almost zero possibility of having two persons with exact similar iris. It can be considered as living password because it neither copied nor forgotten.

For the access control in networking area like computer, iris recognition system can be a better solution than other biometric approaches [1]. Iris recognition is firstly introduced by Dr. Frank Burch. Later it was implemented by Dr. John Daugman who developed algorithm for it in 1990.

Iris is the coloured ring around the pupil, normally in black or brown colour but in rare cases it is found in blue and green colour. Iris is circular and thin part in the eye which control size of pupil and amount of light entering in retina. The white part around the Iris is called as sclera. The growth of the iris is started from the third month of gestation and whole structure is formed during the eight months. After the first year of birth, pigmentation and colour if iris is generated.

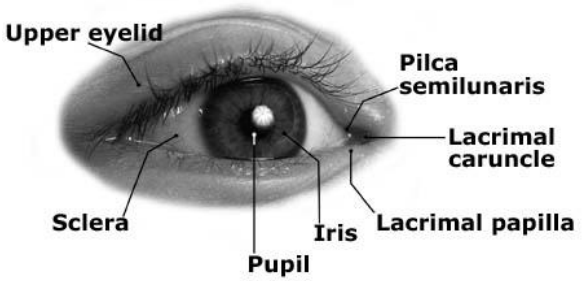



Figure 1: Representation of iris

The human eye remains stable throughout the life, except the surgery or any physical damage. Fingerprint approach can be considered unique application, but iris recognition has more advantages than any other physical biometric approach [2].

## 2. Importance of Biometric

Authentication becomes very important part in this world because of rapidly increasing crime in field of transaction and transportation of products or any tenders. The effectiveness of iris recognition method can increase the security in applications like ATMs, treasure or locker management and used in the other authentication services like Smart attendance system in educational institutes. The following tables compares various biometric approaches based on their security and applications.

Table 1: Various biometric approaches

| **Biometric approach** | **Pattern** | **Mis-identification rate** | **Security** | **Applications** |
|---|---|---|---|---|
| Iris | Iris Pattern | 1/1200000 | Higher | Higher Security |
| Fingerprint | Finger | 1/1000 | Medium | Universal |
| Voice recognition | Voice | 1/30 | Lower | Telephone service |
| Signature | Way of writing, size of letters | 1/10 | Lower | Lower Security |
| Palm | Hand Geometry | 1/700 | Lower | Lower Security |
| Face | Shape of face, nose and eye | 1/100 | Lower | Lower security |

## 3. Database

There are different types of databases for iris recognition are available which are useful in various field of research and educational domain that will helpful for building the Iris recognition system. CASIA, MMU, UPOL, UBIRIS and Bath are some examples of publicly available databases which are publicly available for research as well as in projects.

University of Beira created the UBIRIS database with 241 subjects. There are four version of CASIA Database is available on biometric ideal test. Version 1 has some drawbacks due which they released CASIA version 4 database available on biometric ideal test. IIT Delhi is the Indian Database having 1120 iris images of 224 subjects is also publicly available for research [3].

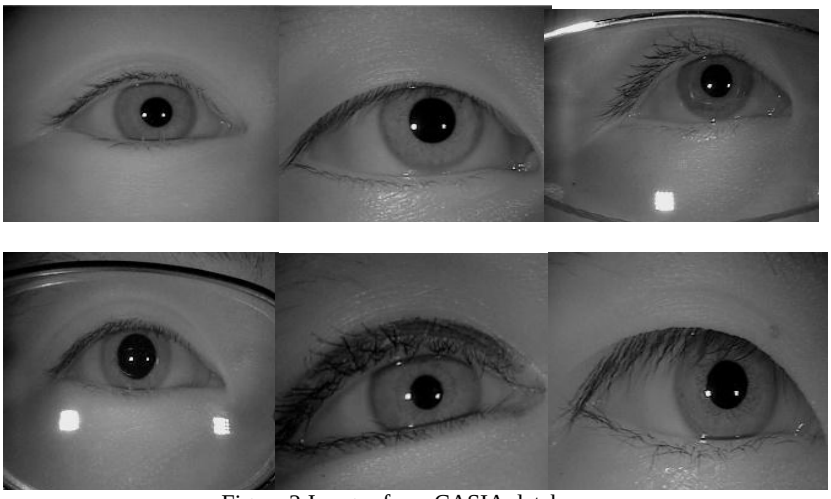


Figure 2:Images from CASIA database.

