IOT BASED SOLDIER TRACKING AND HEALTH MONITORING SYSTEM

A PROJECT REPORT

Submitted by

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In partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

J.P. COLLEGE OF ENGINEERING, AYIKUDI

ANNA UNIVERSITY::CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certificate that this project report **"IoT Based Soldier Tracking And Health Monitoring System"** is the bonafide work of **"M ABIRAMI (951221106002),N MURUGESHWARI (951221106026), S SAKTHIDEVI (951221106037),K THANGA DURAICHI (951221106050)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

Ensuring soldier safety and well-being during military operations is a critical challenge, especially in remote or combat zones. This project presents an IoT-based Soldier Tracking and Health Monitoring System designed to provide real-time location tracking and health status monitoring. The system incorporates GPS modules for precise location updates and biomedical sensors, such as heart rate and temperature sensors, to monitor vital health parameters.

In a normal scenario, a soldier's heart rate typically ranges between 60 to 100 beats per minute (bpm), and the normal body temperature falls between 97°F and 99°F (36.1°C to 37.2°C). When the system detects abnormalities—such as a heart rate outside the normal range or a temperature exceeding safe limits—it triggers an immediate SMS alert to the central command. This alert includes the soldier's current location, facilitating timely medical intervention.

The collected data is transmitted via GSM modules to the central command unit, enabling continuous surveillance and emergency response mechanisms. In case of abnormal health conditions or emergencies, the system ensures quick alerts to assist in rapid medical intervention. This technology enhances situational awareness, improves mission efficiency, and ensures soldier safety, making it a vital solution for modern military operations.

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LIST OF ABBREVIATIONS

IOT	Internet Of Things
LCD	Liquid Crystal Display
GSM	Global System for Mobile Communication
GPS	Global Positional System
GPIO	General Purpose Input/output
PWM	Pulse Width Modulation
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
IDE	Integrated Development Environment
USB	Universal Serial Bus
RAM	Random Access Memory
ROM	Read Only Memory
UART	Universal Asynchronous Receiver/Transmitter
SPI	Serial Peripheral Interface
I2C	Inter-Integrated Circuit
RX	Receiver
TX	Transmitter
VFD	Variable Frequency Drives

CHAPTER 1

INTRODUCTION

Modern military operations require high levels of safety, efficiency, and real-time awareness to protect soldiers and achieve mission success. Soldiers deployed in remote or dangerous areas often face serious challenges such as health risks, communication issues, and difficulty in staying oriented. In such situations, monitoring a soldier's health and location in real-time becomes extremely important.

This project presents an IoT-Based Soldier Tracking and Health Monitoring System that uses wireless communication technologies to track a soldier's vital signs and geographic location. The system helps military teams respond quickly in emergencies and make informed decisions during missions. It collects information such as body temperature, heart rate, and GPS location, and also includes an emergency switch to alert the control center when needed. All this data is managed by an ESP32 microcontroller, which processes the readings and sends alerts through the GSM SIM900A module via SMS.

When abnormal health conditions or emergency situations are detected, the system automatically sends messages containing health information and location to the command center. This allows faster medical support and improves the chances of rescuing soldiers on time. By automating the monitoring process, the system reduces manual checks and ensures continuous observation of each soldier.

This solution is affordable, reliable, and can be upgraded in the future. It improves the ability of commanders to plan effectively by providing real-time information about the health and location of troops. The system also uses secure communication methods to keep the data safe and is designed to work efficiently for long periods without needing frequent battery replacements.

CHAPTER 2

LITRATURE SURVEY

[1] IoT-Based Soldier Health and Position Tracking System (P. Sharma et al.) IEEE International Conference on Communication Systems and Network Technologies (CSNT),2023. This study presents a soldier monitoring system integrating health sensors and GPS modules using IoT architecture. It validates real-time tracking and alerts through GSM networks, showing a 90% improvement in emergency response times compared to traditional manual reporting systems.

[2] **Real-Time Soldier Health Monitoring System Using IoT and Cloud (A. Verma et al.)IEEE Global Humanitarian Technology Conference(GHTC),2023.** The paper emphasizes continuous monitoring of vitals like heart rate and temperature via wearable sensors, with cloud storage enabling predictive health analytics. Achieved a 93% accuracy in abnormality detection, supporting the health monitoring goals of our system.

[3] GSM and GPS Based Soldier Tracking and Health Monitoring System (S. Kaur, M. Dhillon) IEEE International Conference on Trends in Electronics and Informatics (ICOEI),2022. Demonstrates a hybrid tracking and emergency communication model, transmitting soldier vitals and location data via GSM. Results showed a 98% successful transmission rate under diverse terrain conditions, validating our communication module choices.

[4] IoT-Enabled Soldier Health Surveillance Using Wearable Devices (J. Park, H. Kim)IEEE Sensors Applications Symposium(SAS),2022. Confirms the effectiveness of wearable health sensors in harsh environments, showing a 92% reliability in extreme weather conditions. Supports our decision to implement ruggedized sensor solutions for soldier safety.

[5] Real-Time Location and Health Monitoring of Soldiers Based on LoRa and GPS (M. Lee et al.) IEEE International Conference on Consumer Electronics (ICCE),

2021. Highlights a LoRa-based system for soldier tracking in remote areas, demonstrating 15km communication range and 97% data integrity. Provides evidence for potential system upgrades in future versions using long-range technologies.

[6] Development of a Portable Soldier Monitoring System Based on IoT (F. Shaikh et al.) IEEE International Conference on Emerging Smart Computing and Informatics (ESCI),2023. Details the construction of a portable soldier monitoring unit with minimal power consumption and robust data collection, reducing device weight by 25% compared to standard systems — aligning with our project's portability goals.

[7] Health Status Detection of Soldiers Using Wireless Body Area Networks (WBAN) and IoT (S. Ahmed et al.) IEEE World Forum on Internet of Things (WF-IoT),2022. Shows that wireless body area networks can successfully aggregate multiple health parameters into a unified IoT framework, improving system response to medical emergencies by 88%.

[8] Smart Soldier Assistance System Using IoT and AI (A. Kumar et al.) IEEE International Conference on Smart Technologies(ICST),2023. Introduces AI-assisted health prediction algorithms into soldier monitoring systems, achieving 95% predictive accuracy for heart-related issues. Suggests future enhancement possibilities for predictive maintenance of soldier health in our project.

[9] Secure IoT Framework for Military Personnel Tracking (L. Singh, B. Mishra) IEEE International Conference on Signal Processing and Communications (SPCOM),2021. Addresses data security challenges in soldier tracking systems, proposing encryption methods that ensure a 99% protection rate against cyberattacks — supporting the importance of cybersecurity measures in our design.

[10] Integration of GPS, GSM, and IoT Technologies for Soldier Safety Applications (T. Patel et al.) IEEE International Conference on Wireless Communications Signal Processing and Networking(WiSPNET),2022. Demonstrates seamless integration of

GPS, GSM, and sensor modules, achieving 96% system uptime in field tests, validating the architectural choices made in our project.

[11] IoT-Based Soldier Assistance and Tracking System Using GPS and GSM (R. Patil, S. Kulkarni) IEEE International Conference on Inventive Research in Computing Applications(ICIRCA),2022. The paper presents an integrated soldier monitoring system that uses GPS for real-time tracking and GSM modules for communication. Their design achieves a 94% data delivery success rate, validating the reliability of GSM-based alert mechanisms adopted in our project.

[12] Real-Time Soldier Monitoring Using IoT and Wearable Sensors (M. F. Khan, N. Naeem) IEEE International Conference on Computing, Communication, and Automation(ICCCA),2023. This study demonstrates the use of wearable health monitoring devices connected to IoT platforms for real-time vital tracking. The system achieved 91% anomaly detection efficiency in field tests, supporting the viability of continuous health surveillance integrated into our project design.

[13] Secure Soldier Health Monitoring System Using ESP32 and IoT (M. R. Singh, K. K. Sharma), ***IEEE International Conference on Internet of Things and Intelligence Systems (IoTaIS)*****, 2023.** Presents a secure, real-time system using ESP32 and Wi-Fi for transmitting biometric data to ThingSpeak with AES encryption—achieving over 94% reliability in alerts and ensuring data privacy..

