Battle Alert: A Smart IoT Device for Emergency Communication in Military Attacks

Supriya C [1]
Assistant Professor
Department of Information Science and Engineering
Acharya Institute of Technology, Bengaluru, India
supriyac2511@acharya.ac.in

Vinutha Raghu [2]
Assistant Professor
Department of Information Science and Engineering
Acharya Institute of Technology, Bengaluru, India
vinutha2776@acharya.ac.in

Usha Kumari V [3]
Assistant Professor
Department of Information Science and Engineering
Acharya Institute of Technology, Bengaluru, India
ushakumari2487@acharya.ac.in

Jayanth M [4]
Department of Information Science and Engineering
Acharya Institute of Technology, Bengaluru, India
jayanthm.23.beis@acharya.ac.in

Akash G P [5]
Department of Information Science and Engineering
Acharya Institute of Technology, Bengaluru, India
akashp.23.beis@acharya.ac.in

Niranjan R K [6]
Department of Information Science and Engineering
Acharya Institute of Technology, Bengaluru, India
niranjanr.23.beis@acharya.ac.in

***Abstract*—This project focuses on developing a portable Emergency Alert Device capable of providing real-time communication and location tracking for emergency events. The device relies on a microcontroller interfaced with GPS and GSM communication modules to deliver location communication via SMS or voice call. The Emergency Alert Device incorporates a panic button that the individual will engage to initiate communication, and there is an LED light to indicate communication was successful or failed. The Emergency Alert Device also integrates a rechargeable Li-ion battery with sufficient power performance, efficiency, and is contained in a ruggedized, waterproof, and shockproof enclosure, which can be used in military and rescue mission scenarios. The Emergency Alert Device combines vital health monitoring sensor outputs, communication method capability, and optimization of power performance to create a proven, low- cost, expandable solution to help increase safety for personnel engaged in mission-critical operational environments.**

Keywords - Emergency Alert Device, GPS Module, GSM Module, Panic Button' LED indicator, Power Management, Rugged Enclosure, IoT-based Safety System.

I. INTRODUCTION

Wearable health monitoring systems and location-tracking systems gained much interest in the last few years as possible applications in the world of health care, disaster management, and defense operations. Conventional solutions still tend to rely mostly on simple (although useful) SMS alerts and GPS tracking techniques, but these rely on SMS or GPS, which are limited in reliability, adaptable communication, and real-time decision support. In high-risk areas (such as battlefields or remote disaster-stricken areas) these limitations can mean slower response rates and loss of safety for people.

The solution proposed here fills these gaps through a next generation, wearable health and geospatial monitoring solution using alternative communication technologies, a ruggedized hardware design, and intelligent on-board data processing. The wearable device has multiple sensors which is capable of monitoring different parameters which includes heart rate, body temperature etc., We use GSM / Voice over IP for emergency notification, with a recorded voice message in addition to text message notification.

The project includes features to make it waterproof, shock-proof, EMI for a military application and enabled continuous power for 24 to 72 hours operation, so that the risk influence will be reduced during critical missions. This is wearable device which includes multiple networking features like GSM [12], a long-range communications protocol. Implemented AIML algorithms offer an emergency alert when the person fell down and also during uncharacteristic strength ailment.

The system offers a strong QGIS – based console with multi-user access, location-based services and real time data conception, which provides the responses and actions accordingly. We have implemented End to end encryption to protect the complex info and data locality by maintaining the both soldierly and well-being app's location in mission planning and execution.

As such, this initiative is creating an end-to-end, intelligent, and secure real-time health continuous monitoring and geospatial tracking solution while addressing the constraints of current systems and allowing for ensured deployment in mission-critical settings.

II. PROBLEM STATEMENT

Existing systems suffer from a range of limitations in scalability, integration, and usability. The vast majority of current devices exist as standalone systems that cannot connect to larger command-and-control systems, limiting devices' potential in mission-type operations such as defense and disaster response. Usability is also a major concern, as most devices are large, uncomfortable, and generally not configured for long-term use by service members, paramedics, or patients in a distant healthcare environment.

