A Real Time Driver Drowsiness Detection System

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ABSTRACT
Driving with drowsiness is one of the main causes of traffic accidents. Driver fatigue is a significant factor in a large number of vehicle accidents. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Due to the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects. This paper describes a real-time non-intrusive method for detecting drowsiness of driver. It uses webcam to acquire video images of the driver. Visual features like mouth & eyes which are typically characterizing the drowsiness of the driver are extracted with the help of image processing techniques to detect drowsiness. A study about the performance of this proposal & some results are presented.

Keywords
Face detection, eye detection, yawn detection, drowsy detection

1. INTRODUCTION
Recently, the total number of serious car crashes is still increasing regardless of improvements in road and vehicle design for driver safety. The U.S. National Highway Traffic Safety Administration (NHTSA) data indicate that more than 40,000 Americans suffer serious injuries from 56,000 sleep related road crashes annually [1]. According to a study by the Sleep Research Center (UK), driver drowsiness at the wheel causes up to 20% of accidents on monotonous roads [2]. Several studies have produced various estimates of the level of sleep deprivation as it relates to road accidents. In addition, driver distraction or inattention is another critical problem for safe driving [3].

Driver drowsiness and distraction are major causal factors behind road accidents. To reduce the number of road accidents, it is necessary to monitor driver and driving behavior and alert the driver when he or she is drowsy or in distraction state. In addition, if it were possible to predict unsafe driving behaviors in advance, this would contribute to safe driving. According to one report [4], the amount of car crashes would be reduced by 10- 20% by monitoring and predicting driver and driving behaviors. A reliable and robust driver drowsiness and distraction detection system would send an alert to the driver and thus reduce the number of hazardous situations on the road. If it were possible to predict unsafe driving behavior in advance, this would also be helpful in preventing road accidents. Thus, it is desirable to design a framework consisting of two phases, that is, both Monitoring and predicting driver and driving behavior.

For a driver monitoring system, two issues such as driver fatigue measurement and distraction detection should be solved. Usually, driver fatigue or drowsiness may be related with symptoms including eye movement, facial expression, heart and breathing rate, and brain activity [5-10]. To detect driver drowsiness, visual features such as eye movement and facial expression are very important.

Yawning measurement is also good indicator of a driver's drowsiness [11]. As non-visual features, heart rate variability (HRV), galvanic skin response (GSR) and conductivity, steering-wheel grip pressure, and body temperature are possible candidates for estimating the driver's fatigue level indirectly [12]. Electroencephalogram (EEG) and Electro-oculogram (EoG) give additional psycho physiological information about drowsiness or emotional reactions [13]. Driving behavior information such as steering wheel movement, lane keeping, acceleration pedal movement and braking, etc., should also be considered to detect driver drowsiness.

2. LITERATURE REVIEW
Many researchers have worked in recent years on systems for driver inattention detection, focused mainly in drowsiness, with a broad range of techniques. Sleep has a long history of research in the fields of psychology and medicine, where accurate measurements and indicators have been developed [14]. Electroencephalograms (EEG) [15] represent the electrical changes in the brain, measured with a series of electrodes placed in the scalp. The electrodes detect small voltages produced in the brain cortex. These potentials form waves at several frequencies, known as delta, theta, alpha, beta and gamma waves, which are linked to different cognitive and motor processes, including drowsiness and the different sleep stages. Brain studies couple EEG with electrooculography (EOG), which detects eye movements, and electromyogram (EMG) that monitors muscular tone. These measurements provide the best data for detection of drowsiness, and as such have been used by several drowsiness detection systems, usually in conjunction with heart rate and breathing rate. The problem of these techniques is that they are intrusive to the subject. They require electrodes and other sensors to be placed on the head, face and chest, which may annoy the driver. They also need to be carefully placed: installing the electrodes to obtain an EEG requires external help and takes a few minutes, and medical equipment is always expensive. Recent research has introduced some contact-less readings, but no remarkable results have been achieved so far. Nonetheless, physiological measures such as EEG have been used in some projects [16], and are frequently used as the ground truth for testing other, less invasive methods.
A driver's state of attention can also be characterized using indirect measurements and contact-less sensors. Lateral position of the vehicle inside the lane, steering wheel movements and time-to-line crossing are commonly used, and some commercial systems have been developed. These systems do not monitor the driver's condition, but its driving. Volvo Cars introduced its Driver Alert Control system [Volvo Car Corp. 08] in 2008, which is available on its high-end

models. This system uses a camera, a number of sensors and a central unit to monitor the movements of the car within the road lane, to assess whether the driver is drowsy. Mercedes-Benz has introduced a similar system (ATTENTION ASSIST) [DaimerAG 09] in its newest E-Class vehicles.

