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Smart Shield – Accident Detection & Alert System

P. Madhavi Latha[1], T. Lakshmi Naveena[2], T. Kavya Sri[3], P. Sujana[4], K. Krishna Teja[5]
[1]Associate Professor- Cyber Security, Ramachandra College of Engineering, Eluru, India.
[2,3,4,5]UG - Cyber Security, Ramachandra College of Engineering, Eluru, India.
Emails: *latharcee@gmail.com[1], tnaveenanavi@gmail.com[2], thammisettykavya@gmail.com[3], sujanapandala@gmail.com[4], krishnatejakamma@gmail.com[5]*

Abstract
As per the estimation of WHO, nearly 1.3 million people die in road accidents manually, often due to delayed rescue efforts and inadequate communication with authorities. To address this critical issue and reduce fatalities, we propose an innovative accident detection system. Utilizing sensors, GPS, and GSM technologies, this system promptly identifies road accidents and dispatches emergency alerts to nearby hospitals, police, and designated contacts of the user. By providing real-time information on accident location and severity, it facilitates swift medical response, potentially saving lives. Additionally, users can cancel false alarms or request further assistance as needed, enhancing the system's effectiveness in crisis situations.
Keywords: *Arduino Nano Board, GPS Module - Neo6M, GSM Module - SIM 800L, Buzzer, Accelerometer – ADXL 335, LCD Display, Antenna.*

1. Introduction
The global issue of road accidents, claiming around 1.3 million lives annually, has spurred the development of the accident detection system. This innovative technology, integrating advanced sensors, GPS, and GSM, aims to revolutionize road safety and emergency medical care. By swiftly detecting and reporting accidents in real- time, the system facilitates rapid communication with nearby hospitals and emergency services, ensuring prompt medical assistance reaches accident scenes. Users also benefit from enhanced autonomy, being able to initiate alerts, cancel false alarms, or request additional aid, fostering a sense of security. Moreover, by analyzing sensor data, the system can prioritize emergency responses based on accident severity, thereby potentially saving lives and minimizing traffic disruptions. [1-5]

1.1.Overview of the Project
The main objective of this project is to help reduce the time factor in case of accidents. There are many cases where an accident occurs during the night and the person met with the accident is unconscious then it would take hours for someone to find out and inform the authorities about it. So, saving such precious time will indeed save lives. In connection with this concept, an experimental setup is constructed that can detect accidents automatically without any human help. After the accident detection, the same setup will send accident coordinates to the ambulance to help to find the location easily. [6-9]

1.2.System Study

1.2.1. Feasibility Study
The feasibility of the accident detection project depends on the accuracy and reliability of effectiveness the of sensors the used, the pre-processing techniques, and the suitability of the algorithms used.

1.2.2. Operational Feasibility
The operational feasibility of the accident detection system relies on essential components like the Arduino Nano board, GPS, GSM modules, accelerometer, button, buzzer, LCD display, wires, and antenna. These components work together for real time processing, location tracking, communication with emergency services, user interface, and visual feedback. The Arduino Nano board is cost-effective and versatile, enabling sensor interfacing and real-time processing. GPS and GSM modules track location and communicate with emergency services. The button, buzzer, and LCD

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display provide user interaction and feedback.

1.2.3. Economic Feasibility

The economic feasibility of the accident detection project is high due to the low cost of components, relatively low development time and resources, and high potential market demand for road safety solutions. The system's flexibility and scalability make it suitable for various market segments. However, careful consideration of marketing, distribution, and maintenance is necessary for the product's success.

1.2.4. Technical Feasibility

The technical feasibility of the accident detection project is high, supported by the well-documented and popular Arduino Nano board for easy code development, reliable GPS and GSM modules for location tracking and communication, and the accelerometer's capability to detect sudden changes in acceleration. [10-12]

2. System Requirements

Hardware Requirements:

1. Arduino Nano Board
2. GPS Module - Neo6M
3. GSM Module - SIM 800L
4. Button
5. Buzzer
6. Accelerometer – ADXL 335
7. LCD Display
8. Wires
9. Antenna

Software Requirements:

1. Arduino IDE

2.1.Accelerometer (ADXL 335)

Figure 1 Accelerometer Sensor Module

An accelerometer serves as an electromechanical device designed to gauge acceleration forces, predominantly reflecting gravitational influence. Specifically, it quantifies acceleration in units of "g," where on Earth, denotes an acceleration dynamic accelerations stemming from motion, shock, or vibration, making them versatile tools for various applications. (Refer Figure 1)

