

LifeLine: Smart Soldier Health Monitoring and Situational Awareness System Powered by ESP8266 and IoT Integration

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Abstract—The army, navy, and air force are among the armed forces that mainly depend on soldiers, who frequently face grave dangers in combat. Numerous soldiers die as a result of delayed medical attention or poor communication during missions. The purpose of the Health Monitoring and Tracking is to address issues by Plan for Troops An innovative and effective way to improve safety and operational preparedness is to use ESP8266. In addition to oxygen saturation, this system uses wearable IoT-enabled devices to continuously monitor blood pressure, body temperature, heart rate, and other critical health parameters. The soldier's exact location is tracked by GPS technology, which guarantees situational awareness and safety. Rapid responses and prompt medical intervention are made possible by the wireless transmission of data from calm devices to a central command unit for real-time analysis. While continuous updates advance coordination and decision-making throughout missions, automated alerts inform command and medical staff of anomalous conditions. In order to improve early risk detection, future developments may incorporate AI and machine learning predictive health assessments. Techniques for data encryption can be used to guarantee secure communication in vital military applications. Comprehensive situational awareness can be achieved by adding more sensors for environmental variables like temperature and air quality. This plan offers real-time monitoring and smooth communication, even in remote and dangerous environments, which greatly increases soldier safety, lowers health risks, and guarantees operational effectiveness. It creates a strong basis for upcoming developments in military health monitoring systems.

Keywords—Health Monitoring System, Soldier Safety, ESP8266 Microcontroller, IoT-enabled Wearable Devices, Real-time GPS Tracking, Military Health Surveillance, Predictive Health Assessment and Operational Readiness.

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I. INTRODUCTION

Among the world's militaries, India's 1,200,255 active personnel and 990,960 reserve troops make it the third biggest standing army. There is a significant problem for the army because there is no way to know how many soldiers have been injured, which could lead to an increase in the number of casualties and disabilities. Casualties on the battlefield are more often attributed to injuries than to direct attacks [1, 2]. If the control room had access to real-time information regarding the soldier's health and whereabouts, these numbers could be minimised [3 and 4].



Fig.1. Health Monitoring besides Tracking System for Soldiers.

Concerns about the security of troops are numerous. There are a number of significant safety concerns, including

knowing where troops are at all times, not being able to maintain constant connection with the control room, not having access to urgent medical treatment, and conducting operations in varied geographical situations [5].

Over the past few decades, the most popular methods for monitoring soldiers' whereabouts on the battlefield have relied on technologies including cable-based systems, RF transceivers, walkie-talkies, ZigBee, and GSM-based tracking systems. Nonetheless, there were a number of issues with each of these systems, including theft, signal loss, high noise, and expensive installation costs [6]. To save lives on battlefields, there is an immediate need for a dependable, portable, wireless tracking device that is both cheap and easy to use. In addition, the mechanism in question needs to be real-time in order to launch efficient rescue operations without delay. This work proposes a portable real-time tracking system that is motivated by these difficulties. The idea of the Internet of Things stands at the foundation of the suggested system. The suggested technology will be useful for tracking the whereabouts and vital signs of soldiers in real time [7].

This paper details the development and deployment of an ESP 8266-based health monitoring and tracking system system's ability to for as troops. The system incorporates internet of things (IoT), global positioning system (GPS), and wireless system's ability to communication technologies to system's ability to and offer round-the-clock health

monitoring in combat zones [8 and 9]. Quick response times in are made possible by the track locations, monitor vital signs in real-time, and environment. The article delves into the system design, communication of as protocols, besides prospective improvements [10].

