Car accident detection by using GSM

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Abstract -

In recent years, the rapid increase in the number of vehicles on roads has led to a parallel rise in road traffic accidents, causing immense loss of life and property. Timely medical response and emergency assistance can significantly reduce fatalities and long-term injuries resulting from such incidents. However, a major challenge lies in the delay in reporting accidents, especially in remote or less accessible areas. To address this critical issue, this project proposes a low-cost, efficient, and real-time accident detection and alert system using Global System for Mobile Communications (GSM) technology, supported by Global Positioning System (GPS) tracking and an accelerometer-based impact detection mechanism.

This project, titled "Car Accident Detection by Using GSM", is designed to automatically detect vehicle collisions based on sudden impacts and acceleration values and to promptly notify emergency contacts with the precise location of the incident via SMS and an automatic phone call. This implementation aims to eliminate human dependency for accident reporting, ensuring faster emergency response and potentially saving lives.

The core of the system revolves around an Arduino microcontroller interfaced with an accelerometer sensor (typically an analog 3-axis accelerometer such as ADXL335 or equivalent), a GPS module for real-time location tracking, and a GSM module (SIM800L) to facilitate communication with emergency services or predefined contacts. The accelerometer continuously monitors the vehicle's movements across three axes (X, Y, and Z) and computes the resultant force vector. When the force exceeds a predefined threshold—indicative of a significant impact—the system recognizes it as a probable accident.

Keywords: *Automatic Marks Sending System, SMS Notification,GSMModule (SIM900),RFID Technology,Student Information System,Real-Time Communication,Arduino, Embedded Systems*

1.INTRODUCTION

In the modern era, transportation has become a vital part of our daily lives. The rise in the number of vehicles on the road has significantly increased due to the convenience, speed, and independence that automobiles offer. However, this increase in vehicular traffic has also led to an alarming surge in the number of road accidents globally. According to the World Health Organization (WHO), approximately 1.3 million people die each year as a result of road traffic crashes, and an additional 20 to 50 million suffer non-fatal injuries, often with long-term disabilities. The vast majority of these accidents result from delayed medical response times, especially in remote or less accessible locations where accident reporting is either delayed or nonexistent.

One of the most critical periods following a car accident is the “golden hour”—the first 60 minutes after traumatic injury—during which prompt medical treatment can significantly increase the chances of survival and recovery. Unfortunately, in many cases, due to unconsciousness, shock, or lack of bystanders, accident victims are unable to communicate their situation and location to emergency services. This delay in medical attention can often turn survivable injuries into fatalities.

To address this critical issue, this research proposes an automated car accident detection and alert system using GSM (Global System for Mobile Communications) technology. The system leverages a combination of sensors and communication modules to detect accidents in real-time and immediately notify emergency contacts or response teams with the vehicle’s GPS coordinates. This automated response system ensures that critical information about the accident, including the precise location, is transmitted instantly, eliminating the dependency on human intervention during the most vulnerable moments after a crash.

The heart of the system is built around an Arduino microcontroller, which serves as the central processing unit. It is integrated with an accelerometer sensor, which detects sudden changes in motion or impact, a GPS module for obtaining the real-time location of the vehicle, and a GSM module (SIM800L) to send alerts and make emergency calls. When the accelerometer detects a significant force—beyond a predefined threshold—the system assumes that an accident has occurred. It then initiates a series of operations: sounding an alarm (via a buzzer), collecting GPS coordinates, sending an SMS alert containing a Google Maps link to the location, and making an automated phone call to the predefined emergency contact.

This paper presents the design, implementation, and testing of this cost-effective and efficient accident detection system. It outlines the hardware components used, software development process, logic for impact detection, and the communication flow for sending real-time alerts. The system is particularly beneficial in rural or highway environments, where immediate help is often delayed due to lack of timely reporting.

Unlike traditional accident reporting mechanisms, which rely heavily on manual reporting by victims or witnesses, this system operates autonomously. It ensures that, even in situations where the victim is unconscious or alone, help is summoned without any delay. The GSM technology used in this system provides broad coverage and is more reliable than internet-based communication in areas with weak or no mobile data services. Furthermore, the integration of GPS enables pinpoint accuracy in locating the vehicle, helping emergency responders reach the exact site quickly.

From a technical perspective, the accelerometer continuously monitors the vehicle's motion along the X, Y, and Z axes. It measures the voltage variations that result from acceleration and converts them into force values. The Arduino reads these values and calculates the resultant vector magnitude using the Euclidean formula. If this magnitude exceeds the preset threshold—indicating a possible crash—an interrupt is triggered, and the alert sequence begins. This method ensures that the system only activates in the event of genuine impacts, reducing the likelihood of false alarms due to normal driving conditions like bumps or sudden braking.

