DRIVER BEHAVIOR ANALYSIS USING NON-INVASIVE SENSORS

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ABSTRACT

Detecting driver distraction has been an important research topic over the past few years. While there are many common reasons for vehicle crashes, driver distraction and inattention are very prominent causes. Previous studies have shown the impact that inattentions can have on driving behavior, which can lead to many crashes and fatalities. The study reported by The National Highway Traffic Safety Administration (NHTSA) indicated that over 25% of police-reported crashes involved inattentive drivers. The 100-car Naturalistic Study concluded that over 65% of near crashes and 78% of crashes included inattention. These high percentages are not surprising, since 30% of the time drivers are in a moving vehicle, they are engaged in secondary tasks that are potentially distracting. These numbers are estimated to increase as the usage of in-vehicle technologies for navigation, communication and infotainment, and the number of cars on the roads is expected to exponentially increase in the next years. A driver monitoring system that is able to sense inattentive drivers can play an important role in reducing the number of accidents, preventing fatalities and increasing the safety on roads. In this paper Monitoring driving habits of a person is presented, which is based on CAN network. The CAN bus is used as a communication of a distributed control network. This paper mainly introduces the design of the hardware and the software in detail. This device track speed, Engine temperature and Alcohol consumption status.

I INTRODUCTION

There has always been a rapid development of technology in every field. In past few years with the implementation and fast development of the in-vehicle technologies especially in the cars had lead to the vast increase in the unintentional accidents. These accidents are caused by the distraction in the driver's attention due to the involvement in the secondary tasks like operating the radio, GPS, and other in-vehicle technologies. The driver distractions are detected using the various non-invasive sensors. The driver is made to involve in the secondary tasks like operating on the radio, navigation systems like GPS(Global Positioning System) and mobile phones, etc. The changes in the driver's behavior is detected by comparing the values obtained by the sensors when the driver is involved in secondary tasks and when he is not involved in the secondary tasks.

When any abnormality is detected in any of the sensors then the safety measures like indication by the side lights, an alarm system, gradually closing the valve of the fuel tank and the opening of the airbag are taken.

The paper is organized as follows: Section 2 presents the open challenges currently existing in the real time and the related works done in this field of analyzing the driver's behavior. Section 3 describes the methodology of the data collection and the working procedure of the system. Section 4 studies the effects in driver behavior induced by the secondary tasks, including the statistical analysis of multimodal features and discriminative analysis between normal and task driven conditions. Section 5 concludes the paper with final remarks, limitations of the study and the further research directions.

II RELATED STUDIES

Secondary tasks deviate the driver's attention from the primary driving task [1]. Various activities have been proposed to induce cognitive and/or visual distractions. For cognitive distractions, common approaches include solving math problems [2], [3], [4], [5], talking to another passenger [1], [6], and focusing on other activities such as following the stock market [5]. Common secondary tasks for visual distraction are "look and find" tasks [7], [3], [8], operating devices such as a touchscreen [1], or a cellphone [9], and reading sequences of numbers [2]. While these cognitive and visual tasks clearly affect the driver, some of them may not represent the common distractions observed in real scenarios.

While most of the studies on driver behaviors rely on simulators [10], [11], [3], [1], [8], some studies have considered recordings in cars equipped with multiple sensors [2], [12], [13], [14], [6], [15]. Perez et al. [12] presented the "Argos" system for data collection. Murphy-Chutorian and Trivedi [13] reported results on data recorded in the LISA-P experimental testbed. The car has video and motion cameras with near- IR illuminator[. They have used computer visual algorithms to automatically extract visual information, achieving promising results towards detecting driver distraction. Another data collection vehicle was designed by Takeda et al. [16]. The car is equipped with cameras and microphones, laser scanners (front, back), pedal pressure and physiological sensors. A similar car was designed by Abut et al. [17] called UYANIK. The UTDrive is another car platform,[18], [19]. These cars provide more realistic data to study driver behaviors.

Frontal cameras can be useful to assess the distraction level of the driver [13], [20]. Relevant visual features include head pose, gaze range and eyelid movements [2], [7], [8],[21], [22]. Liang et al. [7] showed that eye movements and driving performance measures were useful for detecting cognitive distraction. Su et al. [21] presented an approach to monitor visual distractions using a low cost camera. The study relied on eyelid movements and face orientation to predict driver's fatigue and distraction. Azman et al. [22] used eye and lip movements to predict cognitive distractions in simulated environment. Kutila et al. [2], [4] extracted gaze angle, head rotation and lane position for cognitive distraction detection. Bergasa et al. [14] proposed to predict fatigue with percent eye closure (PERCLOS), eye closure duration, blink frequency, face position, fixed gaze and nodding frequency. They used IR illuminator to mitigate the changes in illumination. A similar approach was presented by Zhu and Ji[23]. Other studies have considered cameras for capturing and modeling foot gestures for brake assistance systems [24], [25],[26].