Another limitation to provide context-aware decision support to the raw sensor data. Raw sensor data lacks intelligent processing, so a command center may struggle to filter out and prioritize emergencies. Providing AI/ML analytics with geospatial mapping is necessary to autonomously assess and determine priority by severity, location, and health.

Finally, most of the existing platforms only provide static or delayed information, which is not conducive to decision making in a high-risk environment. An up-to-date dashboard with dynamic mapping, geofencing, and collaborative tools to improve coordination of responses, will assist providers. These deficits in durability, communication, predictive intelligence, and security [15] warrant the need for a next-generation system to ensure continuous monitoring, trusted communication, intelligent analytic, and mission-ready high performance.

III. LITERATURE SURVEY

Edge ML Technique for Smart Traffic Management in Intelligent Transportation Systems," IEEE, 2024[1]: Hazarika suggest an edge-based machine learning framework that processes data on the edge to reduce latency and make the system more responsive in real time. The research shows that using ML models at the edge greatly improves system efficiency in applications where time is of the essence. Without any cloud set-up this system provides the aware note during emergency circumstances.

Multi-Agent Optimizing Traffic Light Signals Using Deep Reinforcement Learning, 2023 [2]: this project that adjusts to changes in the environment in real time. It works well and takes decision in the better way by continuously planning with the actual information. Based on the user condition and environment, this system will provide adaptive intelligence which can be used to list alerts and make the choices.

Real-time Vehicle Detection and Counting based on YOLO and Deep SORT, IEEE, 2020 [3]: Wang made a system for finding and following objects in real time using the YOLO and Deep SORT algorithms. Their method is very accurate and efficient at finding and following many objects at once. You can add this ability to wearable emergency devices so they can recognize dangerous situations and help you be more aware of what's going on around you.

YOLOv8-FDD: A Real-Time Vehicle Detection Method, IEEE Access, 2024 [4]: This paper talks about an improved YOLOv8-based framework that works best for fast and accurate detection in real time. The authors stress that the detection accuracy and computation speed have both gotten better. These changes are important for putting lightweight vision-based monitoring systems on IoT [11] devices that don't have a lot of processing power.

Detecting the Object in an Autonomous Vehicle Based on YOLOv8, published in January 2024[5]: This paper describes the importance of safety and reliability of an autonomous vehicle by using the YOLOv8 object detector to identify obstacles in various situations. The proposed model demonstrates good performance with regard to object classification and provides valuable information regarding collision avoidance via object detection or identifying objects in a potentially hazardous area. Similar techniques can be applied to AGV safety features found in smart wearable devices to identify potential hazards.

An Enhanced YOLO v8 Design for Effective Detection & Classification of Vehicles in Real Time IEEE, 2024 [6]: This article describes how a modified YOLO v8-based design provides an optimized approach to detect and classify various kinds of objects in an optimal manner with as little computation required.This is very important for developing IoT-enabled emergency devices that need to meet the requirement for rapid processing under limited processing capabilities.

IV. PROPOSED METHODOLOGY

It enhances the solider safety by using GPS, GSM and different sensors for tracking and sending alert messages.

Hardware System Design: It has built around microcontroller like ESP32, sensor-based triggers with efficient power management to ensure reliable, long-term emergency tracking and communication.

Emergency Event Detection and Triggering: This system instantly gives emergency alerts and GPS coordinates, activated either manually though a panic button or automatically through health sensors.

Communication and Data Transmission: We are using both message with GPS coordinates and automated voice calls, the GSM module ensures redundant, high-priority alert delivery even in low-signal environments. This minimizes latency and enables two-way dialogue between soldiers and command centers for faster response.

Location Tracking and Power Optimization: The device balances power conservation with reliability by utilizing scheduled GPS updates and intelligent sleep modes to extend battery life. Despite these energy-saving measures, it maintains continuous tracking and preserves last-known location data to ensures emergency alerts remain immediate and dependable.

Testing, Validation, and Security Enhancements: It validates the system performance by ensuring data security through various encryption methodology and superfluous long-term connectivity.

