

Black Box for Smart Vehicles

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Abstract - Many people lose their lives in road accidents. It is majorly because the medical services are not available at that moment and also cause of the accident is unknown sometimes. To overcome these issues, a prototype of Black Box is being developed. The concept of Black Box is obtained from the aviation industry where it helps in the post-crash investigation. In the proposed system, various sensors along with GPS and GSM modules are interfaced with the controller. In case of an accident, the location and real-time values of the sensors are sent to the pre-saved numbers. Also, the driver is warned using a buzzer when the sensor values go beyond their thresholds. This helps in the further investigation process.

Key Words: accident, Black Box, sensors, GPS, GSM, controller

1. INTRODUCTION

With each passing day, road accidents are becoming more frequent. Despite several coordinated campaigns, the situation continues to be dire. On a daily basis, numerous incidents of rash driving, drink-and-drive, hit-and-run, and other similar offences are recorded. Due to a lack of documentation, it is often difficult to differentiate between the perpetrator and the victim. The victim needs to rely on the surrounding crowd for assistance; however, an accident does not often occur in a crowded environment. To help out in such a situation we introduce a prototype of the Black Box system for vehicles.

In aircrafts Black Box is used for recording and storing information which can be retrieved when required. In the proposed system we are using the same concept for cars. In our system, we are interfacing accelerometer, alcohol, temperature, ultrasonic sensors whose real-time values are being recorded and stored. Since we have used Analog sensors, to feed the values to the controller we used an Analog to Digital convertor (ADC).

Due to the size of SD card, the data stored in it can't be destroyed indisputably. All the data is uploaded in google spreadsheet after every 30 seconds. As in the real-time data is fetched continuously, whenever the threshold value is crossed an alert is generated using a buzzer. Besides, if the accelerometer also crosses its threshold then the real-time value of all the sensors along with the exact location is sent to the pre-coded numbers. All the recorded data can be used for further investigation and also forensic in related crimes.

1.1. Problem Statement

In accidental cases, the shreds of evidence get erased accidentally or on purpose that creates chaos within the investigation process. This results in to injustice to the sufferer. Moreover, the severe injuries caused throughout accidents need immediate medical services for which sufferer needs to rely on nearby folks.

1.2. Existing System

Many solutions are initiated for the issues mentioned above. Each idea has its benefits. Nowadays, the vehicles have GPS installed through which the location of the mishappening can be detected easily. The prevailing system has been programmed in such a way that it only sends the location of the vehicle in case of an accident.

1.3. Proposed System

The system that we are coming up not solely detects the accident however conjointly reads the real-time values of the parameters through sensors which we are interfacing. Whenever the brink of those sensors is crossed the driver is alerted using an alarm/buzzer. The fetched values together with the precise location are sent to the pre-saved numbers just in case of associate accident.

2. LITERATURE SURVEY

P. Swetha, Keerthi, S. K. Asma Parveen, P. A. S. Sowmya, R. Vyashnavi, and Y. Jyosthna Venkat in [1] have proposed Accident Prediction and Crash Recovery by using Car Black Box. In this system, Raspberry Pi was used as the controller. Alcohol, Light, Accelerometer, Distance Gauge, Temperature, and Seat belt sensors along with GPS and GSM module are interfaced with the controlling unit. The different sensors read the specific parameters which are analyzed based on their threshold. The exact location of the vehicle is sent to the pre-coded numbers whenever the accident is detected.

