# WIRELESS BLACK BOX FOR VEHICLE USING IOT

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***Abstract*— The project aims to develop a wireless black box system for vehicles using IoT technology. The system will collect data from various sensors installed in the vehicle, such as GPS, accelerometer, gyroscope, and camera, and transmit the data wirelessly to a cloud-based data storage and processing system. The data will be processed and analyzed using advanced data analysis and visualization techniques to provide insights into vehicle performance and driver behavior. The system will also provide driver feedback in real-time, helping to improve driving behavior and reduce the risk of accidents.**

**The project will involve the design and development of hardware and software components, as well as testing and deployment of the system in vehicles. The wireless black box system has the potential to revolutionize the transportation industry by providing real-time data on vehicle performance and driver behavior, which can be used to improve safety, reduce fuel consumption, and optimize fleet management**

## I. INTRODUCTION

The wireless black box is a small device that can be installed in vehicles and can communicate with other devices using wireless communication technologies such as Bluetooth, Wi-Fi, and cellular networks. It can collect a wide range of data such as vehicle speed, acceleration, location and fuel consumption. The use of wireless black boxes in vehicles has many benefits. It can help to improve safety by providing real-time information about vehicle performance and driver behavior. It can also help to reduce maintenance costs by identifying potential problems early and allowing for timely repairs. In addition, it can provide valuable data to insurance companies, which can be used to calculate premiums based on actual driving behavior.

Fuel leakage detection is an important application of vehicle black box technology that can help prevent accidents and reduce environmental damage caused by fuel leaks. A fuel leak occurs when fuel is released from the fuel system due to a damaged or malfunctioning part, such as a fuel line or fuel tank. If left undetected, a fuel leak can lead to a fire or explosion.

Vehicle black boxes with fuel leakage detection capabilities use sensors to monitor the fuel system and detect any signs of a leak. The sensors can detect changes in fuel pressure, temperature, and other parameters that may indicate a leak. When a leak is detected, the black box can alert the driver or other stakeholders via an alarm or notification.

Overall, the use of wireless black box technology in vehicles using IoT has the potential to revolutionize the way we monitor and manage our vehicles, making them safer, more efficient, and more cost-effective

The current existing solutions that provide assistance to passengers in case of vehicle accident occurrence are mainly concerned with user interaction after the incident happened. Those mobile solutions require that the injured must launch the app and request help manually and that would not be possible if he/she is under critical or serious non-vital situation. The situation becomes even worse if passengers went under unconscious state.

Our proposed solution is a smart IoT system consisting of architecture, design, and implementation. This system requiresno user interaction during or after the accident; consequently,it provides instant automated vehicle accident detection and reporting. This method is applicable for any vehicle used in transportation and mainly for cars accidents. The primary users of this solution are the public safety organizations rescue teams (like Red Cross, Emergency Management Agencies, Law Enforcement Agencies, Fire Departments, Rescue Squads, and Emergency Medical Services, etc.…).

The main contributions of this paper are: (a) Developing a new smart IoT solution which helps the community in reducing the death rate resulting from vehicle accidents. (b) Ensuring that no passenger (injured) intervention is required during or after the accident. (c) Transmitting automatically thebasic medical information needed by the rescue teams to the PSO headquarter. (d) Collecting geographical data which can be fed to a data mining engine to extract roads conditions, and to generate descriptive statistics reports about vehicle accidents. (e) Implementing a navigation system to find the closest rescue team to the crash.

## II. Background Work

There has been significant background work related to the development of wireless black box systems in vehicles using IoT. This work has focused on various aspects of the system, including sensor selection, wireless communication technologies, cloud-based data storage systems, and data analysis techniques.

One area of background work has been in the selection and integration of sensors for the system. Various types of sensors have been used, including GPS, accelerometers, gyroscopes, and cameras. The sensors are used to collect data about vehicle performance and driver behavior, such as speed, acceleration, braking, and turning. The data collected from these sensors can be used to identify unsafe driving behavior and provide real-time warnings to drivers to improve safety.

