ISSN : 2455-9679
SJIF Impact Factor : 6.008

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"AUTO RESCUE: SMART ACCIDENT DETECTION AND REAL-TIME ALERT SYSTEM FOR VEHICLES"

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ABSTRACT

This research presents an innovative accident detection system designed to improve road safety through real-time monitoring and quick emergency response. The system uses a combination of sensors such as accelerometers, tilt sensors, noise sensors, GSM modules, and GPS devices to identify possible accidents. Instead of relying on complex machine learning models, it processes sensor data directly through algorithms embedded in the microcontroller. The system works by continuously analysing parameters like collision impact, vehicle tilt, and sudden motion changes. Logical conditions using operators like "AND" (&) and "OR" (||) are applied to ensure accurate accident detection by verifying multiple factors before triggering an alert. In addition, a call cancellation feature is included to prevent false alarms, ensuring that emergency contacts and services are only notified when a genuine accident is detected. Field testing shows that the system can significantly reduce the delay in accident reporting and improve emergency response times. This research highlights a practical and low-cost solution for enhancing road safety using sensor integration and efficient embedded logic.

Key Words: *Accident Detection System, Road Safety, Embedded Systems, Microcontroller, Sensor Integration, GSM Module, GPS Tracking, Accelerometer, Tilt Sensor, Noise Sensor, Real-Time Monitoring, Logical Algorithm, Call Cancellation, Emergency Response, Collision Detection.*

I. INTRODUCTION

The Auto Rescue Accident Detection & Real Time Automatic Alerting System for Automobile is an innovative project designed to enhance the efficiency and effectiveness of emergency medical services. In the face of growing urbanization and the increasing demand for swift and reliable ambulance responses, this system aims to revolutionize the way ambulance services are managed and dispatched. By leveraging advanced technology, real time data, and automation, this project seeks to reduce response times, save lives, and improve the overall quality of emergency medical care. This introduction outlines the key objectives, features, and benefits of the Auto Rescue Automated Ambulance Dispatch System, demonstrating its potential to significantly impact the field of emergency healthcare.

II. REVIEW OF LITERATURE

S. K. Patil et al. (2024), proposed an IoT-based accident detection and intimation system using an ESP32 microcontroller and an ADXL345 accelerometer sensor. The system continuously monitors sudden acceleration changes to identify collisions. When an accident is detected, it uses GPS and GSM modules to send the vehicle's

ISSN : 2455-9679
SJIF Impact Factor : 6.008

location to emergency contacts. The approach eliminates the need for machine learning and relies purely on sensor threshold logic, making it cost-effective and easy to implement in real-time environments.

P. Kumar and A. R. Singh (2022*)*, developed an Enhanced Accident Detection and Recovery System using MEMS technology. The system integrates vibration and tilt sensors with a microcontroller to detect accidents through pre-set logical conditions. When a crash is detected, the system automatically transmits the vehicle's coordinates to nearby hospitals or family members through GSM and GPS modules. The researchers concluded that MEMS-based systems can provide accurate and fast accident detection without requiring AI or data-driven techniques.

N. Zulkifli et al. (2023), designed a vehicle accident detection system using an MPU6050 accelerometer interfaced with an ESP32 controller. The setup detects tilt and vibration changes beyond defined thresholds to confirm an accident. The GPS module captures the location, while GSM sends alert messages to emergency contacts. The results showed that the proposed system can detect accidents reliably and communicate alerts efficiently without any machine learning algorithms.

From the reviewed studies, it is evident that most existing accident detection systems rely on single-sensor inputs, such as vibration or accelerometer data, and use simple threshold logic for accident identification. While these models successfully detect major impacts, they often face challenges with false alerts caused by road bumps or sudden braking. In contrast, the proposed Auto Rescue system enhances detection accuracy through multiple sensor fusion, combining data from accelerometer, tilt, and sound sensors under integrated logical conditions ("AND", "OR") for more reliable results. Additionally, the incorporation of a call cancellation mechanism makes the system more practical by preventing unnecessary emergency notifications. This combination of multi-sensor logic and intelligent alert control provides a more robust, low-cost, and efficient solution for real-time accident detection compared to conventional single-sensor systems.

III. Problem Identification

Road safety remains a major concern, particularly during long-distance travel or in remote areas where immediate medical assistance is not readily available. In many accident cases, victims are left unattended due to the absence of nearby help or their inability to call for assistance because of unconsciousness or severe injury. This delay in communication and emergency response can often result in the loss of valuable time—time that could potentially save a life.

The fundamental problem, therefore, lies in the lack of an automated system capable of detecting accidents and instantly notifying emergency services or family members without requiring human intervention. Addressing this issue is essential to improve response times and ensure timely medical support for accident victims, especially in isolated or low-traffic regions.

