DESIGN AND DEVELOPMENT OF VEHICLE MONITORING SYSTEM THROUGH BLACK BOX IN A CAR

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ABSTRACT

This paper elaborate the collection of the real time data while driving a vehicle and to check the driving behaviour and a car status, these data will be useful to analyze the accident and to investigate about the accident. The whole system is vehicle based devices which collect the data like speed, rash driving of a vehicle, GPS position, alcohol detection of a driver over a time period. The data recorder will store the values of all sensors which are interfaced with the controller. Then this information will be transmitted over the wireless network. These data can be used to investigate the crime, rescue operation and insurance claims also this data can be transmitted to the Police station, Insurance Company through the GSM network.

Keywords: Event Data Recorder, Vehicle Speed, Rash driving, Alcohol detection, Global Positioning System, Global System for Mobile.


1. INTRODUCTION

In recent days, improving safety driving is an important objective that has led many organization and companies like vehicle manufacturers to invest significant amounts of resources, mainly in improving road infrastructure and to reduce the car crashes [1]. However, another crucial area of research is on analyzing the driver behavior.

Driver behavior and errors are the main reasons for a majority of car crashes, so understanding the driver’s behavior is essential in accident analysis, emergency medical service and insurance settlements. Reasoning-based framework for the monitoring of driving safety will not be practically possible in real time [2]. Like Black Box of airplane, Car Black Box (Event Data Recorder) is used to store the driver’s behavior and car status to analyze the factors for an accident. Recently, Event data recorders (EDR) have emerged as a new system to collect data on driving behavior and to provide feedback to drivers continuously [3].
Peter I.J. Wouters [11] was aimed at assessing the effect of ‘behavioural feedback’ using data recorders. Event Data Recorder are on-board and integrated with wireless devices that collect and record the information. It can be used to improve design of vehicle and Roadway and emergency medical service by government and hospital. Also the stored information is used to evaluate and improve safety equipment and to investigate crash causes. Oren Musicant’s work [4] focuses the Segregating diver’s behavior as aggressive and non-aggressive [14] driving behavior. Several researches are going on the development of systems that monitor driver’s behavior continuously. This data also will be used for traffic safety research.

2. BLACK BOX IN A CAR
Event Data Recorder (EDR) of a Car is also known as a Black Box, which is used to record information related to accidents. Car black box records the important data so that it can be used to analyse the accident. In addition to the basic function, the car black box equipped with wireless communication system can send accident location information to central emergency and disaster server in real-time. Therefore drivers can receive the help quickly by police and hospital ambulance. But in Bao Rong Chang’s [7] work inter-vehicle communication is encouraged to avoid the accident, there is no rescue method for the driver who met an accident. The proposed system consists of data collection devices for collecting the information about car’s status and the driver's actions, a LabVIEW platform is used to create a database server and this database collect the sensor values from microcontroller through USB.

Overview of the proposed system can be subdivided into various sections:

2.1 Data collection
- Behaviour of driver: Drowsiness and alcohol detection of a driver will be detected by using the web camera.
- Driving data: Driving information such as speed, rash driving.
- Car status data: The car positions checked in real time by GPS.

2.2 Report Generation
Analyse the accident easily and to handle many problems related to car accident like crash litigation, insurance settlements. The database is maintained at the LabVIEW platform and the data will be report to the police station /insurance company through the GSM network. So this system resists the fake data to be record in the police station or in insurance settlement [16] [18].

3. PROPOSED SYSTEM MODEL

![Transmitter End section of Black box in a car](image)

*Figure 1 Transmitter End section of Black box in a car*
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Figure 2 Receiver end section of Black box in a car

Figure 1 and Figure 2 represents the block diagram of a transmitter and receiver section of our car Black box respectively. In the proposed system we divide the whole system as two section, they are

