Survey On Driver Drowsiness Detection System

[1]Poonam N. Patil, [2]Bhagyashree R. Patted, [3]Aishwarya R. Kannalli,
[4]Prachi N. Solankure, [5]P. K. Deshpande

Basaveshwar Engineering College (Autonomous)
Bagalkot, Karnataka

***Abstract*— The survey addresses on how a machine learning device that helps in detecting the drowsiness of the driver. This system is developed for driver drowsiness detection to prevent accidents from happening because of driver fatigue and micro sleep. This propose the results and solutions on the limited implementation of the various techniques that are introduced in the project. Whereas the implementation of the project gives the real world idea of how the system works and what changes can be done in order to improve the utility of the overall system. The present system detects the eye closure, yawning and nodding pattern. Furthermore, the paper states the overview of the observations made by the authors in order to help further optimization in the mentioned field to achieve the utility at a better efficiency for a safer road.**

***Index Terms*— Driver drowsiness; eye detection; yawn detection; nodding pattern; fatigue**

I. Introduction

HUMANS HAVE ALWAYS INVENTED MACHINE AND DEVISED TECHNIQUE TO EASE AND PROTECT THEIR LIVES, FOR MUNDANE ACTIVITIES LIKE TRAVELING TO WORK ETC.….

FACTS & STATISTICS

Our current statistics reveal that just in 2015 in India alone, 148,707 people died due to car related accidents. Of these, at least 21 percent were caused due to fatigue causing drivers to make mistakes. This can be a relatively smaller number still, as among the multiple causes that can lead to an accident, the involvement of fatigue as a cause is generally grossly underestimated. Fatigue combined with bad infrastructure in developing countries like India is a recipe for disaster. Fatigue, in general, is very difficult to measure or observe unlike alcohol and drugs, which have clear key indicators and tests that are available easily. Probably, the best solutions to this problem are awareness about fatigue-related accidents and promoting drivers to admit fatigue when needed. The former is hard and much more expensive to achieve, and the latter is not possible without the former as driving for long hours is very lucrative. When there is an increased need for a job, the wages associated with it increases leading to more and more people adopting it. Such is the case for driving transport vehicles at night. Money motivates drivers to make unwise decisions like driving all night even with fatigue. This is mainly because the drivers are not themselves aware of the huge risk associated with driving when fatigued. Some countries have imposed restrictions on the number of hours a driver can drive at a stretch, but it is still not enough to solve this problem as its implementation is very difficult and costly.

Drive drowsiness detection is a car safety technology which helps prevent accidents caused by the driver getting drowsy. Various studies have suggested that around 20% of all road accidents are fatigue-related, up to 50% on certain roads. In this age of era, road accidents happen to be caused by lot of reasons where one of that reason happens to be driver feeling drowsy during driving known as fatigue driving or drowsiness. Drowsiness is a state of near sleep, where a person has a strong desire for sleep. Drowsiness behaviors which are related to fatigue are in the form of eye closing, head nodding or yawning. Hence, we can monitor drowsiness by considering physical changes such as sagging posture, leaning of driver's head and open/closed state of eyes. micro sleeps that are short period of sleeps lasting 3 to 5 seconds are good indicators of fatigue. Thus, by continuously monitoring the eyes of the driver one can detect the sleepy state of driver and a timely warning is issued.

1.SURVEY CARRIED OUT

There are various measures to determine the level of driver drowsiness. These measures can be grouped into three categories:

I. Physiological Measures,
II. Vehicle-based Measures, and
III. Behavioural Measures

In the first category, measurements are obtained by accessing driver's conditions through the addition of electronic devices onto the skin. This includes Electroencephalography (EEG), Electrocardiography (ECG) and Electrooculogram (EOG)[1].