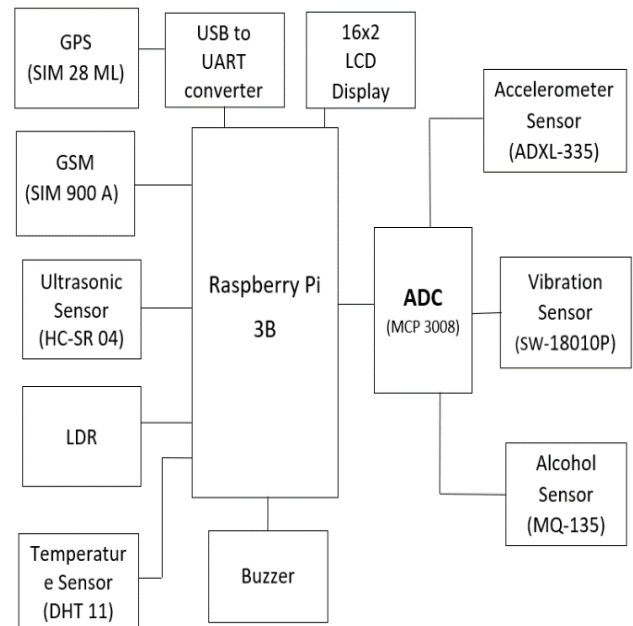
Rekha and Hithaishi in [5] have presented Car Surveillance and Driver Assistance using Black Box with the help of GSM and GPS Technology. Various sensors are interfaced with the UART (AT89S52) is a 40-pin microcontroller. The values of different parameters were fetched through flame, temperature, accelerometer, pressure sensors respectively, and display on LCD. Once the threshold is crossed, GPS locates the exact position of the vehicle which is sent along with the sensor values to the concerned people.

P. Akshaya, L. Aparna, and Mary Suji Mol in [2] have put forward the idea of a Black Box Analysis System for Vehicles using IoT Technology. The alcohol, ultrasonic, speed, MEMS sensors are interfaced with Raspberry Pi which collects the data and stores it in MQTT Cloud. If the process is interrupted due to an accident, all the data is sent through the mail to the pre-stored mail-id.

Nagalakshmi, Nirmala, and Akash Soragaon in [6] came up with Raspberry Pi based Embedded System for Vehicle Automation over the Internet. The project is based on two controllers – Raspberry Pi and Arduino Mega where GPS is interfaced with Pi and the rest of the sensors along with GSM is connected to Arduino. The speed of the vehicle is controlled by the distance sensor and the speed and location are continuously uploaded on Cloud storage.

Vidya and Basavaraj in [5] have proposed implementation of car black box using ARM. In this system they have used (LPC 2129 Controller) that is ARM 7 Controller. They have interfaced ultrasonic, alcohol, accident, CO2 and temperature, fuel sensor, along with GPS and GSM module. All the data read from the sensors were stored in the memory of the controller.

3. BLOCK DIAGRAM



4. HARDWARE SYSTEM

1. **Raspberry Pi 3B:** Raspberry Pi 3 Model B has a 1.2GHz 64-bit quad-core ARM Cortex-A53 processor, onboard 802.11n Wi-Fi, Bluetooth, and USB boot capabilities. Its other features are Power over Ethernet (PoE), USB boot, and network boot. It has a power supply of 5V up to 2.5 Amps. Out of total 40 pins, it provides 26 GPIO pins that interface the outside world with the controller. The rests are power and ground pins. It also has CSI (Camera Serial Interface) port to record the video.



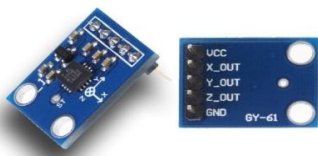
2. **GPS:** Global Positioning System (GPS) tracks the location of any desired object or vehicle. The SIM28ML is a stand-alone or A-GPS receiver with antenna specifications. Even without network assistance, the SIM28ML can detect a signal as low as -165dBm. It also has excellent low power consumption characteristics, requiring just 16 milliamps for acquisition and 15 milliamps for monitoring. The receiver can determine the 2D position i.e., the latitude and longitude of the vehicle. The SIM28ML receives signals from GPS satellites at a nominal frequency of 1575.42 MHz



- 3. GSM:** Global System for Messaging Communication (GSM) operates at a range of 900-1800 MHz. They are virtually similar to an ordinary cell phone from the perspective of a mobile phone network, including the need for a SIM to recognize themselves to the network. In case of an accident, vehicle status and the exact location can be sent using GSM. When the value of sensors reaches its threshold, the GSM is activated for sending SMS to the pre-coded numbers. They are usually used as a part of the embedded system.



