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RESEARCH ARTICLE

Driver Alertness Based on Eye Blinking and Bio-signals

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Manuscript Info *Abstract*

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Drowsiness is the major issue for road accidents and it may lead to severe physical injuries, deaths and significant economic losses. The statistics indicate the need of a reliable driver drowsiness detection system which could alert the driver before a mishappening occurs. The real time drowsiness detection system using sensors will solve these consequences. The drowsiness can be detected by various features like eye blinking rate, and pulse rate. The eye movements can be monitored using eye blink sensor and pulse rate can be monitored using PPG(photoplethysmograph) sensor. The eye blink sensor to be placed on the side of the spectacles or at the steering wheel and drowsiness can be detected with the help of infrared illuminator. The PPG sensor detects the pulse rate of the driver which calculates the heart rate variability(HRV) which is placed on the steering wheel or can be wear as wrist watch. The sensors detects when any abnormal condition occurs and the vibrational sensors are used to awake the driver if he seemed fatigue. A warning signal is provided to alert the driver. We conclude that by designing a drowsiness detection system that combines non-intrusive physiological measures with other measures would accurately determine the drowsiness level of a driver. A number of road accidents might then be avoided if an alert is given to a driver who seemed drowsy.

1. Introduction:

According to available statistical data, over 1.4 million people die each year on the road and 30 to 60 million people suffer non-fatal injuries due to road accidents. Based on police reports, the US National Highway Traffic Safety Administration (NHTSA) conservatively estimated that a total of 1,00,000 vehicle crashes each year are the direct result of driver drowsiness. These crashes resulted in approximately 1,560 deaths, 71,000 injuries and $13.5 billion in monetary losses . In the year 2010, the US National Sleep Foundation (NSF) reported that 54% of adult drivers have driven a vehicle while feeling drowsy and 28% of them actually fell asleep. The German Road Safety Council (DVR) claims that one in four highway traffic fatalities are a result of momentary
driver drowsiness . These statistics suggest that driver drowsiness is one of the main causes of road accidents.

Drowsiness is a multidimensional feature that researchers over the past decade have found difficult to define. Indeed, it is one of the leading contributing factors in traffic accidents worldwide. Solving the problem became critical when the design of earlier accident prevention systems was found ineffective for alerting the driver . Therefore, a real-time fatigue detection system is essential in order to eliminate or reduce the risk of a driver having an accident. To develop drowsiness countermeasures, a greater understanding of driver fatigue in terms of its physiological properties is required. The spectral analysis of the drowsiness state can be classified into a few discrete categories: the driver's facial and body motion and physiological status (heartbeat, pulse rate); the
vehicle's operating condition; the in-vehicle environment; the driver's driving aptitude or behavior (lane-keeping, speeding, anger, anxiety); and a combination of these.

2. Review of Literature:

In our previous methods, a wired system is used to detect the drowsiness of the driver. The real time psychological signal monitoring system to be used. *Chin-Teng Lin, Yu-Chieh Chen.* Proposed by calculating the brain computer interface BCI system to detect the drowsiness. In this method, the driver has to wear a dry electrode in the forehead. This feel uncomfortable to the driver and a gel is used to increase the conductivity of the sensor. This gel wants to wash frequently for the driver. So this is not much efficient to calculate the drowsiness. And also this method is costly. Lee *et al.* proposed a system that uses two fixed cameras to capture images of the driver and the road, respectively. The images are then mapped to global coordinates to monitor the driver's sight line. These systems require extra cameras to be installed to capture driver facial images. And also the images are distracted if the person turns or not facing the camera. Yang *et al.* used a first order Hidden Markov Model (HMM) to compute the dynamics of a Bayesian Network (BN) for compiling information to infer the level of driver fatigue by analyzing multiple physiological characteristics, such as ECG and EEG signals. In order to measure EEG signals, sensors must be placed at the forehead or other parts around the brain. The ECG electrodes are placed at the driver seat and measurements are carried out when the driver's back side is in contact with the electrodes, but ECG signals can't be measured if the driver seat cloth is too thick as the contact distance between body and electrodes is increased. Yang *et al* integrated the sensors in a wearable shirt to measure ECG signals. Most drivers are not willing to wear such shirts during driving as it may feel uncomfortable and most importantly the shirt is difficult to clean and wash. But our proposed system avoids such limitations by integrating the sensors on the steering wheel. The driver's hand is touched on the steering wheel. This calculates the pulse rate and heart rate variability to indicate the person is drowsy or not. A eye blink sensor is used to calculate the eye blinking rate of the driver to indicate whether he s drowsy. This is the efficient way of detecting drowsiness compared to all other techniques.