One of the key sensors used in accident detection systems is an accelerometer. Accelerometers are used to measure the acceleration of a vehicle and can detect sudden changes in velocity, which can indicate an accident. The accelerometer may also be used to detect the orientation of the vehicle, which can provide additional information about the accident.

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Other sensors that may be used in accident detection systems include vibration sensor, gyroscopes, GPS modules, and cameras. Gyroscopes can be used to detect the rotational motion of a vehicle, which can provide additional information about the accident. GPS modules can be used to provide accurate location data of the vehicle, which can be used to notify emergency services or other relevant parties. Cameras can be used to provide visual evidence of the accident and may also be used to detect the presence of other vehicles or pedestrian.

## III. LITERATURE REVIEW

Wireless black box technology in vehicles using IoT has received significant attention in recent years due to its potential for improving vehicle performance, promoting safety, and reducing costs. Researchers have proposed various designs and implementations of wireless black box systems, each with their own advantages and limitations:

1. **Sanketh B Prabhu [1]:** “IoT Enabled Fuel Level Monitoring and Automatic Fuel Theft Detection System”. This paper describes the design and implementation of a smart vehicle black box using IoT technology. The system uses sensors to collect data about the vehicle and driver behaviour, and communicates wirelessly with a cloud-based data storage system.
2. **Chris Thompson [2]:** “Automatic Traffic Accident Detection and Notification with Smartphones”. This paper proposes a real-time monitoring and warning system for vehicle safety using IoT technology. The system uses wireless sensors to collect data about the vehicle and driver behaviour, and provides real-time warnings to the driver in the event of unsafe behaviour.
3. **Md. Syedul Amin [3]:** “Accident Detection and Reporting System using GPS, GPRS and GSM Technology”. This paper describes the development of a wireless black box system for fleet management using IoT technology. The system uses wireless sensors to collect data about vehicle performance and driver behaviour, and communicates wirelessly with a cloud-based data storage system.
4. **Usman Khalil [4]:** “Automatic Road Accident Detection Techniques: A Brief Survey ”. This paper describes the implementation of a vehicle black box system for monitoring and analysis of driving behaviour. The system uses wireless sensors to collect data about vehicle performance and driver behaviour, and uses machine learning algorithms to identify patterns and trends in the data.
5. **Zainab Salim Alwan [5]:** “Car Accident Detection and Notification System Using Smartphone”. This article provides a comprehensive review of IoT applications in intelligent transportation systems, including wireless black box technology. The article highlights the potential benefits of IoT technology in improving vehicle performance, promoting safety, and reducing costs.
6. **Wojciech Kunikowski [6]:** “An Overview of AT mega AVR Microcontrollers Used in Scientific Research and Industrial Applications”. This paper describes the ATmega48 is a microcontroller chip from the AVR family, designed and manufactured by Atmel Corporation. It is a low-power, high-performance 8-bit microcontroller with advanced RISC architectur
7. **Uddesh Shendare [7]:** “Smart Fuel Theft Detection using Microcontroller and IOT”. This paper proposes the installation of a fuel sensor, a microcontroller, and a GSM module to monitor the fuel usage in real-time, process the data, and trigger an alarm when fuel theft is detected.
8. **Pushkar Bhilegaonkar [8]:** “Fuel Theft Prevention System”. This paper describes the installation components, such as a relay and a DC motor, to control the fuel flow and prevent theft. Proper wiring and programming are crucial for the successful implementation of the fuel theft project.
9. **Nandini Hiremath [9]:** “Smart Fuel Theft Detection using Microcontroller ARM7”. This paper describes the implementation of GPS and GSM module. Microcontroller process the data and send a signal to GSM module to sends an alert message to the authorized user's phone number.

## IV. METHOD

Identifying the requirements: The first step is to identify the requirements for the wireless black box system. This involves determining the types of data that need to be collected, the sensors required for collecting the data, the communication technologies required for transmitting the data, and the data analysis and visualization techniques required for processing and presenting the data.

Selecting the hardware and software components: The second step is to select the hardware and software components required for building the wireless black box system. This involves selecting the appropriate sensors, communication modules, microcontrollers, and cloud-based data storage and processing systems.

