A

PROJECT REPORT

ON

"IOT BASED SOLDIER HEALTH MONITORING AND POSITION TRACKING SYSTEM"

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF

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ELECTRONIC ENGINEERING

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MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

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PURANMAL LAHOTI GOVERNMENT POLYTECHNIC, LATUR

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MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

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b. The work has not been submitted to any other Institute for any degree or diploma.
c. I have followed the guidelines provided by the Institute in preparing the project report.
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We are grateful to **Dr.S.S.Kanade**, Head of Department in Electronics, PLGPL. His valuable guidance through the period of this project. Most importantly we would like to thank project coordinator and our project guide **Prof. A.M. Kulkarni** madam for not only encouraging us to work in this social domain but also constantly guiding us with valuable inputs whenever we approached her and thereby making this project possible. Last but not the least; we would like to express our gratitude towards our parents for their kind co-operation and encouragement which helped using completion of this project.

ABSTRACT

An IoT-based soldier health monitoring and position tracking system is a technological solution that enables real-time monitoring of soldier's health and their location during combat operations. The system is designed to ensure the safety of soldiers and enhance their performance on the battlefield. The system utilizes various sensors and devices such as heart rate monitors, temperature sensors, GPS, and accelerometers to gather data on the soldier's vital signs and movements. This data is then transmitted wirelessly to a central monitoring system, which analyzes it and provides real-time feedback to the commanding officers. By monitoring soldier's vital signs, the system can quickly identify any health issues that may arise, such as fatigue or dehydration, and alert the appropriate medical personnel. The system also tracks soldier's positions and movements, allowing commanders to make informed decisions about deployment and resource allocation. Overall, an IoT-based soldier health monitoring and position tracking system is a valuable tool for ensuring the safety and well-being of soldiers on the battlefield.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Soldier is always facing death. He never shirks responsibility. He fights in most difficult terrains, on hills and mountain, in plains and forest. The defense of the country is his primary mission. The role of soldier in safeguarding the frontiers of his modest land is unique. He lives and dies for the nation. It is our responsibility to help our soldier. That's why we are introducing this project which will be very useful for providing health status of the soldiers and provide medical help to them at critical situation in battlefield.

In our system we are basically focusing on Soldier's health in terms of his heartbeats, oxygen level and body temperature. If soldier gets injured and becomes unconscious by gunshot or due to any other reason, then his heart beats, oxygen level and body temperature start increasing or decreasing gradually. In this type of situation where the information about current heart brat rate, oxygen level and body temperature become the indispensable part of soldier, this project emerges out as best to acknowledge the doctors at server site with the correct and fast information.

If heart beat either increases above critical level or decreases below the critical level, the information about soldier is automatically sent to base station with the help of GSM and Wi-Fi modem. GPS tracker will give the current location of the soldier which will be useful for locating soldier's location and providing medical help as early as possible. In case if soldier is injured then by using the GSM modem attached to the device an SMS will be sent to hospitals in the vicinity or to the base station to provide help.

1.2 BASIC IDEA

This project has associate implementation of tracking the soldier and to navigate between soldiers like obtaining their rapidity, distance, their health status throughout the fighting that permits the military decision makers to set up the war strategies.

Figure 1.1: Base station

Base unit acquires location of soldier with the help of GPS. The responsibility of base station operators is to help the soldiers in choosing right path, if there is a threat of missing of soldiers. The base unit will contact this standing of the soldier that is exhibited on the computer. Hence, they can yield instant action by directing assistance for the soldier requested by soldiers having soldier unit. By the use of number of biomedical sensors, health constraints of soldiers are monitored, the location and placement of soldier is confined by the use of GPS module.

Figure 1.2.: Soldier Unit

1.3 PLAN

Our plan was to introduce the cost effective and consistent project which can assist the base unit, regarding the health and security of the soldiers, during war, special operations.

Moreover, soldier can send emergency messages to base station for some kind of help.

1.4 DESIGN

In order to design our project, we used two units namely soldier and base unit. Soldier unit contains a microcontroller (ESP 32), heart beat sensor and oxygen level sensor (MAX30102) are used to calculate the pulse rate of soldier and oxygen level, temperature sensor (LM35) used to calculate the body hotness of the soldier, GPS receiver (NEO 6M) is used for tracking purpose, a Button is used for emergency, GSM Module (SIM 900A) is used to send all the input data to base station and LCD is used to display this data.

The project is mainly divided into four sections as shown in figure 1.3.

1. Input section
2. Output section
3. Circuit section
4. Sensor section

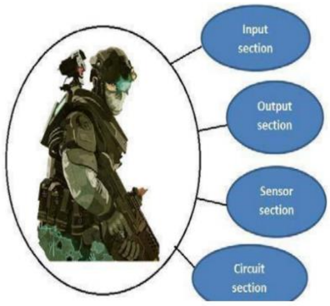

Figure 1.3: Different section of project

CHAPTER 2

REVIEW OF LITERATURE

2.1 GENERAL OVERVIEW

This system enables GPS Tracking of these soldiers and also enables the telemedicine. It is possible by M-Health. The M-Health can be well-defined as medical sensors and communication technologies for health care. In a Real Time, Tracking and Health Monitoring System, smart sensors are attached with the soldiers and other components like LCD, Batteries, GSM and PCB are enclosed in a box, which will be in the bag of soldier. These are implanted with a personal server for complete mobility. This personal server will provide connectivity to the server at the base station using a wireless connection (GSM). A GPS Tracking system is also enclosed in the box, which provides the tracking of the position of soldier. Each unit has a GSM module, which enables the communication between both ends. Thereby, it is possible to back up a soldier or assist a soldier and makes the mission accomplished. At any instant, any soldier is in position of entering the enemy area, it's terribly important for the military base station to understand the situation and the health standing of all troopers as well. In our project we have planned towards a concept of tracking the soldier and also monitor the health standing of the soldier throughout the war that allows the military personnel to set up the war ways.

2.2 LITERATURE REVIEW

In this section highlight the different methods which are previously used for Soldier health monitoring and position tracking system.

[1] **Paper Title:** IOT Based Soldier Position Tracking and Health Monitoring System

Author: Pavan Mankal, Sushmita, Ummeaiman, Shweta.W

Description: He suggests a technique that is specifically designed to meet the safety needs of armed personnel on the battlefield. The proposed method is primarily concerned with determining the exact location of soldiers on the battlefield. For determining human life expectancy, many human key signs and physical status conditions such as temperature, pulse rate, and oxygen saturation are used.

[2] **Paper Title:** Soldier Tracking and Health Monitoring System using LabVIEW

Author: Mahammad Eliyaz, M Leela Venkata Sai Prudvi, G Pragnya Reddy, M Pavan

Description: They suggest technique which specially designed for military application. This system continuously monitors the health-based issues and exact location of soldier during war time. Soldier always lose lives in battle field due to improper communication. It is mandatory to know the health condition as well as position or the base station.

[3] **Paper Title:** IOT and GPS Based Soldier Position Tracking and Health Monitoring System

Author: Monika V. Bhivarkar, Anuja G. Asole, P. B. Domkondwar

Description: This System focused on tracking the location of soldier from GPS. The different types of biomedical sensors used in this system are the heartbeat sensor, temperature sensor and gas sensor. The main essence of this project is that it is an Internet of Things (IoT) based project. Using the IoT, their data can be transferred from one place to another over the network without the computer to computer and human to computer intervention.

