Real Time Based Driver's Safeguard System by Analyzing Human Physiological Signals

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***Abstract--* In this paper a new approach based on bio-signal sensing was used for real time accident avoidance. A wireless embedded system with real time bio-signal processing technique was proposed. The bio-signals sensor module consists of ECG, EEG, EOG and alcohol sensor. These bio-signals were first acquired by the sensor module .Then the signal is processed and scheduled in the processor with the help of the RTOS installed in it. The processed signal is transmitted to the receiving section by using the wireless data communication. The receiver unit can read the sensor data from wireless receiver module using zig-bee protocol. This received real time sensor data is compared with the pre-determined data stored in the processor memory and the decision was taken. This can provide warning to the driver by giving alarm and also having vehicle engine ignition control for stopping the vehicle. The parking light must be turned on before the engine stops so that the driver's coming behind can control the vehicle and thereby accident can be avoided.**

***Keywords--* ECG, EEG, EOG and alcohol sensor, RTOS, zig-bee protocol.**

I. INTRODUCTION

The development of a human bio signal based drowsy state monitoring system for drivers has become a major focus in the field of safety driving and accident prevention because drivers fatigue has been implicated as a causal factor in many car accidents. Accidents caused by drowsiness at the wheel have a high fatality rate because of the marked decline in the driver's abilities of perception, recognition and vehicle control abilities while sleepy. Driver's fatigue has been implicated as a causal factor in many accidents. Preventing such accidents is thus a major focus of efforts in the field of active safety research. A number of methods have been proposed to detect vigilance changes in the past.

A. Imaging processing techniques

This approach analyzes the images captured by cameras to detect physical changes of drivers, such as eyelid movement, eye gaze, yawn, and head nodding. For example, the PERCLOS system developed by W. W. Wierwile et al [16]. The project uses camera and imaging processing techniques to measure the percentage of eyelid closure over the pupil over time. The three-in-one vehicle operator sensor developed by Northrop Grumman Co [19] also used the similar techniques. Although this vision based method is not intrusive and will not cause annoyance to drivers, the drowsiness detection is not so accurate, which is severely affected by the environmental backgrounds, driving conditions, and driver activities. In addition, this approach requires the camera to focus on a relative small area (around the driver's eyes). It thus requires relative precise camera focus adjustment for every driver.

B. Physiological signal detection techniques

This approach is to measure the physiological changes of drivers from biosignals, such as the electroencephalogram (EEG), electrooculograph (EOG), and electrocardiogram (ECG or EKG). Since the sleep rhythm is strongly correlated with brain and heart activities, these physiological biosignals can give accurate drowsiness/sleepiness detection. However, all the researches are up to date in this approach and need electrode contacts on drivers' head, face, or chest. Wiring is another problem for this approach.

Although approaches based on EOG signals showed that eye-activity variations were highly correlated with the human fatigue and can accurately and quantitatively estimate alertness levels, the step size (temporal resolution) of those eye-activity based methods is relatively long (about 10 s) to track slow changes in vigilance. The approaches based on EEG signals have the advantages for making accurate and quantitative judgments of alertness levels, most recent psycho physiological studies have focused on using the same estimator for all subjects [1],[2]. Although ECG measurement techniques are well developed, most of them involve electrode contacts on chest or head, for example the conventional fixed-on chest Ag-AgCl electrodes. When comparing with the imaging processing technique the physiological detection technique is more accurate.

II. PROJECT DESCRIPTION

The proposed system uses the physiological signal detection technique. The existing studies in the field mainly concentrating on EEG, ECG, EOG or either of these signals for avoiding the accident. But in the proposed system for an extra safety an alcohol sensor is also attached nearby to the

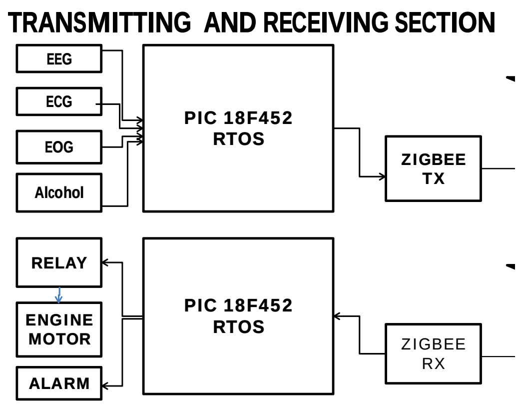


Fig 1.Overall Block Diagram

driver, thereby stopping the vehicle if the driver is consumed more than the permitted amount. Another advantage of the proposed system is the transmitting and receiving section is installed with RTOS .The system is installed with CCS RTOS for both transmitter and receiving sections. The bio-signals were first acquired by the sensor modules .Then the signal is processed and scheduled in the slave processor (transmitting) with the help of the RTOS installed in it. The processed signal is transmitted to the receiving section by using the wireless data communication. The receiver unit can obtain the sensor data from wireless receiver module using zig-bee protocol. This received real time sensor data is compared with the pre-determined data stored in the master processor memory and the decision was taken. The processor at the receiving section has control over the engine relay .So the vehicle can be stopped if necessary.

