IRIS SEGMENTATION USING STATISTICAL MEASUREMENTS FOR THE INTENSITY VALUES OF THE EYE IMAGE

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Abstract

Iris segmentation is quit challenging technique. It needs very careful attention because of its effects on the performance of the iris recognition system.

This paper presents modified iris segmentation method. The method based on the statistical analysis for the grey level values in the processed eye image. These statistical measures are used in advanced iris segmentation operations. The method is applied on large scale database and it is succeeded to allocate the iris region.

Keywords - Biometric, Iris Recognition, Iris Segmentation, Image Processing, Pattern Recognition.

1 INTRODUCTION

Automatic identification system becomes more important these days. Finding secure way to identify person rather than passwords or card that may be forgot or lost is an important research issue.

Biometric recognition systems identifies persons base on their physical or behavioral characteristic. This makes it more reliable than other identification methods. Biometric recognition comes with a solution to most of the recent identification problems. It is widely used in many and different applications.

Iris ring with its complex texture made a reliable biometric recognition method [1]. Iris is an annular area between the pupil and the white sclera in the eye [2]. Its complex pattern contains many distinctive features such as arching ligaments, crypts, radial furrows, pigment frill, papillary area, ciliary area, rings, corona, freckles and zigzag collarette which gives a unique set of feature for each human being, even irises of identical twins are different.[3,4].

Iris recognition system generally includes a series of stages (1) image acquisition (2) iris image localization and segmentation (3) Encoding and matching, as shown in Fig.(1).

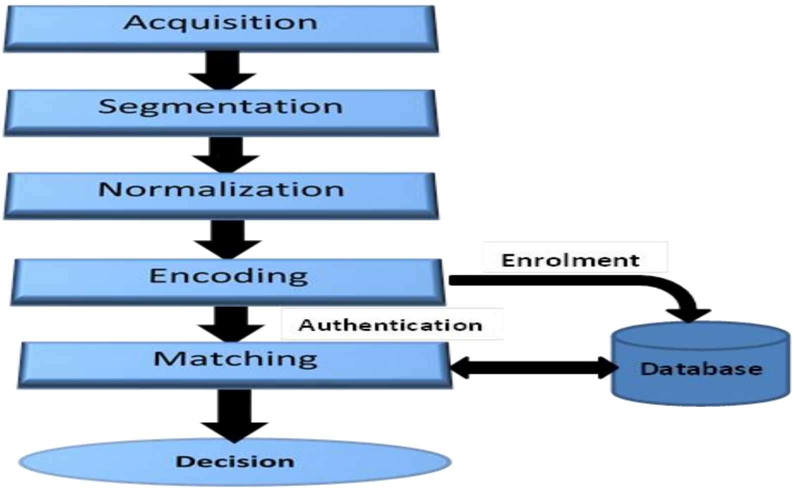


Figure (1) iris recognition system [5]

Image acquisition is the first stage in iris recognition where the image being captured, and the next stage is the image processing that include segmentation start by localizing the iris spatial extent in the eye image and isolating it from the other structures in its vicinity [6].

The later stage in the recognition system start with iris normalization that transforms the iris circular shape into rectangle, this rectangle is coded to generate the template that is used later for matching which is the final step, this stage of the recognition system is not on the scope of this research. The research is focusing on iris segmentation.

Along the time many image processing techniques was proposed for iris segmentation process. The eye image consist of eyelids, eye lashes, pupil, iris, sclera, as shown in Fig.(2). The Iris area must be segmented in order to perform feature extraction stage. The size and the contrast of the eye image is not standard it dependents on lighting conditions and the distance between the eye and the camera [7].

