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Real Time Wireless Embedded Electronics for Soldier Security

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Abstract : In the contemporary era, the security landscape of nations is heavily influenced by the ever-present threat from adversaries. Within this context, the role of military personnel is pivotal and indispensable. Various factors are considered in ensuring the security and well-being of these troops. To safeguard soldiers, a range of equipment and devices are integrated into their gear, focusing on monitoring their health and ammunition status. Utilizing health-related sensors such as those measuring pulse rate, body temperature, and providing real-time weather updates, alongside incorporating emergency alert buttons, data transmission, and processing capabilities, enables the development of affordable wearable solutions for health monitoring. The Global Positioning System (GPS) is employed to accurately pinpoint a soldier's latitude and longitude, facilitating precise location tracking. Furthermore, the inclusion of Wi-Fi modules offers rapid, high-speed data transmission capabilities, vital for relaying critical information related to situational awareness, tactical guidance, and covert surveillance during specialized missions. Through the incorporation of these devices, our aim is to establish a fundamental life protection system for soldiers that is both cost-effective and highly reliable.

Keywords – GPS, Wi-Fi module, health monitoring, embedded systems

I. INTRODUCTION

The safeguarding of a nation's security is entrusted to its armed forces, including the army, navy, and air force. The safety and well-being of soldiers remain a top priority, and concerns persist, especially when troops are deployed in battlefield conditions where lives can be at risk due to various factors, including a lack of connectivity. Maintaining constant connectivity and the ability for army base stations to monitor the location and health status of every soldier are critical components in minimizing these life-threatening situations. Continuous monitoring of soldiers operating in challenging environments is essential to ensure their safety. Wireless Sensor Networks (WSN) emerge as a pivotal tool for health monitoring, offering the capability to integrate sensors that collect data pertaining to soldiers' health and their surrounding environment. This data can be processed to anticipate and prevent critical events, thereby enhancing the overall safety and well-being of military personnel.

GPS technology is essential for pinpointing the exact latitude and longitude coordinates, allowing for the precise location tracking of soldiers. Simultaneously, a Wi-Fi module serves the critical purpose of facilitating high-speed data transmission over a considerable range. This transmission capability is crucial for relaying vital information related to situational awareness, tactical instructions, and covert surveillance data during special operations and reconnaissance missions. By harnessing the capabilities of GPS and Wi-Fi technology, our goal is to develop a cost-effective and highly reliable soldier life-saving system.

Our primary aim was to establish a project that would offer cost-effective and consistent support for the health and security of soldiers engaged in wartime special operations. Additionally, this project incorporates a mechanism for soldiers to request assistance from the base station. The project comprises several vital elements: it initiates by collecting critical biometric data from soldiers, including body temperature, heart rate, and oxygen levels, providing crucial insights into their well-being. Simultaneously, GPS technology is employed for real-time tracking of the soldier's location, ensuring constant monitoring. Data related to environmental factors like atmospheric temperature and atmospheric pressure is also gathered to provide a comprehensive environmental context. This data is then processed through the Blynk server and made accessible through the Blynk app, facilitating real-time monitoring and data visualization. In cases where irregularities are detected in a soldier's data, immediate alerts are sent to both the soldier and the relevant authorities, ensuring swift emergency responses. Furthermore, during active conflicts, the project offers tracking and navigation capabilities, including monitoring the soldier's speed, distance, and health status. This information is invaluable for military decision-makers to formulate effective strategies and promptly direct assistance to soldiers in need. Overall, this project serves as a holistic system for monitoring soldier health and security, leveraging biological sensors for health constraints and GPS modules for location tracking and positioning, ultimately enhancing the safety and efficiency of military operations in dynamic and challenging settings.

The objectives of this system are:

- The system continuously monitors gas levels, temperature, humidity, body temperature and location of the soldier to make sure they are safe.
- By analysing data, the system detects signs of hazards or unsafe conditions of the surroundings, allowing quick action to prevent accidents.
- The system alerts higher officials promptly when it detects abnormal or dangeroussituations, giving them time to respond and prevent risks.
- The system is designed to detect hazardous gases. It sends alerts to ensure soldier safety.
- An embedded-based system can provide continuous, real-time monitoring of various parameters for soldier safety, such as temperature, humidity, gas concentration, and location, and alert the appropriate personnel in the event of any anomalies.