[4] **Paper Title:** IoT Based Soldier Navigation and Health Monitoring System

Author: Krutika Patil, Omkar Kumbhar, Sakshi Basangar, PriyankaBagul

Description: This system uses GPS module and wireless body area sensor network to record all parameters in real time and send it to the base station. The different types of sensors used in this system are the humidity sensor, temperature sensor and pulse sensor which help in deciding the health status of that particular army official. This is a wearable technology which is the most important factor of this project.

[5] **Paper Title:** Health Monitoring and Soldier Tracking System using IOT

Author: Puneeth Kumar D N, Archana Padikar A, Cinmayee C K, Chaithra E, Chethan

Description: This work deals with the keep track of the soldier parameters such as temperature, breathing and heart rate. Arduino Uno and Node MCU are used in designing the soldier monitoring system. Internet of Things (IoT) with Global Positioning System (GPS) is used for tracking the location of the soldier and monitoring of the health parameters like heartbeat, gas sensor and body temperature.

[6] **Paper Title:** Health Monitoring and Tracking System for Soldiers Using Internet of Things

Author: Niketpatii; Brijeshiyer,

Description: The paper reports an Internet of Thing (IoT) based health monitoring and tracking system for soldiers. The proposed system can be mounted on the soldier's body to track their health status and current location using GPS. This information will be transmitted to the control room through IoT. The proposed system comprises of tiny wearable physiological equipment's, sensors, transmission modules. Hence, with the use of the proposed equipment, it is possible to implement a low-cost mechanism to protect the valuable human life on the battlefield.

[7] Paper Title: Real-time Location Tracker for Critical Health Patient using Arduino, GPS Neo6m and GSM Sim800L in Health Care

Author: Pratik Kanani and Dr. Mamta Padole

Description: proposed a paper entitled “Real-time Location Tracker for Critical Health Patients using Arduino, GPS Neo6m and GSM Sim800L in Health Care”. They focused their proposed work on an IOT device that detects the precise latitude and longitude, i.e., the location of the patients in relation to the base station room. Doctors and health centre staff can also determine the exact location of the patient using web applications on the server and Google Maps, and medical assistance can be provided accordingly

CHAPTER 3

PROPOSED METHODOLOGY

In this chapter the Block diagram, hardware requirement and software requirement of the project is explained with different sections.

3.1 BLOCK DIAGRAM

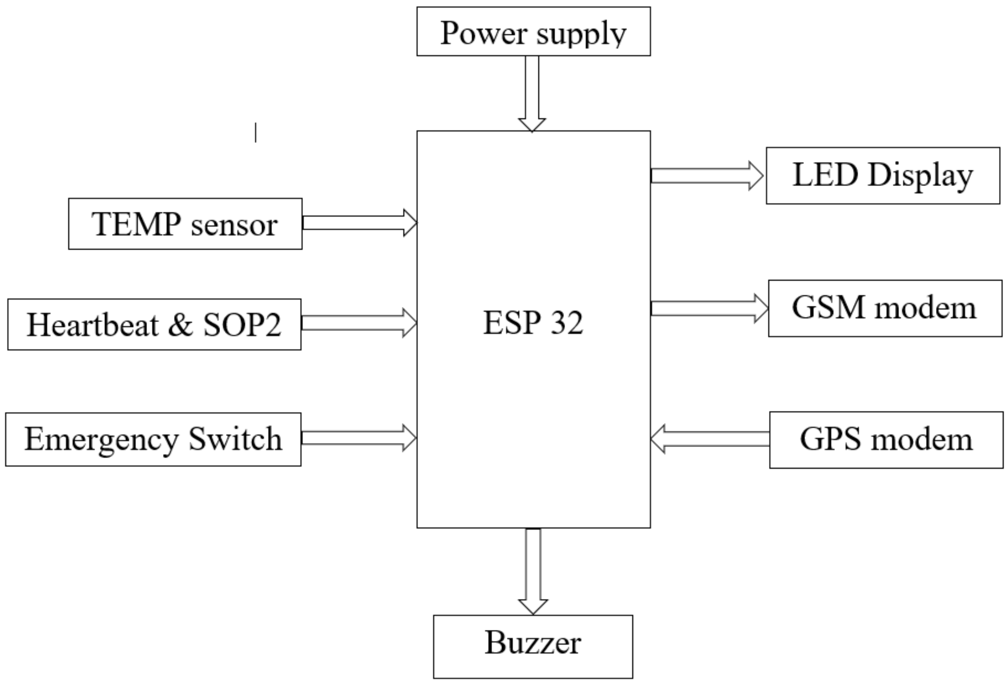

Figure 3.1: Block Diagram

3.2 HARDWARE DESCRIPTION

In this section the overview of components used in the project is explained briefly. And we briefly discussed general characteristics of these components. Following are the main components and their general description.

- Microcontroller (ESP 32)
- GPS (NEO 6M)
- GSM (SIM 900A)
- Heartbeat and Oxygen level sensor (MAX 30100)
- Temperature sensor (LM35)
- LCD Display
- Power supply

3.2.1 Microcontroller

ESP32 is a low-cost, low-power Microcontroller with an integrated Wi-Fi and Bluetooth. It is the successor to the ESP8266 which is also a low-cost Wi-Fi microchip albeit with limited vastly limited functionality.

It is an integrated antenna and RF balun, power amplifier, low-noise amplifiers, filters, and power management module. The entire solution takes up the least amount of printed circuit board area. This board is used with 2.4 GHz dual-mode Wi-Fi and Bluetooth chips by TSMC 40nm low power technology, power and RF properties best, which is safe, reliable, and scale-able to a variety of applications. The ESP 32 microcontroller is shown in Figure 3.2.

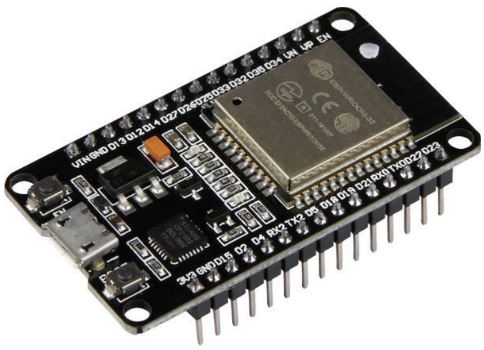

Figure 3.2: ESP 32 Microcontroller

3.2.1.1 ESP32 Pinout

In our project, we are using ESP32 microcontroller. Its pin out diagram is shown in Figure. 3.3.

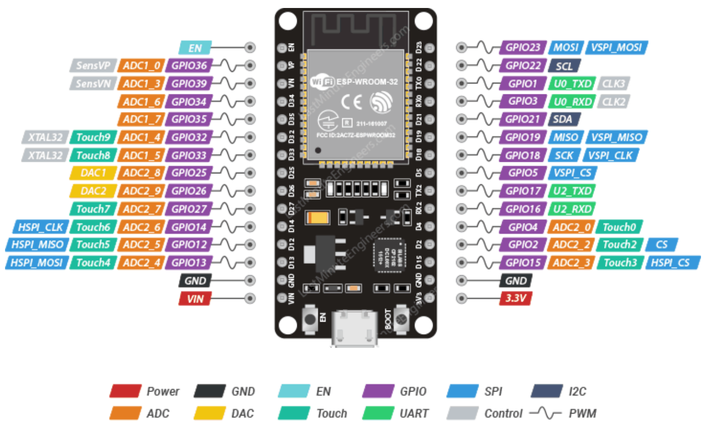

Figure 3.3: Pin out Diagram

3.2.1.2 Pin function

- **Input Only GPIOs**

Pins GPIO34, GPIO35, GPIO36(VP) and GPIO39(VN) cannot be configured as outputs. They can be used as digital or analog inputs, or for other purposes. They also lack internal pull-up and pull-down resistors, unlike the other GPIO pins.