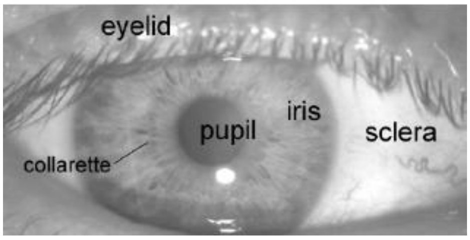


Figure (2) a front-on view of the human eye[8]

2 IRIS SEGMENTATION PREVIOUS WORK

A lot of work and many methods where used to localize the iris pattern. An efficient and fast computation method is the main goal for iris segmentation process, to reduce the overall time and improves the accuracy of the recognition system. Iris segmentation is the most challenging part in the iris recognition system because of the various noisy conditions which is usual in natural environment [9].

Daugman [10] proposed a circle-based method is effective in high quality iris images, but its performance degrades in case of specular reflection and low contrast images, the other methods have high computational complexity and are sensitive to noise.

Wildes [11] introduced an iris segmentation method using Hough transform. The method work in two stages the first step is gradient based binary edge map. While the second step use hough space for the parameters of the circle passing through each edge point.

Yew et.al.[12] proposed to apply Hough transform on the eye image to find localize the pupillary region then outer iris boundary is allocated by searching two areas to the left and the right of the pupil. Finding the maximum difference in intensity values for these regions to get the outer boundary

Abra et.al.[13] purposed to use optical composite correlation filter. The algorithm eliminates redundancy by using new design of composite filter called Indexed Composite Filter (ICF). The values of the inner and the outer boundary are determined through two ICF. The method is strongly affected with noise that degraded it performance.

In histogram based techniques, pupil is considered as the darkest region in an eye image and these holding are used for locating the pupil, Guan-zhuetal [14] Detected the pupil region by first dividing the eye image into small rectangular blocks of fixed sizes and then finding the average intensity value of each block. The minimum average intensity value was selected as a threshold to find the pupil region. Finally, the iris boundaries were detected in the predefined regions.

Basit et.al. [15] Used a binarized eye image for pupil allocation. And for the outer boundary horizontal line that passes through the center of the pupil and pass through the center of the pupil and calculate its gradient. This approach is very efficient but it performance degraded in the partially opened eye.

The first step in the iris segmentation is to detect the pupil which is the black circular part surrounded by iris tissues and it forms the inner radius of the iris. After localizing the pupil it come to find the outer radius of the iris pattern [16].

3 THE PROPOSED IRIS SEGMENTATION METHOD

The grey scale iris image is divided into different regions with different intensity level, these regions are: purple, sclera, eyelids, eyelash, and skin. Based on that fact the iris area will be segmented from the other part of the eye image.

The proposed method analyzes the intensity values for the eye image. The method is an improvement to Histogram based approaches. The main principle is degrade the error that accrue in the previous methods by using a clockwise navigated line that passes through the bottom half of the iris image to find the outer boundary instead of using a single horizontal line close to the center. The proposed method simplifies the complicated calculation by analyzing the observed information on the navigated line and separates the observed information in two regions iris and sclera this will help to find the iris boundary. The proposed method works in two stages: (1) pupil localization, (2) Iris Localization.

3.1 PUPIL LOCALIZATION

The grey scale image is divided into three regions of grey intensity levels: lower, medium and high. Lower region comprises gray levels that normally correspond to pupil and eyelashes and eye brow, which are the darkest regions in the eye image. Gray levels of medium region correspond to iris and eyelids. High region contains sclera and other parts of face.

Mostly the gray levels of eyelashes and pupil are almost same. Therefore, it becomes difficult to locate pupil only on the basis of gray levels. In the proposed method image histogram is used to create binary image for the lower grey values. Image histogram is shown in Fig. (3,b),(4,b),(5,b). Eyebrow, eyelash and glasses are considered as noises that may affect pupil allocation operation. As shown in Fig.(3,c),(4,c),(5,c).

To eliminate the noise in the binary image nearby pixels are connected into groups. Each group of connected pixels labeled with a different color. As shown in Fig.(3,d),(4,d),(5,d).