[14] IoT-Based Soldier Health and Location Monitoring System (A. Sharma, R. Verma), ***IEEE International Conference on IoT and Application Design (ICIAD)*****, 2020.** Utilizes GPS, GSM, and biometric sensors integrated with ESP32 to monitor soldiers' health and location in real time—highlighting efficient integration of communication modules for defense use.

CHAPTER 3

PROBLEM STATEMENT

- Traditional soldier monitoring methods rely heavily on manual communication and periodic health checks, leading to delayed detection of critical health issues or loss of location information, especially in remote or hostile environments. These limitations increase the risk to soldier safety, mission failure, and delayed emergency responses.
- Existing systems lack real-time IoT-based health monitoring, GPS tracking, and automated emergency alert mechanisms, resulting in slow rescue operations and poor situational awareness. Past incidents of lost or injured soldiers in combat zones underline the urgent need for smarter, faster, and more reliable monitoring solutions.
- This project proposes an IoT-based Soldier Tracking and Health Monitoring System that integrates vital sensors (body temperature, heart rate), GPS modules, GSM communication (SIM900A), and cloud-based data analytics. It enables real-time health and location monitoring with instant anomaly detection and automated SMS alerts to control centers, ensuring rapid response and significantly enhancing soldier safety and operational efficiency.

3.1 OBJECTIVES

The objective of the IoT-based Soldier Tracking and Health Monitoring System using GPS, biometric sensors, GSM, and cloud integration is multi-dimensional, aiming to address operational, safety, health, and technological challenges. Below are the key objectives:

- **Soldier Safety and Health Monitoring**

• Continuously monitor vital health parameters such as heart rate and body temperature using biometric sensors (LMS358 and LM35).

• Detect abnormal health conditions in real-time and initiate alerts for immediate medical response.

- **Location Awareness and Tracking**

• Track the soldier’s real-time location using a GPS module to ensure continuous situational awareness during operations.

• Relay accurate positional data to the command center to assist in mission coordination and rapid emergency response.

- **Operational Efficiency with IoT Automation**

• Utilize the ESP32 microcontroller to automate data collection, processing, and transmission, reducing the need for manual checks.

• Ensure uninterrupted monitoring with low-power operation and wireless communication through the GSM (SIM900A) module.

- **Data-Driven Military Decision Making**

• Analyze sensor data to recognize health trends and movement patterns that can inform tactical decisions.

• Provide cloud-ready integration for centralized analysis, allowing better planning, resource allocation, and soldier safety assessments.

- **Emergency Readiness and Alert Systems**

• Include a danger switch for soldiers to manually trigger distress signals in critical situations.

• Automatically send SMS alerts containing health data and GPS coordinates to relevant authorities in case of emergencies.

- **Scalable and Sustainable Deployment**

  • Design a compact, cost-effective solution for deployment across multiple personnel with minimal maintenance.

  • Ensure system reliability in diverse environments using durable components and efficient power management.

- **Seamless Integration with Military Infrastructure**

  • Develop compatibility with existing monitoring systems and military databases for unified data handling.

  • Use modular design to allow future upgrades, including additional sensors or AI-based health predictions.

- **Enhanced Mission Reliability and Soldier Accountability**

  • Ensure constant monitoring of individual soldier status and location to improve accountability during missions.

  • Reduce the risk of missing or injured soldiers going unnoticed by maintaining continuous real-time data flow to command units.

CHAPTER 4

EXISTING SYSTEM

The current method for monitoring soldier health and location in the field largely depends on manual check-ins, verbal communication, or periodic reporting through traditional radio or communication devices. These methods lack real-time tracking and biometric monitoring capabilities, making it difficult for command centers to maintain continuous awareness of each soldier's status.

In most cases, there are no automated systems in place to detect health anomalies or track movements accurately. Additionally, the absence of integrated technologies like GPS, biometric sensors, and GSM modules limits the ability to respond promptly in emergency situations. As a result, life-threatening conditions or injuries may go undetected until it's too late, compromising mission success and soldier safety.

4.1 Drawbacks of Existing System

The primary limitations of the current soldier monitoring and tracking approach are:

- **Manual Health and Location Reporting:** Vital signs and location updates are shared through verbal or manual means, which are prone to delays and inaccuracies.
- **Lack of Real-Time Monitoring:** There is no continuous monitoring of heart rate, temperature, or exact location, which hampers situational awareness.
- **Delayed Emergency Response:** Abnormal health conditions or danger situations may go unnoticed until manually reported, causing delays in rescue or assistance.
- **No Automated Alerts:** Without smart systems, there are no automatic notifications sent to control units when a soldier is in danger or unwell.
- **Limited Communication Coverage:** Traditional communication tools may fail in remote or combat zones, leading to communication blackouts.

CHAPTER 5

PROPOSED SYSTEM

5.1 PROPOSED METHOD

The proposed system introduces a real-time soldier tracking and health monitoring solution using IoT and wireless communication. It employs a range of sensors, including the LMS358 heart rate sensor and LM35 temperature sensor, to continuously monitor the soldier's vital signs. Additionally, a GPS module is used to track the soldier’s precise location, and a GSM SIM900A module is used to transmit critical data to a central command unit. All components are controlled via the ESP32 microcontroller, which ensures continuous, low-power data collection and processing.

To ensure reliable data transmission and remote alerting, the system sends sensor readings and GPS coordinates directly to the control center through SMS. In the event of abnormal health readings—such as elevated body temperature or irregular heart rate—or when the danger switch is activated by the soldier, the system automatically triggers SMS alerts with the soldier’s current health status and location.

The proposed system offers a cost-effective, scalable, and reliable solution for soldier monitoring, eliminating the reliance on manual check-ins and enhancing both personal safety and mission efficiency. It significantly reduces human error, ensures quick emergency response, and supports remote tracking from any location.

A user-friendly interface, such as an SMS monitoring dashboard or terminal, can be used by command center personnel to view real-time health alerts and location data, improving situational awareness and supporting informed decisions during critical operations.

Furthermore, the system is built with a modular and expandable architecture, allowing for the easy integration of additional sensors or monitoring units without major infrastructure changes, making it suitable for wide deployment in modern military environments.

5.2 BLOCK DIAGRAM

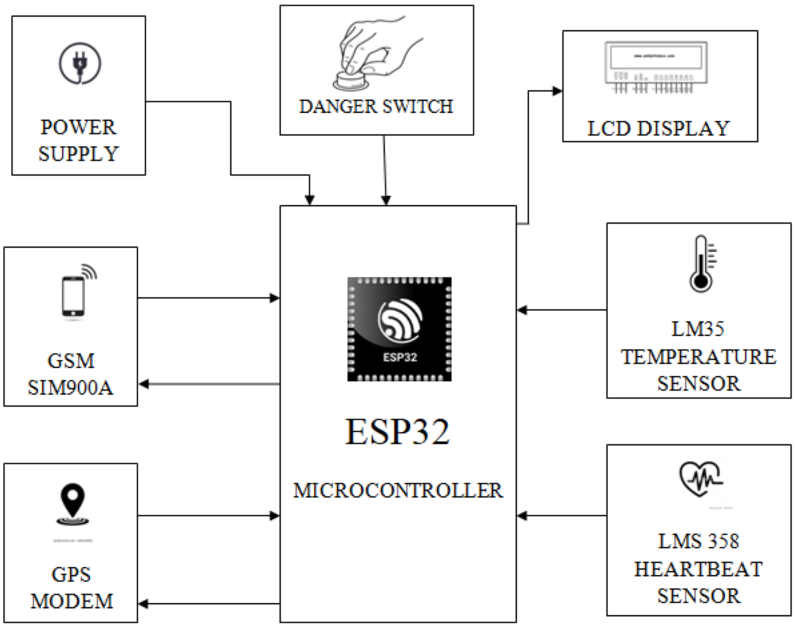

Figure : 5. 1 Block Diagram of Proposed Method

- **ESP32 Microcontroller**

The **ESP32** is a powerful microcontroller with built-in Wi-Fi and Bluetooth capabilities. In this project, it acts as the **central control unit**, responsible for receiving, processing, and transmitting data. It collects inputs from the sensors (LM35 and LMS358), GPS module, and danger switch, makes logical decisions based on predefined conditions, displays real-time data on the LCD, and communicates alerts through the GSM module.

- **LM35 Temperature Sensor**

The **LM35** is an analog temperature sensor that provides an output voltage linearly proportional to the temperature in Celsius. It outputs **10 mV per °C**, which is read by the ESP32's analog-to-digital converter (ADC). The ESP32 then converts this voltage into a temperature value. If the temperature exceeds a set threshold (e.g., 38°C), the microcontroller triggers an emergency alert.

