International Journal of Research (IJR) Vol-1, Issue-6, July 2014 **ISSN 2348-6848**

Road Accident Prevention System Using Driver's Drowsiness Detection by Combining Eye Closure and Yawning

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Abstract—

Driver Fatigue is one of the major reasons causing most fatal road accidents around the world. This shows that in the transportation industry specially, where a heavy vehicle driver is often open to hours of monotonous driving which causes fatigue without frequent rest period. Due to the frequent driver fatigue occurrence, this has become an area of great socio economic concern. Consequently, it is very essential to design a road accidents prevention system by detecting driver's drowsiness, which determines the level of driver inattention and give a warning when an impending hazard exists. In this paper the aim is to design a prototype system which detects driver's drowsiness based on eye blinking and yawning to prevent road accidents. The system includes a video camera either externally attached or inbuilt camera in Laptop which extracts video which detects facial features and finally eye closure and open mouth are detected simultaneously followed by alert. The system so designed is a non intrusive real time monitoring system. The programming for this is done in MATLAB 2013a using the computer vision toolbox.

Keywords— face detection, eye detection,mouth detection,alert.

I. INTRODUCTION

Drowsiness is a state of impaired awareness associated with the desire or inclination to sleep. Driver drowsiness is one of the major reasons for fatal reason because the sleepy drivers fail to take right actions prior to a collision. With effect of driver fatigue it becomes difficult to know or realize the driver its own drowsiness level so that it stops driving and take some rest. In transportation industry sometimes companies face heavy losses due to heavy vehicle accidents occur on highways.[1] National Highway Traffic Safety Administration (NHTSA) data analysis indicates that drowsiness while driving is a conducive factor for road accidents and due to which there is 4-6 times higher crash risk relative to alert drivers. Most of the serious road accidents occur at speeds greater than 70 kmph.

The *Global status report on road safety 2013* shows information on road safety from 182 countries, evaluating for almost 99% of the world's population. The report demonstrates that worldwide the total number of road traffic deaths remains undesirably high at 1.24 million per year. [2] Nearly 3,400 people die on the roads every day in world. Tens of millions of people are injured or disabled every year. Pedestrians, children, cyclists and the elderly are among the most susceptible of road users. [3]

The development of technologies and for preventing or detecting drowsiness at the wheel is a major challenge in the field of accident prevention system, many accidents can be avoided if a robust detection system is designed to determine whether a driver is feeling sleepy or not and alert is there if required. Many systems have been designed for the same purpose using different methodologies. Some research imply intrusive methods in which electrodes has to be connected to a driver's body directly to measure his physiological behavior and drowsiness detection accordingly. These techniques have the most accurate detection but they require physical contact with the driver .Thus, these are impractical. Another method is non Intrusive in which system doesn't distract the driver. The system measures the level of alertness of the driver by monitoring steering wheel movements, braking patterns, tracking road lane view [4]. The driver is alerted accordingly through visual and audio signals without any physical contact with the driver. They have some limitations such as driver experience, road condition and these are in luxury or very expensive vehicle. Some of the major automobiles brands which use this kind of system are Mercedes Ben 2, Volvo, Audi, BMW [5]. Third Method is face expression analysis. Human face is dynamic and has a high degree of variability. Face detection is the first step of face expression analysis .Today different methods in computer vision research are being followed for successful face detection. One of the salient features of face is eyes for face recognition and facial expression analysis. Therefore eyes are detected and by using eyes location of other facial feature can be estimated such as mouth and nose. So basically analysis of these detected facial features is done in this technique. The aim of this research is to develop a drowsiness detection system which will prevent road accidents .The vision based systems have been widely used because of its accuracy and no intrusiveness. Visual cues

such as eye states and mouth states (whether they are open or closed) can typically reflect the driver's level of alertness or

