RESEARCH PAPER

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CRASH ALERT PRO : "A Smartphone Application for Bicycle Crash Detection and Reporting"

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***Abstract*— The Vehicle Fall Detection System, using Arduino and IoT technology along with GPS, is an advanced safety system for moving vehicles. It incorporates a small Arduino-based sensor system that can identify sudden changes in the vehicle's orientation or acceleration, indicating a potential fall or accident. In case of such an event, the system utilizes IoT connectivity to instantly send real-time alerts and relevant data to a centralized platform. GPS is employed to accurately record and transmit the incident's location, facilitating prompt response and assistance during emergencies. The system activates an alarm and automatically sends alerts through the IoT network, containing crucial information like the precise location and time of the incident. This integration of hardware and wireless connectivity not only ensures immediate notifications but also provides detailed geographic context, significantly improving vehicle safety and response times, especially in remote areas.**

***Keywords* — GPS , Emergency response , Accident detection , Sensor technology , Real-time monitoring , Gyro sensor , Vehicle rollover detection , Fire and gas hazard monitoring , Modular design , Adaptability , Remote monitoring , Cost-effectiveness , Privacy concerns , False alarm reduction , Fleet management , Logistics ,Transportation safety**

INTRODUCTION

In the vehicular transportation, ensuring the safety of passengers and vehicles has become paramount. Accidents, collisions, and potential hazards such as fire or gas leaks pose significant threats to both life and property. In response to this, the Vehicle Fall Detection System (VFDS) with IoT and GPS integration using Arduino emerges as a critical innovation in the realm of automotive safety. This system amalgamates advanced sensor technologies, including gyro, ultrasonic, temperature, gas, and fire sensors, with the versatile Arduino Uno microcontroller, creating a robust safety network for vehicles. The gyro sensor is employed to detect sudden changes in the vehicle's orientation, indicating a potential accident or fall. Simultaneously, the ultrasonic sensor is utilized to identify clashes or collisions that might compromise vehicle integrity. To address fire-related risks, the system integrates a fire sensor, a gas sensor, and a temperature sensor to monitor for smoke, gas concentrations, and temperature variations within the vehicle environment. The integration of GPS technology further enhances the system's capabilities by providing precise location tracking. In the unfortunate event of an accident or collision, the Arduino Uno microcontroller processes data from these sensors, triggering an immediate response. The IoT unit, in the form of a NodeMCU, facilitates seamless communication between the vehicle and a centralized server or cloud platform. This real-time data transmission not only enables swift emergency responses but also empowers remote monitoring of vehicle conditions. This paper delves into the design, implementation, and functionality of the VFDS, aiming to offer a comprehensive safety solution for vehicles. The modular nature of the system ensures adaptability across various vehicle types, from individual automobiles to comprehensive fleet management systems. As vehicular safety takes center stage, the VFDS with IoT and GPS integration using Arduino emerges as a pivotal advancement in safeguarding lives and property on the roadways.

OBJECTIVE

- **Real-time Safety Monitoring:** Create a system capable of continuously monitoring the movement and orientation of vehicles to detect sudden falls or rollovers, thereby enhancing the safety of vehicle occupants.
- **Accurate Location Tracking:** Integrate GPS technology to provide precise and real-time location data, enabling immediate response and assistance in the event of an accident.

- **IoT Connectivity:** Establish a seamless IoT network for the automatic transmission of critical accident information to a central server, ensuring rapid alert dissemination to relevant authorities and emergency responders.
- **Alert System:** Develop an automated alert system that triggers notifications, including vehicle location, time of the incident, and other relevant data, to inform authorities and emergency services about accidents as they occur.

