Real-Time Soldier Healthcare Monitoring and Position Tracking System

P. Tirumala Rao
Department of Electronics and Communication Engineering, Vignan's Institute of Information Technology,
Visakhapatnam, India,
pechetyytirumalarao@gmail.com

Pampana Jahnavi
Department of Electronics and Communication Engineering, Vignan's Institute of Information Technology,
Visakhapatnam, India,
Pampanajahnavi2003@gmail.com

Siriki Harsha Vardhan
Department of Electronics and Communication Engineering, Vignan's Institute of Information Technology,
Visakhapatnam, India,
harshasiriki2703@gmail.com

Vanapalli Nithish
Department of Electronics and Communication Engineering, Vignan's Institute of Information Technology,
Visakhapatnam, India,
Vanapallinithish@gmail.com

Tulasi Krishna Chaitanya
Department of Electronics and Communication Engineering, Vignan's Institute of Information Technology,
Visakhapatnam, India,
chaitu110501@gmail.com

Abstract*—One of the vital roles in a country's defense is played by the army soldiers. Soldiers become lost or hurt every year, and search and rescue missions take a lot of time. This Device mainly tracks the Position and assistant. health monitoring approach in which sensor data is processed using a robust and stable algorithm implemented in the controller. After processing, these data are transmitted via low-power, low-cost means to the base station. We focus on monitoring environmental factors such as temperature; physical factors such as position, and geographic location i.e. latitude and longitude using GPS, and health parameters like heart rate, and body temperature. The system's goal is to employ an embedded system that is power-efficient and minimizes response times for any emergency.

Keywords—***Embedded System, Health Monitoring, Geographic Position System (GPS), Global System For Mobile Communication (GSM)***

I.INTRODUCTION

Soldier healthcare is an essential component of a country's defense strategy. It is crucial for maintaining the physical, mental, and emotional well-being of military personnel, which in turn directly influences their readiness, effectiveness, and morale. A healthy and ready fighting force is essential for deterring aggression and defending a nation's sovereignty.

A health monitoring system is a comprehensive and often technologically-driven approach to monitoring and managing health-related data. These systems can range from simple self-monitoring apps to complex, networked systems that integrate data from multiple sources. The goal of such systems is to provide timely and accurate information to healthcare providers and patients, aiding in the prevention, diagnosis, and treatment of health issues. Healthcare providers can remotely monitor the health of patients recovering at home, reducing hospital readmission rates and improving care coordination.

The operation of a Health monitoring system is that it collects data from various sources, including wearable devices, electronic health records (EHRs), diagnostic tests, sensors, and patient-reported information. This data is aggregated and stored in a central database. Many health monitoring systems provide real-time monitoring of vital signs and other health metrics. This allows for the early detection of abnormalities and prompt intervention if necessary. Health monitoring systems can generate alerts and notifications when certain thresholds are met or when specific health issues are detected. These alerts can be sent to healthcare providers, caregivers, or patients themselves. The collected data can be analyzed using various algorithms and techniques to identify trends, predict outcomes, and generate reports. These reports can be used by healthcare providers to make informed decisions about patient care.

The location of the patient along with his health conditions were also important if the person is in a remote location. A position tracking system is a technology that determines and monitors the location of a person, object, or device in real-time or at regular intervals. These systems typically use a combination of hardware and software to provide precise positional information.

GSM (Global System for Mobile Communications) and GPS(Global Positioning System) are two different technologies that are sometimes used together for location-based services, but they serve distinct purposes. Certain devices, like some smartphones and dedicated GPS trackers, integrate both GSM and GPS functionalities. The device can transmit location data (from GPS) through the GSM

network, allowing remote monitoring and sharing of location information.

