IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

VEHICLE BLACKBOX SYSTEM FOR ACCIDENT ANALYSIS USING IOT

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Abstract: The rapid increase in vehicle usage worldwide has led to a surge in road accidents, resulting in millions of deaths and injuries annually. Human errors, vehicle malfunctions, and poor road conditions are major contributors. Delayed emergency responses exacerbate the issue. Road accidents have become a serious global concern. Traditional safety features like seat belts and airbags reduce injuries but don't prevent accidents. Modern technologies like IoT and sensor-based systems are being integrated into vehicles to improve safety. These systems detect potential hazards and alert drivers. They can prevent accidents and improve road safety. Millions of people die due to the accidents. The main purpose of this paper is to provide vehicle safety and a solution that automatically alert the driver to be cautious. In this system continuously monitoring the vehicle performance using sensors and the behaviour of driver with the use of IOT Technology. The Vehicle black box receives the information from various sensors like the MEMS sensor. If the accident occurs, by using GPS the vehicle location is traced and the information is sent to local hospital and police through the message. With the IOT Technology, this location is always traced in the cloud platform service. If any panic problems arises then the location is automatically sent through message and also the data will be uploaded through an IOT platform. The system incorporates an ultrasonic sensor to detect obstacles around the vehicle, ensuring timely responses to potential collisions. A relay is used to control the DC motor, which simulates vehicle movement, allowing for precise adjustments based on sensor input. Additionally, a buzzer provides audible alerts in the event of abnormal conditions, enhancing overall safety by promptly notifying the operator of any issues.

Index Terms - **Arduino UNO, Ultrasonic Sensor, MEMS Sensor, Alcohol Sensor, Potentiometer, GPS Module, GSM Module, LCD, DC Motor, Relay, Buzzer.**

I. INTRODUCTION

The rapid increase in vehicle usage worldwide has led to a surge in road accidents, resulting in millions of deaths and injuries annually. Human errors, vehicle malfunctions, poor road conditions, and delayed emergency responses are major contributors to these accidents. Traditional safety mechanisms like seat belts and airbags help reduce injuries but don't prevent accidents. To address this, modern technologies like IoT and sensor-based systems are being integrated into vehicles to improve safety.

In recent years, IoT has emerged as a powerful technology in the automotive industry, enabling real-time vehicle monitoring, remote diagnostics, and automated alert systems. Advanced sensors such as MEMS (Micro-Electro-Mechanical Systems) for motion detection and ultrasonic sensors for obstacle detection have

significantly enhanced accident prevention capabilities. The use of GPS for location tracking ensures that in case of an accident, emergency services can be notified promptly, reducing response time and improving survival chances. This project builds upon these technological advancements by developing an intelligent vehicle safety system that integrates IoT, GPS, sensors, and alert mechanisms to enhance road safety. By continuously monitoring vehicle parameters and driver actions, the system provides real-time warnings and automatically reports accidents to emergency services. This approach not only reduces the number of accidents but also ensures faster medical assistance, ultimately helping to save lives and improve overall traffic safety.

Road accidents are a major global issue, causing millions of deaths and injuries annually. Factors like over-speeding, reckless driving, vehicle malfunctions, and poor response times from emergency services contribute to these accidents. The severity of these accidents can be reduced by implementing advanced safety measures that can detect potential accidents and provide immediate alerts to emergency services. The proposed system aims to address these challenges by developing an intelligent vehicle monitoring and accident alert system. By incorporating sensors, GPS tracking, and automated messaging, this system will enhance vehicle safety, provide real-time accident detection, and ensure quick emergency responses. The system will continuously monitor vehicle performance and driver behavior, detecting potential accidents and sending alerts to emergency services. This will significantly reduce response times and improve survival chances for accident victims. Additionally, the system will provide real-time updates to drivers, helping them to take corrective actions and prevent accidents.