The software aspect of the project is developed using the Arduino IDE. It involves interfacing the accelerometer, GPS, and GSM modules through serial communication. Efficient parsing of GPS data ensures accurate location reading, while GSM commands are used to send formatted SMS and make calls. The program is optimized to reduce response time, manage delays appropriately, and ensure that alerts are not only timely but also reliable.

This research also considers the scalability and practicality of the system. Since the hardware components are widely available, low-cost, and compatible with existing vehicle infrastructures, the solution can be easily adopted by manufacturers or retrofitted into older vehicles. Moreover, the system can be extended with additional features such as airbag deployment detection, integration with car ignition systems, voice call prompts, or even internet-based tracking for real-time fleet monitoring.

The broader impact of such a system extends to various stakeholders—car owners, emergency services, insurance providers, and government agencies. For car owners, it provides peace of mind and a safety net during travel. Emergency responders can receive immediate and accurate location information, reducing search time and improving response rates. Insurance companies can benefit from data logs for assessing accident severity and legitimacy. Government bodies and transport authorities can use aggregated accident data to identify high-risk areas and improve road safety policies.

2. HARDWARE REQUIREMENTS

1. Arduino Uno

- **Description:** Acts as the central controller of the system.
- **Function:** Reads data from the accelerometer and GPS module, processes the data, detects impact, and controls GSM module and buzzer.
- **Features:**
- ATmega328P microcontroller
- 14 digital I/O pins
- 6 analog inputs
- 16 MHz clock speed

2. Accelerometer Sensor (e.g., ADXL335 or similar)

- **Description:** A 3-axis accelerometer for motion and impact detection.
- **Function:** Detects sudden changes in acceleration along X, Y, and Z axes, which indicates a possible crash.
- **Features:**
- Measures acceleration from -3g to +3g
- Analog output for each axis
- Small, low-power sensor ideal for embedded use

3. GPS Module (e.g., NEO-6M)

- **Description:** Satellite-based navigation system receiver.
- **Function:** Provides real-time geographical coordinates (latitude and longitude) of the vehicle's location.
- **Features:**
- Operates at 9600 baud rate

- Can lock onto satellites within seconds
- Compatible with UART/Serial interface

4. GSM Module (e.g., SIM800L or SIM900A)

- **Description:** A communication module based on GSM technology.
- **Function:** Sends SMS with accident location and makes an emergency call to a predefined number.
- **Features:**
- Supports SMS, voice calls, and GPRS
- Operates with standard SIM cards
- Quad-band GSM/GPRS 850/900/1800/1900 MHz

5. Buzzer

- **Description:** A small piezoelectric or electromagnetic sound-producing device.
- **Function:** Sounds an audible alarm when an accident is detected to alert nearby individuals.
- **Features:**
- Operates on 5V DC
- Loud enough to attract attention in the vehicle or nearby

6. Resistors, Wires, Breadboard, and Connectors

- **Description:** Basic electronics components and accessories.
- **Function:** Used for connecting modules together, ensuring proper voltage levels and circuit stability.

7. Power Supply or Battery

- **Description:** Powers the Arduino and modules.
- **Function:** Provides stable power to all components, ideally a 12V battery or USB power bank.
- **Features:**
- Should be capable of supplying sufficient current for GSM transmission (up to 2A peak)

8. Voltage Regulator (e.g., AMS1117 or LM7805)

- **Description:** Ensures voltage compatibility between GSM/GPS modules and Arduino.
- **Function:** Converts higher input voltages (e.g., 12V) to 5V for logic-level operation.

3. Implementation

The implementation of the "Car Accident Detection by Using GSM" system involves the integration of various hardware and software components to create a real-time accident detection and alert mechanism. This system is designed to identify a vehicular accident based on abrupt motion sensed by an accelerometer and subsequently transmit the location of the incident to emergency contacts through GSM communication. The system is modular, affordable, and can be deployed in any vehicle to enhance road safety and enable faster emergency response.

3.1 Hardware Integration

1. Arduino Uno (Microcontroller)

- The Arduino Uno is the heart of the system. It is responsible for interfacing with all the connected hardware components such as the accelerometer, GPS module, GSM module, and buzzer.
- It reads sensor data, processes it to detect abnormal movements, and then triggers the GSM and GPS modules to perform appropriate actions.