Designing and testing the hardware: The third step is to design and test the hardware components of the wireless box system. This involves designing the circuit diagrams, PCB layouts, and mechanical components required for the system, as well as testing the individual components to ensure that they function correctly.

Developing the software: The fourth step is to develop the software components required for the wireless black box system. This involves developing the firmware for the microcontroller, the software for the cloud-based data storage and processing system, and the user interface for accessing the data.

Integrating and testing the system: The fifth step is to integrate all the hardware and software components of the wireless black box system and test the system as a whole. This involves testing the data collection, transmission, and processing components of the system, as well as testing the user interface and ensuring that the system meets the requirements identified in step 1.

Deploying and monitoring the system: The final step is to deploy the wireless black box system in vehicles and monitor the system to ensure that it functions correctly and provides the desired results. This involves collecting and analysing data from the system and making any necessary modifications or improvements to the system.

## V. Hardware components and Working:

**ATmega48 micro-controller:**


Fig 1: ATmega48 micro-controller

As shown in the fig 1, ATmega48 is an 8-bit micro-controller from the Atmel AVR family. It is designed to be a low-power, high-performance device for a variety of embedded applications. The ATmega48 has 4KB of Flash memory for storing program code, 512 bytes of SRAM for data storage, and 256 bytes of EEPROM for non-volatile data storage. It also has a 16MHz clock speed, which provides fast and responsive operation.

**Working:**

The ATmega48 is a microcontroller from Atmel, now Microchip Technology, based on the AVR (Advanced Virtual RISC) architecture. The ATmega48 contains a CPU (Central Processing Unit) that executes instructions stored in its program memory. The CPU can execute up to 20 MIPS (Million Instructions Per Second) at 20 MHz clock speed. The ATmega48 has 4KB of Flash memory for storing the program code, and 512 bytes of SRAM for storing data. The microcontroller has a range of peripherals, such as timers, counters, and UARTs, that can be used to interface with other electronic devices. The ATmega48 also contains a range of digital and analog input/output pins, which can be used to control external devices or to read sensor data.

The microcontroller can be programmed using a variety of programming languages, including C, C++, and Assembly, and can be programmed using an In-Circuit Serial Programmer (ICSP) or a bootloader. The ATmega48 can be powered from a range of power sources, including batteries and external power supplies. The microcontroller can be used in a variety of applications, including embedded systems, robotics, and automation.

**Power Supply:**


Fig 2: 12V Battery

As shown in the fig 2, Power supply is used to energies the equipment's such as microcontroller, relay, level converter, GSM, and GPS module. The power supply is used to energies the whole module. The power supply can be in the form of wired or battery. In our project 12V battery is used as a power supply.

**GPS module:**

Fig 3: GPS module

As shown in the fig 3, Global positioning system (GPS) Module is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from various satellites to reach the receiver. The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, you can monitor the status of the module.

**Working:**

A GPS (Global Positioning System) module is an electronic device that receives signals from GPS satellites to determine the location. A GPS module contains a receiver that picks up signals from GPS satellites orbiting the Earth. The receiver uses the signals to determine the distance between the module and each satellite, based on the time it takes for the signal to travel from the satellite to the module. The receiver calculates the module's position by triangulating the distances between the module and multiple GPS satellites. The GPS module also uses data from the satellites to calculate the module's speed and direction of travel. The module can communicate its position, speed, and direction to a microcontroller or other electronic device over a serial interface, such as RS-232 or USB. The GPS module requires an unobstructed view of the sky to receive signals from the GPS satellites. Buildings, trees, and other obstructions can block the signals and reduce the accuracy of the GPS location.

GPS modules are widely used in a variety of applications, including vehicle tracking, navigation systems, and outdoor recreation. They can be integrated with microcontrollers or other electronic devices to provide accurate location and tracking information.

**GSM module:**

Fig 4: GSM module

As shown in the fig 4, GSM is used to send data from control unit to base unit. We can use GSM 300 which operates at frequency 900MHz. It has up link band of 890MHz to 915MHz and down link Band of 935MHz to 960 MHz GSM takes advantages of both FDMA & TDMA. In 25MHz BW, 124 carriers are generated with channel spacing of 200 KHz (FDMA). Each carrier is split into 8 time slots (TDMA). At any given instance of time 992 speech channels are made available in GSM 300.

