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A survey on Driver Drowsiness Detection Algorithms

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Abstract:

The drowsiness in drivers increases the risk of human-error related accidents. Driver's state of mentality and tiredness is one of primary reasons of motor vehicle accidents. It is important for a driver to be observant about the vehicle condition and surrounding area while driving. Drivers with fatigue are found to have decreased observation levels which poses a serious problem to their own life and lives of other persons. In order to prevent such accidents, there rises a necessity for detecting drowsiness efficiently. This survey paper discusses various methods used for drowsiness and fatigue detection.

Keywords — **Fatigue detection, Image processing, SVM, Haar classifiers**

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I. INTRODUCTION

In recent times road accidents related to unfocused driving are increasing in an alarming rate. Fatigue and drowsiness are primary reason for lack of concentration during driving. Fatigue in drivers are caused by extended awake time and reduced sleeping periods. It is necessary to detect drowsiness and fatigue in drivers to avoid fatalities in road accidents. Emerging trends in image processing algorithms paves way for accurate and high-speed fatigue detection methods. This paper presents a survey on various fatigue and drowsiness detection algorithms.

II. DRIVER FATIGUE AND DROWSINESS

Drivers in trucking company and public transport systems have prolonged work hours. Their resting periods are short which causes decreased sleeping time. Studies shows that 8 to 9 hours of extended nocturnal sleep are needed to resolve sleepiness caused by decreased sleep time. This reduced sleeping time causes fatigue and ultimately drowsiness in drivers.

Drowsiness while driving becomes fatal to the driver as well as other people in the vicinity. It is a necessity to identify the symptoms of fatigue and drowsiness in drivers to prevent such accidents.

A. Face in normal condition

The facial features of a well-rested person consist of clear and vibrant eyes. Their blinking rates are normal and yawns rarely occur.

Fig. 1 Eyes of rested person

B. Face in drowsy condition

A person with fatigue primarily has red eyes. Due to tiredness their eyelids droop and have high blinking rate. Drowsiness is usually accompanied by frequent yawning.

Fig. 2 Eyes of fatigued person

The signs of fatigue and drowsiness are evidently visible in a person's face. Thus, analysing a facial feature of a driver, eye state particular, enables us to evaluate their physical condition.

III. LITERATURE SURVEY

Qiang Ji, Zhiwei Zhu, and Peilin Lan et al., (2004), describes a real-time online prototype driver-fatigue monitor. Various visual cues that typically characterize the level of alertness of a person are extracted in real time and systematically combined to infer the fatigue level of the driver. The visual cues employed characterize eyelid movement, gaze movement, head movement, and facial expression. A probabilistic model is developed to model human fatigue and to predict fatigue based on the visual cues obtained. The simultaneous use of multiple visual cues and their systematic combination yields a much more robust and accurate fatigue characterization than using a single visual cue.[1]

Yulan Liang, Michelle L. Reyes, and John D. Lee et al., (2007), proposed use of in-vehicle information systems (IVISs) such as cell phones, navigation systems, and satellite radios has increased, driver distraction has become an important and growing safety concern. To realize this strategy, this paper applied support vector machines (SVMs), which is a data mining method, to develop a real-time approach for detecting cognitive distraction using drivers' eye movements and driving performance data. These results demonstrate that eye movements and simple measures of driving performance can be used to detect driver distraction in real time.

Ji Hyun Yang, Zhi-Hong Mao et al., (2009), revealed the characteristics of drowsy driving through simulator-based human-in-the-loop experiments. It is observed that drowsiness has greater effect on rule-based driving tasks than on skill-based tasks. It is confirmed this finding by inferring driver alertness using the BN paradigm. Based on this paper, it suggested that the driving performance of the rule-based tasks should be investigated further for the effective design of drowsy-driver detection systems. The rule-based tasks examined in our experiments were RT tasks and tracking tasks with unexpected disturbances. Other rule-based tasks such as stopping at traffic signals should be examined. Skill-based tasks, which cover most driving tasks, should also be considered in the detection system.[3]

