Driver Fatigue Management System using Embedded ECG Sensor

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Abstract— During recent years, various studies have suggested that around 20% of all road accidents are fatigue-related and up to 50% on certain roads. In this scenario, preventing accidents under drowsiness state has become a major focus for active safety driving. To reduce the accidents rate, it is needed to provide an efficient safety measure. Literature says that, the drowsiness condition of driver can be best monitored by using an eye blink sensor (or) fabric electrode (or) ECG Sensor. But by monitoring the drowsiness condition alone, the accidents cannot be avoided, unless vehicle speed is controlled. To overcome this problem, the proposed hardware system implemented with ECG electrode and PIC microcontroller measures the heart function of the driver and it compares that with stored ECG signal for drowsy state. For that the electrode is fixed in the right hand and left hand of the driver. If the system identifies that the driver is in drowsy state, it follows the sequence of operation like alters the driver by a buzzer, sends a warning signal to the control room, monitor and control the speed of the vehicle by cutting the fuel supply to the engine. In addition to that, the LED fixed at the backside of vehicle alerts the rear vehicles to reduce its speed. The proposed idea is developed as hardware model using PIC microcontroller and the results obtained are discussed.

Key words: PIC Microcontroller, ECG Sensor, Fabric electrode, Drowsiness

I. INTRODUCTION

Now-a-days, increasing number of transportation accidents has become a serious problem in society. Literature says that, the driver drowsiness state is one of the important factors for causing accidents. Hence drowsiness detection system finds a potential application in intelligent vehicle systems. Previous approach to drowsiness detection primarily makes pre-assumptions about the relevant behavior, focusing on blink rate, eye closure, yawning etc [2], [3].

All the above said works are recommended for monitoring the drowsiness state and alerting the driver by buzzer. Simply by monitoring the drowsiness condition of the driver alone is off no use, unless some control strategies is used for controlling the vehicle speed, due to which accidents can be avoided. This paper, proposes a real time system for drowsiness detection using ECG sensor fixed in driver hands. To execute this, a GSM based embedded control system is proposed to monitor and control the parameters selected using its built-in input and output peripherals. The use of GSM is to receive the information transmitted and processing it further as required to perform several operations. Depending on the nature of the information send the sequence of operations are to be performed like, the transmitted information is stored and polled from the receiver control station and then the required control signal is generated. This signal is send to the intermediate hardware that is designed using PIC microcontroller and the signal is processed accordingly to perform the required task. This idea not only monitors the drowsy state of drivers but it also control the vehicle speed to prevent accidents

II. LITERATURE SURVEY

1) Sang-Joong Jung et al., this paper describes about the driver health condition monitoring system and it alerts the driver under drowsiness condition. This paper proposes an embedded electrocardiogram (ECG) sensor with electrically conductive fabric electrodes fixed on the steering wheel of a car to monitor the ECG signal from driver's palm.

   The driver's health condition such as normal, fatigued and drowsy states were analyzed by evaluating the heart rate variability in the time and frequency domains. But the vehicle speed is not controlled to avoid accidents caused by drowsiness state. [2]
2) D.Jayanthi et al., this system proposes an integrated method to detect driver's low alertness by considering both the performance of vehicle steering and the inattention. They proposed a new image processing algorithm designed to efficiently estimate driver's gaze direction, which is the facial inattention indicator adopted in this work.

   Driver performance is measured according to the manipulation behavior of steering wheel. These two different aspects are generally complementary and thus can be integrated to obtain accurate detection. However, it is difficult to estimate driver's distraction or drowsiness accurately from the observation of those aspects. [8]
3) Swapnil et al., this paper proposed driver's fatigue approach for real-time detection of driver towards the driver's fatigue .The system consists of a sensor directly pointed towards the driver's face. The input to the stream is a continuous stream of signals from the sensors. It monitors the driver eyes to detect micro-sleeps, and monitors the driver jaw movement and it also detects the driver pulse from finger using LED and LDR assembling for detecting the driver illness. Driver fatigue levels based on the response signals were obtained which alerts the driver. It is expensive to be commercialized and needs complex noise processing. [7]
4) Daniel Haupt et al., this paper describes about reliable system for driver's drowsiness recognition. In this paper data taken for analysis is acquired from real traffic and therefore it overcomes all disadvantages partially modeled in laboratory. Here data acquisition has been chosen as an in-direct measurement from car CAN bus.