2.2.Arduino Nano

The Arduino Nano, anchored by the ATmega328P microcontroller, boasts a rich array of features tailored for user-friendly experimentation and tinkering. Its layout encompasses 14 digital input/output pins, with 6 doubling as PWM outputs, alongside 6 analog inputs. Facilitating seamless connectivity, it integrates a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. (Refer Figure 2)

Figure 2 Arduino Nano

2.3.GSM Module (GSM 800L)

The SIM800L GSM/GPRS module, a miniature GSM modem, enables various IoT functionalities like SMS messaging, calls, and internet access. It operates on quad-band GSM/GPRS networks, ensuring global equivalent to 9.8 m/s^2. Beyond gravitational effects, accelerometer excel in detecting compatibility. With an operating voltage range of 3.4V to 4.4V, it's ideal for LiPo battery supply and space-constrained projects. Featuring a SIM800L GSM cellular chip, it offers UART communication via a0.1" pitch header. External antenna integration is essential for network connectivity. (Refer Figure 3)

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Figure 3 GSM Module

2.4.GPS Module

The Global Positioning System (GPS) is a satellite navigation system situated approximately 20,000km above Earth's surface, offering precise location and time data. Originally comprising a minimum of 24 satellites, GPS is utilized across diverse sectors, including aviation, automotive navigation, and GPS trackers, facilitating efficient and accurate positioning regardless of environmental conditions. (Refer Figure 4)

Figure 4 GPS Module

2.5.LCD Display

LCD (Liquid Crystal Display) technology employs a flat-panel design illuminated by a backlight, distinct from CRT displays which rely on electron diffraction. In an LCD 16x2 display, each pixel comprises blue, red, and green sub-pixels, enabling individual activation or deactivation to produce various colors. When all sub- pixels are off, the pixel appears black, while all activated sub-pixels create white. This display configuration allows for the presentation of 32 characters in total, organized into 16 columns and 2 rows. Each character is composed of a 5x8 pixel matrix, resulting in a display containing 1,280 pixels (32 characters' x 40 pixels per character). (Refer Figure 5)

Figure 5 LCD **Display**

2.6.Arduino IDE

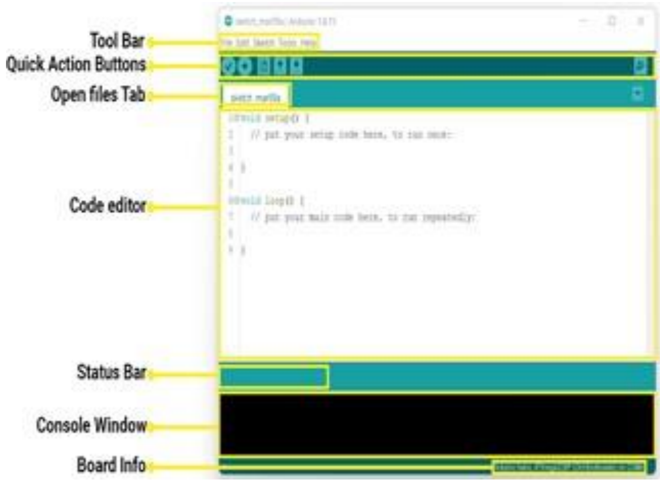

Figure 6 Arduino IDE

As shown in Figure 6, The Arduino Nano, a compact microcontroller board in the Arduino family, offers versatility and power in a smaller form factor. Programmed using the Arduino Integrated Development Environment (IDE), this open-source software supports multiple operating systems and provides essential tools like a text editor and feedback mechanisms. combination of the Arduino Nano and IDE provides a user-friendly platform to realize innovative electronic designs.

3. System Architecture

A blueprint for an Arduino Nano based system designed to detect accidents. The core of this system is the Arduino Nano microcontroller board, which interprets data from various sensors and manages other components. This system prioritizes functionality without relying on internet connectivity, making it suitable for remote areas. (Refer Figure 7)

