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SOLDIER HEALTH MONITORING AND POSITION TRACKING WITH LORA COMMUNICATION

[1]Vikas D. Raskar

[1]Department of E&TC Engineering, Sinhgad Institute of Technology, Lonavala, Affiliate to S.P.P.U, Pune,

[2]Kranti V. Jagadale

[2]Department of E&TC Engineering, Sinhgad Institute of Technology, Lonavala, Affiliate to S.P.P.U, Pune, India

[3]Sanskriti H. Labhade

[3]Department of E&TC Engineering, Sinhgad Institute of Technology, Lonavala, Affiliate to S.P.P.U, Pune, India

[4]Aditya R. Abhale

[4]Department of E&TC Engineering, Sinhgad Institute of Technology Lonavala, Affiliate to S.P.P.U, Pune, India

ABSTRACT

A nation's military strength depends on its ability to deploy forces across land, sea, and air. A compact and effective monitoring system is proposed to enhance soldier safety and operational efficiency. This system consists of a wearable device that tracks the soldier's real-time location and health parameters. By continuously monitoring these vital indicators, commanders can make informed decisions and respond quickly to emergencies. The system also includes additional components that support soldiers in the field. To ensure reliable communication over long distances with minimal data usage, this system utilizes Long Range (LoRa) technology. LoRa enables efficient, low-power transmission of critical information from the soldier's device to the control unit, ensuring seamless coordination in remote and challenging environments.

Keywords — Military Might, Soldier Monitoring, Health Indicators, LoRa Technology, Signal Transmission.

I. INTRODUCTION

Modern military operations increasingly rely on real-time data and robust communication networks to enhance the safety, efficiency, and strategic effectiveness of personnel deployed in the field. Soldiers often operate in remote and challenging environments where conventional communication networks are either unavailable or unreliable. In such scenarios, maintaining situational awareness regarding their health and location is critical for mission success and personal safety.

To address these challenges, this study explores the implementation of Long Range (LoRa) communication technology for soldier health monitoring and position tracking. LoRa is a low-power, long-range wireless communication protocol designed to provide reliable connectivity with minimal energy consumption. By integrating wearable health sensors and GPS modules with LoRa-enabled devices, real-time monitoring of key physiological parameters—such as heart rate, body temperature, and blood oxygen levels—can be achieved alongside accurate position tracking. This system allows command units to maintain a

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comprehensive understanding of each soldier's health and location, facilitating timely decision-making and rapid response in critical situations.

II. RELATED WORK

Survey existing wearable devices designed for military personnel, highlighting their features, limitations, and impact on soldier performance. Analyze the challenges of integrating multiple sensors and communication technologies into a compact, robust wearable device. Review remote health monitoring systems, particularly those used in healthcare and sports applications. Discuss the specific requirements and challenges of military health monitoring, such as the need for real-time data transmission, data security, and privacy.

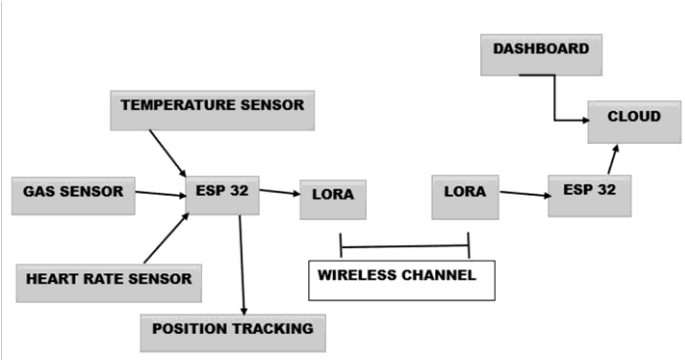
Explore existing position-tracking systems used in various fields, such as logistics, asset tracking, and emergency response. Analyze the unique requirements of military position tracking, such as the need for accurate and reliable tracking in harsh environments.

Paper [2] used: This project provides health checks and location tracking based on GPS and wireless communication for soldiers' health and safety. When soldiers face a crisis, they can use devices with wireless LORA modules with temperature sensors, heart rate sensors, and other sensors to communicate with the control room and find help.

