# IMPLEMENTATION OF THE HUMAN EYE PUPIL DETECTION USING INTENSITY VALUES WITH EDGE DETECTION

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***Abstract:*** *Eye tracking refers to measure gaze positions and movement to reveal what individuals are looking at. Thanks to the advances of eye tracking technology, there are growing numbers of research focus in using eye tracking to study human behavior. In order to improve the accuracy of the eye gaze tracking technology, this paper presents a novel pupil detection algorithm based on intensity level with canny edge detection technique. Field programmable logic array (FPGA) based hardware implementation of the proposed technique is presented, which can be used in iris localization system on FPGA based platforms for iris recognition application.*

***Index Terms – Pupil detection, Hough transform, Canny Edge Detection***

## I.INTRODUCTION

Eyes movement state recognition is to research how to detect the visual process of gazing accurately and non-intrusively. With the research of gazing direction, we can obtain the location information of saccade selection and monitoring process in people's variable observation, and take it as a channel of Human Computer Interaction. There are four forms of eyes movement state, Vergence movement, VOR, saccades and Smooth pursuit, which manifest as the movement of pupil center. Therefore, the movement information of pupil center is key feature of the gaze tracking and how to extract it directly impacts on the precision and accuracy of gaze tracking system.

## II. Related Work

Pupil detection is studied in [2] based on Hough transform, searching pupil's parameters in the three-dimensional parameters space. This method can achieve high accuracy of pupil center and is very suitable for feature extraction of eye movement. However, it performs poorly at processing pattern noise interference, involves a large number of statistical counts and can't meet the demand of real-time. Pupil center is calculated in [4] with geometric average using circle edge detection and local threshold segmentation. This method has a good performance on real-time but cannot meet the accuracy requirements of gaze tracking. In [5], the knowledge of the face structure is exploited to detect the eye region, and its

CDF is employed to extract the eyelids and iris region in an adaptive way in order to locate pupil center. However, the accuracy of pupil center is low. In [6], the threshold for local binarization of the pupil area is adaptively, which results a high accuracy of pupil center. But that system is intrusive. And most recently, pupil center is located precisely in [7], whereas the hardware needed is complicated. What's more, with the research of the gaze tracking technology, eye movement information extraction has become more and more important.

## III. EDGE DETECTION TECHNIQUES

There are many ways to perform edge detection. However, the majority of different methods may be grouped into two categories:

_ Gradient: The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image.

_ Laplacian: The Laplacian method searches for zero crossings in the second derivative of the image to find edges. An edge has the one-dimensional shape of a ramp and calculating the derivative of the image can highlight its location.

### a) Sobel edge detection

The Sobel operator is used in image processing, particularly within edge detection algorithms. Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations. On the other hand, the gradient approximation which it produces is relatively crude, in particular for high frequency variations in the image.

In simple terms, the operator calculates the gradient of the image intensity at each point, giving the direction of the largest possible increase from light to dark and the rate of change in that direction. The result therefore shows how "abruptly" or "smoothly" the image changes at that point and therefore how likely it is that that part of the image represents an edge, as well as how that edge is likely to be oriented. In practice, the magnitude (likelihood of an edge) calculation is more reliable and easier to interpret than the direction calculation.

$$h_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, \quad h_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

Figure 1: Sobel edge detector mask

## IV. PROPOSED SYSTEM

In this proposed system used canny edge detector instead of Sobel detector which is used in existing system for pupil detection.

### a) PUPIL DETECTION

Our pupil center detecting model based on adaptive threshold value(intensity value) combined with the pupil edge gradient information reserves the high accuracy of the pupil detection. Only searching pupil center in the block formed by constraint conditions of pupil's edge points and corresponding gradient information can also improve the efficiency of the locating pupil center.

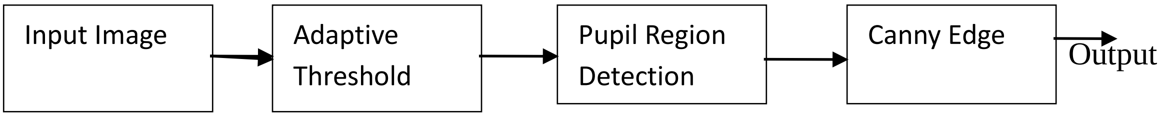


Figure 2: Proposed Block Diagram

### b) CANNY EDGE DETECTION

The canny edge detector first smoothes the image to eliminate gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum (non maximum suppression). The gradient array is now further reduce remaining pixels that have not been suppressed. Hysteresis uses two thresholds and if the magnitude is below the first threshold, it is set to zero (made a non edge). If the magnitude is above the high threshold, it is made an edge. And if the magnitude is between the 2 thresholds, then it is set to zero unless there is a path from this pixel to a pixel with a gradient above second threshold.

