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Eyelid Detection in Localized Iris Images

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Abstract *Localization of human eye (iris) in a non invasive fashion with accuracy has great significance. Iris localization is the back bone of iris recognition systems. In this paper a novel method to localize the eyelid is presented. Iris is localized by applying the texture analysis approach. To find the upper eyelid, a rectangular average filter (size two by five) is applied to the segment above iris center and between left and right boundaries of iris. It is followed by sobel horizontal filter. Points of pupil and iris boundaries are removed and a parabola which best fit among the remaining points. This parabola is the required upper eyelid. Lower eyelid is obtained using the same method. Experimental results show that proposed method is very effective.*

Keywords: *Biometrics, iris localization, segmentation, eyelid detection, parabola estimation.*

1. INTRODUCTION

Iris is one of most important biometrics getting attention since last two decades for automatic human recognition. Biometrics is the branch of science in which human beings are identified with their behavioral or physical characteristics. Physical characteristics [1] include iris, face, finger print, retina scan, ear, hand geometry, palm print, foot print etc. where as behavioral characteristics include signature, voice, gait etc. Biometrics are sweeping the normally used identification methods [2] i.e. ID cards, pin, password etc. Iris is the only inner organ visible outside [3]. The spatial patterns that are apparent as shown in Figure 1, are unique to each eye and are stable throughout ones life. These differences exist in the development of anatomical structures in the body [4]. Iris recognition systems encode the iris patterns from the image acquired by a camera. The iris code of new image is then compared with the ones that were registered earlier. An iris recognition system comprise of generally four steps i.e. image acquisition, iris localization, feature extraction and matching [5].

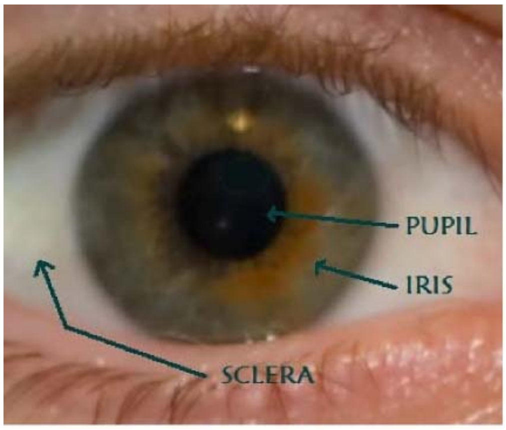

Figure 1: An example of iris.

After acquiring the iris image, iris is localized. This step is very important in iris recognition system because all the subsequent processing depends on its accuracy. Iris and pupil are modeled by two non-concentric circles.

2. BACKGROUND

Iris is a donut shape area between pupil and sclera as shown in Figure 1. Iris localization is generally done by detecting edges and curve fitting. Generally iris is modeled by two circles and eyelids by two parabolas. One circle is between pupil and iris and other is between iris and sclera. One parabola is for upper eyelid and other for lower eyelid.

Integro differential operator:
$\max_{(r,x_0,y_0)} \left| G_\sigma(r) * \frac{\partial}{\partial r}\oint_{r,x_0,y_0} \frac{I(x,y)}{2\pi r} ds \right|$ is used to localize the iris by Daugman [6]. In this expression *I(x, y)* is an image containing eye. The integro differential operator searches over the image domain (x,y) for the maximum in the blurred partial derivative with respect to increasing radius r of the normalized contour integral of image along a circular arc ds of radius r and center coordinates (x0, y0). * denotes convolution and G(r) is a smoothing function

subject to the value of σ. Wildes [4] localized the iris by applying edge detection filter and Hough transform. Edge points are obtained and then circles are fitted to localize the iris. Contours for the upper and lower eyelids are fitted in a similar fashion using parameterized parabolic arcs in place of the circle. Daugman does not find the upper and lower eyelids as it simply excludes the upper and lower most portions of the image where eyelid occlusion is expected to occur. Cui [7] localized the iris by quantized decomposing the image with Haar wavelet of level two using coarse-to-fine strategy. For fording circles, three edge points are used in the general equation of circle. When computing the parameters of circle modified Hough transform is use and outer boundary is localized with a differential operator.

3. IRIS SEGMENTATION TECHNIQUE

Iris segmentation is comprised of two steps i.e. iris localization and eyelid localization. The step of iris localization is done using the technique presented in author's previous work [8].

3.1 Iris localization

Firstly center and radius of pupil is calculated. As pupil is smooth low frequency area in the eye, so first derivative along coordinate axes is taken. Row and column with highest number of zeros is the coordinates of the center and average of these numbers is diameter for inner boundary of iris.