1.1 Research Objectives

The primary objective of this paper is to enhance vehicle safety and reduce road accidents by developing an intelligent vehicle monitoring and accident alert system using IoT technology. This system continuously monitors vehicle performance, detects driver behavior, and provides real-time alerts to prevent potential hazards. By integrating various sensors such as MEMS for motion detection and ultrasonic sensors for obstacle detection, the system ensures proactive accident prevention. The black box technology records vehicle data, which can be crucial for analyzing accident causes and improving road safety measures.

1. Smith J & Doe J proposed the RFID-Based Automatic Fare Collection for Public Transport, this paper proposes an RFID-based Automatic Fare Collection (AFC) system designed to modernize fare payment in public transport. Traditional methods, often reliant on paper tickets and manual verification, suffer from inefficiencies such as delays, human error, and revenue loss. By introducing RFID technology, the paper aims to streamline the boarding process, reduce operational costs, and improve the overall commuting experience through a contactless fare system.

2. S. Johnson & D. Miller addressing Automated Fare Collection Using Smart Cards and GSM for Bus Transit. The goal was to reduce manual work, improve fare accuracy, and make travel more convenient for passengers. The GSM technology allows the system to send travel and payment data to a central server in real-time. This helps in keeping accurate records of fares collected and gives live updates to the transit operators. The system improves passenger flow, reduces fraud, and provides better control over the revenue collected.

3. H. Kim & J. Lee proposed IOT-Based Vehicle Accident Detection and Emergency Response System reduces the time it takes to report accidents and get help to the scene. This system is especially useful in situations where the driver is unable to call for help after a crash. The system uses sensors installed in the vehicle to detect sudden movements, impacts, or unusual behaviour that may indicate an accident. Once an accident is detected, the IoT device sends the vehicle's location and accident information to emergency services through a wireless network.

II. EXISTING METHOD

The "IoT-Based Accident Detection and Vehicle Tracking System" This system uses IoT technology, GPS, and GSM modules to detect accidents and track vehicle movements. It incorporates sensors to monitor the vehicle's behavior, and upon detecting an accident, it sends an automatic alert with the vehicle's location to emergency services such as hospitals and law enforcement. The system continuously tracks the vehicle's location via GPS, enabling real-time monitoring and rapid response. This approach ensures quick communication and assistance, reducing the response time in emergencies and improving overall road safety. The integration of real-time tracking and accident alerts aligns well with the objectives of your project to enhance vehicle safety and minimize response delays.

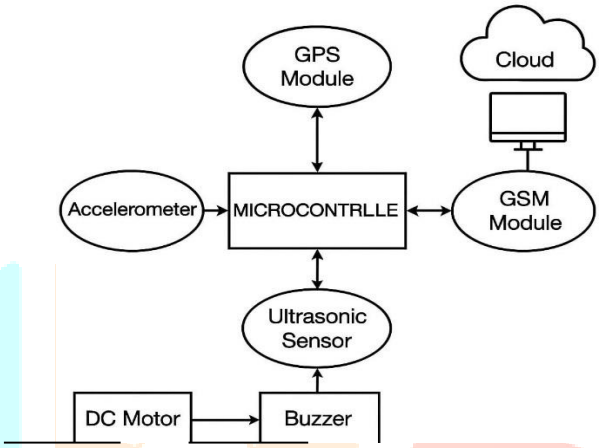

Fig: Block diagram of Accident Detection and Vehicle Tracking System

2.1 Methodology

The methodology of the IoT-Based Accident Detection and Vehicle Tracking System begins with integrating sensors like accelerometers and impact detectors into the vehicle to monitor its movements. These sensors continuously track the vehicle's behaviour, detecting any irregularities, such as sudden deceleration or collisions. When an abnormal event is detected, the system processes the data and confirms if an accident has occurred. If an accident is confirmed, the system activates a GSM module to send an emergency alert containing the vehicle's GPS coordinates to emergency services like hospitals or law enforcement. Along with accident detection, the GPS module continuously tracks the vehicle's location, providing real-time updates to emergency responders. This constant monitoring ensures that in case of an accident, the emergency teams can be quickly notified with the exact location, allowing them to respond rapidly and efficiently.