- **ESP32 Interrupt Pins**

All GPIOs can be configured as interrupts.

- **ADC Pins**

Pins GPIO02, GPIO04, GPIO12, GPIO13, GPIO14, GPIO15, GPIO25, GPIO26, GPIO27, GPIO32, GPIO33, GPIO34, GPIO35, GPIO36, GPIO39 are used as ADC pins.

ESP32 integrates two 12-bit SAR ADCs and supports measurements on 15 channels (analog-enabled pins).

The ESP32's ADC is a 12-bit ADC, which means it can detect 4096 (2^12) discrete analog levels. In other words, it will convert input voltages ranging from 0 to 3.3V (operating voltage) into integer values ranging from 0 to 4095. This results in a resolution of 3.3 volts / 4096 units, or 0.0008 volts (0.8 mV) per unit.

- **DAC Pins**

Pins GPIO25, GPIO26 are used as DAC pins.

The ESP32 includes two 8-bit DAC channels for converting digital signals to true analog voltages. It can be used as a "digital potentiometer" to control analog devices.

These DACs have an 8-bit resolution, which means that values ranging from 0 to 256 will be converted to an analog voltage ranging from 0 to 3.3V.

- **I2C Pins**

Pins GPIO21, GPIO22 is used as I2C pins.

The ESP32 has a single I2C bus that allows you to connect up to 112 sensors and peripherals. The SDA and SCL pins are, by default, assigned to the following pins. However, you can bit-bang the I2C protocol on any GPIO pins with the `wire. Begin (SDA, SCL)` command.

- **SPI Pins**

ESP32 features three SPIs (SPI, HSPI, and VSPI) in slave and master modes. These SPIs also support the general-purpose SPI features listed below:

- 4 timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

Only VSPI and HSPI are usable SPI interfaces, and the third SPI bus is used by the integrated flash memory chip. VSPI pins are commonly used in standard libraries.

- **UART Pins**

The ESP32 dev. board has three UART interfaces, UART0, UART1, and UART2, that support asynchronous communication (RS232 and RS485) and IrDA at up to 5 Mbps.

- UART0 pins are connected to the USB-to-Serial converter and are used for flashing and debugging. Therefore, the UART0 pins are not recommended for use.
- UART1 pins are reserved for the integrated flash memory chip.
- UART2, on the other hand, is a safe option for connecting to UART-devices such as GPS, fingerprint sensor, distance sensor, and so on.

- **PWM Pins**

The board has 21 channels (all GPIOs except input-only GPIOs) of PWM pins controlled by a PWM controller. The PWM output can be used for driving digital motors and LEDs.

The PWM controller consists of PWM timers, the PWM operator and a dedicated capture sub-module. Each timer provides timing in synchronous or independent form, and each PWM operator generates a waveform for one PWM channel. The dedicated capture sub-module can accurately capture events with external timing.

- **Power Pins**

There are two power pins: the VIN pin and the 3V3 pin. The VIN pin can be used to directly power the ESP32 and its peripherals, if you have a regulated 5V power supply. The 3V3 pin is the output from the on-board voltage regulator; you can get up to 600mA from it. GND is the ground pin.

- **Enable Pin**

The EN pin is the enable pin for the ESP32, pulled high by default. When pulled HIGH, the chip is enabled; when pulled LOW, the chip is disabled.

The EN pin is also connected to a pushbutton switch that can pull the pin LOW and trigger a reset.

3.2.1.3 Specification

Table 3.1: Specification of ESP32

Parameters	**Specification**
Microcontroller	Tensilica 32-bit Single-/Dual-core CPU Xtensa LX6
Operating Voltage	3.3V
Input Voltage	7-12V
Digital I/O Pins (DIO)	25
Analog Input Pins (ADC)	6
Analog Outputs Pins (DAC	2
UARTs	3
SPIs	2

I2Cs	3
Flash Memory	4 MB
SRAM	520 KB
Clock Speed	240 MHz
Wi-Fi	IEEE 802.11

3.2.2 Global Positioning System

3.2.2.1 Introduction to GPS

The Global Positioning System (GPS) is radio location using navigation satellites. These systems provide round the clock information on the three-dimensional position, velocity and time for users with the appropriate equipment and are at or near the earth's surface (and sometimes outside it). The first system GPS, widely available to civil users, has become NAVSTAR, serviced by the Ministry of Defense.

Applications include portable guidance on the location, trajectory tracking of ships, as well as the system of driving wireless communication devices, which are designed for the car, the driver provides a personalized and promotional information, receive messages, and use the specific local conditions of travel information and services Security. GPS technology is used in a large number of applications, including maritime, environmental, navigational applications for tracking and monitoring. The GPS consists of three main parts as shown in Figure 3.4.

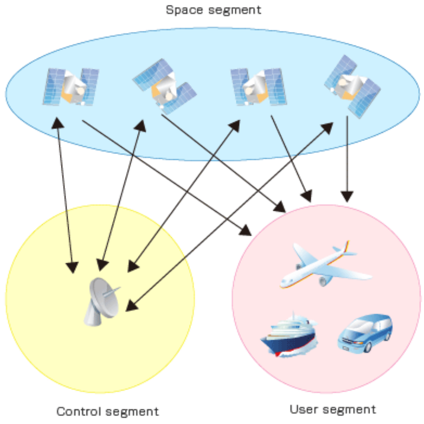

Figure 3.4: GPS segments

3.2.2.2 Application Areas

The GPS is applicable and can be used in the tracking of people in a suitable embedded system. It seems possible because GPS has no effect of weather, works around the globe without operation dues and payment 24 hours a day. The most important is that the GPS also used to define the position in 3 dimensions. So it is able to work accurately in detection of location of user.

3.2.2.3 NEO-6M

The NEO-6M GPS module is a GPS receiver that can locate all locations on Earth as it is able to track approximately 22 satellites. It consists of a high-performance u-box 6 positioning engine. Measuring 16 x 12.2 x 2.4 mm, its compact architecture along with its low power consumption makes it a good choice for IoT projects. Overall, it is a good cost-effective GPS receiver. The GPS NEO 6M as shown in Figure 3.5.

Figure 3.5: GPS NEO-6M

3.2.2.4 NEO-6M Pinout

The Figure 3.6. shows the pinout of the NEO 6M module. It consists of 4 pins named GND, TX, RX, and VCC.

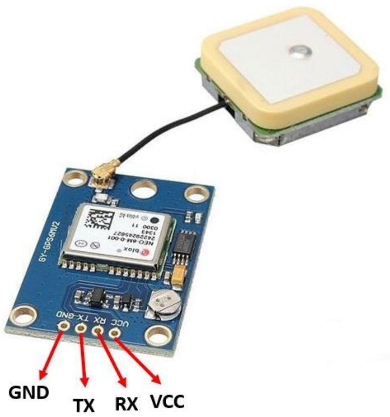

Figure 3.6: NEO-6M pinout

- **GND:** This is the ground pin that will be connected with the ground of the Microcontroller.
- **TX:** This is the transmission pin used for serial communication.
- **RX:** This is the receiver pin used for serial communication.
- **VCC:** This is the VCC pin used to power up the GPS module. Connect to the 5V.