**Working:**

A GSM (Global System for Mobile Communications) module is an electronic device that allows a mobile device or a computer to connect to a GSM network to send and receive data, such as SMS messages or voice calls. A GSM module contains a SIM (Subscriber Identity Module) card slot, which allows the module to connect to a GSM network. When a SIM card is inserted into the module, it registers with the GSM network and acquires a unique identification number. The module communicates with the GSM network using standard AT commands over a serial interface, such as RS-232 or USB. When a command is sent to the module, it sends the command to the GSM network, which performs the requested operation and returns a response to the module. The module can be used to send and receive SMS messages, voice calls, and data packets, such as GPRS or 3G data. The module also contains a range of additional features, such as network signal strength monitoring, network registration status, and SIM card status. GSM modules are widely used in a variety of applications, including security systems, tracking devices, and remote monitoring systems. They can be integrated with microcontrollers or other electronic devices to provide wireless connectivity and communication capabilities.

**LCD Display:**

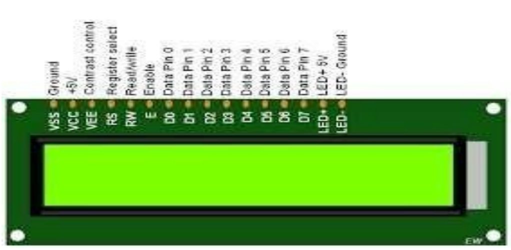


Fig 5: LCD Display

As shown in the fig5, LCD 16x2 is a 16-pin device that has 2 rows that can accommodate 16 characters each. LCD 16x2 can be used in 4-bit mode or 8-bit mode. It is also possible to create custom characters. It has 8 data lines and 3 control lines that can be used for control purposes.

**Working:**

LCD (Liquid Crystal Display) displays are a type of flat-panel display commonly used in electronic devices to display information. An LCD display consists of a layer of liquid crystal material sandwiched between two layers of polarizing material. The polarizing material is oriented at right angles to each other. The liquid crystal material is composed of rod-shaped molecules that are aligned in a specific direction when a voltage is applied. When no voltage is applied, the liquid crystal molecules are randomly oriented, and light passing through the display is blocked by the polarizing material. When a voltage is applied, the liquid crystal molecules align themselves with the applied electric field, causing the polarizing material to allow light to pass through the display. The display can be segmented into individual pixels, each of which can be controlled by a corresponding electrode. By selectively applying a voltage to each electrode, the display can display different patterns and images. The display can be backlit to improve visibility in low light conditions. The LCD display can be interfaced with a microcontroller or other electronic device to display information, such as text, graphics, and icons.

**Vibration sensor:**

Fig 6: Vibration sensor

As shown in the fig 6, vibration sensors are piezoelectric accelerometers It measures the amount and frequency of vibration in a system. And it can used to detect the imbalances and predict the breakdowns. The sensor senses the vibration normally ranges from mV/g to 100 mV/g. the sensitivity of the sensor is differs based on the application.

**Working:**

A vibration sensor is an electronic device that is used to detect and measure vibrations or mechanical oscillations in a system or structure. The vibration sensor contains a sensitive element, such as a piezoelectric crystal or a capacitive sensor, which is designed to detect changes in mechanical stress or strain. When the sensor is subjected to vibration or mechanical oscillations, the sensitive element generates a corresponding electrical signal, which is proportional to the magnitude and frequency of the vibration. The electrical signal is amplified and filtered by the sensor circuitry, which removes unwanted noise and interference. The output of the sensor can be displayed on a monitor or recorded for further analysis.

Vibration sensors are widely used in a variety of applications, including machine condition monitoring, predictive maintenance, and structural health monitoring. They can be designed to measure vibrations in a range of frequency bands, from low-frequency vibrations in buildings and structures to high-frequency vibrations in rotating machinery. They are also available in a range of form factors, from handheld devices to permanently installed sensors, and can be integrated with wireless networks for remote monitoring and data analysis.