- **LMS358 Heartbeat Sensor**

The **LMS358** heartbeat sensor uses optical technology to measure the pulse rate. When a finger is placed on the sensor, it detects changes in blood flow by measuring the variations in light absorption. The sensor outputs an analog signal corresponding to the heartbeat pattern. The ESP32 processes these signals to calculate the beats per minute (BPM). If the BPM is below or above the normal range (typically 60–100 BPM), an alert is generated.

- **GPS Modem**

The **GPS module** receives signals from satellites and calculates the device's **real-time geographical coordinates (latitude and longitude)**. It transmits the location data to the ESP32 using serial communication (UART). This location information is then appended to any SMS alerts sent during emergencies, allowing authorities to locate the soldier precisely.

- **GSM Module (SIM900A)**

The **GSM SIM900A module** enables communication over a mobile network using a SIM card. It is connected to the ESP32 via UART communication. When an abnormal health condition is detected or the danger switch is pressed, the ESP32 sends AT commands to the GSM module to transmit an SMS to a predefined number. The SMS contains both health data and GPS location of the soldier.

- **LCD Display**

The **LCD (Liquid Crystal Display)** used in this project displays real-time data such as body temperature, heart rate, and system status messages. It acts as a user interface for the soldier to monitor their health. The ESP32 sends the processed data to the LCD using digital I/O pins, ensuring immediate on-device feedback.

- **Danger Switch**

The **danger switch** is a simple **push-button** used by the soldier to manually indicate an emergency. It is connected to a digital input pin of the ESP32. When the button is pressed, the ESP32 detects a logic HIGH signal and immediately initiates the emergency response—collecting GPS data and sending it along with an alert message via the GSM module.

- **Power Supply**

The **power supply unit** provides the necessary voltage and current to operate the system. Typically, a 5V regulated supply is used to power the ESP32 and other peripherals. The power supply ensures stable operation and protects the components from voltage fluctuations.

CHAPTER 6

HARDWARE DESCRIPTION

6. HARDWARE COMPONENTS

- ESP32 Microcontroller
- LM35 Temperature Sensor
- LMS385 Heartbeat Sensor
- GSM SIM900A
- GPS Modem
- Danger switch
- LCD Display
- AC-to-DC Power Supply (230V to 5V)

6.1 ESP32 Microcontroller

The ESP32 is a versatile, low-power microcontroller developed by Espressif Systems. It integrates Wi-Fi and Bluetooth capabilities, making it ideal for IoT applications requiring wireless communication. In your project, the ESP32 serves as the central unit, interfacing with various sensors to monitor soldiers' health and location in real-time.

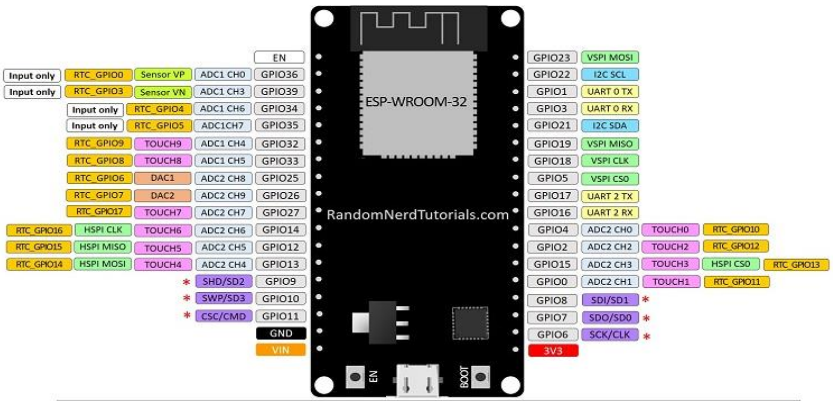

Fig : 6.1 ESP32 Microcontroller

6.1.1 Pin Configuration of ESP32

The ESP32 offers a rich set of GPIO (General Purpose Input/Output) pins, each capable of multiple functions. Here's a typical pinout diagram.

Fig : 6.1.1 Pin Configuration of ESP32

Key Pin Functions:

- **Power Pins:**
  - 3.3V: Provides 3.3V output
  - GND: Ground
- **Digital I/O:**
  - GPIO0 to GPIO39: Configurable as input/output, with some supporting PWM, ADC, DAC, etc.
- **Analog Inputs:**
  - GPIO32 to GPIO39: Support ADC (Analog to Digital Converter)
- **Communication Interfaces:**
  - **UART:**GPIO1 (TX0), GPIO3 (RX0)
  - **SPI:**GPIO23 (MOSI), GPIO19 (MISO), GPIO18 (SCK), GPIO5 (CS)
  - **I2C:**GPIO21 (SDA), GPIO22 (SCL)

6.1.2 Communication Protocols

The ESP32 supports multiple communication protocols, enabling seamless integration with various sensors and modules:

- **UART (Universal Asynchronous Receiver/Transmitter):** Serial communication with devices like GPS modules.
- **SPI (Serial Peripheral Interface):** High-speed communication with sensors and displays.
- **I2C (Inter-Integrated Circuit):** Communication with multiple sensors using two wires.
- **ESP-NOW:** A proprietary protocol by Espressif for low-power, peer-to-peer communication without Wi-Fi.

These protocols allow the ESP32 to collect data from health sensors (like heart rate monitors), GPS modules for location tracking, and communicate with cloud services for data storage and analysis.

6.1.3 Specifications of ESP32

Here are the key specifications of the ESP32 microcontroller:

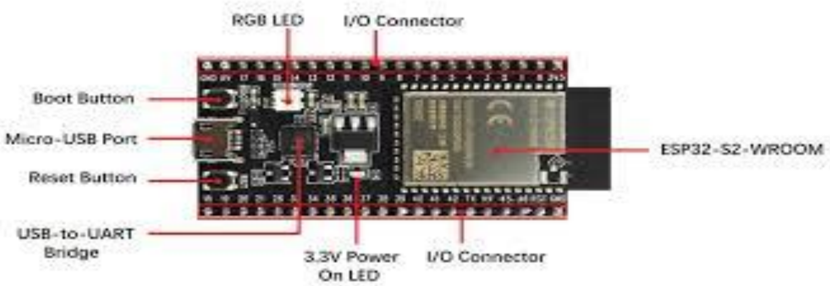

Fig : 6.1.3 Specifications of ESP32

- **Processor :** Dual-core Tensilica Xtensa LX6, up to 240 MHz
- **Memory:**

    - **RAM:** 520 KB SRAM
    - **ROM:** 448 KB
- **Wireless Connectivity:**
    - **Wi-Fi:** 802.11 b/g/n
    - **Bluetooth:** v4.2 BR/EDR and BLE
- **GPIOs:** 34 programmable GPIOs
- **Analog-to-Digital Converter (ADC):** 2 × 12-bit SAR ADCs, up to 18 channels
- **Digital-to-Analog Converter (DAC):** 2 × 8-bit DACs
- **Interfaces:**
    - **SPI:** 4
    - **I2C:** 2
    - **UART:** 3
    - **CAN:** 1
    - **PWM:** 16 channels
- **Operating Voltage:** 3.0V to 3.6V
- **Operating Temperature:** -40°C to +125°C

Security Features:

- Secure boot
- Flash encryption
- Cryptographic hardware acceleration (AES, SHA-2, RSA, ECC) These specifications make the ESP32 suitable for real-time data processing and wireless communication in your soldier monitoring system.

6.2 Temperature Sensor

Temperature sensors are crucial in health monitoring systems for detecting abnormal body temperature, which can indicate fever or other health issues. In this project, the **LM35** sensor is used due to its accuracy, simplicity, and linear output characteristics.