2.2 Working Principle

The IoT-Based Accident Detection and Vehicle Tracking System operates by using sensors like accelerometers, gyroscopes, and impact sensors that are integrated into the vehicle. These sensors monitor the vehicle's movements and detect abnormal behavior, such as a sudden stop, collision, or sharp turn. When such an event is detected, the system processes the sensor data and identifies it as an accident.

Once an accident is confirmed, the system activates the GSM module to send an alert to emergency services. The alert includes the vehicle's GPS coordinates, enabling quick identification of the exact location of the accident. This communication is automatically happened without human intervention, ensuring that emergency responders receive immediate notifications through messages. In addition to accident detection, the GPS system continuously tracks the vehicle's location. While the vehicle is in motion, the GPS updates the location in real-time. In the event of an accident, the system sends regular updates to emergency teams, allowing them to quickly assess the situation and provide the necessary assistance. This integration of IoT technologies ensures faster response times and enhances road safety.

2.3 Drawbacks

1. Moreover, there are delays and inaccuracies due to the expression problem of the witness.
2. Someone has to witness the incident. So, we moved proposed system.

III. PROPOSED METHOD

The IOT based "Vehicle Blackbox System for Accident Analysis". This paper aims to create a smarter and more responsive vehicle system by incorporating essential safety features such as a buzzer for audible alerts and a rely-controlled DC motor for vehicle movement simulation. These features help in providing instant warnings to the driver in case of abnormal conditions, ensuring timely intervention. By implementing this IOT-based solution, the project seeks to significantly reduce road accidents, improve emergency response times, and contribute to the development of intelligent transportation systems that prioritize safety and efficiency.

The main purpose of this paper is to provide vehicle safety and a solution that automatically alert the driver to be cautious. In this system continuously monitoring the vehicle performance using sensors and the behaviour of driver with the use of IOT Technology. The Vehicle black box receives the information from various sensors like the MEMS sensor. If the accident occurs, by using GPS the vehicle location is traced and the information is sent to local hospital and police through the message. With the IOT Technology, this location is always traced in the cloud platform service. If any panic problems arises then the location is automatically sent through message and also the data will be uploaded through an IOT platform. The system incorporates an ultrasonic sensor to detect obstacles around the vehicle, ensuring timely responses to potential collisions. A relay is used to control the DC motor, which simulates vehicle movement, allowing for precise adjustments based on sensor input. Additionally, a buzzer provides audible alerts in the event of abnormal conditions, enhancing overall safety by promptly notifying the operator of any issues.

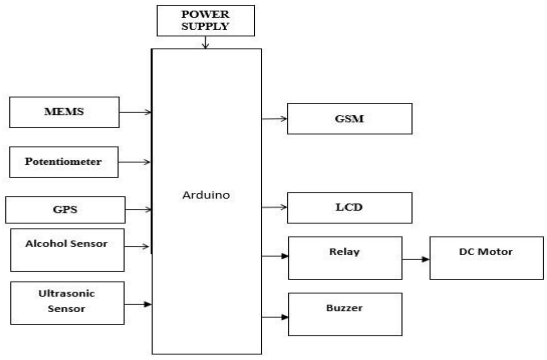

Fig: Block Diagram of Vehicle Blackbox System

3.1 Methodology

In this paper, "Vehicle Black Box System" is designed to enhance road safety by continuously monitoring the vehicle's performance and driver behavior using various sensors integrated with "Arduino". The system collects real-time data from sensors such as the "MEMS" sensor, which detects sudden movements or collisions, and the "potentiometer", which monitors steering input. An "ultrasonic sensor" is incorporated to detect obstacles, ensuring timely alerts to avoid potential collisions. The "alcohol sensor" checks the driver's breath for alcohol levels, preventing intoxicated driving. In case of an accident, the "GPS module" traces the vehicle's location, and the "GSM module" sends emergency messages to hospitals and authorities. Additionally, the system integrates an "IoT platform" to continuously upload vehicle status data, enabling remote monitoring. A "relay and DC motor" simulate vehicle movement, responding to real-time sensor inputs for better control. Safety alerts are provided through a "buzzer" and an "LCD display", notifying the driver of abnormal conditions. This methodology ensures an automated, real-time safety mechanism that minimizes accident risks and improves emergency response efficiency.