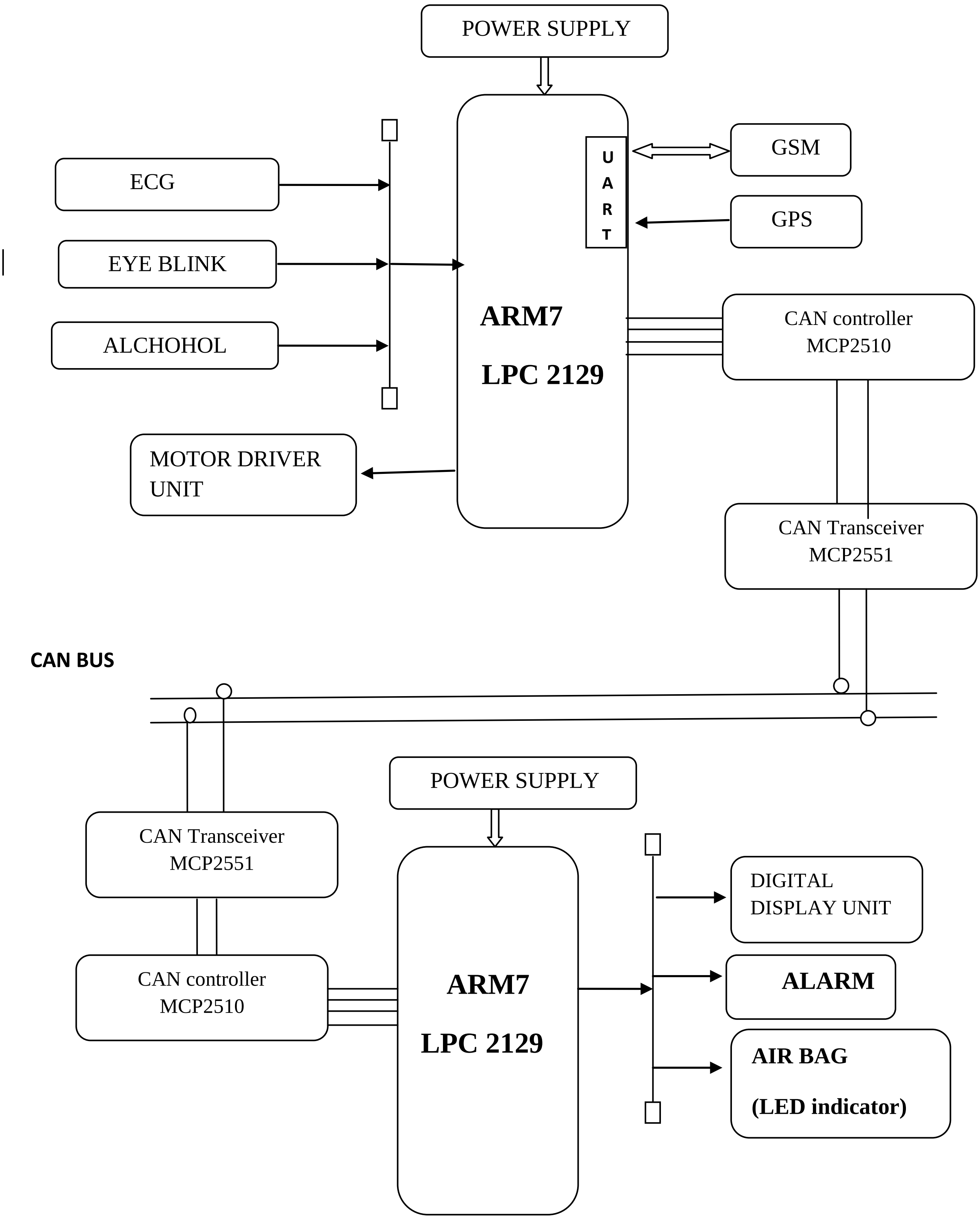

Fig 1: Working Modality of the Module

III METHODOLOGY AND WORKING MODALITY

A real-world driving study inherently involves numerous uncontrollable variables such as traffic, weather and traffic lights which are not easily replicated in a simulated environment. This analysis aims to identify relevant features that are directly affected by the driver's behaviors, and to use these features to quantify the distraction level of the drivers.

