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Arduino based real time driver drowsiness detection and mobile alert system using bluetooth

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Abstract: ***The goal of this propose design is to detect drowsiness in drivers to prevent accidents and to improve safety on the highways. A method for detecting driver drowsiness/sleepiness is developed on Arduino microcontroller board based on Atmega328P for real-time monitoring. The readings taken from different sensors used in this project can be seen in an Android based mobile device. It has an MQ-2 alcohol gas sensor to detect alcohol, if consumed by the driver and a relay circuit to stop him from performing the drive if alcohol consumed. The output from the relay activates the GSM module which sends a message to the driver family. MPU-6050 Micro-Electro-Mechanical-System (MEMS) accelerometer to read the head nodding conditions combined with a gyroscope and a temperature sensor to know the temperature inside the vehicle. The system is also able to monitor the driver physiological conditions such as heart pulse rate, eye blink detection using pulse sensor and eye blink sensor respectively. The alarm will be activated when the driver has consumed alcohol or driver head nods frequently or heart pulse rate goes above the limit or when driver eyes get closed. The microcontroller communicates with the android mobile through HC-05 Bluetooth module connected on the board. The android mobile is provided with the facility to view continuous readings from the sensors connected to the system along with the warning status messages through an android software based application installed in the end device.***

Keywords: Drowsiness, Arduino, Atmega328P, Eye blink sensor, Alcohol sensor, Pulse rate, GSM, Relay, MEMS sensor, Bluetooth, Android mobile

1. Introduction

Drowsy while driving is now being a common issue among all drivers. As this is a very insidious problem, many people have been executed or harmed during crashes related to drowsy, heavy-eyed or exhausted conditions. The officials won't come to know the authentic facts since no one would be aware of when a motorist experiences sleepiness. Often the driver will not admit that he felt drowsy to evade being liable. Also, if the driver can't disclose anything before he/she dies, then we can't know how the crash occurred. So, grabbing the wheels when drowsy is seriously as daring as liquored up driving. Even though we know it's dangerous, it is still treated as an unrecognized traffic safety problem. It has proved from different studies that the main two risky behaviours are sleepy driving and drunk driving, which are interrelated to a reasonable rise in accidents these days. But most of the drivers do not identify the dangers of fatigued driving. It is seen that a person's cerebral and bodily function have been deliberately impaired because of sleepiness, which influence safety-critical tasks such as attention, operating, effective memory and co-ordination. The National Highway Traffic Safety Administration (NHTSA) reported 30% and counting car crashes has been observed because of less driver vigilance. Regardless of these overall concerns on drowsy driving, many skilled drivers possess the issue of low vigilance which is an intermediate state between wakefulness and sleepiness. Thus, to monitor the driver drowsiness, a reasonable and recognizable method has to be initiated at its earliest. Meanwhile, drivers are always keen to new technologies which can make them vigilant at crucial situations.

The proposed system focuses on foreseeing driver lethargy by continuous monitoring the physiological conditions of a driver. The project targets at real time dangerous fatigue behaviours such as eye movements, head nodding and heart pulse activity. Hence, we can measure these behaviours using motion sensors to timely warn him to evade a collision.

2. Objectives

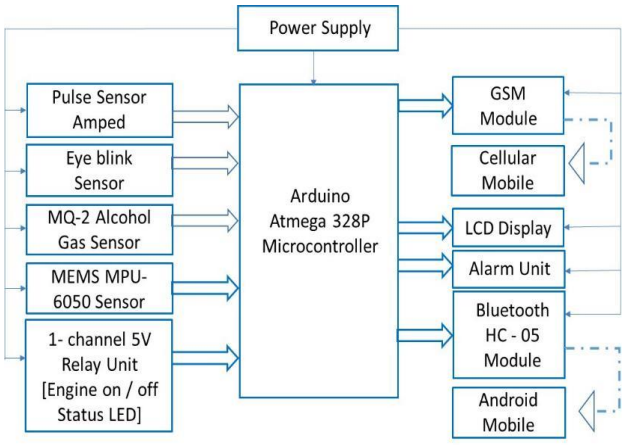
The main intention of this project is to provide driver safeness during highway and long driving conditions. This project arduino based driver drowsiness detection system is designed to monitor and give necessary precautionary indications to the driver when he is found sleepy while driving. The core implication of this project is to:

- Design, fabricate and program a novel method for real time driver drowsiness monitoring and timely warning system.
- Keeping an eye is relied on the sensors which are capable of providing substantial output with mean power usage.
- The driver safety is also ensured by sending a private message to the driver family when driver is found drunk before driving.

