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Design and Implementation of an Emergency Vehicle Security System with Accident Detection and Messaging

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ABSTRACT: This paper presents the design and implementation of an Emergency Vehicle Security System aimed at enhancing safety measures and response capabilities in emergency vehicles. The system integrates various hardware components including a GPS receiver, Arduino Uno microcontroller, GSM modem, and a range of sensors to detect accidents and emergencies. Upon detection, the system automatically sends alerts to predefined contacts, providing accurate location information and facilitating swift response. Detailed descriptions of each hardware component and their functionalities are provided, along with the system's operation and performance.

I.INTRODUCTION

The escalating rate of accidents in recent times poses a significant concern, primarily attributed to the surge in vehicle usage driven by employment demands. With the increased prevalence of cars and bikes on the roads, over speeding has become a rampant issue, further exacerbating the risk of accidents. The lack of advanced safety measures compounds this problem, impeding efforts to reduce accident rates effectively. To address this pressing issue and mitigate the associated risks, this paper introduces a solution: the Vehicle Emergency System. The primary objective of this system is to proactively manage accidents by leveraging wireless communication techniques to promptly notify registered mobile devices, hospitals, and police stations in the event of an accident. At the core of the Vehicle Emergency System lies Arduino, functioning as the central hub orchestrating the transmission of critical messages to various system components. Upon detecting an accident, the system's vibration sensor is triggered, prompting the GSM module to relay pertinent information to registered contacts. Concurrently, the GPS system aids in pinpointing the exact location of the accident, facilitating swift response and assistance. By seamlessly integrating GSM and GPS modules alongside intelligent sensors like the vibration and axis sensors, the proposed Vehicle Emergency System seeks to revolutionize accident management. It aims to not only detect accidents promptly but also ensure timely notification to relevant authorities and individuals, thereby potentially averting severe consequences. Through this paper, we present a comprehensive overview of the Vehicle Emergency System, detailing its components, operation, and capabilities. Additionally, we discuss the system's potential to address the pressing issue of escalating accident rates and pave the way for safer roadways and communities.

II.LITERATURE REVIEW

This review article provides an overview of existing emergency vehicle safety systems and their effectiveness in enhancing safety measures and response capabilities. It discusses various approaches, including GPS-based systems, sensor-based systems, and communication technologies employed in emergency vehicles. The review highlights the importance of integrating multiple hardware components for comprehensive accident detection and response. Integration of GPS and GSM Technologies in Emergency Response Systems This study explores the integration of GPS and GSM technologies in emergency response systems, focusing on their role in providing real-time location tracking and communication capabilities. It examines the benefits of using these technologies in improving response times and coordination among emergency personnel. The study emphasizes the need for reliable hardware components, such as GPS receivers and GSM modems, to ensure the effectiveness of the system.

In study [5], researchers created an Android app utilizing the phone's accelerometer to detect accidents and automatically send a voice message to India's 108 ambulance emergency service. However, this system is limited to India and may generate false alarms due to the lack of filters to distinguish real accidents from false triggers like

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dropping the phone. In study [7], a system named Wreck Watch was developed, utilizing accelerometer and microphone data to detect accidents. Upon detection, the app contacts nearby emergency services and shares the accident location's GPS coordinates. Study [8] utilized similar sensors and hardware but lacked individual responder tracking and direct emergency center notifications, as notifications were sent to a web server for manual checking by responders.

In [9], an Android smartphone-based system utilized the vehicle's ODB-II connection to send SMS notifications to emergency contacts and automatically call emergency services upon accident detection. However, this system requires vehicles to support the OBD-II standard, mainly found in the US and Europe, and is costly to upgrade and maintain.
Finally, [13] introduced a system utilizing accelerometer, GPS, and microphone to detect accidents. Upon detection, it sends emergency notifications to a web server and SMS alerts to emergency contacts, requiring responders to access the web server for accident details.

Arduino-Based Emergency Vehicle Security Systems
An investigation into Arduino-based emergency vehicle security systems is presented in this research paper. It discusses the design and implementation of such systems using Arduino microcontrollers and various sensors for accident detection and alerting. The paper evaluates the performance and reliability of Arduino-based systems in enhancing safety measures in emergency vehicles.

Sensor Technologies for Accident Detection in Vehicles
This review paper explores the use of sensor technologies for accident detection in vehicles, focusing on vibration sensors, axis sensors, and other relevant sensors. It discusses the principles of operation, advantages, and limitations of different sensor types for detecting accidents and emergencies. The paper provides insights into integrating sensor technologies with GPS and communication systems for robust accident detection and response.