3. System Design:

Drowsiness is one of the major causes for road accidents occurring in world wide. Many existing technologies are using a video camera to be placed in front of the driver. The camera captures the facial image of the person and monitors the eye movements, head movements; PERCLOS rate (Percentage of closure) etc. These methods have so many disadvantages. By using a video camera, the image is not properly taken when he tilts his face and continuous monitoring to be done. And also it requires more memory to store the images of the face. In our project, instead of using the video camera we are using the eye blink sensor to calculate the blinking rate of the driver. This sensor to be fixed on the side of the spectacles or in the steering wheel. So there is no issue when he turns his face.

The temperature sensor is used to monitor the room temperature. Health condition of the driver is also an important factor of the driver fatigue. Due to the blood pressure variations also the driver occurs drowsiness. In our project, we are combining both physical and psychological features to detect the drowsiness. The hybrid method of eye blink sensor and biomedical sensors are used to detect the drowsiness of the driver. Finally a warning alarm is produced to awake the driver when he feels drowsy. Also the vibrational sensors are used to awake the driver to be placed on driver seat. The architecture diagram to be explained below.

The eye blink sensor and biomedical sensor are used to detect the drowsiness of the driver. These two sensor signals are given as the input to the system. The system monitors the signals and a warning signal is sounded to the driver if he seemed drowsy. The temperature sensors are used to monitor the room temperature. The sensors detect the driver's behaviour and health conditions through the wireless sensors and these signals are monitored in the system. The signals are transmitted using the wireless transmission such as Bluetooth. Thus the hybrid approach of monitoring the driver's behaviour and health conditions of the driver using various sensors. Finally a warning alarm is produced to awake the driver. Also the vibrational senosors are used to awake the driver when he falls down the steering wheel. These information are sent to the control room using 3g through mobile. The engine of the vehicle can be controlled using the relay or switch when any abnormal condition occurs.

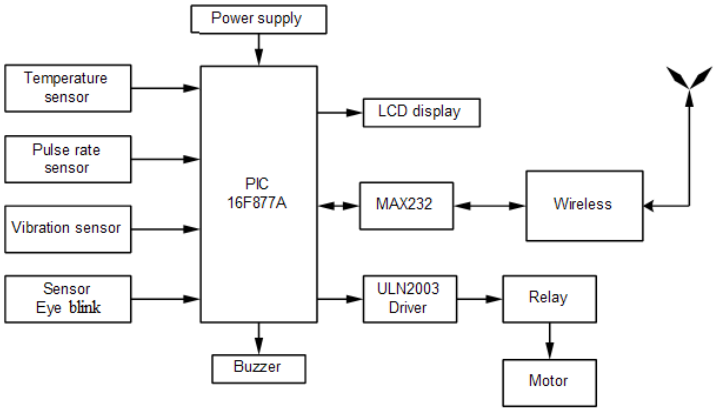

Fig1: Architecture Diagram of Driver Alertness

3.1 Eye Blink Sensor:

The eye blink sensor is used to detect the drowsiness of the person. It calculates the blinking rate of the eyes. The blinking rate defines the number of times the person closes his eyes using the eye blink sensor. The Eye blink sensor consists of infrared (IR) light emitting diode which includes IR LED and IR photodiode. The sensor was attached to the implanted holder and positioned in front of the eye. During eyeblink detection, IR light from the LED illuminates the eye and reflected IR light induces an electrical current through the IR photodiode. As the eyelid closes, increasingly more IR light is reflected on the photodiode, since the eyelid has a higher IR reflectivity than the cornea. When the eyes are closed, then reflectivity is high and when it is open then its reflectivity is low. The resulting IR signal is amplified, digitized, and then sent to the microcontroller. The microcontroller monitors the operation of the eye blink sensor.

