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GPS-Based Health and Safety Monitoring Device for Trekkers

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ABSTRACT: Trekking in remote and mountainous regions involves various safety challenges, including health emergencies, loss of location information, and delayed rescue operations. This paper presents an IoT-Based GPS Health and Emergency Monitoring Device for Trekkers that integrates real-time health monitoring and location tracking into a compact wearable system. The proposed device utilizes an ESP32 microcontroller, a MAX30102 sensor for measuring heart rate and blood oxygen saturation (SpO₂), and a NEO-6M GPS module for obtaining location coordinates and altitude information. An OLED display provides local visualization of health and location data, while dedicated SOS buttons enable emergency alert generation. Audible and vibration alerts are produced using a buzzer and vibration motor to improve user awareness. The collected data can be monitored through a mobile application for continuous supervision. The developed prototype offers a portable, rechargeable, and cost-effective solution for enhancing trekker safety in remote environments. Experimental testing demonstrates reliable monitoring of physiological parameters and GPS-based tracking, making the system suitable for outdoor adventure and emergency support applications.

KEYWORDS: IoT, ESP32, GPS Tracking, Health Monitoring, SpO₂ Sensor, Heart Rate Monitoring, Trekker Safety, Emergency Alert System, GPS Altitude Monitoring.

I. INTRODUCTION

Trekking and mountaineering activities are becoming increasingly popular among adventure enthusiasts. However, trekkers often travel through remote regions where communication facilities and medical assistance may not be readily available. Health emergencies, exhaustion, altitude-related discomfort, and difficulties in determining the exact location of an individual can lead to serious consequences.

Recent developments in the Internet of Things (IoT) have enabled the creation of intelligent monitoring systems capable of collecting and transmitting real-time information. Wearable monitoring devices can assist trekkers by continuously tracking their physiological conditions and geographical location.

The proposed system combines health monitoring and GPS tracking in a portable device designed specifically for trekkers. The system continuously measures heart rate, blood oxygen saturation (SpO₂), location coordinates, and GPS-derived altitude information. In emergency situations, SOS buttons allow users to generate alerts for quick assistance. The proposed solution aims to improve trekker safety and support timely rescue operations in remote areas.

II. PROBLEM DEFINITION

Trekkers traveling through remote and mountainous regions are exposed to various risks, including sudden health issues, lack of communication, and difficulty in obtaining immediate assistance during emergencies. Rescue teams often face challenges in locating affected individuals due to insufficient real-time monitoring systems.



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Therefore, there is a need for a portable and cost-effective device capable of continuously monitoring health parameters, tracking geographical location, displaying altitude information, and generating emergency alerts to improve trekker safety and emergency response

III. LITERATURE SURVEY

Several researchers have proposed IoT-based monitoring systems for mountain climbers and trekkers. Existing systems primarily focus on health monitoring, location tracking, and emergency communication.

Kumar et al. developed a health and position tracking system that utilized GPS technology for location monitoring and wireless communication for emergency support. Other researchers implemented LoRa-based monitoring systems to improve long-range communication in mountainous environments. Advanced systems have also been developed using cloud platforms and wearable sensors to monitor physiological parameters such as heart rate, body temperature, and oxygen levels.

Although these systems provide useful safety features, many lack integrated emergency alert mechanisms, mobile application support, or compact wearable implementation. The proposed system combines heart rate monitoring, SpO₂ measurement, GPS tracking, GPS-based altitude information, OLED display functionality, and SOS emergency alerts within a single portable device, making it suitable for trekking applications.

IV. PROPOSED SYSTEM

The proposed system is an IoT-based wearable device developed to enhance the safety of trekkers during outdoor activities. The system continuously monitors the user's heart rate and blood oxygen saturation using the MAX30102 sensor while simultaneously obtaining geographical coordinates and altitude information through the NEO-6M GPS module.