3. PROPOSED SYSTEM

3.1 System Overview

The complete block diagram representation of the proposed system is as shown in Fig 1.

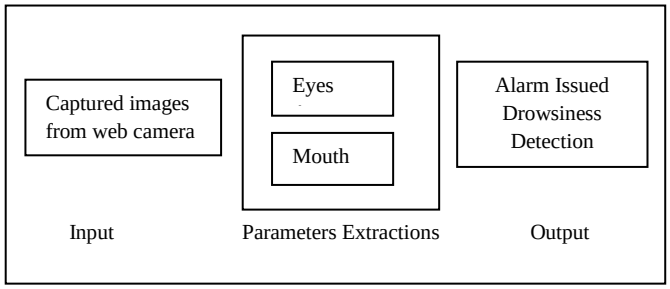

Fig.1. Block Diagram of the Proposed System

In literature, there were many drowsiness detection methods appearing & the best is visual feature based approach, as human face contained much information about physical condition. Here, mouth & eyes tracking done in real time using webcams to detect drowsiness of driver.

The continuous drowsiness estimate needs to be mapped to a decision whether the driver is feeling sleepy or not. There are different physical indicators of drowsiness and out of that a person's eyes show the most obvious signs of drowsiness. Therefore, one approach is continuous monitoring eye area & its statistical property. If 2-3 conservative frames found eye closed then warning is issued. The other approach is that continuous monitoring mouth area to detecting yawning, which is also good indication to find driver's drowsiness. Once mouth area is greater than predefined threshold, warning is issued.

3.2 Image Acquisition Method

The proposed system used i Ball face2face CHD12.0 webcam having 5G wide angle lenses, 6 LEDs for night vision, with brightness controller, interpolated 12Mpixels still image & 2M pixel video resolution. The camera is placed in front of the user, approximately 30 cm away from the face. The camera must be positioned such that the following criteria are met: First is the user's face takes up the majority of the image & second is the user's face is approximately in the centre of the image. After that converting it into gray scale, as RGB components are dependent on the lighting conditions thus the face detection may fail if the lighting condition changes. Next is face-detection step, the face region is found within the driver's entire facial image to remove unnecessary background.

3.3 Face Detection

Viola-Jones method is adopted for face detection [17], which is easy to use & gives satisfactory results. The features that Viola and Jones used are based on Haar wavelets.

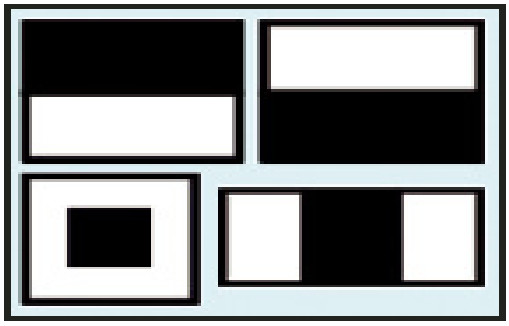

Figure 2: Haar like Features

Haar wavelets are single-wavelength square waves (one high interval and one low interval). In two dimensions, a square wave is a pair of adjacent rectangles one light and one dark. The actual rectangle combinations used for visual object detection are not true Haar wavelets. Instead, they contain rectangle combinations better suited to visual recognition tasks. Because of that difference, these features are called Haar features or Haar like features, rather than Haar wavelets. Above Figure 2 shows the features that used. The presence of a Haar feature is determined by subtracting the average dark-region pixel value from the average light-region pixel value. If the difference is above a threshold, that feature is said to be Present. After that cascade classifier are used to combine all Haar features to obtain face.

