RESEARCH ARTICLE

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Accident Detection and Monitoring using Black Box

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Abstract

This paper is proposed to record informational data, such as, vehicle speed, the temperature of the engine, and the amount of alcohol taken by the driver, etc., to revolutionize the field of motor vehicle accident investigation. It is also used for vehicle mapping and accident alert with the help of a global positioning system (GPS) and global system for mobile (GSM) technology.

Keywords: Accidental detection, Arduino Uno, Black box, Monitoring data.

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Introduction

The vehicle accident problem is increasing due to driver's careless behaviors, such as, reckless driving, drunk driving, driving without sufficient sleep, etc. A car black box is designed with logical features considering that more people die in car accidents than that of airplane crashes, as found from investigations. The causes of car accidents are not too difficult to investigate as that of plane crashes, but there are some cases that are very difficult to solve due to contradictory stories of drivers.

For a truthful investigation, it is important to record the status of the vehicle before, during, and after the crash. In order to know what type of sensors should be installed into the vehicle, research was carried out to identify the main information needed for better accident analysis. After filtering information and taking into consideration what could be done and what could help the most, the following data were found to be the most important, which one needs after an accident: seatbelt status, road condition, brake status, speed measurement, interface, position of the accident, and main lights status.[1] A wireless box using a micro electro mechanical systems (MEMS) accelerometer and GPS tracking system is developed for accidental monitoring. In the event of an accident, this wireless device will send a short message on the mobile phone, indicating the position of the vehicle using a GPS.[2] As soon as the driver runs the motor, the system will begin saving the events of corrresponding vehicle.[3] Black box refers to collection of several different recording devices . Car black box is "event data recorder".[4] The causes of the car accident are not too difficult to investigate as that of plane crashes but many cases are very difficult to solve due to contradictory stories of drivers.[5] The collection of the real time data after the detection of collision around the vehicle environment and analyze the collected data to have the conclusion regarding the collision and simultaneously transmitting the data over the wireless network.[6] A black box system is very useful for the automobile industry innovative black box is developed using various sensors like steer touch sensor, hall effect sensor and an android app that contains features of audio/video and GPS/GSM.[7] This could be done effectively using a black box.[8] Car black box is digital electronics device, which records and stores vehicle's speed, vehicle location, vehicle temperature, distance from obstacles, and realtime and vehicle's other status informations. It helps to discover and to analyse the reason of an accident easily and to settle many disputes related to a car accident, such as, crash and insurance settlements.[9] Data from all sensors is recorded using electrically erasable programmable read only memory (EEPROM). All the data is displayed on mobile app via Bluetooth Model.[10]

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Material and Methods

The black box for the car is designed to sense various parameters of the car, such as, speed of the vehicle, the temperature of the engine, and the amount of alcohol taken by the driver. The project is designed with ATmega328P, speed sensor, alcohol sensor, temperature sensor, collision sensor, and the information collected by these sensors is stored in EEPROM for displaying the data on the Bluetooth app.

Figure 1 shows the proposed system, in which the power supply supplies the power to all the four sensors, *viz.*, an alcohol sensor, an ultrasonic sensor, a temperature sensor, and an infrared (IR) sensor, which will supply all the data to the controller, which is Atemga 328P. The GPS module also keeps feeding the live location to the controller and all this data gets stored into EEPROM. All the data via the Bluetooth module is transmitted to the Android application.

Power Unit

The power supply will supply power to all the four sensors, *viz.*, alcohol sensor, ultrasonic sensor, temperature sensor, and IR sensor, and also the brush less direct current (BLDC) motors attached to the wheels of the model car.

Sensing Unit

It consists of the following four sensors. They are described in detail below.

Alcohol Sensor (MQ3)

It is an alcohol detector sensor, which is used to detect the alcohol concentration in human breath. This sensor provides an analog resistive output based on alcohol concentration, which is then converted into a digital signal using A to D converter, this value is mapped into alcohol percentage, stored in EEPROM, and shown on the user's app.

Temperature Sensor (LM35)

A temperature sensor is a device which senses variations in temperature across it, which gives a reading in centigrade (degree Celsius) since its output voltage is linearly proportional to temperature. It uses the fact that as the temperature increases, the voltage across the diode increases at a known rate.