II. LITERATURE SURVEY

The literature survey provides a comprehensive overview of existing research and developments in the field of real-time soldier health monitoring and tracking systems, covering various aspects such as sensor technology, wireless communication, data security, sensor integration, data acquisition, remote monitoring and alerts, and case studies. [1] This article presents the design and implementation of the health monitoring system for blood pressure (BP), heart rate (HR), and blood oxygen saturation levels. Integration of multiple sensors and wireless communication technologies for real-time data transmission. It proposed a remote health monitoring system and its potential impact on healthcare delivery, providing valuable insights for further research and development in remote patient monitoring and telemedicine. [2] It proposed a remote health monitoring system enabling family members and consultant doctors to monitor patients' health remotely via the Internet. Using an E-health sensor shield kit interface kit, the system collects and transmits health data. However, it lacks crucial notification features such as email and SMS alerts, limiting its effectiveness in promptly notifying stakeholders about critical health changes. The system presents an innovative solution to the challenges of soldier monitoring in military operations. By combining IoT and blockchain technologies, the proposed system offers enhanced security and reliability, ensuring the integrity of vital data collected from soldiers in real-time [3]. With LoRaWAN, it suggested an Internet of Things (IoT)-based health monitoring system that uses ten times less power than more conventional cellular options like GPRS, 3G, and 4G. This development offers more economical and effective remote patient monitoring in the medical field [4]. Using IOT technology, the system is designed to track soldiers' whereabouts and keep an eye on their health. This device provides location tracking and real-time health data monitoring, improving soldiers' situational awareness and enabling prompt medical care during difficult missions [5]. It looks at different uses for location-tracking technologies. Presumably, it covers how location monitoring is used in emergency services, asset management, navigation, and logistics. The study may also examine the difficulties and underlying technology of location-tracking systems [6]. It offers a way to use GPS technology to track soldiers' whereabouts and keep an eye on their health. With the help of this system, command centers will be able to get real-time health and location data, improving military safety and well-being. The study presents a comprehensive approach to handling the issues related to tracking and monitoring soldier health during military operations through the integration of GPS technology [7]. This internet resource probably offers information on the causes, signs, available treatments, and preventative steps unique to high blood pressure in older persons. It is an invaluable tool for medical experts, caretakers, and senior citizens who want to comprehend and deal with this common health problem [8]. It suggested a Health-IoT platform that combined an intelligent medicine box, discrete biosensors, and intelligent packaging. Through the control of patient health and medication adherence in real-time, their work offers a holistic system designed to improve healthcare. [9]. This technology improves situational awareness by providing health indicators and real-time location tracking for soldiers, as well as ensuring timely medical assistance when needed [10].

III.MATERIALS AND METHODS

A. Block diagram of the work

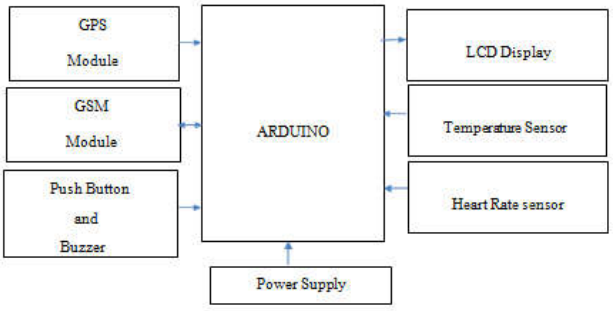

Fig 1. Block Diagram of soldiers' health monitoring and tracking system

Arduino

Arduino is an open-source hardware and software platform that may be used to create interactive objects and digital gadgets. The heart of the Arduino Uno is the ATmega328p microcontroller, which is an 8-bit AVR microcontroller with 32KB of flash memory for program storage, 2KB of SRAM, and 1KB of EEPROM. Clocking at 16MHz, it furnishes 14 digital I/O pins (including 6 PWM outputs) and 6 analog input pins, along with UART, SPI, and I2C communication interfaces.

LCD Display

A liquid crystal display (LCD) is a flat, thin electronic visual display that takes advantage of liquid crystals' ability to modulate light. The liquid crystal display is a crucial component of embedded systems technology. The user has a great deal of flexibility with it because he can see the necessary info on it. They are utilized in many different places, such as cockpit displays, televisions, computer monitors, instrument panels, and airplanes.