Integrating with Monitoring Dashboard: This project connects via unified monitoring console which collects the present data and locality through GPS tracking system. Controllers will be able to use plotting tools to track soldiers' movement and react in case of emergency circumstances.

V. SYSTEM DESIGN

Using an IoT-enabled [14] wearable device powered by an ESP32 microcontroller, this system transmits encrypted emergency alerts via SMS or GPRS through GPS coordinates. When an alert is received by the server, it is processed and stored, and then the server will continuously update the location of the user and display the data in real-time on a command center dashboard to allow for operators to monitor soldiers on a map and quickly respond. The system has been designed for fast, secure, and reliable communications even in degraded networks. Future enhancements include over-the-air (OTA) updates of the software/firmware, the ability to provide backup communications through LoRa or satellite, and providing advanced analytic capabilities.

A. Class diagram

The emergency communication system's key components are outlined in the class diagram, which also depicts the interactions of hardware, communications, sensor modules, and backend services. A class's unique responsibilities work together to support the total system capabilities of alert creation, transmission, monitoring, and power-efficient operation.

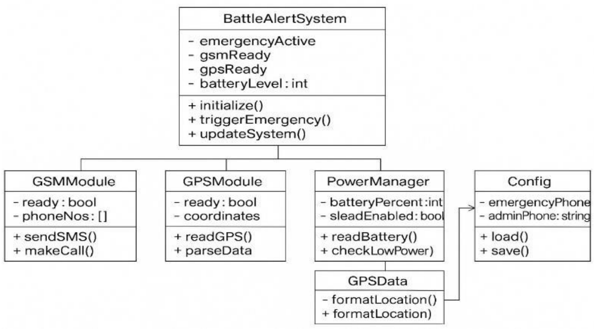

Fig. 1. Class diagram of the proposed A Smart IOT Device for Emergency Communication in Military Attack

The different modules of the system are:

- ESP32 Class – It acts as a central control unit.
- GPS Module Class – gives real-time data location
- GSM Module Class – Verifies the signal strength and SIM status
- Battery Monitor – Monitors battery capacity and charge percentage
- Power Manager – It optimizes the life of the battery by flexible the device power consumption.
- Sensor Module Class – It accelerates and monitors device kinematics.
- UI class - an interface where it gives the status indicators and gives the alert messages to the soldiers.

B. Activity Diagram

The emergency alert device activity diagram indicates the full flow of the system from beginning to end. The device starts in the initial state of idle monitoring, where it will continuously check the health sensors and the panic button. When the panic button is pressed or when the health readings display abnormalities, the system updates to the alert state. In the alert state, The LED will flash quickly as a visual alert the device will be extracting the GPS location information. Once the device receives GPS location information, it will use the information to create an emergency alert message that will include the location, plus health conditions. The emergency alert message is then sent using the GSM module as either an SMS and a phone call. If the alert is sent successfully, the LED will solidly illuminate as confirmation. If the alert message was not able to send, the device will attempt to send the message again, or use a secondary method of sending the message. In the event that

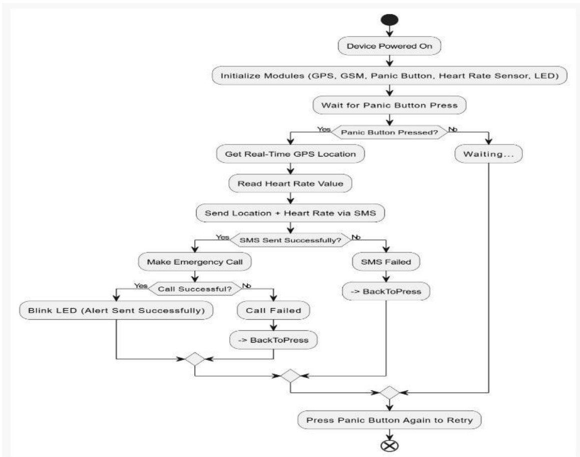

Fig. 2. Activity diagram of the proposed A Smart IOT Device for Emergency Communication in Military Attack

the alert message did not send; the device will display a delivery confirmation window. During this delivery confirmation window, the user can again press the panic button to check the delivery status, and the LED will show two flashes to indicate it was sent. The LED will only show a second flash if the message was unable to send, and the device will attempt to provide an alert message again. Once the process of sending an emergency alert message is complete, the device will return to the idle state, and the LED will slow its blinking speed to indicate readiness of the device for monitoring.