Ultrasonic Sensor (HCSR04)

The ultrasonic sensor uses sonar to determine the distance of an object. The transmitter (trig pin) sends a high-frequency sound signal, when the signal finds an object, it is reflected back and the receiver (echo pin) receives it. The time between the transmission and reception of the signal allows us to calculate the distance of an object. At the following different distances, different operations were performed by our vehicle using the proposed system:

- Under 4 cm: Vehicle stop
- Between 4–10 cm: Vehicle moves in the right direction
- Between 10–80 cm: Vehicle runs with full speed

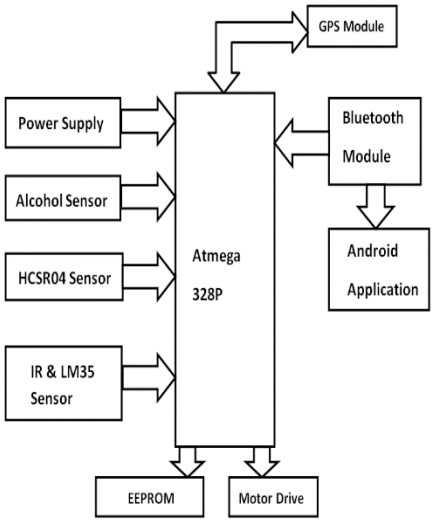

Figure 1: Block diagram

IR Sensor (L2398D)

It is mainly used to determine the speed of the vehicle. IR sensors are placed near the motor of the vehicle in such a way that every time the blades rotate the IR sensor detects it. Timers and interrupts in Arduino are used to calculate the time taken for one complete rotation of the motor.

For obtaining the revolutions per minute (rpm),

- Find out how many pulses your proximity sensor produces per revolution (pulses per revolution)
- Count the number of pulses in one minute (pulse per minute)
- $$\text{RPM} = \frac{\text{Pulses per minute}}{\text{Pulses per revolution}} \quad \ldots[1]$$

Control Unit

AVR AT mega 328P microcontroller is used to control and co-ordinate all modules' activities. The algorithm/code for the operation of the system is written in Embedded C, according to which microcontroller senses the sensor conditions and actuates components for further processing.

Motor driver Integrated Circuits (IC)

L293D is a typical motor driver IC, which allows Direct Current (DC) motor to drive in either direction. L293D is a 16-pin IC that can control a set of two DC motors simultaneously in any direction. It means that a person can control two DC motors with a single L293D IC designed to provide bidirectional drive currents of up to 600 mA at voltages from 4.5 to 36V. It is used to drive inductive loads, such as, BLDC motor.

GPS Module

GPS tracking is a device that uses the global positioning system to determine the precise location of a person, vehicle, or other assets to which it is attached, and record the position of the asset at regular intervals. The recorded data location can be stored in the tracking unit.

Bluetooth Module (HC-05)

This module is used to communicate between two microcontrollers, like Arduino, or communicate with any device with bluetooth functionality, like a phone or laptop. The module communicates with the help of USART at 9600 baud rate hence, it is easy to interface with any microcontroller that supports USART. The HC-05 has two operating modes, one is the data mode, in which it can send and receive data from other bluetooth devices, and the other

is the AT command mode, where the default device setting can be changed.

System Specifications

- 12V power supply used for the system.
- 1 kB EEPROM memory for storing data.
- IR sensor using IC LM 2398D with detection range 2 to 30 cm.
- Alcohol sensor using IC MQ3 with detecting concentration range of 0.05–10 mg/L.
- Temperature sensor using IC LM 35 with a temperature range of -55–150°C.
- Ultrasonic sensor using ICHC-SR 04 with detection range 3–4 cm.

The flow chart, in Figure 2, shows how the proposed system working flow goes:

- Interface all the sensors with Atmega328P.
- Set reference values for each sensor, respectively.
- Read data from each sensor. Store the data of all the sensors in EEPROM.
- ConFig.GPS.Store location of GPS in EEPROM.
- Via the Bluetooth module, send data to the mobile application.
- Observe the received data in the Android application.