The PIC 18F452 is the heart of the hardware section. The features of PIC 18 series make the microcontroller user friendly than others. The main part of the processing module is the 16 bit PIC microcontroller (PIC 18F452) which can execute the tasks with the help of the RTOS .The hardware section consists of transmitter and receiving part. Both transmitting and receiving part uses the PIC 18F452 for signal processing and drowsiness prediction. Transmitting section performs the signal processing and the receiver section deals with drowsiness prediction by comparing the incoming signal with the pre-determined data stored in the memory.

In this section, RTOS project are based on the CCS compiler, one of the popular PIC C compilers developed for the PIC16 and PIC18 Series of microcontrollers. Some of these services offered by CCS RTOS are Interrupt handling services, Time services, Device management services, Memory management services, Input-output services. PIC microcontroller is installed with 16 bit CCS RTOS by which the sensor signals are executed at real time. Each task will communicate or share the data by inter-task communication using RTOS. The entire task is scheduled by round robin scheduling algorithm.

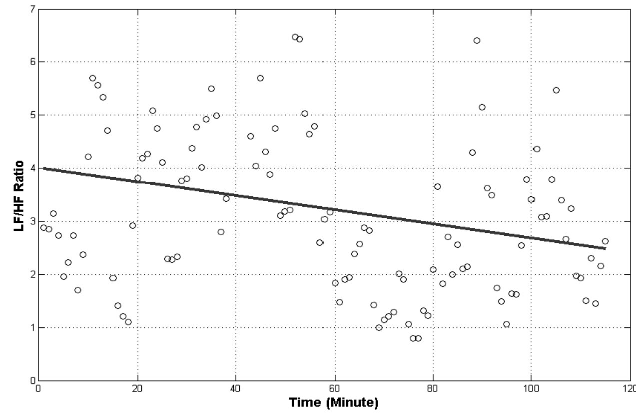


Fig. 2. The LF/HF ratio during two-hour driving simulation for f male subject

execution of the sensor signals. The entire task can meet deadline in Hard Real Time System to control the Driver Alert System.

III. SENSOR MODULES

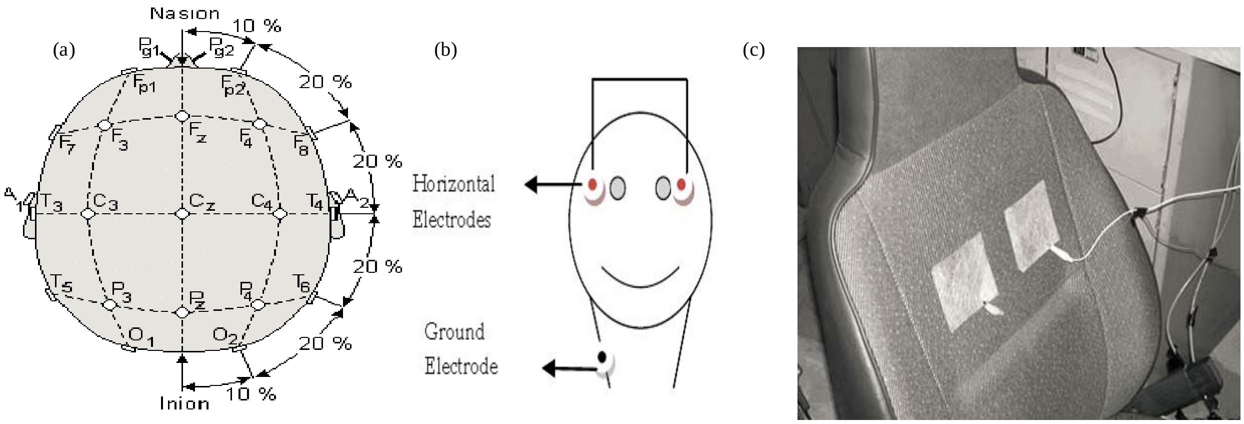
The sensor modules sense the human bio signals such as EEG, ECG, EOG, Alcohol and the module consists of EEG, ECG, EOG, and alcohol sensors.

