IOT – BASED ACCIDENT DETECTION AND EMERGENCY ALERT SYSTEM USING LORA RF MODULE

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ABSTRACT

Road accidents are still one of the greatest issues in the world today and India leads the world among road accident fatalities and accounts for 11% of world deaths due to road accidents. aside from the road accidents, deaths are mostly triggered due to the lag between the accident and when the patient is treated. To minimize this delay, we have developed an accident detection and emergency alert system. It employs vibration and tilt sensors, to sense the collision and collapse of the vehicle to identify the accidents. Then, the data is saved in the microcontroller. It also comes with a GPS sensor, which continuously monitors the location coordinates to report the last location of the vehicle before the accident. The gathered data is then sent to the receiver side through LoRa (Long Range) Radio frequency module. On the receiving end, the data is received through another LoRa module on the receiving end. The data received is transformed into readable form and is presented in an OLED display. The variation that makes this stand out is, this solution does not require a cellular or Wi-Fi connection to work since we are utilizing radio frequency modules. With this system, we are able to avoid the delay and minimize human interaction. Such a system will be of extremely helpful use in the reduction of the death tolls which are augmented due to the lag faced because of absence of cellular signals and intervention of people.

(Keywords - Accident detection, Emergency alert, Vibration sensor, RF communication, Real-time monitoring.)

I. INTRODUCTION

Road crashes result in serious deaths globally, with about 1.19 million people losing their lives every year as a result of road-related injuries, based on reports from the World Health Organization (WHO). Non-fatal injuries affect an estimated 20 to 50 million people each year. India accounts for approximately 11% of the world's road accident fatalities, with road accident deaths rising from 134,000 in 2010 to 151,000 in 2021. Present technologies, though, rely much on cellular networks, which are mostly out of reach in remote locations such as hills or forests where accidents are more likely. Such a void exists for a more efficient and independent accident alert system. This project employs radio frequency modules of long range for an emergency alert system that can sense accidents and send information wirelessly without the use of cellular or Wi-Fi networks. Parts such as accelerometer MPU6050, NEO-6M GPS module, Arduino Uno, RYLR 896 for wireless communication, Li-Pon 18650 for power supply, and OLED display for location coordinates. It detects car accidents through vibration sensors and provides location coordinates immediately through the LoRa module. The system suggested here is an improvement over the current models because it does not rely on cellular networks, thus, being economic and efficient, particularly in areas where there is no cellular/Wi-Fi coverage like forests or hill stations. It sends data through very low power over long distances.

II. LITERATURE SURVEY

Emergency alert systems and accident detection have gained more attention in recent years as they can potentially cut down response times during critical accidents. To mitigate these drawbacks, researchers have focused on automated detection and wireless communication technologies like GSM, GPS, Wi-Fi, and Bluetooth. In recent years, RF-based LoRa and LoRa WAN modules have been realized as promising candidates to communicate accident data with low power consumption over long distances.

Jinsong tao proposed an IoT-based intelligent accident detection and early warning system that utilizes smartphone sensors to detect collisions and integrates with the Blynk application for real-time alert and location tracking and transmits information to emergency response networks [1].

Han Zhang designed a real time IoT based public safety alert and response system using a distributed network of sensors (gas, flame, vibration etc), edge computing nodes (ESP32, Raspberry pi) and cloud platforms (Firebase) tailored for rapid detection, classification and dissipation of alerts during emergency situations [2].

Vijayan developed an intelligent accident detection and emergency alert system using Bluetooth and LoRa communication which enhances vehicle safety by providing real-time alerts [3].

Andrii Oliinyk implemented an IoT-Based intelligent accident detection and emergency alert system using Bluetooth Lora communication which focuses on real-time accident detection and emergency response [4].

Veera Anusuy proposed a sustained approach for accident detection and rescue using IoT Systems that addresses the challenges in timely Accident detection and response [5].

S Kotte developed a framework for IoT - based accident detection System which uses IoT sensors, privacy preserving algorithms which emphasizes the importance of privacy in accident detection systems [6].

Victor Adewopo introduced a deep learning ensemble approach for traffic accident detection using deep learning models, traffic data etc., which presented a novel approach for traffic accident detection using deep learning techniques [7].

C.V Suresh babu developed a smart accident detection and alert system using IoT sensors, GPS, Arduino Uno which enhances emergency response time by providing real-time accident alerts [8].