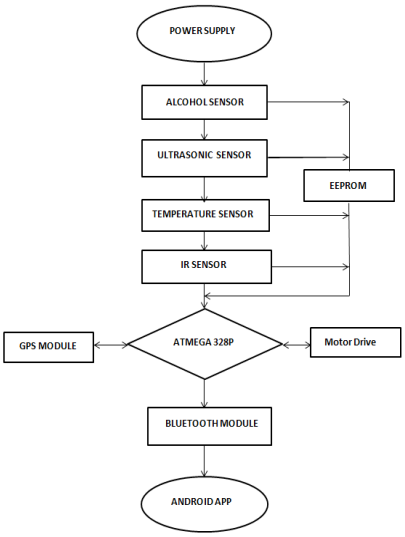

Figure 2: Flow chart

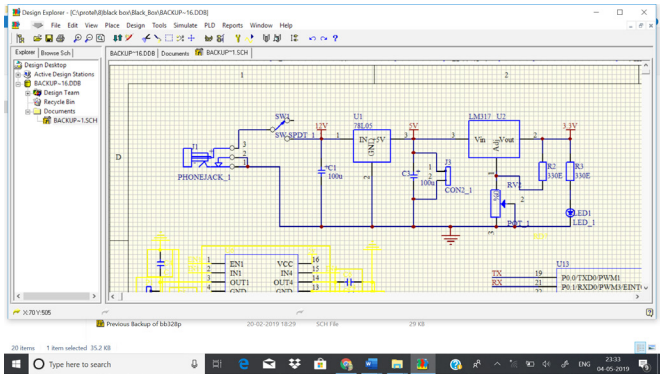

Figure 3: Simulation of power supply design

Results and Discussion

Power Supply

Figure 3 shows the simulation of the power supply design, which will supply power to the sensors and motors. It consists of 5 and 12V power supply. LM7805 IC is used to provide a constant 5V supply for the faithful operations of the controller, sensors, and servomotor. A 12V DC battery is used to provide 12V supply to the BLDC motors.

Printed Circuit Board (PCB) Layout

Simulation and software design diplicts proposed system as shown in Figure 4. PCB mechanically supports and electrically connects electronic components using conductive tracks, pads, and other features etched from copper sheets laminated onto a non-conductive substrate. A printed circuit board has pre-designed copper tracks on a conducting sheet. The pre-defined tracks reduce the wiring, thereby reducing the faults arising due to loose connections. One simply needs to place the components on the PCB and solder them. Figure 5 shows the PCB layout of the proposed circuit with the sensors controller and the motor driver IC. Figure 6 shows the implemented model of PCB design.