3.2.2.5 Specifications

The table below shows some specifications of the NEO-6M module.

Table 3.2: Specification of NEO-6M

Type	GPS
Supply	2.7 V-3.6 V
Operating Current	45mA
Operating Temperature	-40°C ~ 85°C
Horizontal Position Accuracy	2.5m
Communication Protocol	NMEA, UBX Binary, RTCM
Features	RTC Crystal and External Interrupt/Wake up
Interface	UART, SPI, USB and DDC

3.2.2.6 Features

- High sensitivity for tracking
- Low supply current (~45mA)
- Is able to track 5 locations per second with an accuracy of 2.5m (horizontal).
- Comes equipped with PSM also known as Power Saving Mode. This mode causes very less power consumption by turning the module ON/OFF according to the need.
- Great use as GPS trackers in smart watches due to very low power consumption (~11mA)

3.2.3 Global System for Mobile Communications

GSM (Global System for Mobile communications) originally from special mobile Group, is the most general standard for mobile telephony systems in the world. Everywhere it achieved international nomadic preparations between mobile phone operatives, allowing subscribers to use their phones in everywhere in the world. Global System for Mobile Communication differs from its prototype in that both signaling and speech channels are digital technologies. So, GSM is 2nd generation (2G) mobile phone system, which facilitates the utilization and application of a widespread range of data communications applications in the system. It was everywhere in the implementation of the GSM standard feature for both customers, who may take advantage from the skill to travel and change carriers without changing phones, and network operatives as well. GSM also initiated a application of the Short Message Service (SMS), also called text messaging whose cost is very low, held on other mobile phone ideals as well.

GSM networks operate in very different carrier frequency bands. Mostly 2nd Generation GSM systems operate in the 900 MHz or 1800 MHz bands. Where already been assigned to these bands, it was used 850 MHz and 1900 MHz bands instead. In occasional circumstances it is set ranges of 400 and 450 MHz in few countries because in the past it was used for First Generation systems. Mostly 3G networks in Europe function in the frequency range of 2100 MHz. One of the main features of GSM is the Subscriber Identity Module, called as the SIM card. And SIM is a separate smart card that contain the information related to the user subscription and the phonebook. In this way user keep the information even after the switching of phones. Instead, if user wants to change operators the user should change the SIM without changing the holding device.

3.2.3.1 SIM900A Overview

The SIM900A is a common GSM/GPRS module found in various cell phones and PDAs. The module can also be used to create Internet of Things (IoT) and Embedded Apps. The SIM900A is a dual-band GSM/GPRS engine that operates on the EGSM 900MHz and DCS 1800MHz frequencies. SIM900A supports the GPRS coding schemes CS-1, CS-2, CS-3, and CS-4 and has GPRS multi-slot class 10/class 8 (optional).

Figure 3.7: GSM SIM 900A

3.2.3.2 SIM900A Features

- Single supply voltage: 3.4V – 4.5V
- Power saving mode: Typical power consumption in SLEEP mode is 1.5mA
- Frequency bands: SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the two frequency bands automatically. The frequency bands also can be set by AT command.
- GSM class: Small MS
- GPRS connectivity: GPRS multi-slot class 10 (default), GPRS multi-slot class 8 (option)
- Transmitting power: Class 4 (2W) at EGSM 900, Class 1 (1W) at DCS 1800
- Operating Temperature: -30ºC to +80ºC
- Storage Temperature: -5ºC to +90ºC
- DATA GPRS: download transfer max is 85.6KBps, Upload transfer max 42.8KBps
- Supports CSD, USSD, SMS, FAX
- Supports MIC and Audio Input

- Speaker Input
- Features keypad interface
- Features display interface
- Features Real-Time Clock
- Supports UART interface
- Supports single SIM card
- Firmware upgrade by debug port

3.2.4 Heartbeat and Oxygen level sensor

MAX30100 is an integrated pulse oximeter and heart-rate monitor sensor solution. It's an optical sensor that derives its readings from emitting two wavelengths of light from two LEDs a red and an infrared one then measuring the absorbance of pulsing blood through a photodetector. This particular LED colour combination is optimized for reading the data through the tip of one's finger. It is fully configurable through software registers and the digital output data is stored in a 16-deep FIFO within the device. It has an I2C digital interface to communicate with a host microcontroller.

The pulse oximetry subsystem in MAX30100 consists of ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter. It has an ultra-low-power operation which makes it ideal for battery operated systems. MAX30100 operates on a supply in the range of 1.8 to 3.3V. It can be used in wearable devices, fitness assistant devices, medical monitoring devices, etc. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Figure 3.8: MAX30100

3.2.4.1 Working Principle and Operation

The MAX30100, or any optical pulse oximeter and heart-rate sensor for that matter, consists of a pair of high-intensity LEDs (RED and IR, both of different wavelengths) and a photodetector. The wavelengths of these LEDs are 660nm and 880nm, respectively.

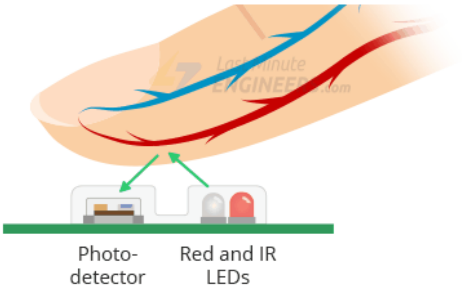

Figure 3.9: Working of MAX 30100

The MAX30100 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn't too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector. This method of pulse detection through light is called Photoplethysmogram.

The working of MAX30100 can be divided into two parts: Heart Rate Measurement and Pulse Oximetry (measuring the oxygen level of the blood)

Heart Rate Measurement

The oxygenated haemoglobin (HbO2) in the arterial blood has the characteristic of absorbing IR light. The redder the blood (the higher the haemoglobin), the more IR light is absorbed. As the blood is pumped through the finger with each heartbeat, the amount of reflected light changes, creating a changing waveform at the output of the photodetector. As you continue to shine light and take photodetector readings, you quickly start to get a heart-beat (HR) pulse reading.

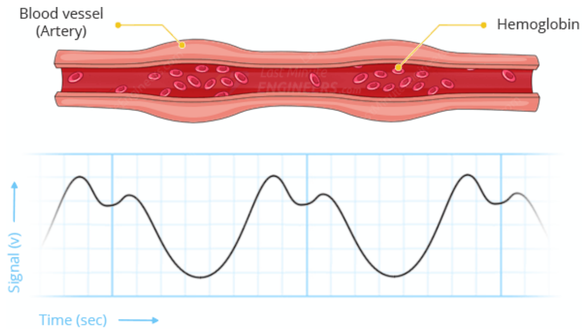

Figure 3.10: Heart Rate Measurement

Pulse Oximetry

Pulse oximetry is based on the principle that the amount of RED and IR light absorbed varies depending on the amount of oxygen in your blood. The following graph is the absorption-spectrum of oxygenated haemoglobin (HbO2) and deoxygenated haemoglobin (Hb).