B.-G. Lee S.-J. Jung W.-Y. Chung et al., (2011), demonstrated an ingenuity method that combined both computer vision and physiological bio-signals for drowsiness detection. Initially, PCA model indicated the face region; follow by determination of eye region using GA based on face segment. The eye pattern is further classified by optimising the minimum differences between the target eye region and the template eye regions. Certain PPG waveform characteristics can present significant changes when a driver alertness level is decreasing. Fitness function integrated both vision and bio-signal to justify a driver fatigue level presented higher reliable and valid drowsiness detection for safety awareness.[4]

Shuyan Hu, GangtieZheng et al., (2012), studies have shown promising results in applying the proposed detection system by EEG. A new ICA-R algorithm is proposed together with the GramSchmidt orthogonal to remove EOG from seriously contaminated EEG and the presented ICA-R approach is proved to perform superiorly than adaptive filter in coefficient tests. EEG spectrum feature extraction and selection are then carried out. Seventy-five features are extracted and in order to reduce computation and improve the detection accuracy, SVM-RFE is applied to find the optimal feature number and combination. The results show that SVM-RFE effectively extracts a subset of 40 key features leading to a higher accuracy and features can be downsized to nearly half, thus reducing the complexity of the model.[5]

Kanchan Manohar Sontakke et al., (2015), researches show that in order to the drowsy driver, this paper contains a new fatigue driving detection algorithm. Experts told that such drivers who do not take usual break, when driving long distance can be feeling sleepy. Most of the severe road accidents are caused by sleepy drivers than drink driving.

In order to avoid accidents fatigue detection method will detect early signs of fatigue in drivers. If driver is falling symptoms of weariness then immediately message is generated that driver is fatigue, then this message will be transferred to the control room in COMMAND navigation system that indicating status of driver. The fatigue is detected in the system by image processing method of comparing the images in video and by using human features we will detect the driver is fatigue or not.[6]

Bappaditya Mandal, Liyuan Li et al., (2017), presented a vision-based method and system towards bus driver fatigue detection using existing dome cameras in buses. Our approach starts with the detection of head-shoulders of the figure in the image, followed by face and eye detections and eye openness estimation. Finally, a multi-model fusion scheme is designed to infer eye state and a PERCLOS measure on the continuous measure of eye openness is computed to predict driver's attention state, i.e., normal or fatigue driving state. Experimental results show that our proposed method is able to distinguish the simulated drowsy and sleepy states from the normal state of driving on the low-resolution images of faces and eyes observed from an oblique viewing angle. Hence, our system might be able to effectively monitor bus driver's attention level without extra requirement for cameras.[7]

Fnu Rohit, Vinod Kulathumani et al., (2017), proposed system has a broad range of applications in vehicular safety. We would like to build on these results and collect data over a longer term using the wearable EEG sensors in an actual vehicular setting inside surface mines. This data can be used to understand the issue of driver fatigue in more detail and help in designing better work hours and shifts. Drowsiness data can also be used to develop personalized work shifts for drivers based on their specific pattern of drowsiness. We also intend to explore real-time warning systems that use a combination of blink analysis and spectral data for more accurate and timely warnings.[8]

Lei Zhao. Zengcai Wang, Xiaojin Wang et al., (2017), demonstrated propose a driver drowsiness expression classification method that uses dynamic facial fusion information and a DBN. The facial texture and landmarks are extracted from image sequences and fused by using DBN to enhance the performance of driver drowsiness detection. We assess the effects of different facial subregions on recognition accuracy and determine that combining the eye and mouth areas can result in the highest recognition accuracy. We also investigate the effects of different frame rates on the recognition results. The results show that the method using a 24fps video exhibits the most effective performance. The results of the experiments indicate that the dynamic landmark and texture of the facial region can effectively reveal the facial drowsiness status of the driver. The average accuracy of our method is 96.7% on a database that we built. The proposed method outperforms four state-of-the-art driver fatigue recognition methods. [9]

Chung Kit Wu, Wing Kuen Li et al., (2017), studies reveal that a driver drowsiness classifier (DDC) based on the ECG signals is developed. Also, a self-defined kernel is designed and implemented based on the optimal correlation analysis. The convolution kernel is fused with the cross-correlation kernel by a genetic algorithm. In the performance evaluation, the DDC obtains an overall accuracy of 97.01%, the sensitivity of 97.16% and the specificity of 96.86%. If either the convolution or the cross-correlation kernel is employed, then the performance of the classifier will be degraded by more than 10% on average. From the statistical viewpoint, 97% of the accidents are caused by the drowsy drivers. Hence, if the developed DDC is fully utilized in the worldwide market, then 1.26 million people may be rescued and 48.5 million traffic injuries may be avoided. This also saves more than 500 billion USD in the medical expenses.[10]

