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A Survey on Driver's Drowsiness Detection Techniques

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***Abstract*—** Nowadays, there are many systems are available in market like navigation systems, warning alarm systems etc. to make driver's work easy. Traffic accidents due to human errors cause many deaths and injuries around the world. Drowsiness and sleeping while driving are now identified as one of the reasons behind fatal crashes and highway accidents caused by drivers. Various drowsiness detection techniques researched are discussed in this paper. These techniques are classified and then compared using their features. Computer vision based image processing techniques is one of them. This uses various images of driver to detect drowsiness states using his/her eyes states and facial expressions. This technique is on the focus of this survey paper.

Keywords- *Drowsiness detection techniques, Driver fatigue, Image processing, Face detection, Eye Detection, Accidents, Alert*

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I. INTRODUCTION

The increasing number of traffic accidents due to a driver's diminished vigilance level has become a serious problem for society. Some of these accidents are the result of the driver's medical condition. However, a majority of these accidents are related to driver fatigue, drowsiness of drivers. Car accidents associated with driver fatigue are more likely to be serious, leading to serious injuries and deaths. Fletcher et al. in [9] has mentioned that 30% of all traffic accidents have been caused by drowsiness. It was demonstrated that driving performance deteriorates with increased drowsiness with resulting crashes constituting more than 20% of all vehicle accidents [10]Traditionally transportation system is no longer sufficient. One can use a number of different techniques for analyzing driver's drowsiness. These techniques are Image Processing based techniques, Electroencephalograph based techniques, and artificial neural network based techniques. And image processing based techniques can be divided in three categories. These categories are template matching technique, eye blinking technique, yawning based technique. These techniques are based on computer vision using image processing. In the computer vision technique, facial expressions of the driver like eyes blinking and head movements are generally used by the researchers to detect driver drowsiness. Various drowsiness detection techniques researched are discussed in this paper.

II. VARIOUS DROWSINESS DETECTION TECHNIQUES

As shown in fig. 1 there are three various techniques being used by researchers to detect drowsiness wiz. I) Images Processing based techniques II) Artificial neural network based techniques III) EEG (electroencephalograph) based techniques.

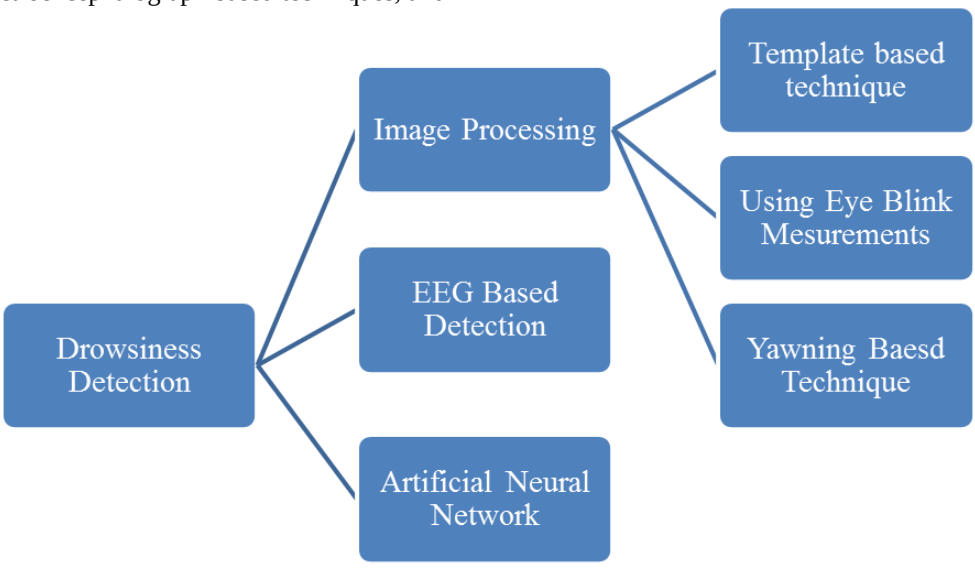


Figure 1: Various Drowsiness Detection Techniques

A. Images Processing Based Techniques

In image processing based techniques, drivers face images are used for processing so that one can find its states. From the face image one can see that driver is awake or sleeping. Using same images, they can define drowsiness of driver because in face image if driver is sleeping or dozing then his/her eyes are closed in image. And other symptoms of drowsiness can also detected from the face image. We can classify these techniques in three sub-categories.

