



Design And Simulation Of Lorawan Based Soldier Health Detection And Position Tracking System (Low Power And Long Range Access)

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Abstract:

The design and simulation of a comprehensive health monitoring and position tracking system for soldiers, developed using IoT technology and tested in Proteus. Targeting the limitations of traditional military tracking systems, this solution integrates an STM32F401CB microcontroller with sensors and utilizes the LoRa SX1278 module for long-range, low-power data transmission. Due to Proteus simulation constraints, real-time visualization was limited, with only GPS functionality successfully validated through NMEA sentence display. Nevertheless, this scalable system demonstrates strong potential for real-time health monitoring and position tracking, promising enhanced safety and rapid response capabilities for soldiers in remote military operations.

Keywords: LoRaWAN, IoT, Soldier Health Monitoring, Position Tracking, STM32 Microcontroller, Long-Range Communication, GPS NMEA Sentences, Remote Military Operations, Low-Power Solution, Proteus Simulation, Real-Time Monitoring.

1.Introduction:

In military operations, the health and safety of soldiers in remote or hostile environments are of paramount importance. Ensuring effective real-time monitoring and rapid response capabilities can be challenging, especially in situations where traditional military tracking systems are limited in range, power efficiency, and adaptability. Continuous monitoring of vital health parameters and location tracking are essential to provide immediate support and improve soldier safety in the field.

To address these needs, this study proposes a scalable, low-power health monitoring and position tracking system specifically designed for military use. The system leverages LoRaWAN (Long Range Wide Area Network) technology for long-range communication, allowing for efficient data transmission across extensive distances with minimal power consumption. The design integrates an STM32F401CB microcontroller with sensors that monitor vital health parameters such as body temperature, heart rate, oxygen levels, and environmental gas concentrations. GPS tracking is also incorporated, enabling precise location tracking of soldiers in real time.

Developed and simulated in Proteus, this system was tested to assess its feasibility and effectiveness in military scenarios. Although real-time sensor data visualization was constrained by simulation limitations, GPS location data was successfully validated, demonstrating the system's functionality in position tracking. The simulation environment also provides a cost-effective, flexible means to refine and validate the system's architecture prior to hardware implementation, supporting a seamless transition to physical deployment in the future.

This work offers a foundational step towards a deployable monitoring solution that can enhance soldier safety, optimize resource usage, and provide reliable health and positional data in challenging field conditions. The proposed system holds significant promise for improving communication, monitoring, and intervention capabilities in modern military operations.

2. Literature Survey:

Gayathri Durga Harish et al. (2023) presented a LoRaWAN-based system for tracking soldiers' health and position. The system continuously monitors vital signs, including oxygen levels, heart rate, and body temperature. It is designed to ensure long-range communication between soldiers and the control room, allowing for timely medical attention during emergencies. However, while the system shows promise, its practical implementation and simulation details are not thoroughly explored [1].

Arshad et al. (2022) developed a LoRaWAN-based smart agriculture decision support system, which offers insights into low-power, long-range communication techniques. While the system is focused on agriculture, the communication framework can be adapted for military use. However, the study lacks the military-specific health tracking and environmental considerations necessary for field applications [3].

Garg et al. (2021) proposed a wireless sensor network-based health monitoring system for mountaineers in extreme environments. This system monitors vital parameters without relying on Wi-Fi and uses a low-power communication module. The solution offers reliability in challenging terrains but does not address real-time data processing or the specific communication needs of soldiers during critical military missions [8].

Bhattacharjee et al. (2021) introduced the "Soldier Strap," which is a wearable system equipped with multiple sensors to collect health data such as heart rate and temperature. The data is transmitted using LoRaWAN to ensure seamless communication over long distances. This system also integrates NavIC for precise tracking of the soldiers' location. Although this system enhances monitoring capabilities, the focus remains on hardware implementation without exploring extensive simulation techniques [2].

Akash et al. (2020) developed an IoT-based real-time health monitoring system using Proteus for design and simulation. The system focused on tracking vital health parameters like heart rate and body temperature. It employed an Arduino Mega to collect data from sensors, displaying real-time results on an OLED screen and transferring data to a mobile application for remote monitoring. The use of Proteus helped validate the system's functionality, ensuring seamless integration of hardware and software components for efficient health tracking [12].