Power Supply: 5V DC from USB or vehicle battery (via voltage regulator).

- Digital & Analog Pins Used:
- A0, A1, A2 → Accelerometer (X, Y, Z axes)
- D2, D3 → GSM module (RX, TX)
- D8, D9 → GPS module (RX, TX)
- D12 → Buzzer output

2. Accelerometer (ADXL335 or compatible)

- The accelerometer detects sudden changes in acceleration, which helps identify an accident event.

Connections:

- VCC → 3.3V or 5V (based on the sensor model)
- GND → GND
- X-OUT → Arduino A0
- Y-OUT → Arduino A1
- Z-OUT → Arduino A2

Working:

- Outputs analog voltage proportional to acceleration on each axis.
- Arduino reads these voltages and calculates the net acceleration using vector math.

3. GPS Module (e.g., NEO-6M)

- The GPS module is used to fetch the current location (latitude and longitude) of the vehicle.
- This location is sent via SMS in case of an accident.

Connections:

- TX → Arduino D9 (SoftwareSerial RX)
- RX → Arduino D8 (SoftwareSerial TX)
- VCC → 3.3V/5V
- GND → GND

Functionality:

- Continuously streams NMEA sentences.
- Arduino extracts $GPGGA sentence to retrieve GPS coordinates.

4. GSM Module (SIM800L)

- The GSM module is responsible for sending SMS and making a phone call when an accident is detected.

Connections:

- TX → Arduino D3 (SoftwareSerial RX)
- RX → Arduino D2 (SoftwareSerial TX)
- VCC → 4V (via buck converter or regulated power source)
- GND → GND
- Antenna → External GSM antenna

Note: The GSM module requires a separate 4V, 2A power source for reliable operation.

Functionality:

- Arduino communicates via AT commands.
- Sends SMS with GPS location.
- Makes an emergency phone call to the saved contact number.

5. Buzzer

- The buzzer acts as an alerting device immediately after an accident is detected.
- It provides an audible signal to alert passengers and nearby people.

Connections:

- Positive terminal → Arduino D12 (Digital Output)
- Negative terminal → GND

Working:

- Triggered using digitalWrite(buzzerPin, HIGH) in the code.
- Remains on for a few seconds after accident detection.

6. Power Supply

- For Arduino Uno: 5V via USB, battery, or adapter.
- For GSM Module: Needs stable 4V supply with minimum 2A current; use a buck converter if powered from a 12V vehicle battery.
- For GPS and other components: Usually powered from Arduino's 5V or 3.3V pin.

3.2 Software Development

1. Arduino IDE

- The Arduino IDE is the primary software used for writing, compiling, and uploading the embedded code to the Arduino Uno microcontroller.
- Version Recommended: Arduino IDE 1.8.x or later

Key Features:

- Built-in code editor and serial monitor
- One-click compile and upload functionality
- Support for third-party libraries

Role in Project:

- Writing the embedded C++ code to read sensor data and trigger GSM/GPS modules
- Communicating with Arduino via USB during code upload and debugging
- Monitoring serial output for sensor readings and event logging

2. Programming Language: Embedded C / C++

- The logic of the system is developed using Embedded C/C++, which is the standard language used with Arduino microcontrollers.
- Core Functionalities Implemented:
- Reading analog voltage data from the accelerometer (X, Y, Z axes)
- Calculating net impact using vector mathematics (Euclidean norm)
- Comparing calculated values with a predefined threshold to detect accidents
- Interfacing with the GPS module to fetch live location (latitude, longitude)
- Sending SMS with Google Maps link using GSM module via AT commands
- Making an automatic emergency call post-accident detection
- Activating a buzzer to alert nearby individuals

3. Arduino Libraries Used

- Several essential Arduino libraries are included to simplify communication and hardware interfacing:
- <SoftwareSerial.h>
- Purpose: Enables creation of multiple serial communication ports using digital I/O pins.

Used For:

- Communicating with SIM800L GSM module
- Interfacing with GPS module
- Reason: Arduino Uno has only one hardware serial port (used for debugging), hence software serial is used for GSM and GPS.
- b. <math.h>
- Purpose: Provides standard mathematical operations such as square root.