In this project, the driver is the input element whose actions are taken as inputs for the monitoring system to condition the driving situations. When the driver desires to start a driving process he is undertaken to verify the alcohol content present in him. The alcohol sensor absorbs the content and pass the signal to the microcontroller for formulating the decision. If he is drunk then a private message is send to driver's family indicating that he is not fit to drive. When he has cleared the drunken test, he is allowed to ignite the vehicle engine. While driver is driving he is been continuously monitored by the eye blink sensor to check he is sleepy or not. Also, he will be notified when his vision gets distracted from the road by the MEMS sensor. The pulse rate sensor keeps on monitoring the variations in driver's heart beat to ensure his physiological state of being awake. Each sensorial activities are presented on LCD display and detailing of it will be displayed in a mobile application installed in an android mobile having a bluetooth connectivity with the monitoring system..

3. Technical Concept

Figure 1 below gives a picture of the driver drowsiness-detection-system. This system enlightens the importance of safety while driving a vehicle. It comes up with a driver monitoring system which is looked after by an eye blink sensor, an alcohol sensor, pulse sensor and MEMS sensor. The GSM module transmits a signal to a registered cell phone when the alcohol sensor is prompted. The distinctive signals from each sensor is collated by means of ATmega328P microcontroller in an arduino based platform for faster sensor signal processing. The LCD display put on a view of the major output details of each sensor. The bluetooth module synced with the user mobile phone spreads out the entire sensors outputs on-screen. When the set values become distorted the microcontroller initiates a signal to the alarm unit which in turn alerts the driver to wake up.



4. Methodology

Figure 1: Block diagram of the designed system

5. Hardware Architecture

5.1 Control Unit

The control unit is embraced by arduino mc board based on ATmega328P microcontroller. The Atmel ATmega328P is an individual from the Atmel 8-bit microcontroller family. Every individual of the family has distinctive measures of RAM, ROM, I/O ports, and so forth. Contingent upon the no. of outside pins necessary they are packaged with more than 100 or as less to eight. The ATmega328P contains these subsequent features:

- Two 8-bit timers and one 16-bit counters.
- 6 channels of 10-bit ADC.
- Serial communication port.
- I2C interface port for communication with other I2C's.
- 21 lines of general purpose I/O.

5.2 Arduino Uno R3 Board

Arduino boards basically entails with an Atmel microcontroller through corresponding modules that aid program writing and unification into supplementary circuits. A significant characteristic of Arduino is its regular connectors, which makes users easily handle in connecting the CPU board to other variety of add-on modules known as shields. Certain shields are capable of communicating with the arduino directly thru certain pins, but mostly communicate thru I2C serial independently. Arduino's have made use of the mega AVR series of chips. Arduino compatible boards are been in supporting other processors to work on. Most boards have a 5V linear regulator and a 16 MHz crystal. Arduino microcontroller is pre-programmed with a boot loader that makes simpler for uploading programs to the on chip flash memory, because other devices need an external programmer. This makes arduino renowned for its easiness in programming with using a normal computer.

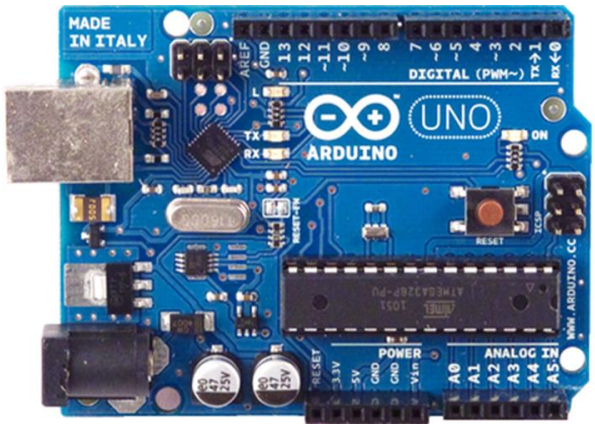


Figure 2: Arduino Uno R3 board [1]

5.3 LCD Display

LCD (Liquid Crystal Display) is been made use as a part of all the electronics works to show the status of the procedure. A 16x2 alphanumeric LCD is most generally utilized module of LCD these days. There are a few other kind of LCD obtainable too. The intention for selecting LCD above other display components is because it is:

- Low cost
- Easily programmable
- Large number of display character etc.

