Automatic Localization of Iris Using Region Properties

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Summary

Iris localization is one of the most important step in iris based recognition systems. Iris localization means locating the inner boundary (pupil localization) and outer boundary of iris. Both boundaries of the iris are nearly circular which are surrounded by pupil, sclera, eyelashes and eyelids. In the proposed algorithm inner boundary (Pupil) is localized by using two region properties Eccentricity and Area without using any iterative method. On the other hand the outer boundary of iris is located using Gaussian derivatives. The proposed algorithm is tested on CASIA-1 Iris database. Experimental results show that the proposed method is quite fast efficient and accurate method.

Key words:

*Iris Recognition, Iris Segmentation, Pupil Localization***.**

Introduction

A lot of question arises to a person's identity in variety of forms and in different contexts. Is this person is entitled for using these facilities? Is this person a wanted criminal? Or is this person is allowed to enter here? And the list may goes on and on. But with this discipline of biometrics, we can reduce misrepresentation; fraud etc in all the above listed lists and also in all others disciplines as well. This is why biometric based person identification is getting popular due to its accuracy and high reliability. For this purpose different biometrics are used like, Face recognition, Fingerprint identification, Voice recognition, Signature verification and Iris recognition. Among these biometrics iris is believed to be more foolproof as it can't be artificially copied and also it remains same during a person's life time. Generally an iris recognition system is based on four steps or blocks which are given in Fig1[1].

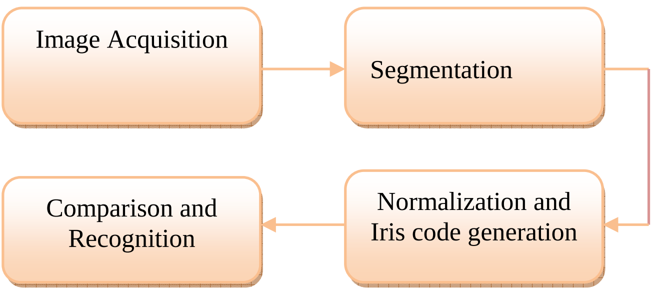

Fig. 1 Major blocks of Iris recognition system

Iris localization is one of the fundamental step of any Iris recognition system, because the speed and accuracy of the system is totally solely depends on the segmented Iris. Segmentation of Iris is normally considered as Iris segmentation is considered as first step in any Iris recognition system [2].

In many machine vision applications, such as Pupil Tracking [3], Iris Recognition, Pupil Size estimation [5], Ocular Torsion Measurement [4], Pupillometry [6] and Point of Gaze Extraction [7] etc. localization of the inner boundary (Pupil Localization) of Iris is consider as the most important preprocessing step. As, performance and accuracy of any pupil based system depend on pupil localization. Thus, it is very important to develop an accurate and fast pupil localization method for these systems.

Pupil is nearly a circular region which is located in the center of the Iris of the eye. The basic function of pupil is to control the amount of light that enters in the eye [8]. Pupil absorbs most of the light that enters inside the eye. Due to this reason it appears black. Most of the algorithms use two methods to locate the pupil region either by finding its edges using circular mask since pupil is nearly a circular region or by using thresholding as it is the darkest region in an eye image.

A circular based algorithm proposed by J. Daughman [9][10][11] is very much popular for iris localization. In it circular edge detector are used for Iris segmentation. Wildes [12] proposed a two stage algorithm. It constructs an edge map based on gradient in stage-1. In stage-2 Hough transform is used for Pupil and Iris are segmentation. Lui et al [13] uses an improve Hough Transform for the segmentation of Pupil and Iris region. A. Basit et al [14] uses adaptively binarization and centroid of the region utilization for pupil localization and for iris localization gradient of pupil's central horizontal line is calculated.

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Tariq et al [15] uses eccentricity based bisection method for pupil localization. Although this method is working well but as it is iterative it is quite slow process which restricts the use of this algorithm for real time applications. Therefore, we present a modified eccentricity based pupil localization method which is locating the true pupil region without using iterations. For outer boundary localization we locate the boundary by observing 10 rows bellow the pupil's central horizontal row by using the Gaussian derivative.

Rest of the paper is organized as. In section 2 the proposed algorithm for inner boundary localization is presented. Section 3 will cover the outer boundary localization. Experimental results are depicted in section 4. Finally section 5 concludes the presented work.

2. Inner boundary (Pupil) Localization

Pupil and iris localization means locating the inner boundary and outer boundary of the Iris. In literature it is found that Different techniques are used to locate the inner and outer boundary of the Iris. Two most commonly used are circular edge detection based techniques and Histogram Based. In Histogram based techniques Pupil is considered as the darkest region in an eye image.

The steps of proposed algorithm for pupil localization are given below:

1. In first step the RGB image is converted to gray level image.
2. As in [15] it is stated that pupil region is normally lies in the range of 20-60 intensity value of gray level so we get a binary image by using thresholding with threshold value = 100, by assigning zero to all gray levels above 100 and 1 to all gray levels bel0w 101.The results of step 2 are shown in Fig. 2
3.