In [2] EEG Based Technique where it is compulsory to wear electrode helmet by drivers while driving. This helmet has various electrode sensors which placed at correct place and get data from brain. Researchers have used the characteristic of EEG signal in drowsy driving. A method based on power spectrum analysis and Fast ICA 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 Fast ICA algorithm, to remove ocular electric, my electric and power frequency interferences. Figure 1 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 1: EEG data acquisition system

In [3] it details the proposed approach to detect driver's drowsiness that works on two levels. The application is installed on driver's device running Android operating system (OS). The process starts with capturing of live images from camera and is subsequently sent at local server. At the server's side, Dlib library is employed to detect facial landmarks and a threshold value is used to detect whether driver is drowsy or not [3]. These facial landmarks are then used to compute the EAR (Eye Aspect Ratio) and are returned back to the driver. In our context, the EAR value received at the application's end would be compared with the threshold value taken as 0.25[3]. If the EAR value is less than the threshold value, then this would indicate a state of fatigue. In case of Drowsiness, the driver and the passengers would be alerted by an alarm. The subsequent section details the working of each module.

Behavioral parameters are non-invasive measures for drowsiness detection. The techniques in [4] measures drivers' fatigue through behavioral parameters of driver such as eye closure ratio, eye blinking, head position, facial expressions, and yawning. The Percentage of eye Closures (PERCLOS) is one of the most frequent used metrics in drowsiness detection based on eye state observation. PERCLOS is the ratio of eye closure over a period, and then on the result of PERCLOS, eyes are referred as open or closed. Yawning based detection systems analyze the variations in the geometric shape of the mouth of drowsy driver such as wider opening of mouth, lip position, etc. Behavioral based techniques used cameras and computer vision techniques to extract behavioral features. The general framework of process in behavioral pattern-based drowsiness detection techniques is presented in Figure 2. A list of drowsiness detection system based on behavioral patterns is presented in Table 1. The problems associated with behavioural measures are environmental factors, such as the illumination, brightness, and road conditions influence the credibility and accuracy of measurement [4].

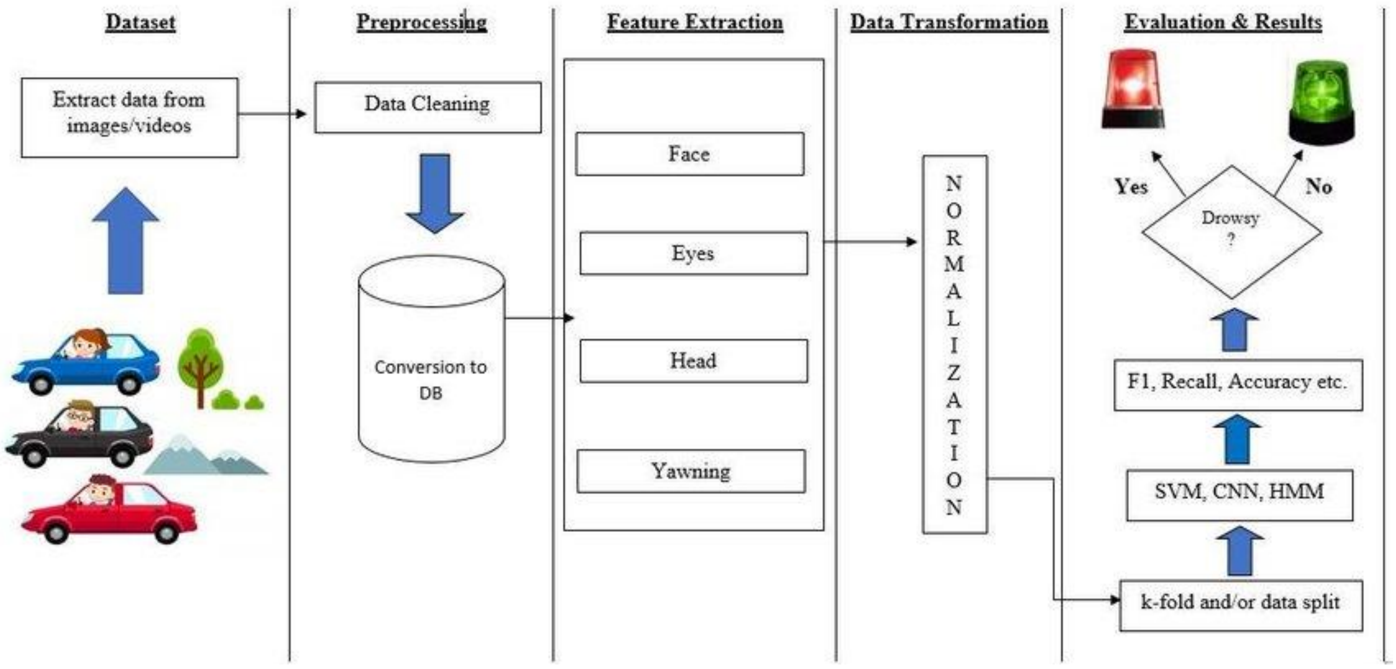

Figure 2: A general framework of Behavioral Pattern-based techniques.

