Intelligent Automatic Accident Detection System Using GPS and GSM Modem

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***Abstract*— The adding number of road accidents has stressed the critical need for effective accident discovery and reporting systems to minimize response time and potentially save lives. This design presents an Intelligent Automatic Accident Detection System designed using Arduino UNO, GPS, GSM SIM900A, MPU6050(Accelerometer and Gyroscope), a 16x2 LCD display, buzzer, Bluetooth module, and a motor driver controlling four motors. The MPU6050 detector continuously monitors the vehicle's stir and exposure. In the event of an unforeseen impact or rollover indicating a possible accident, the system automatically triggers the alert medium. The GPS module acquires the real-position of the vehicle, which is also transmitted via the GSM SIM900A to apre-defined exigency contact as an SMS, including the latitude and longitude of the accident spot. contemporaneously, a buzzer is actuated to warn near individualities, and the LCD display shows applicable information for on-point askers. Bluetooth is integrated to grease original monitoring and control during testing. Also, the system incorporates a motor driver to pretend the movement of the robotic vehicle, enhancing its real-time perpetration during testing phases. The entire setup aims to give a cost-effective, real- time, and automated accident discovery and alert system that can significantly reduce the detention in exigency response, particularly in remote or less accessible areas.**

***Index Terms*— Accident Detection, Arduino UNO, GSM SIM 900A, GPS Module, MPU6050, Buzzer, LCD Display, Bluetooth, Motor Driver.**

I. INTRODUCTION

Road accidents have become a critical concern worldwide, claiming millions of lives each year and causing severe injuries and property damage. In most cases, delayed emergency responses play a major role in the loss of life. To address this pressing issue, our project aims to design and develop an Intelligent Automatic Accident Detection System that can instantly detect vehicular accidents and immediately alert emergency services with accurate location data. This system leverages the combined power of real-time sensors, GPS tracking, GSM communication, and automated vehicle control to ensure timely assistance and potentially save lives.

At the heart of the system lies the Arduino UNO microcontroller, which acts as the brain of the project. The MPU6050 sensor, which combines a 3-axis gyroscope and a 3-axis accelerometer, continuously monitors the vehicle's motion and detects any sudden changes in orientation or acceleration indicative of a collision. When such an event is detected, the Arduino processes the data and triggers an automatic alert mechanism.

The system integrates a GPS module to fetch the real-time geographical coordinates of the accident site. These coordinates are then sent to pre-defined emergency contacts via the GSM SIM900A module, which enables SMS-based communication. This immediate transmission of the accident's exact location ensures that medical and rescue teams can reach the spot without delay.

To enhance user interaction, a 16x2 LCD display is used to show live status messages, including system activity, GPS location, and alert confirmations. Additionally, a buzzer is employed to give audible feedback or warnings when the system detects anomalies. For manual control and wireless interfacing, Bluetooth connectivity is included, allowing the user to interact with the system via a smartphone or other Bluetooth-enabled devices.

The system is mounted on a vehicle prototype driven by four motors, which are controlled using a motor driver module. This setup not only simulates a real vehicular environment but also provides scope for future expansion, such as integrating automatic braking systems or steering control in case of imminent collisions.

This Intelligent Automatic Accident Detection System is a low-cost, efficient, and scalable solution, especially useful in remote areas where immediate human response might not be available. Its implementation has the potential to drastically reduce fatalities and improve post-accident response time, making roads safer for everyone.

II. RELATED WORKS

[1] Patil, S., & Pawar, M. (2021) In their study titled "Smart Accident Detection and Notification System Using GPS and GSM", Patil and Pawar proposed an Arduino-based model that integrates GPS and GSM modules to detect vehicular accidents in real-time. The system uses an accelerometer to sense collision impacts and immediately sends the coordinates to emergency services via SMS. Their implementation uses an ATmega328 microcontroller with a GSM SIM 900A module and GPS NEO-6M, showing significant improvements in response time after an accident.

