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A Survey Paper On Drowsiness Detection & Alarm System for Drivers

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Abstract - *Our safety is the first priority while travelling or driving. One mistake of the driver can lead to severe physical injuries, deaths and significant economic losses. Nowadays there are many systems available in market like navigation systems, various sensors etc. to make driver's work easy. There are various reasons especially human errors which gives rises to the road accidents. Reports say that there is a huge increment in the road accidents in our country since last few years. The main reason occurring from the highway accidents is the drowsiness and sleepiness of driver while driving. It is a necessary step to come with an efficient technique to detect drowsiness as soon as driver feels sleepy. This could save large number of accidents to occur. We conduct the survey on various designs on drowsiness detection methods to reduce the accidents.*

Key Words: Drowsiness, PERCLOS, Computer-Vision, Accident, Image Processing

1.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. It is estimated 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. 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, Vocal based techniques, Vehicular 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.

1.1 VARIOUS DROWSINESS DETECTION TECHNIQUES

As shown in fig. 1 there are five 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 IV) Vehicular method V) Vocal measures . These approaches are described in the further part of paper.

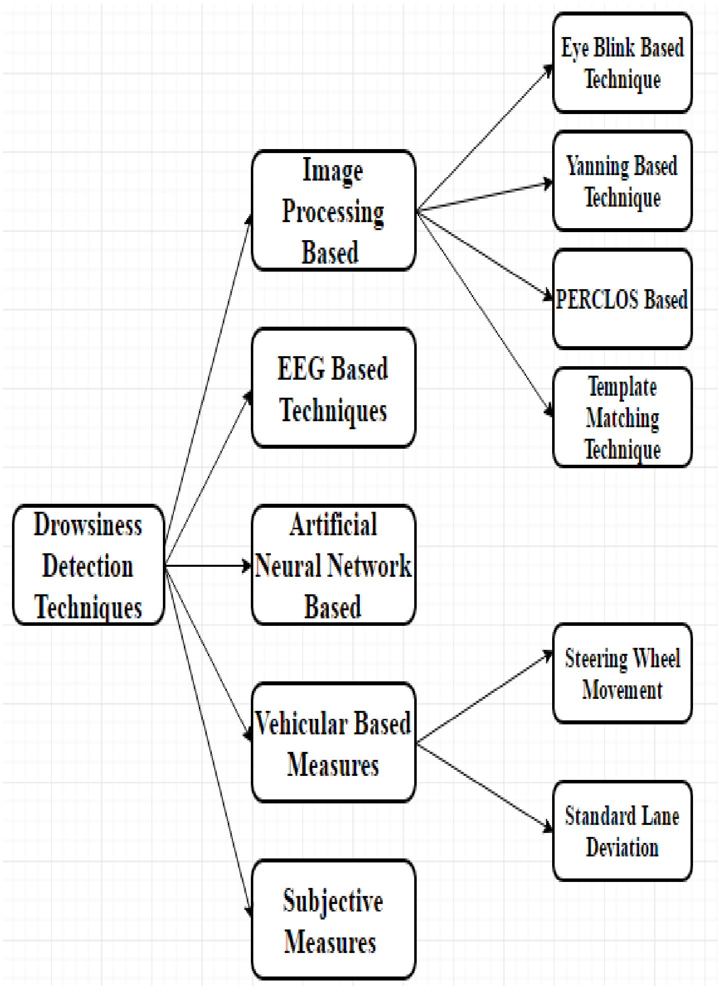

Fig -1: Various Drowsiness Detection Techniques

2. IMAGE 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.

2.1 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 close duration.[16]. And in this type of system uses a remotely placed camera to acquire video and computer vision methods are then applied to sequentially localize face, eyes and eyelids positions to measure ratio of closure.[17] . Using these eyes closure and blinking ratio one can detect drowsiness of driver.

2.2 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. Because 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.

Fig -2: Open Eye And Close Eye Template[4]

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. [8]

2.3 PERCLOS TECHNIQUE

PERCLOS is an established parameter to detect the level of drowsiness. The PERCLOS (the percentage of time that an eye is closed in a given period) score is measured to decide whether the driver is at drowsy state or not. On an average human blinks once every 5 seconds (12 blinks per minute).

2.4 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 [7], they detect yawning based on opening rate of mouth and the amount changes in mouth contour area as shown in figure 3.

