American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-04, Issue-01, pp-43-48
www.ajer.org
Research Paper open Access

Eye State Detection Using Image Processing Technique

Vijayalaxmi[1], D.Elizabeth Rani[2]

[1] *Electronics & Communication Engineering Department, Vignan Institute of Technology and Science, Hyderabad, India;*

[2] *Electronics & Instrumentation Engineering Department, Gitam Institute of Technology, GITAM University, Vishakapatnam, India;*

ABSTRACT: *Estimation of driver fatigue is a significant factor in driver assistance system. Recent statistics shows that annually 1,550 deaths and 71,000 injuries are attributed to fatigue related accidents. Because of the hazard that drowsiness present on the road, methods need to be developed for counteracting its affects. The focus may be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes. In this paper, an algorithm is proposed for determining the state of an eye, based on the mean and standard deviation of eye image. In the proposed algorithm, Skin segmentation and Lab transform is used to detect face and Eye. To know the state of eye, mean and standard deviation of eye area is determined. It is found from a result that if mean is >0.2 and standard deviation is <0.02 then the state of the eye is open otherwise closed. This method is tested on face database from M/s. Audio Visual Technologies Group (GTAV) and also a new database is created in-house for the testing purpose. The overall success rate of the algorithm is 89.5%.*

KEYWORDS: *Face Extraction, Eye State, Mean, Standard Deviation*

I. INTRODUCTION

Many accidents occur due to the manual error and more so due to fatigue. While many of the drunken driving may be highly publicized, the major contributing factor in most accidents particularly fatal is due to driver fatigue. According to the Road Safety Authority, driving tired is as lethal as driving drunk. up to 20% of fatal crashes may be linked to driver fatigue, later research indicates that driver fatigue could be a contributory factor up to a fifth of driver deaths. This calls for the development of a device to alert the driver, if not control the vehicle automatically. In the recent years, many researchers worked on these devices and few approaches have been reported [3-12]. One of the suggested methods is to monitor the movement of the vehicle to detect drowsiness of the driver [3]. However this method has limitations as the results are influenced by the type of vehicle and the condition of road. Another method is to process the electrocardiogram (ECG) signals of driver [4]. This approach also has limitations as ECG probes shall always be connected to the driver's body. That would disturb the driver. Few researches tried to assess the fatigue factor by monitoring the eye blink rate of the driver [5-11].

Successful detection of eye blink rate has been the interest of many researchers. H Wen-Bing, et.al. [5] proposed methods based on combination of projection and the geometry feature of iris and pupil. T. D'Orazio, et.al. and Z.Zhang, et.al. [6,7] use the fact that the iris and pupil are darker than skin and white part of the eye. Y.Lei, et.al. [11] proposed an algorithm based on the cascade AdaBoost classifier. T.Hong, et.al.[12], a gray level image of an eye is converted to a binary image, using a predetermined threshold. Then, based on the number of black and white pixels of this binary image, state of the eye is determined. The algorithm presented by Ms.Devi, et.al. [8] used the Hough Transform to detect the iris and to determine openness of the eye. Some researchers are based on the projection of the image, to determine the state of an eye. Z.Liu, et.al. [9], the vertical projection of the image of both eyes is used. J.Wu, T.Chen, et.al. [10], horizontal projection image of an eye is used to determine the interval between eyebrows and eyelids and to recognize the state of an eye. MJ Flores, et.al. [14], the horizontal projection of the image of a face is calculated to determine state of an eye. Some works also are based on "Support Vector Machine" (SVM) classifier. P.Viola, et.al. [15], the SVM classifier is used to detect state of the eye. F Smach, et.al.[16] used SVM classifier and Gabor filter to extract eye characteristic. In the above methods, the authors used some conditions which make some difficulties in the eye state recognition.