**Relay:**


Fig 7: Relay

As shown in the fig 7, Relay module acts as an automatic power switching circuit which is operated by electromagnet. When the relay module is energized or activated by DC, electromagnet pulls the circuit to either open or closed. The single channel 5V relay module consists of a coil and two contacts that is normally open (NO) and normally closed (NC).

**Working:**

A relay is an electrically operated switch that is used to control the flow of current in an electrical circuit. A relay consists of two circuits, the control circuit and the load circuit. The control circuit is the circuit that controls the operation of the relay, while the load circuit is the circuit that is controlled by the relay. The control circuit is typically a low-voltage circuit, such as a microcontroller or a switch. When the control circuit is activated, it energizes the relay coil. The relay coil generates a magnetic field, which attracts the movable contacts of the relay. The movable contacts are typically made of a conductive material, such as copper or silver, and are held in place by a spring. When the movable contacts are attracted to the relay coil, they make contact with the stationary contacts of the relay, which are connected to the load circuit. The contact between the movable and stationary contacts allows current to flow through the load circuit, which can be a high-voltage or high-current circuit, such as a motor or a lamp. When the control circuit is deactivated, the relay coil loses power and the magnetic field dissipates. This causes the spring to return the movable contacts to their original position, breaking the contact with the stationary contacts and interrupting the flow of current through the load circuit.

Relays are widely used in a variety of applications, including industrial control systems, automation equipment, and household appliances. They are available in a range of sizes and configurations, including single-pole single-throw (SPST), single-pole double-throw (SPDT), and double-pole double-throw (DPDT) configurations.

**DC motor:**

Fig 8: DC motor

As shown in the fig 8, A DC motor is any of a class of rotate electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electro-mechanical or electronic, to periodically change the direction of current in part of the motor.

**Working:**

When an electric current is applied to the motor, it flows through a coil of wire (the armature) that is positioned between two magnets, creating a magnetic field. The magnetic field produced by the current-carrying armature interacts with the stationary magnetic field of the two permanent magnets, causing the armature to rotate. As the armature rotates, it passes through a series of contacts (the commutator), which reverses the direction of the current in the armature coils every half turn. This reversal ensures that the magnetic forces that drive the motor continue to act in the same direction, enabling continuous rotation. The rotation of the armature is transferred to the motor's output shaft, which can be used to perform mechanical work.

The speed of a DC motor can be controlled by varying the voltage supplied to the motor, or by using electronic speed control circuits that adjust the amount of current flowing through the motor. The direction of rotation can be changed by reversing the polarity of the power supply or by using a reversing switch. DC motors are used in a wide range of applications, including robotics, electric vehicles, and industrial machinery.

**LM7805C Voltage Regulator:**

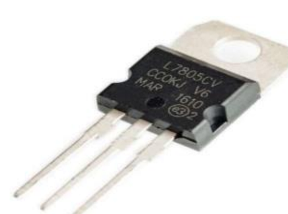


Fig 9: LM7805C Voltage Regulator

As shown in the fig 9, A voltage regulator based on an active device (such as a bipolar junction transistor, field effect transistor or vacuum tube) operating in its "linear region" and passive devices like Zener diodes operated in their breakdown region. The regulating device is made to act like a variable resistor, continuously adjusting a voltage divider network to maintain a constant output voltage.

**Working:**
The input voltage is applied to the input pin (pin 1) of the LM7805C. The input voltage must be at least 2 volts higher than the desired output voltage, up to a maximum of 35 volts. The LM7805C contains a voltage reference and error amplifier that compares the output voltage to the reference voltage. If the output voltage drops below the desired level, the error amplifier increases the output voltage.The LM7805C also contains a series pass transistor that controls the amount of current flowing through the device. The pass transistor is connected between the input and output pins of the IC. The regulated output voltage is available at the output pin (pin 3) of the LM7805C.

The LM7805C also has a heat sink tab (pin 2) that must be connected to a heat sink to dissipate excess heat. The heat sink must be chosen based on the amount of current flowing through the IC and the ambient temperature.