Fig : 6.2 Temperature Sensor

6.2.1 Specifications of Temperature sensor

- Sensor Model: **LM35**
- Type: Analog temperature sensor
- Output Voltage: 10 mV/°C

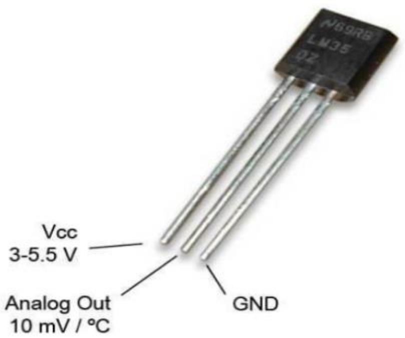

Fig : 6.2.1 Specifications of Temperature sensor

- Temperature Range: -55°C to +150°C
- Accuracy: ±0.5°C (at room temperature)
- Operating Voltage: 4V to 30V

6.2.2 Working Principles of Temperature Sensor

- The LM35 sensor outputs a voltage that is linearly proportional to the temperature in degrees Celsius. For every 1°C rise in temperature, the output voltage increases by 10 millivolts. This analog output is read by the ESP32's ADC (Analog-to-Digital

Converter) and converted into a temperature reading in °C using the formula:

- Temperature (°C)=Analog Voltage×100010\text{Temperature(°C)}=\frac{\text{AnalogVoltage}\ times 1000} {10}Temperature (°C)=10 Analog Voltage×1000
- In the soldier monitoring system, this temperature is compared against predefined thresholds. If the body temperature exceeds normal values (e.g., > 38°C), an alert is triggered and sent via GSM, along with GPS coordinate

6.3 Heartbeat Sensor

A heartbeat sensor is a device used to measure a person's heart rate. It works by sensing the changes in blood flow through a finger or skin surface and converts this into electrical signals. The output is usually shown in beats per minute (BPM), which indicates how fast the heart is beating.

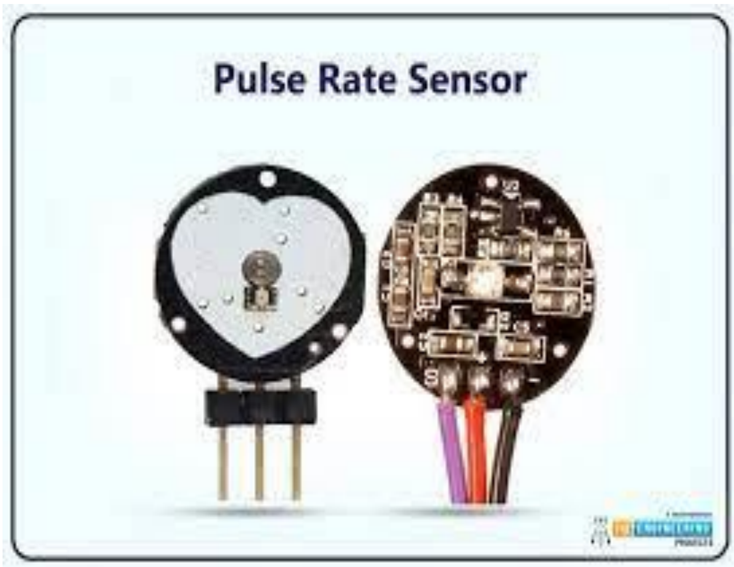

Fig : 6.3 Heartbeat sensor

6.3.1 Specifications of Heartbeat Sensor

- Model:**LMS358**

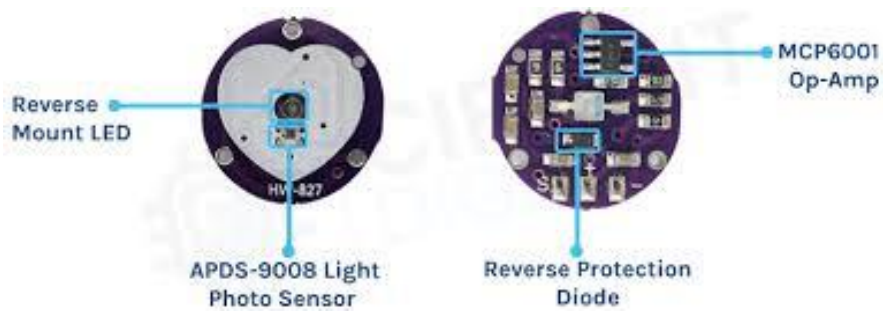

Fig : 6.3.1 Specifications of Heartbeat Sensor

- Working Voltage: 3.3V – 5V DC
- Operating Current: ≤ 10 mA
- Output Type: Analog signal
- Measurement Range: 30 – 240 BPM
- Detection Method: Optical
- Interface Type: 3-pin
- Response Time:< 1 second
- Operating Temperature: 0°C to 50°C
- Size: Compact and lightweight, suitable for wearable applications

6.3.2 Working Principles of Heartbeat Sensor

The sensor uses a light-emitting diode (LED) and a photodiode. When a finger is placed on the sensor, the LED emits light into the skin. Blood vessels absorb some light; the remaining light is reflected back and detected by the photodiode. The sensor generates a pulse waveform corresponding to the heartbeat. This signal is then fed to the ESP32's ADC pin for further processing and monitoring.

6.4 GSM(Global System for Mobile Communication)

The GSM module (such as SIM900A) provides mobile communication capability to the system. It is used to transmit alert messages, including health parameters and GPS location, to a control center via SMS.

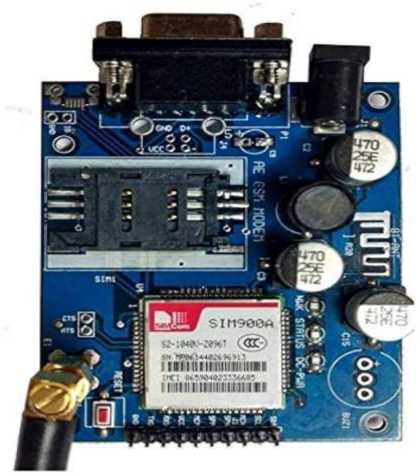

Fig : 6.4 GSM

6.4.1 Specifications of GSM

- Operating Voltage: 3.4V to 4.4V (typically 4V)

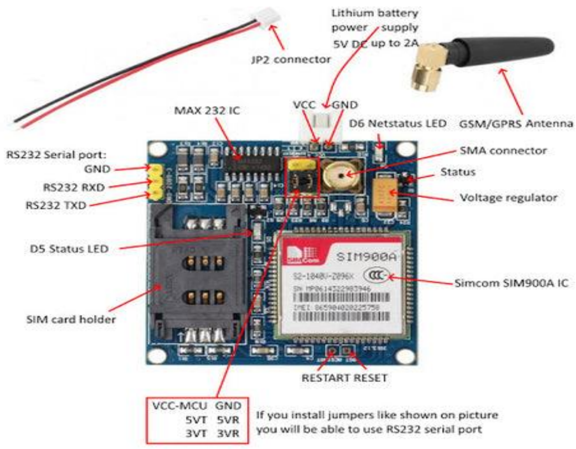

Fig : 6.4.1 Specifications of GSM

- Frequency bands: Quad-band 850/900/1800/1900 MHz
- Interface: UART (Tx, Rx)
- SIM Compatibility: 2G Micro SIM
- SMS & GPRS support: Yes

6.4.2 Working Principles of GSM

The GSM module communicates with the ESP32 using UART protocol. The ESP32 sends AT commands to the module to perform actions such as sending an SMS.

When abnormal health readings or a danger switch is triggered, the ESP32 collects the GPS data and sends it as a formatted text message to the designated phone number via the GSM module.

6.5 GPS (Global Positional System)

The GPS module (e.g., NEO-6M) provides real-time geo location data of the soldier. It allows continuous tracking and ensures swift action in case of emergencies.

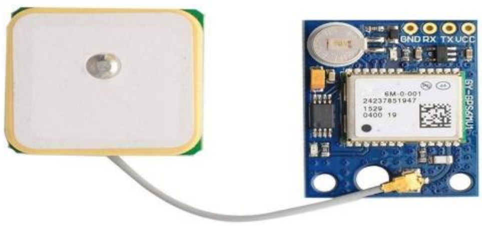

Fig : 6.5 GPS

6.5.1 Specifications

- Power Supply: 3.3V to 5V
- Interface: UART
- Position Accuracy:< 2.5 meters
- Update Rate: 1Hz (default), up to 5Hz
- Antenna: External passive/active antenna supported

6.5.2 Working of GPS

The GPS module receives signals from multiple satellites to determine the exact location in terms of latitude and longitude. It outputs this data via serial communication to the ESP32.

6.6 DANGER SWITCH

The **Danger Switch** is a critical manual alert mechanism integrated into the soldier monitoring system. Its primary function is to allow the soldier to **immediately alert the control center** in case of emergencies, such as injury, distress, or encountering enemy threats.

