

# FAST EYELID LOCALIZATION USING IMAGE GRADIENT

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## ABSTRACT

This paper proposes a novel iterative algorithm to detect eyelids to compensate accuracy problem caused by the non-standard circle characteristic of the iris. Image gradient is the external force to reposition the points present in the two semi circular rings radiating from pupil center. The semi circular rings are iteratively expanded by modifying the radius from inside toward outside to search for the abrupt gradient changes in order to find the iris contour formed by the image feature. In addition, occlusions of the iris images from eyelids are automatically excluded from the detected iris region. The experimental result shows that the proposed scheme is robust in finding exact eyelid boundary and outperforms both in accuracy and speed.

**Keywords:** Eyelid localization, Zero-crossing, Image Gradient.

## 1. INTRODUCTION

Recently, Personal Identification System becomes a key factor for safety and secured environments. Iris recognition is a technology to identify individuals based on iris, and is more accurate and reliable among other biometric technologies, such as fingerprint, face and voice recognition. Iris localization is an important step that plays is computationally heavy. Another method was proposed by Kong et al [8] to detect iris boundary by mapping the image from Radial coordinate to Cartesian coordinate. The noise is not canceled in this method but it solved the eyelashes problem. Chen. Yu et al. [4] used Sobel edge detector and used multiple circles and line connection for detecting eyelid and outer boundary. However this method is time consuming and localizes both boundaries as a perfect circle, and degrades the performance of iris matching. Kennell. L.R. et al [10] used gray scale distribution of the pixels within the iris to exhibit different statistical properties on the boundary. Ann A. Jarjes et al [2] adopted angular integral projection function and curve fitting, especially for locating the limbic boundary, eyelids, and other occlusions.

However, all these methods locate the iris considering it as a standard circle, while the texture part of iris is actually not bounded with a circle [11] which surely causes some

a vital role in the accuracy and efficiency of Personal Identification System. The overall performance of an iris recognition system is highly related to the localization accuracy. Localization is important because the iris is almost always partially occluded by eyelids and eyelashes which will increase the danger of false acceptance and false rejection if not properly excluded. The best known iris localization algorithm is perhaps due to the work of Daugman. D.J. [5][6]. He proposed an integro-differential operator to localize both iris boundaries and fit the eyelids with an arc model. This method is sensitive to noise and may be trapped in local maxima of noncircular iris boundaries. Wildes. R.P. [18] used the first derivative of image intensity to find the location of edges corresponding to the iris boundaries. The noise of pupil and eyelashes cannot be eliminated by this method. Both these methods assume that pupil and limbus have circular shapes and searches for large circular variations in the image to detect the boundary. Ma. L et al [12] presented a method to determine high contrast parts of boundary and then localized the outer boundary and eyelids using Hough Transform. This method is hard to implement because of its lower SNR. Masek. L. [14] and Tisse. C. et al [17] proposed iris localization algorithms based on circular and elliptical Hough transform with combination of Canny edge detection and also with integro differential operator. Hough transform requires thresholding which can suffer loss of significant points in an edge map of the image and it errors in the location accuracy. But the apparent size of the iris shows much more variability and the images will also be more subject to motion blur, inconsistent illumination, shadows, and variation in subject gaze angles which makes the iris boundaries appeared as non-circular. To deal with arbitrary shape of the iris, Ritter. N. et al [15] proposed active contour model. This method uses a circular active contour to evolve towards the real boundaries by searching for the equilibrium of two defined forces: an internal force and external force. Active contours have also been considered for non-ideal iris segmentation in Daugman's latest paper [7] which accommodates off-axis images, the plots of gradients for the pupil and limbic boundaries form two "snakes," and each of which is then approximated by a discrete Fourier series. The iris ring is thus bounded by smooth closed curves which project behind occluding eyelids. Ross and Shah [16] proposed geodesic active contour, which combines the energy minimization

approach of classical snakes and the geometric active contour based on curve evolution. Arvacheh et al [1] proposed active contour models to localize the pupillary and limbic boundaries using Level set. However, the localization result of a snake model is highly dependent on the location of the initial contour which is required to be close to the object contour. This approach is elegant, but frequently miss-converges in the presence of noise or complex contours and needs more iterations to converge. Due to these difficulties, transform-based techniques have been applied to iris detection in recognition. However, the Fourier transform is global and not well adapted to local singularities. It is hard to find the location and spatial distribution of singularities with Fourier transforms. On the other hand, wavelet analysis is a local analysis and is suitable for time-frequency analysis [13], which is essential for singularity detection. This idea is similar to that of Canny's approach which selects a Gaussian function as a smoothing function. In almost all of these methods outer boundary and eyelids are detected in different steps, causing a considerable increase in processing time of the system.