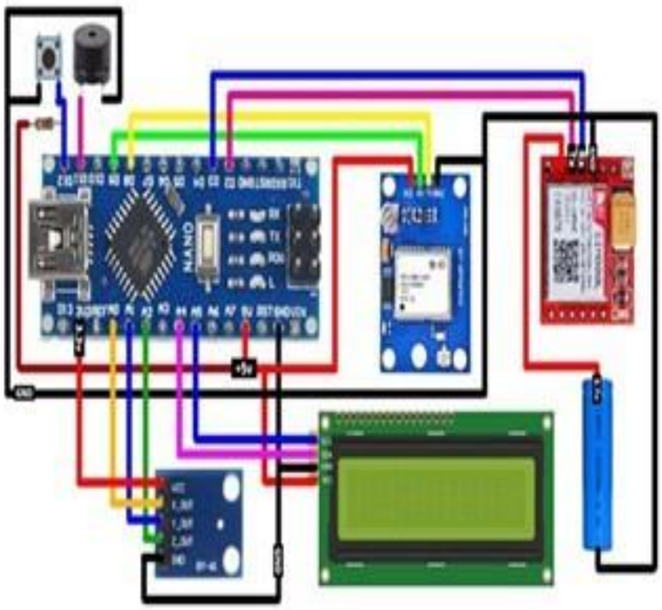

Figure 7 System Architecture

3.1.Work Flow of Proposed System

1. GPS signals are transmitted by satellites to provide navigation data to receivers on Earth.
2. These signals consist of ranging signals for measuring distances to satellites and navigation messages containing satellite data.
3. Four signal specifications exist for civilian use: L1 C/A, L2C, L5, and L1C, though modernized signals are not fully operational for civilian use.
4. GPS signals are modulated onto carrier waves at two frequencies: 1575.42 MHz (L1) and 1227.60 MHz (L2), aiding in error correction.
5. Receivers process signals to determine position, velocity, and timing, using algorithms to combine measurements for accuracy.
6. Four or more satellites are needed for accurate navigation, with navigation equations providing position and timing solutions.
7. Each satellite broadcasts a signal with a pseudorandom code; the P code is carried on L1 and L2 frequencies, with P(Y) code enhancing security. (Refer Figure 8)

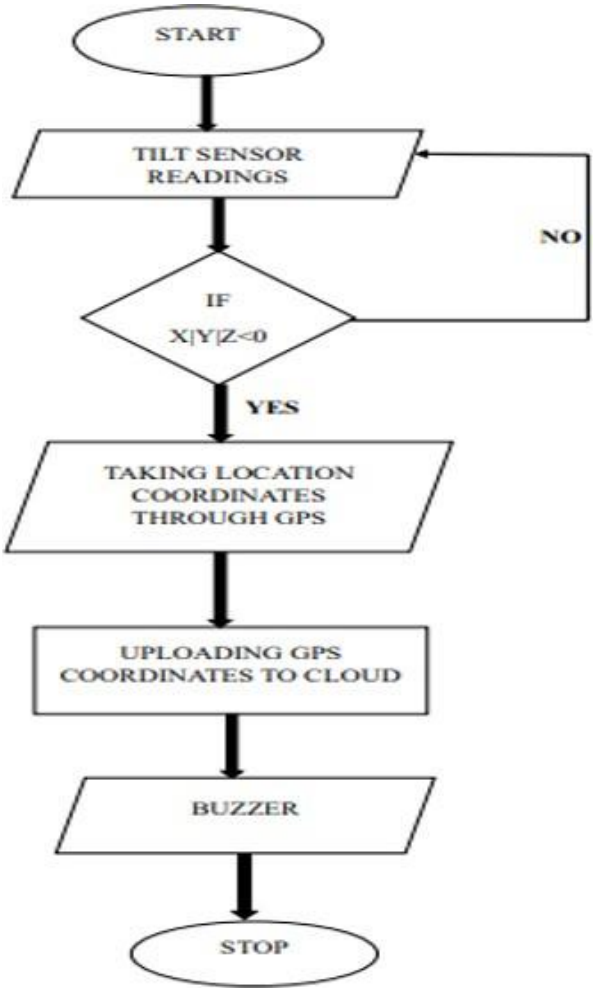

Figure 8 Work Flow

3.2.System Testing

The System testing is a crucial phase in software development, evaluating the functionality and performance of a fully integrated software solution. It assesses the entire system against specified requirements, ensuring suitability for end-user delivery. Taking place after integration testing and before acceptance testing, it encompasses both functional and non-functional aspects like performance, security, and usability. The primary objective is to uncover defects or issues within the system, guaranteeing its reliability, scalability, and maintainability.

3.3.Integration Testing

Integration testing for the accident detection system employing Arduino Nano is crucial to validate the collaboration and functionality of various modules within the system. This testing ensures that individual components, such as the accelerometer, GPS module, GSM module, LCD display, and accident detection algorithms, work together seamlessly to provide accurate and timely responses in case of accidents. Integration testing involves validating interactions between components, such as the accelerometer triggering alarms that prompt the GPS module to capture accident locations swiftly and accurately.