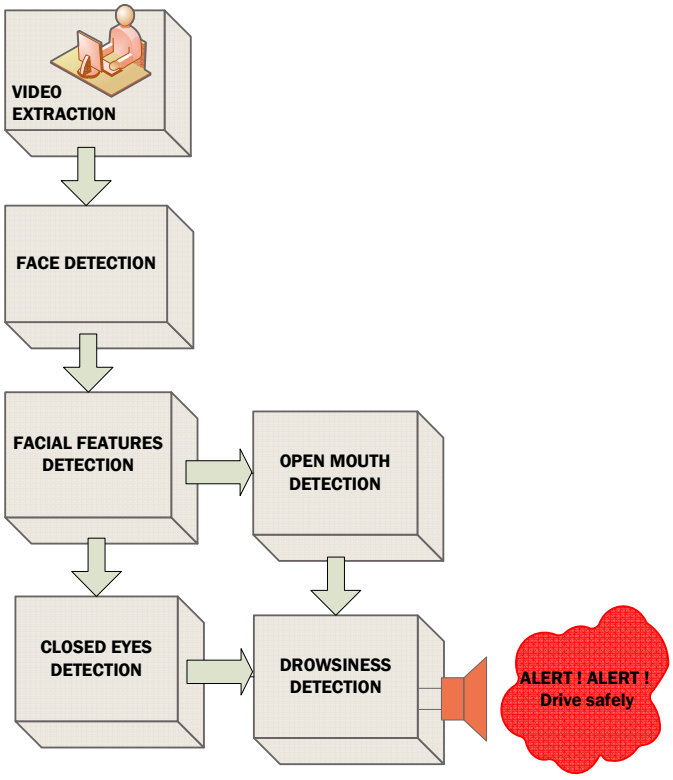

Figure.1 Block diagram of proposed system

fatigue. [8]Therefore an automatic and robust approach to extract the eyes and mouth's state from real time video camera capturing video of driver is essential. Monitoring of eyes and mouth is done that will detect the open or closed state of eyes and mouth which will detect sleepiness and yawning and apparently the symptoms of driver fatigue can be determined early enough to avoid a car accident.

II. PROPOSED WORK

Among the possible three approaches of drowsiness detection that is Vehicular measures, Behavioral measures and Physiological measures, here behavioral measures are focused on. In behavioral measuring or visual based approach different gestures of driver like eye blink, head movement and yawning are monitored to examine the state of the driver. The aim of this work is to detect closed eyes and open mouth simultaneously to observe yawning and alert the driver with a buzzer on positive detection. This is done with the help of mounting a camera in front of the driver and continuously capturing its real time video using MATLAB 2013a. Figure1 gives the block diagram of the proposed work.

III. PRESENT WORK

The proposed work is mainly focused on driver's drowsiness detection based on behavioral measures like yawning and eye blink detection.[7] This study gives a blend of yawning and eye blink detection altogether. This work is segregated into different steps given below:

Step 1 Video Capturing

Step 2 Face and facial feature detection

Step 3 Eye state detection (closed)

Step 4 Mouth State detection (open)

Step 5 Combining Step 3 and Step 4

A. *Video Capturing*

A 1.3 MP video camera mounted in front of the driver captures real time video and processing is done on this. This video is then extracted by MATLAB 2013a software using 'winvideo' command by designing a GUI in computer vision toolbox of software. The facial image information is in 480X640 pixel format. There are four axes designated as windows as given in figure 2 which gives real time video in Window 1, cropped eye image in Window 2, Intensity plot of eyes and mouth region in Window 3 and cropped mouth image in Windows 4.

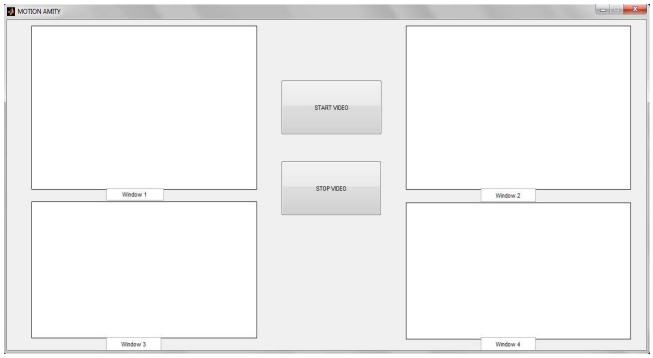

Figure 2 GUI window in Matlab

B. *Face and Facial Feature detection*

Face and facial feature detection has been a major research area in the computer vision field because of its number of applications like monitoring, surveillance, biometrics, robots and driver alert systems like the present system. Here the first ever real time face detection technique is being used that is Viola-Jones Algorithm. [6] In this work Viola-Jones object detectors for left and right eyes, nose, mouth and face are combined together on the basis of CascadeObjectDetector for facial features.

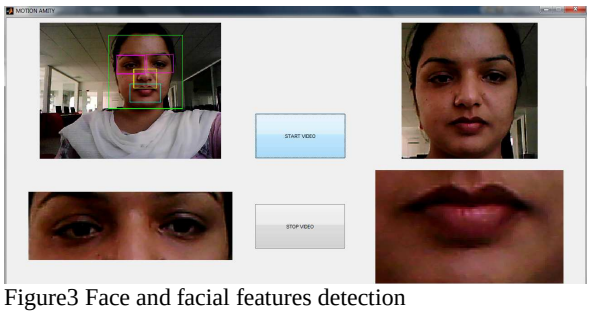

Figure3 Face and facial features detection

These object detectors are provided by MATLAB Computer Vision Toolbox. Figure3 is MATLAB output of face and facial feature detection respectively.

