ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 9, September 2015

Computer Vision System for Driver Fatigue Detection

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***Abstract*—One of the leading reasons for traffic accidents is distracted attention of driver. As day by day numbers of vehicles on road are increasing, the proportion of number of accidents is also increasing. Drivers with a low vigilance level suffer from marked decline in their abilities of perception, recognition, and vehicle control and gives critical situations to their own life and the lives of others. This project aims to design a system which can actively monitors driver vigilance level and alert the driver for any insecure driving condition. Methodology for drowsiness detection of driver is based on viola jones algorithm for face and eyes detection. System is developed using video camera, Raspberry Pi hardware, and open source computer vision library (OpenCV) and Microsoft visual studio. This paper presents a real-time non-intrusive driver monitoring system which explores the driver's facial expression to detect and alert fatigued drivers.**

***Keywords*—Face detection; OpenCV; Raspberry Pi; Vigilance; Drowsiness;**

I. INTRODUCTION

Public safety improvement is one of the important goals of scientific researches related to road environment improvement systems. One of the important factors responsible for road accidents are based on physical and physiological state of the driver while driving. Fatigue reduces driver perception and decision-making capability to control the vehicle. Research shows that usually after 2-3 hours of continuous driving, driver is fatigued and steering performance deteriorated [1]. In the early afternoon hours, after eating lunch and at midnight, driver drowsiness is much more than other times. In addition, drinking alcohol, drug addiction and using hypnotic medicines can lead to loss of consciousness. There are mainly three types of distractions cognitive, visual and manual distraction. Visual distraction means eyes off the road, cognitive means mind off the road and manual means hands off the steering wheel. In present systems there are tools available or in development phase for detection of visual and manual distraction detection, but tools are not available to detect cognitive distraction. Some system use intrusive techniques to detect drowsiness conditions based on heart rate measurement or applying sensors to detect physical measures. But as these systems are intrusive their application in real time is difficult as they are attached with driver's body parts. Proposed system is non-intrusive to apply in real time driving environment. Here Raspberry Pi system on chip is used for testing of system on hardware, with Logitech camera for image access purpose.

The organization of rest of the paper is as follows: Sections 2 gives details about the concepts behind the face and eye detection. Section 3 discusses about design and implementation details of face and eyes detection. And Section 4 presents the results achieved for face and eyes detection. Section 5 gives conclusion of work.

II. FACE DETECTION

A video camera is mounted in front of the driver to continuously capture the video of the driver. Face detection module detects the driver's face region to monitor it further. The face detection algorithm is based on Viola-Jones face detection approach [2]. There are three main approaches working together for implementation of algorithm. First is integral image formation by using four corner pixel values of the image for feature computation. Second is AdaBoost classifier for feature selection from large set of features. Features are selected by comparing facial features with Haar like features. Third is a cascade of classifier for selection of most appropriate features of face. Due to which efficiency of algorithm is increased. Mainly feature based method is used for face detection. Face detection algorithm should accurately classify faces from non-face images. False detection rate should be minimized. And as the integral image gets formed first memory required for storage of image is less and efficiency of algorithm gets increased. Features-based system operates faster than a pixel-based system.

Viola Jones [2] has defined three kinds of Haar-like rectangle features:

Two-rectangle feature was defined as a difference between the sum of the pixels within two adjacent regions (vertical or horizontal). Three-rectangle feature was defined as a difference between two outside rectangles and an inner rectangle between them. And four-rectangle feature was defined as a difference between diagonal pairs of rectangles.

The coordinates of the driver's eyes are detected by using HAAR Classifier based eyes detection module. It takes the reference from integral image formed by the face detection

module. Special features of face can be detected like nose area, eyes, so that further processing can be easy. Negative image and positive image concept is developed here. Our necessary region of face is known as positive image and unnecessary part is known as negative image by comparing to images of same object. It can be considered oppositely too.

III. Design Process

Face detection algorithm has been applied on acquired frame of image. Image is acquired by accessing the camera. When face gets detected in the acquired image frame, region of interest of face is cropped from image frame.