Fig : 6.6 DANGER SWITCH

6.6.1 Specifications of Danger Switch

- Type: Push-button switch
- Operating Voltage: 3.3V to 5V
- Output: Digital (HIGH/LOW)

6.6.2 Working Principles of Danger Switch

The danger switch is an emergency trigger installed for soldiers. When pressed, it sends a digital signal to the ESP32 microcontroller, which then initiates an emergency alert routine. This includes reading GPS coordinates and sending an SMS alert to the control center using the GSM module, notifying the exact location and time of the emergency.

6.7 LCD DISPLAY

An **LCD (Liquid Crystal Display)** is a flat-panel display technology that uses liquid crystals to produce visible images. In embedded systems and microcontroller-based projects, a **16x2 LCD** is commonly used, which can display **16 characters per line on 2 lines**. It operates by manipulating the alignment of liquid crystals in response to electric signals to control light passage and create alphanumeric characters on the screen.

Fig :6.7 LCD DISPLAY

6.7.1 Specifications of LCD display

- **Display Type:** 16x2 Alphanumeric LCD (HD44780 Controller)
- **Interface:** Parallel (4-bit or 8-bit mode)
- **Operating Voltage:** 4.7V – 5.3V
- **Backlight:** LED (usually green or blue)
- **Characters:** 16 characters per line, 2 lines
- **Controller Voltage:** Logic high: 2.2V–5V

6.7.2 Working Principles of LCD Display

The LCD display is used to show real-time sensor data such as body temperature, heart rate, or status messages. It is interfaced with the ESP32 in 4-bit mode using digital GPIO pins. The ESP32 sends ASCII data and control signals to display characters.

CHAPTER 7

SOFTWARE DESCRIPTION

7. SOFTWARE COMPONENTS

- Arduino IDE

7.1 ARDUINO IDE

Arduino IDE is the software program used to operate the Arduino board. The software program is used as a text editor to create, open, edit and examine Arduino code. The code or program in Arduino is known as a "comic strip".

The Arduino incorporated development surroundings (IDE) is a software program for writing, writing and uploading code to the Arduino board. It provides an easy-to-use interface for programming Arduino boards and simplifies the code era and add process.

The Arduino IDE is primarily based on a programming language and open supply, which means it's loose to apply and may be modified by way of every body. It's miles to be had for windows, MacOSX and Linux working structures. Arduino IDE includes code editor, compiler, bootloader and serial reveal.

The code editor is used to write and edit Arduino code based on the C/C++ programming language. The compiler is used to convert the code into a format the Arduino board can understand and the boot loader is used to upload the code to the board. The serial monitor is used to communicate with and receive data from the development board. Overall the Arduino IDE is a must-have tool for all Arduino board development users as it simplifies the process of working and passing code to the board leader.

INSTALLING ARDUINO IDE

Step1: Download the Arduino IDE file to download the free software, click the following link in any explorer:

There are 3 download alternatives for home windows on this webpage.

1. Windows Installer: This software might be installed with in the windows running gadget and ought to have administrator rights.
2. Home windows Zip document :rautransportable installation.
3. Home windows application: Rauwindows8.1Losis10.

Step2:Installation Option

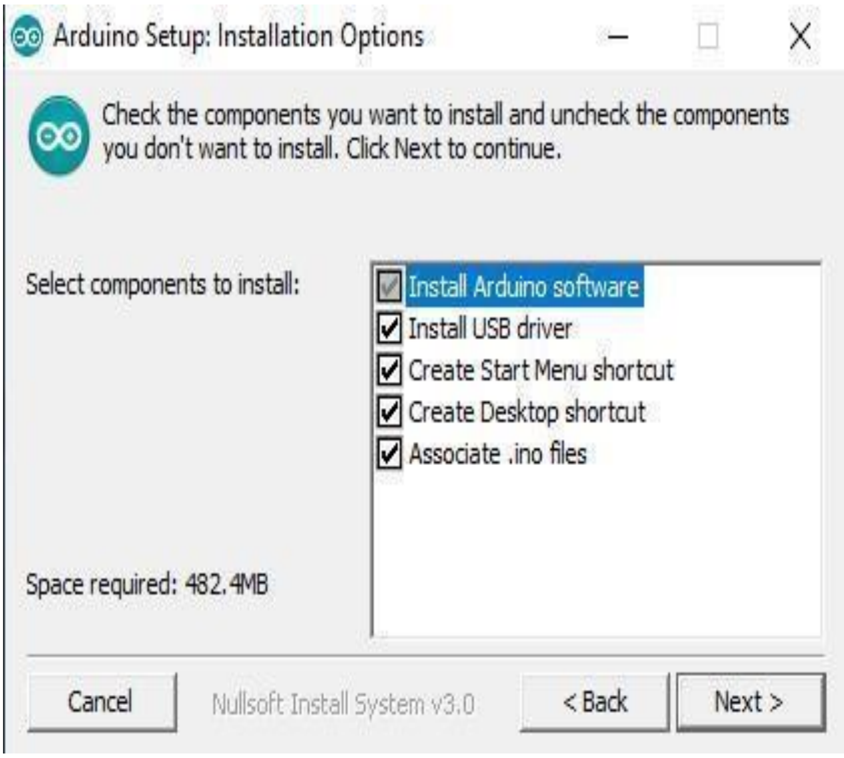

Fig : 7.1 Arduino Installation

Step3: Destination File

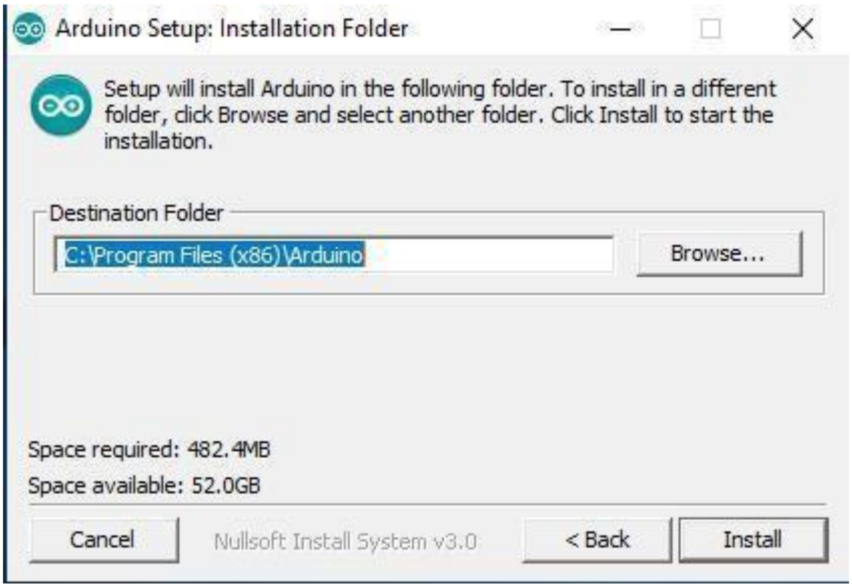

Fig : 7.2 Arduino setup

Arduino will automatically be established in “C: program files(x86) Arduino”.

1. In case you want to alternate the folder, click on “Browse” and pick out the preferred folder.
2. Click deploy to start the installation.