The ESP32 microcontroller serves as the central processing unit responsible for collecting, processing, and transmitting sensor data. The acquired information is displayed on an SSD1306 OLED screen and can also be monitored through a mobile application.

To improve emergency response, two SOS buttons are incorporated into the device. When activated, the system generates alerts through a buzzer and vibration motor while transmitting the trekker's location information. The device is powered by a rechargeable Li-ion battery supported by a TP4056 charging circuit and a DC-DC boost converter, making it suitable for portable outdoor applications

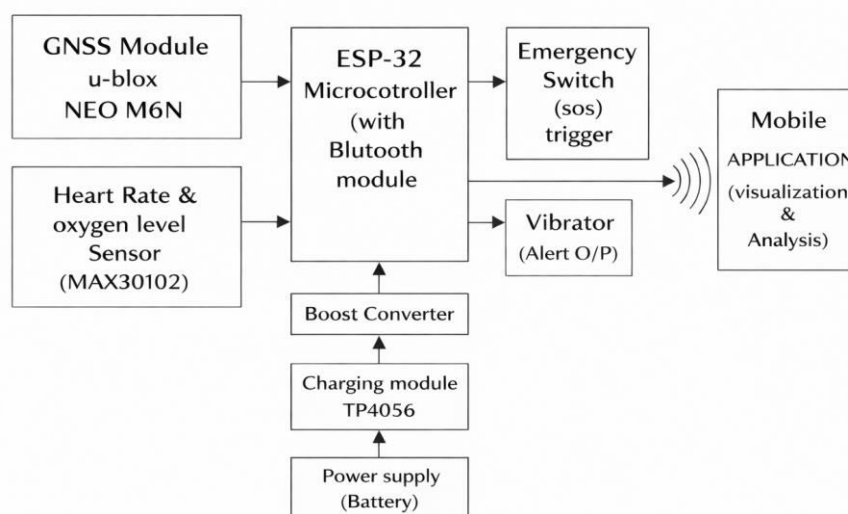


FIGURE.1. BLOCK DIAGRAM



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V. SYSTEM ARCHITECTURE

The system architecture consists of the following modules:

A. Health Monitoring Module

- MAX30102 Sensor
- Heart Rate Monitoring
- SpO₂ Monitoring

B. Location Tracking Module

- NEO-6M GPS Module
- Latitude and Longitude Tracking
- GPS-Based Altitude Information

C. Processing Module

- ESP32 DevKit V1

D. User Interface Module

- SSD1306 OLED Display
- Mobile Application

E. Emergency Alert Module

- SOS Button 1
- SOS Button 2
- Active Buzzer
- Vibration Motor

F. Power Management Module

- 3.7V Li-ion Battery
- TP4056 Charging Module
- DC-DC Boost Converter

The ESP32 receives data from the health monitoring and GPS modules, processes the information, and displays it locally as well as on the mobile application. Emergency alerts are generated whenever the SOS buttons are activated.

VI. FLOW CHART

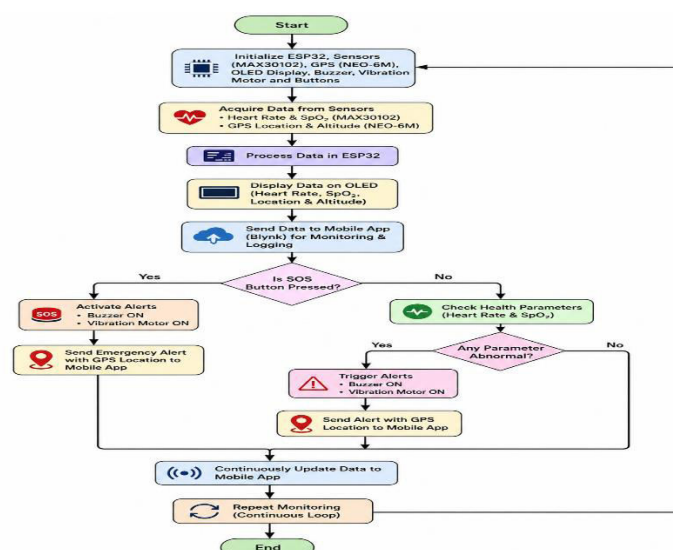


FIGURE.2. FLOW CHART



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VII. RESULTS AND DISCUSSION

The developed prototype successfully monitored heart rate, blood oxygen saturation, geographical location, and GPS-based altitude information in real time. Sensor readings were accurately processed by the ESP32 and displayed on the OLED screen as well as the mobile application.