1. Event Data Recorder section (Transmitter)
2. Reporting section (Receiver)

EDR section deals with the sensors, which is interfaced with the ATmega16 microcontroller. By using the sensors like Hall Effect, Accelerometer and MQ3 gas sensors we are detecting speed of the vehicle, rash driving status and driver’s alcohol detecting status. The status of these sensors will be displayed on the 2*16 LCD, also these data will be sent to the database of LabVIEW environment. The data transfer between the microcontroller and LabVIEW environment process through the USB cable. A new breath alcohol detector [5] for a driver has been introduced in this proposed system. A mouthpiece is not required for the detection because driver’s breath sample is captured by an electric suction fan of the detector. Yulan Liang’s [6] work focuses on the detection of driver’s distraction using the eye movement of a driver. In proposed system driver’s drowsiness will be detected by using the video processing algorithm called Viola-Jones algorithm. Webcam is used to monitor the actions of a driver and Viola-Jones algorithm will keep tracking our eyes. If a driver’s eye still closes after 5 to 7 seconds, the algorithm will concluded that the driver is sleeping. So this Drowsiness status and sensor status like speed, rash driving and alcohol detection will be updated in a database which is created at the LabVIEW platform. In addition, the proposed system records the current latitude and longitude of our vehicle using the GPS module [18]. If any severe accident or crash occurs, suddenly the status of a car and the driver will be send to the reporting section through GSM module [17].

Reporting section like Police station, Insurance Company, Hospital will receive the driver’s behaviour and car’s status after an accident occurred. This section consists of a mobile and GSM receiver. The necessary action will be taken by the receiver according to its received data through the GSM network.

4. EXPERIMENTAL DESCRIPTION

4.1 ATmega16 Controller

ATmega16 is an 8-bit high performance microcontroller with low power consumption. This microcontroller will operate at 16MHz operating frequency. ATmega16 is a 40 pin microcontroller. And 32 I/O lines are available, which are divided into four 8-bit ports as PORTA, PORTB, PORTC and PORTD. It has various peripherals like UART, ADC, SPI, I2C, etc. Every pin has an alternative function related to in-built peripherals. This controller is used in the proposed system to acquire the necessary signals from the different sensors like Hall Effect, accelerometer, and alcohol detector.
4.2 Speed detection

The Hall Effect is an ideal sensing technology. When the sensor experienced the magnetic field, it provides an output voltage proportional to the magnetic field strength. The ATmega16 is then programmed to get the input signal on T0 pin. The pulse will be given to the counter input. So the Input Counter is incremented for each time a pulse is detected on a particular pin. In order to find the Revolution per Minute (RPM) of a wheel, we must count the pulses for one minute which is raised from the Hall Effect sensor. Software interrupt is created for one minute and the pulses are counted at that period. Then the product of RPM and wheel circumferences will give the speed of a vehicle in meter per seconds. Every three seconds a new value is displayed on the LCD.

\[ V = C \times \text{rpm} \quad (V=\text{speed}) \]  
\[ C=2\pi r \quad (C=\text{circumferences of wheel}) \]  
\[ V=\pi d \times \text{rpm} \quad (m/s) \]  

4.3 Rash driving detection

An Accelerometer is a device that measures the acceleration as “G-force”. Accelerometer at rest on the surface of the Earth will measure an acceleration \( g = 9.81 \, \text{m/s}^2 \). Accelerometers have different applications in industry products and research. Highly sensitive accelerometers are components of navigation systems for aircraft and missiles [10]. The proposed system is developed to detect the Rash driving of a vehicle by using the MPU6050 accelerometer [9], which is interfaced with ATmega16 microcontroller. The controller continuously reads the x, y and z axis values of a car. These values are recorded and the vehicle orientation is tracked on every minute [19]. The proposed system will judge the rash driving status of a vehicle from these x, y, and z-axis values [20].

4.4 Driver’s drunkenness detection

In this proposed system driver’s breathalyser is very essential. Most of an accident happens because of the driver who consumes alcohol [17]. In accident analysis driver’s drunkenness is the important factor for the insurance market and the police record. MQ3 sensor is an alcohol sensor, which detects ethanol in the air. It is one of the gas sensors so it works almost the same way with other gas sensors. Typically, it is used as part of the breathalysers for the detection of ethanol in the human breath. From the analysis of ethanol concentration in human’s breath, the drunkenness status can be determined.