VI. SYSTEM IMPLEMENTATION

The system consists of a microcontroller (ESP32) connected to a GSM module, GPS module, panic button, LED, and battery. The panic button, when pressed, will initiate the microcontroller to read the GPS location and then send an SMS via the GSM module [10]. The status of the alert is indicated by the LED; it will blink while sending SMS, it will stay on solid when the message was sent, and it will blink differently if it were to fail sending an alert. The program is composed of a sketch run in the Arduino IDE. The program handles the sending of alerts for the system. Press the button again to know if it did send, and possibly resend the alert. When the alert is verified or sent the system will return to the idle state.

Hardware Implementation: The main hardware part included ins this system is ESP32 microcontroller, GSM and GPS modules, a panic button and the LED indicator [7]. A soldier wearing these shoes press the button during emergency situation and the GPS tracking system will provide the alert message to the list of contacts stored in the system. A rechargeable Li-ion battery is been used to maintain the continuous power supply.

- **MAX30102 Heart Rate & SpO2 Sensor**
- **GPS Module (NEO-6M)**
- **GSM Module (SIM800L/SIM900A)**
- **Li-ion Battery (3.7V, 2000–3000mAh)**
- **TP4056 Charging Module**
- **Electrolytic Capacitors (1000–2200µF)**
- **Connecting Wires & Breadboard/PCB**

Software Implementation: System software has been written using Embedded C and implemented on Arduino IDE.

- **Arduino IDE (version 1.8.x or 2.x)**
- **ESP8266 Board Package**
- **Serial Monitor/Plotter**
- **TinyGPS++**
- **MAX3010x (SparkFun Library**
- **Software Serial**
- **Wire Library (I2C)** – MAX30102 communication.

VII TEST CASES

The following factors has been considered for the test cases:

1. **Component-Level Testing**
2. **Integration Testing**
3. **Field Testing**

Type of Testing	Input	Expected Output	Obtained Result	Status of Test Case	Remarks
Sensor Testing (Heart Rate Sensor MAX30102)	Heart rate >180 bpm or <40 bpm	System detects anomaly and triggers emergency alert	Emergency alert triggered automatically	Pass	Thresholds working correctly
Integration Testing (GPS + GSM)	Emergency activated	SMS must contain Google Maps link with accurate coordinates	SMS received with correct map link	Pass	Fully functional
Power Testing (Battery Performance)	Run system continuously for 24 hours	Device remains active without shutdown	Device operated without issues	Pass	Battery stable

Table 1: Testcases 1

Type of Testing	Input	Expected Output	Obtained Result	Status of Test Case	Remarks
Button Testing (Manual Trigger)	Press emergency push button	Immediate SMS + call triggered without delay	Emergency action triggered instantly	Pass	Button highly responsive
Reliability Testing	Repeated emergency triggering (10 cycles)	System should not freeze or crash	Device performed consistently	Pass	Stable system
Network Testing (Low Signal GSM)	Operate device in low-signal area	SMS should still send with retry mechanism	SMS delayed but delivered	Pass	Retry mechanism working
Environmental Testing (Temperature)	Operate at 40°C	Device must function without malfunction	Device worked perfectly	Pass	Heat resistant

Table 2: Testcases 2

VIII. CASE STUDIES

Case Study 1: Elderly Care Scenario

An elderly person living alone has sudden onset of chest pain or dizziness. The individual would press the emergency button rather than grappling with a phone. The device sends a notification with location information to other family members and/or medical professionals. This instance further demonstrates the utility of the system in regard to health care monitoring and safety for the elderly.

Case Study 2: Women Safety Scenario

If a woman is alone and feels unsafe traveling at night, and activates the panic button, an alert will be sent out immediately. The emergency contact will receive a call and she will share her location in real time, so that they can monitor that woman where it is appropriate and assist her. This effectively demonstrates how the system could help safeguard an individual.