The LM7805C is widely used in electronic circuits that require a stable +5V supply, such as microcontrollers, digital logic circuits, and sensors. It is available in a range of packages, including the TO-220, TO-92, and SOT-223 packages, and can provide up to 1A of output current.

**Fuel Sensor/Float Switch:**

Fig 10: Fuel Sensor/Float Switch

As shown in the fig 10, A float switch is a type of level sensor, a device used to detect the level of liquid within a tank. The switch may be used to control a pump, as an indicator, an alarm, or to control other devices.

**Working:**
The float switch is installed inside the fuel tank and floats on the surface of the fuel. The switch contains a float, which is connected to a lever arm that moves in response to changes in the fuel level. The lever arm is connected to a set of contacts, which are either normally open or normally closed. As the fuel level in the tank rises, the float moves upwards, causing the lever arm to move and change the position of the contacts. When the contacts change position, they either complete or break an electrical circuit, depending on whether they are normally open or normally closed. The electrical signal generated by the float switch is transmitted to a fuel gauge or other control system, which displays the fuel level or activates an alarm or other system.

Fuel tank float switches can be used in a range of applications, including automotive and marine fuel tanks, generators, and industrial equipment. They are typically made from materials that are resistant to the corrosive effects of fuel, such as stainless steel or brass, and can be designed to operate in a variety of fuel types, including gasoline, diesel, and biodiesel.

**ADXL335 Accelerometer:**


Fig 11: ADXL335 Accelerometer

As show in the fig 11, An accelerometer is an electromechanical device that will measure acceleration force. It shows acceleration, only due to cause of gravity i.e gravitational force force. It measures acceleration in g unit. On the earth, 1g means acceleration of 9.8 m/s2 is present. On moon, it is 1/6th of earth and on mars it is 1/3rd of earth. Accelerometer can be used for tilt-sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

**Working:**
The ADXL335 is a three-axis accelerometer sensor that measures acceleration in three perpendicular axes. The ADXL335 contains three MEMS (Micro electro mechanical Systems) structures that are designed to measure acceleration in the X, Y, and Z axes.

Each MEMS structure consists of a small mass suspended by springs, which move in response to changes in acceleration. The movement of the mass causes a change in capacitance, which is measured by an internal circuit in the ADXL335. The ADXL335 converts the capacitance measurements into an analog voltage output, which is proportional to the acceleration in each axis. The analog voltage output can be read by a microcontroller or other electronic device, which can use the data to calculate the acceleration in each axis. The ADXL335 also contains an internal self-test feature, which allows the device to be tested for proper operation.

The ADXL335 can measure acceleration in a range of applications, including tilt sensing, vibration monitoring, and motion detection. It is available in a small, low-profile package and can operate on a single power supply. The device also includes several features that help reduce noise and improve accuracy, such as a low-pass filter and a range of sensitivity options.

## VI. SOFTWARE COMPONENTS

**The software components used in our project is listed below:**

1. CVAVR cross compiler : CVAVR (CodeVision AVR) is a cross compiler for programming AVR microcontrollers. A cross compiler is a software tool that runs on one platform (host) but generates code that can be executed on another platform (target).

In the case of CVAVR, the host platform is typically a

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Windows PC, and the target platform is an AVR microcontroller. The cross compiler takes the high-level programming code written in C or Assembly language and converts it into machine language that can be executed by the AVR microcontroller.
The CVAVR cross compiler provides a comprehensive set of tools for programming AVR microcontrollers, including an editor, assembler, compiler, linker, and debugger. It also includes a range of libraries and drivers to simplify the programming process and enable the developer to focus on the application logic.

2. AVR studio programmer : AVR Studio is an integrated development environment (IDE) used for programming AVR microcontrollers. It is a software tool that provides a range of features and tools to simplify the development process, including code editing, compilation, debugging, and simulation.
An AVR Studio programmer is a hardware device that interfaces with AVR Studio to program AVR microcontrollers. The programmer typically connects to the microcontroller via a set of pins on the microcontroller's package, allowing it to read and write data to the microcontroller's flash memory.