II. RELATED WORKS

A flexible thermoelectric fabric made of MXene that can accurately detect strain and temperature stimuli was suggested by Peng et al., [11]. An adhesive polydopamine (PDA) layer is created and applied surface nylon fabric in order to do this. This layer then easier to attach hydrogen bonding. An MXene thermolectric fabric with superior strain and temperature sensing capabilities is the end product of this fusion. The thermoelectric fabric made of MXene has by exceptional cyclic by stability besides temperature detection capabilities; it also has great sensitivity, fast response time (60 ms), and extraordinary strain sensing endurance (3200 cycles). Furthermore, this MXene thermoelectric fabric can precisely detect the respiration rate of the wearer by turning the body's heat into electrical energy when to at as attached to a mask, all thanks temperature differential between the wearer and their surroundings. Furthermore, the thermoelectric fabric made of MXene can detect the condition of the body's joint by stretching itself. Additionally, it may transform solar energy into heat. In light of these results, thermoelectric fabric based on MXene shows considerable potential for use in energy production, tracking of mobility, and health monitoring.

For a clear picture of where the field is at the moment, Fayyad et al., [12] summarises the fly-by SHM method by combining scientometric analysis with qualitative systematic literature reviews. Our study's unique addition is that it categorised the literature on fly-by SHM into four distinct groups: (1) using unmanned aerial vehicle (UAV) technology for vision-based monitoring; (2) combining drones with AI, advanced sensor technologies, and automation; (3) using drones for SHM with modal analysis, energy learning; besides (4) using robots and automation in drones for SHM. The study outlines the current state of fly-by SHM research, identifies research gaps, and proposes new routes for future studies by integrating modern technologies including sensors, artificial intelligence, and machine learning with the fly-by technique.

A novel, reliable framework for cloud-based remote patient monitoring has been proposed by Ebadinezhad and Mobolade [13] for the purpose of detecting health concerns through the Internet of Things (IoT). The study stands out from other real-time frameworks because it considers the patient's temperature, heart rate (BPM), besides blood oxygen saturation (SpO2) all at once. The software and hardware system are developed and tested through six primary stages. To make sure the tactic was effective, BOT-IoT databases. As a result of proving that the proposed framework achieves better decision times (16.3 seconds for 46 features, with 100% accuracy) than earlier comparison protocols, patient satisfaction, data security, and healthcare results are all enhanced.

A health monitoring system has been constructed using an ESP8266 microcontroller (ESP01), a MAX30100 pulse oximeter, an LM35 OLED display (Chavan et al.,) [14]. The gadget keeps track of critical health indicators like temperature, SpO2, and BPM (heart rate). For remote monitoring, the Thing Speak platform receives data at regular intervals and responds in real-time via an OLED screen. This approach offers a quick and easy way to keep tabs on your health. With this technology's user-friendly health tracking features, proactive health management can be made possible. Future updates may include more sensors for comprehensive health monitoring and integration with mobile applications. This approach is light years ahead of the competition in terms of personal health monitoring and proactive health management.

The authors Al-Ali et al. [15] suggest an IoT-based bridge health status monitoring and warning system that is wireless, cheap, long-lasting, and easy to use. The proposed method takes engineering standards and guidelines into account when classifying bridge health status as "excellent" or "collapse condition." It makes use of infrared light, temperature, vibration, and deflection sensors as well as an IoT network and a fuzzy logic system. The primary objective is to improve transportation safety, reduce maintenance costs, and lengthen bridge lifespans through the use smartphone app as an early warning system. By integrating with Google Maps, an interface provided for viewing live traffic footage and the current status of the bridges. The proposed system was validated through the construction and evaluation of a three-dimensional model. The outcomes actual testing logic algorithm validated accurately assessed the bridge's health status, which was simulation results.

III. PROPOSED MODEL

The ESP 8266 microcontroller is used in the proposed Health Monitoring then Tracking System for Soldiers provide continuous real-time health monitoring and precise tracking through an integrated, automated approach. Even in remote environments, soldiers' well-being is continuously monitored thanks system's ability gather, process, and transmit vital health data.



Figure.2. Health Monitoring and Tracking Scheme for Soldiers Using ESP 8266.

The ESP 8266 microcontroller, an affordable, low-power, Wi-Fi-enabled device, is the central component of the system. To interface with a variety of wearable sensors that

measure vital signs like heart rate, blood pressure, blood oxygen saturation (SpO₂), and electrocardiogram (ECG) signals, the ESP 8266 is programmed machines, and pulse oximeters, continuously gather data from the soldier. The microcontroller processes this data to eliminate noise and guarantee accuracy.