Standard deviation of the coordinates (x,y) corresponding to each connected group is computed using the following equations:

$$std_x = \left(\frac{1}{n} \sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2 \right)^2 \quad (1)$$

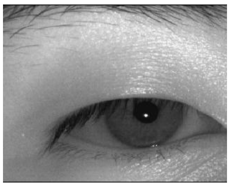
$$std_y = \left(\frac{1}{n} \sum_{i=1}^{n} \left(y_i - \bar{y} \right)^2 \right)^2 \quad (2)$$

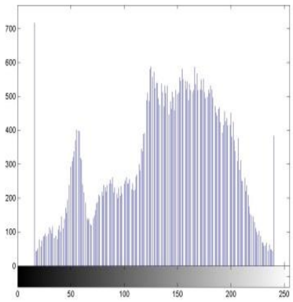
$$\bar{x} = \sum_{i=1}^{n} (x_i) \quad (3)$$

$$\bar{y} = \sum_{i=1}^{n} (y_i) \quad (4)$$

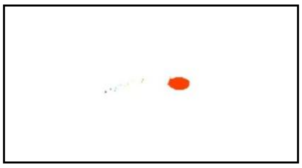
$$std\_diff = \left| std_x - std_y \right| \quad (5)$$

The final output pupil localization is shown in Fig.(3,d),(4,d),(5,d).


(a) original image


(b)image histogram


(c) binary image


(d) grouped regions

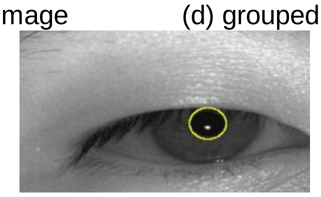
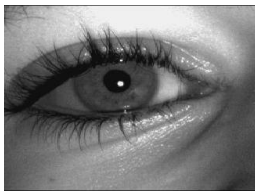
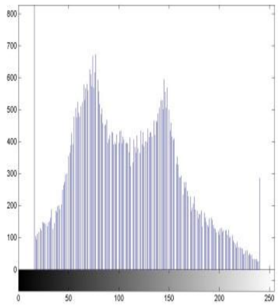
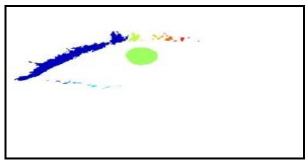

(e)final pupil localization

Figure (3) example 1 normal eye pupil allocation


(a) original image


(b)image histogram


(c) binary image


(d) grouped regions

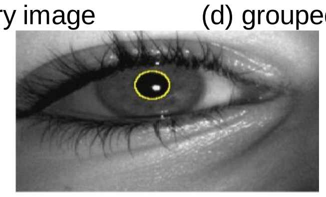
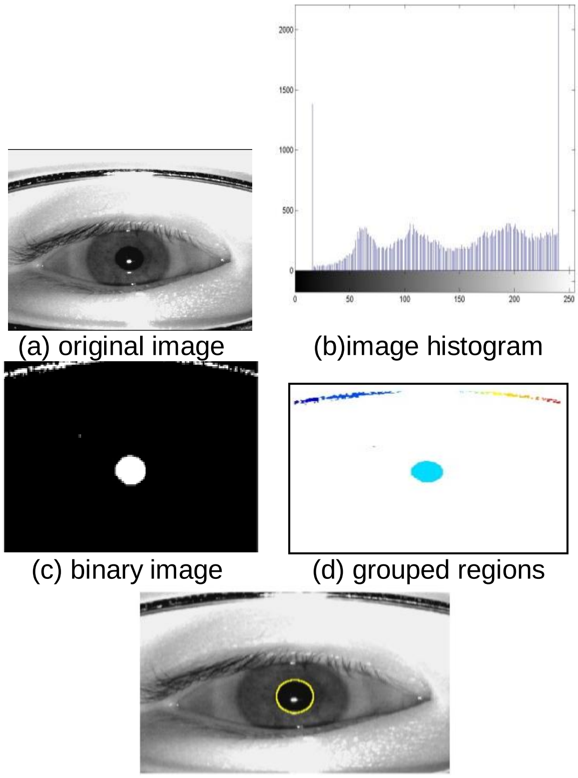