16x2 LCD owns 2 horizontal lines, embracing a room for 16 displaying characters. It has 2 types of registers in-built:

- Command Register
- Data Register.

Command register is made use to supplement special commands into the LCD. A command is a special form of data which makes use of giving internal commands to LCD like clear screen, move to line 1 character 1, setting up the cursor etc. Whereas data register is made use to supplement a data into the LCD.

5.4 Bluetooth Module

The bluetooth device used here is HC-05 module which is an easy going Bluetooth SPP module (Serial Port Protocol) for translucent wireless serial connection. The HC-05 module can either be set in a Master or Slave configuration creating a notable resolution for wireless communication. This module is a fully fit Bluetooth V2.0 + EDR (Enhanced Data Rate), 3Mbps modulation with 2.4GHz radio transceiver and baseband [5]. It is benefited with CSR Bluecore 04 single chip with CMOS technology.

The HC-05 module is a Slave by default factory settings. The AT commands determines the role of the module to work as master/slave. The slaves are limited to initiate a connection to another bluetooth module, but instead it can accept connections. Connection initiation to other devices can only be done by Master module. The user can easily make use of it to form connection between MCU, GPS, PC to project etc.

5.5 GSM Module

The GSM module used is SIM900 Quad-band GSM/GPRS module. It is an ultra-compact and consistent wireless module. It communicates with the controllers by making use of AT commands and it supports software power on and reset. The calibration firmware to reduce complex and costly system level integration for discrete devices in different motion facilitated products to supply best performance.

The MPU-6050 devices come together with a 3-axis gyroscope and accelerometer on the same die, with an on-board Digital Motion Processor (DMP) which can deal with complex 6-axis algorithms. It can also access external sensors thru I2C or SPI communication port to allow the devices to collect all set of sensor data without interrupting system processor. The devices are offered in a 4 mm x 4 mm x 0.9 mm QFN package.

5.9 Pulse Rate Amped Sensor

module is internally handled by AMR926EJ-S processor [6], which has its domination over phone communication, data communication and interfacing circuits with the cell phone. The SIM card added to the outer wall of the module is also controlled by the processor.

5.6 Relay

A relay can be defined as an electrically activated device. Relay circuit can be divided into two sections: - Input circuit and Output circuit [7]. Input circuit is called control system and output circuit as controlled system. A relay is widely exploited in automatic circuit controlling. So it is said that, as an automatic switch actuated by a low-current signal to control a high-power circuit.

A relay has many advantages like moving with lower inertia, stability, highly reliable, compact in size. It is widely applied in devices which need power protection, automation field, remote controlling, electro-mechanics and power electronics. The middle part between input and output part is for coupling and isolating input current besides output actuation.

5.7 Eye Blink Sensor

The eye-blink sensor functions by lighting up the infrared light onto the eyelid area, and then monitor the variations in the reflected light with the help of a photo-transistor and a differentiator circuit. To get accurate results it would be determined by how exactly the emitter and detector are placed and targeted.

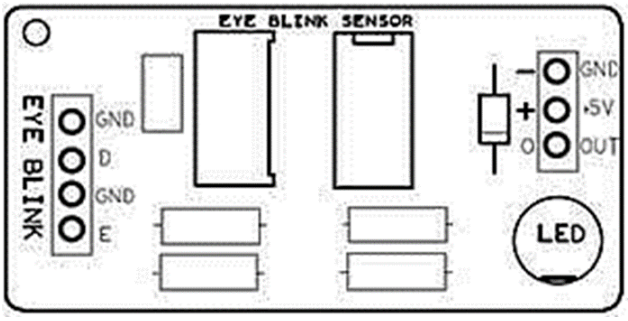


Figure 3: Schematic drawing of Eye blink sensor [8]

5.8 MEMS MPU – 6050 Sensor

The MPU-6050 sensor is designed for the low power, low cost, and high-performance requirements. The MPU-6050 unites Inven-Sense's Motion-Fusion^{TM} [4] and run-time

Heart rate data will be really useful for studying human activity for designing a system in which human involvement is really required. So in this system we have used a plug-and-play optical heart-rate sensing device working on the principle of photoplethysmography. The principle says it is a calculation based on the variation of light produced by the photo led with respect to a particular part of the body where the sensor is placed for reading the pulses. It comes up with an amplification and noise cancellation circuitry to achieve fast and consistent pulse readings. It needs a 5V DC supply with current drawn of just 4mA makes it feel as an excellent choice for arduino based projects. The 24" cable on the sensor comes up with standard male headers which means soldering is not needed.