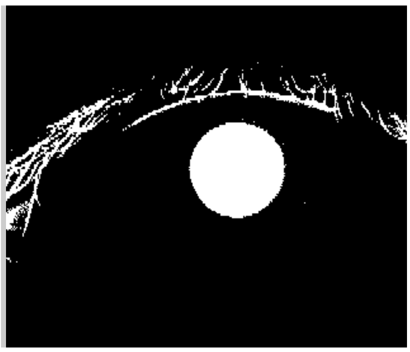

Fig. 2 Binary Image after applying the thresholding

4. Now the binary image contains different regions including the pupil region. In this step we used morphological operators opening and closing for removing some unwanted regions. The results of step 3 are shown in Fig. 3

Fig.3 Resultant image of step 3 after applying the morphological operators on Fig. 2

5. After step 3 we marked all regions by checking the connectivity of regions.
6. Now we find out the eccentricity of all marked regions by suing the following formula.

$$e = \sqrt{\frac{Maj^2 - Min^2}{Min}} \quad 1)$$

Where Maj and Min are the major and minor axis

7. In this step we sort out all the eccentricities and calculate the area of corresponding region. The lowest eccentricity region corresponding to the selected values of area is marked as pupil region. Value of area is selected on experimental basis by finding the area of more than 50 pupil images. Fig.4 shows the extracted pupil region.

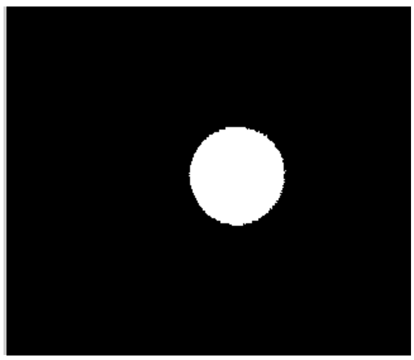

Fig. 4 Lowest Eccentricity Region

8. After locating the true pupil region the next step is to find out the center coordinates and radius of the pupil region.

$$Pupil_R = \frac{\max(y) - \min(y)}{2} \quad 2)$$

$$Pupil_{Cy} = \frac{\max(y) + \min(y)}{2} \quad 3)$$

$$Pupil_{Cx} = \max(x) - Pupil_R \quad 4)$$

Fig.5 shows the localized pupil.

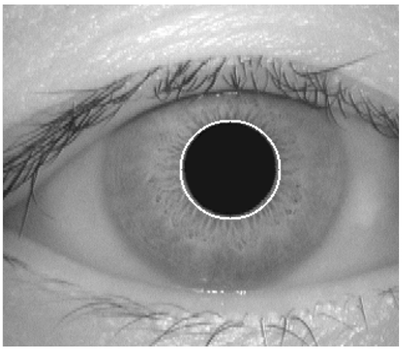

Fig. 5 Localized pupil

3. Outer boundary Localization

From literature it is found that the center of pupil and iris are not concentric. Therefore, we can't assume the center of pupil as the center of iris. We have to locate center of iris separately. For this purpose first we reduced the search space by extracting a region from pupil outer boundary to 3 times the radius of pupil as shown in Fig.6

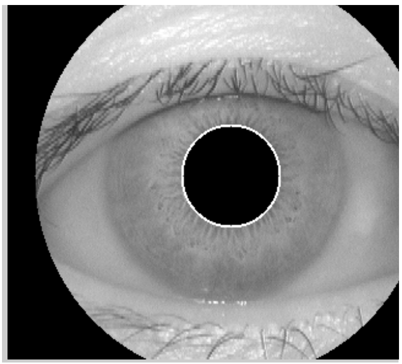

Fig. 6 Minimized region for iris localization

Now we extract the pupil's central horizontal row. Then by applying our proposed peak selection algorithm we find out the edges of outer boundary. The peak selection algorithm is given below:

1. In first step we extract 10 rows starting from pupil's center with the difference of 3. Fig. 7 shows the 10 extracted rows.

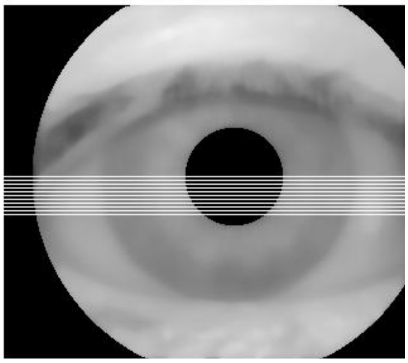

Fig. 7 Extracted Rows

2. Then a Gaussian operator is constructed by using:

$$G = \exp(-\frac{x^2}{2\sigma^2}) \quad 5)$$

Where $x = -\frac{w}{2} : 1 : \frac{w}{2}$ and w is the width here we select the value 5 for w.