II. LITERATURE SURVEY

An embedded system is a specialized computer system designed to perform specific tasks, often with real-time computing requirements. These systems are typically an integral part of a complete device, including both hardware and mechanical components. In contrast, general-purpose computers, like personal computers, can perform a wide range of tasks through programming. Embedded systems play a crucial role in many common devices we use today. They are tailored to specific functions, allowing design engineers to optimize them for reduced size and cost or improved reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Physically, embedded systems vary in size and purpose, ranging from portable devices like digital watches and MP3 players to larger stationary installations such as traffic lights, factory controllers, or nuclear power plant control systems. These systems can be relatively simple, with just a single microcontroller chip, or highly complex, with multiple units, peripherals, and networks housed within a substantial chassis or enclosure.

The term "embedded system" lacks a precise definition in a broad sense, as many systems have some degree of programmability. For example, handheld computers share certain components with embedded systems, including operating systems and microprocessors, but they are not considered true embedded systems because they allow the loading of different applications and connection of peripherals. Embedded systems represent a fusion of computer hardware and dedicated functionality, making them indispensable in various applications. and software, which can be either fixed in its capabilities or programmable, and is specifically tailored for a particular application or device.

Embedded systems find applications in a diverse range of fields, including industrial machinery, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, toys, and even in devices as common as cellular phones and PDAs. These systems, when programmable, come equipped with a programming interface, and working with embedded systems programming is a specialized occupation. In the realm of embedded systems, certain operating systems and language platforms are tailored to meet specific needs, such as Embedded Java and Windows XP Embedded. These platforms enable the development of software that runs on embedded systems, enhancing their functionality. In the rapidly advancing landscape of science and technology, new inventions, innovations, and advanced implementations continually emerge. These cutting-edge technologies are readily adopted by defense services to bolster safety and efficiency, reflecting the dynamic and evolving nature of embedded systems in addressing various challenges and applications across different industries.

III. PROPOSED WORK

The system in development involves an ESP32 microcontroller, and it will incorporate various sensors like the Max30100, DHT11, and MQ135.To interface with these sensors and gather data, the system will employ Embedded C programming. Data verification and processing will be facilitated through the Blynk IoT platform, comparing the collected sensor data. When the soldier's pulse rate or body temperature deviates from predefined thresholds, the system will trigger a message directly within the mobile app.

1.Hardware setup: The hardware setup will involve connecting the ESP32, MQ135 Sensor, DHT11, Pulse Oximeter Sensor (MAX30100), GPS (NEO-7M), Buzzer, Regulated Power Supply, Jumper wires.

2.Data collection: The data collection phase will involve collecting data from ESP32 which collects data from different sensors and storing it in the Blynk IoT platform. All the data goes into the Blynk cloud and gets stored there. The app allows us to see the real-time readings of temperature, humidity, heart rate, location and detection of harmful gases.

A. Modules used

1. ESP32: The ESP32 is a popular microcontroller board widely used in IoT applications. It is developed by Espressif Systems and is known for its versatility, low power consumption, and built-in Wi-Fi and Bluetooth capabilities. The ESP32 features a dual core processor, ample memory, and a rich set of peripherals, making it suitable for a wide range of projects. With its integrated connectivity options, the ESP32 enables seamless communication with other devices and networks, making it an ideal choice for projects. It can be used to collect data from various sensors, process it locally, and transmit it to the cloud for further analysis and monitoring. The ESP32's programmability and extensive software development ecosystem, including Arduino and Micro Python support, make it accessible for developers with different programming backgrounds.

2. MQ135: The MQ135 is a gas sensor module widely used for detecting various combustible gases, smoke, and harmful gases in the environment. It consists of a sensing element that changes its electrical resistance when it comes into contact with specific gases. This sensor is highly sensitive and can detect gases like LPG, methane, propane, smoke, carbon monoxide (CO), and hydrogen

sulphide (H2S). The MQ135 sensor finds applications in diverse fields. One of its primary uses is gas leakage detection. MQ135 flammable gas and smoke sensor detects the concentrations of combustible gas in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of flammable gas of 300 to 10,000 ppm. The sensor can operate at temperatures from -20 to 50°C and consumes less than 150 mA at 5 V.