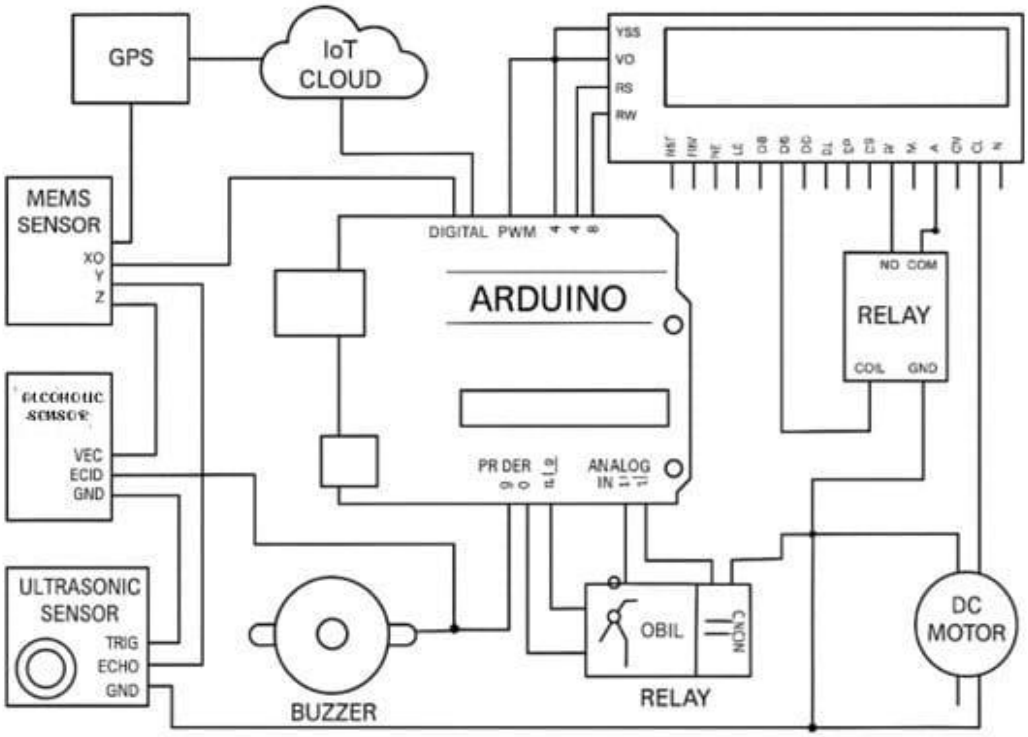

Fig: Circuit Diagram of Vehicle BlackBox System

3.2 Circuit Description

This circuit diagram shows a smart vehicle safety system using Arduino. The “Arduino Uno” is the main controller that connects all the components. A “MEMS sensor” (like MPU6050) is connected to detect accidents or sudden movements. It connects to the Arduino using “SDA (A4)” and “SCL (A5)”, with “VCC to 5V” and “GND to GND”.

An “ultrasonic sensor” is used to detect obstacles in front of the vehicle. It connects “TRIG to pin 9”, “ECHO to pin 8”, “VCC to 5V”, and “GND to GND”.

A “GPS module” tracks the vehicle’s location. It connects “TX to pin 4”, “RX to pin 3”, “VCC to 3.3V or 5V”, and “GND to GND”. A “GSM module” sends emergency messages. It connects “TX to pin 7”, “RX to pin 6”, and is powered by an external “4V supply”, with “GND connected to Arduino’s GND”.

A “relay module” is connected to “pin 10” to control a “DC motor” that simulates the vehicle’s movement. A “buzzer” is used for alerts and is connected to “pin 11 and GND”.

An optional “IoT module” (like ESP8266) can be used to upload data to the cloud. It connects “TX and RX” to Arduino’s RX and TX (with voltage divider if needed), “VCC to 3.3V”, and “GND to GND”.

This setup helps detect accidents, alert the driver, and send emergency messages with real-time location.