[2] Kumar, A., & Singh, R. (2022) Kumar and Singh designed a cost-effective accident detection system using Arduino UNO, MPU6050, and GSM SIM900A in their work "Low-Cost Embedded Solution for Vehicle Collision Detection and Alert". The accelerometer detects abrupt motion changes, and the GPS module fetches the location, which is sent via GSM. The system also included a buzzer for immediate local alerts. Their prototype included a motor driver for motion simulation and was tested under various speed conditions, demonstrating efficient detection capability.

[3] Srinivas, H., & Joshi, M. (2023) In "Real-Time Accident Detection System Using Microcontrollers and Wireless Communication", the authors presented an Arduino-based system that integrates MPU6050 for motion detection, Bluetooth for short-range communication, and GSM for long-distance alerting. They emphasized the role of Bluetooth in notifying nearby devices, like mobile phones or smart helmets, while also using a 16x2 LCD to display status messages. Their approach also introduced motor control to simulate vehicle movement, testing the system's response during simulated collisions.

[4] Ahmed, F., & Choudhury, N. (2023) Their research work "Enhanced Road Safety Using an Arduino-Based Emergency Alert System" highlighted an intelligent model that combined GSM, GPS, and LCD modules to offer both audible and visual alerts. The MPU6050 sensor played a vital role in recognizing motion anomalies. They incorporated a buzzer to provide an immediate on-site signal, and their use of a 16x2 LCD ensured real-time status updates, which proved useful during trials in remote areas with limited mobile coverage.

[5] Sharma, R., & Patel, T. (2024) In "Advanced Embedded System for Vehicle Accident Monitoring with Motor Control", the authors enhanced the typical accident detection system by integrating a motor driver to control DC motors, simulating real vehicle dynamics. The Arduino UNO coordinated MPU6050-based crash detection, GSM-based alert messaging, and LCD display communication. This work stands out by showcasing the system in a mobile robot platform, aligning closely with autonomous navigation applications.

III. METHODOLOGY

The system comprises an MPU6050 sensor to detect sudden acceleration or tilt indicative of a crash, a GPS module to obtain the precise geographical coordinates of the incident, and a GSM SIM 900A module to send an automated alert message to predefined contacts or emergency services. A 16x2 LCD display is used to display the system status and messages, while a buzzer is included to provide an audible alert in case of detected anomalies. The vehicle is driven using four motors controlled by a motor driver, and Bluetooth connectivity allows for remote system monitoring or manual override via a mobile device.

1. System Design and element Integration MPU6050 – Accident Detection Sensor.

The MPU6050 is a 3- axis accelerometer and 3- axis gyroscope used to descry unforeseen movements, tilts, or impacts. The Arduino constantly reads data from this sensor. However, the system identifies it as a implicit accident, If the acceleration crosses a predefined threshold.

Arduino UNO – Main Controller the Arduino UNO acts as the central processing unit. It receives data from the MPU6050, processes it, and initiates posterior conduct similar as cranking the buzzer, displaying status on the TV, costing GPS data, and transferring dispatches via GSM.

GPS Module – Location Tracking When an accident is detected, the GPS module obtains the current geographical equals (latitude and longitude) of the vehicle. This information is essential for exigency response brigades to detect the accident point.

GSM SIM 900A Module – Message Transmission After detecting the accident and acquiring position data, the GSM SIM 900A module sends an SMS to a predefined mobile number. The communication contains an alert along with a Google Charts link of the position.

16x2 LCD Display – Real- time Monitoring the LCD display is used to give feedback to the stoner. It displays dispatches similar as "System Ready," "Accident Detected," "transferring SMS," and "SMS transferred," enabling the stoner to visually cover the system status.

Buzzer – Audible Alert A buzzer is included to sound an alert when an accident is detected. This point is useful in drawing attention to the scene in case near backing is possible.

Bluetooth Module – Remote Monitoring A Bluetooth module (similar as HC- 05) is included to allow the system to be covered or controlled ever through a smartphone app or computer. This can be used for testing, resetting the system, or homemade control.

Motor Driver and Motors – Vehicle Simulation The system uses motor driver to control four motors bluffing vehicle movement. This is particularly useful for prototyping and testing the accident discovery system in a controlled terrain.