3. DHT11: The DHT11 is a popular temperature and humidity sensor module widely used in various applications. It consists of a capacitive humidity sensor and a thermistor for temperature measurement. The DHT11 module provides accurate and reliable readings of ambient temperature and relative humidity. The DHT11 sensor operates on a single-wire digital communication protocol, transmitting data in a time-division multiplexing format. It provides temperature readings with an accuracy of ±2°C and relative humidity readings with an accuracy of ±5%. The sensor also features a built-in 8-bit microcontroller that handles data processing and calibration, simplifying the integration process. The DHT11 sensor is relatively inexpensive, making it accessible for hobbyists, students, and projects with budget constraints. The DHT11 sensor communicates over a simple digital interface, requiring only a single data pin for both temperature and humidity readings. This makes it easy to integrate into various microcontroller project.

4. MAX30100 Oximeter Module: MAX30100 is a multipurpose sensor used for multiple applications. It is a heart rate monitoring sensor along with a pulse oximeter. The sensor comprises two Light Emitting Diodes, a photodetector, and a series of low noise signal processing devices to detect heart rate and to perform pulse oximetry.

5. GPS(NEO-7M): The NEO 7M GPS module is a high sensitivity, low-power GPS module that has 56 channels and outputs precise position updates at 10Hz.

6. BUZZER: A buzzer as shown in fig 3.6 is an electromechanical device that generates sound, typically a buzzing or beeping sound. It is a straightforward and commonly used component in electronics. Buzzers are designed to convert electrical energy into mechanical vibrations, which, in turn, create audible sound waves. The primary purpose of buzzers is to provide auditory alerts, notifications, or alarms within electronic systems.

7. Blynk app**:** This module serves as the recipient of data transmitted from the Cloud server. The central server module takes on the crucial task of data processing and subsequently relaying it for analysis. It incorporates threshold-based monitoring to detect anomalous readings. In cases where any sensor data surpasses predefined threshold values, it activates an alert or notification mechanism. This module is an immensely popular Internet of Things (IoT) platform, empowering users to construct custom applications for the control and monitoring of various hardware devices and projects. Its primary objective is to simplify the creation of IoT applications, particularly for individuals who may not possess extensive programming or electronics expertise. Users can design the user interface of their applications visually, making it user-friendly and accessible to a diverse audience, including hobbyists, makers, and developers.

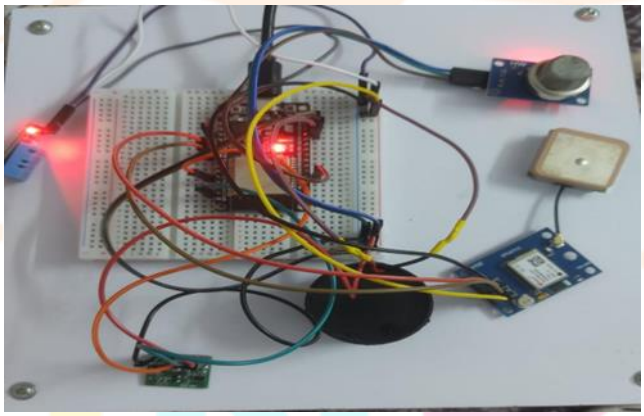

Fig. 1. Proposed System

B. Libraries Used

1. WiFi.h:

The "WiFi.h" library, typically used in Arduino projects with ESP8266 and ESP32 microcontroller platforms, is used for connecting your microcontroller to Wi-Fi networks. Here are some common use cases for the "WiFi.h" library:

- Internet of Things (IoT) Projects: ESP8266 and ESP32 microcontrollers are popular choices for IoT projects due to their built-in Wi-Fi capabilities. The "WiFi.h" library allows these devices to connect to the internet, send and receive data, and interact with cloud services.
- Home Automation: You can use ESP8266 or ESP32-based devices to control smart home devices over Wi-Fi, such as lights, switches, and sensors. The library enables communication with your local network.
- Remote Monitoring: Create systems for remote monitoring and control of various processes. For example, you can build a weather station that uploads data to a web server or cloud service via Wi-Fi.
- Web Servers: You can run a web server on an ESP8266 or ESP32 to serve web pages, create web-based user interfaces for your projects, or receive HTTP requests from other devices.
- Data Logging: Store sensor data, logs, or telemetry data on remote servers or cloud platforms through Wi-Fi connections.
- OTA (Over-The-Air) Updates: The library facilitates firmware updates for your microcontroller devices via Wi-Fi, saving the hassle of physically connecting them to a computer for updates.