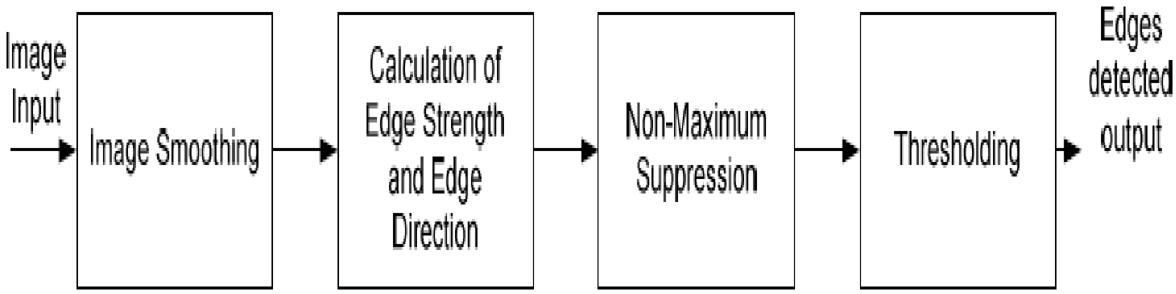


**Figure 3. Block diagram of the stages of the Canny edge detector.**

A block diagram of the canny edge detection algorithm is shown in Figure 2. The input to the detector can be either a color image or a grayscale image. The output is an image containing only those edges that have been detected.

### c) CALCULATION OF THE STRENGTH AND DIRECTION OF EDGES

In this stage, the blurred image obtained from the image smoothing stage is convolved with a sobel edge operator. The canny edge operator is a discrete differential operator that generates a gradient image. Horizontal and vertical Sobel operators that are used to calculate the horizontal and vertical gradients, respectively.

### d) Calculating Edge Direction

Edge direction is defined as the direction of the tangent to the contour that the edge defines in 2-dimensions" [1: 690]. The edge direction of each pixel in an edge direction image is determined using the arctangent .The edge strength for each pixel in an image obtained from equation A = arctan (Gy/Gx) is used in non-maximum suppression stage. The edge directions obtained from equation are rounded off to one of four angles--0 degree, 45 degree, 90 degree or 135 degree--before using it in non-maximum suppression.

### e) NON-MAXIMUM SUPPRESSION

Non-maximum suppression (NMS) is used normally in edge detection algorithms. It is a process in which all pixels whose edge strength is not maximal are marked as zero within a certain local neighborhood. This local neighborhood can be a linear window at different directions of length 5 pixels. The linear window considered is in accordance with the edge direction of the pixel under consideration for a block in an image.

### f) ADVANTAGES OF EDGE DETECTION

Edge detection forms a pre-processing stage to remove the redundant information from the input image, thus dramatically reducing the amount of data to be processed while at the same time preserving useful information about the boundaries. Thus edge detection provides basic information which is used for extracting shapes like lines, circles and ellipses by techniques such as Hough Transform.

## V RESULTS

Simulation of proposed technique is done by Modelsim and output is viewed through Matlab.

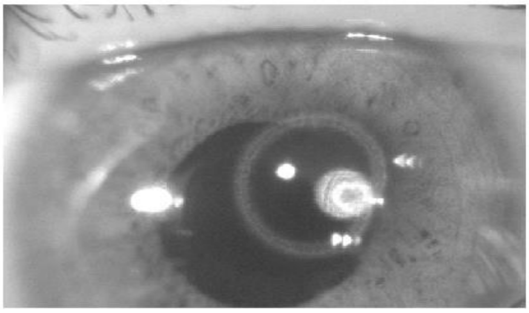

Figure 4a) Input Image in focus

Figure3 b) Pupil Region in focus

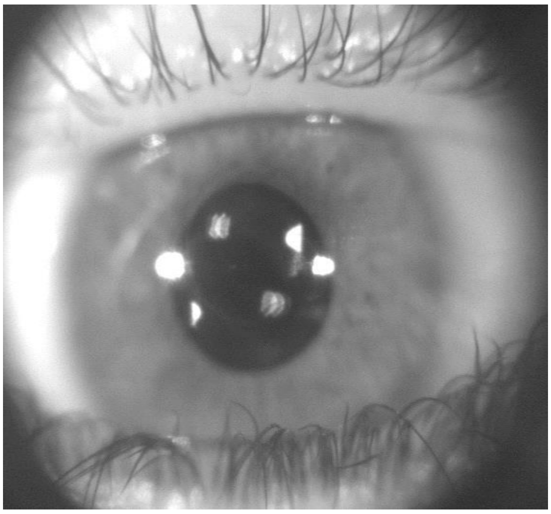

Figure 5a) Input Image in out of focus

Figure 4b) Pupil Region in out of focus

## VI CONCLUSION

Iris localization is the most important step in iris recognition systems. In this research work, a novel and fast method of complete iris localization is proposed based on intensity value analysis of gray scale eye images. Iris is localized by first finding the boundary of pupil followed with canny edge detection. Eyelids are detected by getting parabolas using points satisfying different criterions and then eyelashes are removed using adaptive threshold. Simulation results show the efficiency of the proposed method.