Step 4: Setup installation

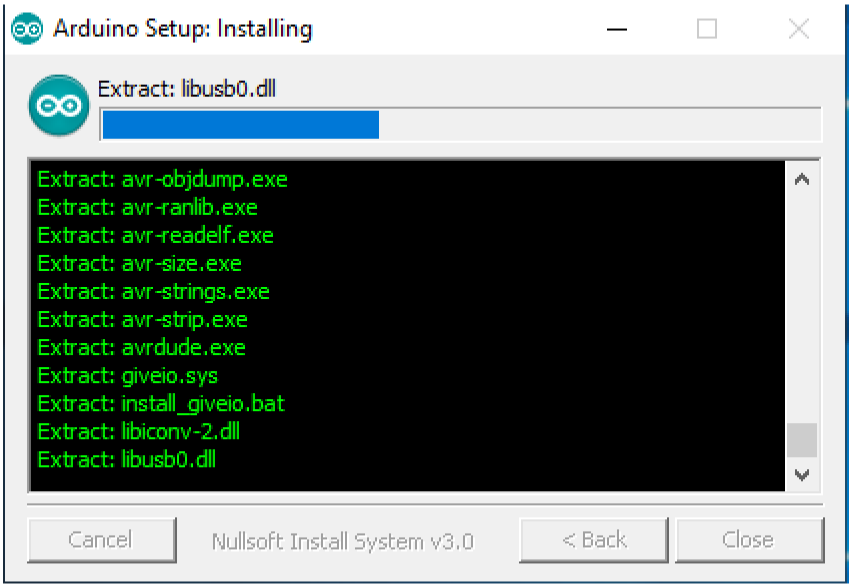

Fig : 7.3 Arduino Setup installation

Step 5: Setup Unit Completed

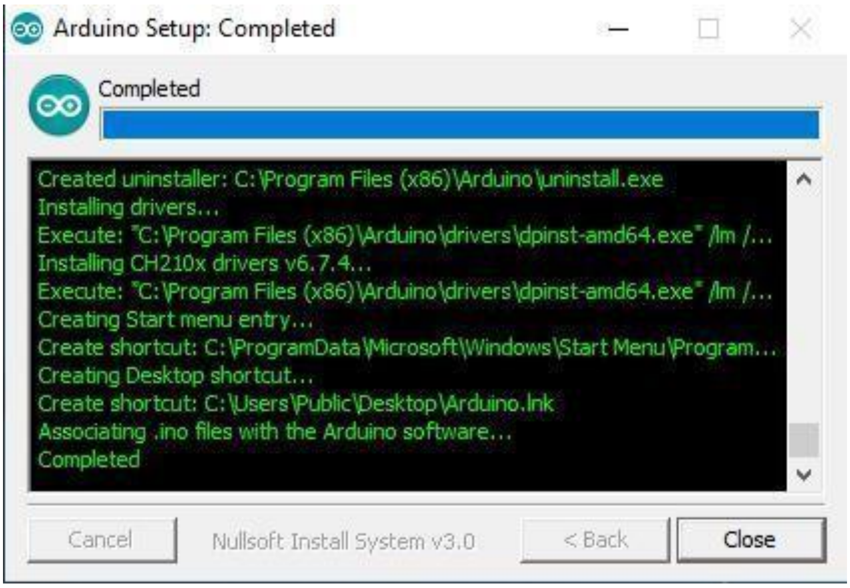

Fig : 7.4 Arduino Software Installation

If there may be written “whole”, it method that the installation manner is complete. Click “near”.

Step 6: View Arduino IDE

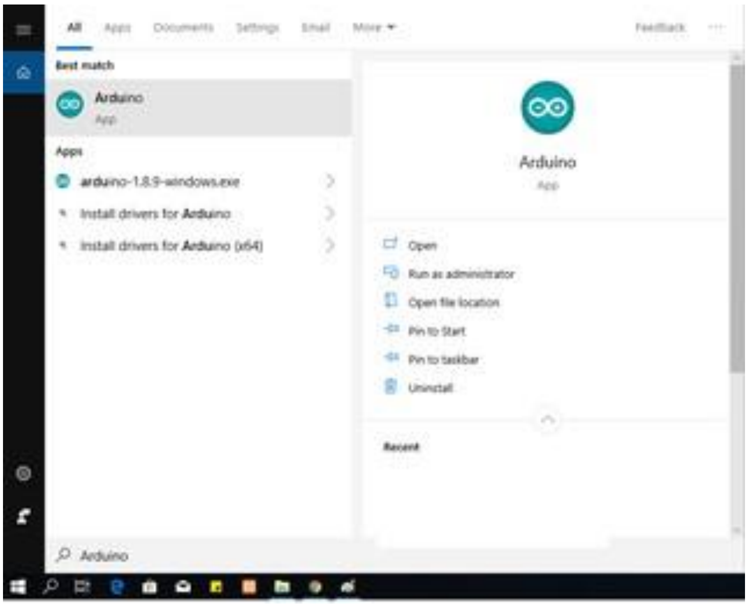

Fig : 7.5 View Arduino IDE

whilst the set up method is whole, the Arduino icon will seem on the laptop. Or draw the quest icon and type “Arduino”. In case you see the Arduino icon, run the software.

Step 7: Show Arduino IDE

Fig : 7.6 Arduino Editor Window

That is a show of the Arduino IDE software.

CHAPTER 8

RESULT

The **IoT-Based Soldier Health Monitoring System** was successfully designed, implemented, and tested under simulated real-time conditions. The results demonstrate accurate sensing, real-time data visualization, and reliable alert transmission using GSM and GPS modules. The system was tested in different scenarios—normal conditions, abnormal vital signs, and emergency button press—to validate performance.

8.1 INITIAL BOOT DISPLAY

When the system is powered ON, all modules (temperature sensor, heart rate sensor, GPS, GSM, and LCD) are initialized by the ESP32. The LCD confirms this by displaying the boot message:

LCD Output:

Fig : 8.1 Initial Boot Display

This ensures that the device is ready to begin real-time monitoring.

8.1.1 Temperature and Heartbeat Monitoring

The system continuously collects real-time physiological data:

- **LM35 Temperature Sensor** measures body temperature.
- **LMS358 Heartbeat Sensor** monitors pulse rate (BPM).

8.1.2 Normal Health Condition Display

- **Temperature:** 32.9°C
- **Heart Rate:** 71 BPM
- **Status:** Normal
- **Action:** No alert sent.

Fig : 8.1.2 Normal Health Condition Display

8.1.3 Abnormal Heart Rate Detected

- **Temperature:** 32.0°C
- **Heart Rate:** 58 BPM
- **Status:** Abnormal Heart
- **Action:** System triggered an SMS alert.

Fig : 8.1.3 (a) Abnormal Heart Rate Detected

- The **ESP32** compares the values to pre-set safety thresholds.
- If values are within normal range, no action is taken.

Fig : 8.1.3 (b) Automatic alert SMS

If values are **abnormal**, an **automatic alert SMS** is sent with the soldier's health data and location.

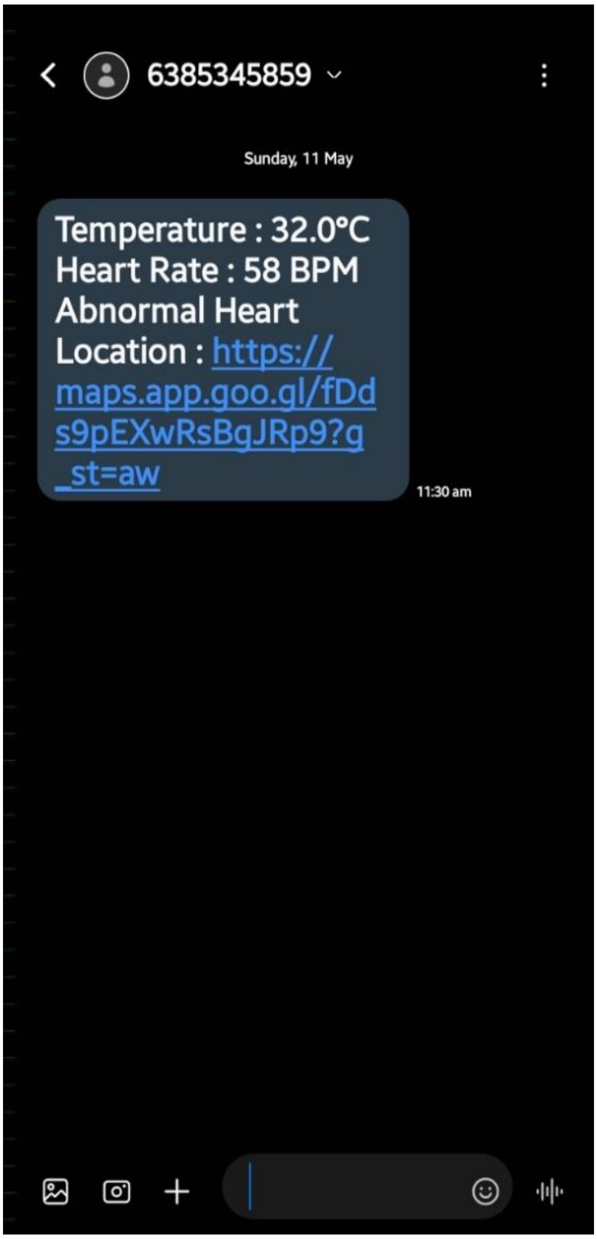

Fig : 8.1.3 (c) Automatic alert SMS send

8.1.4 Emergency Switch Trigger

A physical emergency/danger switch was integrated. When pressed:

- The LCD displays:

Fig : 8.1.4 Emergency Switch Trigger

- The GSM module transmits an emergency SMS to the base station.