Outer boundary of iris is difficult to find as the difference between intensities of sclera and iris is very small. A donut shape is estimated within which iris outer boundary lies. Radially low pass filter is applied. This donut is searched radially outwards at different angles for pixels whose gradient is greater than a specific threshold. Distance from these points to center of pupil is taken and points located at most frequent distance are taken with certain error and then a circle with least square error is fitted through these points. This circle is outer boundary of the iris.

3.2 Eyelid localization

To find the upper eyelid, upper half semi-circle from iris center of the image is region of interest. For computation, rectangle limiting the upper semi circle is taken. If upper eyelid is in this semi circle then it is useful to detect. A rectangular average filter is applied followed by sobel horizontal filter. Points within pupil and outside of iris are deleted, resulting image is shown in Figure 2. Following points are used to draw a parabola

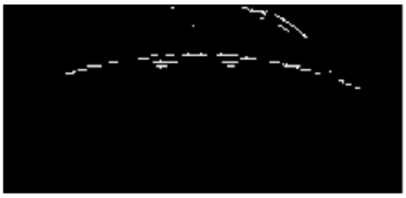

Figure 2: Points for parabola

A parabola is obtained which best fits the points as shown in Figure 3. Parameters of the parabola are obtained and used to draw in the original image.

Lower eyelid is localized in the similar manners except that a rectangle with lower half semi circle is used for processing. A complete localized iris is shown in Figure 4.

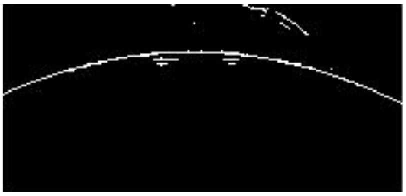

Figure 3: Best fitted parabola

4. EXPERIMENTAL RESULTS

The proposed scheme is implemented in Matlab 7.0 on a personal computer with Pentium 1.8 GHz processor and 512MB of RAM. CASIA Iris Database [9] is used for comparison of results. It contains iris images of 108 different people and each has seven images captured in two different sessions of one month difference. Three iris images are acquired in first session and four in second session. Result of localization of upper eyelid on above mentioned database of 756 images is shown in Table 1.

Table 1: Accuracy and time for upper eyelid

Accuracy	Time		
	Mean	Min	Max
90.61%	1.16	0.83	1.39

Result for lower eyelid is given in Table 2, where as Table 3 demonstrates the comparison of the proposed technique with existing methods.

Table 2: Accuracy and time for lower eyelid

Accuracy	Time		
	Mean	**Min**	**Max**
94.05%	1.40	1.03	1.92

It is clear from the figures presented in Table 3 that given method is consuming more time than others and results for upper eyelids are less than that of Cui et al. Time for lower eyelid is also greater than Cui's method but its accuracy is increased by 0.66%.

Table 3: Comparison with other methods

Method	**Upper eyelid**		**Lower eyelid**	
Daugman	N/A		N/A	
Wildes	N/A		N/A	
	Accuracy	Mean Time	Accuracy	Mean time
Cui et al.	97.35%	0.18 sec	93.39%	0.77 sec
Proposed	90.61%	1.16 sec	94.05%	1.40 sec

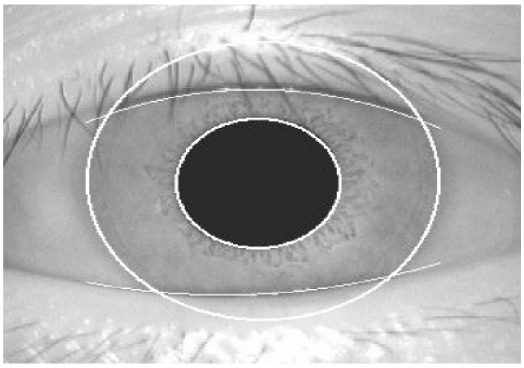

Figure 4: A localized iris

5. CONCLUSIONS

In this paper a new method of eyelid localization is presented. Iris is localized by applying the texture analysis approach [8]. A rectangular average filter is applied to upper half iris portion to find the upper eyelid. It is followed by sobel horizontal filter then obvious redundant points i.e. within pupil and outside iris boundaries are deleted and a parabola which best fit among the remaining points. Similarly lower eyelid is obtained using the same method. Accuracy of finding correct upper and lower eyelid is 90.61% and 94.05% respectively.

6. ACKNOWLEDGEMENTS

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