- 4. Accelerometer:** ADXL335 is a 3-axis accelerometer with an onboard voltage regulator IC and signal conditioned Analog Voltage output. An accelerometer will determine the angle which is inclined with respect to the earth by calculating the amount of acceleration due to gravity. By sensing the amount of dynamic acceleration, the accelerometer can find out in what direction the device is moving. An ADC on the controller can be used to read the values. The x and y-axes can have bandwidths ranging from 0.5 Hz to 1600 Hz, while the z-axis can have bandwidths ranging from 0.5 Hz to 550 Hz. Accelerometers are flexible devices that can be used to monitor high- or low-frequency vibrations as well as shock.



- 5. Vibration Sensor:** When an external force, such as movement or vibration, is applied to the vibration sensor SW180010p, the sensor's two contact pins close and contact is made between the two pins. The sensor terminals revert to open

contacts when the force is withdrawn. The vibration measured can be used to detect accident also.



- 6. Temperature Sensor:** The DHT11 is a sensor that measures temperature and humidity. The sensor includes a dedicated NTC (Negative Temperature Coefficient) for temperature measurement and an 8-bit microcontroller for serial data output of temperature and humidity values. It can measure temperature from 0°C to 50°C and humidity from 20% to 90%.



- 7. Distance/Ultrasonic Sensor:** The sensor HC-SR04 is commonly used with both μ p and μ c platforms like Arduino, Raspberry Pi, etc. It is a widely used sensor in a variety of applications that include measuring distance or sensing artefacts. The ultrasonic transmitter sends out an ultrasonic wave that passes through the air, and when it encounters some object, the wave is reflected back to the sensor which is observed by the ultrasonic receiver. It is used to measure the distance within the range of 2cm to 400cm.



- 8. LDR Sensor:** Light Dependent Resistors (LDR), are light-sensitive devices most often used to indicate the presence or absence of light. In the dark, the resistance measured is less, but when the LDR sensor is exposed to light, the resistance increases, depending on the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied.



9. **LCD Display:** LCD is use to display all the parameter continuously on the screen. A liquid crystal display (LCD) screen is a type of electronic display module. A 16*2 LCD display is a very simple module that can be used in a variety of devices and circuits.



10. **ADC:** The Analog to Digital Converter MCP3008 is an 8-channel 10-bit device. This chip is a great choice for reading simple analog signals. It uses the SPI bus protocol which is supported by the Pi's GPIO header.



11. **USB 2.0 to UART TTL Converter Module:**

This USB to TTL adapter is based on the CP2102 USB to TTL serial converter IC. When microcontrollers such as Arduino, Raspberry Pi, and PIC communicate with computers through serial communication, it is used. It can also use AT commands to program and/or communicate with a GPS/GSM module.