## 4. Iris Recognition

There are following steps required for iris recognition:

1. Input Image
2. Iris Segmentation
3. Iris Normalization
4. Feature Extraction & Matching
5. Result

### A. Input Image

- All the images are used from CASIA database (Chinese Academy of Sciences). This database contains around 756 images with 640×480 pixels dimensions and jpg (Joint Photographic expert Group) format.

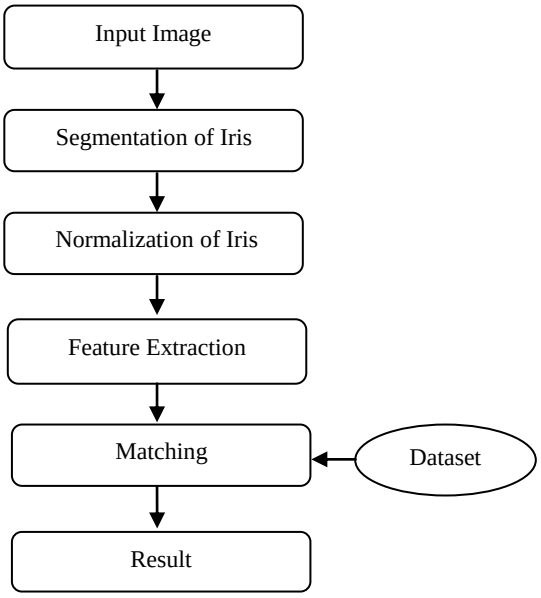


Figure 3: Block diagram

**B. Iris Segmentation**

- Pupil and iris these two circles must be detected in the iris segmentation stage. For getting exact match, proper segmentation and boundary detection is performed to isolate the eyelashes and eyelids in an eye image.
- Because eyelids and eyelashes occlude the lower and upper region of eye. There is another factor which also lead the incorrect detection of iris and pupil boundaries is specular reflection.
- Therefore, it is essential to reduce or remove such artifacts otherwise it will affect the feature extraction stage.

There are some conventional methods for detecting the iris boundary:

**1. Canny Edge Operator:**

It is used as detecting edges of iris in an eye image and has three main performance criteria which is given below

i. Good detection: Marking for all real edges in the image which will give low error rate.
ii. Good Segmentation: Distance between detected edge and real edge should be minimized.
iii. Low response: It should detect single edge and not false edge.

Steps for performing canny edge detector:

a) First smoothen the image for eliminating the noise.
b) Finding and defining the strength and direction of edge.
c) Performing non-maximal suppression.
d) Final step is edge tracking by using hysteresis.

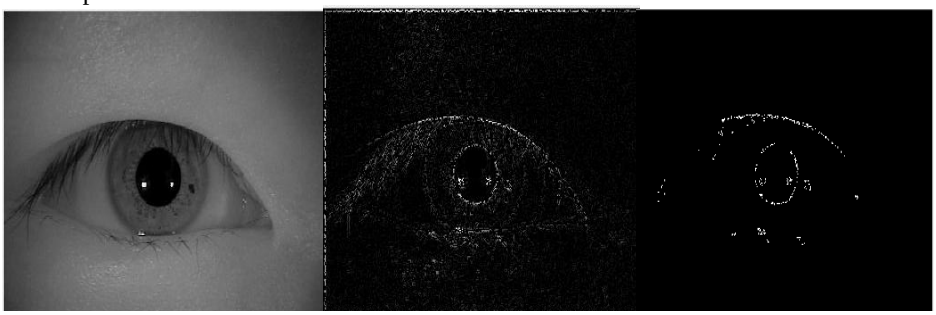
Errors can be calculated by using probability, but it requires some complex computations and false zero crossing [4].