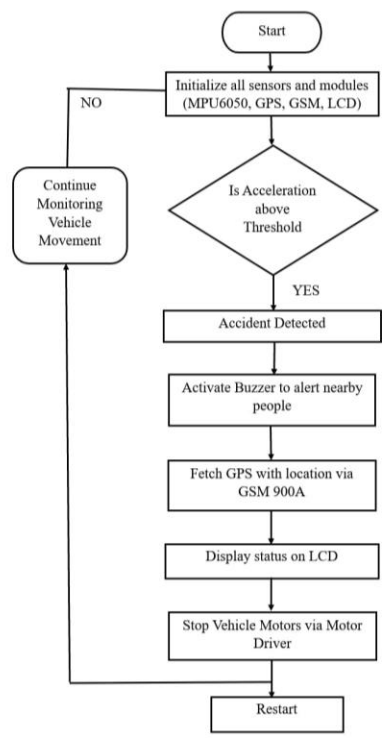
2. Working Medium

When the vehicle (or dissembled model) is powered on, the system enters the covering mode. The MPU6050 continuously transmits real-time stir data to the Arduino. Still, the Arduino recognizes it as an accident, if an abnormal stir or impact is detected (grounded on predefined threshold values). The Arduino incontinently activates the buzzer and displays the status on the LCD Display. Contemporaneously, it retrieves the GPS equals and formats the data into a readable link. The GSM module sends an exigency SMS to predefined connections with the system via Bluetooth for reset or data logging.

3. Software perpetration

The Arduino is programmed using the Arduino IDE. The software is responsible for Reading MPU6050 detector values. enforcing threshold- grounded sense for accident discovery. Communicating with the GPS module to cost equals. Transferring SMS through the GSM module. Displaying dispatches on the LCD Display. Controlling the buzzer and motors. Allowing Bluetooth communication for extended functionalities.

IV. MODEL ARCHITECTURE



1. Start

This is the initial point of the system where power is supplied to the Arduino UNO and all the necessary components. The system prepares itself to begin monitoring the vehicle's condition and movement.

2. Initialize All Sensors and Modules (MPU6050, GPS, GSM, LCD)

In this stage, the Arduino initializes all the essential hardware components connected to it:

MPU6050: This is a motion-tracking sensor that combines a gyroscope and accelerometer. It plays a critical role in identifying unusual acceleration, jerks, or impacts that are commonly associated with accidents.

GPS Module: The GPS module locks the location of the vehicle in real-time, which will later be used to send the exact coordinates during an emergency.

GSM SIM 900A Module: This module is responsible for sending SMS alerts to predefined mobile numbers in case an accident is detected.

16x2 LCD Display: It is used to display messages such as system status, confirmation of accident detection, and GPS coordinates.

3. Is Acceleration above Threshold?

Once the system is fully initialized, it begins to continuously monitor the motion and acceleration data from the MPU6050 sensor. This decision block checks whether the measured acceleration crosses a predefined threshold value. The threshold is chosen based on typical impact levels observed during vehicle collisions. If the value is below the threshold, it means normal vehicle movement is occurring. If the value is above, it indicates a possible accident.

4. No → Continue Monitoring Vehicle Movement

If the acceleration stays below the threshold, the system assumes that no accident has occurred. It loops back to continue monitoring the vehicle's movement in real time. This loop keeps the system actively checking for any abnormal events without interruption.

5. Yes → Accident Detected If the acceleration value exceeds the threshold, the system concludes that an accident has occurred. This is the trigger point for all the following alert and communication functions.

6. Activate Buzzer to Alert Nearby People

Immediately after detecting an accident, a buzzer is activated. The buzzer emits a loud sound to grab the attention of people nearby, which could potentially bring help quickly in real-life situations, especially in isolated or less-traveled areas.

7. Fetch GPS with Location via GSM SIM 900A

After the buzzer is activated, the system uses the GPS module to fetch the exact latitude and longitude of the accident location. This location is then transmitted through the GSM SIM 900A module in the form of an SMS alert to emergency contacts (family, friends, or authorities). This message helps in reducing the time taken for help to arrive, as rescuers get precise information on where the accident took place.

8. Display Status on LCD To provide a clear and immediate status update, the system shows relevant information on the 16x2 LCD display. This might include: "Accident Detected" "Sending Message" GPS coordinates. It helps the user, or anyone nearby understand what the system is doing.