3.4 Eye Based Drowsiness Detection

To conclude drowsiness depending on eyes, edge detection technique is used. As edge detection is a fundamental tool in image processing, particularly in the areas of feature detection and feature extraction. If 2-3 conservative frames found eye closed then warning is issued. Roberts method is best suited than others for eye based drowsiness detection.

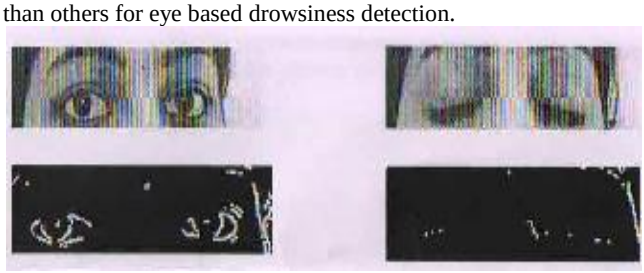

Figure 3: Edge Detection Results of Roberts Method

3.5 Yawn Based Drowsiness Detection

Instead of using any algorithm to detect yawning, here simple logic is used. Once face detection is finished, mouth area image cropped from face detected image as shown in Figure 4. After that one mask image is prepared, this covered the mouth area of cropped images. A mask image is nothing but a fully white image consisting of all ones & having same size of mouth area cropped image.

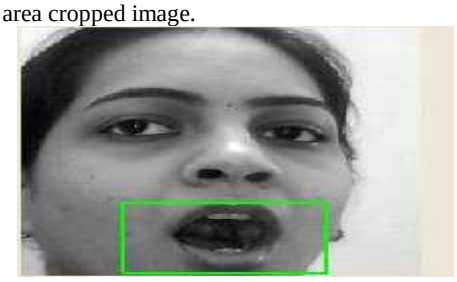

Figure 4: Mouth Area Image Cropped from Face Detection Image

After that the boundary of pixel positions of mouth area in mask image is being found. Then apply threshold technique, (for Male set the threshold value as 250 and for Female set the value as 10). Finally, count the total no of black pixel, if the count is greater than threshold means yawn detected.

3.6 Experimental Result

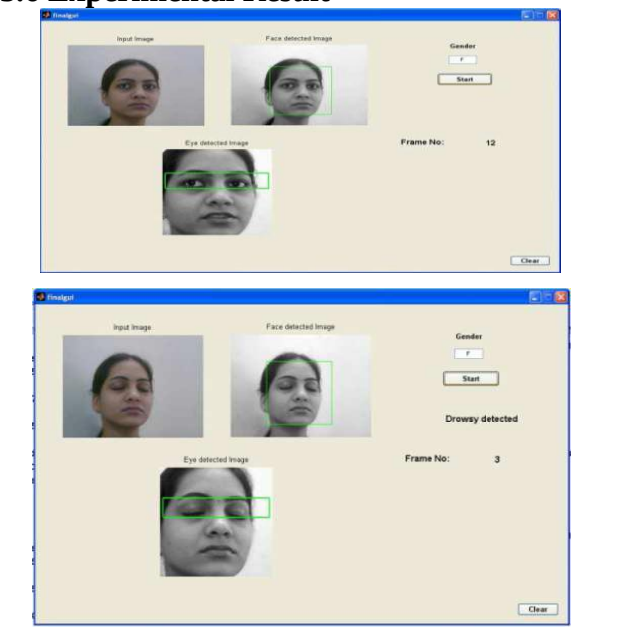

Figure 5: (a) Main GUI Window for Eyes Base Drowsiness, (b) Eyes Base Drowsiness is Detected, (c) Drowsiness Result for Different Frames & Eyes Area

4. CONCLUSION

The proposed system detecting drowsiness of driver by continuously monitoring mouth area & eyes. This non-intrusive approach to detecting drowsiness of driver without interference in both daytime & night time as webcam having 6 LEDs for night vision, with brightness controller. However, there will be some false detection, where the results are not good when there is quick head-movement. At that time face detection is failed so, future work will be done based on drivers quick head-movement and make it feasible to detect driver's drowsiness.

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