The NEO-6M GPS module provided reliable latitude, longitude, and altitude information, enabling continuous location tracking during outdoor activities. The SOS alert mechanism successfully generated audible and vibration alerts when activated.

Experimental testing demonstrated stable operation of the health monitoring, GPS tracking, and emergency alert modules. The results indicate that the proposed system can effectively improve trekker safety by providing continuous health monitoring and rapid emergency assistance support.

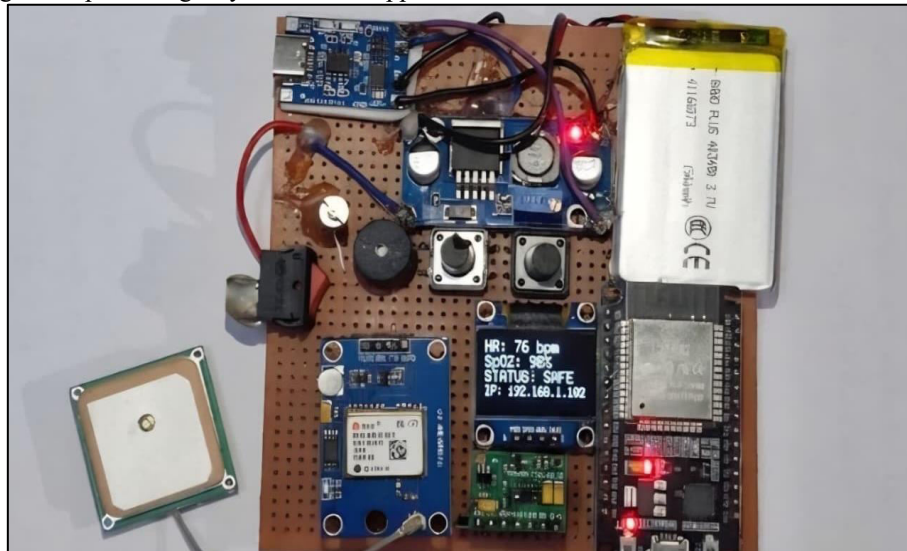


FIGURE.3. PROTOTYPE OF GPS-Based Health and Safety Monitoring Device



FIGURE.4. OLED DISPLAY SHOWING MEASURED PARAMETERS OUTPUT



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Trekkers App – User Interface Flow Showcase

