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A Survey on Driver Fatigue-Drowsiness Detection System

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Abstract: *One of the major reasons for road accidents now a days is due to driver fatigue. Be it long distant travelling or drunk driving drowsy state leads to risky crashes which is hazardous to lives as well. To overcome such accidents some method has to be developed that is feasible to all vehicle drivers . This paper is a survey based on various methods for preventing road accidents and designs on drowsiness detection methods which were proposed and have advantages and disadvantages.*

Keywords: OpenCV, PERCLOS, PERLOOK

1.INTRODUCTION

Sleepiness during driving is a major cause for road accidents. Most people thought that drunken driving is the serious cause of accidents and unaware of drowsy driving which is just fatal. It also deteriorates vigilance, concentration and alertness so that the ability to perform different consciousness-based activities (such as driving) is impaired, decreases awareness,reduces judgment and increases the risk of crashing. Road accidents caused due to driver fatigue is more serious and leads to death other than drunken driving and rush driving accidents due to drowsiness is more crucial because the driver is loss the consciousness which leads to serious injuries or death. Not only the people traveling in vehicles are the victims. The pedestrians will also get affected.

The cause of a fatal crash where drowsy driving involves is nearly impossible to determine with certainty. However, the investigators tell that there are a number of clues at a crash scene that shows the person fell asleep at the wheel. For example, accidents due to drowsy driving occurs usually in vehicles where the driver is alone and the injuries seems to be serious or fatal, especially during nights the drivers drive under stress on highways and as a result, they mostly lose control over the vehicle and become the victims of accidents.

We conduct the survey on various designs on drowsiness detection methods to reduce the

accidents, which are implemented using Computer Vision as well as Image Processing which are related to each other. Image processing means processing the images, that means analyze the images and produce results for the further experiment. Computer Vision deals with extraction of high dimensional data from computers and convert it into symbolic notations or digital.images or videos. In the view of engineering, it's main aim is to automate tasks that the human visual system can do whereas Image Processing use mathematical operations and any form of signal processing. Here the input signal processing can be an image, a series of images, or a video.

The various steps in drowsiness detection are image acquisition, face detection, eye area extraction, blink detection, yawning detection etc. Various experiments are conducted using Android Auto and Android OpenCV which can be installed in low cost smartphones. Different experiments have been conducted which resulted in high accuracy of driver distraction in different camera locations and vehicles. A real time Image Processing technique, OpenCV which is having patent free implementations on latest Computer Vision algorithms. It contains all libraries for vision based algorithms. Different implementation methods are explained in the remaining parts.

Section II describes survey of all methods in details and Section III concludes with a brief summary.

2. LITERATURE REVIEW

A survey was done among different proposals and this survey paper includes survey among different methods for preventing accidents while driving.

The paper[1] addresses the development of a system that is able to deal with a large set of different traffic situations. The input to the system comes from cameras, which are supplemented by active sensors (such as radar and laser scanners) and vehicle dynamic data, digital road maps, and precise vehicle-positioning data.

The system is structured on a model-based approach with the use of vehicle-side technologies. Its decomposition is made in three layers: the perception layer, the decision layer, and the action layer. The perception layer consists of a sensor system and image processing. The basic input comes from cameras that are monitoring the road in front of the vehicle. The cameras are supplemented by vehicle controller area network (CAN) bus data, digital road maps, and precise vehicle positioning (GPS). Radar provides supplementary information that is integrated in the data-fusion module. The action layer comprises all system reactions in critical lane-

departure situations and involves the control of acoustic or/and haptic warning actuators, as well as an active steering actuator. The decision layer determines the current overall situation using a situation model with respect to the driver state, the actual driven maneuver, the environment, the lane, and the street condition. Based on the identified situation, the decision model determines the output to be sent to the actuator system. Input parameters are the most likely path (MLP) of the vehicle, the fused lane data, as well as the estimated future vehicle trajectory. Vehicle data like velocity, steering angle, and yaw rate are also integrated.

The paper[2] presents a driver-monitoring systems that contains both drowsiness detection method and distraction detection method. Drowsiness involves a driver closing his eyes because of fatigue, and distraction involves a driver not paying sufficient attention to the road despite the presence of obstacles or people. Here an eye-detection algorithm is designed which combines adaptive boosting, adaptive template matching, and blob detection with eye validation. Also a novel eye state–detection algorithm that combines two techniques PCA and LDA is used.
It consists of face-detection, head orientation– estimation, eye-detection, eye-state–detection, drowsiness-detection, and distraction-detection steps. The distraction and drowsiness are determined from the head pose of a driver. The driver-drowsiness level is measured as PERCLOS, which is the percentage of eye closure time during a certain time interval. Similarly, the distraction level is measured as PERLOOK, which is the percentage of time spent not looking ahead during a certain time interval. Here the computational cost of system can be decreased and also eye-detection errors and the consequent false alarms for drowsiness are decreased. The proposed system works during both day time and night time.