AVR Studio programmers come in various forms, from simple ISP (in-system programming) programmers to more advanced JTAG (Joint Test Action Group) programmers. The choice of programmer depends on the specific requirements of the project and the features required for debugging and testing.

3. Embedded C**:** Embedded C is a programming language used for developing software applications for embedded systems, which are computer systems designed to perform a specific task within a larger mechanical or electrical system. Embedded C is a variation of the C programming language and has been optimized for use in embedded systems, which often have limited memory and processing power.

Embedded C allows developers to write efficient and optimized code for controlling hardware devices such as sensors, actuators, and other peripherals. It provides a range of features and libraries that enable developers to write efficient code for specific tasks such as interrupt handling, power management, and communication with other devices.

Embedded C is typically compiled with a cross-compiler, which is a specialized toolchain that can generate machine code for the target hardware. Cross-compiling enables developers to write code on a high-level language and then compile it for the target device without having to run the code on the target device itself.

## VII. RESU LTS

Accurate location data: The GPS module provided accurate location data that was included in the SMS notification. The location data was correct and useful in dispatching emergency services to the location of the accident.

Accident detection: The combination of the vibration sensor and accelerometer will enable the system to accurately detect and differentiate between normal driving vibrations and sudden impact caused by accidents. The system will then trigger an alarm or notification through the GSM module to alert relevant authorities or emergency services.

Fuel theft detection: The system accurately detected the simulated fuel theft using the fuel sensor. The microcontroller immediately sent a signal to the GSM module, which initiated the SMS notification to the vehicle owner. The SMS notification included the location data.

Effective notification system: The GSM module was effective in notifying the emergency contacts or vehicle owner of the accident or fuel theft. The SMS notifications were sent immediately and included the necessary information, such as location data.

User-friendly interface: The LCD display provided a user-friendly interface that showed a message indicating the occurrence of an accident or fuel theft. The message was clear and easy to understand.

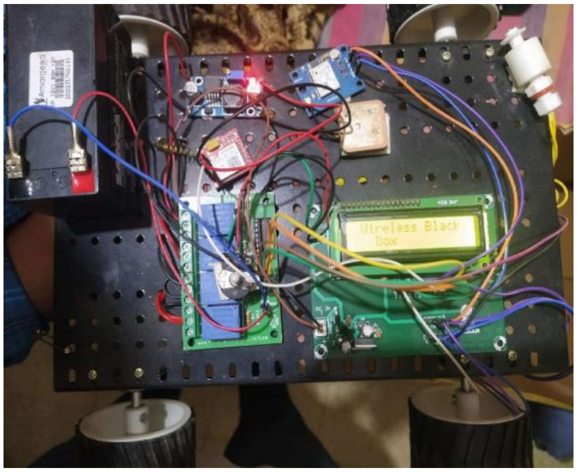

Fig 12: Output of the Black Box

Accident detection:

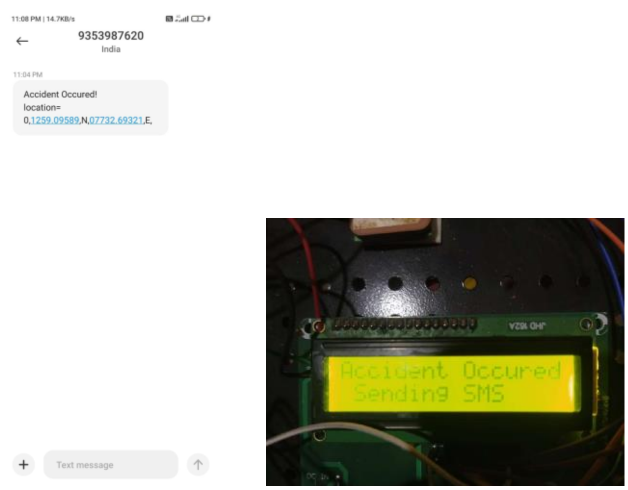


Fig 13: Notification of accident

As shown in the fig 13, results show the co-ordinates of the location where the accident happened. This information is useful to provide immediate help to the person who is injured as the details would be sent to their respective family members, emergency services.