RELATED WORKS

Examining related literature, many approaches to prevent bike accidents have been found **R.Lavanya** proposed a model that addresses this by offering a solution to enhance timely data and assistance for emergency services. It includes a mechanism to prevent accidents caused by reckless driving and speeding, issuing alarms to drivers and notifying concerned parties. The model emphasizes the importance of prompt accident reporting to investigative agencies and research departments for minimizing response times and improving overall road safety. The systems compatibility with different vehicle makes and models may be limited. Customization and adaptation for various vehicles may require additional time and effort, making it less accessible for a wide range of users**[1]**. **Dilkush** proposed system involves an accident detection and notification system that alerts the driver or authorities in case of a potential accident, using GPS and GSM technologies. The primary goal is to enhance road safety by promptly notifying registered mobile numbers and relevant authorities, potentially saving lives in the event of an accident. In the systems may have limited data transmission capacity, which could restrict the amount of information that can be sent in an accident notification. This limitation may impact the comprehensiveness of the alerts and the details provided to emergency services**[2]**. **P.G. Kate** proposed a system which utilizes a vibration sensor monitored by Arduino, which triggers a response when sensor readings exceed a threshold, indicating an accident. In such cases, the system sends an SMS to authorities for immediate assistance. This embedded approach shows promising results in enhancing road safety. Despite efforts to raise awareness about careless driving, accidents persist, emphasizing the critical need for efficient automatic accident detection and notification to emergency services for prompt response and saving lives. The cost of implementing and maintaining a GPS-based accident detection system can be relatively high. This includes the cost of GPS hardware, data plans for real-time tracking, and maintenance expenses**[3]**. **Tafadzwa Petros Chikaka** paper presents an automatic vehicle accident detection and alert system using an accelerometer to detect vehicle tilting and crashes. The system swiftly communicates the GPS location of the accident to designated security, medical, and family contacts. Compared to conventional rescue systems, this design achieves a faster turnaround response, leveraging technology to potentially save more lives in critical situations. It can be complex and may require professional assistance. This complexity can increase the cost implementing the system**[4]**. **CH. Gowri** paper introduces an automated system for accident detection and immediate alert to the nearest emergency services. The system utilizes sensors such as accelerometer, ultrasonic sensor, vibration sensor, GPS, and GSM module. Accelerometer detects sudden changes in the car's axes, vibration sensor detects heavy vibrations, and ultrasonic sensor adjusts vehicle speed. The GSM module sends an alert message to mobile devices with the accident's location, represented as a Google Map link derived from GPS coordinates. This ensures prompt action and aids in reaching rescue services quickly, potentially saving lives. The system can involve significant costs, including the purchase of hardware, data plans, and installation. This cost may be a disadvantage for individuals or organizations with limited budgets**[5]**. **Arnav Chaudhari** paper introduces a smart accident detection and alert system that immediately notifies user's emergency contacts via SMS with the detected location. The vehicle's sensor identifies accidents, triggering the system to send emergency messages. A reset button allows preventing false alarms when everyone inside the vehicle is safe. The escalating number of vehicles on the road, particularly in India, has led to a surge in road fatalities. The proposed system aims to address this issue by providing prompt alerts to emergency contacts, potentially saving lives by ensuring timely medical assistance. A limited detection range, which can be a disadvantage in scenarios where accidents occur beyond the sensor's range. This limitation may result in delayed or missed accident detection in larger areas or on highways**[6]**.

The above papers focuses on various aspects of accident detection and prevention systems, each offering unique perspectives and methodologies. While the specific details of each paper vary, they generally address the challenges of rising accidents and propose solutions leveraging technologies such as GPS, GSM, accelerometers, and Arduino microcontrollers. These papers highlight the importance of timely reporting to emergency services and innovative approaches to enhance road safety. On the other hand, the described vehicle fall detection system using Arduino and IoT technology focuses on a specific scenario of detecting falls or accidents within a vehicle. It incorporates a broader range of sensors, including fire and gas sensors, to address potential hazards. The system's emphasis on real-time alerts, IoT connectivity, and precise geographic context sets it apart, showcasing a comprehensive approach to vehicle safety that extends beyond traditional accident detection. While the research papers contribute valuable insights to the field, the described system presents a more holistic and advanced solution, integrating multiple sensors and IoT technology to revolutionize vehicle safety and emergency response.