**2. Adaptive Thresholding:**

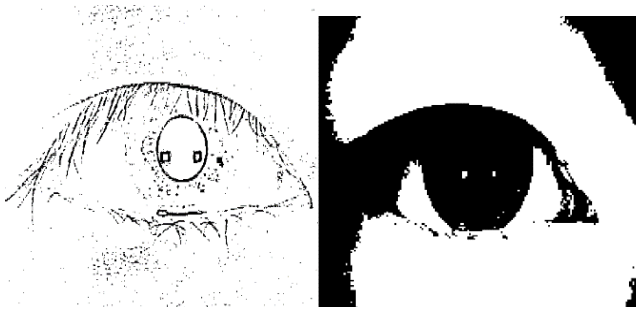
- Thresholding is the basic step in image segmentation in which pixel value is set to foreground if this value is above threshold otherwise it considered as background.
- In the adaptive thresholding process, input image is in the form of gray or RGB image and it gives output a binary image which shows segmentation.
- First threshold value is calculated for the pixels in an image. If these values of pixel are lower than threshold value, then it is considered as background value otherwise it is set to the foreground values.

**3. Ostu's Thresholding:**

- Ostu's thresholding method is the thresholding or reducing gray level to binary image based on the clustering.
- This method has the assumption that the image contains two classes which follows the bimodal histogram; then it calculates the optimal value for the threshold which separates two classes, dueto their combined spread is minimum.



(a) (b) (c)



(d) (e)

Figure 4. a) Input image; b) Non-maximum suppression; c) Result for canny edge detection; d) Image with output of Adaptive threshold; e) Output for Ostu's threshold.

**4. Daugman Method**

- Dr. John Daugman created the Integro Differential Operator (DIO) algorithm for the detecting the Iris and the pupil boundaries, curves of lower and upper eyelids in an eye image.
- Daugman's formula,

$$max_{(r,x0,y0)}|G_r * \frac{\partial}{\partial r}\oint \frac{I(x,y)}{2\pi r}ds| \quad (1)$$

Where $I(x,y)$is an eye image, r indicates radius and G(r) is the Gaussian smoothing function.

- After the smoothening of image, the operator searches for the circular edges iteratively the edges which gives maximum response.
- First, operator finds the circular path which is made by max change inpixel value is from the r, centre x and y position of the contour. Exact location of the eyelids can be attained by varying the x, y and centre position.
- First derivative of the image is used in the DIO for finding the geometric parameters. Due to this thresholding operation is avoided because it has basic raw information [2].
- The algorithm for the iris segmentation, first it segments or detects the pupil and second its egments or detectsiris.

(a) (b) (c)

Figure 5. a) Input Image; b) Pupil Segmentation; c) Iris Segmentation.

**5. Circular Hough Transform:**

- Computer vision contains various standard algorithm out of which hough transform is used to find the geometric parameters in an image.
- Boundaries of the iris and the pupil is detected by the circular hough transform whereas isolation of eyelids and eyelashes is done by the Linear Hough Transform [5].
- First, pre-processing steps including morphology and filtering operation takes place. Then, the outline of an eye is found using Canny edge detector.
- Mathematical form of circle in x, y plane is given below:

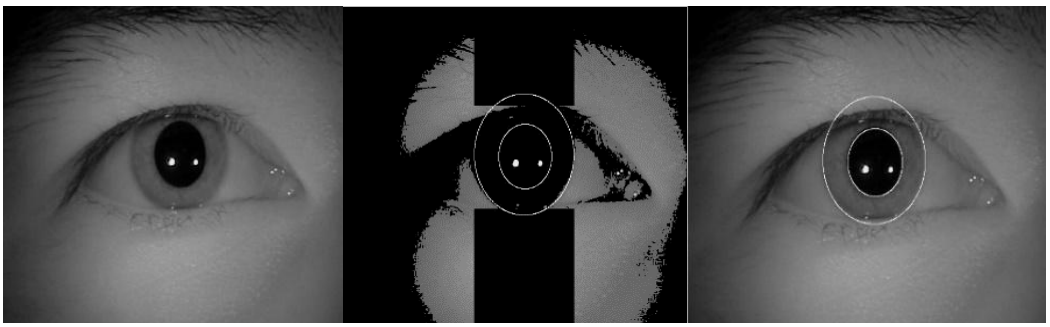
$$(x-a)^2 + (y-b)^2 = r^2 \quad (2)$$

Where a, b is the centre and r is radius of circle.

$$x = a + r\cos\theta \quad (3)$$

$$y = b + r\sin\theta \quad (4)$$

- Above equations represents the parametric form or circle equation. r, a and b are the three parameters of the circle hence the parameter space will be $R^3$[6].



(a) (b) (c)

Figure 6.a) Input image; b) Noise Effect; c) Iris and Pupil Segmentation using Circular Hough Transform.

**C. Iris Normalization**

- Slight movements of the pupil (contraction and relaxation) can vary boundaries of iris. These variations are needs to be minimized before the comparison of various iris images.
- For this purpose, segmented iris image is mapped into a fixed rectangular region. Daugman's Rubber sheet model is used for mapping the segmented iris into a rectangular dimension.
- Normalization is performed by remapping the iris $I(x,y)$,from the rectangular$(x,y)$ to the polar$(r,\theta)$coordinates. The mathematical expression is given below,

$$I\big(x(r,\theta), y(r,\theta)\big) \longrightarrow I(r,\theta) \quad (5)$$

Where θ is an angle with [0,2π] range,r is in between [0,1]. $x(r,\theta)$ and $y(r,\theta)$is the linear combination of pupil and iris boundary points ($x_p$(θ); $y_p$(θ)), ($x_s(\theta)$;$y_s(\theta)$) respectively [7].

$$x(r,\theta) = (1-r)x_p(\theta) + rx_s(\theta) \quad (6)$$

$$y(r,\theta) = (1-r)y_p(\theta) + ry_s(\theta) (7)$$

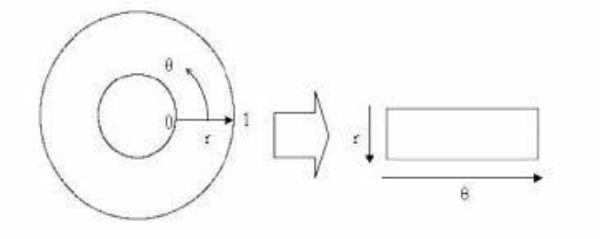
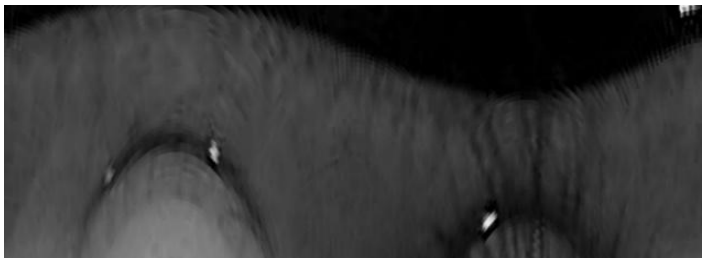



Figure 7. Rubber sheet model

(a)



(b)

Figure 8. a) Input image from Database; b) Iris Normalization Using Rubber sheet model.

**D. Feature Extraction**

- In feature extraction stage templates are created which represents the iris pattern information is useful for future matching step.
- The two different images having the difference in lightening in an image causes the error at the time of direct comparison based on the pixel intensity of two iris images [8].
- To avoid such problem, template is produced in feature extraction which contain special feature of an iris.
- For making the comparison between the templates, only significant features are encoded. Such extracted features are in form of 0's and 1's.

(a) (b)

Figure 9. a) Iris Pattern;b) Noise Mask.

