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Military Soldier Health Monitoring System

Project Report

P15

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1.0 Background

During the wartime period in Sri Lanka, soldiers lacked a monitoring system that could indicate their status whether they were alive, injured, or had been shot. This absence of tracking meant that even locating the bodies of fallen soldiers was often impossible. Additionally, there was no tool to monitor their health status and relay this information to headquarters. If a military base was under attack and all soldiers were injured or killed, there was no system in place to alert headquarters. This lack of real-time monitoring reduced the chances of defending the base against opponents, as senior officers were unable to send reinforcements in time [1,2].

This issue is not unique to Sri Lanka. It represents a global military challenge. Since World War II, military forces have recognized the strategic value of monitoring systems for fleet management, navigation, positioning, and targeting. Location monitoring has gained significant attention, especially with the rise of wireless technologies and embedded systems [3,4].

During wars and search and rescue missions, soldiers usually get serious injuries or even lose their lives. Implementing real-time monitoring and tracking technology is essential to improve their protection. That kind of technology helps prevent serious injuries by minimizing search operation time and enabling timely rescue efforts. Moreover, GPS devices at base stations are crucial to accurately locate soldiers, ensuring both their safety and the defense of military bases [5,6].

According to the recent advances in Arduino-based health monitoring systems, it is possible to combine sensors for lively signs and location tracking into small, wearable devices. These systems are energy-efficient, and they can transmit real-time data to centralized control rooms, and it makes them ideal for battlefield conditions [7]. Coordination, responsiveness, and soldier welfare in military operations will be improved by these technologies.

2.0 Problem and Motivation

2.1 Problem

Soldiers willingly risk their lives for their nation, yet during special operations, many become lost or die unidentified on the battlefield. This lack of tracking not only leaves the army vulnerable but also means the situation on the battlefield often remains unknown until soldiers return to base. Additionally, soldiers' health statuses frequently go unmonitored, and without timely medical assistance, minor injuries or infections contracted during combat or training can escalate, sometimes with fatal consequences. These challenges affect all branches of the armed forces.

To address the uncertainty of the battlefield, we must ensure that every soldier is safe and accounted for. Due to the lack of real-time monitoring, this often does not happen. Many of the casualties have been determined to be due to a lack of prompt medical assistance rather than a direct enemy attack. As a result, finding a mechanism to track these soldiers becomes critical. Therefore, implementing a mechanism to track soldiers' vital signs and locations is essential to ensure their safety and enable prompt intervention when needed.

2.2 Motivation

In addition to enemy threats, soldiers face numerous environmental and physical dangers that endanger their health and safety in the harsh conditions of the battlefield. Without a trustworthy monitoring system, critical delays in providing aid often put soldiers' lives and mission success at risk. Despite their commitment and selflessness, soldiers currently lack a system that can track their location and health in real time, a capability that could be vital in the event of illness or injury. By enabling prompt responses to medical emergencies, such a system would enhance military operations coordination, facilitate timely medical interventions, and increase the likelihood of successful mission outcomes.

Our dedication to protecting the lives of those who serve drives us to pursue this endeavor. Our goal is to provide military personnel with a reliable safety net by introducing a wearable device that continuously monitors their health and transmits real-time location updates. This device offers commanders and medical team’s instant insight into soldiers’ conditions, empowering them to make quick, informed decisions in critical situations. By setting up a new benchmark for military health and safety protocols, our proposed solution aims to increase mission resilience and efficiency, while also improving the welfare of individual soldiers.

This device is designed for dependable, energy-efficient remote health monitoring and position tracking. Through real-time transmission of sensed and processed data, it enables the army control room to track essential vital signs, such as heart rate and body temperature, using body sensors. Additionally, by monitoring soldiers’ navigation from one to another and tracking their health statuses, army staff can prepare more effective battle strategies, strengthening the military's overall coordination and strategic response.

The benefits of this system are profound:

- **Improved Soldier Safety and Survival Rates**: The real-time monitoring of vital signs means that any sign of health deterioration or injury can be detected immediately. In such cases, medical support can be dispatched quickly, reducing the risk of complications or fatalities that might arise from delayed assistance.