3. The Gaussian Derivative is constructed by:

$$G_d = -x.*G \quad 6)$$

4. In this step we normalize the Gaussian derivatives by using the following equations:

$$G = \frac{G}{sum(G)} \quad 7)$$

$$G_d = \frac{G_d}{sum(G_d.*x)} \quad 8)$$

5. The normalized Gaussian derivative is then convolved with the extracted rows.

6. Finally the lowest peak value from the beginning to the mid of Gaussian derivative applied rows and Highest peak from the mid to end are find out. These two peaks represent the starting and ending boundary of iris outer boundary.

7. The distance from these peak points to the center of pupil is calculated and the difference of these distances is found. All rows having difference greater than 10 are neglected. The averaged sum of remaining peak points is calculated and is marked as the starting and ending points of iris outer boundary.

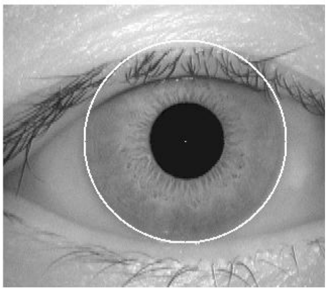

Fig. 8 Localized outer boundary of iris

4. Experimental results

The proposed algorithm is tested on CASIA-1 iris database. In this database there are total 756 images of 108 individuals. Some of the results on CASIA-1 iris database are shown in Fig. 9. The average speed of pupil localization is 0.5 seconds and the accuracy of our proposed algorithm is 97.35%.

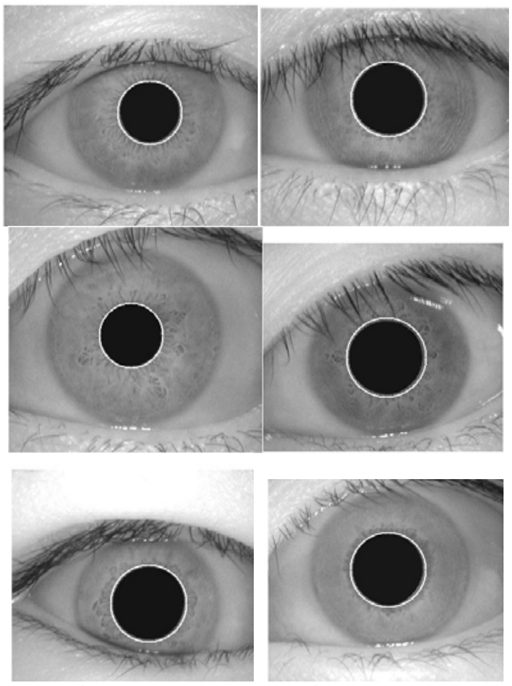

Fig. 9 some of the results on CASIA of proposed pupil localization algorithm

Fig. 10 shows some of the results of CASIA 1 iris database of proposed outer boundary localization algorithm. The average speed of outer boundary localization is 2 seconds and the accuracy is 96.56%

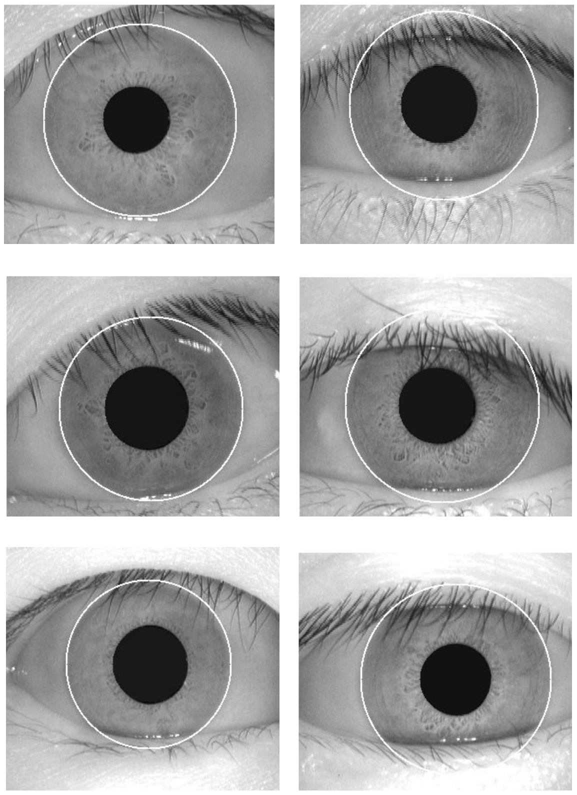

Fig. 10 some of the results on CASIA-1 of proposed outer boundary localization algorithm

4. Experimental results

In this research paper a new method for iris localization is presented. Inner boundary of iris is localized using region properties without using any iteration, which makes the use of proposed scheme in real time applications. For outer boundary localization Gaussian derivative are used which are lees noise sensitive as compared to simple Derivatives. Experimental results reflect that the proposed scheme is quite fast and accurate.

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