R. Thommandru introduced an automatic vehicle accident detection and alert system using accelerometer, GPS module, GSM module, helping to achieve faster response times compared to conventional rescue systems [9].

Pavan Manikanta proposed a system that detects accidents and alert rescue teams using MEMS sensor, GSM module, GPS module, Arduino Uno. This helps to facilitate timely rescue operations through automated alerts [10].

Govardhan developed a intelligent IoT accident detection system for medical services using IoT sensors, Communication modules. This helps to improve emergency medical response times through intelligent detection [11].

Akash Bhakat designs a vehicle accident detection and alert system using IoT Sensors and AI algorithms. It enhances accident detection accuracy through AI integration [12].

Balamurugan proposed an IoT-based disaster monitoring and railway accident warning alerts using IoT sensors and communication modules. It improves safety in railway transportation through disaster monitoring [13].

Zavantis compared automatic accident detection systems with traditional traffic centre systems using IoT sensors and communication modules. It highlights the advantages of IoT-based systems over traditional methods [14].

Nossam developed an alcohol triggered accident detection and alert system using Alcohol sensor, GSM module and GPS module. It prevents accidents caused by alcohol consumption through detection [15].

Waqas Ashraf introduced V-CAS. a real-time vehicle anti-collision system using vision transformers on multi-camera streams using cameras, vision transformer model and adaptive braking mechanism. It enhances vehicles safety through advanced collision avoidance [16].

Kurt Hovarth presented a 6g and AI-enable framework which uses AI algorithms, sensors and 6G communication which helps to improve traffic safety through advanced detection and classification [17].

Tafadzwa petros chikaka developed a compact innovative system that operates at low cost to save to human lives. The system comprises Arduino uno, GSM module, GPS module. It proposes an integrated system that detects accidents [18].

Vaishnavi Santhosh utilized various sensors and communication technologies and intelligent algorithms which uses accelerometer, gyroscope, GPS module, GSM module and microcontroller. It enhances road safety by promptly detecting and reporting vehicle accidents [19]

Md. Rakib Al-Amin proposed a novel automatic detection and notification system specially designed for motorbike accidents which uses Microcontroller, Accelerometer, GPS module, GSM module, This develops a dual-component system that detects motorbike accidents and monitors the rider's health status [20].

III. PROPOSED METHODOLOGY

The suggested accident detection and emergency response system is meant to monitor the behaviour of a vehicle at all times and inform the almost emergency networks when the transmitter is mounted inside the vehicle using LoRa radio frequency module. The hardware configuration consists of a Neo 6-M GPS module, two RYLR 896 modules (one receiver and one transmitter), two Arduino Uno microcontrollers (one receiver and one transmitter), MPU 6050 accelerometer for tilt detection. The side which sends detects the accidents via vibration and tilt sensing .The coordinates of the location are being monitored in GPS module for providing the location coordinates for the convenience of determining the accident area. After detecting the accident, the emergency message and the location coordinates are given through microcontroller and sent wirelessly via LoRa radio frequency module. On the reception side, the data is detected by the LoRa radio frequency module. The information received is processed in the microcontroller and displayed on the OLED screen. Displayed message includes a warning message with the latest location coordinates. Fig 1. Demonstrates the workflow of the prototype.

BLOCK DIAGRAM

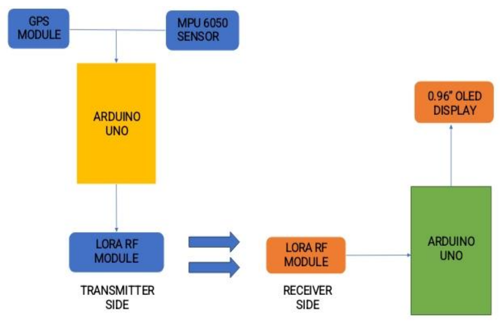

Fig 1.Block Diagram

A.NEO 6-M GPS Module

The Neo-6M GPS Module that is presented in Fig. 2 is a crucial component in the designed IoT-based Accident Detection and Emergency Alert System, as it can accurately track the location of the vehicle at the time of collision. Its capability to send real-time latitude and longitude coordinates makes the emergency message dispatched on occurrence of an accident include accurate positional information so that the rescue team reaches the accident spot in time. This is particularly helpful in rural or remote locations where landmarks and road signs are scarce. It works independent of Cellular / Wi-Fi connectivity.