Through a secure Wi-Fi connection, the microcontroller's built-in Wi-Fi module enables wireless transmission of the health data to a distant server. This makes it possible for vital signs to be transferred in real time to the server, where they are saved for later analysis in a database management system (like MySQL). To track soldiers' health, the system is set up with a web-based interface that authorised personnel, like military commanders or medical teams, can access. In the event of an emergency or health anomaly, the interface's user-friendly format allows for prompt action to be taken.

When it comes to system configuration, the ESP 8266 receives to wearable sensors and processes the as data locally before transmitting it. By connecting the microcontroller to an accessible network, the Wi-Fi module sends the distant server, where web-based platform allows for secure access. Long-lasting batteries power sensors and microcontroller, guaranteeing continuous as monitoring throughout missions.

Wearable sensors are deployed on soldiers during field operations as part of the experiment setup, and real-time data is transmitted back to the central server. Proactive medical intervention is made possible by the remote server's data analytics capabilities, which enable the identification of trends and abnormal health patterns.

Real-time tracking and monitoring, better health data accuracy, and increased situational awareness for military personnel are few benefits system. The system offers scalable communication through Wi-Fi besides makes use inexpensive yet dependable microcontroller (ESP 8266) provides a reliable solution for ongoing health surveillance field. By delivering vital data and enhancing soldiers' general safety and preparedness, architecture guarantees system will continue to be economical, effective, and flexible enough to meet the demands military organizations.



Figure.3. Block diagram proposed classical.

Health Monitoring and Tracking System for Soldiers Using ESP 8266: This paper is aims to provide a comprehensive health monitoring and tracking solution for soldiers operating in high-risk environments, utilizing the ESP 8266 microcontroller sensors and IoT technologies. The system is designed to continuously track soldiers' parameters such temperature, blood pressure, heights, while also providing real-time site tracking for improved situational awareness. The next ladders outline approach achieving this scheme:

A. Data Collection (Sensor Inputs)

- **DHT11 Sensor:** This sensor is used to measure the soldier's body temperature. It provides real-time temperature readings, which critical for detecting abnormal health conditions such as fever or hypothermia.
- **Blood Pressure (BP) Sensor:** This sensor is used to monitor the soldier's blood pressure, helping detect potential health risks such as hypertension or hypotension.
- **Oxygen Level Indicator (SpO₂ Sensor):** This sensor measures the oxygen saturation levels in the soldier's blood, enabling the detection of respiratory issues such as hypoxia.

B. Data Processing and Transmission (Controller - ESP 8266)

- The ESP 8266 microcontroller serves as the central hub of the system. It collects data from the DHT11, BP, besides oxygen level sensors, processes ensure accuracy, besides sends it wirelessly via Wi-Fi remote server storage and analysis.
- The ESP 8266 programmed using the Arduino IDE to interface with the sensors, filter data, and handle wireless transmission over the Wi-Fi network.

C. Location Tracking (GPS Module)

- The GPS module tracks the soldier's real-time geographic location. This information is critical for ensuring the soldier's safety and situational awareness during operations, as it allows commanders to know precise whereabouts of each soldier at altogether times.
- The GPS data is transmitted along parameters to the remote server, pretty decision-making in addition emergency reply capabilities.

D. Real-Time Alerts (Buzzer)

- In the event that any health parameter falls outside of predefined normal ranges, the scheme triggers an alert. This has been achieved using a buzzer that provides an instantaneous auditory signal to the soldier or nearby personnel, indicating the intervention.
- The buzzer is activated if the soldier's temperature, blood pressure, or oxygen saturation levels are abnormal, signaling potential medical emergencies.

E. Data Storage and Remote Monitoring (IoT Integration)

- The health data from all sensors, along with the GPS location data, is stored in an IoT-based platform. This platform continuously monitors and facilitates data retrieval for analysis and medical intervention.
- The IoT system provides cloud-based storage, making the health data accessible to authorized personnel for decision-making, even in remote areas without direct communication infrastructure.