3.3 Flow Chart of the System

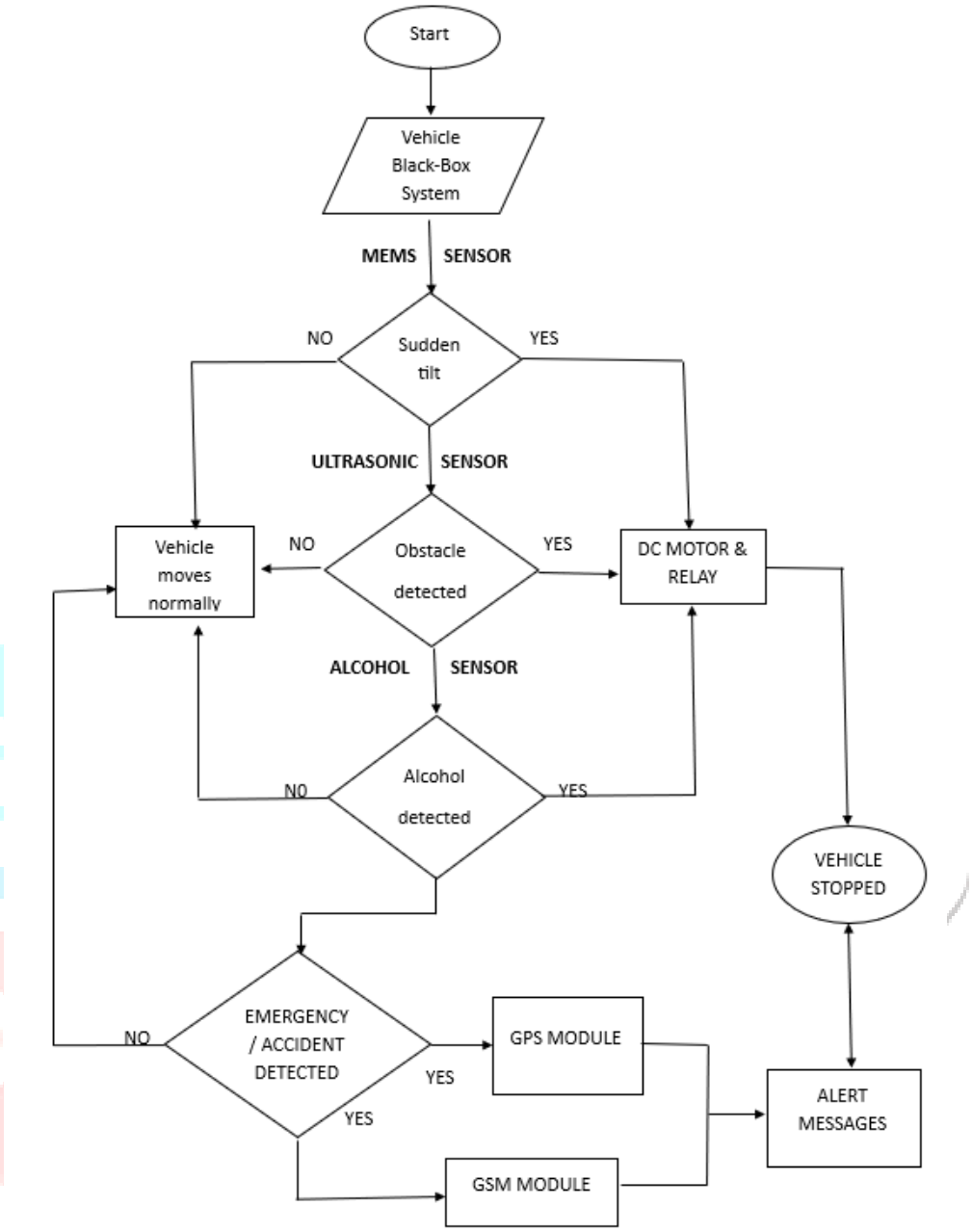

Fig: Flow Chart of Vehicle BlackBox System

3.4 Working Principle

In this paper, the “Vehicle Black Box System” operates by continuously monitoring the vehicle's status through various sensors. The “MEMS sensor” detects sudden shocks or tilts, indicating a potential accident. If an accident occurs, the “GPS module” determines the vehicle’s location, and the “GSM module” sends emergency alerts to nearby hospitals and authorities.