All data are preprocessed according to assumptions about driver's behavior are transformed to frequency domain by means of orthogonal transform (STFT, CWT and DWT). Subsequently, data is analyzed by data mining methods including features extraction and filter feature selection. The performance of the feature is measured by the area under the receiver operating characteristics. Especially in Noninvasive systems the accuracy of driver's drowsiness detection is not sufficient. [5]

III. PROPOSED SYSTEM

In order to overcome the problem in the existing system, the proposed system best monitors and control the vehicle under drowsiness condition of driver using PIC Microcontroller. The overall block diagram of the proposed system is divided into two sections namely transmitter section and receiver section as shown in fig 1 and 2 respectively. This systems comprises of ECG electrode, GSM, Display unit, alarm and control circuitry. In the transmitter section, a dry embedded electrocardiogram electrode is fixed on the right hand and left hand of the driver to detect the ECG signal. An electrocardiogram electrode records the electrical activity of the heart over time produced by an electrocardiograph. Since the measured ECG signal is of 0.2mV level, it is amplified and converted into electrical codes before it is given to PIC microcontroller (PIC16F877A).

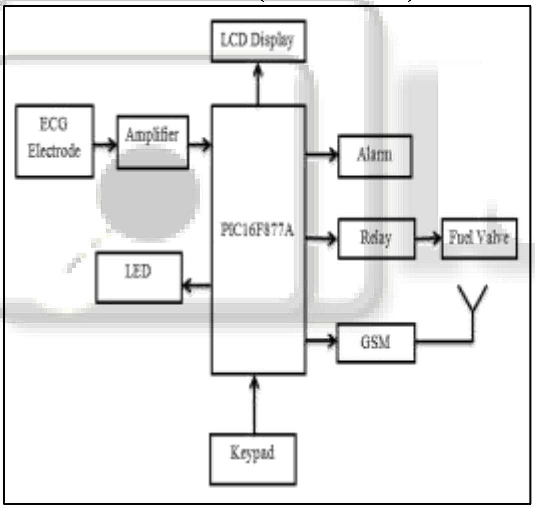

Fig. 1: Transmitter Section

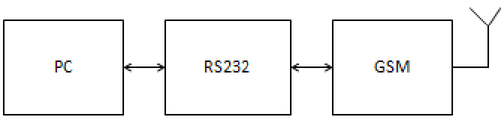

Fig. 2: Receiver Section

The microcontroller receives the electrical codes and processes it accordingly. Here global system for mobile communication is used which has high performance, low consumption and allows long distance communication. By using GSM, these signals are transmitted to control room continuously. Then the normal ECG level is monitored, if the received signal is beyond the normal level it indicates the driver is in drowsiness state, and then the processor will activate the driver circuit, it alerts the driver by producing an alarm.

The LCD monitors the condition of the driver and LED fixed at the back side of the vehicle alert the following vehicles to reduce it speed. At the same time the relay will pass the control signal to the fuel valve to cut-off the fuel given to the engine to stop its operation temporarily.

A. Algorithm:

1) Step 1: Start the program.
2) Step 2: Initialization the system. Check whether the driver is in normal state or in abnormal state.
3) Step 3: If the driver is in drowsiness state the alarm will be intimate otherwise again go to step 2.
4) Step 4: Check the heart rate, if it indicates drowsiness state then it displays condition of the driver.
5) Step 5: Stop the Program.