C. *Eyes State detection*

Since facial features are detected successfully in the previous step, the next step is to crop the focused parts that are eyes and mouth. In this step processing on cropped image of eyes is done which will provide information about the state of eyes (open or closed).

When eyes are successfully located, the average horizontal intensities are plotted and distance of two deep valleys is calculated as D in figure6. As eyelashes would move far from the eyebrows the distance between valleys (1 & 2) will increase which shows closed state of eyes. We set a threshold so that if the distance between valleys is less than threshold it determines the eye state as open and vice versa.

In figure 5 one window is divided into 2X2 window where left top is for face and feature detection, right top is for gray scale image of face, right bottom is for segmented gray scale of only feature region and left bottom is the intensity plot of gray scale feature image which is showing when eyes are closed and open according to the distance D.

If (D > Threshold)
Eyes are closed
else
Eyes are Open

D. Open mouth detection

Eye blinking is a major sign of drowsiness and when the state of eyes has been determined the next step is to discover the state of mouth (open or closed). The similar approach is followed in mouth state detection after locating mouth in face, it is cropped and the average horizontal intensities are plotted and distance between valleys is calculated.

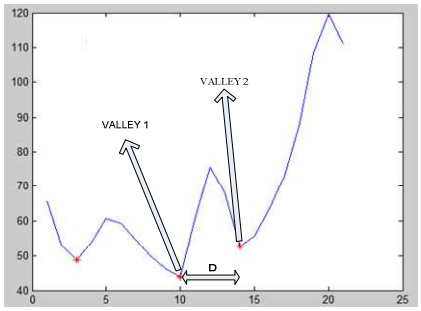

Figure4. Intensity plot of mouth region/eye region

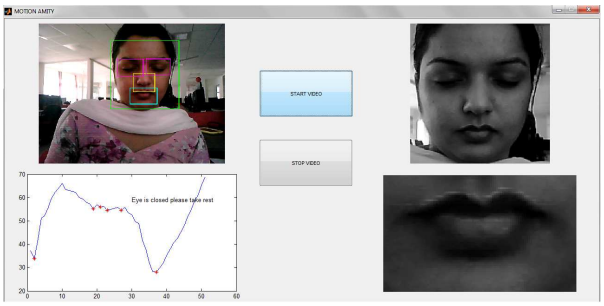

Figure.5 Closed eye detection

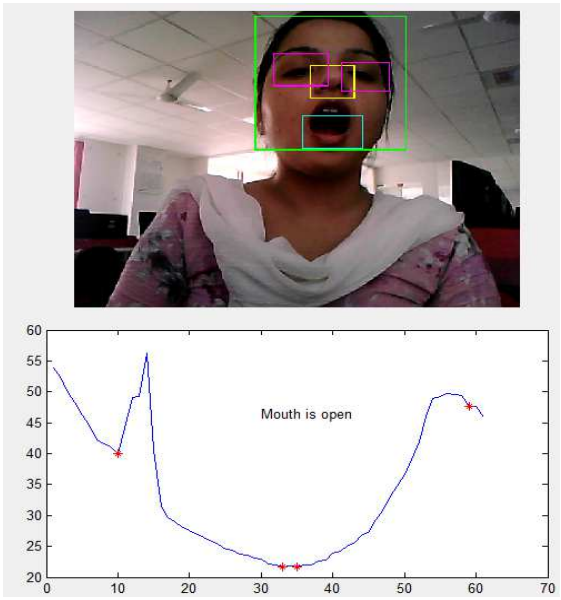

Figure.6 Open mouth detection

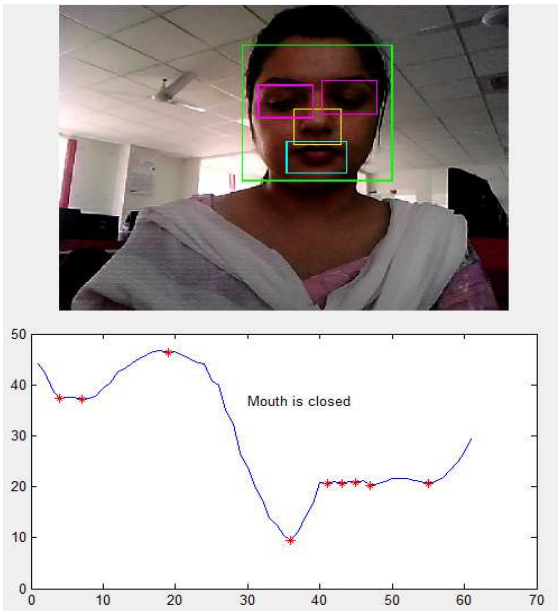

Figure.7 Closed mouth detection

More the distance between upper lip and lower lip more will be the distance between valleys. Here also a threshold distance is set beyond which the mouth state will be considered as open shown in figure 6 else closed which is shown in figure 7.