Ref	Behavioral Features	Method & Classifier	Description	Efficiency
[3]	Eye tracking	HSI color model, Sobel edge detection method	HSI color model is independent of brightness. Sobel edge detection to locate eyes.	88.9
[4]	Yawning	Cascade classifier. SVM, Viola-Jones algorithm	applied SVM to train mouth and yawing images. Detects fatigue using cascade.	Nil
[5]	Face components (eyebrow raising, eye closing, yawning)	Background subtraction method, Horizontal projection technique	Used infrared light-based hardware to monitor the eye closing and eyebrows rising to detect drowsiness levels of driver.	Nil
[6]	Yawning	SVM, CHT	Used three steps face extraction, mouth region selection and wide, mouth open detection using SVM. CHT is applied to the results proposed wide, mouth open detector.	98%
[7]	Head movement, eye closeness duration	Viola Jones algorithm, WNC classification	Detects drowsiness based on eye blinking and head pose. A novel WNC based supervised method is proposed.	88.57%
[8]	Eye blinking and yawning	Haarcascade classifier, Active Contour Method, Viola Jones Algorithm	Used eye blinking duration and yawning to detect drowsiness. The System give better results if drivers are without glasses and moustache.	Nil
[9]	Eye state and blinking rate	Viola-Jones method & CART method, Binary cascade classifiers	Used cascade object identifier from vision tool box of mat- lab to eye region. Average drowsiness is calculated, and closed eye is regarded as zero.	90%
[10]	Eye state	Viola-Jones technique, Standard Ada-Boost (Adaptive Boosting) training method & PERCLOS method	Provides user friendly GUI. System requires compact hardware to execute on mid– range, microprocessor or it may be implemented on smart phone having hardware and software requirements.	95%
[12]	Eye blinking	Viola Jones algorithm, Adaboos computational approach, Haar cascade classifier, Luminosity Algorithm & Harris Corner Detector	Non-intrusive and work well in real time. Requires clear visibility of the eye. In poor lightening or sun glasses, system become unable to detect eye region and fails.	94% (in good lightening condition)
[13]	Head tilting and eye blinking frequency	Haar Cascade Classifier	Detection using eye blinking rate and head level, but efficiency declines in poor lightening and with sun glasses.	99.59

Table 1: Behavioral-parameter based drowsiness detection systems [4]

Artificial Neural Network Based Technique used in [5] is a technique in which 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 neuron. Some researchers [5] 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 3 shows that flow how an artificial neural network system can detect drowsiness.

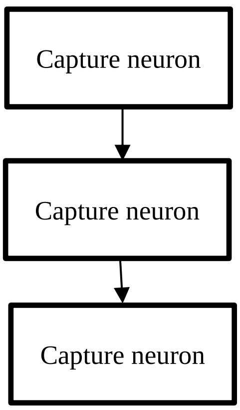

Figure3: Working of ANN

In [6] Automated video-based measurement of eye closure for detecting behavioural microsleep.

Behavioural microsleeps (BMs) are brief episodes of behavioural signs of sleep in which an individual unintentionally stops responding to the task they are performing [6]. Lapse of responsiveness at the wrong moment in high-risk jobs such as commercial truck and bus drivers, pilots, air-traffic controllers, and medical house-staffs can lead to disastrous consequences, including multiple fatalities [7] [8]. A non-intrusive device capable of identifying signs of drowsiness and onset of BM will provide a valuable early warning system to prevent accidents. Some of the visible facial signs of drowsiness and BM are prolonged eyelid closure [6], change

in eye-blink parameters such as reduced spontaneous-blink rate, increased blink duration and amplitude, slow eye movements, reduced facial tone, and head nods. One of the most reliable and valid visual measure of a driver's alertness considered by the American Federal Highway Administration is PERCLOS which uses measure of percentage of eye closure over a 1 min window.
Data collection and annotation

I. Data collection

Videos of nine subjects imitating signs of drowsiness and microsleep were recorded under dark and ambient recording conditions. There were 5 males and 4 females subjects, out of which 5 of them were Asian and 4 were Europeans. Also 4 of the subjects wore glasses.