- **Enhanced Tactical Decision-Making**: By providing insight into soldiers' locations and health statuses, commanders can prepare battle strategies that consider each soldier's physical readiness and proximity to others. This situational awareness not only optimizes coordination but also supports more effective responses to battlefield dynamics.

- **Increased Mission Resilience and Efficiency**: A system that ensures prompt medical intervention and quick responses to emergencies significantly boosts the resilience and efficiency of military operations. This fosters a well-coordinated force that is better prepared to achieve mission success.

3.0 Aim and Objectives

3.1 Aim

The main aim was to create a Health Monitoring and Location Tracking System for soldiers to maintain constant real-time communication between the headquarters and the on-field soldiers. For this purpose, we have used a system which aims to measure the heart rate and the body temperature of the soldier, and the location and transmit this information to the army headquarters. For this purpose, heartbeat sensor, temperature sensor (LM35), GPS Model and Node MCU ESP-32 as the processors.

This system aims to track the heartbeat, temperature, and location of the soldier. The location will be tracked using the GPS module. Heartbeat, temperature will be tracked using a pulse rate sensor, LM35 sensor respectively.

Lots of soldiers are facing many problems such as communication with the control room and no proper medical help at a proper time which leads to the death of the soldier. To minimize such cases, we have proposed a continuous alert system to track location and monitor the health of the soldiers. The proposed system is very useful in detecting the location of the soldier in real time using GPS and communicating the health status using parameters embedded in the microcontroller. The tiny sensors can be attached to a soldier's gloves to monitor body parameters and send information to the control center when the body rate drops below a preset threshold.

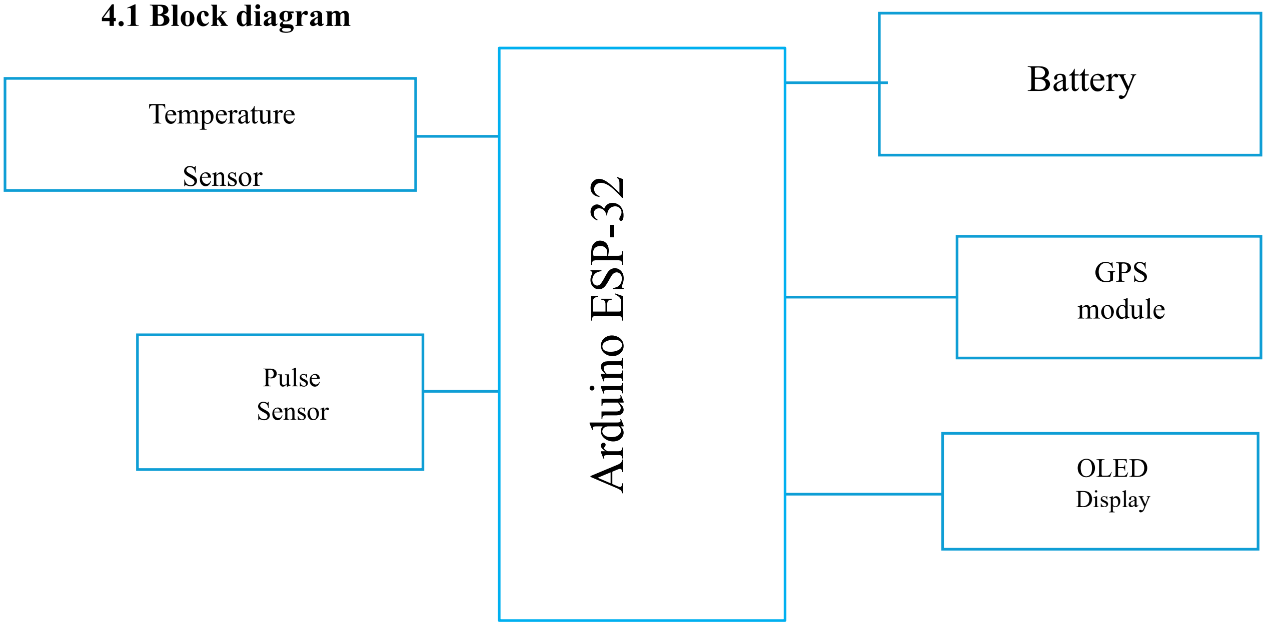
3.2 Objectives

The primary objective of creating a health band for military soldiers equipped with a temperature sensor and a pulse sensor, along with GPS tracking, is for ensuring their safety and well-being.