(e)final pupil localization

Figure (4) example 2 dense eye lashes pupil allocation



(a) original image (b)image histogram

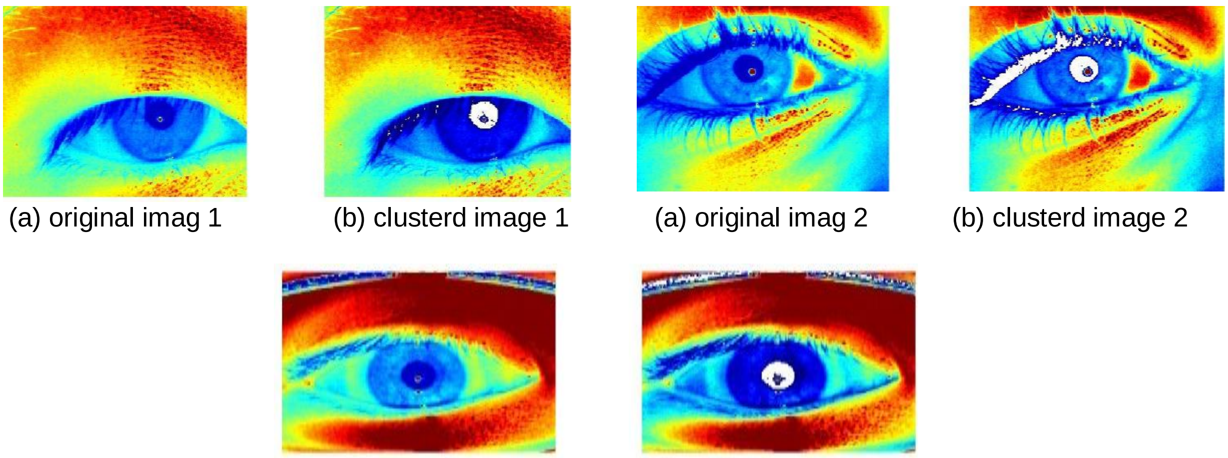
(c) binary image (d) grouped regions

(e)final pupil localization

Figure (5) example 3, eye with glasses pupil allocation

3.2 IRIS LOCALIZATION

First step is enhancing the boundary between the iris and the sclera. The contrast for the eye image has to be enhanced, by grouping different neighbors gray scale values into one cluster. Applying this process will divide the image into less clusters and that produce sharper edge between the iris and the sclera, as shown in Fig. (6).



(a) original imag 1 (b) clusterd image 1 (a) original imag 2 (b) clusterd image 2

(a) original imag 3 (b) clusterd image 3

Figure(6) applying contrast enhancement method

Then the iris region has to be segmented around the pupil with circular mask. This will reduce the noise. The center of the circular mask is the center of the pupil; the values in the pupillary area are assigned to 0.

Now the main operation is to find a boundary point between the sclera and the iris. This point is used to draw an edge around the iris. After find the coordinates of the pupil boundary. A line (L) is drawn where its start point at the pupil boundary, and its end point at the mask boundary. The line navigates in clockwise circular movement inside the mask in the bottom half of the iris region. This region is least affected with noise. As in Fig. (7), where the red line shows sequentially the navigating positions in the bottom half of the circular mask.