SYSTEM MODEL

The existing system addresses the critical issue of street car accidents, which have a significant impact on public health due to the loss of life, property damage, and time. The proposed solution aims to mitigate these impacts by introducing a smart mishap detection and warning system. This system is designed to promptly alert the user's emergency contacts when a mishap occurs, providing the location of the incident. The system operates by utilizing a combination of sensors and communication modules. When a vehicle is involved in an accident, a ultrasonic sensor immediately detects the impact and triggers the system. This triggers the transmission of an SMS to the designated crisis contacts. Additionally, an ultrasonic sensor is employed to determine if there are individuals inside the vehicle. If no individuals are detected, the system will not be activated, preventing false alarms. The system is equipped with a micro-controller, which processes the vibration data and coordinates with a GPS module to obtain the precise location of the mishap. Once the coordinates are obtained, the micro-

controller uses a GSM module to transmit the location to the emergency contacts via SMS, providing them with a Google Maps URL for the exact location of the incident. Furthermore, the system includes a reset button that can be used in the event that everyone in the vehicle is safe. This button prevents the alert from being sent to the emergency contacts, ensuring that unnecessary notifications are not sent out. In summary, the proposed system employs a combination of sensors, micro-controllers, and communication modules to swiftly detect and communicate the occurrence of a mishap, providing crucial location information to emergency contacts. This approach aims to improve response times and potentially save lives in the event of a car accident.

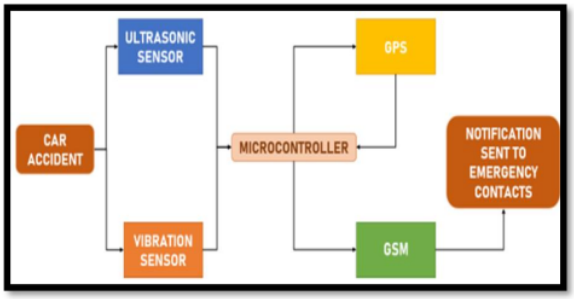


Fig.1.Existing System Architecture

DISADVANTAGE

- In areas with inadequate cellular network coverage, the proposed smart mishap detection and warning system may encounter significant challenges. The system relies on a GSM module to transmit SMS alerts to designated emergency contacts. If the vehicle is involved in an accident in an area with poor or no network reception, the system may be unable to communicate with the emergency contacts. This limitation can result in delays in reporting accidents or, in extreme cases, render the system entirely useless. Without a reliable cellular network connection, the timely transmission of crucial information, including the vehicle's location and the occurrence of a mishap, becomes compromised. This drawback emphasizes the importance of considering the system's functionality in diverse geographical areas and addressing potential limitations in network coverage.
- These systems can alert emergency services quickly, the effectiveness of the response depends on the availability and proximity of emergency services. In remote or rural areas, response times may still be lengthy.

In this proposed system, a Vehicle Fall Detection System (VFDS), incorporates cutting-edge technology to enhance road safety and improve response times during vehicular accidents. This system combines an Arduino-based hardware platform with the integration of a Gyro Sensor (ADXL335), ultrasonic sensor, Gas sensor, temperature sensor, fire sensor, GPS technology, and the Internet of Things (IoT) to provide a comprehensive solution. The Gyro Sensor and ultrasonic sensor work in tandem to monitor the vehicles movement and detect sudden falls or rollovers, enabling real-time assessment of potential accidents.

The system comprises a suite of sensors strategically placed within the vehicle. A gyro sensor is employed to detect sudden changes in the vehicle's orientation, signalling potential accidents or falls. Simultaneously, a ultrsonic sensor is integrated to identify clashes or collisions, providing an additional layer of accident detection. To mitigate fire-related risks, the system incorporates a fire sensor, a gas sensor (MQ2), and a DHT11 temperature sensor, collectively monitoring for smoke, gas concentrations, and temperature anomalies within the vehicle environment. The GPS module is employed to provide accurate location data, ensuring that the vehicles precise coordinates are known at all times. The IoT network forms the backbone of our system, facilitating the seamless transmission of critical accident information to a central server, accessible to relevant authorities and emergency responders. In the event of a fall or rollover, the system triggers an automatic alert that includes the vehicles location and relevant data, allowing for immediate response. The integrating these technologies, the vehicle fall detection system aims to significantly enhance vehicle safety, reduce accident severity, and expedite response times, with timely information for effective emergency responses and ongoing safety management, ultimately contributing to a safer and more efficient transportation ecosystem.