**E. Matching**

- Evaluation of the similarity between the two iris representation is the aim of matching. Templates which are created in the feature extraction stage are compared with the help of Hamming distance or Euclidean Distance.
- Hamming distance represents similarity between two-bit patterns.
- Result of matching can be displayed based on, whether the generated iris pattern is from the database images or not. This can be decided by Hamming Distance of corresponding bit pattern.
- Hamming Distance is obtained by,

$$HD = \frac{1}{N}\sum_{j-1}^{N} x_j\,(xor)\,y_j \qquad (8)$$

where N is the total no. of bits.

## 5. Proposed System

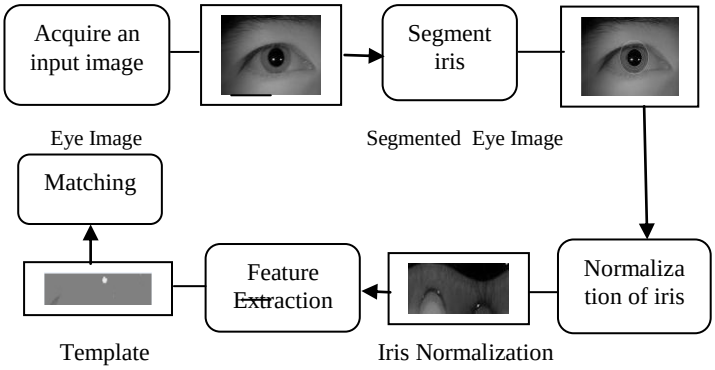



Figure 10. Overview of the proposed system

## 6. Result

- The images which are taken from CASIA dataset provides good segmentation result by using the circular hough transform method.
- Due to proper result of segmentation, the implementation of the next stages becomes easier and accurate. The extracted features are further used for comparison and matching.
- Hamming distance is the metric which was chosen for iris recognition. Hamming Distances of all the iris images from database are calculated and saved.
- Output of the presented method is shown in Figure 10 and Figure 11 which indicates two cases first is match found with respective image number and second is match not found.

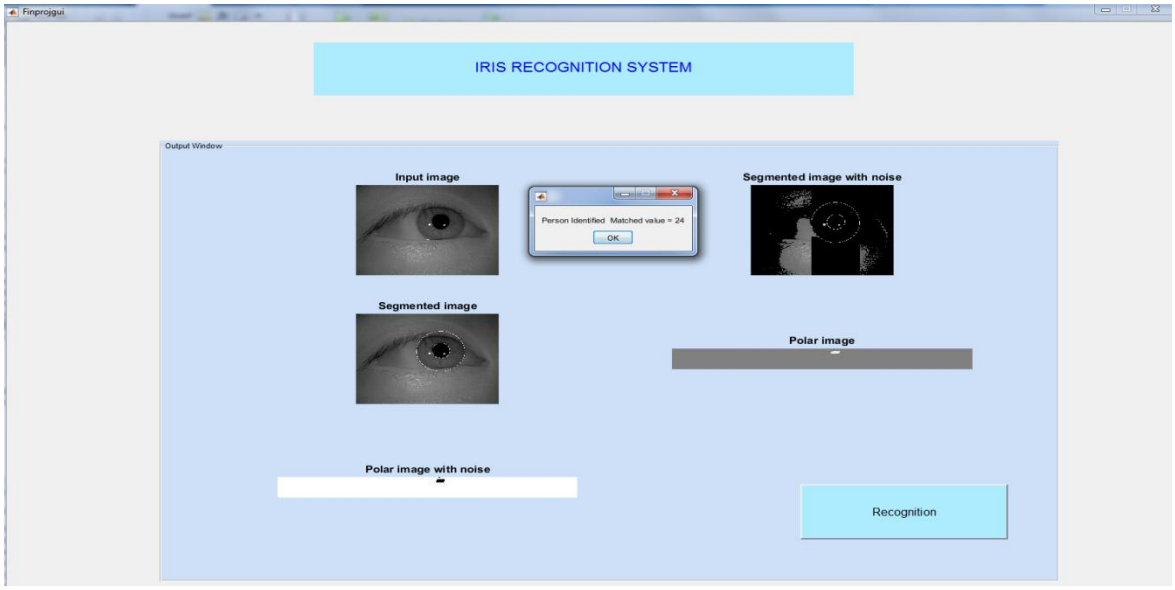



Figure 11. Result with first case matched value is 24.