If (D > Threshold)
Mouth is open
else
Mouth is closed

E. Drowsiness detection

When successful open mouth and closed eye detection has been accomplished the next and most important step is combining these two steps into one and detect error free yawning. We know that when a human being yawns his eyes are closed and mouth is open so here we combine the two states detection that is open mouth and closed eyes. We monitor that if this occurs in more than 5 frames the system

alerts the driver with a buzzer and text saying “Alert! Alert! STOP YAWNING” given in figure 7.

IV. Conclusion and Future scope

A non intrusive visual based system is developed to locate eyes and mouth and determines the driver’s drowsiness level through horizontal average intensities of the eyes and mouth region in face. During monitoring the system is able to detect when the eyes are closed and mouth open simultaneously for too long thus giving a buzzer sound to alert the driver. Also the system alerts the driver if he closes his eyes for long time which is giving information that the driver might have slept. Table 1 gives a comparative analysis of the system implemented on number of persons in different cases like wearing spectacles and having different facial color. This is also represented in form of a Bar graph in figure 8 . Hence a Road accident prevention system is developed using drowsiness detection.

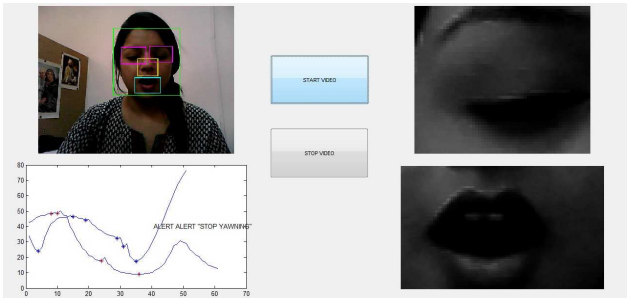

Figure.7 Successful yawning is detected

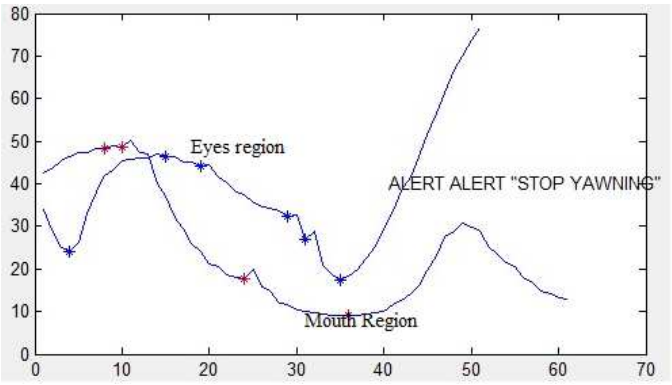

Figure.8 Plot of horizontal average intensities in case of Successful drowsiness detection

Cases	Sample size	Success	Success rate
Drivers with spectacles	6	4	66%
Drivers without spectacles	12	11	91.6%
Drivers with fair face color	8	7	87.5%
Drivers with dark face color	7	5	71.4%

Table1 Comparative analysis of the system taking different types of faces.

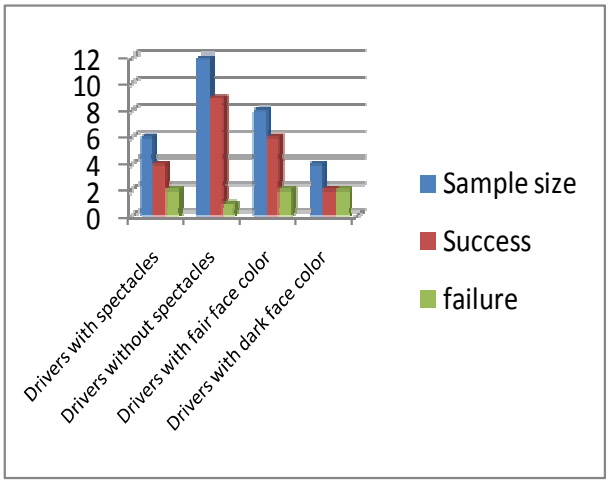

Figure8. Bar Graph representation of comparative analysis of the system

A. *Future Scope*

In this work an inbuilt camera has been used for capturing video of the driver instead of this a wireless camera can be used whose video is transferred to control system wirelessly, processed and give alert to a wireless buzzer system. This work includes only yawn detection and sleep detection, Head movement detection can also be added to this system to give and additional feature. A night vision camera can be used for the same system to increase the usability in all light conditions whether dark or dim.

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