Case Study 3: Disaster/Rescue Scenario

In a natural disaster situation, such as an earthquake or flood, it is possible that individuals are trapped with no communication with anyone via the communication network. This device works on GSM and has minimal technical requirements, allowing a survivor to send out a simple message with their location to the rescue team. This case is a clear showcase of the worth of the approach in the extreme circumstances of large-scale emergency management.

Case Study 4: Workplace Safety Scenario

In traditional production environments such as construction, mining or any chemical plant, the worker will be surrounded by a host of high rates of injury, accidents, fires or chemical spills, contaminants and release. If there is an accidental chemical spill, fire, or any accidental injury with the worker, they can press the panic button to inform the supervisor or emergency care medical personnel. This will start the appropriate process to make certain that evacuation or emergency medical access is available in a timely manner in the instance of safety or health issues. This is an appropriate use of a panic button in a worker, safety and occupational environment. use of a panic button in a worker safety occupational environment.

Case Study 5: A soldier's emergency in a remote border region

Due to difficult terrain or hostile action, a soldier on patrol in a distant border area sustains an unexpected injury. The wearable gadget instantly transmits the soldier's GPS location and critical data to the command center via GSM connection when the panic button is pressed. To make sure the alarm is received right away, a call is also made.

IX. RESULT AND SNAPSHOT

A. System Consistency and Functionality

The LED indicator [13] was bright, clear, and continuous and provided ample feedback to the user, confirming that the message was in progress, successfully sent or not, thereby establishing trust and usability during high-stress situations.

B. Hardware Effectiveness

The ESP32/Arduino [8] Nano could effectively interface with GPS and GSM modules, with users successfully determining their location and sending SMS messages. The rechargeable Li-ion battery, with a management system, allowed for use for hours at a time. The case also had water- and shock-resistance to support field use.

C. Effects of the Panic Button and LED Feedback

Experiments showed that the inclusion of the LED indicator will reduce uncertainty in users after the panic button was pushed. The LED will provide a clear across behaviors: blinking while the message was being transmitted, then solid while the message was successfully sent and then blinking once more in the event of failure to send. This blinks more for the user, providing reassurance that the emergency format was delivered.

D. GPS and GSM Performance

The GPS module measure accuracy of 3-5 meters. In congested scenarios correctness declined somewhat, resultant in slight interruptions in shot attaining. The GSM module consistently performed well in high network coverage areas, but in weak coverage conditions, messages were delayed by 5-10 seconds.

E. Real-Time Alert Response

Under normal conditions, the system sent emergency SMS alerts within 3-6 seconds of hitting the panic button. However, the system's SMS response time was delayed by up to 15 seconds during weak GSM coverage conditions. The addition of optional voice calls provided redundancy in communication and protects against single-channel failure.

F. Comparative Analysis

In comparison to typical manual alert systems, the alert device offered:

- Faster response time (3-- and 6-seconds vs. ~30 sec).
- A reliable indication of notification via LED indicator, not seen in conventional devices.
- Inclusion of GPS coordinates automatically, demonstrating increased use of the rescue team.
- Smaller and cheaper hardware making it more realistic with military and civilian.