DHT11 Sensor

The DHT11 sensor is a low-cost digital temperature and humidity sensor widely used for its affordability and ease of use. It offers a temperature range of 0°C to 50°C with an accuracy of +/- 2°C and a humidity range of 20% to 90% RH with an accuracy of +/- 5% RH. It communicates via a simple digital protocol and is commonly used in DIY projects and educational settings. While it may not offer the highest accuracy or fastest response time, it remains popular for basic temperature and humidity monitoring applications.

GPS Module

A GPS module is a compact electronic device that receives signals from satellites to determine precise location coordinates. It uses the information from multiple satellites to perform triangulation and determine the exact location. It gives precise location information including latitude and longitude. It takes around 27 seconds to acquire satellite signals for a cold start. Typically operates on a voltage between 3.0V to 5.5V. It typically includes components such as a GPS receiver, antenna, processor, interface, and firmware. GPS modules are widely used in navigation systems, vehicle tracking, and location-based services due to their accuracy and reliability.

GSM Module

A GSM module is a compact communication device facilitating connectivity over the GSM network. It integrates essential components for voice, data, and a SIM card slot for network authentication. Utilizing an external antenna, connected via a designed pin, it operates within a voltage range of 3,4V to 4.5V. With GPIO pins for digital input and output, it supports diverse applications such as IOT, security systems, and remote monitoring, enabling seamless cellular network connectivity for remote control and communication.

MAX30100

The heart-rate sensor functions by detecting fluctuations in blood volume within the fingertip, providing an accurate measurement of the user's heart rate. Simultaneously, the SpO2 measurement gauges the oxygen saturation level in the blood, crucial for assessing overall health status. These sensors typically operate at a voltage of 3.3V, ensuring stable and reliable performance. The heart rate sensor covers a range from 30 to 250 bpm (beats per minute), offering comprehensive monitoring capabilities across a wide spectrum of heart rates. Similarly, the SpO2 measurement spans from 0% to 100%, enabling precise assessment of oxygen levels in the bloodstream.

Panic Button and Buzzer

The Panic button is one kind of switch that is provided to soldiers to help in a panic situation. It provides an immediate means for patients and healthcare professionals to summon assistance or alert designated responders in emergencies. This feature is essential for enhancing the safety and security of individuals within healthcare facilities or remote care settings. The panic button can be easily activated with a single press or touch, triggering an immediate alert to designated recipients, such as nurses, security personnel, or emergency responders. Alerts generated by the panic button can be transmitted via various communication channels, including mobile devices, desktop applications, email, and SMS, ensuring timely notification of responders regardless of their location. Whenever the push button is pressed, the buzzer will be turned on and remain in that state until the message is delivered. Once the message is successfully delivered to the respective mobile numbers, the buzzer will automatically turn off.

B. Software Description

Arduino IDE (Integrated Development Environment) is a user-friendly software application designed for programming and developing applications for Arduino microcontrollers. The required code is developed with Arduino IDE and dumped into ESP8266. Before coming into the Arduino IDE, the Board file has to be added to the ESP-8266 board. It offers a streamlined interface with features such as code editing, compiling, and uploading firmware to Arduino boards. The IDE supports various programming languages, including C and C++, making it accessible for both beginners and experienced developers. With extensive libraries and community support, the Arduino IDE serves as a versatile tool for prototyping and creating diverse electronics projects efficiently and effectively. Arduino-compatible sensors, including heart rate monitors, temperature sensors, and GPS modules, are seamlessly integrated to monitor soldiers' vital signs and location data accurately. The Arduino IDE facilitates the programming of algorithms for real-time data processing, allowing for immediate analysis of sensor data to detect anomalies, injuries, or distress signals among soldiers. Soldiers can interact with the system using intuitive interfaces developed using Arduino IDE, enabling them to view their health status, receive alerts, and trigger emergency responses with minimal training.