Videos were collected using Quick Cam 4000 webcam whose IR block filter was removed. The videos with 640×480-pixel image resolution was collected at 30 fps. A 7 cm diameter ring of 6 infra-red emitting diodes (IRED) were placed concentric to the camera to illuminate the scene. During the recording, the subjects were asked to perform various actions, including slow eyelids closure imitating drowsiness, gaze in different directions and varying degrees with and without head movement, and also droopy head-nods followed by a quick recovery of head posture to simulate microsleep.

II.Annotation

From the videos of each subject, set of 66 frontal face frames (33 frames for dark and ambient lighting conditions each) were selected for manual annotation. For each lighting conditions, 3 frames for each of 5 levels of eyelid closers and 6 different gaze directions were selected. Fig. 1 shows an example of manual annotation carried out in the 594 frames. Each frame was manually annotated with the coordinates of nose, eyebrows, centre and radius of iris, area of visible sclera, apex positions of eyelids, and corner of the eyes to form the reference data.

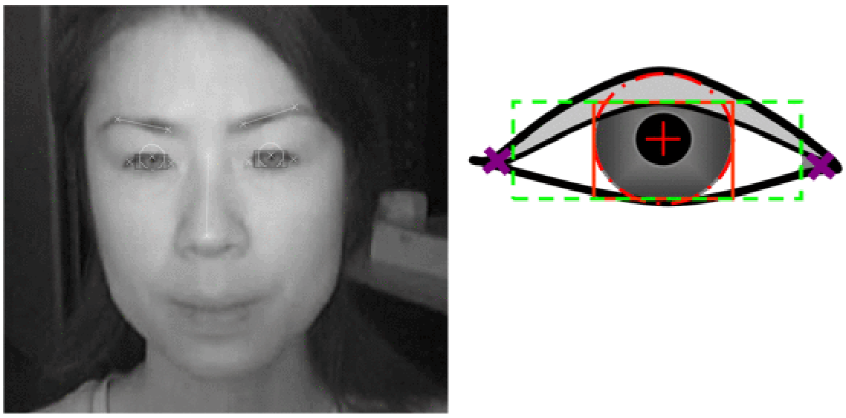

Fig. 4. Annotation of the eye and other facial features. In total 594 frames comprising of 66 frames for 9 subjects were annotated.

In [7] EYE CLOSURE AND HEAD POSTURES METHOD Tayeb et al. [9] proposed the Drowsy Driver Detection using Eye Closure and Head postures. Firstly, video is captured using webcam and for each frame of video, following operations are performed. To detect the ROI (face and eyes), viola-jones method is used. The face is partitioned in to three areas and the top one presenting the aye area is browsed by the Haar classifier. Then to detect the eye state, Wavelet Network based on neural network is used to train the images then the coefficients learning images is compared with the coefficients of the testing images and tells which class it belongs. When the closed eye is identified in the frames then the eye closure duration is calculated, if the value exceeds the pre-defined time, then the drowsiness state is detected. Then the developed system estimates the head movements which are: left, right, forward, backward inclination and left or right rotation. The captured video is segmented into frames and extract the images of head and determines the coordinates of image. Then the images are compared to determine the inclined state of head and same case with other head postures. Finally, the system combines the eye closure duration and head posture estimation to measure the drowsiness. To evaluate the system, experiment is performed on 10 volunteers in various situations. And results show that the systems achieve the accuracy of 80%.