Dimensions: 0.625" Diameter and 0.125" Thick

5.10 MQ-2 Alcohol Gas Sensor

The MQ-2 series gas sensor comprises of a small heater with an electrochemical sensor [2]. They are profound for a range of gases and are used indoors. The output signal is an analog type and it can be read easily with the analog input of the arduino.

MQ-2 gas sensor detects gas leakage in home and industries. It can sense LPG, i-butane, alcohol, propane, methane, hydrogen and smoke. It has a built-in potentiometer to adjust the sensor sensitivity. The connections are:

- Vcc to Arduino 5V pin
- GND to Arduino GND pin
- Output to Arduino Analog A0-pin

Output	**Level of Drunkenness**		
	130 ppm – 260 ppm	261 ppm – 390 ppm	391 ppm – 650 ppm
LCD Display	Alcohol not detected	Alcohol detected	Alcohol detected
Buzzer	OFF	ON	ON

Table 1: Level of drunkenness in PPM

5.11 Alarm Unit

Buzzer is used for giving warning signal. It indicates that the driver starts getting drowsy. Here we are using 5V DC, HXD piezo-buzzers. Piezo-buzzers are working under the principle of piezoelectric effect. When a mechanical pressure is applied to certain materials it produce electricity and vice-versa [3]. When exposed to an alternating electric field they stretch or compress, in accordance with the frequency of the signal by this means producing sound.

6. Results

6.1 Implemented System

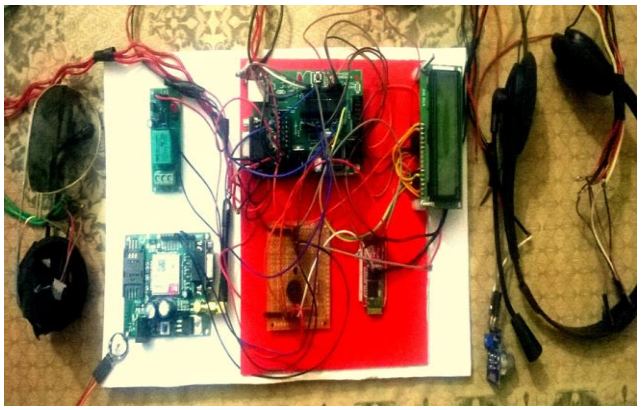


Figure 4: Overall configuration of the designed system

6.2 Software Used

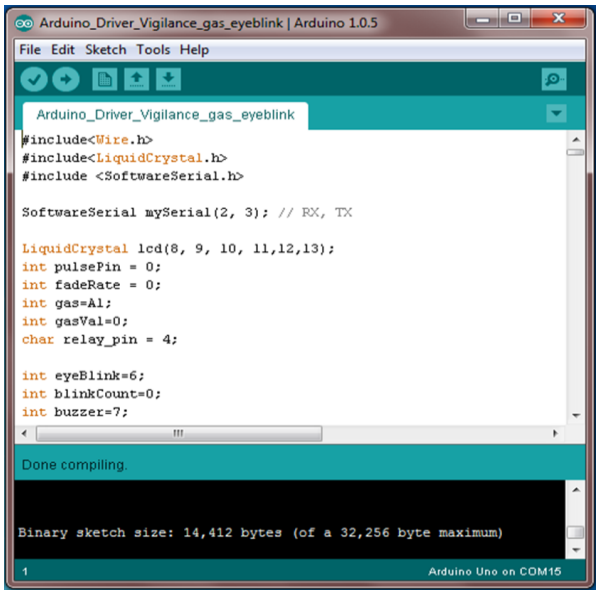


Figure 5: Program coding in Arduino 1.0.5 IDE

6.3 LCD Display Results

(a)

(b)