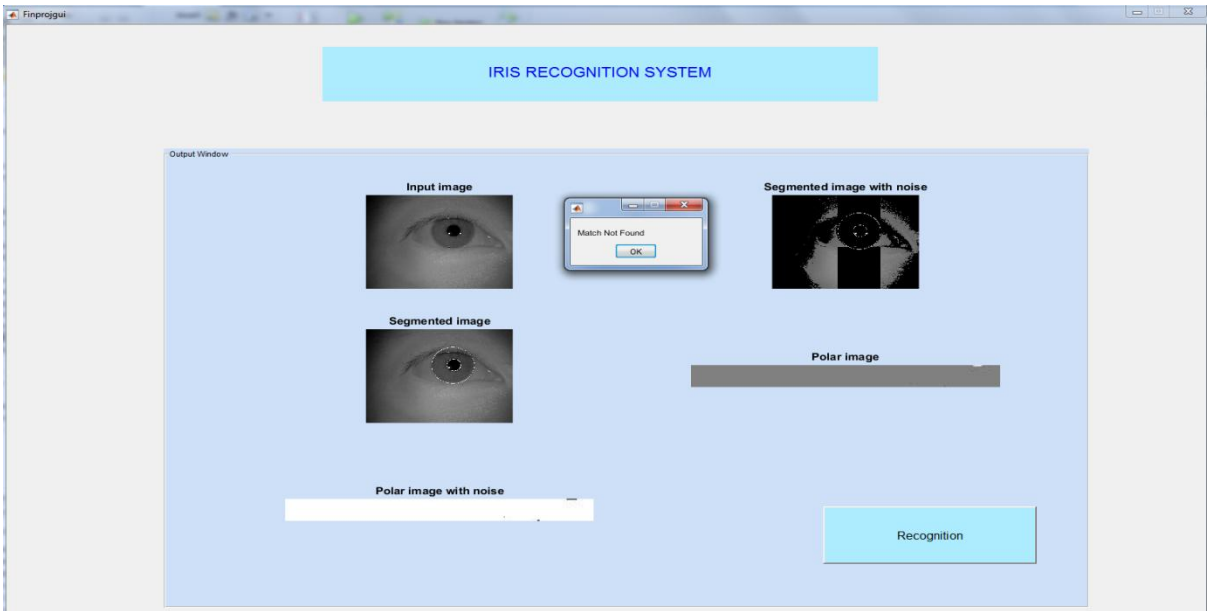



Figure 12. Result with match not found case.

## 7. Applications of Biometric

- Automic teller machine (ATM) is widely used in daily life. Iris recognition can be useful in the such wide field. PIN which is used for withdrawing the money can be stolen or forgotten, also there is possibility to lose the ATM card. This can be avoided by employing the iris recognition method where there is no need of PIN, card.
- Iris recognition can be an alternative for the regular attendance and can be considered as smart attendance system in organization, educational institutes or universities, company.
- Biometric can be used in airport for the security.
- Computer login, credit card authentication because Iris is internally protected and externally visible. It is like living password cannot be forgotten or copied and it remains stable throughout the age.

## 8. Conclusion

The proposed iris recognition method is tested on CASIA dataset for the evaluation of method. The paper presented iris recognition method in which segmentation is performed using the circular Hough transform because Daugmans method not well suitable for all images present in the dataset. Iris and pupil circle detection is very important part of the biometric authentication. If this are not properly segmented it will affect the overall system. Next part is the normalization for which Rubber sheet model is used. Finally, feature is extracted, and matching is done by using Hamming Distances. Iris recognition can be perfect alternative for the other biometric approaches which is accurate also useful in various field where security is needed.

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