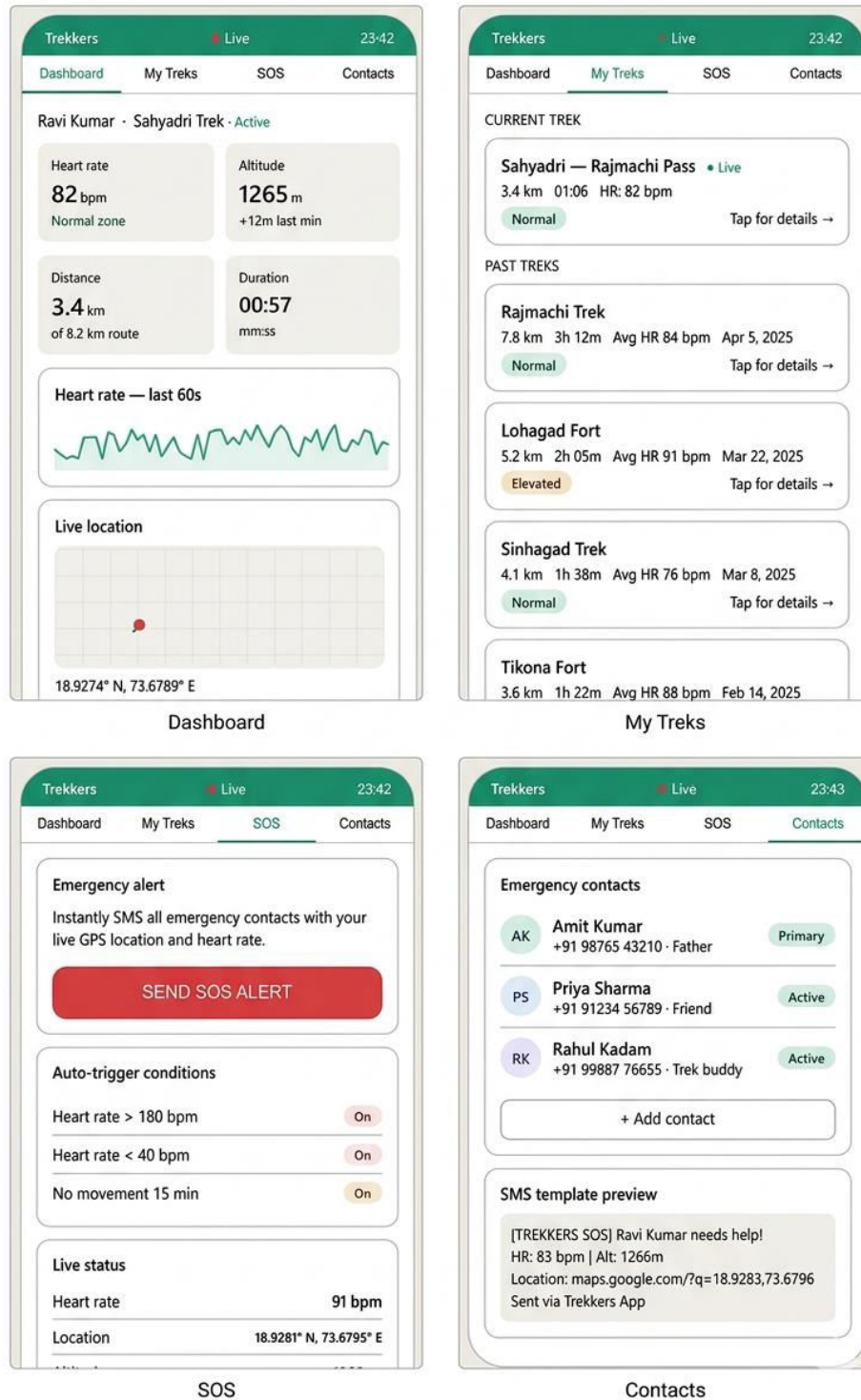


FIGURE. 5. Trekker's App User Interface



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VIII. CONCLUSION AND FUTURE SCOPE

Conclusion

This paper presented an IoT-Based GPS Health and Emergency Monitoring Device for Trekkers that integrates health monitoring, GPS tracking, altitude information, and emergency alert generation within a portable wearable platform. The system continuously monitors heart rate and blood oxygen saturation while providing real-time location information through the GPS module. The inclusion of SOS buttons, buzzer alerts, and vibration notifications enhances emergency response capabilities. Experimental evaluation demonstrated the effectiveness of the proposed system in providing reliable monitoring and tracking functions. The developed solution offers a practical, affordable, and user-friendly approach for improving trekker safety in remote and challenging environments.

Future Scope

The proposed system can be enhanced by integrating GSM or satellite communication technologies for operation in areas with limited network connectivity. Additional health monitoring sensors such as body temperature and blood pressure sensors can be incorporated to improve health assessment. Cloud-based data storage and artificial intelligence techniques can also be integrated for advanced health analysis and predictive emergency detection.

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