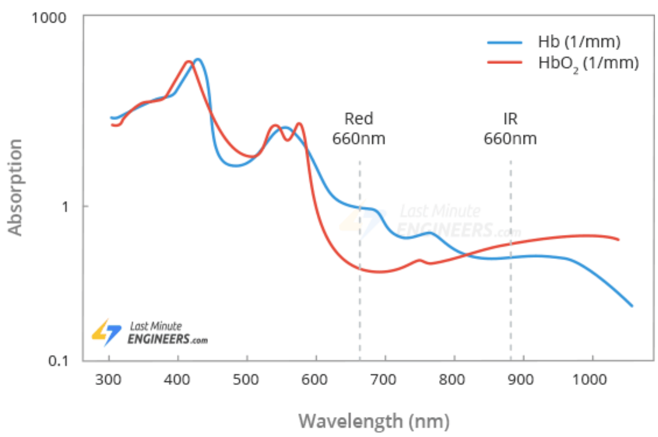

Figure 3.11: Pulse Oximetry measurement

As you can see from the graph, deoxygenated blood absorbs more RED light (660nm), while oxygenated blood absorbs more IR light (880nm). By measuring the ratio of IR and RED light received by the photodetector, the oxygen level (SpO2) in the blood is calculated.

3.2.4.2 MAX30100 Module Pinout

The MAX30100 module brings out the following connections.

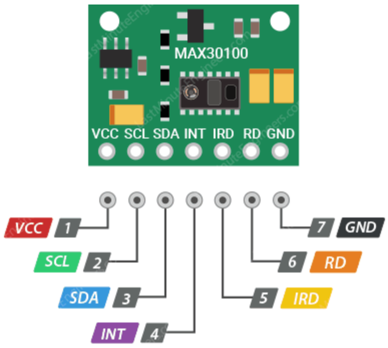

Figure 3.12: Pinout of MAX 30100

- **VIN:** is the power pin. You can connect it to 3.3V or 5V output from your Arduino.
- **SCL:** is the I2C clock pin, connect to your Arduino's I2C clock line.
- **SDA:** is the I2C data pin, connect to your Arduino's I2C data line.
- **INT:** The MAX30100 can be programmed to generate an interrupt for each pulse. This line is open-drain, so it is pulled HIGH by the onboard resistor. When an interrupt occurs the INT pin goes LOW and stays LOW until the interrupt is cleared.
- **IRD:** The MAX30100 integrates an LED driver to drive LED pulses for SpO2 and HR measurements. Use this if you want to drive the IR LED yourself, otherwise leave it unconnected
- **RD:** pin is similar to the IRD pin, but is used to drive the Red LED. If you don't want to drive the red LED yourself, leave it unconnected.
- **GND:** is the ground.

3.2.4.3 Specifications

- It is an integrated pulse oximetry and heart rate monitor sensor solution.
- Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End
- Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
- Measures absorbance of pulsing blood
- I2C interface plus INT pin
- Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package
- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
- Programmable Sample Rate and LED Current for Power Savings
- Ultra-Low Shutdown Current (0.7µA, typ)
- Advanced Functionality Improves Measurement Performance
- High SNR Provides Robust Motion Artifact Resilience

- Integrated Ambient Light Cancellation
- High Sample Rate Capability
- Fast Data Output Capability

3.2.5 Temperature sensor

The LM35 series are accurately combined circuit that works as a temperature sensor, which has output voltage directly proportional to °C Celsius (Centigrade) temperature. It is most use full than any other temperature sensor because the user does not need to remove any constant value of voltage from output voltage to obtain the appropriate centigrade values.

Figure 3.13: LM35

The temperature sensor LM35 has low output impedance, linearly generated output, and accurate essential standardization that make possible for interfacing to information and control circuitry particularly very easily. LM35 operates easily on single supplies of power and some time may require any plus minus supplies. The LM35 has series that is existing in form of bundled hermetic TO-46.

3.2.5.1 Features

- Regulated linearly in degree Celsius.
- Direct 10 mV per °C measuring ability.
- 0.5°C accurateness with assurance.
- It is rated from −55° to +150°C.
- Applicable for applications like remote.

- Has very less cost.
- Less than 60µA current drain
- Has Very small effect of nature heating, typically 0.08°C in air.
- Shows non-linear behaviourQ at only ±1⁄4°C typical.

3.2.5.2 Working

We have connected LM35 with pin 17 (ADC0) of microcontroller. And LM35 sensor is placed with the body of soldier. The sensor gives input to microcontroller and display body temperature on LCD of soldier unit and send date to base station.

3.2.6 LCD Display

Liquid crystal display (LCD) is the device, which shows output in graphical form. In our project, we used LCD module.

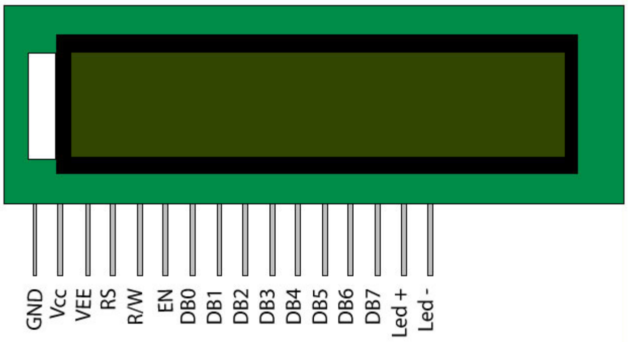

Figure 3.14: LCD Display

3.2.7 Power supply

The power supply is the most important part of every electronic device or circuit. To work all components in proper way a perfect power supply is desirable. The supply must be proficient of supplying the essential power for every component in circuit. The protection from over voltage should be used, which is resistor.

3.2.7.1 Battery

A 12-volt battery can be used to power the system. LM7805 is used to provide constant supply to the components.

Figure 3.15: Battery

3.3 Software Requirement

In this section the overview of software used in the project is explained briefly.

- Arduino IDE
- Proteus
- Thingspeak

3.3.1 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program setup main () into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

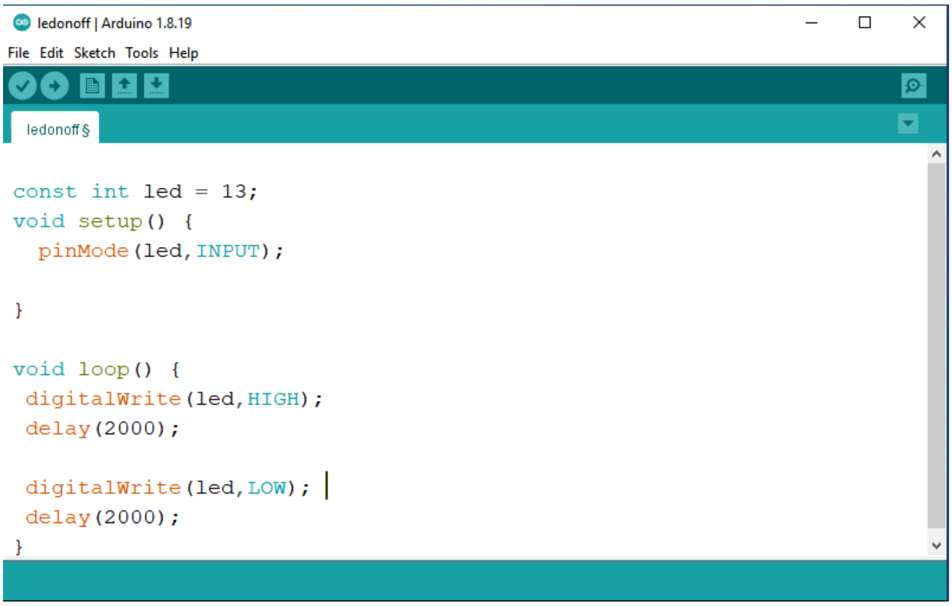

Figure 3.16: Code in Arduino IDE

3.3.2 Proteus

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

3.3.3 Thingspeak

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

3.4 Working

The circuit diagram of a Real Time Tracking and Health Monitoring System for Soldier is shown in Fig. 4.3. The heart of this circuit is a ESP32 Microcontroller. Other important components used in this circuit are LM35, MAX30100, GSM module, GPS modem, Emergency switch, LCD and some discrete components.