Fig 2. Neo 6-M GPS Module

B.ARDUINO UNO Microcontroller

The Arduino UNO Microcontroller, which appears in Fig. 3., is the system's brain that controls all the sensors and the communication modules of the embedded IoT-based systems. The UNO microcontroller receives the accident condition from the MPU-6050 accelerometer and the remaining data from the Neo-6M GPS module for the location. Upon detecting the accident by the microcontroller, the UNO utilizes these parameters and initiates the radio for the emergency message with the coordinates of the car. The Arduino UNO is very well-suited for embedded IoT applications because it has a simple interface, low power consumption, and is easily compatible with different sensors and communication protocols. In the accident scenario, the Arduino UNO deals with real-time data from the sensors and follows the programmed logic to check for emergency alerts. Through management of data flow and performance of tasks, the Arduino UNO is instrumental in facilitating prompt detection and warning devices, thereby playing a part in enhanced road safety and prompt help during emergencies.

Fig. 3 Arduino uno microcontroller

D. RYLR 896 RF Module

The RYLR896 RF Module presented in Fig.4 is a low-power, long-range wireless module that offers a stable communication link from the accident detection unit to the remote monitoring station. RYLR896 module utilizes UART to communicate and microcontroller, and it can integrate with the Arduino UNO very well. As soon as the MPU-6050 accelerometer senses an accident, the Arduino transmits the accident details and GPS locations of the Neo-6M GPS module to the receiving monitoring station via the RYLR896 module. The extent of a few kilometres and the capability of operation without cellular connectivity make the module suitable for emergency reporting in rural or distant areas. In addition, the RYLR896's low power consumption, high noise immunity, and reliable data communication guarantee effective communication. With this module, the proposed system improves the efficiency of communication and guarantees that important accident notification is sent to rescue teams on time manner.

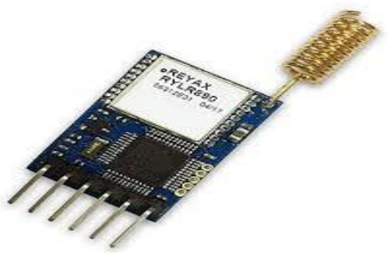

Fig 4. RYLR 896 RF Module

IV. COMPARATIVE ANALYSIS

Feature	Accident detection and emergency alert system using GSM module	IoT-Based accident detection and emergency alert using LoRa RF module
Accident Detection Method	Uses accelerometers, gyroscopes, pressure sensors, sometimes AI/ML for pattern recognition	Uses a vibration sensor with threshold-based detection
Detection Accuracy	High (due to sensor fusion and AI algorithms)	Moderate (depends on vibration threshold calibration)
Location Tracking	GPS integrated with mobile apps or GSM modules	GPS module directly interfaced with microcontroller
Communication Medium	GSM, Wi-Fi, or mobile data networks	LoRa RF module (no cellular network required)
Network Dependency	Requires cellular or internet connectivity	Completely independent of cellular networks
Range of Communication	Limited by mobile network or Wi-Fi coverage	Long-range (up to 10–15 km in open areas)
System Complexity	High – involves multiple sensors and software layers	Low – simple hardware and logic
Cost	Higher due to advanced components and data charges	Lower – cost-effective and no recurring charges
Response Time	Slower due to sim registration and SMS sending delay	Faster real time signal transmission through RF link
System Scalability	Limited to one-to-one communication via SIM numbers	Can support multiple receivers in a networked system
Best Use Case	Urban areas with strong network infrastructure	Rural or remote areas with limited connectivity

E.FINAL HARDWARE IMPLEMENTATION

The final implemented hardware includes two small units with evidently divided circuits: The transmitter unit shown in fig 5. in the vehicle and the receiver unit as illustrated in fig 6. in the emergency centre nearby. As LoRa Radio frequency modules are not based on cellular/wi-fi networks for their operation, this circuit can even operate where there is no cellular network. This unit needs low power supply and conversely it is able to travel a long range of distance without the support of cellular networks.