Some of the library files used in this project are

- #include<MAX30105.h>: This library is used to interface with the MAX30105 sensor module, which is employed for monitoring heart rate and blood oxygen saturation levels.
- #include"heartRate.h": This library likely contains functions and definitions for calculating heart rate based on the data obtained from the MAX30105 sensor.
- #include<Liquidcrystal.h>: This library provides functions for interfacing with liquid crystal displays (LCDs), allowing for the display of information such as vital signs and system status.
- #include"DHT.h": This library is used to interface with DHT series humidity and temperature sensors, enabling the monitoring of environmental parameters such as temperature and humidity.
- #include<SoftwareSerial.h>: This library facilitates software-based serial communication, enabling communication with external devices or modules using additional UART ports.

IV. RESULTS AND DISCUSSION

The project demonstrates the successful implementation of soldiers' healthcare monitoring and position tracking system. Real-time monitoring of vital indicators, including heart rate, blood pressure, and temperatures, was made easier by the system. Monitoring of soldiers' health data, such as vital signs, medical history, and recent illnesses, is made possible by the system. This ongoing observation makes it easier to identify health problems early, which allows for quicker action and treatment.

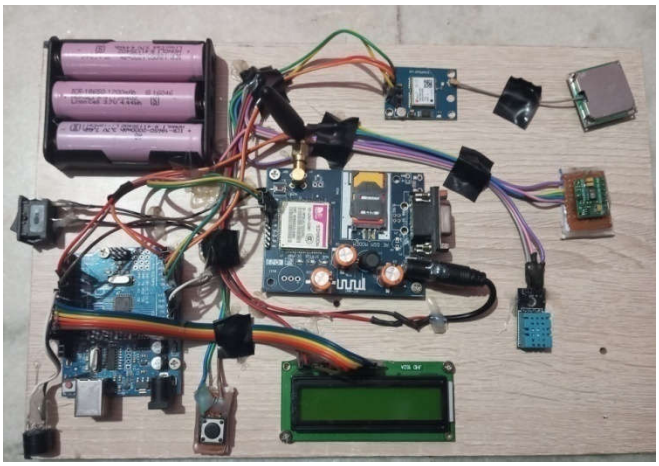

Fig 2. Circuit connections of soldiers' health monitoring and tracking

Through close monitoring of soldiers' health conditions, the system improves mission and training exercise safety. Early detection of health issues reduces the likelihood of medical emergencies, guaranteeing that soldiers receive help when they need it. Better resource allocation inside military healthcare facilities is made possible by the data gathered by the monitoring system. By analyzing health trends and patterns, healthcare providers can more effectively administer treatment by foreseeing medical requirements and allocating resources appropriately.

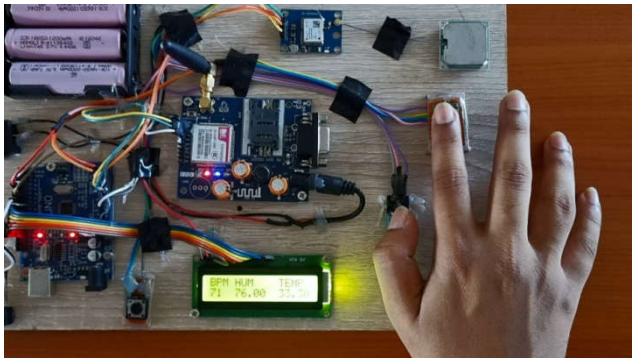

Fig 3. Working model of soldiers' health monitoring and tracking

Military healthcare personnel can reduce health risks among soldiers by implementing preventative measures with access to complete health data. By taking a proactive stance, the frequency of avoidable diseases and injuries is decreased, which improves military personnel's general health and readiness.

The system offers insightful information about the health of both individual soldiers and entire groups. Based on this information, commanders and medical experts can make well-informed decisions on everything from training program adjustments to the deployment of medical personnel to specific places as needed.