The “ultrasonic sensor” helps in obstacle detection by identifying objects in the vehicle’s path, preventing collisions. If an obstacle is detected, a “buzzer” provides an audible warning, and the system can automatically adjust vehicle speed via the “relay-controlled DC motor”. The “alcohol sensor” ensures driver sobriety; if alcohol is detected beyond a threshold, the vehicle can be prevented from starting, thereby reducing accident risks.

All collected data, including speed, driver behavior, and accident status, is uploaded to an “IoT cloud platform”, allowing real-time monitoring and analysis. This system significantly enhances vehicle safety

by ensuring quick emergency response, reducing human errors, and enabling proactive accident prevention.

3.5 Circuit Diagram

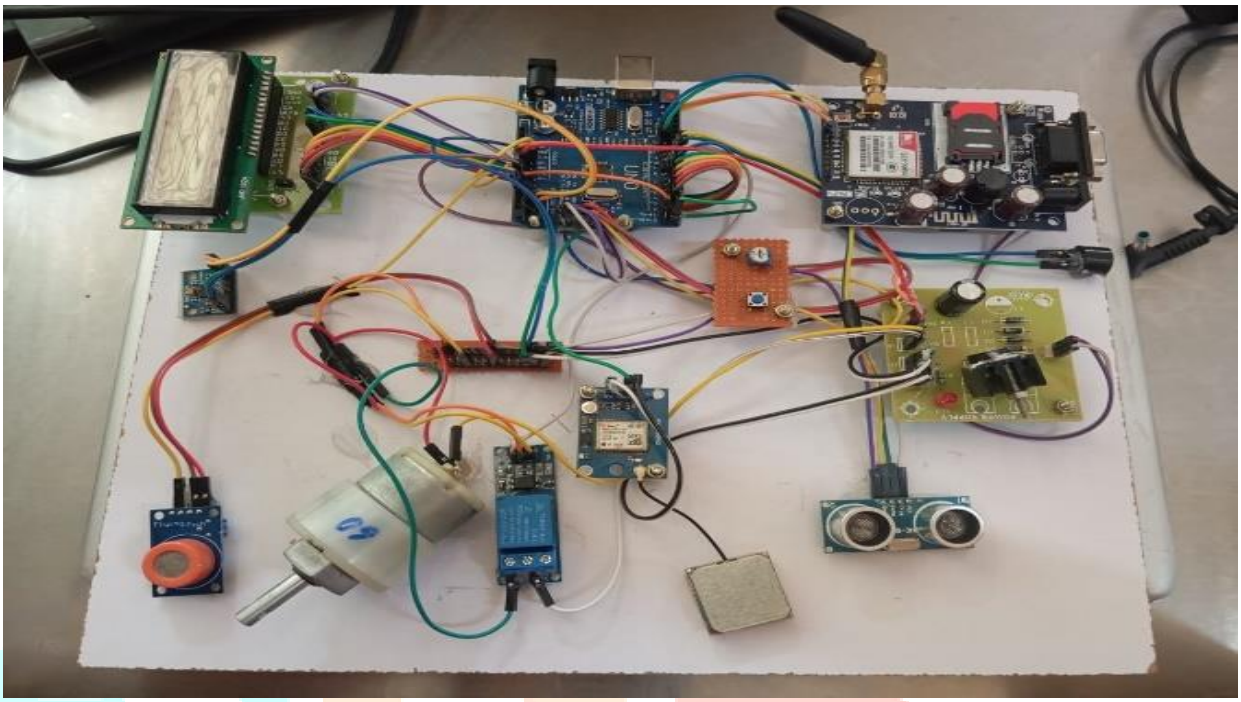

Fig: Circuit Diagram of Vehicle BlackBox System without Power Supply

IV. RESULTS

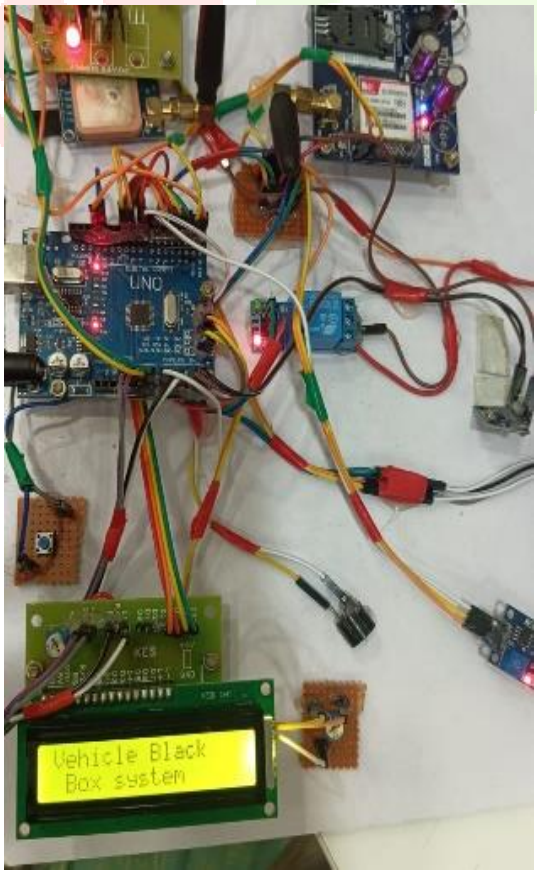

Fig: Working Model of Vehicle BlackBox System

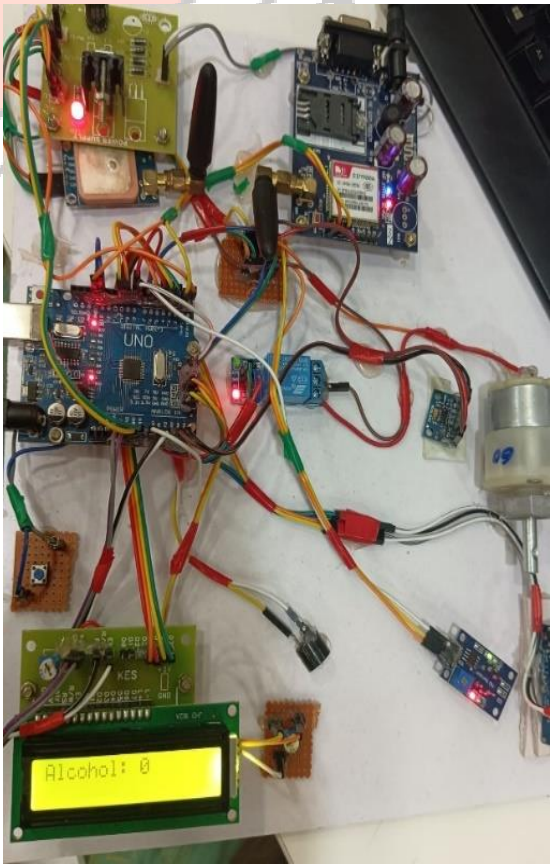

Fig: LCD Display when Alcohol Detected

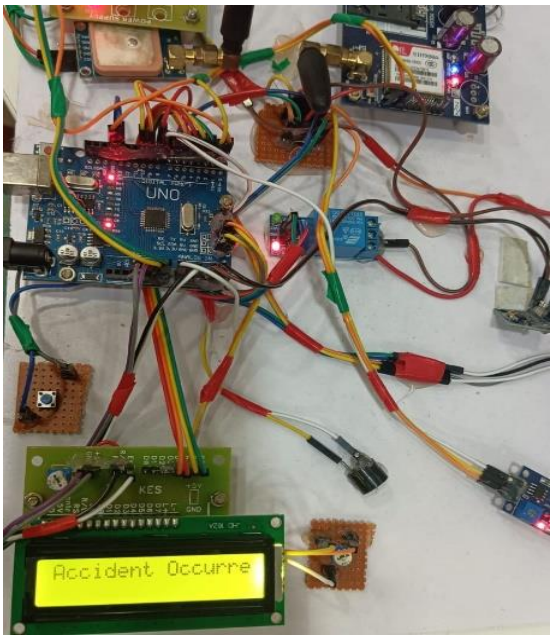

Fig: LCD Display when MEMS Sensor activated

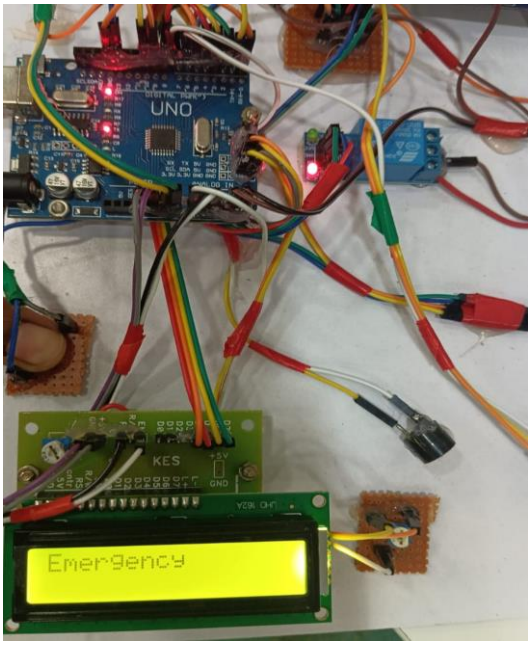