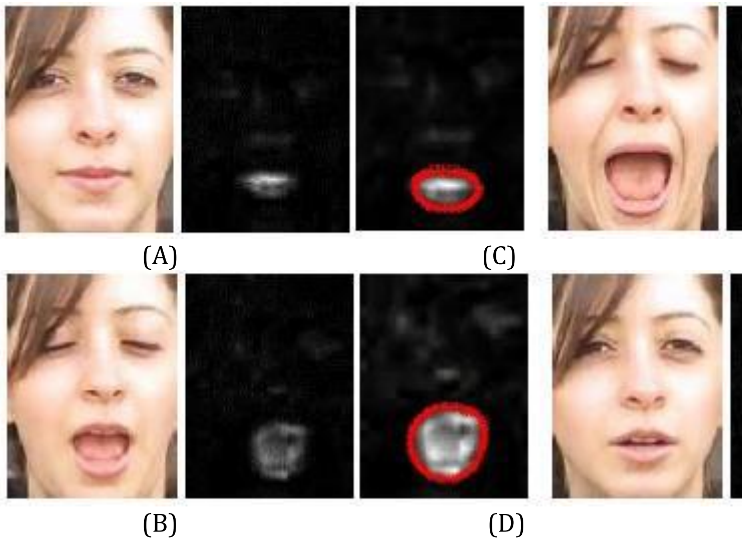

Fig -3: (A)Normal mouth image (B) Staring yawn image (C) Wide open mouth larger then speaking ,its yawn (D) Closing mouth completing yawn. [5]

When yawn is detected by system 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.

3.Artificial Neural Network Based Technique

In this approach they use neurons to detect driver's drowsiness. Only one neuron is always not much accurate and the result of that is not good as compare to more than one neurons. Some researchers [6] 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.

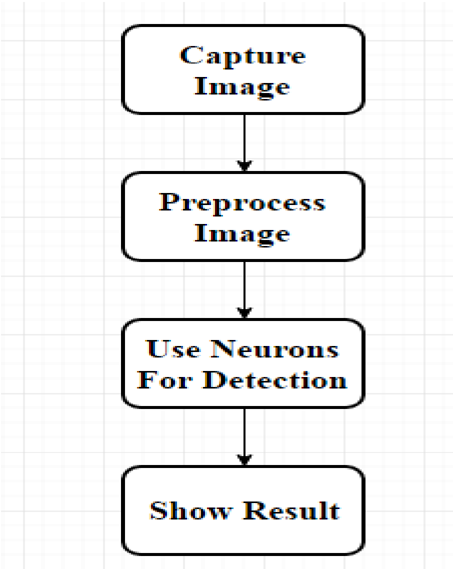

Fig -4: Working Of Artificial Neural Network

4 .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 [5] 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.

Fig -5: EEG data acquisition system[4]

5.VEHICULAR BASED METHODS

Another approach for measuring driver drowsiness involves vehicle-based measurements. In most of the cases, these measurements are determined in a simulated environment by placing sensors on various vehicle components, such as steering wheel and the acceleration pedal; the signals sent by the sensors are then analyzed to determine the level of drowsiness. Some researchers found that sleep deprivation can result in a larger variability in the driving speed [13]. However, the two most commonly used vehicle-based measures are the steering wheel movement and the standard deviation of lane position.

5.1 STEERING WHEEL MOVEMENT(SWM)

SWM is measured using steering angle sensor and it is a widely used vehicle-based measure for detecting the level of driver drowsiness [13]. The driver's steering behavior is measured using an angle sensor mounted on the steering column. When the driver is drowsy, the number of micro-corrections on the steering wheel reduces compared to normal driving . Fairclough and Graham found that sleep deprived drivers made fewer steering wheel reversals than normal drivers [13]. To eliminate the effect of lane changes, the researchers considered only small steering wheel movements (between 0.5° and 5°), which are needed to adjust the lateral position within the lane [12]. Hence, based on small SWMs, it is possible to determine the drowsiness state of the driver and thus provide an alert of drowsy driver if needed. In a simulated environment, light side winds that pushed the car to the right side of the road were added along a curved road in order to create variations in the lateral position and force the drivers to make corrective SWMs . Car companies, such as Nissan, BMW, Volvo, Renault etc. have adopted SWMs but it works in very limited situations . This is because they can function reliably only at particular environments and are much more dependent on the geometric characteristics of the road and to a very less extent on the kinetic characteristics of the vehicle .