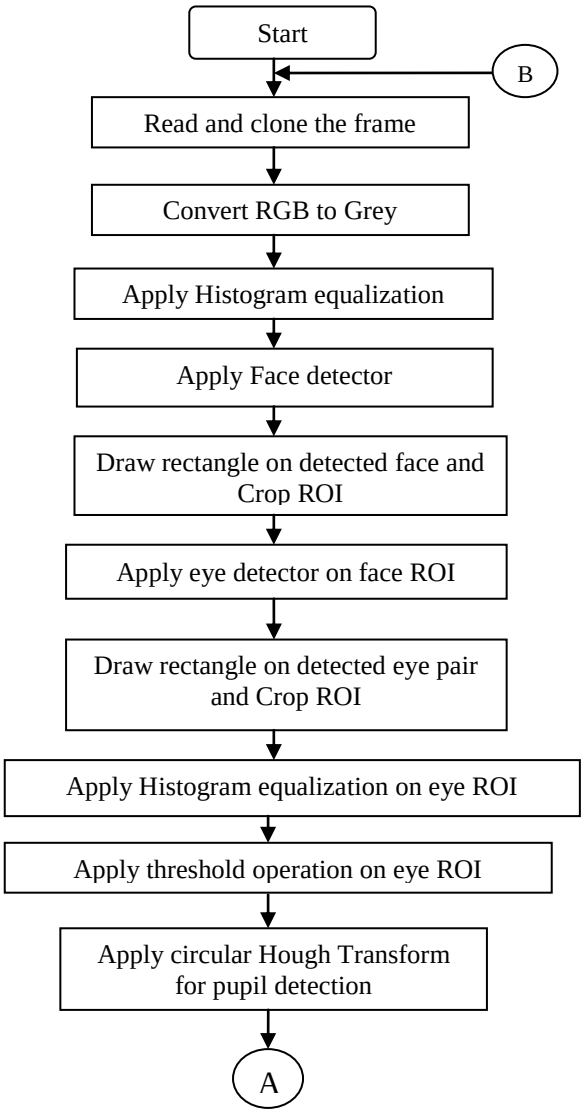
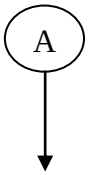


Fig. 1. Face and Eye Detection flow chart part-I



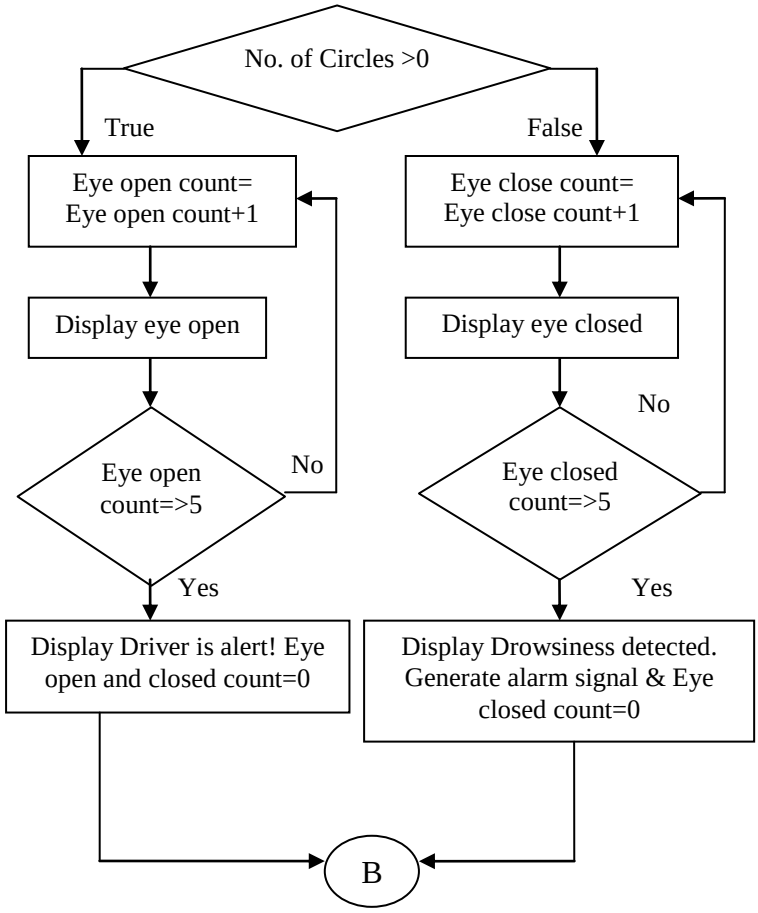


Fig. 2. Face and Eye Detection flow chart part-II

After detection of face region of interest, (by applying multiple cascades of classifiers) conversion of image frame from RGB scale to Grey scale is done. For further processing eye region is detected and cropped. Eye region of interest is further processed by different image processing functions, like edge detection, histogram equalization, filtering, thresholding, etc.

After that by Circular Hough transform pupil detection is achieved, where circles are formed on respective pupils. Counter is applied to detect no of circles in each frame of image. From which eye open count is increased or decreased. If number of circles detected is zero then eye close count will increase else if number of circles detected is greater than one then eye close count will increase. So by counting and analyzing the eye open count and eye closed count different conditions of driver alertness or fatigued had been detected and successfully demonstrated. Different results are obtained in the development process that is explained in following section.

IV. Results

Step by step achieved results are explained in following section. First face detector is applied on acquired frame of image accessed by camera.