ESP32 controls and co-ordinate the working of the circuit. It consists of 30 pins. It can operate on 3.3V power supply, positive terminal is connected to the pin 30 and ground terminal is connected to the pin 29. When the switch is power offed, the system terminates all the activities; microcontroller will start program execution from the beginning. ESP works according to the program written on to it. The program is written in C language.

The function of the ESP32 in our project is to collect information from body temperature sensor LM35, MAX30100, GPS modem and sent this information to the base station using GSM and Wi-Fi module.

The LM35 is a temperature sensor that senses the temperature and converts it into typical voltage. This voltage is given to an analog to digital converter (ADC) of the microcontroller which converts the analog value in its input to a digital value ranging from 0 to 255. It is connected to the ADC0 pin of Microcontroller, i.e., to the 17 no pin. Temperature sensor measure the atmospheric temperature. This helps to know the temperature variation by weather changes, bomb blasts etc. And this information is transmitted to microcontroller and then to base station.

Heart beat sensor and oxygen level sensor used in this project is MAX 30100. The device has two LEDs, one emitting red light, another emitting infrared light. For pulse rate, only the infrared light is needed. Both the red light and infrared light is used to measure oxygen levels in the blood. When the heart pumps blood, there is an increase in oxygenated blood as a result of having more blood. As the heart relaxes, the volume of oxygenated blood also decreases. By knowing the time between the increase and decrease of oxygenated blood, the pulse rate is determined. It turns out, oxygenated blood absorbs more infrared light and passes more red light while deoxygenated blood absorbs red light and passes more infrared light. This output of Sensor is sent to microcontroller. Where microcontroller calculates heartbeat display in on the LCD and send to base station through GSM and Wi-Fi.

This help to know about the physical status of the soldier. Decreasing in heart beat and oxygen level may be of the injury by a gunshot, bomb blast or any other causes. It also helps to know the soldier is alive or dead during the time of mission. The sensor is connected to 11 and 14 pin of ESP32. The GPS unit calculates the position of the soldiers and then sent the latitudinal longitudinal values corresponding to the position of soldier to the microcontroller. The GPS unit used is NEO 6M, the TX pin of GPS is connected to the Rx pin of ESP32.

Finally, at base station, the calculated data is received using GSM and Wi-Fi. This is then displayed on pc or laptop.

CHAPTER 4

HARDWARE AND SOFTWARE DESIGN

In this chapter the circuit and hardware design of the project is explained with different sections. We tried to design the hardware in such a way so that the soldier could use this package easily. All the hardware is enclosed in small bag that soldier can easily carry with him. Sensors are placed on body parts where they can give a better performance. The project has a weight less than 1kg so it can be easily carried by a soldier. We designed a better software design to get the better performance and focus on the problem of processing capability of microcontroller.

4.1 HARDWARE DESIGN

Figure 4.1 shows the hardware design of our project:

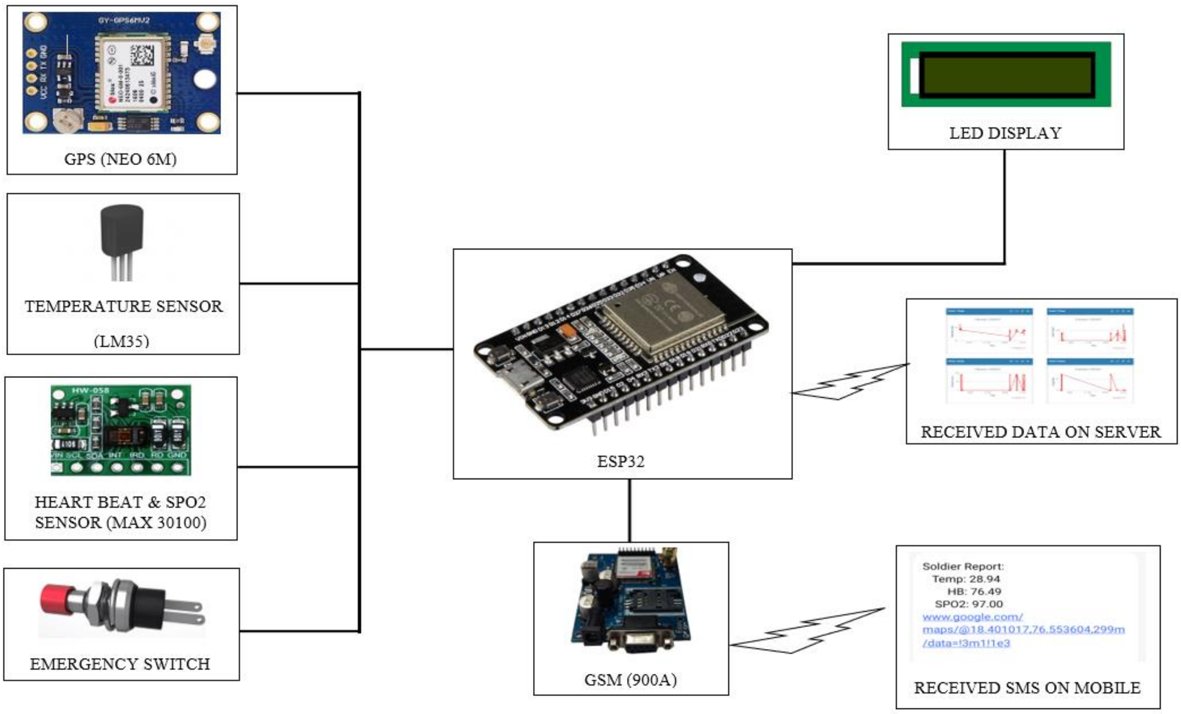

Figure 4.1: Project hardware design

Our project is mainly divided into three parts.