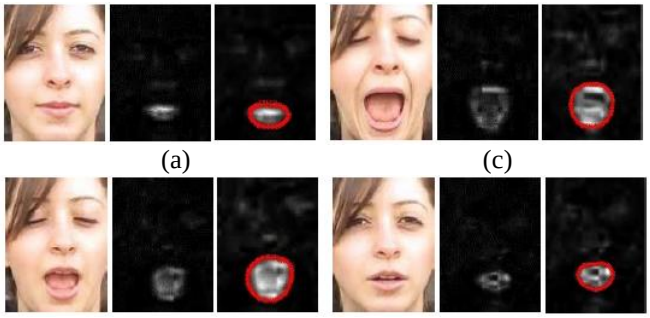
1) Template Matching Technique: In this technique, one can use the states of eye i.e. if driver closes eye/s for some particular time then system will generate the alarm.Becasue in this techniques system has both close and open eyes template of driver. This system can also be trained to get open and closed eye templates of driver.

Figure 2: Open and closed eyes template.

This method is simple and easy to implement because templates of both open and closed eye states shown in figure 2 are available to system. Researchers have used this technique. [4]

2) Eye Blinking based Technique: In this eye blinking rate and eye closure duration is measured to detect driver's drowsiness. Because when driver felt sleepy at that time his/her eye blinking and gaze between eyelids are different from normal situations so they easily detect drowsiness. In this system the position of irises and eye states are monitored through time to estimate eye blinking frequency and eye clouse duration. [5]. And in this type of syetem uses a remotly plced camrea to aquire video and computer vision methodes are then applied to sequentially localize face, eyes and eyelids positions to measure ratio of closure.[11] . Using these eyes clouser and blinking ration one can detect drowsiness of driver.

3) Yawning Based Technique: Yawn is one of the symptoms of fatigue. The yawn is assumed to be modeled with a large vertical mouth opening. Mouth is wide open is larger in yawning compared to speaking. Using face tracking and then mouth tracking one can detect yawn. In paper [6], they detect yawning based on opening rate of mouth and the amount changes in mouth contour area as shown in figure 3.



(a) (c)

(b) (d)

Figure3: (a) Normal mouth image (b) Staring yawn image (c) wide open mouth larger then speaking ,its yawn (d) closing mouth completing yawn.

When yawn is detected by syetem then it alarm the driver.

Instead of using just one technique to detect drowsiness of driver, some researchers [1, 2, 3] have combined various vision based image processing techniques to have better performance.

B. EEG Based Technique

In this technique it is compulsory to wear electrode helmet by drivers while driving. This helmet have various electrode sensors which placed at correct place and get data from brain. Researchers [7] have used the characteristic of EEG signal in drowsy driving. A method based on power spectrum analysis and FastICA algorithm was proposed to determining the fatigue degree. In a driving simulation system, the EEG signals of subjects were captured by instrument NT-9200 in two states, one state was sober, and the other was drowsy. The multi-channel signals were analyzed with FastICA algorithm, to remove ocular electric, my electric and power frequency interferences. Figure 4 shows how EEG based systems get data for acquisition. Experimental results show that the method presented in this paper can be used to determine the drowsiness degree of EEG signal effectually.

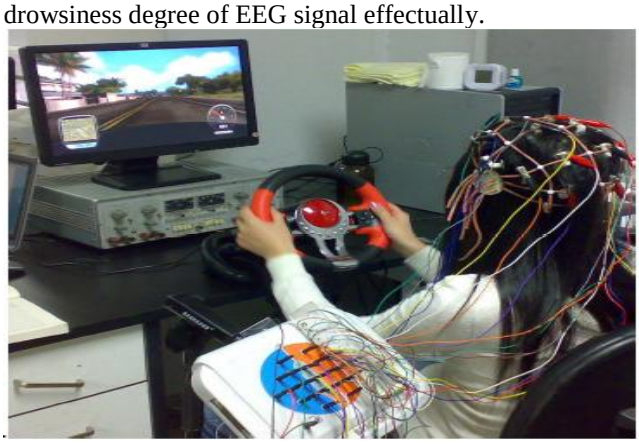


Figure 4: EEG data acquisition system

C. Artificial Neural Network Based Technique

In this technique they use neuron to detect driver's drowsiness. Only one neuron is not much accurate and the result of that is not good compare to more than one neurons. Some researchers [8] are carrying out investigations in the field of optimization of driver drowsiness detection using Artificial Neural Network. People in fatigue exhibit certain visual

behaviors that are easily observable from changes in facial features such as the eyes, head, and face. Visual behaviors that typically reflect a person's level of fatigue include eyelid movement, gaze, head movement, and facial expression. To make use of these visual cues, they made artificial neural network to detect drowsiness. They tested samples and got 96% result. Figure 5 shows that flow how an artificial neural network system can detect drowsiness.