1. Real time health monitoring is done by the military base from the time the soldier wears
2. This provides the location data to track down the soldier’s movement and position so that in case of emergency a rescue team can be sent.
3. We can ensure that soldiers are physically fit for their mission.

4.0 System Diagram

4.1 Block diagram



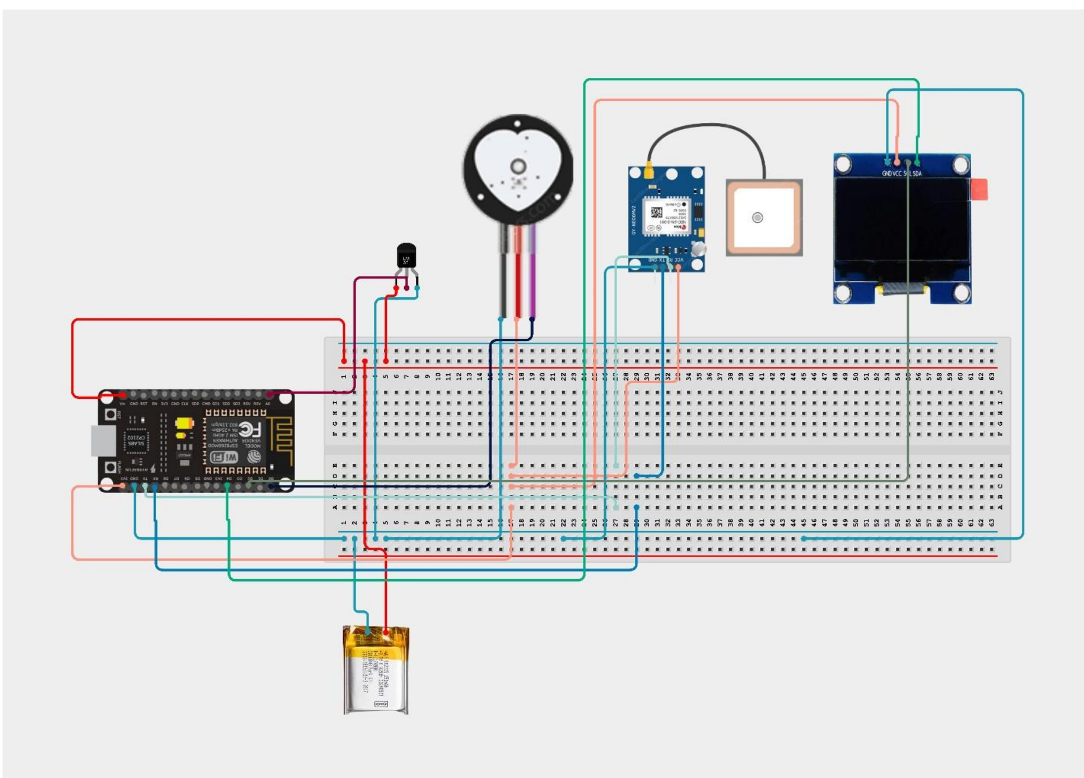


Figure 1: System Diagram

5.0 Methodology

5.1 Design

The Overall Design of our system consists of the following phases

(01) Setup the Components

- ESP-32: A potent microcontroller with Bluetooth and Wi-Fi integrated. It manages, processes, and transmits sensor data to the control room, acting as the system's central processing unit.
- Pulse Sensor: This sensor detects blood flow through the skin to determine the soldier's heart rate. The measurements aid in keeping an eye out for any indications of stress or unusual heart rates that might lead to medical problems.
- Temperature Sensor: Determines the soldier's body temperature, which aids in keeping an eye out for possible fever or hypothermia, two conditions that can pose major health hazards in a variety of settings.
- GPS Module: Offers real-time location information, which is crucial for monitoring a soldier's whereabouts and reacting to crises.
- OLED Display: Provides pertinent information, including location, temperature, and heart rate, so the soldier may verify their own health measurements if needed.