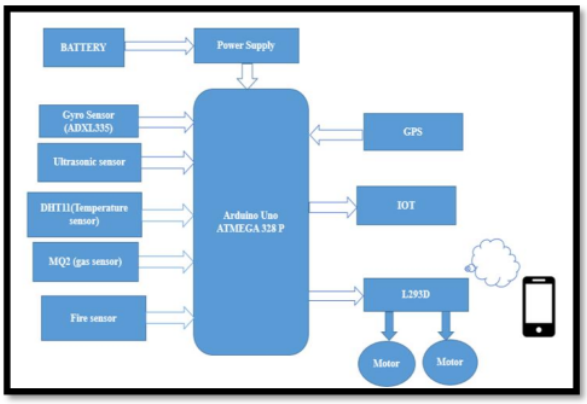


Fig.2.Proposed System Architecture

SYSTEM DESIGN

SENSORS UNIT

- **Accelerometer Sensor:** Connect the accelerometer to the microcontroller's analog pins. It typically requires power (VCC), ground (GND), and data (OUT) connections.
- **Ultrasonic Sensor:** Connect the ultrasonic sensor to the Adriano Uno, typically using two pins (trigger and echo).Use a suitable library to measure the time taken for ultrasonic waves to travel and return. Convert the time to distance, providing information on the proximity of objects. VCC to 5V on Arduino. GND to GND on Arduino. Trig to digital pin (e.g., D2) on Arduino. Echo to digital pin (e.g., D3) on Arduino.

- **GPS Sensor:** Connect the GPS sensor to the microcontroller using suitable communication interfaces like UART or I2C. It requires power (VCC), ground (GND), and communication pins (TX, RX).
- **DHT11 temperature sensor:** Connect the DHT11 to Arduino Uno, providing power (VCC), ground (GND) and selecting a digital pin (OUT). Use the DHT library to read temperature and humidity values from the sensor.
- **Gas sensor:** Connect the Gas Sensor (MQ2) to an analog pin on Arduino Uno. Read analog values from the sensor to detect the concentration of gases. Implement logic to trigger alarms for high gas concentrations.
- **Fire sensor:** Connect the Fire Sensor to a digital or analog pin on Arduino Uno. Monitor the sensor's output for the presence of flames. Implement a logic to trigger an alarm in case of fire detection.

MICROCONTROLLER UNIT (ATMEGA328P)

- The brain of the system, responsible for processing sensor data and making decisions.
- Connect power (VCC) and ground (GND) pins of the microcontroller to the appropriate power supply.
- Connect the accelerometer and ultrasonic sensors to analog or digital pins, based on their specifications.
- Connect the GPS sensor to the microcontroller's communication pins (TX, RX) for data exchange.

IOT UNIT

- IoT Module (e.g., ESP8266 or similar): Facilitates communication with the IoT platform.
- Connect the IoT module to the microcontroller using a suitable communication protocol (e.g., UART, SPI, etc.).
- Provide power (VCC) and ground (GND) to the IoT module.
- Implement any necessary level shifting or voltage regulation, if required.

VEHICLE MODEL UNIT

- L293D Driver Board: Used for driving DC motors.
- DC Motor: The actuators that might perform specific actions (e.g., deploy airbags, trigger alarms, etc.).
- Connect the L293D driver board to the microcontroller. Wire the input pins to the microcontroller's output pins, and connect power (VCC) and ground (GND).
- Connect the DC motor to the output pins of the L293D driver board. Ensure proper power supply and polarity.