4.5 Drowsiness detection

Driver’s drowsiness status also should be taking into the consideration while recording the driver’s behavior [5]. Driver cannot control the vehicle if he falls on sleep. So the drowsiness detection of a driver can be determined based on the pattern matching algorithm. Yulan Liang’s [7] work focuses the support vector machines (SVMs), which is a data mining method, to develop a real-time approach for detecting cognitive distraction using drivers’ eye movements and driving performance data. The real time image is acquired by a camera through the vision acquisition tool on LabVIEW. Then vision assistant tool in a LabVIEW is used to detect the drowsiness of a driver by applying the pattern matching algorithm over an real time image. Here Region of Interest is taken to track the driver’s eye over an real time image. Before storing or training the template for pattern matching, we should apply filter and proper resolution on the template which is going to compare with the real time image. This system will continuously acquire the real time image of driver from a web camera and it will compare with the template, if the real time image doesn’t match with the template, then the system will conclude whether the person is sleeping or not.
5. RESULTS AND DISCUSSIONS

Prototype of the system for detecting the driver’s behavior was developed and the data transferred to the system was done through the serial protocol. Further prototype should be equip with the database which is created on LabVIEW platform and it should store and update all the accumulated data like drowsiness detection, speed, rash driving, GPS location and alcohol detection. Figure 4 shows the experimental setup to measure the RPM of a vehicle. This system is constructed by using the Hall Effect sensor and ATmega16 Microcontroller. Figure 3 shows the flowchart for drowsiness detection.

![Flowchart of drowsiness detection](image)

**Figure 3** Flow chart of drowsiness detection

Figure 4 shows the interfacing of Hall Effect sensor with microcontroller and figure 5 shows the interfacing of Alcohol detection sensor with microcontroller. Figure 6 shows the interfacing of Accelerometer sensor with microcontroller.

![Interfacing Hall effect sensor with Microcontroller](image)

**Figure 4** Interfacing Hall effect sensor with Microcontroller
Driver’s alcohol consumption can be detected by using the system which is shown in below as Figure5. This system is also called as Breath analyzer and it is constructed by MQ3 sensor and Microcontroller.

![Alcohol detection sensor with ATmega16 Microcontroller](image)

**Figure 5** Alcohol detection sensor with ATmega16 Microcontroller

Rash driving of a car is predicted by using the MPU6050 accelerometer. While driving a car, we can read the values of the x, y and z axis values from the accelerometer. From these values we can conclude the rash driving status of a car. Rash driving is depending on the environment and the traffic rules which is formulated by the corporation. Accelerometer interface with the controller is shown in below as figure6. This system is handling the rash driving related status.

![Accelerometer sensor with ATmega16](image)

**Figure 6** Accelerometer sensor with ATmega16

The vehicle section is shown in Figure7. Here all the sensors Hall Effect, alcohol detector, accelerometer are interface with the microcontroller and this system is placed on the toy car, which is modeled for the prototype of the real car.

![Vehicle section with controller and sensors](image)

**Figure 7** Vehicle section with controller and sensors
Overall data received from the sensor and microcontroller is transmitted to the computer by serially through the USB. These data further going to be stored and updated every second in the database, which is created in LabVIEW environment. Figure 8 shows the overall database on LabVIEW environment.

![Database on LabVIEW](image_url)

**Figure 8** Database on LabVIEW

Figure 9 and Figure 10 shows the driver’s drowsiness status on the LabVIEW front panel. It shows the result by using the pattern matching algorithm.

![Drowsiness status front panel on LabVIEW for Opened Eye](image_url)

**Figure 9** Drowsiness status front panel on LabVIEW for Opened Eye

![Drowsiness status front panel on LabVIEW for Closed Eye](image_url)

**Figure 10** Drowsiness status front panel on LabVIEW for Closed Eye
6. CONCLUSIONS
Event Data Recorder (EDR) systems provides useful information to analyze the driver’s behavior in real driving situations. This system has been effectively constructed by using the different type of sensors like Hall Effect, Accelerometer, Alcohol detector, etc. ATmega16 microcontroller is used to acquire the signals from these sensors. These data are stored/updated in memory card which is interfaced with the controller. Through GSM, only the critical information are send to the reporting sections like insurance companies, hospital and police station. The memory card database is created with LabVIEW for experimental purpose. This paper also detects the drowsiness of the driver. This system ensures safe driving and avoids fake insurance claim.

REFERENCES