- Wi-Fi Communication: Use ESP8266 or ESP32 boards as Wi-Fi-connected clients or servers to exchange data between devices, access online resources, or interface with web APIs.
- Overall, the "WiFi.h" library enables you to add wireless connectivity and internet access to your microcontroller projects, making them capable of interacting with the online world and expanding their functionality.

2. WiFiClient.h:

The #include <WiFiClient.h> is a library in the Arduino framework, particularly used in projects involving Wi-Fi communication. Here's what it's used for:

- Client-Side Wi-Fi Communication: This library is used when you want to create a Wi-Fi client on an Arduino device, which means the Arduino will connect to a Wi-Fi network as a client to interact with other devices or servers on the network.
- Socket Communication: It provides the necessary functions and classes for creating and managing socket connections over Wi-Fi. Sockets are endpoints for sending or receiving data over a computer network, and they are fundamental for network communication.
- Interacting with Servers: You can use this library to connect your Arduino device to remote servers or services via Wi-Fi. This is useful for sending data, receiving data, making HTTP requests, or connecting to cloud services.
- Data Retrieval: It allows you to retrieve data from web servers, APIs, or other devices on the same network. This is essential for IoT (Internet of Things) applications, where devices need to fetch or exchange data.
- Web Client: The library helps your Arduino board act as a web client, enabling it to access web services or websites, retrieve data, and integrate with online resources.
- Overall, #include <WiFiClient.h> is an essential library for IoT projects and other applications where Wi-Fi communication is required. It enables the Arduino to connect to Wi-Fi networks and interact with various networked devices, servers, and services, making it a valuable tool for creating connected and networked devices.

3.BlynkSimpleEsp32.h:

The #include <BlynkSimpleEsp32.h> is a library in the Arduino framework, and it is specifically designed for use with the ESP32 microcontroller and the Blynk IoT platform. Here's what it's used for:

- Blynk Integration: This library is used to integrate ESP32-based projects with the Blynk IoT platform. Blynk is a popular platform for building Internet of Things (IoT) applications, and it provides tools for creating smartphone or web-based interfaces to control and monitor your IoT devices.
- Wi-Fi Communication: The library handles the Wi-Fi connectivity of the ESP32 microcontroller, allowing it to connect to a Wi-Fi network and communicate with the Blynk cloud servers. This is essential for remotely controlling and monitoring your ESP32 devices.
- User Interface Development: Blynk provides a simple drag-and-drop interface for creating custom control panels on a smartphone or web app. The library makes it easy to link your ESP32's sensors, actuators, and other components to the Blynk interface.
- Cloud Integration: It enables your ESP32 device to communicate with the Blynk cloud servers, which can be used to relay commands from your smartphone or web app to the ESP32 and vice versa.
- Data Visualization: Blynk allows you to create real-time graphs, gauges, buttons, and other graphical elements to visualize data from your ESP32 sensors.
- Remote Control: You can use Blynk to remotely control your ESP32 devices from anywhere with an internet connection.
- In summary, #include <BlynkSimpleEsp32.h> is a powerful library for building IoT projects with the ESP32 microcontroller and integrating them with the Blynk platform. It simplifies the process of creating a user interface and connecting your ESP32 devices to the internet, making it a great choice for remote monitoring and control of IoT projects.

IV. WORKING

In this Existing system the soldier Health and Position Tracking System allows military to track the current GPS position of soldier and also checks the health status including body temperature and heartbeats of soldier. The System also consists extra feature with the help of that soldier can ask for help manually or send a distress signal to military if he is in need. The GPS modem sends the latitude and longitude position with link pattern with the help of that military can track the current position of the soldier. The system is very helpful for getting health status information of soldier and providing those instant help for that they are using Zigbee module on LPC1768 ARM Microcontroller. In This Proposed System the soldier Health and Position Tracking System allows military to track the current GPS position of soldier and also checks the health status including body temperature and heartbeats of soldier.

