



Automatic Vehicle Accident Detection and Messaging System using Arduino Uno, GSM & GPS

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ABSTRACT :

Vehicle accidents continue to be a significant cause of fatalities and injuries on the roads. Rapid detection and immediate response are crucial to minimizing the impact of such accidents. This paper presents the design and implementation of a Vehicle Accident Detection and Messaging System (VADMS) based on Arduino Uno, Gas Sensor (MQ-2), GSM (SIM900), GPS (Neo-6M), and Infrared Sensors. The system is designed to detect accidents through the use of various sensors, including those for collision detection, gas leakage, and proximity sensing, and then send instant emergency notifications to relevant contacts. The system's functionality, effectiveness, and real-world performance are evaluated, demonstrating its potential in improving road safety and enhancing emergency response times.

Keywords: Arduino Uno, Gas Sensor (MQ-2), GSM (SIM900), GPS (Neo-6M), and Infrared Sensors. Collision detection, gas leakage, and Proximity Sensing, and then send instant emergency notifications to relevant Contacts

1. INTRODUCTION :

1.1 Problem Statement

Traffic accidents result in millions of deaths and injuries each year, often due to delayed emergency responses. Despite advancements in vehicle safety technologies, many accidents go undetected until a human being reports them. Current systems rely on drivers manually contacting emergency services, which can delay rescue operations. Therefore, an automated, real-time accident detection and messaging system could significantly reduce response times and help save lives.

1.2 Objectives

This paper aims to:

- Design and develop an automated vehicle accident detection system using Arduino Uno and various sensors.
- Implement a messaging system based on GSM and GPS for sending real-time accident alerts to emergency responders.
- Evaluate the system's performance in detecting accidents and delivering notifications accurately and quickly.

2. LITERATURE REVIEW :

2.1 Existing Accident Detection Systems Various accident detection systems exist today, but most require manual intervention to notify emergency services. These systems often use accelerometers, gyroscopes, or speed sensors to detect sudden changes in motion. However, some systems lack integration with communication technologies, which can delay response times. Additionally, many fail to detect non-collision accidents, such as gas leaks or proximity-based accidents.

2.2 GSM and GPS Integration in Accident Detection The integration of GSM and GPS has been used for automatic crash notification systems (ACN) to send real-time location data to emergency responders. GPS provides the vehicle's coordinates, while GSM ensures quick communication via text messages, which can significantly reduce the time it takes for help to arrive.

2.3 Gaps in Current Systems Current systems lack versatility in detecting various types of accidents (e.g., collision, gas leak, or proximity-related accidents). Additionally, few systems integrate infrared sensors or gas sensors into the accident detection mechanism.

3. SYSTEM DESIGN & ARCHITECTURE :

The system architecture for the Vehicle Accident Detection & Messaging system (VADMS) consists of key components working together to monitor, process, and control environmental parameters based on user-defined set points. The design ensures simplicity, modularity, and adaptability for various applications.

3.1 Components Used

- **Arduino Uno:** The central processing unit, which handles sensor input and controls the accident detection logic.
- **Gas Sensor (MQ-2):** Detects hazardous gases such as smoke, LPG, methane, and carbon monoxide, which may result from a vehicle accident involving fuel leakage or fire.
- **Infrared Sensors:** These sensors monitor the distance between the vehicle and objects, detecting potential collisions or proximity to other vehicles.
- **GSM Module (SIM900):** Sends SMS notifications to emergency contacts and services.
- **GPS Module (Neo-6M):** Provides the vehicle's location coordinates during an accident for precise dispatch of help.
- **Accelerometer:** Monitors sudden deceleration or changes in vehicle orientation, indicating a potential collision.

4. Methodology :

The Vehicle Accident Detection & Messaging system (VADMS) operates using the following components and steps:

4.1 Hardware Setup

- **Arduino Uno** is programmed to interface with various sensors and the GSM module.
- **Gas Sensor (MQ-2)** is connected to the analog pins of Arduino to detect combustible gases.
- **Infrared Sensors** are placed on the vehicle to detect obstacles or proximity to other vehicles.
- **GPS Module (Neo-6M)** is connected via serial communication to the Arduino, providing real-time GPS coordinates.
- **GSM Module (SIM900)** is connected to Arduino to send emergency SMS messages.

4.2 Accident Detection Algorithm

The accident detection algorithm works as follows:

- 1. Accelerometer Reading:** If the vehicle experiences sudden deceleration or a sharp change in orientation (e.g., flipping or a crash), the system identifies this as a potential accident.
- 2. Gas Leakage:** If the gas sensor detects smoke or hazardous gases, it indicates that the vehicle may have been involved in a collision or fire.
- 3. Proximity Detection:** The infrared sensors monitor the vehicle's environment, detecting objects in close proximity (which could indicate an impact).