A. ELECTROENCEPHALOGRAM(EEG) Sensor

The EEG electrode senses the EEG pulses. Then the signal is filtered and amplified by passing through the amplifier and filter circuit. This analog signal is sampled and converted into digital signal using the ADC converter. The EEG-signal can be classified on the basis of its amplitude and frequency range. They are: Beta waves (13-25 Hz), Alpha waves (8-12 Hz), Theta waves (5-7 Hz), Delta waves (0.5-4 Hz).Ulrika Svensson et al [3]. When a driver gets drowsy a burst of alpha activity can often be seen in the central regions of the brain (C3 and C4). An increase in alpha activity is thus the first indicator of drowsiness. However, as mentioned before, some people do not show any alpha activity. As the driver gets drowsier, alpha activity is replaced by theta activity [1]. When delta activity occurs in the EEG the driver is no longer awake; this is an indicator of deep sleep. In summary the transition from wakefulness to sleep can be described as a shift towards slower frequencies in the EEG. The process differs between individuals but seems to be consistent within the individual.

B. ELECTROOCULOGRAM (EOG) Sensor

Senses eyeball movement using IR sensors, comparators and potentiometers and location of iris is detected by two IR sensors and output is given to two comparators. The low power signal is amplified by the instrumentation amplifier and signal is inverted by the inverting amplifier. The analog signal is sampled and converted into digital signal by using the analog to digital convertor.



F : frontal, O : occipital,
C: central, P : parietal and T : temporal

Fig. 3. (a) EEG electrode placement based on international 10/20 system, (b) Placement of electrodes to acquire EOG, (c)ECG electrode placement on driver's seat back

As drowsiness arises the blink duration gets longer, the blink amplitude smaller and the blinks occur more often. The delay in lid reopening increases and velocity of lid opening and closure decreases. These parameters can be detected by the EOG. Horizontal placement of EOG electrodes is shown in Fig. 3(c).Another indicator of drowsiness is the slow eye movements, which often occur late in the drowsiness process

C. *ELECTROCARDIOGRAM (ECG) Sensor*

The sensor determines the Electro-Cardio-graph using difference in electrical energy measured from the electrodes placed in driver's seatback.ECG electrode placement on driver's seatback is shown in Fig. 3(c). The ECG pulse obtained is amplified and filtered by the signal conditioning unit and signal is inverted by the inverting amplifier. The analog signal is sampled and converted into digital signals by using the ADC The frequency domain spectral analysis of HRV shows that typical HRV in human has three main frequency bands: high frequency band (HF) that lies in 0.15–0.4 Hz, low frequency band (LF) in 0.04–0.15 Hz, and very low frequency (VLF) in 0.003–0.04 Hz. Xun Yu et al [5]. A number of psycho physiological researchers have found that the LF to HF power spectral density ratio (LF/HF ratio) decreases when a person changes from waking into drowsiness/sleep stage. In this proposed research, heart beat pulse signals will be measured by biosensors embedded in the driver's seat.

D. *Alcohol Sensor*

When the target alcohol gas exist, the sensor's conductivity is higher along with the gas concentration rising. MQ-3 gas sensor has high sensitivity to alcohol, and has good resistance to disturb of gasoline, smoke and vapor. The sensor could be used to detect alcohol with different concentration; it is with low cost and suitable for different application. This can sense alcohol content of 0.04Mg/l and above.

IV. WIRELESS TRANSMITTER and RECEIVER MODULE

RFM70 is a GFSK transceiver module operating in the world wide ISM frequency band at 2400 - 2483.5 MHz Burst mode transmission and up to 2Mbps air data rate make them suitable for applications requiring ultra low power consumption. A transmitter and a receiver must be programmed with the same RF channel frequency to be able to communicate with each other. For this short distance communication zig-bee protocol is used for wireless transmission and reception.RFM70 operates in TDD mode, either as a transmitter or as a receiver.

V. SIMULATION RESULTS

It has been well documented that eyelid parameters provide a good measure of drowsiness. Fig. 4 shows vertical EOG recording, both in alert and drowsy condition. As drowsiness arises the blink duration gets longer, the blink amplitude smaller and the blinks occur more often. The delay in lid reopening increases and velocity of lid opening and closure decreases. These parameters can be detected by the EOG.

The simulation can be viewed through the Proteus ISIS 7 professional simulator. Alcohol detection for drunk and drive condition is shown in Fig. 5.The drowsiness prediction analysis system uses DC motor instead of vehicle engine. The DC motor is connected to the master section using the relay control. When any abnormalities in the sensed values are detected by the master, the relay is opened and the motor stops running. Here, SPDT relay is used for connecting the DC motor with the master processor.