Figure 4: Simulation of software design

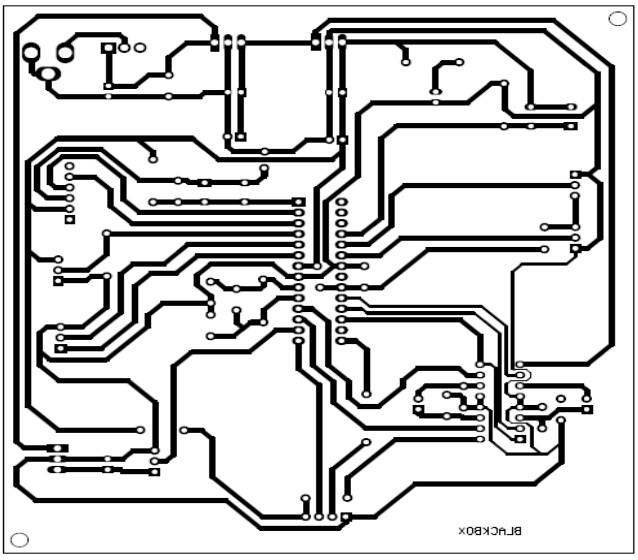

Figure 5: PCB layout

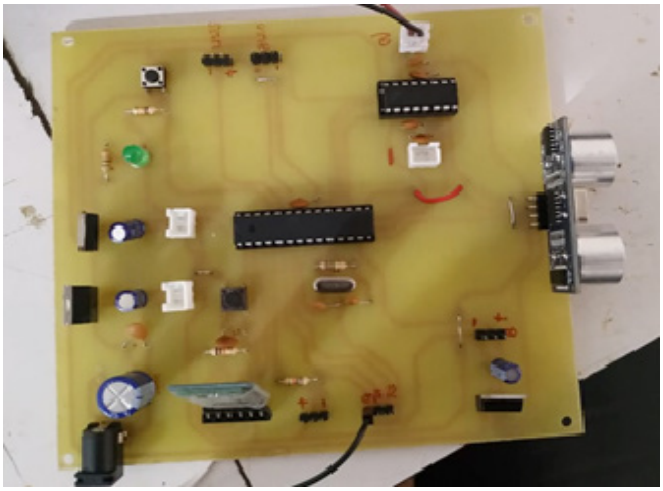

Figure 6: PCB design

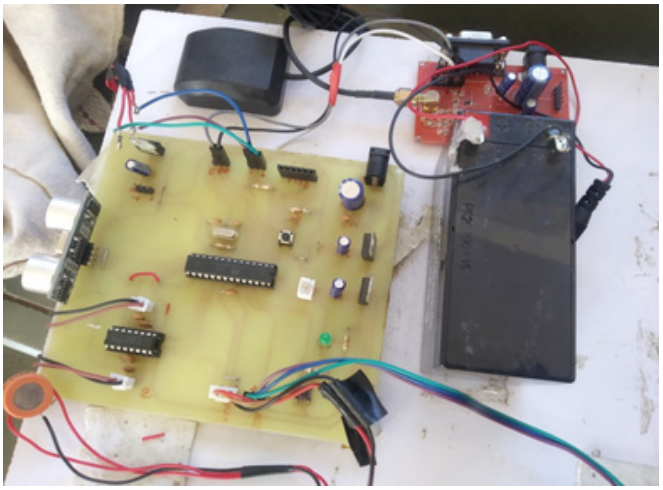

Figure 8: Top view of the black box prototype

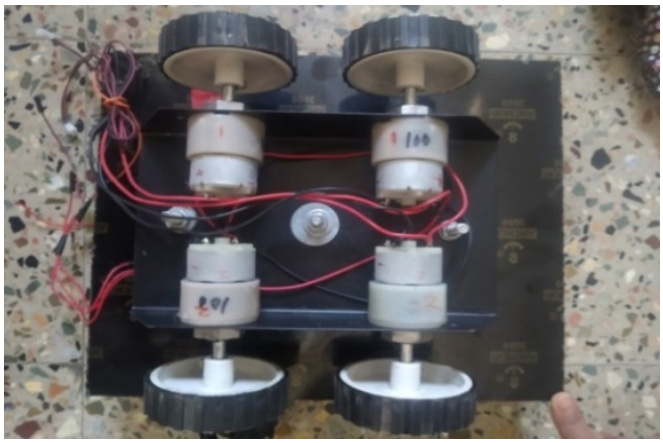

Figure 7: BLDC motors attached to wheels of car

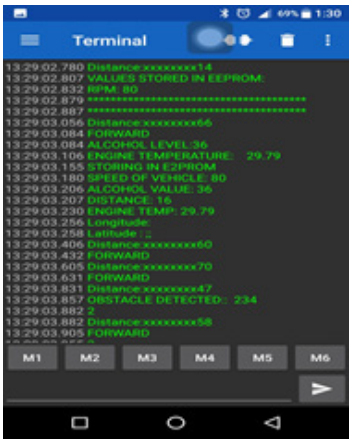

Figure 9: Display on Android

BLDC motors work according to the distance measured by the ultrasonic sensor. When the circuit is on, the motors start rotating in the forward direction making the car move forward. If the car is too close to an obstacle, the car will stop and will rotate 15 degrees right so that the car avoids the accident. Figure 7 shows the BLDC motor circuit attached to the car wheels, and if the car is at a collision distance, the car will slow automatically.

Top view of black box prototype with connection of all circuit parts is represented in Figure 8 . All the parametric results like engine temperature, driver's alcohol level, distance of car from obstacle and number of obstacles detected during travelling can be displayed on android as shown in Figure 9.

Conclusion

This paper has presented a new vision for vehicle industries, which is the box system used for vehicles. A full and detailed description is made for every part of the system. This paper also offers a basic program to analyze the data of the accident.

As soon as the driver starts the vehicle, this system starts collecting the data from all the sensors, such as, speed, distance, temperature, and amount of alcohol content consumed by the driver. The prototype is able to detect all the data successfully and this data is stored in EEPROM. The data is being retrieved in case of the accident for privacy purposes, using a serial cable from EEPROM, and simultaneously displayed to the user via Bluetooth app.

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