(02) Designing the Hand

• This entails creating a wristband or wearable band that the soldier can wear with ease. Strong, waterproof, and able to survive challenging military conditions are all requirements for the design.

(03) Assembling the Components

• Physically fastening every sensor and gadget to the enclosure or wearable band. For longevity and functionality, proper assembly is essential, guaranteeing that every part is firmly in place for the best possible data collecting and security.

(04) Wiring the System

• Attaching all parts (sensors, GPS Module, OLED screen) to the ESP-32, making sure the wiring is sturdy, properly insulated, and doesn't impede the soldier's comfort or mobility.

(05) Coding

• Writing the software code that will manage sensor data collecting, process and show data on the OLED, control the ESP-32, and interface with the control room. Coding consists of:

• Data acquisition: Analyzing temperature and pulse sensor inputs.

• Data processing: Accurately filtering and processing sensor data.

• Communication: Using Bluetooth or Wi-Fi to send processed data to the control room.

• Display logic: Using the OLED to present data in an understandable manner.

(06) Getting the Location Status

•Utilizing the GPS Module to obtain real-time location data. This function ensures that the control room can continuously monitor the soldier's location, which is crucial for responding to emergencies or tactical movements.

(07) Getting Health Status by Using Pulse Sensor and Temperature Sensor

• Taking the soldier's temperature and pulse on a regular basis to track their health. This data aids in the identification of any unusual medical conditions, such as fever, hypothermia, or increased heart rates, which may be signs of disease, stress, or injury.

(08) Collecting Data and Location

• Combining information from the GPS, temperature, and pulse sensors to create a comprehensive profile of the soldier's whereabouts and health. This information may be transferred to the control room on a regular basis for logging and analysis, and it is essential for continuous monitoring.

(09) Checking the Accuracy of the System with Medical-Grade Devices

•Testing the system's sensors (pulse and temperature) against medical-grade devices to verify accuracy. This step is critical for ensuring that the health data provided by the system is reliable and within an acceptable range.

(10) Communicating from the Health Band to the Control Room

• Implementing a communication protocol to send data from the health band to the control room in real-time. This may use Wi-Fi, Bluetooth, or another wireless communication standard supported by the ESP 32. The control room can use this data for live monitoring and emergency responses if necessary.

Each phase ensures the system is robust, reliable, and capable of monitoring soldiers' health and location effectively, enhancing safety and readiness.

5.2 Hardware Requirements

1. ESP-32:

Figure 2: ESP-32

Our project's main controller, the ESP-32, controls wireless communication, processing, and computations. Express if Systems created this adaptable microcontroller, which is well-known for its robust features and excellent performance, making it perfect for Internet of Things applications.

The ESP-32 is ideally suited for remote monitoring and control because of its dual-core processor, built-in Wi-Fi, and Bluetooth capabilities, which enable wireless communication. Its numerous I/O ports, digital-to-analog converters (DAC), and analog-to-digital converters

(ADC) also offer versatility in connecting sensors and actuators, enabling effective data processing and gathering. Because of its low-power modes, which improve power efficiency when the device is idle, the ESP-32 is also perfect for battery-powered applications.

2. Heartbeat Sensor/Pulse Sensor:

Figure 3: Heartbeat Sensor

One of our project's main sensors for health monitoring. There are three major pins on the pulse sensor. the output pin, ground, and VCC. The four pins in the simulation version are the test pin, the other three being the ones already specified. We utilize the test pin because we are unable to physically verify whether the pulse is present.

3. LM35 Temperature Sensor:

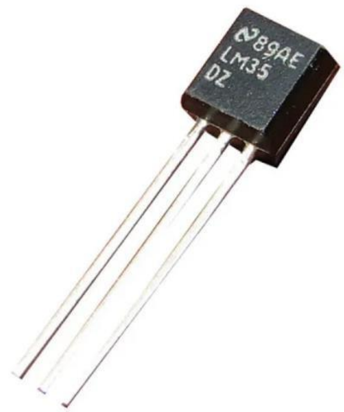


Figure 4: LM35 Temperature Sensor

A common three-pin precision centigrade temperature sensor is the LM35. On the battlefield, it is utilized to take our soldiers' temperatures, as the name implies. It has three pins as normal. Output, Ground, and VCC.