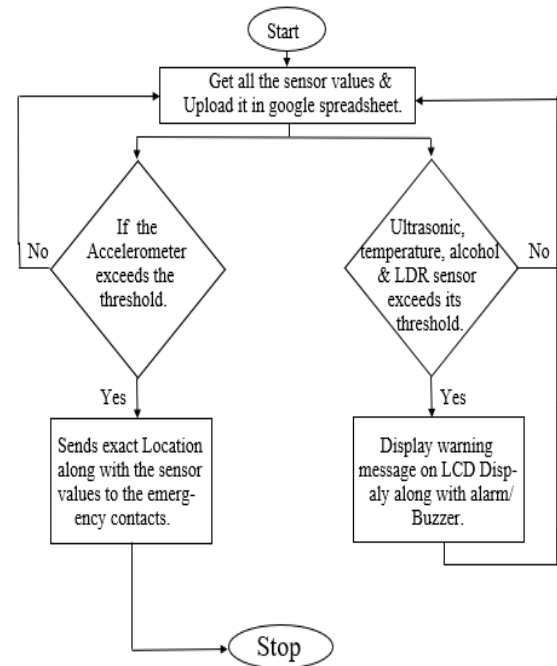


Fig -1: Flow Chart for the Working of Prototype

The above flow chart depicts the working of the prototype. After reading the values, if the accelerometer has crossed its upper limit then it is considered an accident. So, according to our prototype, the GSM will send a message which contains the exact location along with the other sensor values to the emergency contacts. While for other sensors, when they cross their threshold, the sensor values are displayed on the LCD as well as an alert is generated using a buzzer. The process repeats itself continuously until an accident does not occur.

6. **ADVANTAGES**

1. The location of the accident can be easily detected.
2. It also acts as a security system for the vehicle.
3. The emergency services can be provided as soon as possible.

7. **RESULT**

The prototype of Black Box for vehicles has been designed in which all the sensor values are recorded after every 30 seconds and an alert is given using the buzzer when thresholds are crossed. In case of any mishap, the accelerometer crosses its upper limit, causing the GSM to send message to the pre-coded numbers. This message contains the location of the vehicle and the sensor values. The recorded values and message is shown in the figure below:

5. **METHODOLOGY**

Raspberry Pi 3B acts as a mini-computer once connected to monitor, keyboard, and mouse. The SD card is employed for storing the information in Pi. The sensors, GPS, and GSM modules are interfaced externally with Pi. These work simultaneously to read the real-time data and store within the SD card. The operating system which is being used for the prototype is Raspbian Stretch and the sensors are being programmed using Python IDLE.

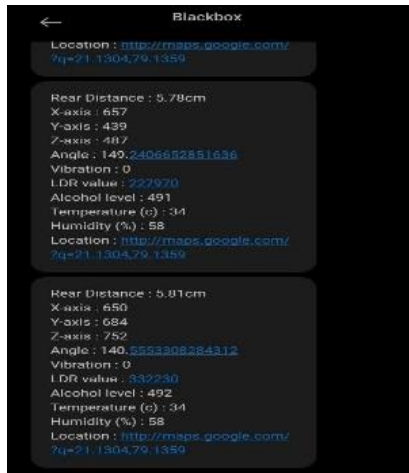
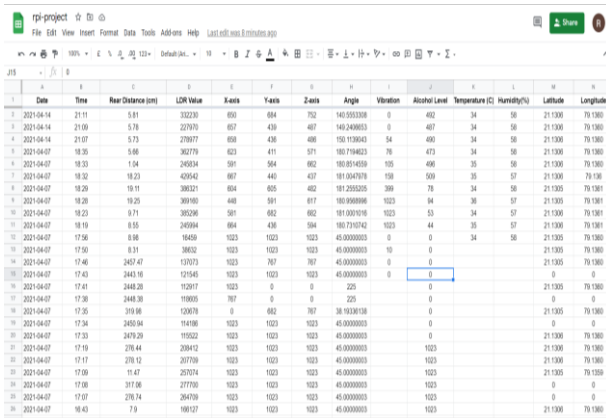