3.2 PPG Sensor:

The photoplethysmography(PPG) signal is used to detect the pulse rate of the person to calculate the heart rate variability(HRV). It is one of the biomedical sensor to monitor the health conditions of the person. Heart rate is the number of heartbeats per unit of time and is usually expressed in beats per minute (bpm). In adults, a normal heart beats about 60 to 100 times a minute during resting condition. The resting heart rate is directly related to the health and fitness of a person. We can measure heart rate at any spot on the body where you can feel a pulse with your fingers. The most common places are wrist, fingers and neck. We can count the number of pulses within a certain interval (say 15 sec), and easily determine the heart rate in bpm. The microcontroller based heart rate measurement system that uses optical sensors to measure the alteration in blood volume at fingertip with each heart beat. The sensor consists of an infrared light emitting diode and photodiode. The infrared diode transmits an infrared light into the finger tip and photodiode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. The reflected light varies based on the heartbeat that can be detected by the photodiode. With a proper signal conditioning, this little change in the amplitude of the reflected light can be converted into a pulse. The pulses can be counted by the microcontroller to calculate the heart rate.

4. Results and Discussions:

The eye blink sensor and ppg sensor detects the blinking rate and pulse rate of the driver and send the information to the embedded kit. These informations are displayed in the LCD display. The warning signal is produced when the driver feels drowsy. The motor is stopped using relay or switch when the driver faints due to heart attack. The temperature sensors are used to read the room temperature. The sensor signals are send to the micro controller using Bluetooth. All the informations are controlled by the pic controller.