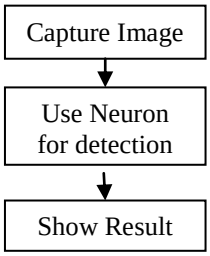


Figure5: Working of ANN

III. Review of Image Processing Based Drowsiness Detection

General architecture for drowsiness detection using vision based image processing techniques is shown in Figure 2. First of all in these techniques they captured video putting camera in vehicle and get images from video frames. From these video frames one can use face detection algorithms to detect face of driver. After that eyes detection algorithms is used to detect eyes. Than eyes and face tracking algorithms are used to track them. Using these various processed images one can detect drowsiness using various symptoms and techniques which they defined in their systems. Researches carried using this technique is reviewed here.

Advanced Driver Assistance System (ADAS) has been proposed [1]. In this, a research project to develop a non-intrusive driver's drowsiness system based on Computer Vision and Artificial Intelligence has been presented. This system uses advanced technologies for analyzing and monitoring drivers eye state in real-time and in real driving conditions. They use different algorithms for various tasks like face tracking, eye tracking etc. they give separate results for face tracking, eye tracking, eye state analysis. Based on the results presented in this paper, the proposed algorithm for face tracking, eye detection and eye tracking is robust and accurate under varying light, external illuminations interference, vibrations, changing background and facial orientations. This paper has very good results of drowsiness detection but in this system, sometimes it creates false alarms.

A nonintrusive prototype computer vision system for monitoring a driver's vigilance in real time is proposed [2]. It is based on a hardware system for the real-time acquisition of a driver's images using an active IR illuminator and the software implementation for monitoring some visual behaviors that characterize a driver's level of vigilance. They used Percent eye closure (PERCLOS), eye closure duration, blink frequency, nodding frequency, face position, and fixed gaze. This system consists of four major modules: 1) image acquisition; 2) pupil detection and tracking; 3) visual behaviors; and 4) driver vigilance. They detect drowsiness using visual behaviors and pupil detection. These parameters are combined using a fuzzy classifier to infer the level of inattentiveness of the driver and detect state of driver and if it detects fatigue then this system alert the driver. This system is fully autonomous; it can initialize automatically, and reinitialize when necessary. The performance of the system decreases during daytime, especially in bright days, and at the moment, the system does not work with drivers wearing glasses.

Driver hypo vigilance (fatigue and distraction) detection based on the symptoms related to face and eye regions is introduced [3]. There are three main contributions in this method: (1) simple and efficient head rotation detection based on face template matching, (2) adaptive symptom extraction from eye region without explicit eye detection, and (3) normalizing and personalizing the extracted symptoms using a short training phase. They used eye region related symptoms like PERCLOS, eyelid distance changes with respect to the normal eyelid distance (ELDC), and eye closure rate (CLOSNO). The symptom related to face region is head rotation (ROT). The proposed method extracts the symptoms related to eye region using horizontal projection of top half segment without explicit eye detection; the symptom related to face region is extracted based on face template matching. Monitoring these symptoms, one can detect drowsiness to alarm the driver. The main disadvantage of our system is the face tracking method which is inaccurate and very computationally complex.

Figure 2: General Architecture of Drowsiness Detection

IV. Conclusion

After reviewing various techniques used for drowsiness detection, we can concluded that, different techniques will be suitable according to given conditions. EEG based techniques are efficient but practically it is not suitable for driver to wear electrodes. Artificial Neural Network based technique is simple but if you want better result than 3 neurons is ideally suitable. Image Processing techniques are one of the favorite ones for researchers. These techniques are much simpler and user friendly. Driver's spectacles make this complex, but researches are going on to eliminate this drawback. So there is a lot of scope in drowsiness detection using Image Processing.

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