CIRCUIT DIAGRAM

TRANSMITTER SIDE

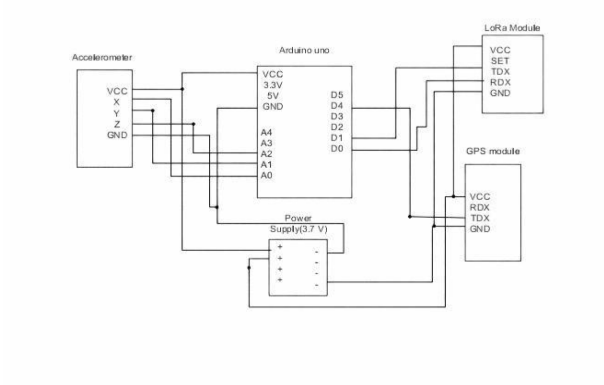

Fig 5. Circuit diagram of the transmitter side

RECEIVER SIDE

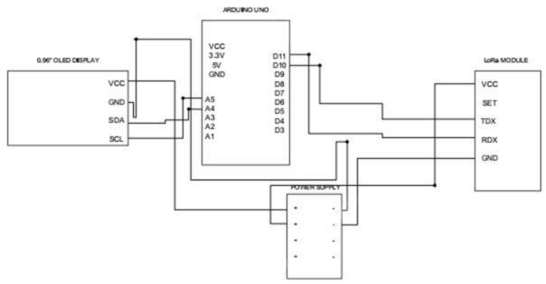

Fig 6. Circuit diagram of the receiver side

Type equation here.

1) $\Delta v = \sum_{k=k0}^{k} \; a[k] \; \Delta t$

(difference in mpu6050 before collision and after collision)

Where,

Δv = change in velocity from before the collision to after the collision(m/s),

a[k] = discrete acceleration sample at index (m/s²),

Δt = sampling interval(s),

k0,k1 = indices covering the impact interval.

2) Pr(dBm)=Pt(dBm)+Gt(dBi)+Gr(dBi)−Lfs (dB)−Lmisc(dB)

(Used to check if received power is above receiver sensitivity)

Where,

Pr = received power in dBm

Pt = received power in dBm

Gt,Gr = tx/rx antenna gains (dBi)

Lfs = free-space path loss (dB).

Lmisc = other losses(cables, body ,mismatch)

RESULT

The result in Fig 7. is obtained using stimulation by wokwi software

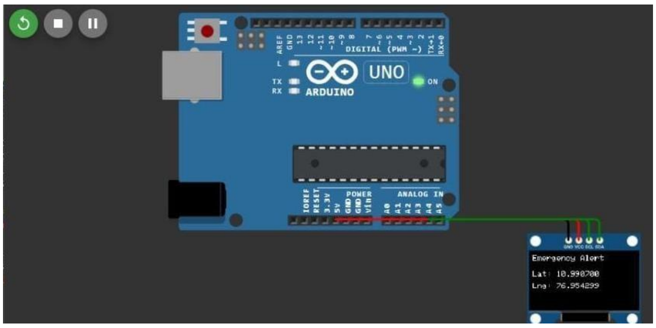

Fig 7. Result obtained via stimulation

DISCUSSION

In Fig 9., it can be seen that the accident is sensed through Arduino uno and the "Emergency Alert" message is indicated on the OLED display along with the coordinates of the location. This outcome assists us to sense the accident and the coordinates of the accident for the ambulance to show up in the location for assisting the victims hit. This is a critical advancement compared to the old system that relies on cellular networks.

V. CONCLUSION

The available systems suggest solution wherein there is a reliance of either cellular or Wi-fi networks for transfer of alerts. The system facilitates wireless communication via radio frequency modules which renders the alert system not relying on the dependency and diminishes human intervention as well as reliance of cellular networks.

VI. REFERENCES

[1]
Jinsong Tao, Razi Iqbal, Shahan Ahmad, “An IoT-Based Intelligent Accident Detection and Early Warning System,” IEEE Access, vol. 13, pp. 100947–100958, 2025.

[2]
Han Zhang, Runze Zhang, Jiamanzhen Sun, “Real-Time IoT-Based Public Safety Alert and Emergency Response System,” IEEE Internet of Things Journal, vol. 12, no. 8, pp. 7654–7665, 2025.

[3]
N. Vijayan, "Intelligent Accident Detection and Emergency Alert System Using Bluetooth and LoRa Communication," International Journal of Engineering Research, vol. 11, no. 4, pp. 112–118, 2025.

[4]
J. A. Jamil Alsayaydeh, M. F. Yusof, M. A. Aliff Abdillah, A. J. A. Al-Gburi, S. G. Herawan, A. Oliinyk, "IoT-Based Intelligent Accident Detection and Emergency Alert System Using Bluetooth and LoRa Communication," IEEE Access, vol. 11, pp. 98765–98774, 2023.