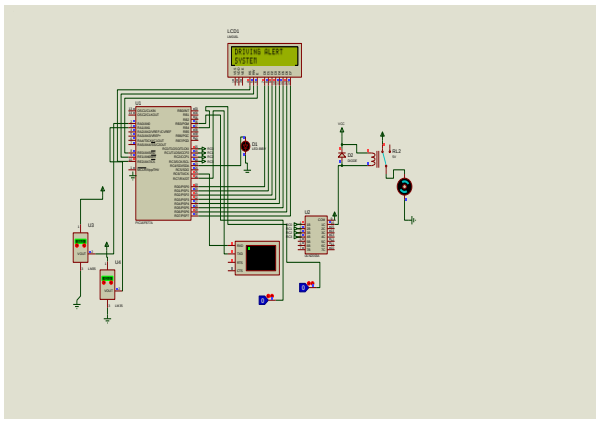

Fig2: Driver Alert System

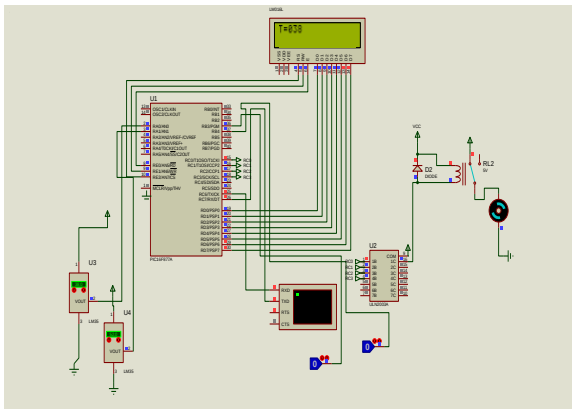

Fig3: Display of Temperature sensor

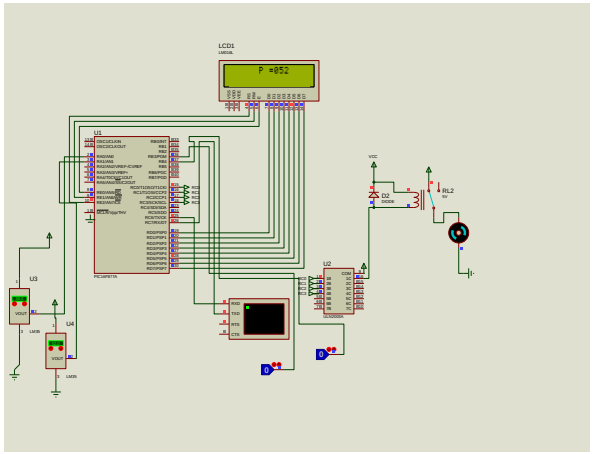

Fig4: Display of PPG sensor

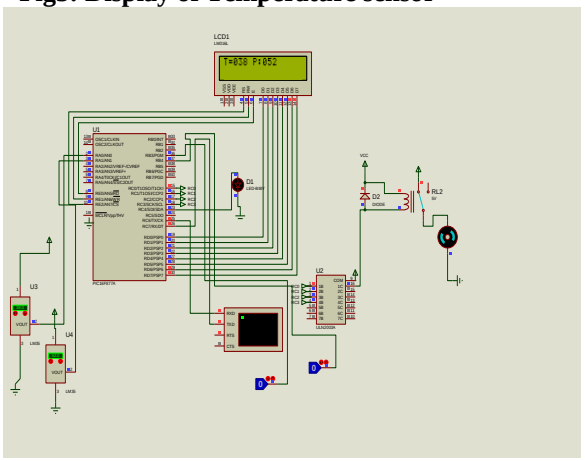

Fig5: Display of Temperature and PPG sensor

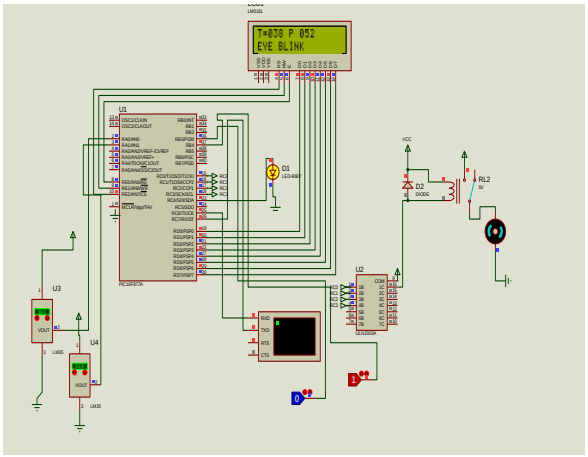

Fig6: When Eye blink sensor is detected

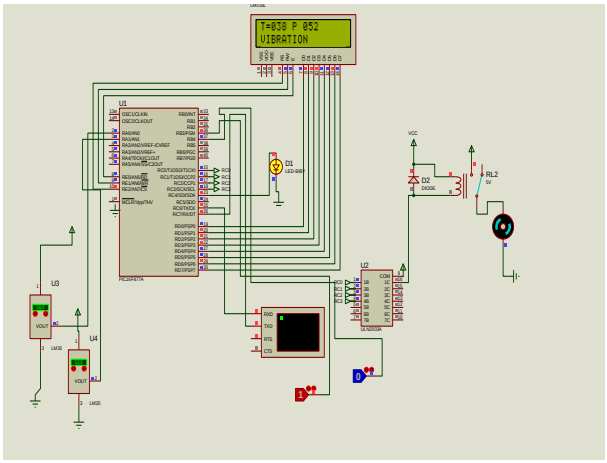

Fig7: Vibration sensor detected

5. Conclusion:

A hybrid drowsiness monitoring system is used to calculate the drowsiness of the driver. In our proposed system it uses two wireless sensors such as eye blink sensor and biomedical sensor that are to be placed in the steering wheel or in the spectacles of the driver. The eye blink sensor is used to calculate the eye blinking rate and biomedical sensor is to calculate the pulse rate. A wireless transmission is used to receive the sensor signals through Bluetooth. Finally a warning signal is given to alert the driver, if he feels fatigue. This is the most efficient method to detect drowsiness and the cost of sensors are to be low. The feedback from the volunteers was promising and

encouragement was given for further improvement in the future. Signals changes for person in different conditions such as illness will be studied and considered in our future works as well.

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