Fig: LCD Display in case of Emergency

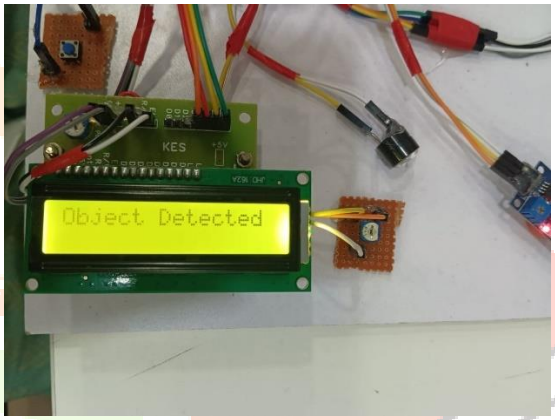

Fig: LCD Display when Ultrasonic Sensor Activated

V. COMPARISONS

1. From previous existing methods we know that they have used different sensor for one purpose only.
2. In this method, we have included all the ultrasonic sensor, MEMS Sensor, Alcohol Sensor, GPS Module, GSM Module.
3. This system is used for multiple purposes like Obstacle Detection, Sudden tilt or movements, and alcohol detection when driver is drunken and GPS is shared using latitudes and longitudes.

VI. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

The Vehicle Safety System project is designed to provide an innovative solution for reducing road accidents and fatalities. By utilizing advanced sensors and IoT technology, the system continuously monitors both the vehicle's performance and the driver's behavior. This enables it to detect any unusual activity, such as sudden deceleration or sharp turns, and alert the driver to take necessary precautions before an accident occurs. In the event of an accident, the system immediately activates GPS tracking to pinpoint the vehicle's exact location. It sends critical information, including the vehicle's location, to emergency services like hospitals and law enforcement. This allows for rapid response times, helping to reduce the time it takes for responders to reach the accident site and provide assistance.

The system incorporates additional features such as ultrasonic sensors to detect nearby obstacles and a buzzer that provides audible alerts to warn the driver of potential collisions. By combining these technologies, the Vehicle Safety System aims to revolutionize road safety, improving overall driver awareness and reducing the number of accidents, ultimately saving countless lives.

6.2 Future Scope

To provide an innovative solution to reduce accidents and fatalities on the road. By continuously monitoring vehicle performance and driver behavior using sensors and IoT technology, the system can automatically alert drivers to be cautious and send critical information to emergency services in the event of an accident. With its robust features, including GPS tracking, ultrasonic sensors, and audible alerts, this system has the potential to revolutionize vehicle safety and save countless.

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