5.2 STANDARD DEVIATION OF LANE POSITION (SDLP)

SDLP is another measure through which the level of driver drowsiness can be evaluated [14]. In a simulated environment, the software itself gives the SDLP and in case of field experiments the position of lane is tracked using an external camera. Ingre *et al.* conducted an experiment to derive numerical statistics based on SDLP and found that, as KSS ratings increased, SDLP (meters) also increased [14]. For example, KSS ratings of 1, 5, 8, and 9 corresponded to SDLP measurements of 0.19, 0.26, 0.36 and 0.47, respectively. The SDLP was calculated based on the average of 20 participants; however, with some drivers, the SDLP did not exceeded 0.25 m even for a KSS rating of 9. In the above experiment by performing correlation analysis on a subject to subject basis significant difference is noted. Another limitation of SDLP is that it is purely dependent on external factors like road marking, climatic and lighting conditions. In summary, many studies have determined that vehicle-based measures are a poor predictor of performance error risk due to drowsiness. Moreover, vehicular-based metrics are not specific to drowsiness. SDLP can also be caused by any type of impaired driving, including driving under the influence of alcohol or other drugs, especially depressants [15].

6.SUBJECTIVE MEASURES

Subjective measures that evaluate the level of drowsiness are based on the driver's personal estimation and many tools have been used to translate this rating to a measure of driver drowsiness. The most commonly used drowsiness scale is the Karolinska Sleepiness Scale (KSS), a nine-point scale that has verbal anchors for each step, as shown in Table 1 [12]. Hu *et al.* measured the KSS ratings of drivers every 5 min and used it as a reference to the EoG signal collected [11]. Some researchers compared the self-determined KSS, which was recorded every 2 min during the driving task, with the variation of lane position (VLP) and found that these measures were not in agreement [9]. Ingre *et al.* determined a relationship between the eye blink duration and the KSS collected every 5 min during the driving task [10]. Researchers have determined that major lane departures, high eye blink duration and drowsiness-related physiological signals are prevalent for KSS ratings between 5 and 9 [10]. However, the subjective rating does not fully coincide with vehicle-based, physiological and behavioral measures. Because the level of drowsiness is measured approximately every 5 min, sudden variations cannot be detected using subjective measures. Another limitation to using subjective ratings is that the self-introspection alerts the driver, thereby reducing their drowsiness level. In addition, it is difficult to obtain drowsiness feedback from a driver in a real driving situation. Therefore, while subjective ratings are useful in determining drowsiness in a simulated environment, the remaining measures may be better suited for the detection of drowsiness in a real environment.

Table -1: KSS Sample Table

Karolinska Sleepiness Scale (KSS)	
Rating	**Verbal Descriptions**
1	Extremely Alert
2	Very Alert
3	Alert
4	Fairly Alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, but no effort to keep alert
8	Sleepy, some effort to keep alert
9	Very sleepy, great effort to keep alert

7.ADVANTAGES AND LIMITATIONS OF TECHNIQUES

The following table (Table -2) gives the advantages and limitations of all the techniques that we discussed above. Image Processing techniques are non intrusive in nature and also easy to use but they do not provide high accuracy on which a driver can rely. It is also affected by lighting conditions and background. Whereas EEG based techniques provides better accuracy but they are intrusive in nature .Artificial Neural Network based techniques also provides good results but are time consuming and not easy to implement. Vehicular Measures are more dependent on the geometric conditions like quality of road etc. rather than kinetic properties of vehicle. Subjective measures are questionnaire in nature and hence they are not possible in real time.

Table -2: Approaches Comparison Table

Measures	Parameters	Advantages	Limitations
Image Processing Technique	PERCLOS, Yawning, Eye Blink Rate	Non-intrusive; Ease of use	Lighting condition Background

Artificial Neural Network	Neural Network	Reliable, Accurate	Implement ,calculation intensive
EEG Based Technique	EEG,ECG, Heart Rate	Reliable; Accurate	Intrusive
Vehicular Measures	SWM, SDLP	Non intrusive	Unreliable
Subjective Measures	Questionnaire	Subjective	Not possible in real time

8. CONCLUSIONS

The existing system consists of various approaches like image processing, EEG ,vehicular , vocal measures etc. Any of these approaches doesn't give 100% results. The maximum result is achieved using EEG based approaches but these are intrusive in nature. Other techniques also have some limitations which don't allow them to give perfect result.