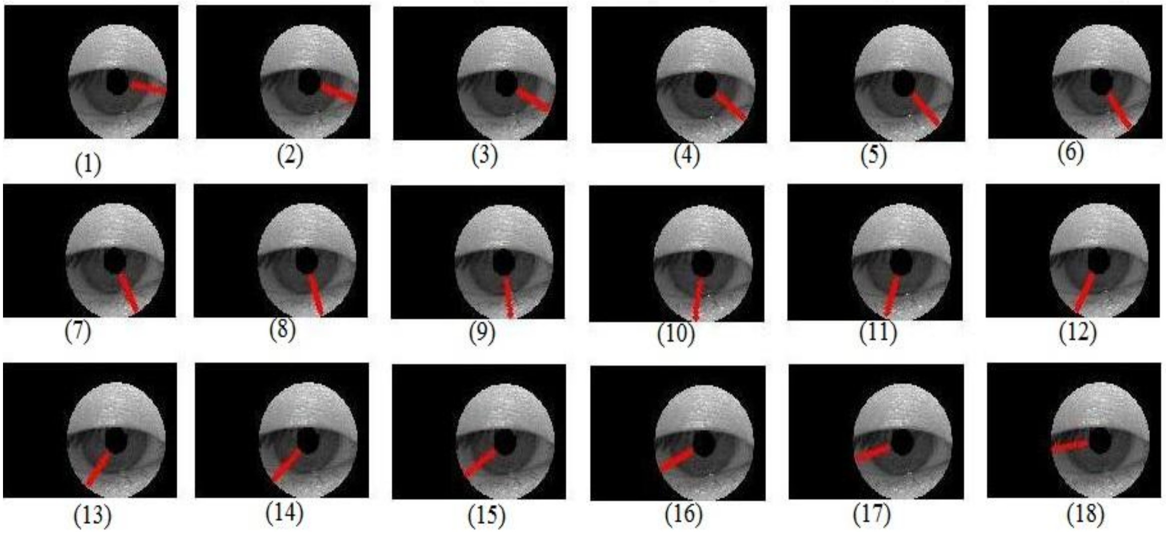
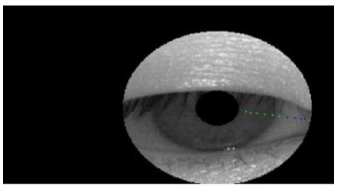


Figure (7) Navigated line tracking stop point in the low half of the sample image inside the circular mask

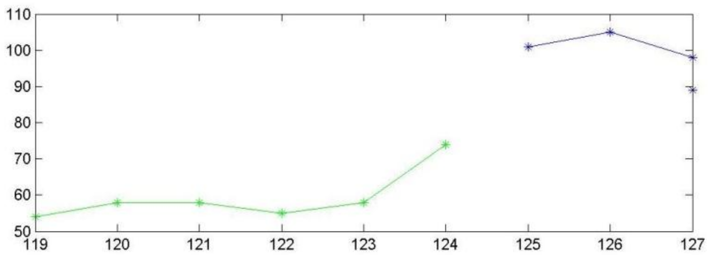
The line (L) will carry the grey level values it crosses. The observed information is shown in Fig. (8). The line pixels should be enough to get the right measures. The green line is defining the iris region while the blue line defines the sclera area.

L is divided into iris region and the sclera region. These two regions are different in their intensity and they can be separated by observing the highest “max=max (L)” and the lowest “min=min (L)” grey level values. The pixels in L(x,y) with grey level which are close to the (max) are considered as sclera region called R0, and those of values are close to the (min) are iris region called R1.

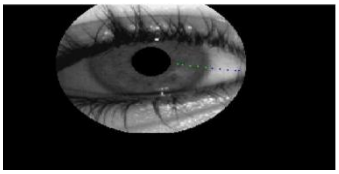
Where the end value in R0 is the value that precedes the first value in R1. This point defines the boundary between the iris and the sclera.