3.4.Future Enhancement

The proposed program focuses on detecting incidents swiftly and ensuring rapid emergency response by alerting paramedics and guiding them to the exact accident location. To further enhance the system's capabilities, future enhancements could involve integrating features such as on-spot medication provision for accident victims. By equipping the system with the ability to administer immediate medical aid at the accident site, it can significantly improve the chances of survival and reduce the severity of injuries sustained.

3.5.Expected Outcome

The Expected Outcomes of the Accident Detection System are designed to provide real time precision in detecting accidents, swift severity assessment, seamless information dissemination, and user-centric design for enhanced control. Additionally, the system allows users to manually initiate emergency alerts, cancel false alarms, and request additional assistance beyond basic emergency medical services.

4. Details of Experimental Result

In Figure 9, 10, the SMS sub-system of the framework has been shown. The SMS is sent via the GSM module to the number that is already stored in the database. The message will contain detailed information on the accident location. When the system collecting the stored contact numbers of users, the system will send SMS of accident location link to the users by GSM Module. GSM (Global System for Mobile Communication) is an architecture used for mobile communication in almost all of the countries now a day. When a user clicks on the link indicating the accident location, it triggers the display of the precise location on Google Maps. This feature allows any user or rescue team to efficiently navigate the shortest route to reach the destination. Additionally, an ambulance is dispatched to the accident location promptly to provide emergency medical assistance. The result and testing phase is divided into two distinct sections, emphasizing the uniqueness of the framework and ensuring the accuracy of the outcomes. In Figure 11, users are provided with location details, empowering both users and rescue teams to dynamically plan and navigate the shortest path for reaching the accident site. (Refer Figure 12)

Figure 9 Alert Call

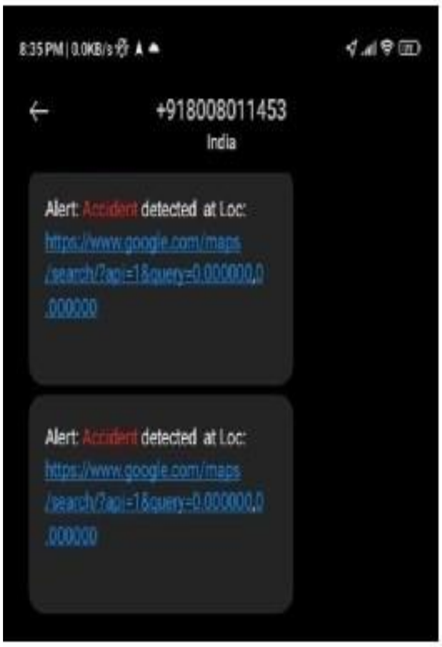

Figure 10 Alert Message

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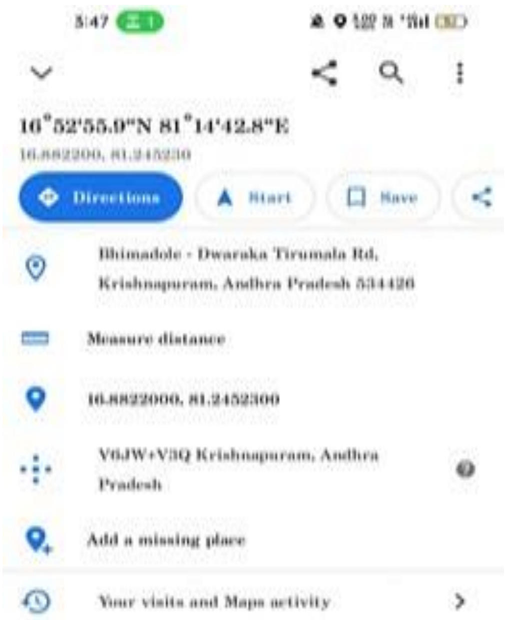

Figure 11 **Direction for Reaching Accident Site**

Figure 12 **Directions on Maps**

Conclusion

The smart shield system, utilizing Arduino Nano, GSM, GPS, and accelerometers, plays a pivotal role in modern vehicle safety. Engineered to detect sudden motion changes indicative of collisions, it swiftly alerts emergency services upon impact. This real time transmission of critical data, including precise accident location and impact severity, significantly enhances emergency response times, potentially saving lives. Seamlessly integrated into vehicles, this innovative system represents a transformative leap forward in road safety, mitigating the consequences of traffic accidents.

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