Before the motor can start the driver has to give the alcohol test. If any alcohol content is detected then the valve of the fuel tank will be closed. When no alcohol content is detected then the motor starts. While driving the sensors like eye blink and pulse sensors will monitor the eye blink and heart beat continously. If any abnormalaties are detected then the accident preventive measures like the opening of the air bag, sounding the alarm system and indication using the side lights are taken. The vibration due to the crash by the other vehicle can be detected using the vibration sensor and if any vibration due to the crashes is detected, then the accident preventive measures are taken.

With the help of the CAN(Controller Area Network Bus the signals from a controller which monitors the driver's behavior and to which the sensors are interfaced is communicated to the other controller to which the external features are connected. In case the accident occurs then the message about the accident is given through the GSM technique. The position of the car is tracked using GPS (GLOBAL POSITIONING SYSTEM).

The output of the heart beat sensor is active high for each and every heartbeat and this can be given to the microprocessor. LED flashes for each heartbeat whenever sensor starts working. The sensor works on the basis of light modulation by blood flow through finger for each pulse.

Fig 2: ECG Sensor

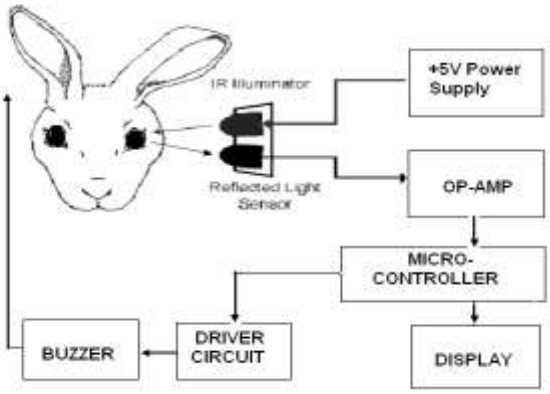

Fig 3: Eye blink sensor

The EBM (Eye Blink Monitoring) system works on the principle of monitoring eyelid movements of the person inside the vehicle continuously by the use of an IR sensor. Whenever the driver falls asleep, then the buzzer will rang to wake him up.

The Alcohol breathalyzer estimates the Blood Alcohol Concentration by detecting and measuring the presence of the ethanol vapour in our breath. The alumina tube and the coils are the heating system, the yellow, brown parts and the coils in the picture. If the coil is heated up SnO2 will become the semi conductor further we can find more movable electrons, which indicates the current flow is ready. Whenever the alcohol gas molecules meet the electrode which is present in the air, then gradually ethanol in the air burns into acetic acid which further produces more current.

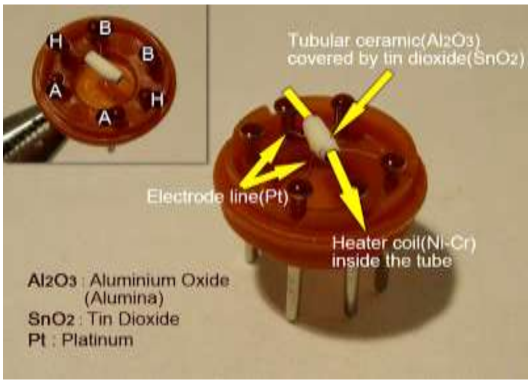

Fig 4: Gas sensor

IV EFFECTS IN DRIVER BEHAVIOR

The secondary tasks force the driver to be distracted from the primary task which is driving. These distractions in the driver behavior can be detected by using a series of sensors.

The normal pulse rate of the human being is about 72 heart beats per second. In case of any stroke or any other problems related to the heart beat then the count of the heart beat varies from the normal value. The range from 65 to 80 heart beats is considered to normal. If the pulse rate is not in this range then the driver's behavoir changes due to the abnormalities.

The normal eye blink rate is about 15 to 20 blinks or lesser. When the driver is in drowsy state the number of blinks may increase than the normal level as the driver tries to come out of the drowsy state or the eye lids remain closed for a longer period than it is required for the normal eye blink.

The breath of the person who is not drunk does not contain any alcohol content or very minute traces of the alcohol. If the breath contains more than the allowed level of the alcohol content then it is concluded that the person is in drunken state.

V CONCLUSION

The system proposed in the paper is a fully functional automatic mentoring system which is a step ahead of presently available in terms efficiency, accuracy and simplicity. The system is designed with an objective of minimizing road accidents that occur due to over speeding. The algorithm used for position matching and subsequent speed limit extraction is the first of its kind relying on both GSM and GPS input signals, complementing each other and thus avoiding limitations of using them individually for position tracking.

This system can be implemented in the larger vehicles like trucks and buses and further more vehicles like passenger and cargo trains. This proposed system can be used as the warning system to avoid collisions in the National Highways.

This system can be further developed using the image processing technique to analyze the driver's facial expressions to understand the different situations that can arise while driving.

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