IV. Solution

To address the issue of delayed assistance after road accidents, the proposed system provides an automated and reliable accident detection and alert mechanism. It integrates multiple sensors such as accelerometer, tilt, and sound sensors to accurately detect collision events using logical conditions. Once an accident is confirmed, the system immediately sends the vehicle's location via GSM and GPS modules to emergency contacts or rescue teams, ensuring quick response even when the driver is unconscious.

Unlike smartphone-based systems that rely solely on cellular connectivity, this model operates independently through a microcontroller, ensuring consistent performance even in low-network areas. Furthermore, the inclusion of a call cancellation feature minimizes false alerts, enhancing system reliability. This sensor-fusion approach provides a low-cost, real-time, and efficient solution for improving road safety and reducing fatalities by enabling timely rescue operations.

V. Proposed Methodology

The methodology is divided into block diagram, algorithm and flow chart of the system. The block diagrams provide the conceptual idea of how each block are interrelated to the whole task. It defines the basic link of various blocks with

ISSN : 2455-9679
SJIF Impact Factor : 6.008

each other while the hardware specification will detail out the components involved in this design process. Software portion will be detail out the part mainly focused in the platform and its interface with number of sensor where the flow of the system operation will be detailed out elaborately. Since the system is mainly in automation, accuracy is focused more. The system has been being well designed. The algorithm includes the working sequence for the system with expected output. Algorithm defines how the system flows while flowchart section helps understand the flow of the system for better visualization.

Accident detection are done through various sensor data where a threshold limit is set during coding part. We use Accelerometer sensor for X, Y, Z coordinate of vehicle. For better precision and lower the false detection we use sound and tilt sensor which provide additional data to microcontroller to detect accident. Arduino-Nano is attached with the Wi-Fi module this help to transfer the data to IOT database. After detection of accident Arduino-Nano search for nearest location of hospital base on GPS location provided by GPS module with the help of Google API key. SIM 900A, GSM module is used to inform user family.

Block Diagram:

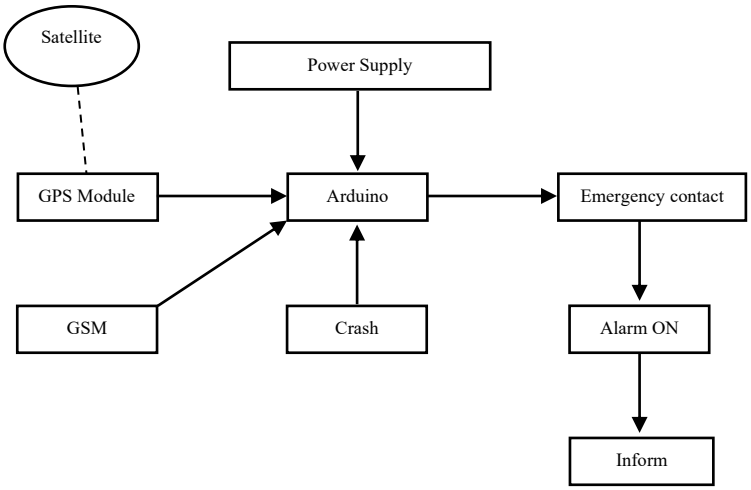

Figure 1: Block diagram of Auto-Rescue system

The block diagram above shows the general working process of the system. It consists of the Arduino nano as core of system. Arduino nano is microcontroller unit of our system where all the necessary code are burn and necessary peripheral device are attached for processing the system. The microcontroller takes all the sensor readings data and sends it over to the Database. This system is simple light weight protocol for machine-to-machine communication designed for IoT. Basically, we can control and read nodes remotely using this protocol. Further from gateway we send data over to internet. The different IoT service providers, provides us the platform such to give data to users and public. An android application will be designed which will allow farmers to monitor and control the basic environmental parameters of the farm.

Algorithm:

Denotation:
Accelerometer reading = A
Accelerometer Threshold = AT
Sound reading = S
Sound Threshold = ST
Tilt sensor reading = T
Tilt sensor Threshold = TT

1. **Start**
2. **Read sensor data**.
3. Check condition:
   If **((A > AT && S > ST) || (T > TT && S > ST) || (A > AT && T > TT))**,
   then go to step 5.
4. **If condition is false**, no accident → go back to step 2 (continuous monitoring).
5. **If condition is true**, activate **alarm/buzzer**.
6. Wait for cancel input:
   - If **Cancel Button pressed** under 10 seconds, stop alarm and return to step 2.

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- Else, read **GPS coordinates** and continue.