Performance Evaluation of Emergency Vehicle Security Systems
A study evaluating the performance of emergency vehicle security systems is presented in this paper. It discusses the methodology for testing system reliability, accuracy, and response times under various simulated scenarios. The study assesses the effectiveness of hardware components, such as GPS receivers, Arduino microcontrollers, and GSM modems, in detecting accidents and sending alerts to predefined contacts.
Overall, the literature highlights the importance of integrating GPS, GSM, Arduino microcontrollers, and sensors in emergency vehicle security systems for enhancing safety measures and response capabilities. It underscores the need for comprehensive hardware integration, reliable communication technologies, and thorough performance evaluation to ensure the effectiveness of such systems in real-world emergency scenarios.

III.METHODOLOGY OF PROPOSED SURVEY

The sensing unit comprises various sensors, including axis sensors, shock sensors, fire sensors, smoke sensors, and alcohol sensors. Axis and shock sensors detect sudden changes in vehicle orientation and impact forces indicative of accidents.
Fire and smoke sensors monitor for signs of fire or smoke within the vehicle. The alcohol sensor detects alcohol presence, crucial for identifying drunk driving incidents. Together, these sensors continuously monitor the vehicle's environment for any abnormal conditions or emergencies. The microcontroller, typically an Arduino board, acts as the central processing unit of the system. Upon detection of an incident by the sensing unit, the microcontroller receives sensor data and analyzes it to determine the nature and severity of the emergency. It coordinates the overall operation of the system, including the activation of alert mechanisms and transmission of relevant information. The GSM module enables wireless communication for transmitting emergency alerts to predefined contacts. Upon detecting an incident, the microcontroller orchestrates the transmission of SMS or voice messages via the GSM module to emergency services, designated individuals, or relevant authorities. This allows for swift notification and mobilization of assistance, contributing to timely response and mitigation of the emergency. The GPS receiver provides real-time location information, allowing responders to pinpoint the exact location of the vehicle in case of an accident or emergency. Upon activation, the microcontroller retrieves geographical coordinates from the GPS receiver, which are then included in the alert messages sent via the GSM module. This real-time location data facilitates rapid response and efficient deployment of emergency services to the scene of the incident.
By integrating these components, the proposed methodology establishes a comprehensive approach to accident detection and emergency response in vehicles. The continuous monitoring by the sensing unit, coupled with the

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processing capabilities of the microcontroller, ensures prompt detection and analysis of emergencies. The utilization of GSM communication and GPS technology enables swift alerting and accurate location tracking, thereby enhancing safety measures and response capabilities in emergency vehicles. Overall, this integrated system contributes significantly to accident prevention and mitigation efforts, ultimately improving overall road safety.

The proposed system utilizes various sensors including axis, shock, fire, smoke, and alcohol sensors to continuously monitor the vehicle's environment for abnormalities. Upon detecting an incident, the microcontroller, typically an Arduino board, analyzes sensor data to determine the nature of the emergency and coordinates the activation of alert mechanisms. The GSM module enables wireless communication for transmitting emergency alerts to predefined contacts, while the GPS receiver provides real-time location information to facilitate rapid response. This integrated approach enhances safety measures and response capabilities in emergency vehicles, contributing to accident prevention and mitigation efforts, and ultimately improving road safety.

Block Diagram of Proposed work:

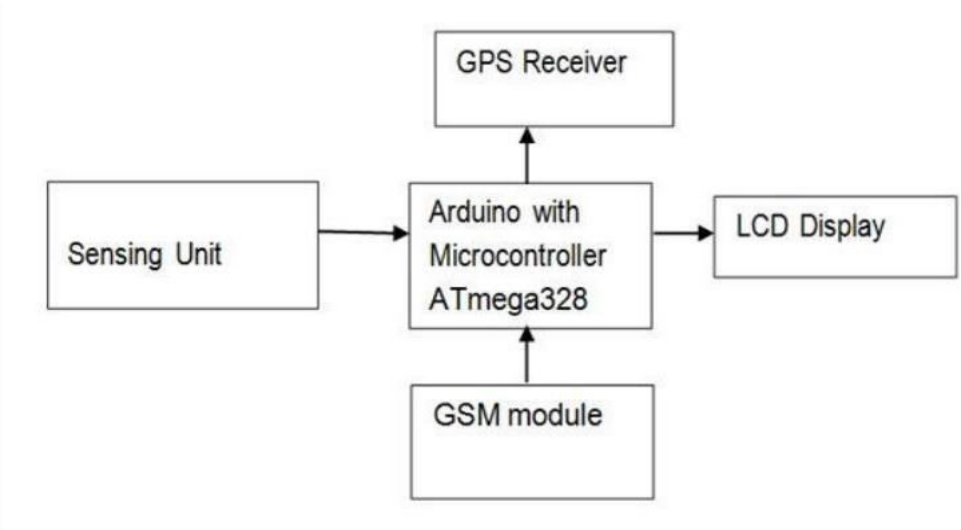

Figure 1: Block diagram of Proposed work

SENSING UNIT: The sensors like axis sensor and shock sensor used to detect an accident. System also uses fire sensor, smoke sensor to detect fire. It also includes alcohol sensor.