- On finger
- On arm
- In the bag

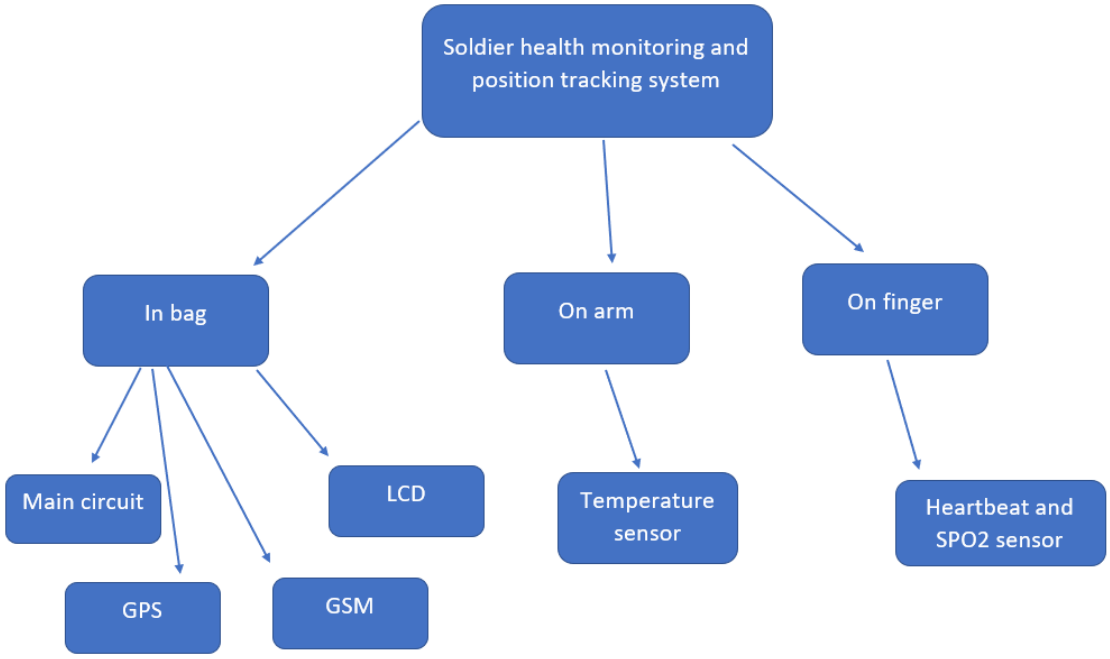

Figure 4.2: Breakdown structure of the project

4.2 CIRCUIT DIAGRAM

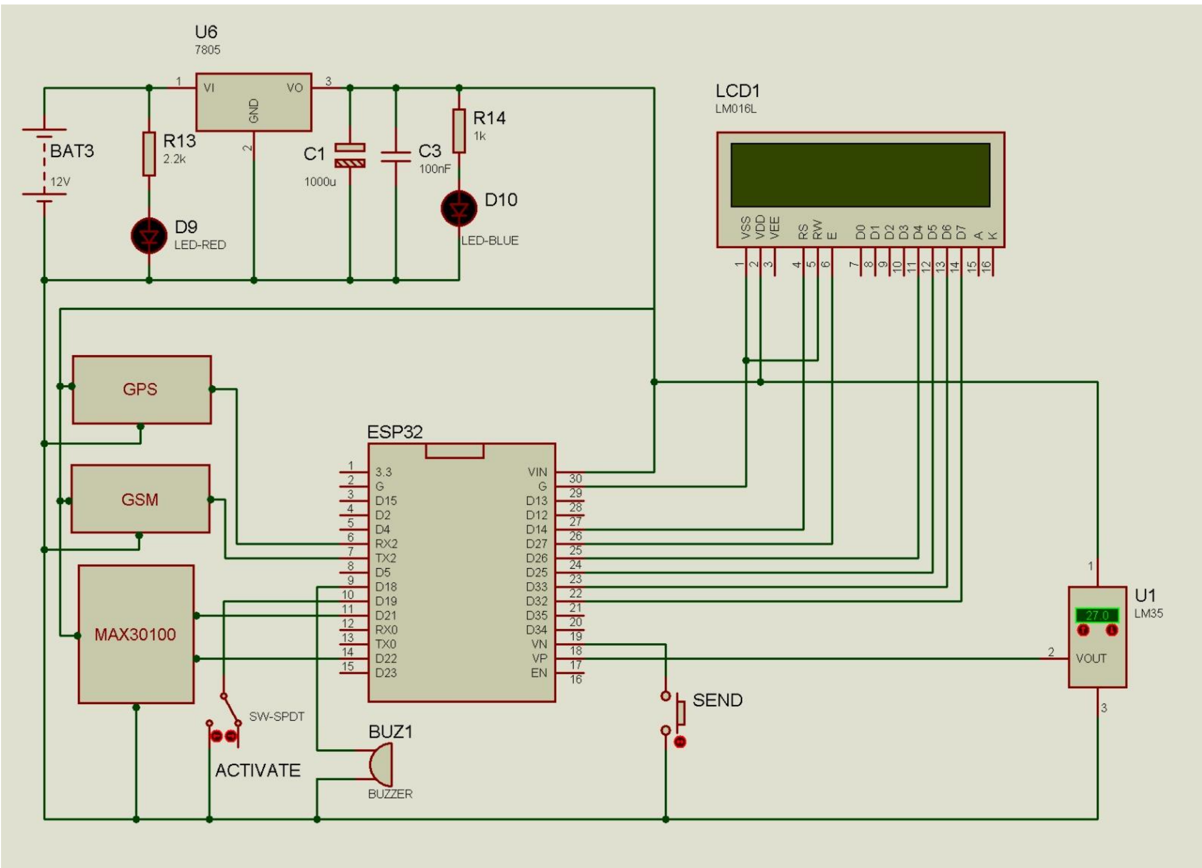

Figure 4.3: Complete Circuit Diagram

4.3 PCB LAYOUT

The PCB layout of our project is shown in figure. In making PCB design, we have tried our best to make PCB as much small as possible having in mind that soldering will be done manually.