F. System Benefits and Future Advancements

- **Enhanced Operational Efficiency:** The system facilitates better decision-making during missions by offering real-time health updates and location data.
- **Data Encryption and Security:** The integration of advanced encryption techniques will ensure the security and confidentiality of the transmitted data, which is crucial for military applications.
- **Predictive Health Monitoring:** Future advancements could incorporate AI and machine learning models to predict health issues before they occur, allowing for preventive care and reducing the risk of medical emergencies.
- **Improved Soldier Safety:** By continuously monitoring vital signs and providing location tracking, the system enhances soldier safety and allows for prompt intervention in case of medical emergencies.

Through continuous monitoring of soldiers' health parameters and location, combined with real-time alerts and IoT integration, this system progresses as a solution for soldier safety and operational readiness. It provides an efficient solution for health tracking in remote and hostile

environments, where traditional communication besides healthcare systems may not be available.

IV. RESULTS AND DISCUSSION

From the above figure, using an ESP8266 Wi-Fi Module with a 32-bit RISC microprocessor. Digital temperature and humidity sensor module with a humidity range of 20-95% RH and temperature measurement range of 0-50-degree C. Pulse Oximeter MAX 30100 module. Blood pressure C2C3R2 R1 Module. Active buzzer module with a resonant frequency of 2500HZ. NEO-6M-0-001, GY-GPS6MV2 module with a baud rate of 9600bps as default.

A. Circuit diagram of the proposed model

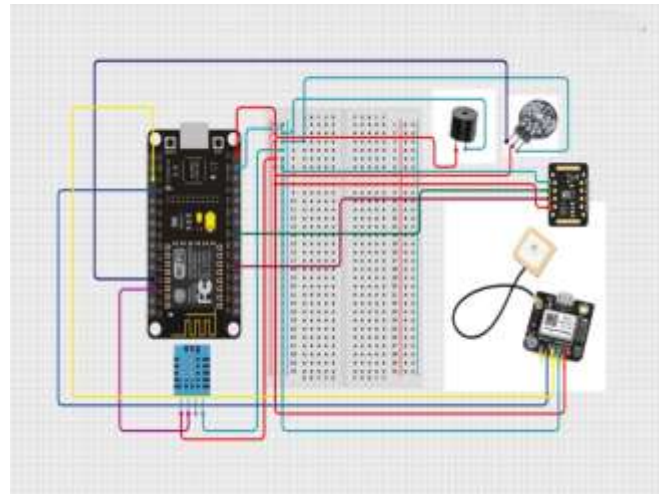


Figure.4. Circuit diagram of the proposed model. In the above Figure.4, it represents the circuit diagram of the proposed model. In this circuit diagram, the ESP32 module and different sensors are used to build the model to attain better results.

B. Hardware Implementation of the proposed model

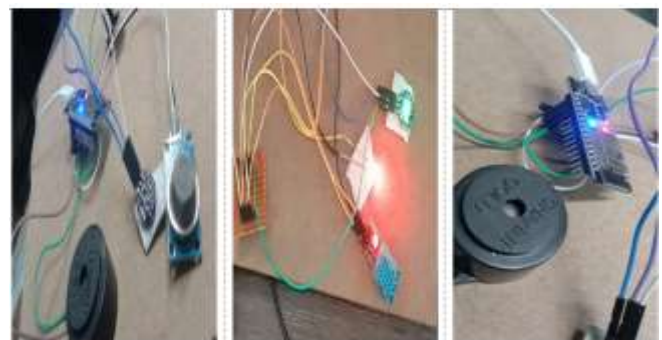


Figure.5. Hardware Implementation of the proposed model.