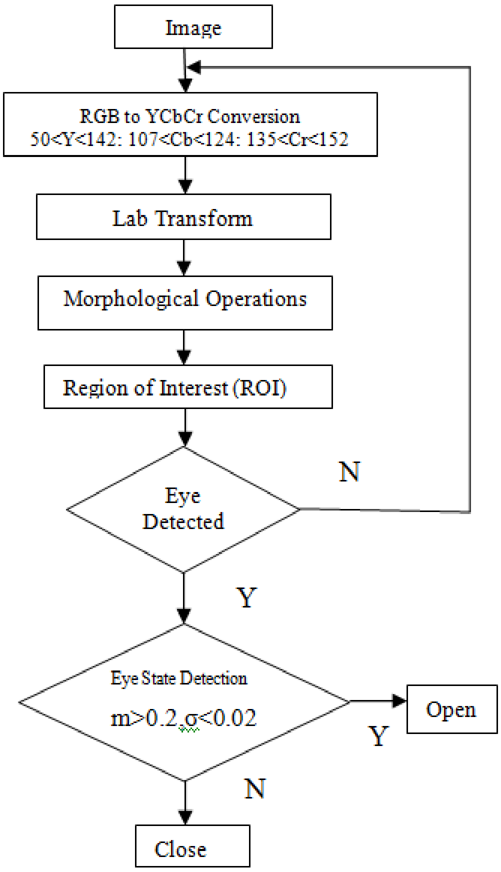

Fig.1. Flow Chart of proposed algorithm

A new algorithm is now proposed to learn the eye status that takes all the earlier stated constrains, thus enhances the reliability. This algorithm does not need training and hence easily handles varying light conditions. In order to verify the correctness of the proposed algorithm, a computer simulation is developed. The algorithm is verified for its accuracy with images available in different data bases.

The rest of this paper is organized as follows. The proposed algorithm is discussed in Section II. Section III describes face extraction, the eye state detection and tracking is described in Section IV, Section V discusses results and conclusions are drawn in section V.

II. PROPOSED ALGORITHM

The proposed algorithm is implemented on SIMULINK and all the required functions are developed using MATLAB routines. The first step is face extraction and then the localization of the eyes. This is done by following one of the methods proposed by Dr.P.Sudhakar Rao, et.al.[24]. Subsequently the algorithm learns the status of each eye as 'CLOSE' or 'OPEN'. The proposed algorithm is shown in Fig.1. This proposed algorithm extracts the face and eyes using skin segmentation and state of eyes is recognized based on mean and standard deviation.The eye state detection algorithm is divided into three steps i) face detection and extraction ii) eye detection and iii) eye tracking. The performance of each step is highly dependent on the previous steps as the results obtained in each step are passed on to the next step as input.

Face Extraction : Given an arbitrary image, the goal of face detection is to determine whether or not there are any faces in the image and if so return the image location . The common approach of face region detection is by using the characteristic of the skin colour.

Algorithm for face extraction: The following is the sequence of steps followed for the face extraction.

[1] i. Convert the given image in RGB colour space into YCbCr colour space.

[2] ii.The Y, Cb and Cr ranges for skin region are: $50<Y<142$, $107<Cb<124$ and $135<Cr<152$. Each pixel of YCbCr is compared against the limits of Y, Cb and Cr to determine if the skin is present and if so by

means of thresholding, the face is identified and segmented. In order to eliminate non-skin regions in the image, it is required to erode and dilate the image using a structured element. Subsequently do filling operation to fill the area defined by locations with connectivity.

[3] iii.Compare the dimensions with certain thresholds for each region and percentage of skin in each region, which will help in removing non -face object.

[4] iv.For each region if height and width are within the range then the processed image is a face and otherwise it is not a face.

An example of an original image and the face extracted image are shown in Figure 2(a) and (b).

	
Original Image	Extracted face

Fig.2.Face Extraction

III. EYE STATE DETECTION

After the face detection, the next step is to determine the location of the eyes. In this process, the area where both eyes are located is found or two eyes individually localized. Eye areas are marked by a rectangle after successfully locating. The steps followed to find and track eyes are

[1] Apply Lab transform to the extracted face to eliminate unwanted portion.
[2] ii.Apply morphological operations on the output of transformed image to remove noise.
[3] iii.Determine the region of interest which locates eyes.
[4] iv.Apply region properties to track the eye pair.

Before eyes are tracked, eyes must be first located. Eyes should also be relocated periodically during the tracking in order to make sure that the correct feature is being considered. The face is divided into 6 quadrants. The region of eyes will be in the uppermost 2 quadrants. Lab transform is applied on the extracted face to locate the eyes. Connected component analysis is applied to detect the eyes. The result of Eye Detection is shown in Figure 3.