Thus on the basis of our study we conclude that if we try with a combination of two or more approaches such that one can reduce the limitations of other approach and thus helps us in providing best result. This can lead us in making a non intrusive and most efficient driver drowsiness detection system. We can combine some image processing approaches with some vehicular measures and physiological measures. Heart rate and respiration rates can be a good example of physiological measures which are clear indicators of drowsiness. To remove the intrusive nature of physiological measures we can use wireless sensors which can be effectively fitted in seat belts, seat covers etc..

REFERENCES

[1] Marco Javier Flores • José María Armingol • Arturo de la Escalera.: Real-Time Warning System for Driver Drowsiness Using Visual Information. In: Springer Science + Business Media B.V. 2009

[2] Luis M. Bergasa, Jesús Nuevo, Miguel A. Sotelo, RafaelBarea, and María Elena Lopez.:Real-Time System forMonitoring Driver Vigilance. In: ieee transactions on intelligent transportation systems, vol. 7, no. 1, march 2006

[3] Mohamad-Hoseyn Sigari, Mahmood Fathy, and Mohsen Soryani.: A Driver Face Monitoring System for Fatigue and Distraction Detection. In: Hindawi Publishing Corporation International Journal of Vehicular Technology, Volume 2013, Article ID 263983, 11 pages

[4] Jay D. Fuletra, Bulari Bosamia: A Survey On Driver's Drowsiness Detection Techniques presented at IJRITCC in November 2013.

[5] 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.

[6] 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

[7] Behnoosh Hariri, Shabnam Abtahi , Shervin Shirmohammadi,Luc Martel.: A Yawning Measurement Method to Detect Driver Drowsiness. In: Distributed and Collaborative Virtual Environments Research Laboratory, University of Ottawa, Ottawa, Canada

[8] D.Jayanthi, M.Bommy. : Vision-based Real-time Driver Fatigue Detection System for Efficient Vehicle Control. In: International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-1, October 2012

[9] Sommer, D.; Golz, M.; Trutschel, U.; Edwards, D. Biosignal based discrimination between slight and strong driver hypovigilance by support-vector machines. In Agents and Artificial Intelligence; Springer: Berlin, Germany, 2010; Volume 67, pp. 177–187.

[10] Ingre, M.; ÅKerstedt, T.; Peters, B.; Anund, A.; Kecklund, G. Subjective sleepiness, simulated driving performance and blink duration: Examining individual differences. J. Sleep Res. 2006, 15, 47–53.

[11] Hu, S.; Zheng, G. Driver drowsiness detection with eyelid related parameters by support vector machine. Exp. Syst. Appl. 2009, 36, 7651–7658.

[12] Otmani, S.; Pebayle, T.; Roge, J.;Muzet, A. Effect of driving duration and partial sleep deprivation on subsequent alertness and performance of car drivers. *Physiol. Behav.* **2005**, *84*, 715–724.

[13] Fairclough, S.H.; Graham, R. Impairment of driving performance caused by sleep deprivation or alcohol: A comparative study. *J. Hum. Factors Ergon.* **1999**, *41*, 118–128.

[14] Ingre, M.; ÅKerstedt, T.; Peters, B.; Anund, A.; Kecklund, G. Subjective sleepiness, simulated driving performance and blink duration: Examining individual differences. *J. Sleep Res.* **2006**, *15*, 47–53.

[15] Simons, R.; Martens, M.; Ramaekers, J.; Krul, A.; Klöpping-Ketelaars, I.; Skopp, G. Effects of dexamphetamine with and without alcohol on simulated driving. *Psychopharmacology* **2012**, *222*, 391–399.

[16] Artem A. Lenskiy and Jong-Soo Lee.: Driver's Eye Blinking Detection Using Novel Color and Texture Segmentation Algorithms. In: International Journal of Control, Automation, and Systems (2012) 10(2):317-327 DOI 10.1007/s12555-012- 0212-0 ISSN:1598-6446 eISSN:2005-4092

[17] Amol M. Malla, Paul R. Davidson, Philip J. Bones, Richard Green and Richard D. Jones, "Automated Video-based Measurement of Eye Closure for Detecting Behavioral Microsleep" presented at 32nd Annual International Conference of the IEEE EMBS Buenos Aires, Argentina, August 31 -- September 4, 2010