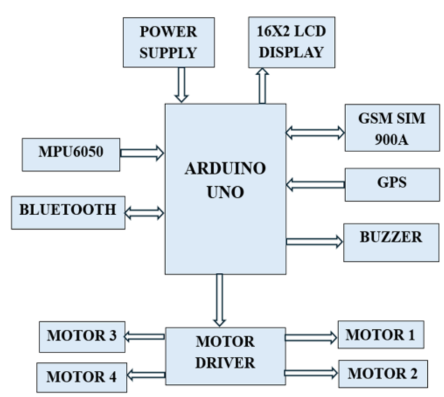
9. Stop Vehicle Motors via Motor Driver

For safety, especially in a working prototype or model car setup, the system uses a motor driver to stop all four DC motors immediately after detecting an accident. This simulates the real-world scenario where a vehicle should stop after a collision and prevents further damage or risk.

10. Restart

Finally, once all the operations are complete, the system restarts automatically. This allows it to reset all sensors and modules, and begin monitoring again from the beginning, ensuring continuous operation without needing manual intervention.

V. BLOCK DIAGRAM



1. Power Source

The system's core is the power supply unit, which gives all the electronic parts the necessary operating voltage and current. It guarantees that the sensors, actuators, communication modules, and Arduino UNO all operate steadily. The system usually uses an external adapter or batteries to provide a regulated 5V DC supply.

2. Arduino Uno

Coordinating the interactions between all connected modules, the Arduino UNO serves as the central processing unit. It manages communication duties, controls actuators, runs decision-making algorithms, and reads sensor data. After processing data from sensors like the MPU6050 and GPS, the microcontroller sends signals to the buzzer, LCD display, motor driver, and GSM module to initiate the desired action.

3. MPU6050 (Accelerometer Gyroscope Sensor)

This sensor continuously monitors the stir and exposure of the vehicle. However, it sends that information to the Arduino, helping identify possible accidents, If it detects unlooked-for changes in acceleration or angular haste (like during a crash).

4. Bluetooth Module

The Bluetooth module allows wireless communication with a smartphone or other Bluetooth-enabled bias. It can be used to manually control the system or admit live data updates from the Arduino.

5. Motor Driver and Motors (Motor 1 to Motor 4)

The motor driver receives control signals from the Arduino and powers four motors. This section is generally used for vehicle movement — helping the system navigate or respond if it's a robot- predicated accident discovery unit.

6. 16x2 LCD Display

This screen shows real- time updates, and possibly the GPS position or system instructions. It enhances user commerce by displaying vital dispatches.

7. GSM SIM 900A Module

This GSM module is responsible for transferring SMS cautions in case of an accident. It can automatically shoot text communication to emergency connections with the accident position gathered from the GPS module.

8. GPS Module

The GPS module provides the exact position of the system or vehicle. When an accident is detected, the equals from this module are transferred via GSM to predefined connections for help.

9. Buzzer

The buzzer acts as an audible alert system. When an accident or abnormal stir is detected, the buzzer sounds to notify people near or to act as an alarm.

VI. CONCLUSION

The development of an intelligent automatic accident detection system utilizing the Arduino UNO microcontroller, integrated with GPS and GSM modules, represents a significant advancement in vehicular safety technology. By employing sensors such as the MPU6050 for motion detection, and incorporating real-time communication modules, the system effectively identifies accidents and promptly notifies emergency services and designated contacts with precise location information. The inclusion of a 16x2 LCD display and a buzzer enhances user interaction and immediate alert mechanisms, while the motor driver and multiple motors facilitate responsive control actions post-incident.

This system addresses the critical need for rapid accident detection and response, aiming to reduce emergency response times and potentially save lives. Its modular design ensures scalability and adaptability to various vehicle types and conditions. Future enhancements may include the integration of additional sensors for more comprehensive monitoring, implementation of machine learning algorithms for predictive analysis, and expansion of communication capabilities to include internet-based notifications. Overall, this project lays a robust foundation for further research and development in the field of intelligent transportation systems and vehicular safety.

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