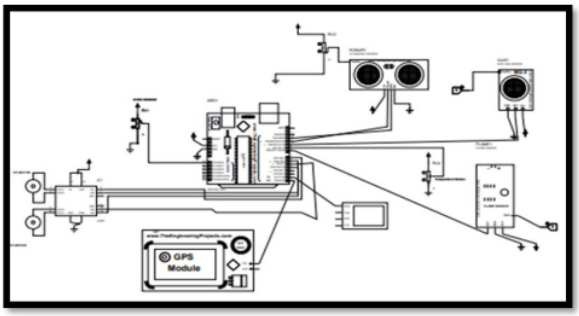
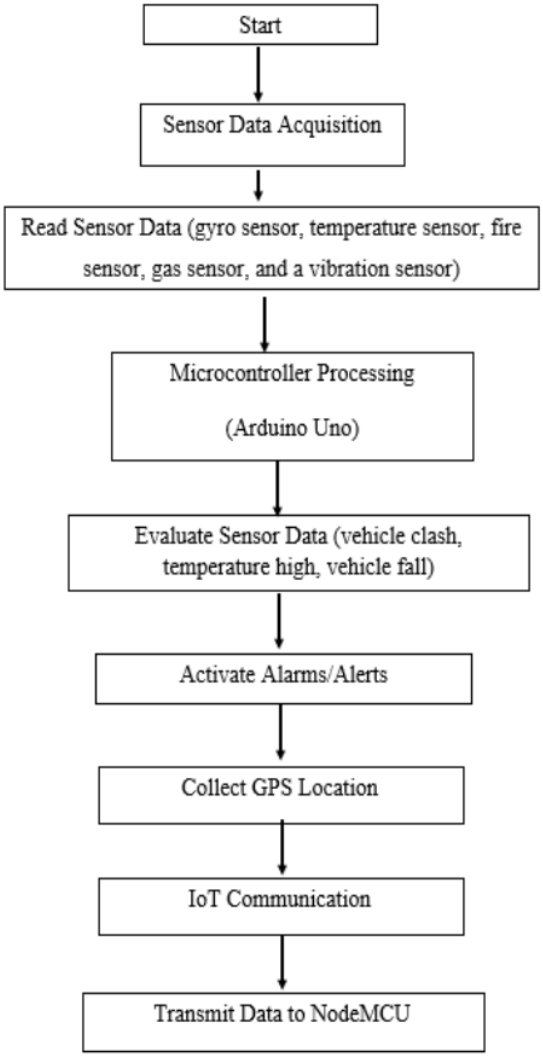


Fig.3.Circuit Diagram

FLOW DIAGRAM



FUTURE ENHANCEMENT

Advanced Sensor Fusion

- Image Recognition: Integrate a camera with AI image recognition to visually detect rollovers, cliff edges, or hazardous road conditions.
- LiDAR: Implement LiDAR sensors for precise 3D mapping of the vehicle's surroundings, enhancing obstacle detection and fall prevention.

Predictive Algorithms 15

- Machine Learning: Train machine learning models on historical accident data to predict potential risks based on real-time sensor readings, enabling proactive warnings.
- Edge Computing: Perform real-time data analysis on the edge device itself (e.g., using an NVIDIA DRIVE platform) to reduce latency and improve response times.

Enhanced Communication and Response

Two-way Communication: Enable two-way communication between the VFD system and emergency responders for real-time updates and guidance.

Drone Deployment: Integrate the system with emergency drones for rapid visual assessment and casualty assistance in remote or inaccessible locations.

Additional Features

Driver Drowsiness Detection: Implement additional sensors and algorithms to monitor driver fatigue and issue drowsiness alerts to prevent accidents.

Post-Accident Analysis: Utilize post-accident data to analyze accident patterns and improve the system's accuracy and effectiveness over time.