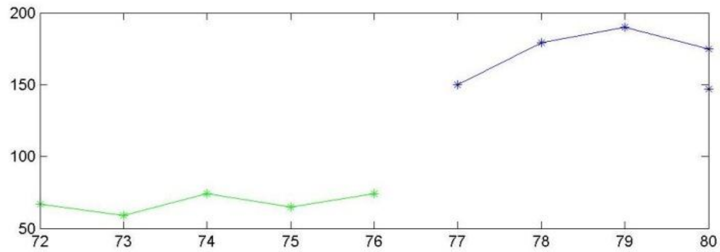


(a) example 1 stop point



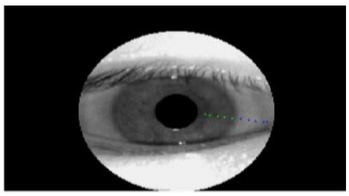
plot for the grey value that observed by navigated line at the stop point

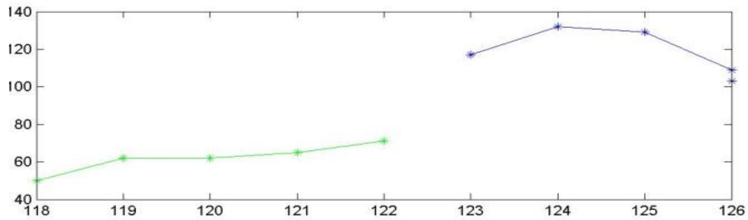




(b) example 2 stop point

plot for the grey value that observed by navigated line at the stop point





(c) example 3 stop point

plot for the grey value that observed by navigated line at the stop point

Figure (8) Finding iris boundary point

4 USED IRIS DATA BASE

CASIA-IrisV1 CASIA Iris Image Database Version 1.0 (CASIA-IrisV1) includes 756 iris images from 108 eyes. For each eye, 7 images are captured in two sessions with our self-developed device CASIA close-up iris camera, where three samples are collected in the first session and four in the second session. All images are stored as BMP format with resolution 320*280 [17].

MMU database MMU1 iris database contributes a total number of 450 iris images which were taken using LG IrisAccess®2200. This camera is semi-automated and it operates at the range of 7-25 cm. These iris images are contributed by 100 volunteers with different age and nationality. They come from Asia, Middle East, Africa and Europe. Each of them contributes 5 iris images for each eye [18].

5 RESULTS

The proposed method is tested on a widely used free iris database (CAIA-V1 and MMU1). The method is applied on all images in the selected data bases. Proposed method is programmed using MATLAB-2012a on a computer with 2.5 GHz Core 2 Duo processors and 4GB RAM.

The performance of the proposed method is evaluated using the same method suggested in [19]. The accuracy rate is used as a measure to evaluate the performance. The accuracy rate (AC_{rate}) is based on the accuracy error (AC_{err}).

$$AC_{err} = \frac{|N_{act} - N_{det}|}{N_{act}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6)$$

Where N_{act} and N_{det} are the number of actual and detected iris pixels, respectively. Is AC_{err} is less than (10%), and then the detected iris is considered as true iris. AC_{rate} is refined is follows:

$$AC_{rate} = \frac{N_{success}}{N_{total}} \times 100 \text{ ....}(7)$$

Where $N_{success}$ is the total number of images in which the iris has been successfully localized and N_{total} is the total number of images in the data base. Table(1) describes comparative result between the performance of the proposed method and other methods applied on CASIA V1 database as reported in [19,12,13].

Table(1) comparative result between the performance of the proposed method and other methods applied on CASIA V1 database, as reported in [19,12,13].

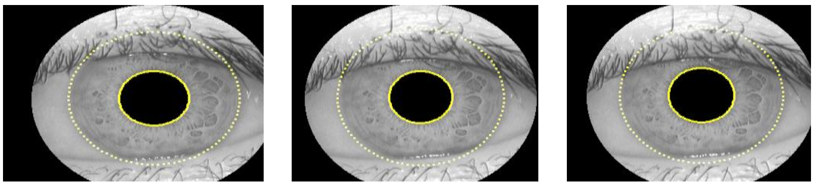
method	Accuracy (%)
Wildes	100
Daugman	98.6
Yew	98.68
Arba	75
Preposed method	99.9

Table(2) describes comparative result between the performance of the proposed method and other methods applied on MMU database, as reported in [19].