A. Face Detection

By applying viola jones algorithm for robust face detection positive results are obtained. On detected face bounding box is formed for selection of required region of interest of face. Here nearly thirty- four cascades are applied in face detector for more accuracy of detection process.

Fig. 3. Face Detection

In adaboosting algorithm features of faces are matched with referance features in directory of open source computer vision library.

B. Eye Region of Interest Detection

After face detection eye region of interest is detected and cropped from image for further processing. Bounding rectangle is getting formed around the eye region of interest.

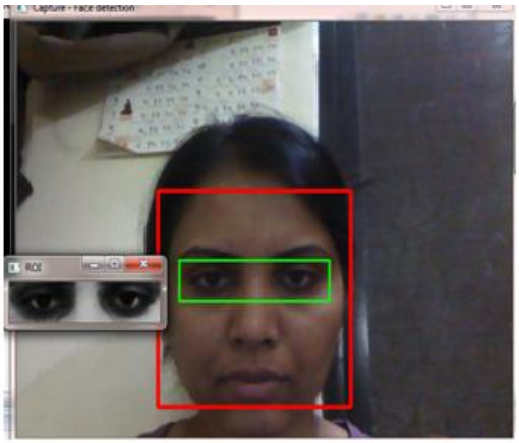


Fig. 4. Eye Region of Intrest Detection

C. Driver Alert Condition

After face detection, eyes are detected. Then ROI of eyes has been selected for further processing. On eye ROI smoothing is applied to make their edges more clear. Then masking on image is applied for filtering purpose.

Finally for pupil detection application of circular Hough transform has been taking place. For continuous five frames if one or two circles (formed on pupils of eyes) have been detected then the eye open condition will occur. And it display result as driver is alert.

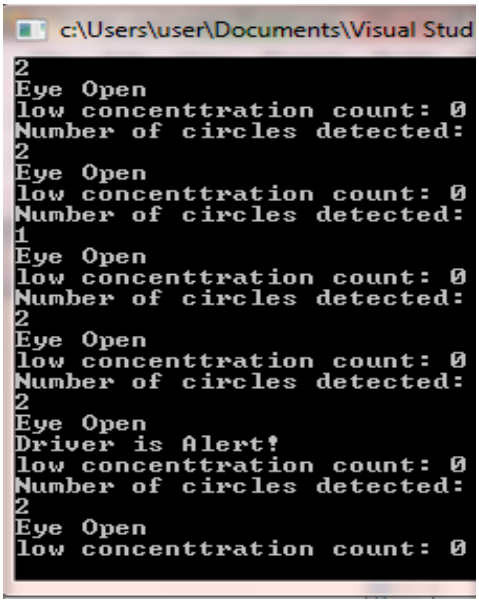


Fig. 5. Driver Alert Condition

D. Driver Drowsiness Condition

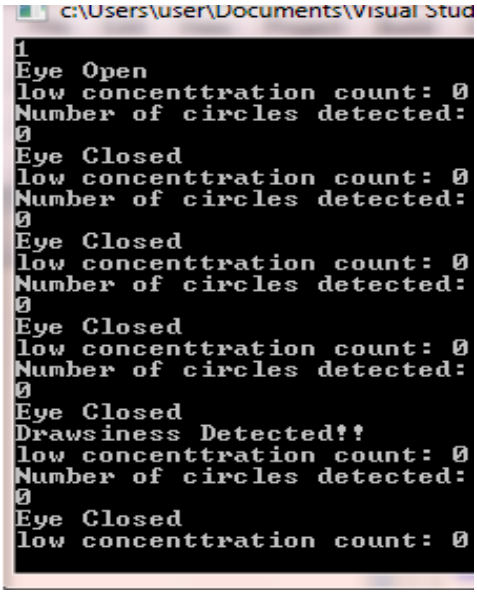


Fig. 6. Driver Drowsiness Condition

For closed eye condition all the steps has been followed like open eye condition. And as eyes are closed number of circles detected (formed on pupils of eyes) will be zero.

So pupil detection case is false, hence eyes are declared as closed. For continuous five frames eyes condition has been checked and then result of drowsiness detection is generate by alarm sound, displayed on screen as drowsiness is detected.

V. CONCLUSION

A driver vigilance monitoring system based on computer vision has been developed and demonstrated in this paper. The ultimate goal of the system is to detect drowsiness condition of driver. By using Viola Jones algorithm rapid face detection with feature extraction has been achieved. In this method integral image is formed and then AdaBoost classifier is applied on this image, and by cascading of classifiers face detection accuracy is further increased. The future works may focus on the utilization of outer factors such as vehicle states, sleeping hours, weather conditions, mechanical data, etc. for fatigue measurement.

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