Used For:

- Calculating the resultant vector from accelerometer values using:
- impact = sqrt($x^2 + y^2 + z^2$)

4. AT Command Set (SIM800L GSM Module Communication)

- The SIM800L GSM module is operated using AT Commands, which are standard text-based instructions used to control GSM modems.
- Used Commands in the Project:
- AT+CMGF=1 – Sets SMS format to text mode
- AT+CMGS="MobileNumber" – Sends an SMS to the given number
- (char)26 – Terminates the message (CTRL+Z character)

- ATD+MobileNumber; – Initiates a voice call
- ATH – Terminates the ongoing call

Purpose in Project:

- Automatically notify emergency contacts via SMS
- Provide real-time GPS location through a clickable Google Maps link
- Trigger a call to ensure redundancy if SMS fails or goes unnoticed

5. Code Structure and Execution Logic

- The software follows a simple but robust structure:
- **Setup Function:**
- Initializes serial communication for debugging, GSM, and GPS
- Sets input/output pin modes for accelerometer and buzzer

Loop Function:

- Continuously reads analog inputs from accelerometer sensors
- Calculates the overall impact force
- Compares it against a threshold to detect accidents

If detected:

- Activates the buzzer
- Fetches GPS location
- Sends SMS with location info
- Makes a voice call to a predefined number

Custom Functions:

- sendLocation() – Reads GPS data and formats it into a URL
- sendSMS(String msg) – Sends SMS using AT commands
- makeCall() – Initiates and ends a call automatically

6. Debugging and Serial Monitoring

- Serial.print() functions are widely used throughout the code for real-time debugging and output tracking.
- The Serial Monitor of the Arduino IDE helps in:
- Monitoring sensor data (acceleration values)
- Confirming GPS and GSM communication
- Identifying logical bugs or delays in command execution

7. Customization Options in Software
Threshold Adjustment:

- The impact threshold (float threshold = 4.2) can be adjusted for sensitivity tuning based on vehicle type or environment.
- Contact Number Configuration:
- Easily change the recipient number in the sendSMS() and makeCall() functions.

Location Format:

- Location strings can be adapted to different map services or APIs for flexibility.

4. Real Time Implementation

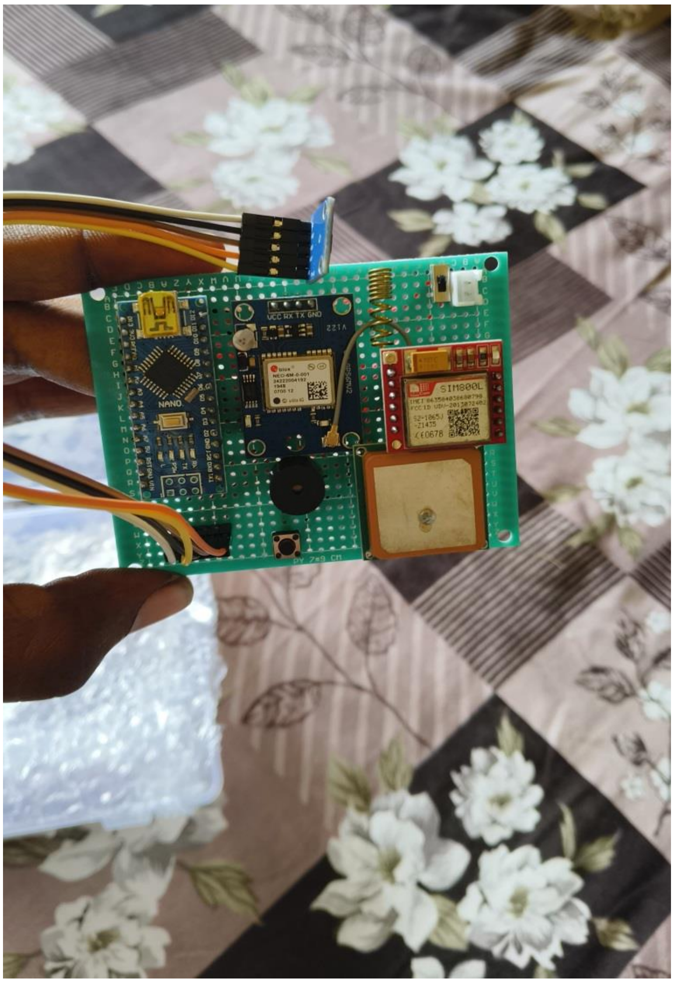

Fig -1: Hardware Implementation

The real-time implementation of the Car Accident Detection System using GSM focuses on effectively simulating real-world scenarios where vehicular accidents occur and demonstrating how the system detects, responds, and communicates during such critical events. This phase is vital to validate the project's performance in actual operating conditions and to ensure its reliability in emergency situations.