B. Flow Chart:

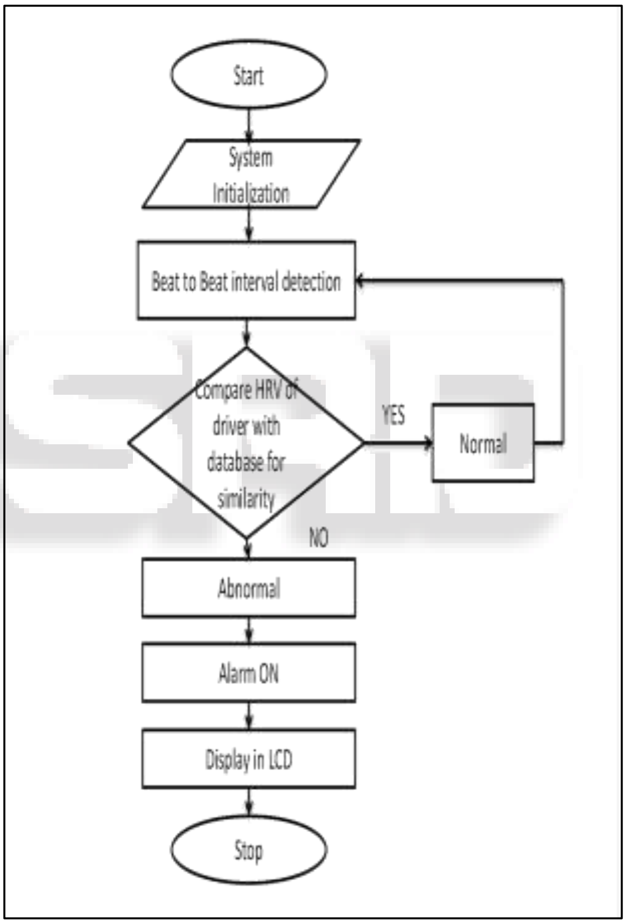

Fig. 3: Simulation Output in UTLP Kit

Eclipse is a platform that has been designed from the ground up for building integrated web and application development tooling. By design, the platform does not provide a great deal of end user functionality by itself. Eclipse provides a common user interface (UI) model for working with tools. It is designed to run on multiple operating systems while providing robust integration with each underlying OS.

In the ARM 8 processor, the control panel consists of two options namely normal state and drowsiness ON state.

Here keypad is used to feed the input.

When selecting the option 1 in keypad it represents the normal state

When selecting the option 2, it represents the drowsiness ON state.

The hardware verification output for normal state and abnormal state is shown in fig 4 and 5 respectively. The fig 6 shows the indication to stop the vehicle by stopping the fuel level when abnormal condition is detected.

Fig. 4: Representation of Normal State

Fig. 5: Representation of Abnormal State

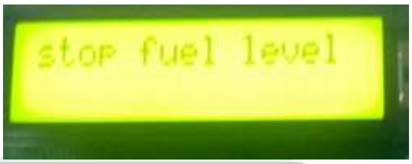

Fig. 6: Representation of Fuel Level

IV. PROTOTYPE IMPLEMENTATION

The hardware setup comprises of two sections namely, (i) Transmitter section and Receiver section.

The transmitter section consists of following units like:

1) Sensor unit
2) Display unit
3) Communication unit
4) PIC Microcontroller unit
5) Keypad and alarm unit

The electrocardiography is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the driver hands. In the proposed system clamp ECG Ag/Agcl electrode is used as sensor. It is a handheld ECG monitoring device to monitor the driver drowsiness condition.

Normally the ECG sensor is working under the principle that it determines the Electro-cardio-graph using difference in electrical energy measured from the electrodes placed in driver hands. 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 0.15-0.4Hz, low frequency band (LF) in 0.04-0.15Hz, and very low frequency (VLF) in 0.003-0.04Hz when the LF to HF power spectral density ratio (LF/HF ratio) decreases it indicates person changes from waking into drowsiness/sleep state. In this proposed research, heart beat pulse signals are measured in driver hands based on above principle using ECG sensor.

In the transmitter section for acquiring the input biomedical signals continuously an embedded ECG sensor is used. These sensors are fixed in the right hand and left hand of the driver.

The beat to beat time interval sensed by ECG sensor ranges between 0.2mV to 0.75mV for normal state. Then the signal is filtered and amplified through the proper signal conditioning circuit to remove the noise. The cut-off frequency for filter here is 0.5-34Hz then total gain is 27dB and SNR is 20.37dB. Then the signals are converted into equivalent electrical codes and send to PIC microcontroller through portA0. The PIC Microcontroller operates at 5V, 4MHz Crystal frequency range. One advantage of PIC in that, it consumes less power and it can be easily altered.

The microcontroller receives the equivalent electrical codes of amplified output and processes it accordingly. Here MPLAB software is used to perform the operation. The status of the driver state is continuously monitored and transmitted to the PC through GSM technology.

If the signal received from ECG sensor shows that the beat to beat time interval is beyond the normal level, automatically the alarm will be ON and at the same time LCD will display the status of the driver. Here 16x2 LCD display is used which operates at 5V and consume less power. LED (BC547) is fixed at the backside of vehicle alerts the rear vehicles to reduce its speed.

The BC547 operates at low current (max. 100mA)and low voltage(max. 65V)and at the same time the single pole double throw relay will pass the control signal to the fuel valve to cut-off the fuel given to the engine to stop it operation temporarily. If the signal is within the range of 0.2mV to 0.75mV then the LCD will display that the person is in normal condition.

The receiver section consists of following units like:

1) Communication unit
2) PC
3) Power Supply

In the receiver section GSM is used to receive the information from the transmitter. Then the received signal is transmitted to the PC through MAX 232 which converts the signal into binary values. The MAX 232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5V supply.

The hardware output for transmitter and receiver section is shown in fig 7 and 8 respectively.