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Fuel Theft Detection:

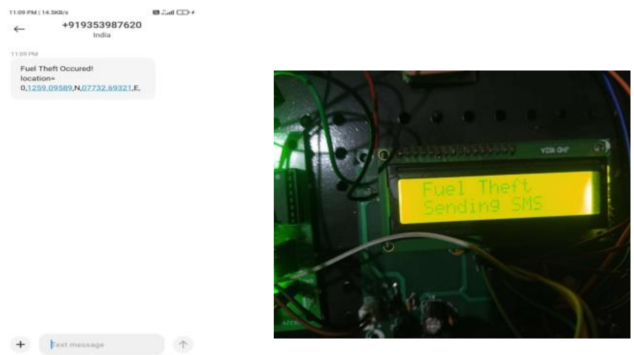


Fig 14: Notification of Fuel Theft

As shown in the fig 14, Fuel theft/leakage can be detected using this model and it sends an alerting message to the respective owner about the same. This prevents unnecessary loss of fuel.

| S/N | Time | Delay time (s) |
|---|---|---|
| 1 | 6:00am | 20 |
| 2 | 8:00am | 23 |
| 3 | 10:00am | 25 |
| 4 | 12:00pm | 31 |
| 5 | 2:00pm | 50 |
| 6 | 4:00pm | 40 |
| 7 | 6:00pm | 38 |
| 8 | 8:00pm | 24 |
| 9 | 12:00am | 17 |
| 10 | 3.00am | 15 |

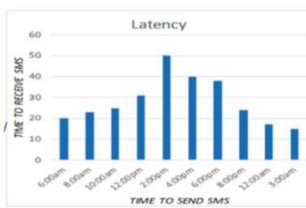


Fig 15. Accident alert SMS messages delay time

| S/N | Condition | Peak Current (A) | Power (W) |
|---|---|---|---|
| 1 | Idle | 0.35 | 2.59 |
| 2 | Crash | 0.45 | 3.33 |
| 3 | Rotating | 0.42 | 3.11 |
| 4 | Getting GPS | 0.60 | 4.44 |
| 5 | Sending SMS | 1.85 | 13.69 |

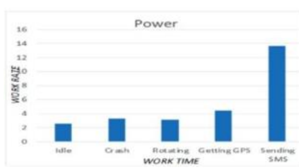


Fig 16. Power consumption measured

Performance

The performance of Black Box can be evaluated based on various factors such as accuracy, reliability, and speed of response.

In terms of accuracy, the system must be able to detect accidents and fuel theft with a high degree of accuracy to prevent false alarms or missed incidents. The use of multiple sensors and advanced algorithms can help improve the accuracy of the system.

Reliability is another critical factor in the performance of the system. The system must be able to operate continuously without downtime or malfunction. Regular maintenance and testing can help ensure the reliability of the system.

The speed of response is also essential, especially in emergency situations. The system must be able to detect and alert the appropriate authorities quickly and efficiently to minimize the response time and prevent further damage.

## VIII. Conclusion

In this current modern world road accidents has become the major issues in many metropolitan cities. The main aim of the black box system project is to decrease the chances of losing life in such accident which we can't stop from occurring. Whenever accident is alerted, the paramedics are reached to the particular location to increase the chances of life. This device invention is much more useful for the accidents occurring in deserted areas and midnight. In our work, we have developed a vehicle black box and alerting system that is flexible, customizable and accurate. All the parameters sensed by the sensors will send the signal to Atmega48. At the time of accident, the message will be sent from GSM module built inside the car to the registered mobile numbers, police stations, hospitals, family members etc.

Fuel theft detection and alert system has proven to be a reliable and effective solution for detecting instances of fuel theft, fuel leakage and notifying the owner in real-time. The system uses advanced sensors monitor fuel usage and detect any anomalies that may indicate theft and leakage. The system is designed to send automated alerts with appropriate co-ordinates to the owner or designated personnel when a potential theft is detected. This feature ensures that appropriate action can be taken quickly to prevent further losses and increase the chances of catching the perpetrators.

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