Fig 4. Parameters being shown on the LCD

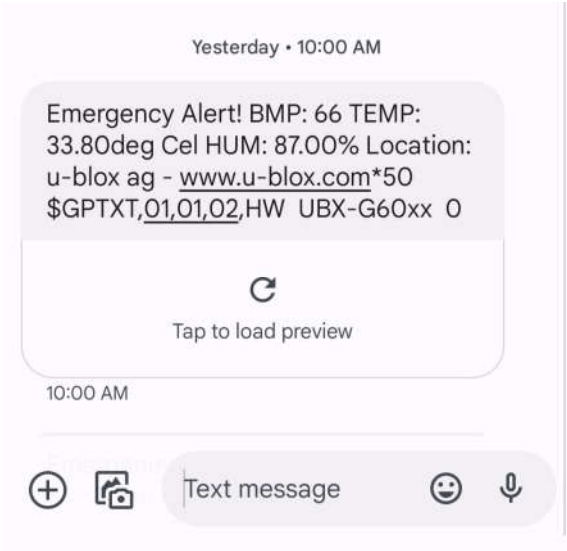

Fig 5. SMS sent after pressing the push button

We are able to measure the soldiers' body temperature, humidity, and heart rate. Temperature, heart rate, and humidity are displayed on the LCD display. When the push button is pressed, an SMS is sent to the authorities. When the SMS is issued, we can monitor the soldier's whereabouts.

V.CONCLUSION

This paper presents a successfully implemented smart soldier health monitoring system, which has the potential to improve military operations substantially. It helps to acquire information from the warzone about each soldier's health condition and can detect biohazards with the help of vigorous algorithms. Our system includes biological sensors to monitor soldiers' vital signs and environmental conditions, using Arduino boards to save costs and send data to control rooms. This technology aids in accurately locating missing soldiers during critical situations.

VI. FUTURE SCOPE

The system can be expanded to accommodate other sensors, such as biochemical, electrodermal activity, and electroencephalography (EEG) sensors. Flexible electronics can be used to incorporate the soldier's unit into the wearable gear, improving convenience for the soldiers.

REFERENCES

[1] Chike Nwibor, Shyqyri Haxha, “Remote Health Monitoring System for the Estimation of Blood Pressure, Heart Rate, and Blood Oxygen Saturation Level” IEEE Sensors Journal, VOL. 23, NO. 5, 1 March 2023

[2] S. D. Guler, M. Gannon, K. Sicchio, “Wearables in Crafting Wearables: Blending Technology with Fashion”, Berkeley, CA: Apress, pp. 3-10, 2016.

[3] J. Pabla, V. Sharma and R. Krishnamurthi, "Developing a Secure Soldier Monitoring System using Internet of Things and Blockchain, "2019 International Conference on Signal Processing and Communication (ICSC), NOIDA, India, 2019, pp. 22-31.

[4] A. Mdhaffar, T. Chaari, K. Larbi, M. Jmaiel and B. Freisleben “IoT-based Health Monitoring via LoRaWAN” IEEE EUROCON, 2017.

[5]]Niket Patil and Brijesh Iyer, “Health Monitoring and Tracking System For Soldiers Using Internet of Things(IoT)” IEEE Internet of Things Conference, 2017.

[6] S.Gamache, “Location Tracking Applications”, IEEE 15-10-0519-00, JULY 2010.

[7] M.V.N.R. P.Kumar, G.R. Vijay, P.V.Adhikrao and B.S. Vijaykumar,” Health Monitoring and Tracking of Soldier Using GPS”, International Journal of Research in Advent Technology, Vol.2, No.4, April 2014 E-ISSN: 2321-9637, page no.291-294.

[8] National Institute on Aging. (2022). High Blood Pressure and Older Adults. Accessed: Apr. 7, 2022. [Online]. Available: https://www.nia.nih.gov/health/high-blood-pressure-and-older-adults#whatis

[9] G. Yang, L. Xie, M. Mantysalo, X. Zhou, Z. Pang, L. D. Xu, S. KaoWalter, Q. Chen, and L. Zheng, “A health-iot platform based on the integration of intelligent packaging, unobtrusive bio-sensor, and intelligent medicine box,” IEEE Trans. Industrial Informatics, vol. 10, no. 4, pp. 2180–2191, 2014.

[10] S. Nikam, S. Patil, P. Powar, V. S. Bendre “GPS Based Soldier Tracking and Health Indication System” International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,2013.