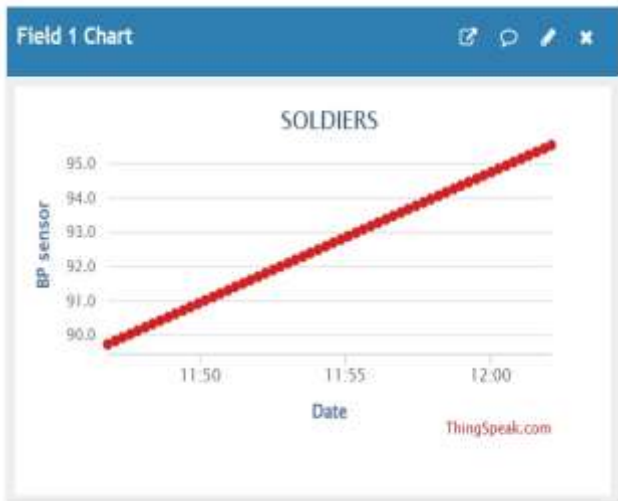


Figure.6. BP sensor results.

In above figure 6 represent the BP sensor result obtained from proposed model, in this analysis get the proper and better efficient of the model.



Figure.7. Oxygen sensor results.

In above figure 7 represent the oxygen sensor result of the model. conduct an experiment with our college 30 students with the proposed health monitoring with various trails which has summarized in the below table.

Table 1: students with the proposed health monitoring with various trails

Number of trails	Normal	Abnormal
20	15	9
40	15	7
60	10	10
80	12	5
100	15	7
120	13	9
140	12	6
160	13	9
180	11	9

200	12	5
No Results	0	0
Total	128	76

In above table 1 represent the proposed health monitoring system was tested across various trails, recording 128 normal cases and 76 abnormal cases from a total of 10 intervals ranging from 20 to 200 trails. At 20 trails, 15 normal and 9 abnormal cases were observed, while at 40 trails, 15 normal and 7 abnormal cases were reported. Similar trends were noted with fluctuations, as 10 normal and 10 abnormal cases were recorded at 60 trails, and 12 normal with 5 abnormal cases at 80 trails. For 100 trails, the counts were 15 normal and 7 abnormal, and at 120 trails, 13 normal and 9 abnormal cases were noted. The counts at 140 trails were 12 normal and 6 abnormal, and at 160 trails, 13 normal and 9 abnormal cases. Further, at 180 and 200 trails, the numbers stood at 11 normal with 9 abnormal and 12 normal with 5 abnormal, respectively. No cases were left unrecorded, showcasing the system's reliability in capturing all events accurately.

The monitoring analysis across various trials is summarized below, highlighting normal and abnormal outcomes: Normal outcomes total 128, consistently outperforming abnormal cases. Peaks are observed at 20, 40, and 100 trials, each recording 15 normal results. Abnormal outcomes total 76, with maximum cases (10) occurring at 60 trials. Other higher counts include 9 abnormalities at 120, 160, and 180 trials. Across all trials, there are no instances of missing results (0 no results), ensuring a fully tracked analysis. The results suggest that the monitoring process predominantly leans toward normal outcomes, with abnormalities steadily distributed but in fewer numbers. This indicates reliable monitoring performance over the observed trials. To made an analysis include iterations from 1 to 200 (in steps of 20), along with the total counts of "Normal" and "Abnormal" cases, and a "No Results" row. The summarized table is now available for review.

V. CONCLUSION

The Health Monitoring and Tracking Scheme for Soldiers Using ESP8266 offers a cost-effective, innovative solution to enhance safety and operational readiness in challenging environments. By integrating wearable sensors, GPS tracking, and the ESP8266 microcontroller, the system provides continuous monitoring of vital health parameters and real-time location tracking, enabling early detection of health risks and prompt medical intervention. Its low-power and wireless capabilities ensure seamless data transmission to command centers, even in remote areas, enhancing situational awareness and decision-making. Future enhancements could include AI and machine learning for predictive analytics, advanced encryption for data security, and additional sensors to monitor environmental factors like temperature and air quality. The system can also be expanded to support group-level monitoring through multi-node networks, improving coordination among soldiers. This project underscores the possible of IoT and embedded

systems in ensuring soldier safety, laying the groundwork for further innovations in military health monitoring.

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