III. METHODOLOGY

Wireless RF modules are then used to transfer the data gathered from the sensors (current position) to the following level of the hierarchy. This technology enables the control room unit to use the wireless body sensor network and the RF receiver at regular intervals to continuously track the position and monitor the troops' vital signs. As part of the suggested architecture, an ESP8266 connected to the control room continuously checks the data received from the various subsystems and issues an alert if any values go over or below predetermined thresholds. The soldiers' whereabouts and live health status are tracked to guarantee their safety on the battlefield, and if any irregularities are discovered in the values supplied to the control unit node, they make sure that help is delivered from that node or the squadron leader's node as soon as possible.

This project aims to enhance soldier safety in emergencies by employing GPS technology and a Wireless LORA module for communication and location tracking.



A) LoRa Communication Technology: -

Range and Coverage: LoRa provides extended coverage over a few kilometers in rural areas and up to hundreds of meters in urban areas. Its long range is suitable for applications where soldiers may be far from each other or a central monitoring station. Low Power Consumption:

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This is ideal for soldiers needing portable, battery-powered devices that can last long periods in the field. Network Topology: LoRa supports various network topologies (e.g., star, mesh), allowing flexibility depending on the scale and nature of deployment.

B) Health Monitoring Parameters

Vital Signs: Common metrics include heart rate, body temperature, and blood oxygen levels. These can be tracked via wearable sensors integrated into devices communicating via LoRa.

Stress and Fatigue: Monitoring physical exertion, hydration levels, and fatigue indicators helps soldiers stay within safe physical and mental limits.

Injury Detection: Sensors can detect sudden movements or impacts, signaling possible injuries or falls.

C) Position Tracking

GPS Integration: GPS modules can be integrated with LoRa-based devices for real-time location tracking. However, GPS consumes significant power, so intermittent GPS signals may be used to balance power consumption.

Indoor Positioning: In environments like urban warfare, indoor positioning can be achieved through techniques like signal triangulation and integration with inertial measurement units (IMUs).

Real-Time Tracking: Combining GPS with LoRa allows for real-time location tracking with minimal data transfer, which conserves battery life.

D) Data Transmission and Security

Data Compression: To minimize bandwidth usage, data from sensors can be compressed before being sent via LoRa.

Encryption: Soldier data is sensitive, so end-to-end encryption is necessary to prevent interception and unauthorized access to health or location data.

Bandwidth Management: LoRa's limited bandwidth calls for efficient data management strategies, where only essential data is transmitted at critical times.

E) Challenges and Limitations

Network Congestion: In densely populated soldier groups, LoRa networks might face congestion, affecting real-time data flow.

Environmental Interference: Terrain and environmental factors such as dense forests or urban settings can impact LoRa signal quality.

Power Source: While LoRa is low power, integrating it with GPS and multiple sensors can still drain batteries quickly, so renewable energy sources like solar might be explored.

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IV. LITERATURE SURVEY

SR. NO.	AUTHOR	TITLE	YEAR OF PUBLICATION	DESCRIPTION
1.	Kruthikaran, Nandhu, Sakthi Krishnan, Sajan P Philip	Lora-based soldier tracking and health monitoring device	Mar 2023	Today, we can see that many troops were affected by health problems. As a result, our suggested system can identify the circumstances when users are in any urgent situations or conditions outside of networked regions
2.	Shital Shinde, Madhura Nale, Prerna Sonawale, Gayatri Buddhe	Soldier Health Monitoring and Position Tracking System	May 2024	This project provides health checks and location tracking based on GPS and wireless communication for the health and safety of soldiers.
3.	Dr. B.G. Kudamble, G Naveena, L Vidya, K Vijay, C Manoj, T Venkata Prasad	Soldier Health and Position Tracking System	March-April-2024	When soldiers face a crisis, they can use devices with wireless LORA modules with temperature sensors, heart rate sensors, and other sensors to communicate with the control room to find help.
4.	Varshitha N Gowda, Sridhara M N, Madan Patel H S, Praveen S D, Nagesha D	Soldier's Health and Position Tracking System	September 2024	During any special operation or mission that's been carried out by these services, soldiers involved tend to get injured or get lost on the battlefield