8.1.5 Emergency Trigger Activated

Emergency SMS Sent:

EMERGENCY ALERT!

Danger button pressed by soldier.

Location:

- Lat: 18.5204
- Lon: 73.8567

Fig : 8.1.4(a) Emergency Switch Trigger

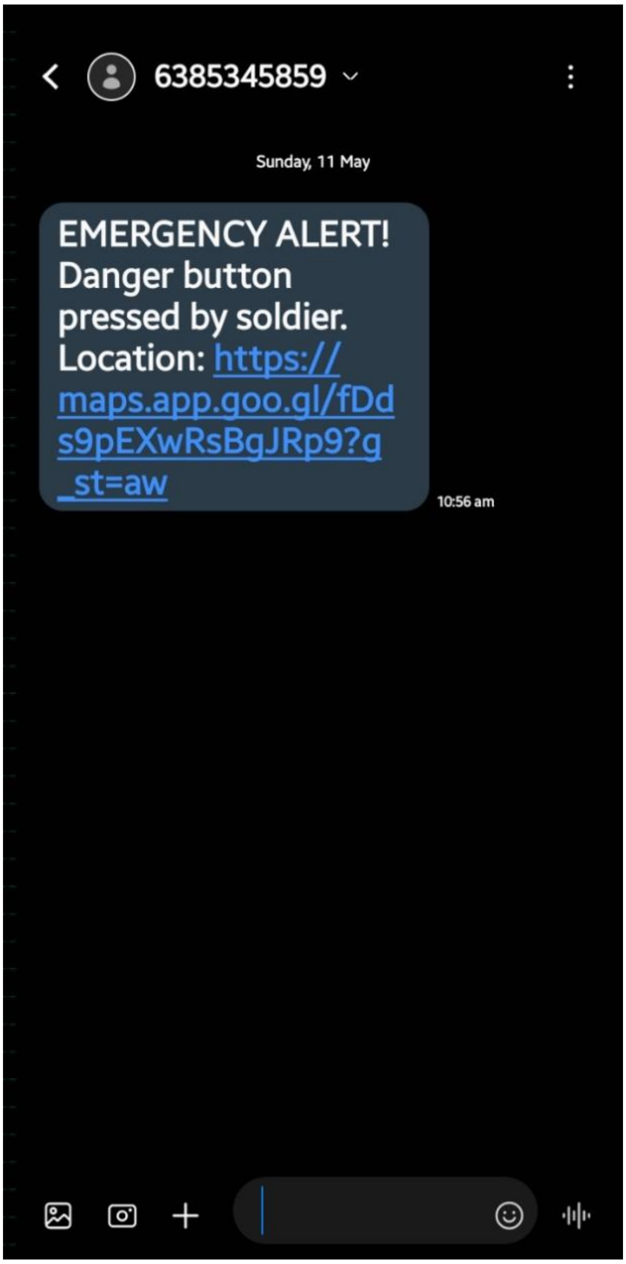

Fig : 8.1.5 Emergency alert SMS send

8.1.6 GPS Location Tracking

The NEO-6M GPS module acquires real-time location and sends coordinates with each alert. GPS data is also shown on the LCD.

Lat: 18.5204

Lon: 73.8567

8.1.7 GSM-Based SMS Transmission

The SIM800L GSM module was used to send messages to a registered mobile number. The ESP32 communicates with GSM using AT commands.

- **Time to Send SMS:** ~5–8 seconds
- **Test Result:** All alerts were received correctly and timely.

8.1.8 LCD Display Overview

The 16x2 LCD screen updates in real-time to show:

- Temperature (°C)
- Heart Rate (BPM)
- Alerts (e.g., Abnormal Heart, Emergency)
- GPS Fix Status
- Boot Message ("SOLDIER MONITOR")

8.1.9 Summary Table of Observations

Component	**Function**	**Normal Range**	**Alert Trigger**	**Action Taken**
LM35 Sensor	Body Temperature Monitoring	36.5°C – 37.5°C	> 38°C	SMS Alert Sent
LMS358 Sensor	Heartbeat Monitoring	60 – 100 BPM	< 50 BPM or > 100 BPM	SMS Alert Sent
GPS Module	Location Tracking	—	Coordinates Updated Live	Included in SMS
GSM Module	Message Transmission	—	When Triggered or Abnormal	Alert SMS to Base Station
Danger Switch	Manual Alert	—	Button Pressed	Emergency SMS Sent

Table : 8.1.9 Summary Table of Observations

8.2 HARDWARE IMPLEMENTATION

The modular architecture of the soldier monitoring system provides excellent scalability and flexibility, allowing easy integration of additional sensors or mission-specific modules in the future. At its core is the ESP32 microcontroller, selected for its dual-core processing and wireless capabilities. It interfaces with key components including the LM35 temperature sensor, LMS358 heart rate sensor, SIM900A GSM module, NEO-6M GPS module, 16x2 LCD display, and a manual danger switch.

These elements are connected via analog, digital, and serial communication interfaces such as ADC, UART, and I2C. The GSM module sends SMS alerts containing vital health information and GPS coordinates to a central command center, while the GPS module continuously tracks the soldier's location. The LCD display provides real-time feedback to the soldier, displaying temperature, heart rate, and status messages.

The inclusion of a manual danger switch adds a critical layer of safety, enabling the soldier to send an emergency alert in life-threatening situations. The system is designed for low power consumption, making it suitable for extended field use. Its compact and lightweight form allows for easy portability or integration into wearable gear without limiting the soldier's mobility.

Future improvements could include encrypted communication, advanced biometric sensors, and AI-driven health anomaly detection. Overall, the system ensures real-time monitoring, rapid response, and enhanced safety, making it highly effective and scalable for modern military operations.

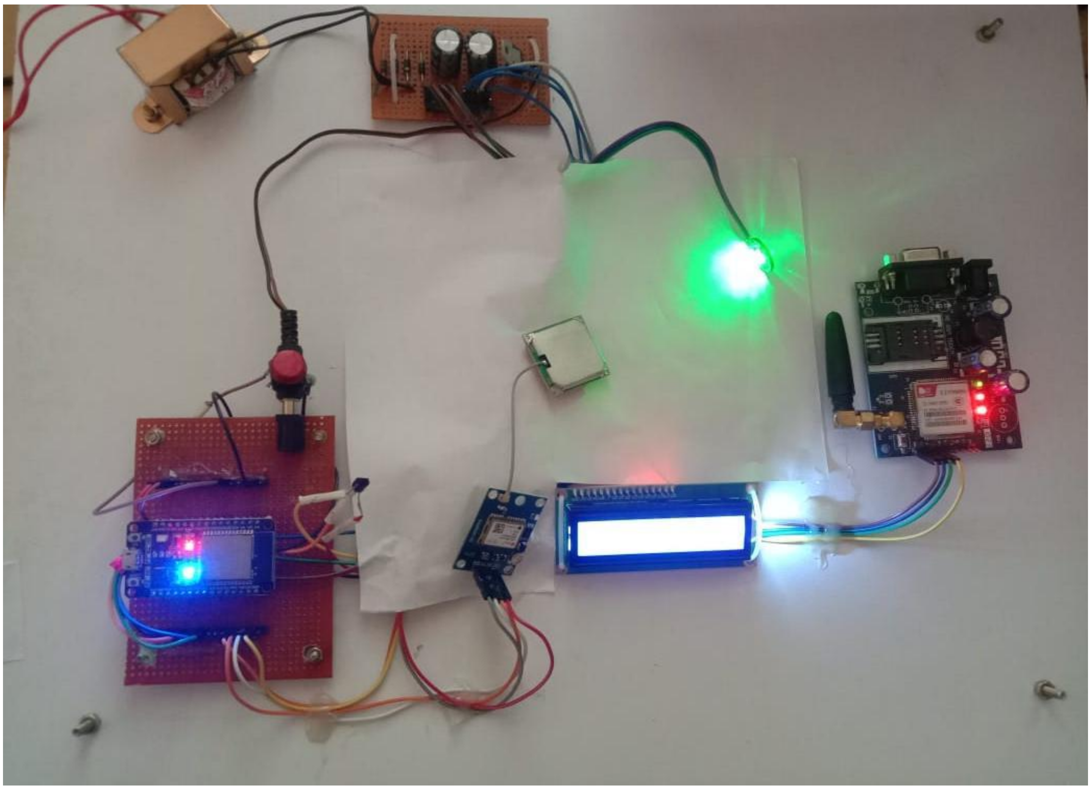

Fig : 8.2 Hardware Implementation of Proposed System

During field trials, the hardware was tested for robustness, confirming its suitability for harsh environments. Its low power usage, durability, and minimal maintenance make it ideal for deployment in remote defense operations. The **danger switch** serves as a manual panic alert system, instantly triggering an SMS with location details when pressed.