3. Proposed Approach:

Building upon the limitations of the existing systems, this work proposes a design and simulation of a LoRaWAN-based Soldier Health Detection and Position Tracking System using Proteus software. Unlike prior research, which focuses primarily on hardware implementation or generic communication techniques, the proposed system simulates real-time health monitoring of soldiers (including oxygen levels, heart rate, and temperature) using IoT sensors integrated with the STM32F401CB microcontroller. The system incorporates an SX1278 LoRa module for long-range communication and GPS for precise location tracking. Simulation in Proteus allows for comprehensive testing of the system's performance, including sensor data acquisition, transmission to control rooms, and display on the LM016L LCD. This approach offers a cost-effective and scalable solution for military applications, addressing both health and communication challenges in remote battlefields without the need for immediate hardware deployment.

Block Diagram:

The proposed soldier health detection and position tracking system consists of an STM32F401CB microcontroller, various sensors, a LoRa SX1278 module, and a GPS module for real-time monitoring.

Components:

Microcontroller (STM32F401CB): Central control unit.

DHT11: Temperature and humidity.

MAX30100: Heart rate and oxygen levels.

MQ7: Gas detection.

LoRa SX1278 Module: Long-range data transmission.

GPS Module: Location tracking.

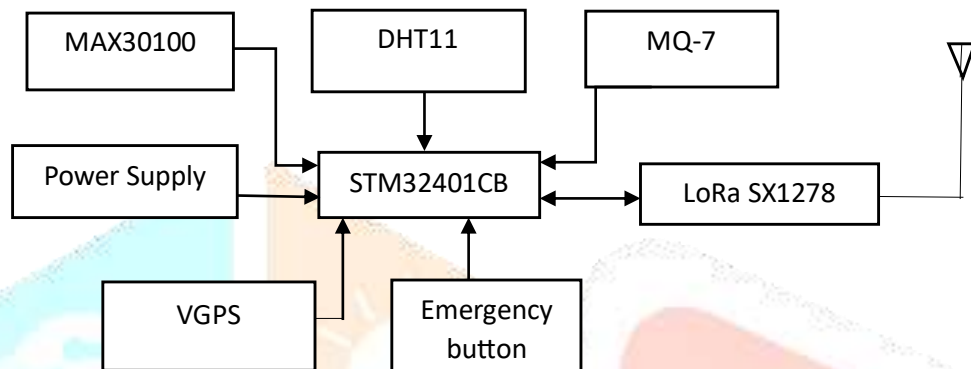
Transmitting Section:

Fig 1: Block Diagram of Transmitting Section

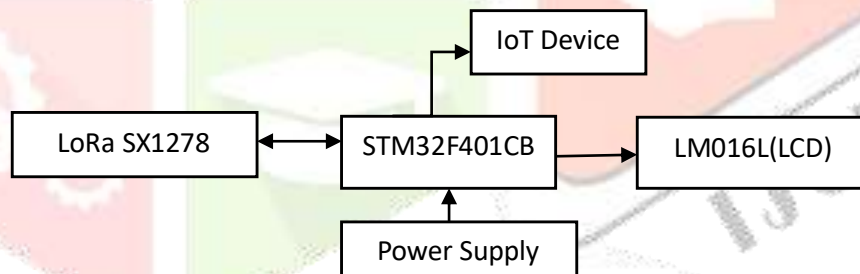
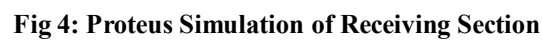
Receiving Section:

Fig 2: Block Diagram of Receiving Section

Simulation in Proteus

Proteus software was used to simulate and virtually test each component. The STM32F401CB microcontroller processes sensor data, with outputs displayed on an LCD. The simulation confirmed GPS data, displaying NMEA sentences, but Proteus constraints limited real-time sensor output visualization for other health parameters.



4. Results :

In the simulation of the proposed LoRaWAN-based Soldier Health Detection and Position Tracking System, the following results were observed:

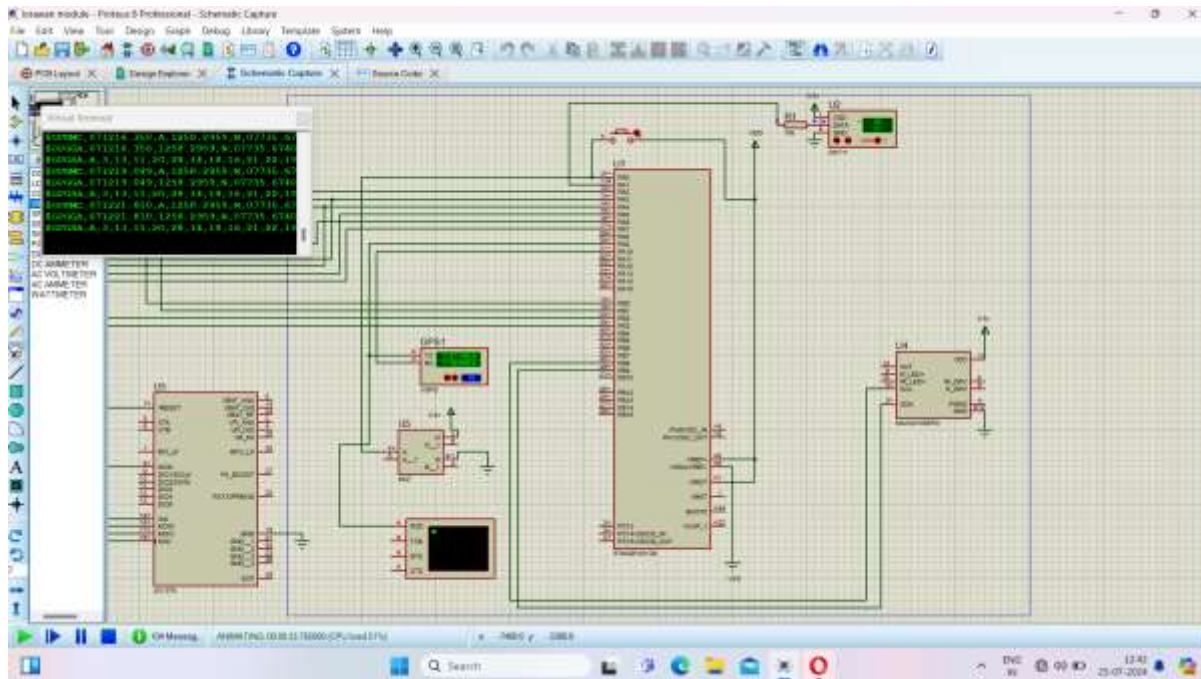


Fig: GPS NMEA sentences in Proteus

1. GPS Data Output:

The GPS module successfully displays NMEA sentences in the virtual terminal, confirming the functionality of real-time location tracking. This output serves as proof of GPS integration with the STM32 microcontroller, enabling accurate position tracking for field monitoring.

2. LoRa SX1278 Communication:

The LoRa SX1278 module is integrated for long-range data transmission between the soldier's device and the control room. While actual sensor values were not displayed due to default configurations in the Proteus simulation, the design is intended to enable transmission of health data, such as temperature, heart rate, oxygen levels, and gas concentration, over long distances using LoRa communication.

The module's inclusion demonstrates the system's potential for reliable, low-power communication across a wide area, essential for remote monitoring applications in military settings.

3. Expected Sensor Outputs:

Due to simulation constraints, real-time sensor readings (temperature, heart rate, oxygen levels, and gas concentration) were not visualized on the LCD or virtual terminal. However, the system is designed to support these outputs, and expected values are presented below as hypothetical data to illustrate the intended functionality of the system.

Table 1: Hypothetical Data Output(Simulated Data)

Parameter	Hypothetical Value
Temperature	36.5°C
Heart Rate	75 bpm
Oxygen Level(SpO2)	98%
Gas Concentration	0 ppm

Note: The above values are intended to represent the system's design capabilities rather than actual data from the simulation.

5. Conclusion:

The design and simulation of a LoRaWAN-based Soldier Health Detection and Position Tracking System demonstrate significant potential to improve safety and monitoring for military personnel in the field. The system successfully integrates GPS for real-time location tracking, confirmed by the GPS data output in the Proteus simulation.

The LoRa SX1278 module is critical to the system's architecture, providing low-power, long-range communication for transmitting soldier health data to a remote control center. Although Proteus simulation limitations prevented real-time display of sensor values, the design is intended to support comprehensive health monitoring, including parameters like temperature, heart rate, oxygen levels, and gas concentration.

Future work with actual hardware or advanced simulation tools would enable full testing of the LoRa communication and sensor data transmission, further validating the system's robustness. This scalable, efficient, and reliable design has strong potential for field applications in military healthcare, supporting remote monitoring in challenging environments.

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