[1] Paper Name: Lora-based Soldier tracking and health monitoring device

Author: - Kruthikaran, Nandhu, Sakthi Krishnan, Sanjan P Philip

Abstract: - In today's world, warfare is an important factor in any nation's security. One of the vital roles is played by the army soldiers. There are many concerns regarding the safety of soldiers. So for their security purpose, many instruments are mounted on them to view their health status as well as their real-time location. Bio-sensor systems comprise various types of small physiological sensors, transmission modules, and processing capabilities, and can thus facilitate low-cost wearable unobtrusive solutions for health monitoring. This paper gives the ability to track the location and monitor health of the soldiers in real-time who become lost and get injured in the battlefield. It helps to minimize the time, search, and rescue operation efforts of the army control unit. This system enables to army control unit to track the location and monitor the health of soldiers using GPS modules and wireless body area sensor networks (WBASNs), such as temperature sensors, heart beat sensors, etc. The data coming from sensors and GPS receivers will be transmitted wirelessly using a ZigBee module among fellow soldiers. Furthermore, LoRa WAN network infrastructure has been proposed to be used between the squadron leader and the control unit in high-altitude warzones where cellular network coverage is either absent or does not allow data transmission. The collected data will be uploaded to the cloud for further data analysis and predictions using the K-Means Clustering algorithm.

[2] Paper Name: - Soldier Health Monitoring and Position Tracking System

Author: - Shital Shinde, Madhura Nale, Prerna Sonawale, Gayatri Buddhe

Abstract: - This paper presents a smart health monitoring and position tracking

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system that facilitates the real-time position of a soldier and collects and transmits health data to the base station. The Defense Sector is the backbone of any country. In the modern era, the Indian Air Force, Indian Army, and Indian Navy play vital roles in making the security strategy of the nation. We are familiar with the attacks done by enemies on Indian soldiers, like a URI and a Pulwama. Already India has lost thousands of soldiers in this attack. In this project, for the safety purpose of troopers, several appliances and devices are attached with them to take a check on their health status. GPS is used for a place the latitude and longitude to find the exact position of a soldier. Health-related sensors like Amax30102 Heart Rate, Pulse oximeter Sensor Module, and AHT10 High Precision Digital Temperature and Humidity Measurement Module can help to make low-priced wearable solutions for health monitoring. This can help troopers enhance situational awareness and search operations. The soldier health monitoring and position tracking system permits military base units to trace the present GPS position of soldiers and also checks health parameters including body temperature, heart rate, and blood pressure. This technique will deliver both these details to the base unit. An emergency switch is also allocated to the soldier for emergency motives. The system is handy for getting the health data of soldiers and providing them with immediate help.

[3] Paper Name: - Soldier Health and Position Tracking System

Author Name: - Dr. B.G. Kudamble, G Naveena, L Vidya, K Vijay, C Manoj, T Venkata Prasad

Abstract: - The Soldier Health and Position Tracking System (SHRYS) is an integrated technological solution designed to address the multifaceted challenges associated with monitoring and ensuring the well-being of military personnel in dynamic and unpredictable operational environments. This system amalgamates state-of-the-art wearable devices, GPS technology, and health monitoring sensors to provide comprehensive real-time insights into soldiers' physical conditions and locations. The wearable devices continuously collect vital health metrics such as heart rate, body temperature, and activity levels, fostering a proactive approach to healthcare management. Simultaneously, the GPS technology enables precise and continuous tracking of soldiers' positions on the battlefield. The collected data is then transmitted to a centralized monitoring system, where advanced analytics and machine learning algorithms assess soldiers' health trends, detect anomalies, and facilitate timely medical interventions. The SHPTS aims to enhance the overall situational awareness of military commanders, optimize resource allocation, and ultimately ensure the optimal health and safety of soldiers deployed in challenging and high-risk scenarios. This innovative system stands at the forefront of leveraging technology to safeguard the well-being and operational effectiveness of military personnel.