[5]
V. Veera Anusuy, B. Jasmith, P. Sugasini, M. Jeeva Dharshini, "IoT-Based Sustained Approach for Accident Detection and Rescue," International Journal of Computer Applications, vol. 182, no. 34, pp. 25–32, 2023.

[6]
S. Kotte, H. M. Yanamadala, "Framework for IoT-Based Accident Detection System with Privacy Preservation," IEEE Sensors Journal, vol. 13, no. 7, pp. 2985–2992, 2013.

[7]
V. Adewopo, N. Elsayed, "Deep Learning Ensemble Approach for Traffic Accident Detection in Smart City Transportation," IEEE Access, vol. 11, pp. 56432–56442, 2023

[8]
C. V. Suresh Babu, A. N. S. Akshayah, M. P. Vinola, R. Janapriyan, "Smart Accident Detection and Alert System Using IoT," International Journal of Engineering Research, vol. 13, no. 2, pp. 145–152, 2024.

[9]
R. Thommandru, S. Ran, B. Borugadda, "Automatic Vehicle Accident Detection and Alert System Using IoT Sensors," International Journal of Computer Applications, vol. 176, no. 12, pp. 34–40, 2024.

[10]
M. Waqas Ashraf, Ali Hassan, Imad Ali Shah, "V-CAS: Real-Time Vehicle Anti-Collision System Using Vision Transformers," IEEE Transactions on Intelligent Transportation Systems, vol. 25, no. 6, pp. 9876–9887, 2024.

[11]
Govardhan R, J. V. Ranagatti, L. S. M., Nagaraja J, "Intelligent IoT-Based Accident Detection System for Emergency Medical Services," International Journal of Computer Science and Information Security, vol. 20, no. 6, pp. 88–95, 2022.

[12]
Akash Bhakat, Neetigya Chahar, Vijayasherly Velayutham, "Vehicle Accident Detection and Alert System Using IoT and AI Algorithms," International Journal of Intelligent Systems and Applications, vol. 13, no. 5, pp. 78–85, 2021.

[13]
S. Balamurugan, G. Sasi, A. Mohanapriya, S. Balasundaram, "IoT-Based Disaster Monitoring and Railway Accident Warning System," International Journal of Advanced Research in Engineering and Technology, vol. 13, no. 7, pp. 145–152, 2022.

[14]
D. Zavantis, "Comparison of Automatic Accident Detection Systems with Traditional Traffic Centre Systems Using IoT," IEEE Transactions on Intelligent Transportation Systems, vol. 25, no. 3, pp. 1785–1794, 2024.

[15]
P. Shinde et al., "LoRa-Based Smart Power Metering System for Remote Areas," in *Proc. Int. Conf. IoT and Smart City*, pp. 175–180, 2019

[16]
M. Pavan Manikanta, et al., "IoT-Based Vehicle Accident Detection and Rescue Alert System Using MEMS Sensors," International Journal of Advanced Research in Engineering and Technology, vol. 15, no. 3, pp. 112–120, 2024.

[17]
Kurt Horvath, Dragi Kimovski, Stojan Kitanov, Radu Prodan, "6G and AI-Enabled Framework for Traffic Safety Enhancement," IEEE Transactions on Intelligent Transportation Systems, vol. 26, no. 2, pp. 1452–1463, 2025.

[18]
Tafadzwa Petros Chikaka, Omowunmi Mary Longe, "Compact Low-Cost IoT-Based Vehicle Accident Detection and Reporting System," International Journal of Advanced Research in Engineering and Technology, vol. 12, no. 3, pp. 45–52, 2021.

[19]
Vaishnavi Santosh Adsul, S. R. Kadam, "Vehicle Accident Detection and Notification System Using IoT and Intelligent Algorithms," International Journal of Computer Applications, vol. 182, no. 34, pp. 20–27, 2023.

[20]
Md Rakib Al-Amin, S. M. Kayser Mehbub Siam, Khadiza Islam Sumaiya, Tamim Hasan Turjo, Ahsanul Islam, A. H. M. A. Rahim, Md Rakibul Hasan, "Real-Time Accident Detection and Physiological Signal Monitoring for Motorbike Safety," International Journal of Intelligent Transportation Systems Research, vol. 22, no. 2, pp. 145–156, 2024.