Table(2) comparative result between the performance of the proposed method and other methods applied on MMU1 database, as reported in [19].

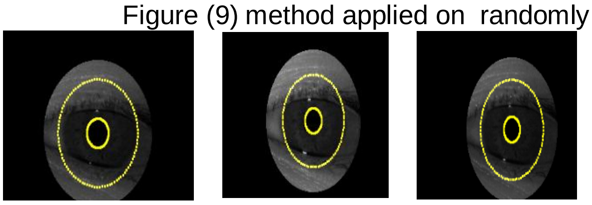
method	Accuracy (%)
Masek	83.92
Daugman	85.64
Ma et. al.	91.02
Somanth et al	98.41
Preposed method	99.6

Fig. (9,10) shows some randomly selected results in the tested database.

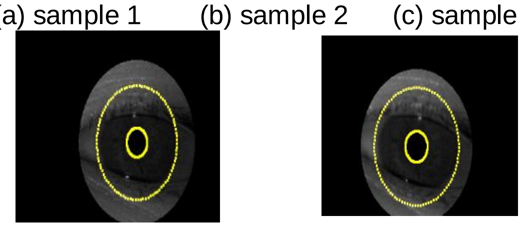


(a) sample 1 (b) sample 2 (c) sample 3

Figure (9) method applied on randomly selected sample from CASIA-V1 data base

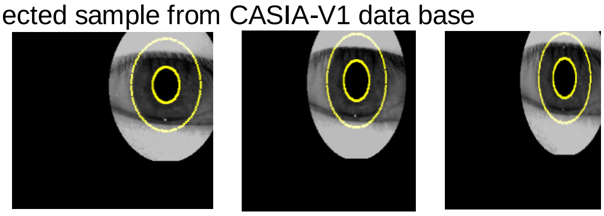


(a) sample 1 (b) sample 2 (c) sample 3

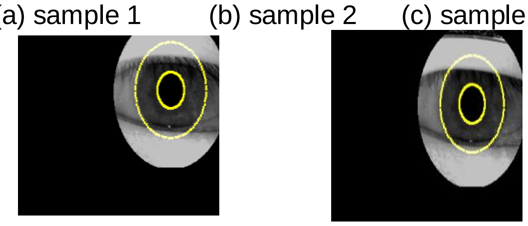


(d) sample 4 (e) sample 5

Example(1)

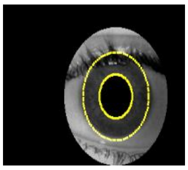
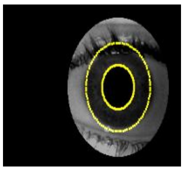
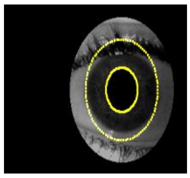


(a) sample 1 (b) sample 2 (c) sample 3

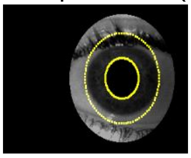
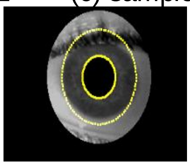


(d) sample 4 (e) sample 5

Example(2)

(a) sample 1 (b) sample 2 (c) sample 3

(d) sample 4 (e) sample 5

Example(3)

Figure (10) method applied on five samples of example 1,2 and 3 from MMU1 data base

6 CONCLUSION

This paper proposed a modified method for iris segmentation. In this proposed method the process start by localizing the pupil area based on histogram and standard deviation, then the iris area is segmented based on the difference in the intensity between the iris and the sclera region using a navigated line. The method is simple and that will simplify the computation time which is necessary in large scale database and the experimental results were obtained are satisfied.

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