Table 1. COMPARISONS OF VARIOUS EXISTING METHODS

Author(s) Name	Paper	Technique	Application
QiangJi, Zhiwei Zhu, and Peilin Lan	Real-Time Nonintrusive Monitoring and Prediction of Driver Fatigue	Kalman filter eye tracker combined with the mean shift eye tracker.	Computer vision system for real-time monitoring of a driver's vigilance.
Yulan Liang, Michelle L. Reyes, and John D. Lee.	Real-Time Detection of Driver Cognitive Distraction Using Support Vector Machines	In-vehicle information systems with support vector machines (SVMs)	Safety Vehicle(s) using adaptive Interface Technology (SAVE-IT) program.
M. Imran K han,A. Bin Manso or.	Real Time Eyes Tracking and Classification for Driver Fatigue Detection	Successive Mean Quantization Transform (SMQT)	Identification of partially-closed eye(s) feature.
Ji Hyun Yang, Zhi-Hong Mao.	Detection of Driver Fatigue Caused by Sleep Deprivation	Probabilistic framework based on the paradigm of Bayesian networks.	Drowsiness detection using Driver-vehicle interaction.
B.G. Lee, S.J. Jung. W.Y. Chung.	Real-time physiological and vision monitoring of Vehicle driver for non-intrusive drowsiness detection	PPG (Photo-plethysmogra phy) and Eye pattern matching.	Drowsiness detection using Bio-signals and facial expression.
Shuyan Hu, Gangtie Zheng.	Driver fatigue detection from electroenceph alogram spectrum after electrooculogr aphy artefact removal	Electroen-cephalogram (EEG) power spectrum analysis.	Electrooculog raphy (EOG) artificial removal from EEG signals for fatigue detection.
Kanchan Manohar Sontakke	Efficient Driver Fatigue Detection and Alerting System	Surface feature detection algorithm	Driver fatigue detection.
Bappaditya Mandal, Liyuan L.	Towards Detection of Bus Driver Fatigue Based on Robust Visual Analysis of Eye State	Modified crystalli-sation filter for eye(s) feature detection.	Driver exhaustion detection.
WangMei, GuoLin, ChenWen-Yuan.	Blink detection using Adaboost and contour circle for fatigue recognition	Adaboost and contour circle for fatigue recognition	Blink rate detection and the accuracy of fatigue blink recognition.
Vikram. K, R.S.Padma vathi	Facial parts detection using viola Jones algorithm	Modified Viola-Jones face detection algorithm.	Facial feature identification for fatigue detection.
Fnu Rohit, Vinod Kulathu-mani, Rahul Kavi, Ibrahim Elwarfalli, Vlad Kecojevic, Ashish Nimbarte	Real-time drowsiness detection using wearable, lightweight brain sensing headbands	EEG spectrum analysis	Blink detection for Driver fatigue identification
Kwok Tai Chui, Kim Fung Tsang, Hao Ran Chi, Bingo Wing Kuen Ling, Chung Kit Wu	An Accurate ECG Based Transpor-tation Safety Drowsiness Detection Scheme	ECG genetic algorithm based support vector machine.	Sleepiness detection using ECG analysis.
Lei Zhao, Zengcai Wang, Xiaojin Wang	Driver drowsiness detection using facial dynamic fusion information and a DBN	Modified Viola–Jones face detection Algorithm.	Facial landmark location and tracking, feature extraction, data pre-processing and DBN construction for classifying driver drowsiness.

Minho Choi, Gyogwon Koo, Minseok Seo	Wearable Device-Based System to Monitor a Driver's Stress, Fatigue, and Drowsiness	Analysis of Bio signals using non-intrusive wearable sensors.	Stress, fatigue, and Drowsiness detection.

IV. CONCLUSIONS

In this paper we have discussed various Drowsiness detecting techniques and algorithms. Spectrum analysis of Bio signals from ECG, EEG and EOG, Physiological information such as eye(s) and facial movement detection techniques are employed by the researchers. These techniques primarily concentrate in identifying driver's fatigue detection for accident prevention.

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