- The System also consists extra feature with the help of that soldier can ask for help manually or send a distress signal to military if he is in need. The GPS modem sends the latitude and longitude position with link pattern with the help of that military can track the current position of the soldier. The system is very helpful for getting health status information of soldier and providing them instant help and here we are using Arduino uno microcontroller and GSM module for Sending message on Health condition and the location of the Soldier to the military.
- This sub-system module can paintings each as a get entry to point for creating the hotspot or wireless internet connection and it connects to base station. For this reason it may effortlessly fetch facts and shared it to the net making

V. RESULTS AND ANALYSIS

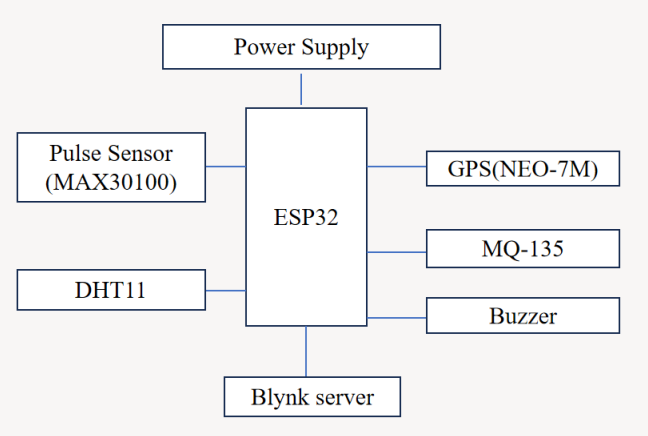

Fig. 2. Block Diagram

This is the outlook of the project, where all the sensors are interfaced with controllers.

System counting heartbeat and measuring body temperature correctly. Whenever beat count increase or decrease to certain level or body temperature increases or decreases below certain level system will alert everyone by alert sound and sends exact location of soldier with the help of GSM and GPS module in the form of SMS. System also sends the exact location of the solder when he or she press the panic mode switch.

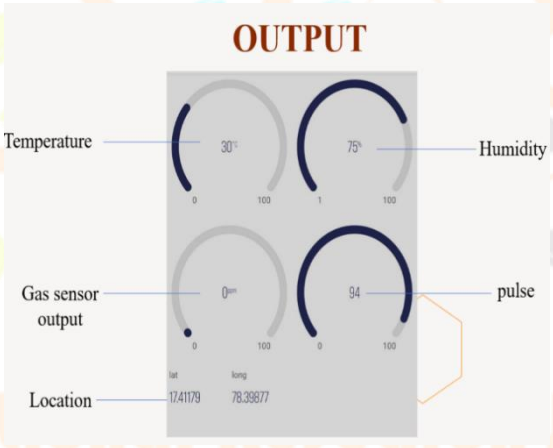

Fig.3.Blynk app template showing inventory levels

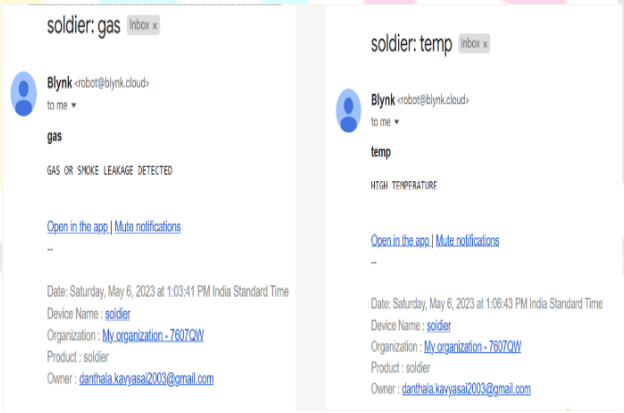

Fig. 4. Blynk alert notification in mail

VI. CONCLUSION

In conclusion, the implementation of real-time wireless embedded electronics for soldier security is a critical and dynamic field of technology aimed at enhancing the safety, situational awareness, and effectiveness of military personnel in the field. This advanced system involves a complex interplay of sensors, data processing, wireless communication, and user interfaces to ensure that soldiers have the information they need to make informed decisions and respond to threats in real-time. The primary objectives of such a system are to improve soldier safety, coordination, and mission success. Embedded sensors play a crucial role in collecting

real-time data on the soldier's health, location, environment, and potential threats. Implementing such systems requires a deep understanding of electronics, communication technologies, sensor integration, cybersecurity, and military operations. It is essential to balance the need for enhanced security with the requirement for usability and reliability in the field. The success of real-time wireless embedded electronics for soldier security is instrumental in safeguarding the lives of military personnel and ensuring mission success in today's dynamic and evolving security landscape.

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