Fig. 7: Transmitter Section

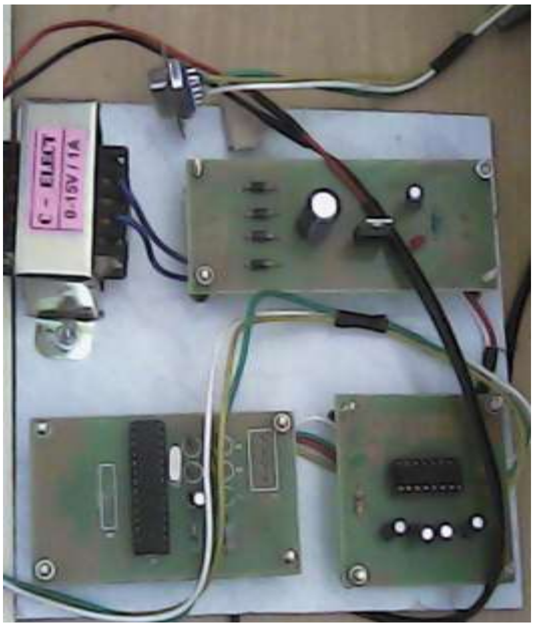

Fig. 8: Receiver Sections

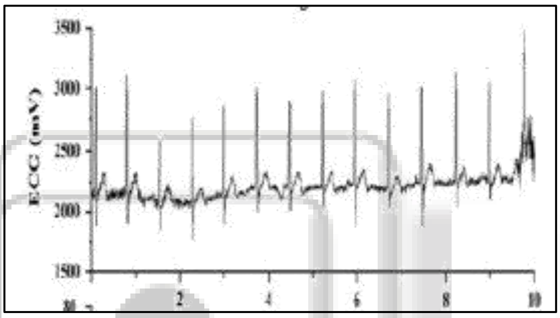

Fig. 9: Output for Normal State

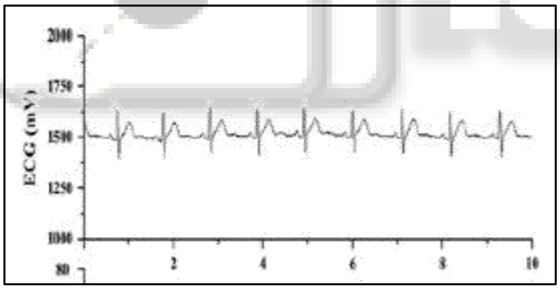

Fig. 10: Output for Abnormal State

A. Coding:

```
#include<pic.h>
#include"pic_lcd8.h"
#include"pic_serial.h"
void keypad1();
void Serial_Out3(unsigned char);
void keypad();
unsigned int vvv=0,en=0,m,k,jj;
void main()
{
        TRISD=0x00;
  Lcd8_Display(0x80," EMBEDDED ECG  ",16);
  Lcd8_Display(0xC0,"BASED REAL TIME ",16);
  Lcd8_Display(0x80," MONITORING AND ",16);
        Lcd8_Display(0xC0,"CONTRL OF DRIVER",16);
        Delay(65000);    Delay(65000);
  Lcd8_Display(0x80,"   DROWSINESS  ",16);
        Lcd8_Display(0xC0,"DETECTION
SYSTEM",16);
        Delay(65000);
        Delay(65000);Lcd8_Command(0x01);
  Serial_Init(9600);
  Delay(65000);Receive(0);Delay(65000);
  mob_inti();Lcd8_Command(0x01);
   Lcd8_Display(0x80,"STORED MOBILE NO",16);
}
 void mob_msg()
  {
         Lcd8_Display(0xc0,"SENDING
MESSAGE",16);
   Serial_Conout("ECG ABNORMAL",12);
         Serial_Out(0x1A);
         Delay(65000); Delay(65000);
                Lcd8_Write(0xc0+jj,aa[jj]);
                Delay(1000);
                       Lcd8_Display(0x80,"MOBILE
NUMBER   ",16);
        Lcd8_Display(0xc0,"STORED        ",16); }
```

V. CONCLUSION

The idea proposed gives a novel embedded drowsiness detection system to monitor and control the human cognitive state and to provide biofeedback to stop the vehicle when drowsiness state is detected. The prototype model developed clearly indicates the drowsiness state of the driver to prevent accidents. This system is suitable for all automobile applications with an intention to save the human life by avoiding accidents rates. The proposed idea was successfully verified in UTLP kit using Eclipse and prototype model was developed using embedded PIC Microcontroller can be easily implemented in vehicles to avoid accident rates.

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