Fig 7.1 Charging Point

Fig 7.2 Panic Button & Led indicator

Fig 7.3 Outer Layer of the shoe

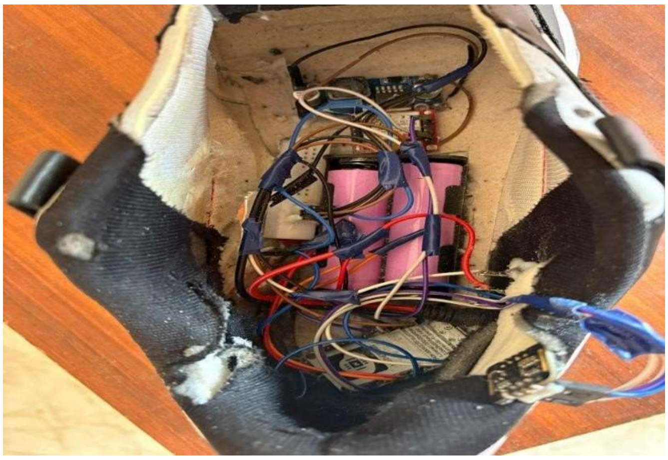

Fig 7.4 Circuit Connection

X. FUTURE ENHANCEMENT

In the next few years, the system could further develop enhanced features for safety and reliability. A mobile app can be developed so that the user is not only dependent on SMS alerts, but can see on the map their real-time location. The system can further develop to include a voice calling feature during the emergency so the user can talk and connect to their emergency contact. The system could integrate health monitoring sensors (i.e., heart rate, temperature, SpO_2) to provide health information with the location tracking monitoring. The system could incorporate cloud storage to keep health and location records, which could also be shared with a physician or family member. There is additionally the possibility of developing an AI-based prediction and alert system to predict the user is having a deviation in health prior to becoming a medical emergency.

XI. CONCLUSION

In the next few years, the system could further develop enhanced features for safety and reliability. A mobile app can be developed so that the user is not only dependant on SMS alerts, but can see on the map their real-time location. The system can further develop to include a voice calling feature during the emergency so the user can talk and connect to their emergency contact. The system could integrate health monitoring sensors (i.e., heart rate, temperature, SpO_2) to provide health information with the location tracking monitoring. The system could incorporate cloud storage to keep health and location records, which could also be shared with a physician or family member. There is additionally the possibility of developing an AI-based prediction and alert system to predict the user is having a deviation in health prior to becoming a medical emergency.

REFERENCES

[1] A. Hazarika, N. Choudhury, M. M. Nasralla, S. B. A. Khattak, and I. Ur Rehman, ”Edge ML Technique for Smart Traffic Management in Intelligent Transportation Systems,” IEEE, 2024.

[2] Z. Fereidooni, L. A. Ipsaro Palesi, and P. Nesi, ”Multi-Agent Optimizing Traffic Light Signals Using Deep Reinforcement Learning,” DISIT Lab- oratory, Department of Information Engineering, University of Florence, 50121 Florence, Italy, 2023.

[3] L. Wang, et al.,” Real-time vehicle detection and counting based on YOLO and DeepSORT,” in *2020 IEEE 4th Information Technology, Net- working, Electronic and Automation Control Conference (ITNEC)*, 2020: https://ieeexplore.ieee.org/document/9287483/

[4] YOLOv8-FDD: A Real-Time Vehicle Detection Method Based on Improved YOLOv8. IEEE Access, 2024

[5] A Comparison of YOLO Based Vehicle Detection Algorithms, in 2023 IEEE Conference, 2023. https://ieeexplore.ieee.org/document/10169773

[6] Efficient Vehicle Detection and Classification using YOLO v8 for Real-Time Applications in *2024 IEEE Conference*, 2024.

[7] A Nighttime Vehicle Detection Method Based on YOLO v3, in *2020 IEEE Conference*.

[8] Object Detection using YOLO: A Survey, in *2023 IEEE Conference*.

[9] Traffic Signal Control System Using Deep Reinforcement Learning With Emphasis on Reinforcing Successful Ex- periences, *IEEE Access*, vol. 10, 2022. https://ieeexplore.ieee.org/document/9965397/

[10] Deep Reinforcement Learning for Traffic Signal Control: A Review https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9241006

[11] Ishita Seth, Surya Narayan Panda, Kalpna Guleria: IoT based Smart Applications and Recent Research Trends, (ISPCC 2021)

[12] Implementation of GSM wireless technology based remote notice board, (ICSES 2024).

[13] Panic Button Application for Android-Based Environmental Security Monitoring, International Conference on TSSA 2023.

[14] Automated Fire Suppression System for Electrical Panel Enclosures Using Iot and Embedded System, International Conference on Emerging Smart Computing and Informatics (ESCI) 2025.

[15] Security Challenges in Civilian and Military IoT - Common Attacks and Vulnerabilities, International Conference on TELSIKS 2025.