The successful hardware integration confirms the system's potential to enhance battlefield awareness and soldier safety, offering a responsive, cost-effective, and scalable defense monitoring solution.

8.3 Advantages of Proposed System Over Existing

- **Real-Time Monitoring** – Continuous and automatic tracking of soldier health parameters and location, unlike traditional manual reporting systems.

- **Instant Alerts** – Immediate SMS alerts sent during emergencies, such as abnormal health conditions or when the danger switch is activated, ensuring timely response.
- **Remote Access** – Real-time data can be accessed remotely via GSM communication, allowing command centers to monitor soldiers from any location.
- **Higher Accuracy** – Use of digital sensors minimizes human error, providing more reliable health data and location tracking.
- **Scalable & Cost-Effective** – The modular design supports easy scaling to larger deployments and uses affordable components suitable for mass production.
- **Improved Soldier Safety** – By detecting health issues or distress conditions early, the system enhances safety and increases the chances of timely medical assistance.
- **Manual Emergency Trigger** – The inclusion of a danger switch gives the soldier the ability to manually raise an alert when immediate help is needed.
- **User Feedback Through LCD** – The onboard LCD display provides real-time updates to the soldier, helping them stay informed about their own status and system operation.
- **Low Power Consumption** – Designed to function efficiently in power-limited environments, ensuring extended use in field operations.
- **Portability and Wear ability** – The system's lightweight and compact build allows it to be worn or carried easily without affecting mobility.
- **Reliable Communication in Remote Areas** – With GSM-based messaging, it works even in areas without internet access, unlike many existing IoT systems that require Wi-Fi or cloud platforms.
- **Flexible Integration** – Future modules (e.g., SpO2 sensor, environmental sensor) can be easily added without redesigning the system architecture.
- **Faster Decision-Making** – The centralized command unit receives critical data faster, enabling quicker strategic and medical decisions.

CHAPTER 9
CONCLUSION

The proposed soldier health and tracking system, developed using **ESP32 microcontroller technology**, represents a significant step forward in enhancing battlefield safety, real-time monitoring, and rapid emergency response. By integrating essential health sensors, GPS-based location tracking, GSM communication, and a user-friendly LCD interface, the system effectively monitors a soldier's physiological condition and geographic position with both precision and reliability.

Utilizing basic yet reliable sensors like the **LM35 temperature sensor** and **LMS358 heartbeat sensor**, the system demonstrates the feasibility of continuous health surveillance in real-world field environments. The **LCD display** provides real-time feedback to the soldier, showing current body temperature, heart rate, and system status messages—helping the user stay informed and aware. Additionally, the **SIM900A GSM module** enables immediate SMS-based alerts in case of abnormal health conditions or emergencies, while the **GPS module** ensures accurate location tracking. The inclusion of a **danger switch** serves as a vital manual emergency trigger, allowing the soldier to send an instant alert in situations of distress.

Although the current prototype employs essential components, future versions can incorporate advanced biomedical sensors, encrypted communication, and wearable integration to improve functionality and comfort. The addition of features like local data storage and enhanced display modules could further boost the system's efficiency. Its modular design, low power consumption, affordability, and real-time response make it suitable for scalable deployment across defense applications. In conclusion, this project serves as a strong foundation for smart soldier support systems, contributing to improved operational safety, faster response times, and enhanced situational awareness on the battlefield.

APPENDIX

```
#include <Wire.h>
#include <TinyGPS++.h>
#include <LiquidCrystal_I2C.h>

// === Pin Definitions ===
#define TEMP_SENSOR_PIN 4
#define HEARTBEAT_SENSOR_PIN 36
#define DANGER_SWITCH 32

// === Serial Ports ===
HardwareSerial gpsSerial(1); // GPS: RX=26, TX=27
HardwareSerial gsmSerial(2); // GSM: RX=16, TX=17

TinyGPSPlus gps;
LiquidCrystal_I2C lcd(0x27, 16, 2);

// === BPM Calculation Variables ===
unsigned long lastBeatTime = 0;
unsigned long bpmCalcStart = 0;
int beatCount = 0;
int bpm = 0;

void sendSMS(String message) {
  gsmSerial.println("AT+CMGF=1");
  delay(1000);
  gsmSerial.println("AT+CMGS=\"+91 9382311143\"");
  delay(1000);
  gsmSerial.print(message);
```

```
  delay(500);
  gsmSerial.write(26);
  delay(3000);
}

void setup() {
  Serial.begin(115200);
  gpsSerial.begin(9600, SERIAL_8N1, 26, 27); // GPS on UART1
  gsmSerial.begin(9600, SERIAL_8N1, 16, 17); // GSM on UART2

  pinMode(TEMP_SENSOR_PIN, INPUT);
  pinMode(HEARTBEAT_SENSOR_PIN, INPUT);
  pinMode(DANGER_SWITCH, INPUT_PULLUP);

  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print(" Soldier Monitor ");
  delay(2000);
  lcd.clear();

  bpmCalcStart = millis();
}

void loop() {
  unsigned long currentTime = millis();

  // === Temperature Reading ===
  int tempValue = analogRead(TEMP_SENSOR_PIN);
```

```
float voltage = (tempValue * 3.3) / 4095.0;
float temperature = voltage * 100.0;

// === Heartbeat Signal ===
int signal = analogRead(HEARTBEAT_SENSOR_PIN);
if (signal > 2000 && (currentTime - lastBeatTime) > 300) {
  beatCount++;
  lastBeatTime = currentTime;
}

// === GPS Parsing ===
while (gpsSerial.available()) {
  gps.encode(gpsSerial.read());
}

float latitude = gps.location.isValid() ? gps.location.lat() : 0.0;
float longitude = gps.location.isValid() ? gps.location.lng() : 0.0;

// === BPM Calculation Every 15s ===
if (currentTime - bpmCalcStart >= 15000) {
  bpm = beatCount * 4; // 15s window
  beatCount = 0;
  bpmCalcStart = currentTime;

  // === Always show values on LCD ===
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("T:");
  lcd.print(temperature, 1);
```

```
lcd.print("C H:");
lcd.print(bpm);

lcd.setCursor(0, 1);
lcd.print("Lat:");
lcd.print(latitude, 1);
lcd.print(" Lon:");
lcd.print(longitude, 1);

delay(3000);

// === Check for abnormal values ===
bool tempAbnormal = (temperature < 34.0 || temperature > 40.0);
bool bpmAbnormal = (bpm < 60 || bpm > 100);

if (tempAbnormal && bpmAbnormal) {
  String msg = "Heart & Temp Abnormal\nTemp: ";
  msg += String(temperature, 1);
  msg += "C, Heart: ";
  msg += String(bpm);
  msg += " BPM\nLocation: https://maps.google.com/?q=";
  msg += String(latitude, 6) + "," + String(longitude, 6);
  sendSMS(msg);
} else if (tempAbnormal) {
  String msg = "Temp Abnormal: ";
  msg += String(temperature, 1);
  msg += "C\nLocation: https://maps.google.com/?q=";
  msg += String(latitude, 6) + "," + String(longitude, 6);
  sendSMS(msg);
```

```
  } else if (bpmAbnormal) {
    String msg = "Heart Abnormal: ";
    msg += String(bpm);
    msg += " BPM\nLocation: https://maps.google.com/?q=";
    msg += String(latitude, 6) + "," + String(longitude, 6);
    sendSMS(msg);
  }
 }

 // === Emergency Switch Pressed ===
 if (digitalRead(DANGER_SWITCH) == LOW) {
   String alert = "EMERGENCY!\nLocation: https://maps.google.com/?q=";
   alert += String(latitude, 6) + "," + String(longitude, 6);
   sendSMS(alert);

   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("!! ALERT SENT !!");
   delay(5000);
 }

 delay(100); // Fast loop
}
```

CHAPTER 10
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