If any of these sensors detect abnormal activity, the system considers the event an accident and activates the GSM module to send an SMS with the vehicle's **GPS coordinates** to emergency contacts.

4.3 Testing Procedure

The system was tested in a controlled environment where various accident scenarios were simulated, including:

- **Sudden Deceleration:** To simulate a collision.
- **Gas Leak Detection:** Simulating fuel leakage after a collision.
- **Proximity Detection:** Using infrared sensors to detect the vehicle's proximity to objects or other vehicles.

5. TECHNOLOGIES USED :

The Vehicle Accident Detection & Messaging system (VADMS) employs a combination of hardware and software technologies to achieve real-time monitoring and control. Below is an overview of the key technologies used:

- 1. Arduino Uno:** Arduino Uno is an open-source microcontroller board based on the ATmega328P chip.
- 2. Gas Sensor:** In this system, the MQ-2 gas sensor is used to detect any potential fuel leakage or combustion gases, which could be an indicator of an accident involving fire or explosion.
- 3. GSM Module (SIM900):** The GSM module (SIM900) enables the Arduino to communicate over a cellular network.

4. GPS Module: This module is crucial in providing the exact location of the vehicle at the time of an accident, ensuring emergency responders can arrive at the scene promptly.

5. Infrared Sensors: In this system, infrared sensors are used to detect obstacles or changes in distance, which could indicate a collision or an object coming too close to the vehicle.

6. BENEFITS :

The Vehicle Accident Detection & Messaging system (VADMS) offers several notable advantages. The five most significant benefits are:

- 1. Faster Emergency Response:** The real-time communication between the system and emergency responders ensures that help is dispatched quickly, reducing response times and potentially saving lives.
- 2. Increased Safety:** By combining multiple sensors (gas, infrared, and accelerometer) to detect accidents, the system offers a multi-layered approach to safety, ensuring that a variety of potential accidents can be detected.
- 3. Cost-Effectiveness:** The Arduino Uno and other components (GSM, GPS, IR sensors, gas sensor) are relatively inexpensive compared to commercial vehicle accident detection systems.
- 4. Scalability and Customization:** The system is flexible and can be easily customized to suit different vehicles or specific user requirements.
- 5. Environmental Awareness:** The infrared sensors detect proximity to objects, which could prevent accidents involving nearby pedestrians or other vehicles, increasing the overall awareness of the vehicle's environment.
- 6. Potential for Further Development:** This system can be integrated with more advanced technologies like machine learning algorithms for smarter accident detection or cloud-based communication systems to track vehicle statuses in real-time across a network of vehicles.

7. CHALLENGES :

Despite its benefits, the Vehicle Accident Detection & Messaging system (VADMS) faces several challenges that could affect its implementation and performance:

- 1. Sensor Limitations:** sensors have limited detection ranges and may not be effective for detecting collisions or obstacles at high speeds or over long distances.
- 2. Cellular Network Dependency:** The effectiveness of the system is limited in regions with poor cellular coverage, which could delay or prevent emergency responders from receiving crucial accident information.
- 3. Message Delivery Delays:** Delays in delivering emergency alerts can reduce the effectiveness of the system in urgent situations.
- 4. GPS Signal Accuracy and Availability:** Inaccurate or delayed GPS readings can affect the accuracy of location data sent to emergency responders, potentially causing them to be misdirected or delayed.
- 5. Power Consumption:** Continuous GPS tracking or constant monitoring of vehicle accidents might drain the vehicle's battery over time, especially in cases where the system is left running unattended.
- 6. False Positives and Sensitivity Tuning:** incorrectly triggered alerts can lead to unnecessary emergency responses, waste of resources, or driver anxiety.
- 7. Scalability and Integration:** Different vehicles have different electrical systems, sensor layouts, and data architectures, making it difficult to implement a standardized system that works across all vehicle types.

8. CONCLUSION :

While the **Vehicle Accident Detection and Messaging System** using Arduino Uno, gas sensors, GSM, GPS, and infrared sensors offers a highly beneficial solution to improving road safety and emergency response times, several challenges need to be addressed. These include limitations related to sensor accuracy, GSM network dependence, GPS signal reliability, false positives in accident detection, environmental conditions, and scalability. By enhancing the system with advanced technologies, sensor fusion, and more robust components, these challenges can be mitigated to create a more effective and widely deployable solution for vehicle safety..

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