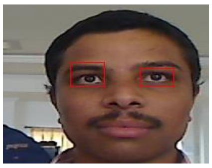

Fig.3. Results of Eye Detection

The image of an open human eye has three different regions, pupil/iris in the middle and two white parts in the left and right sides. However, in the image of a closed eye, these areas can't be discriminated. The effect of this observation is the basis of our proposed algorithm to determine the state of the eye. The vector of the pupil and iris area has less gray values than two other white areas. As a result, the mean and standard deviation of the 'OPEN' are found and concluded that mean is always >0.2 and standard deviation is always <0.02. If the mean is <0.2 and standard deviation is >0.02, then the state of the eye is concluded as 'CLOSE'. Both cases are shown in Figures 4.a. and 4.b.

	
Closed eye (μ=0.179 & σ = 0.01742)	Open eye (μ=0.3366 & σ = 0.2243)

Fig.4.Closed & Open Eyes

IV. RESULTS

The results obtained after testing on GTAV database and in-house database images are tabulated in Table 1.

Table 1: Result Analysis

S. N.	μ	Σ	Output	Status of Eye
1.	0.179	0.01742	0	CLOSE
2.	0.3366	0.2243	1	OPEN
3.	0.2931	0.0166	0	CLOSE
4.	0.2747	0.01384	0	CLOSE
5.	0.4611	0.05534	1	OPEN
6.	0.3534	0.01691	0	CLOSE
7.	0.3189	0.03361	1	OPEN
8.	0.1999	0.04755	1	OPEN
9.	0.3624	0.01552	0	CLOSE
10	0.3281	0.03449	1	OPEN

For most of the cases this algorithm works to the satisfaction. However, in some cases the algorithm fails and 3 such cases are shown in Figure 5,6,7.

Case 1: The case where the algorithm failed

Fig. 5: Failure case1

The left eye is not covered in the region of interest as shown in the figure 5. The eyebrows are covered within ROI hence not detected.

Case 2: The case where the algorithm failed

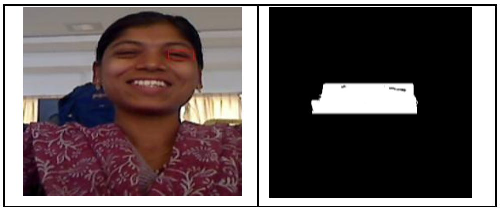

Fig. 6: Failure case2

The right eye is covered in the ROI but its area is too small to be in the range and hence not detected.

Case 3: The case where the algorithm failed

Fig.7: Failure Case3

The right eyebrow is covered in the ROI and hence eyebrows are also detected.

V. CONCLUSION

A new approach for Eye state detection is presented in this paper. Simulation results shows that the proposed algorithm works successfully on different images under different illumination conditions. A total of 36 different images from GTAV database [25] and 30 images from local database have been tested in the laboratory. The success rate of the proposed algorithm is 89.5%. The purpose of this research work is to develop a driver fatigue detection system using vision based approach based on eye blink rate.

REFERENCES

[1] P Boyraz, JHL Hansen, Active accident avoidance case study: integrating drowsiness monitoring system with lateral control and speed regulation in passenger vehicles. IEEE International Conference on Vehicular Electronics and Safety, ICVES 2008, 293–298 (2008) .

[2] K Yun Seong, L Haet Bit, K Jung Soo, B Hyun Jae, R Myung Suk, P Kwang Suk, ECG, EOG detection from helmet based system. 6th International Special Topic Conference on Information Technology Applications in Biomedicine, 2007. ITAB 2007, 191–193 (2007)

[3] PR Tabrizi, RA Zoroofi, Drowsiness detection based on brightness and numeral features of eye image. Fifth International Conference on Intelligent Information Hiding and Multimedia Signal Processing, 2009. IIH-MSP'09, 1310–1313 (2009)

[4] WB Horng, CY Chen, Improved driver fatigue detection system based on eye tracking and dynamic template matching ICS, 11–2.

[5] H Wen-Bing, C Chih-Yuan, C Yi, F Chun-Hai, Driver fatigue detection based on eye tracking and dynamic template matching. Proceeding of the 2004 IEEE International Conference on Networking, Sensing & Control (Taipei, Taiwan, 2004)

[6] T D'Orazio, M Leo, C Guaragnella, A Distante, A visual approach for driver inattention detection. Pattern Recogn 40, 2341–2355 (2007).