4. GPS Module

Figure 5: GPS Module

The GPS Position Tracking Module for Arduino is another crucial sensor that we have utilized. Four pins are on it. Ground, VCC, and two Tx and Rx pins for data transfe

5. OLED Display

Figure 6: OLED Display

The OLED display is used to show real-time information about the Military Soldier such as heart rate, body temperature, and GPS location. It provides a clear visual with low power consumption which is suitable for outdoor military conditions.

6. Li-Polymer Battery

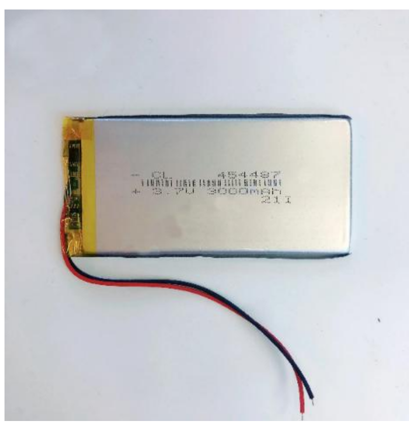


Figure 7: 3.7V Li-Polymer Battery

The Li-Polymer Battery will be used to power up each hardware component that helps in updating and monitoring a soldier's health in real time and updating their location and giving important updates about the soldier to their headquarters.

5.3 Strategic Developments

1. Micro Solar Panel

Figure 8: Micro Solar Panel

This is a further improvement that we are expecting to include in our Military Soldier Health Monitoring System that will help to charge the 3.7V Lipo (Lithium Polymer) battery which will help to keep the system running and help to keep every health condition updated while also updating the soldier location to the headquarters. Additionally, this will help with ongoing missions that will take more than a day when soldiers may not be able to return until the mission is complete therefore this micro solar panel will be a good addition to keeping the system running for days without stopping at any point.

2. IR sensor (Infrared Sensor)

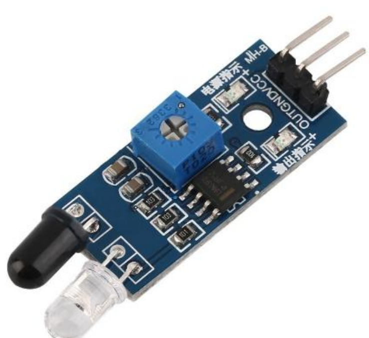


Figure 9: IR Sensor

This is also a further enhancement that we are expecting to use and improve our Military Soldier Health Monitoring System where this IR sensor Infrared sensor will use infrared light to detect objects and measure distances. Therefore, this will help us to find locate and find lost soldiers in case if their wearable glove is removed due to any damage occurred during the war or in a mission where the headquarters will be able to find the missing soldiers' location through the help of this Sensor.

6.0 Evaluation method

1. System Design Verification

Before verifying the design, the components (ESP32, Pulse Sensor and Temperature Sensor) should be integrated and function as expected.

- **Testing:**
  - Each sensor and components needed to be tested independently before integration
  - Ensuring that the ESP32 Module can read the data from the pulse and temperature sensors and send it to the Army headquarters for monitoring.
  - Testing the GPS module to track the location of the soldiers.

2. Performance Testing

Testing the accuracy of the sensors by trying them and comparing them with standard measurements and with medical grade devices.

- **Testing:**
  - Measure the pulse rate and the temperature and compare it with the standard readings and with medical grade device.
  - Pulse Sensor: Test the heart rate accuracy across various conditions
    1. While resting
    2. With a Light exercise
    3. With high weight activity
  - Temperature sensor: Check accuracy in different environmental conditions such as in
    1. Cold
    2. Warm
    3. Normal

3. Other equipment testing and Configuration.

- Ensure the batteries work perfectly and the device can operate reliably over extended periods without frequent recharging.

- Ensuring that the transmitting data is secure without getting interrupted during the battlefield.

- Finally, after testing all the weaknesses, reliability issues solve them and improve it.

4. Field testing

The health band to get the data without any interference and test that the data can be displayed in real time.

This evaluation method will help to make the device work properly and reliable health band.

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