To overcome the aforementioned difficulties a novel transform based image gradient approach is introduced in this paper to detect the eyelid. To detect edge activities in the image, edge detection algorithm is applied where the summation extends only over the first few coefficients. This paper presents a novel iterative algorithm for eyelid detection with the proposed edge detection based on modified zero crossing and provides image. We also focus on reducing the searching space while detecting boundary and this iterative algorithm only needs to run a few rounds to converge to the solution.

The remainder of this paper is organized as follows: In Section II the proposed frame work for eyelid localization is presented. Experimental results and comparison with existing techniques are presented in Section III and Section IV concludes the paper.

## II. EYELID DETECTION

To detect the eyelid, first the horizontal gradient information  $I'$  is computed from

$$I' = (E_{10}'^2)^{1/2} \quad (1)$$

To qualify the eyelid crossing, the first derivative of  $I'$  must be greater than the threshold, whose value is experimentally found. Then the edge map is generated with modified zero crossing. To improve the speed and the robustness of the algorithm, for both the eyelids, search area is proposed in the ROI that covers the eyelid boundaries and lies within the iris region to distinguish the points which are edges between iris and eyelids,

Upper eyelid area:

$$P1 = x_c - R_p$$

$$P2 = x_i - R_i$$

Lower eyelid area:

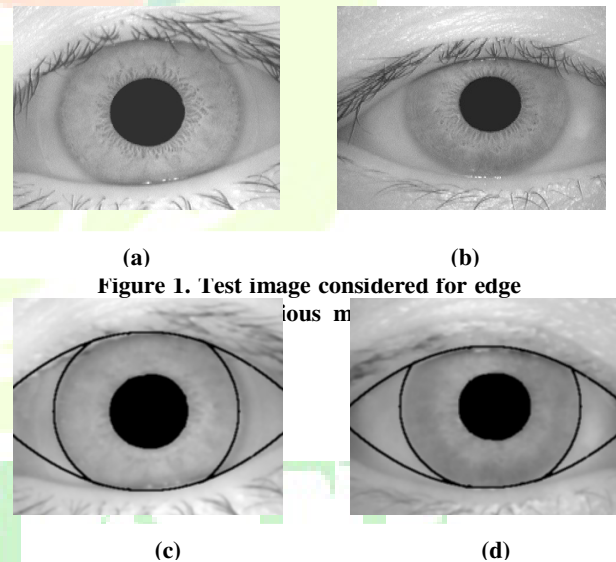
$$P3 = x_c + R_p$$

$$P4 = x_i + R_i$$

where  $(x_c, x_i)$  and  $(R_p, R_i)$  are the center and radius of pupil and iris respectively. The edges between the row P1, P2 are the candidates for the upper eyelid detection, and P3, P4 are the candidates for the lower eyelid detection. The upper eyelid candidates to find the row with the abrupt change in the gradient profile is proposed. The final selected edge is the one where maximizing the gradient has been extracted and the corresponding edge pixel locations form the upper eyelid vertex. For detecting lower eyelid we apply the same algorithm. Then the upper and lower eyelids are localized with parabolic curve fitting method.

## III. EXPERIMENTS AND RESULTS

The proposed method for limbus and eyelid localization has been experimented with standard CASIA V.1 iris datasets. Sample test gray level images which are of size  $(320 \times 280)$  with pixel value in the range 0-255 are presented in Figure 1(a) and (b). The images are preprocessed with median filter to smooth the image and to remove unwanted noise. Then the coarse edge with modified zero crossing in the second directional derivative is identified. The resulting horizontal and vertical edge map obtained after a threshold value 10 for the test images with the proposed model are shown in for the test images shown in Figure 1(a) and (b).



**Figure 1. Perfect Eyelid segmentation: (a-b) Original image (c-d) Eyelid localization**

The effectiveness of the proposed algorithm is also measured with accuracy and computation time required for outer boundary localization. It is observed that the proposed scheme is robust to high percentage of accuracy and computation time i.e. 99.23% accuracy with 1.81 milliseconds (ms) computation time for detecting the outer boundary of test image in Figure 1(a) and 1.54 ms computation time for detecting the outer boundary of test

image in Figure1(b), while the traditional methods robust to 96.32% of accuracy and the computation time for detecting outer boundary of test images with Hough transform takes 2.18ms and 1.78ms respectively and the same is presented in Table 1. From Table 1, it is evident that, the proposed method achieves encouraging detection accuracy with

**Table 1. Computation Time for Detecting the Outer boundary**

Method	Accuracy	Computation Time (Milli Seconds)	
		Sample 1	Sample 2
Proposed	98.23%	1.61	1.34
Hough	94.32%	2.08	1.58

#### IV. CONCLUSION

The proposed method exhibits some important characteristics such as much less sensitive to initialization than the traditional model and there is no internal force used for shape variation. The steepest transition in the gradient is used to locate the real boundary mostly consistent with the true edge. The upper and lower eyelid boundaries are localized with horizontal gradient information. Moreover, the speed of convergence is improved greatly. The experimental results show the promising performance and robustness of the proposed method.

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