MICROCONTROLLER: The microcontroller performs overall operation of system. This System uses Arduino board having microcontroller-based circuit.

LCD DISPLAY: LCDs are available to display arbitrary images which can be displayed or hidden, such as preset words, digits and 7 segment displays as in a digital clock. They use some basic technology, except that arbitrary images are made up of a large number of pixels, while other displays have larger elements. Here this system uses 16X2 LCD display

GSM MODEM: Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982tocreate a common European mobile telephone standard that would formulate specifications for apan-European mobile cellular radio system operating at 900 MHz.

GPS RECEIVER: GPS, in full Global Positioning System, space-based radio-navigation system that broadcasts highly accurate navigation pulses to users on or near the Earth. In the United States' Navstar GPS, 24 main satellites in 6 orbits circle the Earth every 12 hours. In addition, Russia maintains a constellation called GLONASS (Global Navigation Satellite System).

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Flowchart of the Proposed Methodology:

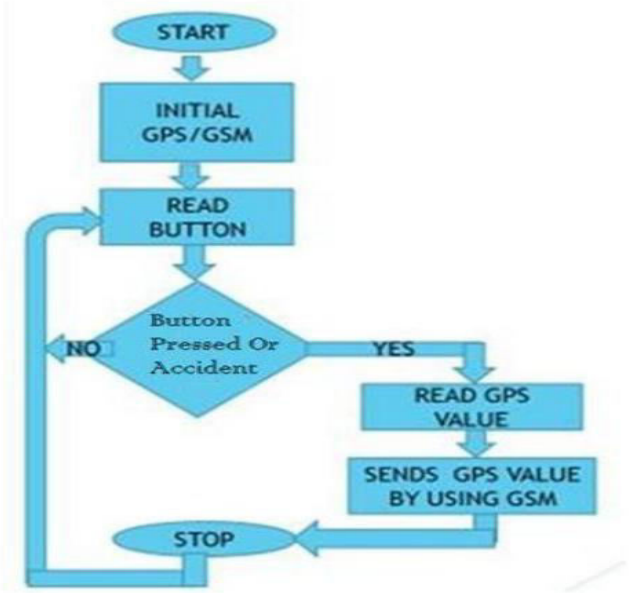

Figure 2: Flowchart of Proposed Work

Circuit Diagram:

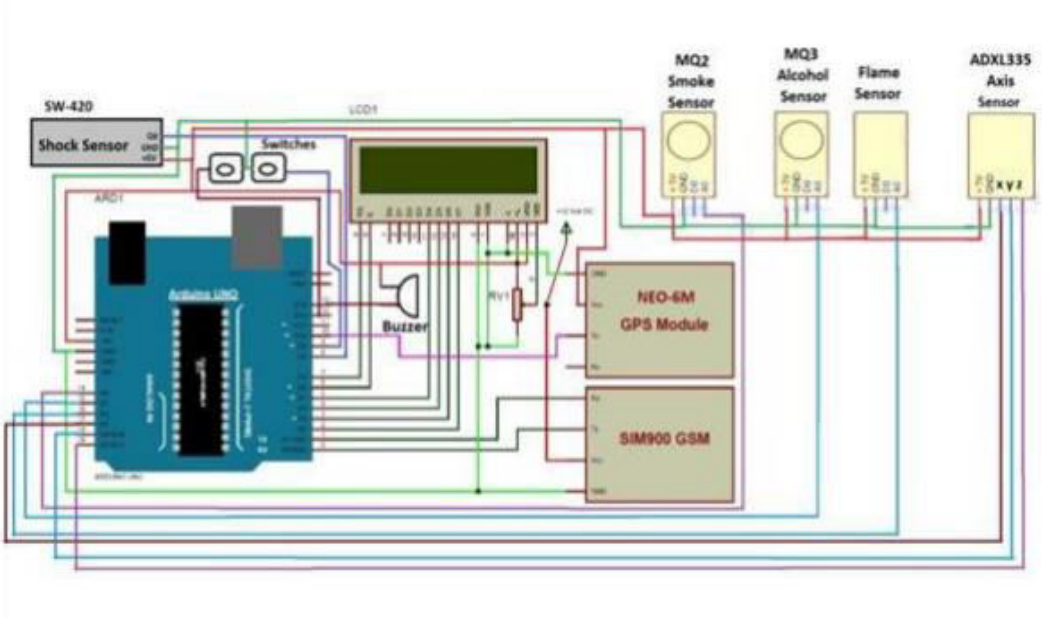

Figure 3: Circuit diagram of Proposed Work

This project clearly uses two main modules of GSM and GPS. The when sensor detects accident or user press the help button then Arduino reads coordinates using GPS module and sends the messages using GSM, through the AT commands. That microcontroller takes the data and it will be displayed to the LCD display.

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IV. RESULT & DISCUSSION

As a result of the project, the system utilizes two primary modules: GSM and GPS. In the event of an accident detection or when the user activates the help button, the Arduino reads coordinates from the GPS module. Subsequently, the microcontroller processes this data and initiates message transmission using the GSM module, employing AT commands. The received data is then displayed on the LCD display for user visibility and acknowledgment

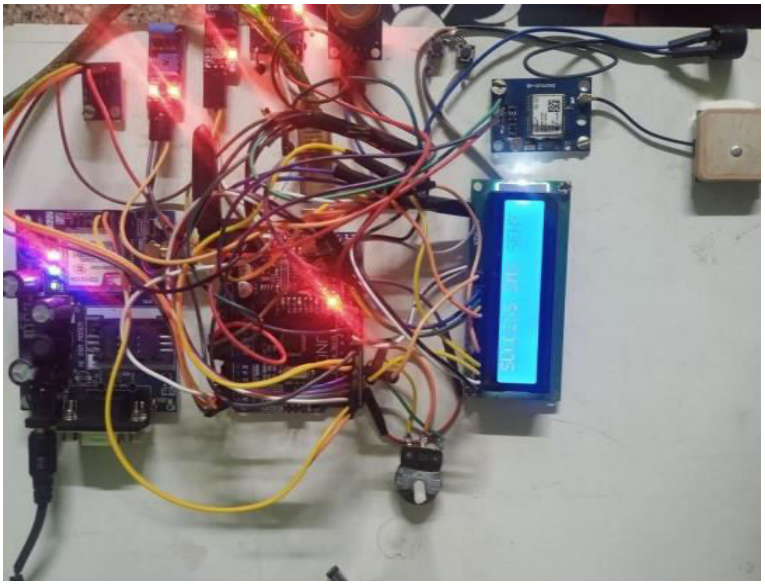

Figure 4: Set up of Proposed Work

V. CONCLUSION AND FUTURE WORK

Conclusion: The Emergency Vehicle Security System presented in this paper represents a significant advancement in enhancing safety measures and response capabilities in emergency vehicles. By integrating various hardware components such as GPS receiver, Arduino Uno microcontroller, GSM modem, and a suite of sensors, the system enables prompt detection of accidents and emergencies. Upon detection, the system autonomously sends alerts to predefined contacts, providing accurate location information for swift response and assistance. The successful implementation of the system underscores its potential to significantly improve emergency vehicle operations and mitigate the impact of accidents

Future Scope:
While the current system offers notable advancements in emergency vehicle security, there are several avenues for future research and development to further enhance its functionality and effectiveness. Some potential areas for future exploration include:

Enhanced Sensor Integration: Investigating advanced sensor technologies and algorithms to improve accident detection accuracy and reduce false alarms, thereby enhancing the reliability of the system.

Integration with Central Dispatch Systems: Exploring integration with central dispatch systems to streamline communication and coordination between emergency vehicles and dispatch centers, optimizing response times and resource allocation.

Advanced Communication Protocols: Researching advanced communication protocols to enable seamless integration with emerging technologies and platforms, ensuring compatibility and interoperability in diverse operational environments.

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Machine Learning and Predictive Analytics: Leveraging machine learning and predictive analytics to analyze historical data and predict potential accident hotspots, enabling proactive measures to prevent accidents and enhance overall road safety.

User Interface Enhancements: Enhancing the user interface of the system to provide intuitive controls and real-time feedback, improving user experience and usability for emergency vehicle operators.
By addressing these areas of future research, the Emergency Vehicle Security System can continue to evolve and adapt to the changing needs of emergency response operations, ultimately contributing to safer roads and more effective emergency services.

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