## *REFERENCES*

*[1] Prabir Bhattacharya, Azriel Rosenfeld, and Isaac Weiss, "Pointto- line mappings as Hough Transforms," Pattern Recognition Letters. Vol.23, No.14, pp.1705-1710, 2002.*

*[2] You Jin Ko, Eui Chu Lee, and Kang Ryoung Park, "A robust gaze detection method by compensating for facial movements based on corneal specularities," Pattern Recognition Letters. Vol.29, No.10, pp.1474-1485, 2008.*

*[3] Mansour Asadifard, Jamshid Shanbezadeh, "Automatic adaptive center of pupil detection using face detection and CDF analysis," Proceedings of the International MultiConference of Engineers and Computer Scientists 2010. Hong Kong, pp.17-19, March 2010.*

*[4] Chul Woo Cho, Ji Woo Lee, Kwang Yong Shin, Eui Chul Lee, Kang Ryoung Park, Heekyung Lee, and Jihun Cha, "Gaze detection by wearable eye-tracking and NIR LED-based headtracking device based on SVR," ETRI Journal. Vol.34, No.4, pp.542-552, August 2012.*

*[5] Su Yeong Gwon, Chul Woo Cho, Hyeon Chang Lee, Won Oh Lee ,and Kang Ryoung Park, " Robust eye and pupil detection method for gaze tracking," Int J Adv Robotic Sy. Vol.98, No.10,*

*pp.1-7, 2013.*

*[6] J. Liu-Jimenez, R. Sanchez-Reillo, B. Fernandez-Saavedra, Iris biometrics for embedded systems, IEEE Trans. Very Large Scale Integr. Syst. 19 (2) (Feb. 2011) 274–282.*

*[7] J. Daugman, How iris recognition works, IEEE Trans. Circuits Syst. Video Technol. 14 (2004) 21–30.*

*[8] Jingge Gao, Shuqiang Zhang, and Wei Lu, "Application of Hough Transform in eye tracking and targeting," Proceedings of the 9th International Conference on Electronic Measurement & Instruments. Beijing, pp.3751–3754, 2009.*

*[9] V.Velusamy, Dr.M.Karnan, Dr.R.Sivakumar, Dr.N.Nandhagopal, "Enhancement Techniques and Methods for MRI A Review", International Journal of Computer Science and Information Technologies, Vol. 5 (1), pp .397-403, 2014.*

*[10] J.R. Parker, A.Q Duong, "Gaze tracking: a sclera recognition approach," Proceedings of the IEEE International Conference on Systems, Man and Cybernetics. San Antonio, pp.3836-3841,*

*2009.*

*[11] Li Dongheng, David W, and Derrick J P, "Starburst: a hybrid algorithm for video-based eye tracking combining feature-based and model-based approaches," Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. San Diego, pp.79-87, 2005*

*[12] H. Ngo, R. Rakvic, R. Broussard, R. Ives, Resource-aware architecture design and implementation of Hough transform for a real-time iris boundary detection system, IEEE Trans. Consum. Electron. 60 (3) (2014) 485–492.*

*[13] K.W. Bowyer, K. Hollingsworth, P.J. Flynn, Image understanding for iris biometrics: a survey, Comput. Vis. Image Underst. 110 (2) (May 2008) 281–307.*

*[14] CASIA Iris Database: Available online at: http://www.cbsr.ia.ac.cn/english/ IrisDatabase.asp (accessed on 28 April 2016).*

*[15] K.Rajiv Gandhi, N.Nandhagopal, R.Sivasubramanian, "Automatic System For Pre-Processing And Enhancement Of Magnetic Resonance Image (MRI)", International Journal of Applied Engineering Research (IJAER) vol.9 (22),pp. 15485-15499, 2014.*

*[16] A. Elhossini, M. Moussa, A memory efficient FPGA implementation of Hough transform for line and circle detection, in: Proc. of the 25th Canadian Conference on Electrical and Computer Engineering, Montreal, QC, Canada, 29 April–2 May, 2012.*