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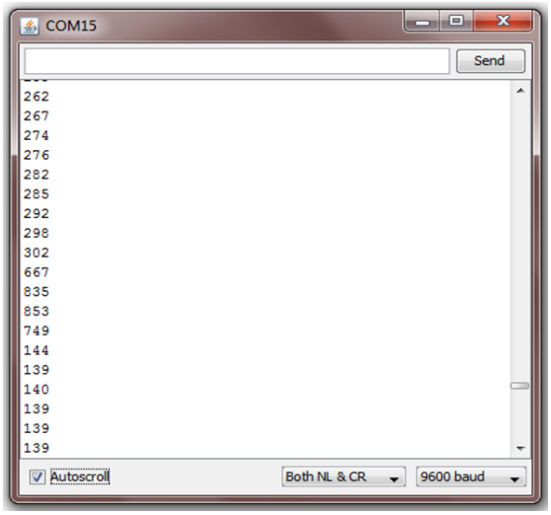
(c)

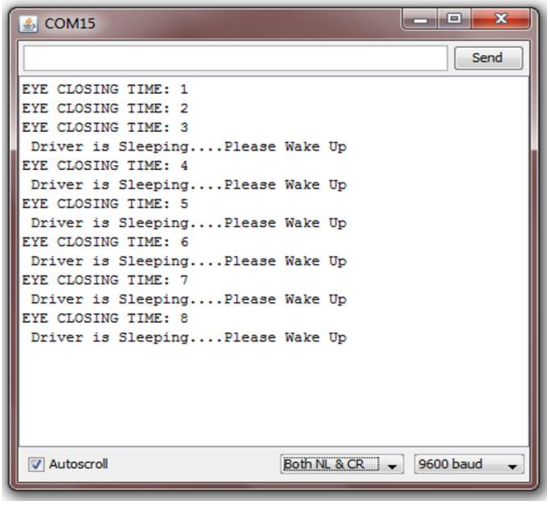
(d)

Figure 6 (a,b,c,d): LCD display results generated from different sensors

6.4 Android Application Results



(a)



(b)

Figure 7 (a, b): Output of Alcohol and Eye blink sensors respectively

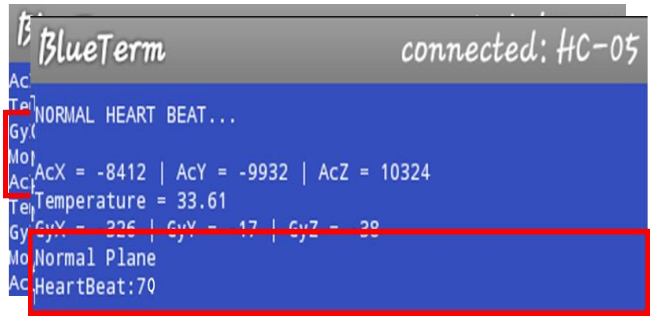


Figure 8: Output from MEMS MPU-6050 sensor (Gyroscope, Accelerometer, Temperature)

Figure 9: Output from pulse rate amped sensor

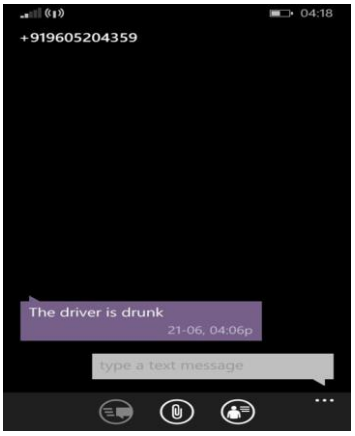


Figure 10: Message send to driver family when driver found drunk

7. Conclusion and Future Scope

The system implemented is a progressive prototype of driver drowsiness detection and alerting system. This system is focused on bringing safety while driving. The alcohol sensor output was linked with relay and SMS facility is also incorporated to notify the driver's family. The behavioral and physiological sensors resulted in providing appropriate safety measures for safe driving.

The project work was put up for study and the implementation on Arduino board with the Atmega328P microcontroller was done. The hardware and programming was prepared in care for successful operation. The aim of this project was to detect and alert the driver when he feels drowsy. That was achieved by doing assessments with this system. The results shows a promising output as it is being a progressive prototype. This project carried out the research in learning about different types of sensors and modules and its application. The user friendly approach made it easy to

understand and operate the system. This system uses very low power, with less complexity in a low cost manner so it can be implemented on road transport vehicles.

This system has a wide scope since the purpose of improving safety in vehicles is a highly focused issue. The IR sensor with a longer distance can show promising results in finding eye closures.

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