Fig -2: Message Sent to Pre-coded number via GSM



Date	Time	Rear Distance (cm)	LDR Value	X-axis	Y-axis	Z-axis	Angle	Vibration	Alcohol Level	Temperature (C)	Humidity(%)	Latitude	Longitude
2021-04-14	21:11	5.81	13220	601	604	752	140.503308	0	402	34	58	21.1300	79.1380
2021-04-14	21:09	5.78	22970	607	439	407	149.248003	0	407	34	58	21.1300	79.1380
2021-04-14	21:07	5.73	22977	608	438	406	150.133043	54	400	34	58	21.1300	79.1380
2021-04-07	18:35	5.66	162779	623	411	571	160.734023	76	473	34	58	21.1300	79.1380
2021-04-07	18:33	5.64	162781	623	411	571	160.821059	105	466	35	58	21.1300	79.1380
2021-04-07	18:32	18.23	43542	607	440	437	161.043178	158	509	35	57	21.1300	79.1380
2021-04-07	18:29	18.11	380321	604	655	402	161.255205	386	78	34	58	21.1300	79.1381
2021-04-07	18:29	18.25	380360	448	591	617	160.990186	1023	84	36	57	21.1300	79.1381
2021-04-07	18:23	8.11	24028	601	462	462	160.821059	105	51	34	57	21.1300	79.1381
2021-04-07	18:19	8.55	24094	604	438	504	160.733142	1023	44	35	57	21.1300	79.1381
2021-04-07	17:58	8.86	16458	1023	1023	1023	45.0000003	0	0	34	58	21.1300	79.1380
2021-04-07	17:58	8.31	38032	1023	1023	1023	45.0000003	10	0	0	0	21.1300	79.1380
2021-04-07	17:48	3457.47	137073	1023	767	767	45.0000003	0	0	0	0	21.1300	79.1380
2021-04-07	17:43	3443.16	125451	1023	1023	1023	45.0000003	0	0	0	0	21.1300	79.1380
2021-04-07	17:41	3443.28	125017	1023	0	0	225	0	0	0	0	21.1300	79.1380
2021-04-07	17:38	3443.38	118805	767	0	0	225	0	0	0	0	21.1300	79.1380
2021-04-07	17:35	339.86	126878	0	602	767	38.1630158	0	0	0	0	21.1300	79.1380
2021-04-07	17:34	3450.94	114188	1023	1023	1023	45.0000003	0	0	0	0	21.1300	79.1380
2021-04-07	17:33	3479.29	115522	1023	1023	1023	45.0000003	0	0	0	0	21.1300	79.1380
2021-04-07	17:19	276.44	208412	1023	1023	1023	45.0000003	1023	0	0	0	21.1300	79.1380
2021-04-07	17:17	276.12	207798	1023	1023	1023	45.0000003	1023	0	0	0	21.1300	79.1380
2021-04-07	17:09	11.47	237074	1023	1023	1023	45.0000003	1023	0	0	0	21.1300	79.1380
2021-04-07	17:08	317.56	277720	1023	1023	1023	45.0000003	1023	0	0	0	21.1300	79.1380
2021-04-07	17:07	276.74	264709	1023	1023	1023	45.0000003	1023	0	0	0	21.1300	79.1380
2021-04-07	16:43	7.9	166127	1023	1023	1023	45.0000003	1023	0	0	0	21.1300	79.1380

Fig -3: Uploading Data over Google Spreadsheet

8. CONCLUSION

A Black Box for Smart Vehicles prototype is designed to identify vehicle incidents and aid in investigations. Alcohol, accelerometer, ultrasonic, temperature, and LDR sensors, as well as a GPS and GSM module, are all linked to the Raspberry Pi. The parameters that could lead to minor mishaps can be prevented to some degree with the use of an alarm/buzzer. When required, the data stored in the SD card can be accessed. As a result, prompt medical attention will save a person's life.

9. FUTURE SCOPE

We can link the device to the vehicle's airbag system in the future. This will maximize the potential of the proposed technologies and result in the best accident detection system possible. According to the study, the majority of accidents are caused by rash driving and, in the case of long driving, drowsiness. As a result, this project is improved by maintaining a speed warning in the event of rash driving and drowsiness detection with an alert in the event that the driver feels drowsy. The proposed system sends the message to notify the

approved person via GSM, which can also be done via E-mail. Within the car, web cameras could be mounted for driver assistance with the consent of the owner.

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