The LCD connected to the transmitting section shows the current sensed values. The receiver section shows abnormal condition calculated by comparing the pre-determined data stored in the memory with the previous sensed data.

an external data storage device and can be retrieved when necessary, thus acts like a black box in vehicles.

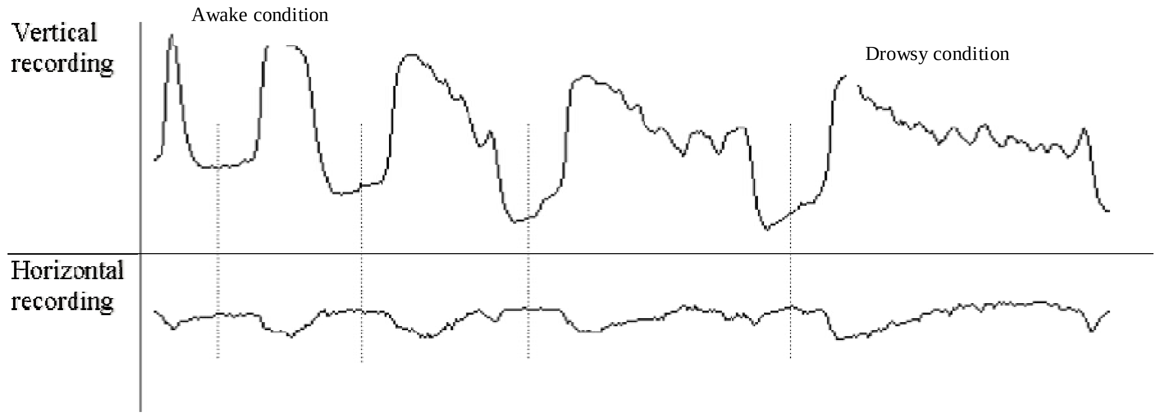


Fig. 4. EOG blink pattern for both vertical and horizontal recording originating from an alert state at the left and a very drowsy state at the right

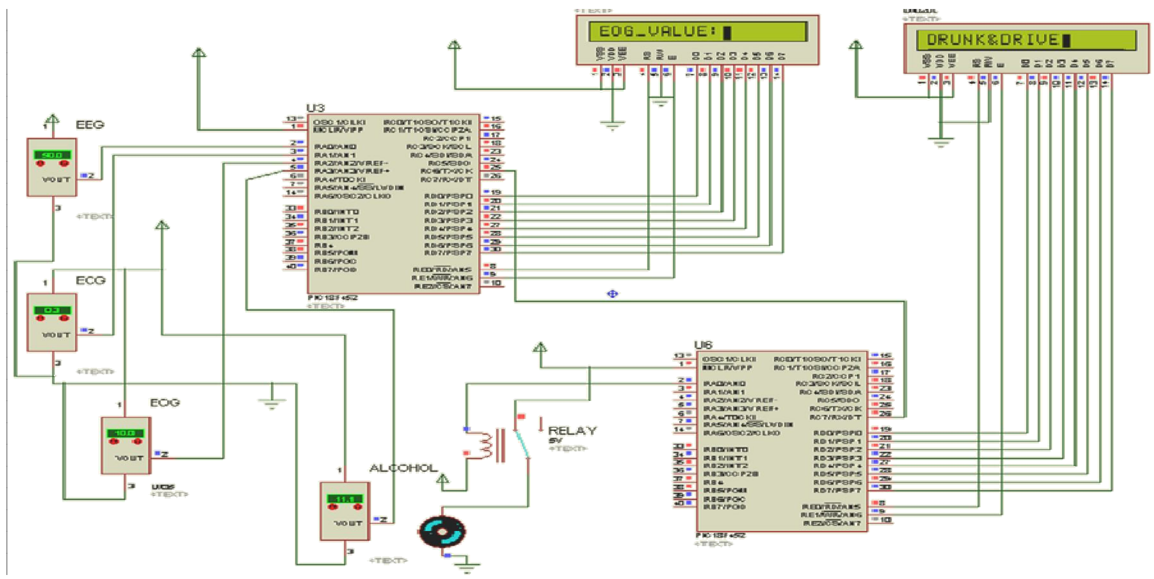


Fig 5. Alcohol detection for drunk and drive conditions

VI. CONCLUSION

In this study human bio signal based real time accident avoidance system shows that the proposed system is more accurate than the existing systems. This is because the proposed paper deals with EEG, ECG, EOG and Alcohol sensing for avoiding accident and also works on RTOS.The method used in this study can be implemented practically by connecting sensors to the seats, jackets, headphones, steering wheels. For future studies, the sensor data can be recorded in

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