This paper [3] presents a non-invasive system to detect individuals driving under the influence of alcohol by measuring biological signals. We used the frequency time series
analysis to attempt to distinguish between normal and intoxicated states of a person as the basis of the sensing system.

Here a seat incorporating an air pack sensor that can be attached to an existing automobile seat and reported the capabilities of this seat for non-invasive detection of impairment of a driver who has consumed alcohol. The sensor system in the seat has since been improved. Biological signals were detected from the back of the driver using the air-pack sensor, a noninvasive and non confining method. The extracted signal was defined as an air-pack pulse wave (AP-PW). An algorithm for the detection of alcohol-impaired driving was generated from investigations of the AP-PW.
This paper tries to invent a novel system for monitoring drivers non-invasively and detecting the drivers' drinking after they start driving. It proposes a new algorithm of the frequency time series analysis to distinguish between the normal and intoxicated states of a person. Measurements of the AP-PW for 20 min also revealed differences due to the consumption of alcohol, suggesting that the AP-PW contains potential information to distinguish sobriety from intoxication.

This [4] paper describes a pedestrian detection system that integrates intensity information with motion information. The human motion pattern is well known to be readily distinguishable from other sorts of motion. Here a detection style algorithm which combines motion and appearance information to build a robust model of walking humans is used. The system robustly detects pedestrians from a variety of viewpoints with a low false positive rate.
The basis of the model is an extension of the rectangle filters to the motion domain. The advantage of these simple filters is their extremely low computation time. As a result, the pedestrian detector is very efficient.

In this paper a detection style approach using information about motion as well as intensity information is described. The system is trained on full human figures and does not currently detect occluded or partial human figures.
This paper include representation of image motion which is extremely efficient, and implement a state of the art pedestrian detection system which operates on low resolution images under difficult conditions . Detection style algorithms are fast, perform exhaustive search over the entire image at every scale, and are trained using large datasets to achieve high detection rates and very low false positive rates.

The paper[5] proposes a method for monitoring driver safety levels using a data fusion approach based on several discrete data types: eye features, bio-signal variation, in-vehicle temperature, and vehicle speed. The driver safety monitoring system was developed in practice in the form of an application for an Android-based smartphone device, where measuring safety-related data requires no extra monetary expenditure or equipment. Moreover, the system provides high resolution and flexibility. The safety monitoring process involves the fusion of attributes gathered from different sensors, including video, electrocardiography, photoplethysmography, temperature, and a three-axis accelerometer, that are assigned as input variables to an inference analysis framework. The sensory data are transmitted via Bluetooth communication to the smartphone device. A fake incoming call warning service alerts the driver if his or her safety level is suspiciously compromised. Realistic testing of the system demonstrates the practical benefits of multiple features and their fusion in providing a more authentic and effective driver safety monitoring.

Even though existing drowsiness monitoring systems perform well, they have limitations in terms of their approach. For instance, methodology that uses facial features requires a long moving-averaged window to track slow changes in a driver's vigilance. In the case of bio-signal processing, existing techniques require that sensors be attached to the human body to obtain vital signs. This could distract the driver and cause discomfort.

The objective of this paper was to develop a reliable, well-controlled and non-intrusive

drowsiness monitoring system that comprises the following aspects: (1) fusion of attributes or data that are obtained from sensory data to derive an accurate drowsiness prediction; (2) implementation of a multi-functional monitoring system in an Android-based smartphone device; (3) integration of a Fuzzy Bayesian network in a smartphone device to predict the driver's aptitude and alertness state over time; (4) a low-cost solution for capturing the driver's image using the front-facing video sensor of a smartphone device; and (5) a reliable fake incoming call type alert system to warn and wake the driver without generating adverse effects on the driver.

The paper[6] proposes a highly efficient system aimed at early detection and alert of dangerous vehicle accidents related to drunk driving. The entire solution requires only a mobile phone placed in vehicle and with accelerometer and orientation sensor. A program installed on the mobile phone computes accelerations based on sensor readings, and compares them with typical drunk driving patterns extracted from real driving tests. Once any evidence of drunk driving is present, the mobile phone will automatically alert the driver or call the police for help well before accident actually happens. The detection system is implemented on Android G 1 phone and have it tested with different kinds of driving behaviors. The results show that the system achieves high accuracy and energy efficiency.This system only bounded toa system which reduces drowsiness due to drunk driving.