[4] Paper Name: - Soldier's Health and Position Tracking System

Author Name: - Varshitha N Gowda, Sridhara M N, Madan Patel H S, Praveen S D, Nagesha D

Author: - In modern military operations, the ability to maintain real-time awareness of soldiers' health and positions is paramount for both mission success and individual safety. Presents a Soldiers Health and Position Tracking System (SHPTS) designed to provide comprehensive monitoring and communication capabilities for military personnel. The SHPTS integrates state-of-the-art wearable sensors, GPS technology, and secure data transmission protocols to continuously track key health metrics such as heart rate, body temperature, hydration levels, and physical exertion. Simultaneously, it records precise positional data, allowing for dynamic tracking of troop movements in real-time.

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V. FUTURE SCOPE

1. Enhanced Data Analytics with AI and Machine Learning: Integrating AI and ML models can help predict health anomalies, fatigue, or stress levels based on patterns in biometric data collected over time.
2. Integration with IoT and Edge Computing: Expanding LoRa networks to interconnect with IoT devices at the edge will allow real-time processing of health and positional data.
3. Increased Coverage and Scalability: Enhancing the LoRa network for higher ranges and scalable capacity could enable monitoring across larger regions or diverse terrains. This will be crucial for missions that require robust connectivity over a wide area without relying on cellular networks.
4. Advanced Sensor Integration: New sensor technologies could capture more detailed data, such as hydration levels, muscle strain, and mental alertness.
5. Augmented Reality (AR) and Real-Time Visualization: AR-enabled devices could show soldiers and commanders real-time health and positional data for improved situational awareness, especially in complex and dynamic environments.
6. Secure Communication and Data Privacy Enhancements: As sensitive health and positional data are transmitted, secure encryption protocols and data privacy measures will be crucial to prevent interception.
7. Extended Battery Life and Energy Harvesting: Developing energy-efficient LoRa communication modules and incorporating energy-harvesting techniques (e.g., solar or kinetic energy) could extend the device's operational life.
8. Global Positioning Enhancements and Offline Functionality.

VI. HARDWARE DESCRIPTION

1) MICROCONTROLLER (ESP32)

The ESP32 is a follow-up to the ESP8266. This low-cost system-on-a-chip (SoC) series was created by Espressif Systems. Based on its value for the price, small size, and relatively low power consumption, the ESP32 is well-suited to several different IoT applications.

2) SENSORS

A) Gas Sensor: - MQ135 air quality sensor

An MQ135 air quality sensor is one type of MQ gas sensor used to detect, measure, and monitor a wide range of gases present in air like ammonia, alcohol, benzene, smoke, carbon dioxide, etc. It operates at a 5V supply with 150mA consumption.

B) Temperature Sensor: - DS18b20

The core functionality of the DS18B20 is its direct-to-digital temperature sensor.

C) Heart rate Sensor: -

The MAX30102 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn't too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector. This method of pulse detection through light is called

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Photoplethysmogram.

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It detects pulse oximetry and heart rate signals by combining two LEDs, a photodetector, optimized optics, and low-noise analog signal processing.

D) Position tracking: - NEO-M*N GPS module

The NEO-M8 series of concurrent GNSS modules is built on the high-performing u-Blox M8 GNSS engine in the industry-proven NEO form factor.

E) LoRa Module: - Reyax RYLR998: -

The RYLR896 transceiver module features the LoRa® long-range modem, which provides ultra-long-range spread spectrum communication and high interference immunity while minimising current consumption.

SOFTWARE DESCRIPTION

MQTT (Message Queuing Telemetry Transport) is a messaging protocol that enables communication between devices over the Internet. It's a publish-subscribe protocol that's commonly used for the Internet of Things (IoT) and industrial IoT (IIoT).

CONCLUSION

A LoRa-based IoT monitoring system was implemented. We have developed a protection system that monitors the soldier's temperature, blood pressure, oxygen saturation, and electrocardiogram while also transmitting the soldier's location in an emergency. This tool aids military authorities in knowing how the soldiers are doing at the bivouac. By using geo-location to narrow the search area and begin checking as soon as the soldier's health starts to change, the rescue procedure is frequently made more effective. Because this technology can be used without network restrictions, it can be of considerable assistance to military troops during combat and rescue operations. And our warriors are protected by this system.

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