[7] Z Zhang, J-S Zhang, Driver fatigue detection based intelligent vehicle control. Paper presented at The 18th IEEE International Conference on Pattern Recognition (2006)

[8] MS Devi, PR Bajaj, Driver fatigue detection based on eye tracking. First International Conference on Emerging Trends in Engineering and Technology, 649–652 (2008)

[9] Z Liu, H Ai, Automatic eye state recognition and closed-eye photo correction. 19th International Conference on Pattern Recognition, 1–4 (2008)

[10] J Wu, T Chen, Development of a drowsiness warning system based on the fuzzy logic images analysis. Expert Syst Appl 34(2), 1556–1561 (2008).

[11] Y Lei, M Yuan, X Song, X Liu, J Ouyang, Recognition of eye states in real time video. International Conference on Computer Engineering and Technology, ICCET'09, 554–559 (2009)

[12] T Hong, H Qin, Q Sun, An improved real time eye state identification system in driver drowsiness detection. IEEE International Conference on Control and Automation 0, 1449–1453 (2007)

[13] Y-S Wu, T-W Lee, Q-Z Wu, H-S Liu, An eye state recognition method for drowsiness detection. IEEE 71st Vehicular Technology Conference, 1–5 (2010)

[14] MJ Flores, JM Armingol, A de la Escalera, Driver drowsiness warning system using visual information for both diurnal and nocturnal illumination conditions. EURASIP J Adv Signal Process 2010, 1–20 (2010) .

[15] P Viola, M Jones, Rapid object detection using a boosted cascade of simple features. Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, CVPR 2001 1, I-511–I-518 (2001).

[16] F Smach, M Atri, J Mitéran, M Abid, Design of a neural networks classifier for face detection. Eng Technology, 124–127 (2005)

[17] C Huang, H Ai, Y Li, S Lao, High-performance rotation invariant multi view face

[18] P Zhang, A video-based face detection and recognition system using cascade face verification modules. Proc of the 2008 37th IEEE Applied Imagery Pattern Recognition Workshop (Washington DC, 2008), pp. 1–8

[19] V Vezhnevets, A Degtiareva, Robust and accurate eye contour extraction. Proc Graphicon-2003 (Moscow, Russia, 2003), pp. 81–84

[20] Caltech vision lab

[21] [http://www.vision.caltech.edu/html/files/archive.html].

[22] Eye SBU database http://faculties.sbu.ac.ir/~eshghi /sbu-database-9008/one_eye.rar.

[23] Dr.P.Sudhakar Rao, Ms.Vijayalaxmi, Mr.S.Sreehari, "A new procedure for segmenting eyes for human face", ISSN: 0974-3588 JULY '11 – Dec '11| Volume 4: Issue 2, IJ-ETA-ETS.

[24] http://gps-tsc.upc.es /GTAV /Research Areas /UPC FaceDatabase /GTAV FaceDatabase. htm

ABOUT AUTHORS

First Author Ms.Vijayalaxmi, received her B.E (E&CE) degree from GNDEC, Visveswaraiah Technological University, Belgaum, Karnataka, India in 2003. M.Tech (DE&CS) from JNT University, Hyderabad, Andhra Pradesh, India in 2008. She is pursuing her Doctorate from Gitam Institute of Technology, Gitam University, Vishakapatnam,Andhra Pradesh, India. Her area of research is Digital Image Processing. She has published 2 Journal papers, 3 International Conference papers and 2 National Conference papers. She received Best Paper award in August 2013 in IEEE International conference organized by Saveetha University, Chennai, India. She is the Life Member of ISTE and Member of IEEE.

Second Author Dr. D.Elizabeth Rani Completed Ph.D.,Electronics and Communication Engineering in 2003 from Anna University, India, Masters in Communication Systems in 1984 from Bharathiar University, India, Bachelors in Electronics and Communication Engineering in 1982 from Madurai Kamaraj, University, India. Presently she is Head of the Department of Electronics and Instrumentation branch in Gitam University, Vishakapatnam, India .She has 25 technical publications/ conference papers to her credit. She is a member of MISTE, IETE, SEMCE (I). She has 26 years of teaching experience and 15 years of research experience. Her area of interest are Signal processing, Communication systems, Network theory, Image processing.