Driver's fatigue is one of the major causes of traffic accidents, particularly for drivers of large vehicles (such as buses and heavy trucks) due to prolonged driving periods and boredom in working conditions. In the paper[7] proposes a vision-based fatigue detection system for bus driver monitoring, which is easy and flexible for deployment in buses and large vehicles.The system consists of modules of head-shoulder detection, face detection, eye detection, eye openness estimation, fusion, drowsiness measure percentage of eyelid closure estimation, and fatigue level classification. The 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 this 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, the system might be able to effectively monitor bus driver's attention level without extra requirement for cameras. One more issue is how to exploit the fatigue detection to improve driver safety in the drowsiness situations.

In this paper[8] ,a demo which presents a vision-based smart environment using in-car cameras that can be used for real time tracking and monitoring of a driver in order to detect the driver's drowsiness based on yawning detection. As driver fatigue and drowsiness is a major cause behind a large number of road accidents, the assistive systems that monitor a driver's level of drowsiness and alert the driver in case of vigilance can play an important role in the prevention of such accidents. The system is built on the top of an embedded platform, that is easy and practical for installation inside a car. Moreover, they have aimed at optimizing the system in a way that it meets the real time requirements of the monitoring task while relying on the limited processing power of the embedded platform.

Continuous monotonous driving for long hours without rest causes drowsiness and consequently fatal road accidents. This paper[9] which proposes automatic driver drowsiness detection,which can prevent a vast number of sleep persuaded road accidents, and hence can save precious lives. Number of techniques for driver drowsiness detection has been examined in the recent past. These techniques detect the driver drowsiness by observing the driving pattern. Abnormalities in driving pattern is hypothesized as a drowsiness state of driver. Various measures such as subjective, behavioral, physiological, and vehicular have been used for this purpose. The comparative analysis of these techniques indicates that behavioral measures are easy to acquire and does not disturb the driver as they are non-invasive. Among various behavioral measures, head movement measure is found to be most precise and effective.

The paper[10] describes a real-time online prototype driver-fatigue monitor. It uses remotely located charge-coupled-device cameras equipped with active infrared illuminators to acquire video images of the driver. 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. This system was validated under real-life fatigue conditions with human subjects of different ethnic backgrounds, genders, and ages; with/without glasses; and under different illumination conditions. It was found to be reasonably robust, reliable, and accurate in fatigue characterization.

Through research presented in this paper, we developed an nonintrusive prototype computer vision system for real-time monitoring of a driver's vigilance. First, the necessary hardware and imaging algorithms are developed to simultaneously extract multiple visual cues that typically characterize a person's level of fatigue. Then, a probabilistic framework is built to model fatigue, which systematically combines different visual cues and the relevant contextual information to produce a robust and consistent fatigue index. These visual cues characterize eyelid movement, gaze, head movement, and facial expression. The main components of the system consist of a hardware system for the real-time acquisition of video images of the driver and various computer vision algorithms and their software implementations for real-time eye tracking, eyelid-movement-parameters computation, eye-gaze estimation, facial-pose determination, and facial expression analysis. To

effectively monitor fatigue, a BN model for fatigue is constructed to integrate these visual cues and relevant contextual information into one representative format. Experiment studies in a real-life environment with subjects of different ethnic backgrounds, genders, and ages were scientifically conducted to validate the fatigue-monitoring system. The validation consists of two parts. The first involves the validation of the measurement accuracy of our computer vision techniques and the second studies the validity of the fatigue parameters that we compute in characterizing fatigue. Experiment results show that our fatigue monitor system is reasonably robust, reliable, and accurate in characterizing human fatigue. It represents the state of the art in real-time, online, and nonintrusive fatigue monitoring.

3. CONCLUSION

About 20% of road accidents occur due to distraction of driver. Among that 30% is due to driver fatigue. There are many methods to monitor driver and there by alert him/her in case of distraction. This survey is conducted to study various methods to detect the driver fatigue and to select an appropriate method to detect the causes of driver's distraction. Inorder to reduce road accidents there is also a need to detect the causes such as drowsiness, fatigue and to alert the driver. This survey enables to choose an efficient method to reduce road accidents due to driver fatigue.

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