7. **Send message** with accident alert and GPS location via GSM.
8. **END** (or restart monitoring)

Flow Chart:

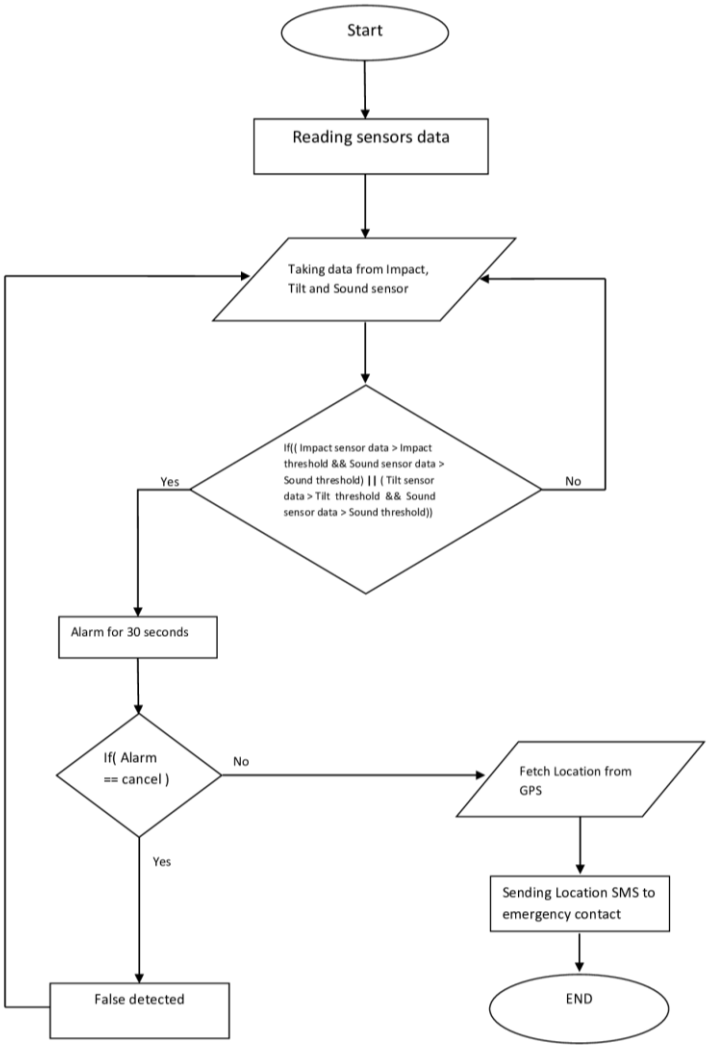

Figure 2: Flow chart of Auto Rescue System

Elementary Conditions of Accident:

Elements	Value 1	Value 2	Value 3	Value 4
Impact threshold	< Impact	> Impact	< Impact	> Impact
Tilt threshold	> Tilt	< Tilt	< Tilt	> Tilt
Sound threshold	< Noise	< Noise	> Noise	< Noise
Accident	**ON**	**ON**	**ON**	**OFF**

ISSN : 2455-9679
SJIF Impact Factor : 6.008

Explanation:
This table explains that when two conditions are both active at the same time, only then will the buzzer be triggered and accident is detected. When only one condition is active, the buzzer will remain off.

System Circuit Diagram:

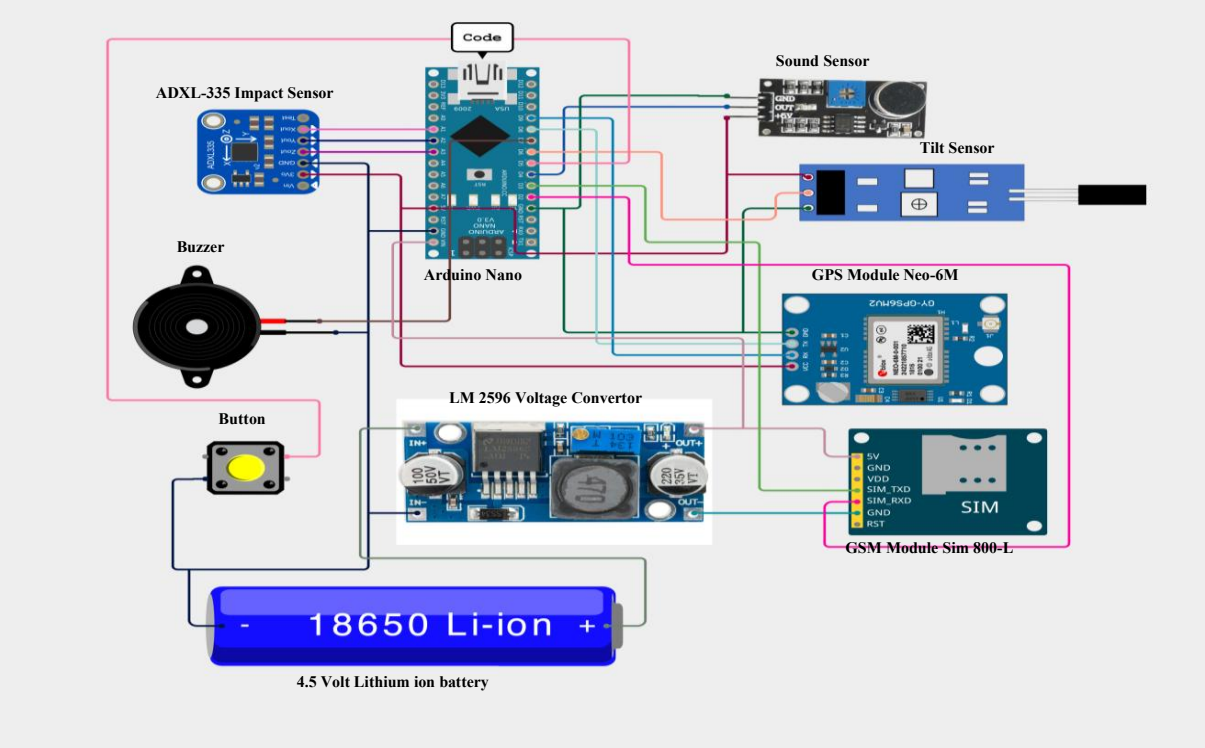

Figure 3: Circuit diagram of Auto Rescue system

VI. RESULT

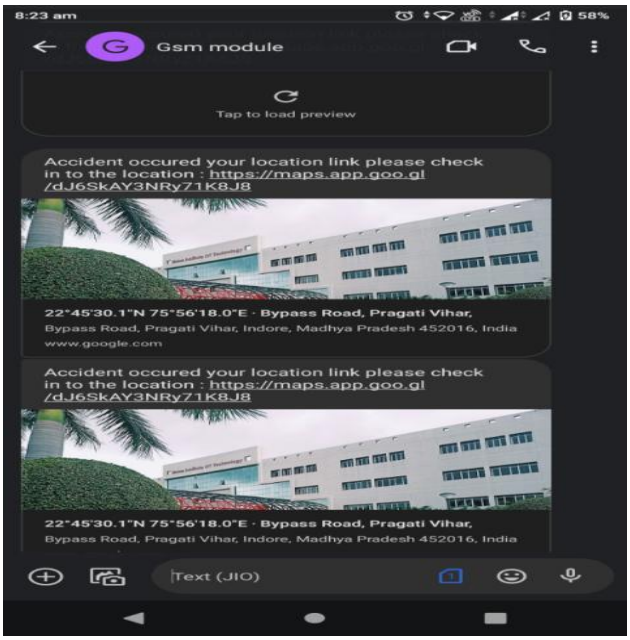

Figure 4: Test Location

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Table Integration test Result

Test Case Expected	Expected Result	Observed Result	Test Result
When the accident occurred the Accelerometer and Sound sensor should be able to detect the accident	Can detect an accident.	Can detect an accident	Pass
When the accident occurred the Accelerometer and Tilt sensor should be able to detect the accident	Can detect an accident.	Can detect an accident	Pass
When the accident occurred Tilt and Sound sensor should be able to detect the accident	Can detect an accident.	Can detect an accident	Pass
GPS Module of this system should be able to detect vehicle location correctly	Location should be exact.	Location is exact.	Pass
GSM Module of this system should be able to send SMS Correctly	SMS will be sent.	SMS has been sent.	Pass
The microcontroller should be able to process data from the sensors and modules	Can send and retrieve data to and from the sensors.	Can send can retrieve data.	Pass

VII. CONCLUSION

The proposed Auto Rescue System offers an efficient and low-cost solution to enhance road safety and emergency response. It accurately detects accidents through a combination of accelerometer, tilt, and sound sensors, using multi-sensor fusion and logical conditions to minimize false triggers. The integration of GSM and GPS modules enables automatic alert messages containing real-time location details, ensuring quick communication with rescue teams or family members. A built-in call cancellation mechanism further increases system reliability by preventing unnecessary notifications. Designed around a microcontroller, the system operates independently of smartphones and remains effective even in low-network areas. Testing results demonstrate that the system can detect collision events promptly and send alerts within seconds, helping to reduce emergency response time. With its simplicity, affordability, and reliability, the Auto Rescue System holds great potential for large-scale implementation and represents a significant step toward safer and smarter transportation.

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