5. Simulations

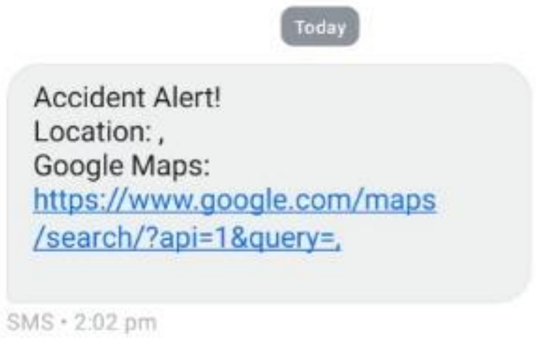

Fig -2: Result

6. ADVANTAGES

The Car Accident Detection System using GSM technology offers a wide range of practical, societal, and technological benefits. With increasing road traffic and accidents worldwide, the need for a real-time, automated emergency notification system has become critical. This project addresses that need by providing a reliable and cost-effective solution. Below are the key advantages:

1. Immediate Emergency Response

- One of the most significant advantages of this system is its ability to detect an accident and instantly send an alert to emergency contacts or services. By doing so, it drastically reduces the response time, which can be crucial in saving lives during golden-hour emergencies. The system automatically:
- Sends a detailed SMS including GPS coordinates.
- Initiates an emergency phone call to a predefined number.
- This automation ensures that no human intervention is needed, which is vital if the driver or passengers are unconscious or immobilized.

2. Cost-Effective Solution

- The entire system is built using readily available, low-cost components such as:
- Arduino UNO
- ADXL335 Accelerometer
- SIM800L GSM Module
- GPS Module
- Compared to commercial car tracking or advanced telematics systems, this setup is significantly more affordable and can be easily installed in both modern and older vehicles. It is particularly beneficial for developing countries where budget constraints are a concern.

3. Real-Time Location Tracking

- With the integration of a GPS module, the system provides real-time latitude and longitude coordinates during an accident. It also converts these into a Google Maps link, allowing emergency responders or family members to quickly view the accident location on their smartphone or computer.
- This eliminates the need for verbal communication during emergencies and makes the system accessible to people of all ages.

4. Reliable Communication via GSM

- The SIM800L module ensures robust communication by leveraging existing GSM networks. It can send SMS alerts and make voice calls in most regions where mobile coverage is available. Unlike internet-based systems, this does not rely on Wi-Fi or mobile data, making it ideal for rural or remote locations where internet access may be poor or unavailable.

5. Minimal Human Interaction

- The system is designed to operate independently of human action once powered on. It continuously monitors acceleration data and, upon detecting an abnormal value, executes the alerting sequence automatically. This feature is particularly important in situations where the accident victim is unable to make a call or send a message.

6. Compact and Portable Design

- Due to the use of compact modules, the system can be easily embedded within the vehicle dashboard, under seats, or in any secure location inside the vehicle. Its portability also makes it suitable for other moving platforms like motorcycles, electric vehicles, or logistics fleets.

7. Enhanced Road Safety Measures

- Deploying such a system on a larger scale promotes safer roads. It enables faster incident reporting, which in turn leads to quicker medical assistance. In fleet management scenarios, it allows companies to monitor their drivers' safety and respond promptly to accidents, improving their operational safety standards.

8. Scalable and Upgradable

- The modular nature of the design means that additional features can be added with ease. These include:
- Airbag integration
- GSM fallback to multiple numbers
- IoT connectivity for cloud-based monitoring
- Dashboard alerts or visual display units

- This makes the system future-proof and adaptable to changing technological trends.

7. CONCLUSION

The increasing number of road accidents across the world has raised serious concerns regarding road safety, emergency response time, and accident reporting mechanisms. The project titled **"Car Accident Detection by Using GSM"** aims to tackle these issues by developing an affordable and efficient system that automates the process of accident detection and alerts emergency services or contacts through GSM communication. The successful implementation of this system demonstrates the significant potential of embedded systems and communication technologies in enhancing vehicle safety and saving lives.

This project utilizes basic yet effective components such as an **Arduino UNO**, **accelerometer (ADXL335)**, **SIM800L GSM module**, and a **GPS module**. Together, these components form a real-time system that constantly monitors vehicular motion. When a sudden impact or abnormal motion is detected — signifying a possible accident — the system instantly springs into action. The microcontroller processes the input from the accelerometer and, upon exceeding a pre-defined threshold, triggers an emergency sequence. This includes activating a buzzer for nearby alert, obtaining the GPS coordinates, and sending them via SMS using the GSM module to a pre-configured emergency number. The system also makes an automatic call to the same number to ensure voice communication is initiated if needed.

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