RESULT

SIMULATION

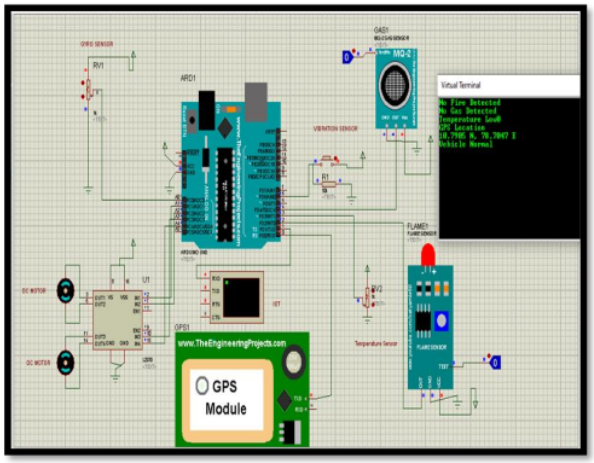


Fig.3.1.Vehicle is normal

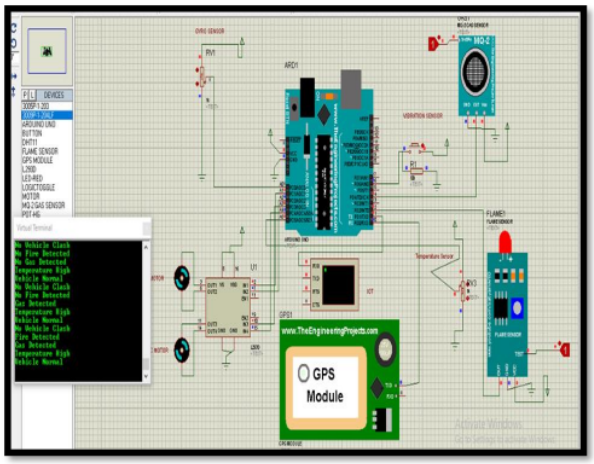


Fig.3.2. Temp Fire Gas Detected

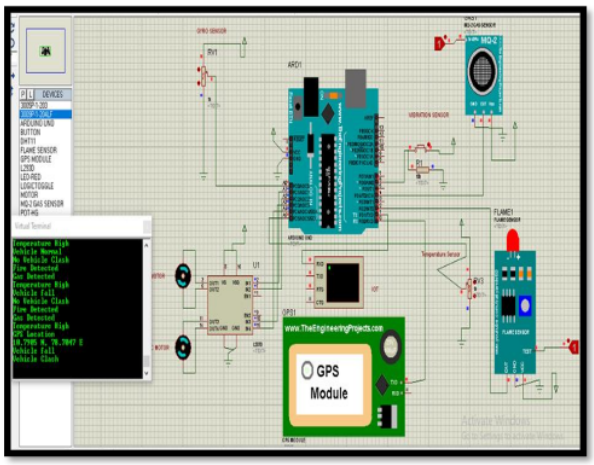


Fig.3.2. Vehicle fall and Crash Detected , GPS Location Shared

HARDWARE IMPLEMENTATION

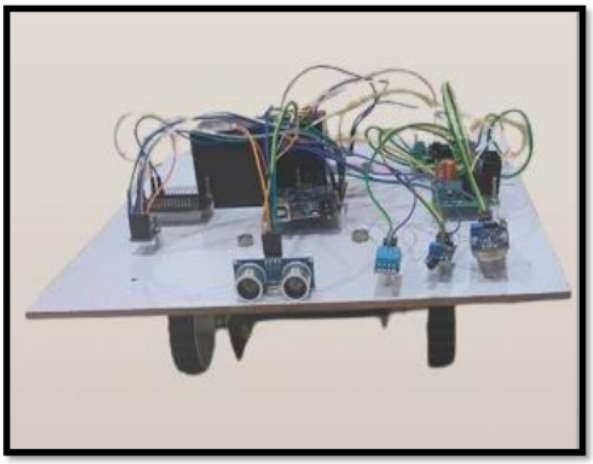


Fig.4.1. Hardware Model

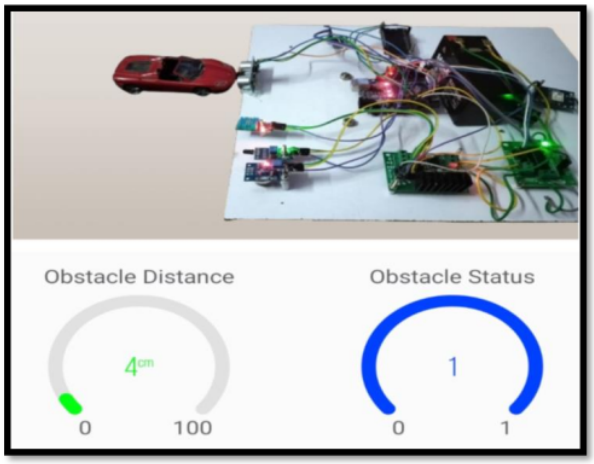


Fig.4.2. Obstacle detected

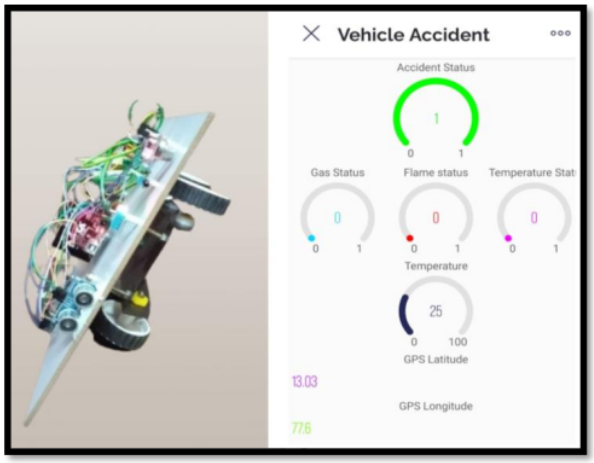


Fig.4.3.Vehicle Clashed and GPS Location Detected

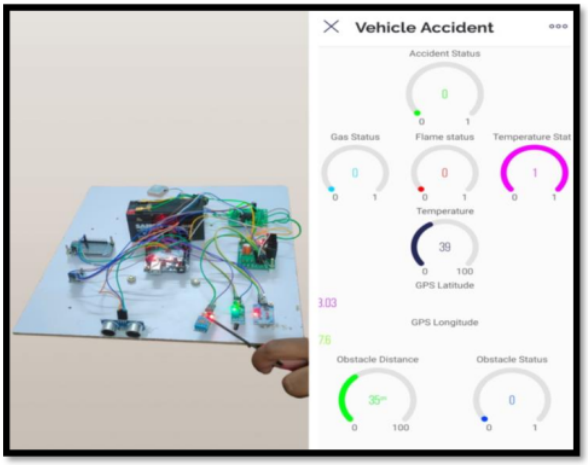


Fig.5.6. Temperature greater than 35

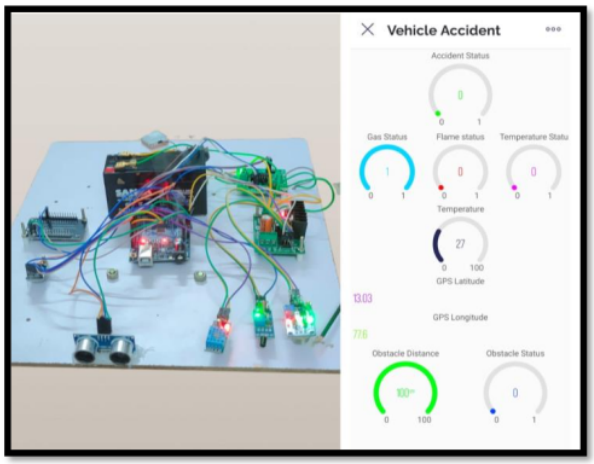


Fig.4.4. Gas Detected

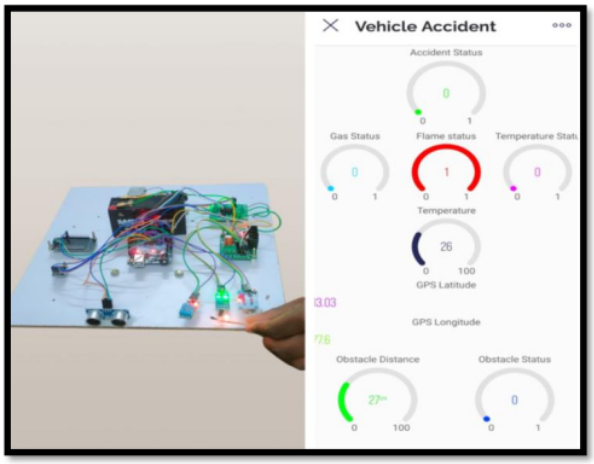


Fig.4.5. Flame detected

CONCLUSION

In conclusion, the Vehicle Fall Detection System with IoT and GPS Integration using Arduino represents a significant advancement in automotive safety and emergency response technology. By leveraging the power of IoT and GPS technology, this system addresses the critical issue of detecting vehicular accidents or rollovers, allowing for rapid and automated response in emergencies. The integration of Arduino microcontrollers and various sensors provides a robust platform for real-time data collection and analysis. When an accident or vehicle rollover occurs, the system can promptly relay critical information, including the accident's location, to a central server or emergency services. This capability has the potential to save lives by expediting the response time of first responders. Moreover, the system is highly adaptable and can be implemented in a wide range of vehicles, from personal cars to commercial fleets. It offers the possibility of enhancing road safety, enabling vehicle tracking, and optimizing emergency response services, which are essential for accident victims. However, it is essential to address certain challenges, such as the accuracy of accident detection to minimize false alarms, privacy concerns regarding the data collected, and ensuring the system's robustness and reliability in different driving conditions and environments. The Vehicle Fall Detection System with IoT and GPS Integration using Arduino is a promising technology that holds the potential to revolutionize vehicle safety and emergency response. It represents a significant step forward in leveraging cutting-edge technology to enhance road safety and save lives. With ongoing research and development, this system can further improve its accuracy and reliability, making it a valuable asset in the field of automotive safety and accident prevention.

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