In [8] REAL TIME ANALYSIS USING EYE AND YAWNING Kumar et al. [10] proposed the real time analysis of Driver Fatigue Detection using behavioural measures and gestures like eye blink, head movement and yawning to identify the drivers' state. The basic purpose of the proposed method is to detect the close eye and open mouth simultaneously and generates an alarm on positive detection. The system firstly captures the real time video using the camera mounted in front of the driver. Then the frames of captured video are used to detect the face and eyes by applying the viola-jones method, with the training set of face and eyes provided in OpenCV. Small rectangle is drawn around the canter of eye and matrix is created that shows that the Region of Interest (ROI) that is eyes used in the next step. Since the both eyes blink at the same time that's why only the right eye is examined to detect the close eye state. If the eye is closed for certain amount of time, it will be considered as closed eye. To determine the eye state, firstly the eye ball colour is acquired by sampling the RGB components on the canter of eye pixel. Then the absolute thresholding is done on the eye ROI based on eye ball colour and intensity map is obtained on Y-axis that show the distribution of pixels on y-axis. Which gives the height of eye ball and compared that value with threshold value which is 4 to distinguish the open and close eye. After that, if the eye blink is detected in each frame, it will be considered as 1 and stored in the buffer and after the

100 frames, eye blinking rate is calculated. Then to detect the yawning motion of the mouth, contour finding algorithm is used to measure the size of mouth. If the height is greater than the certain threshold. It means person is taking yawning. To evaluate the performance of the proposed system, system has been measured under different conditions like persons with glasses, without glasses, with moustache and without moustache for 20 days in different timings. The performs best when the drivers are without glasses and moustache.

CONCLUSION

The brief framework by this literature review we are going to conclude that the project we are developing detects the drowsiness of the driver. This can be met by capturing the face that includes eye state, Head position, Mouth state. If the drivers eyes are closed more than the standard value, the system draws the conclusion that the driver is falling asleep, and then it will activate an alarm sound to alert the driver.

REFERENCES

1. K. Singh and R. Kaur, "Physical and Physiological Drowsiness Detection Methods," vol. 2, no. 9, pp. 35–43, 2013.
2. Ming-ai Li, Cheng Zhang, Jin-Fu Yang.: An EEG-based Method for Detecting Drowsy Driving State. In: Fuzzy Systems and Knowledge Discovery (FSKD), 2010 Seventh International Conference on, 5, pp. 2164-2167, 10-12 Aug. 2010.
3. T. Soukupova and J. Cech, "Real-time eye blink detection using facial landmarks," Computer Vision Winter Workshop (CVWW), 2016
4. L. Barr, S. Popkin, and H. Howarth, ''An evaluation of emerging driver fatigue detection measures and technologies,'' Federal Motor Carrier Saf. Admin., Washington, DC, USA, Tech. Rep. FMCSA-RRR-09-005, 2009.
5.] Er. Manoram Vats and Er. Anil Garg.: Detection and Security System for Drowsy Driver by Using Artificial Neural Network Technique. In: International Journal of Applied Science and Advance Technology January-June 2012, Vol. 1, No. 1, pp. 39-43
6. M. T. R. Peiris, R. D. Jones, P. R. Davidson, G. J. Carroll, and P. J. Bones, "Frequent lapses of responsiveness during an extended visuomotor tracking task in non-sleep-deprived subjects," Journal of Sleep Research, 15, 2006, pp. 291-300.
7. J. L. Kolstad, "Grounding of the US Tankship Exxon Valdez on Bligh Reef, Prince William Sound Near Valdez, AK, March 24, 1989. Washington, DC: National Transportation Safety Board", Washington, 1990.
8. L. Trosvall, and T. Akerstedt, "Sleepiness on the job: continuously measured EEG changes in train drivers," Electroencephalogram Clinical Neurophysiology, 66, 1987, pp. 502-511.
9. I. Teyeb, O. Jemai, M. Zaied, and C. B. Amar, ''A novel approach for drowsy driver detection using Head posture estimation and eyes recognition system based on wavelet network,'' in Proc. 5th Int. Conf. Inf., Intell., Syst. Appl. (IISA), Jul. 2014, pp. 379–384.
10. N. Kuamr, N. C. Barwar, and N. Kuamr, ''Analysis of real time driver fatigue detection based on eye and yawning,''
    a. Int. J. Comput. Sci. Inf. Technol., vol. 5, no. 6, pp. 7821–7826, 2014.