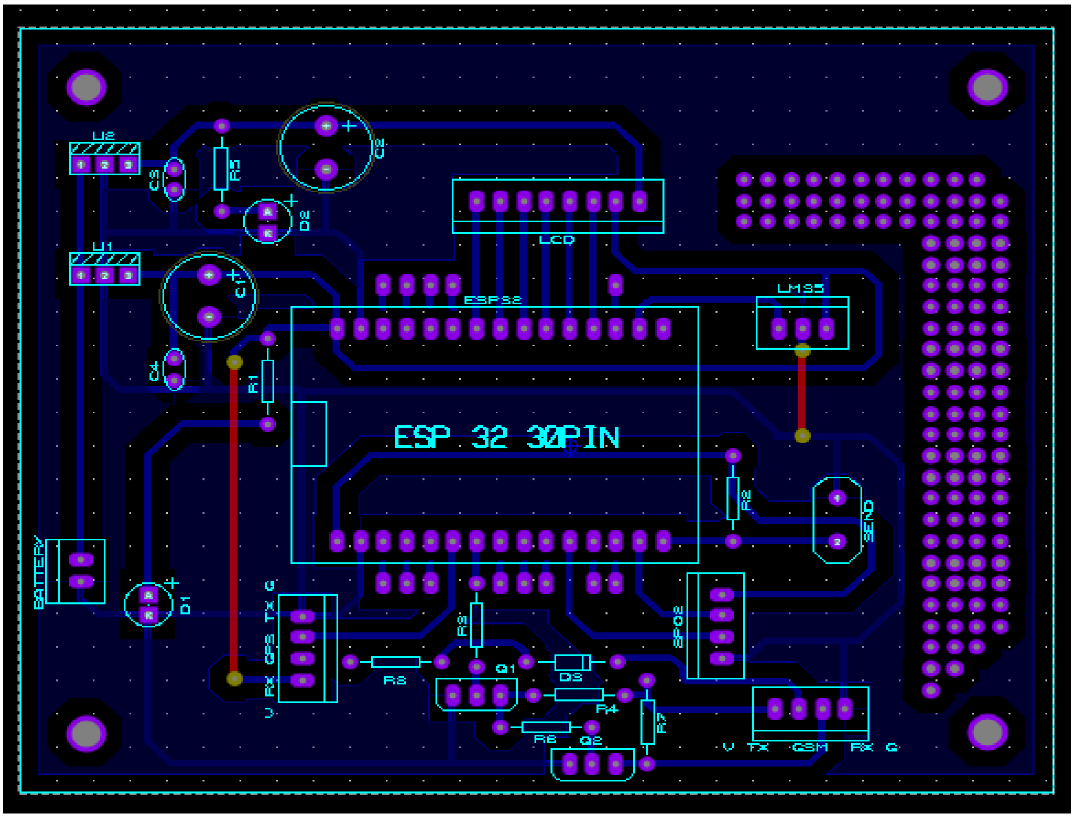

Figure 4.4: PCB Layout

4.5 SOFTWARE DESIGN

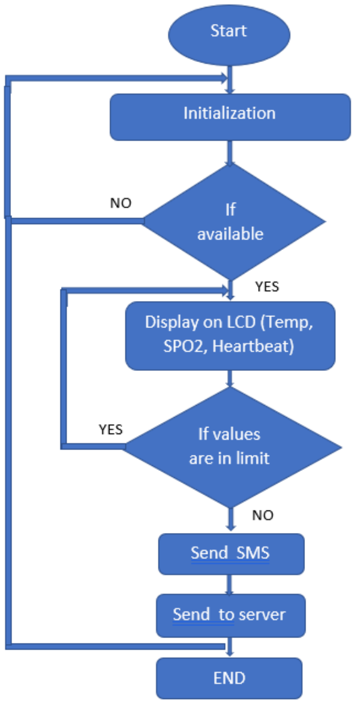

Figure 4.5: Logical structure of system

4.5.1 Source Codes

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(27, 14, 32, 33, 25, 26);  // (Rs, E, D4, D5, D6, D7)
#include <WiFi.h>
#include <ThingSpeak.h>;          //Thingspeak hidder files
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#include <TinyGPSPlus.h>
TinyGPSPlus gps;
#define SEND 23
#define buzzer 19
#define measure 18

const char* ssid = "digital”;  // your network SSID (name)
const char* password = "12345678”;  // your network password
```

```
unsigned long myChannelNumber = 2100587;
const char * myWriteAPIKey = "U5VQTMLD63ZMSX27";

//temperature sensor
int analogtemp = A0;                    //temp analog Value
float temp= 0;
float avgtemp=0;

//pulse oximeter
// Connections : SCL PIN - D1 , SDA PIN - D2 , INT PIN - D0
#define REPORTING_PERIOD_MS     1000
   PulseOximeter pox;
   float BPM, SpO2;
  uint32_t tsLastReport = 0;

// Timer variables
   unsigned long lastTime = 0;
   unsigned long timerDelay = 30000;

WiFiClient  client;

char mob_1[]="+919767141668";
long wait;

float long1;
float lati1;

void onBeatDetected()
{
    lcd.print("Beat Detected!");
}
void displayInfo()
{
  //Serial.print(F("Location: "));
```

```
  if (gps.location.isValid())
  {
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("Lat: ");
    lcd.print(gps.location.lat(), 6);
    //Serial.print(F(","));
    lcd.setCursor(0,1);
    lcd.print("Lng: ");
    lcd.print(gps.location.lng(), 6);
    lcd.println();
  }

  else
  {
    //Serial.print(F("INVALID"));
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("INVALID LOCATION");
  }
  delay(200);
}

void updateSerial()
{
  delay(500);
  while (Serial.available())
  {
    Serial2.write(Serial.read());      //Forward what Serial received to Software Serial Port
  }
  while (Serial2.available())
  {
    Serial.write(Serial2.read());          //Forward what Software Serial received to Serial Port
  }
```

```
}
void beep()
{
  digitalWrite(buzzer, HIGH);
  delay(500);
  digitalWrite(buzzer, LOW);
  delay(500);
}
void(* resetFunc) (void) = 0; //declare reset function @ address 0
void setup()
{
  Serial.begin(9600);  //Initialize serial
  Serial2.begin(9600);
  lcd.begin(16, 2);              // LCD's number of rows and colomns:
  pinMode(23, INPUT_PULLUP); pinMode(measure, INPUT_PULLUP);
  pinMode(buzzer, OUTPUT);

    //Blynk.begin(auth, ssid, pass);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("Initializing....");
    lcd.setCursor(0,1);
    lcd.print("Pulse Oximeter-.");
    delay(500);

    // Connect to WiFi network
  WiFi.begin(ssid, password);
  //Serial.println("\nConnected.");
  ThingSpeak.begin(client);

 beep(); beep();

    if (!pox.begin())
    {
```

```
        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("     Failed     ");
        for(;;);
    }
    else
    {
        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("   Success...   ");
    }

     // Configure sensor to use 7.6mA for LED drive
  pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

  // Register a callback routine for every 1 sec
  pox.setOnBeatDetectedCallback(onBeatDetected);

   lastTime = millis();
}

void loop()
{
   pox.update();

    BPM = pox.getHeartRate();
    SpO2 = pox.getSpO2();

     avgtemp=0;
        for (int i = 0; i < 10; i++)
        {
          temp= analogRead(analogtemp);   // Read ADC value
          temp = (temp*500) / 4096;       //5000 (5V), 10mV/* change, 12 bit ADC
          avgtemp=avgtemp+temp;
```

```
        delay(5);
      }
      avgtemp = avgtemp/10.0;

    if (millis() - tsLastReport > REPORTING_PERIOD_MS)
    {
      lcd.clear();
      lcd.setCursor(0,0);
      lcd.print("  O2="); lcd.print(pox.getSpO2());  lcd.print("%");   lcd.print("  T  :");
lcd.print(avgtemp);  lcd.print(" C");
      lcd.setCursor(0,1);
      lcd.print("HeartBeat ="); lcd.print(pox.getHeartRate());
      //oxilevel=pox.getSpO2();
      BPM = pox.getHeartRate();
      SpO2 = pox.getSpO2();

      //tsLastReport = millis();
      lastTime = millis();
    }
    if(!digitalRead(measure))
    {
    if(!digitalRead(SEND) || avgtemp >40 || avgtemp<=20 || BPM<=30 || BPM>=90 ||
SpO2<=85)
    {
     beep();
        // updateSerial();
     while (Serial2.available() > 0)
      if (gps.encode(Serial2.read()))
      {
        //displayInfo();
      }

      if (millis() > 5000 && gps.charsProcessed() < 10)
      {
```

```
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.println(F("No GPS detected:"));
  while (true);
}

delay(500);

lcd.clear();
lcd.setCursor(0,0);
lcd.print("Temp = ");
//Serial.print(avgtemp);          // Print Temperature on the serial window
//Serial.print("°C\n");
delay(100);

lcd.clear();
lcd.setCursor(0,0);
lcd.print("  Sending Msg  ");    // lcd print

Serial2.print("AT+CMGS=\""); Serial2.print(mob_1); Serial2.println("\"");
delay(500);
Serial2.println("Soldier Report:"); Serial2.print("\r\n");
delay(200);

Serial2.print("   Temp: "); Serial2.println(avgtemp); Serial2.print("\r\n");
delay(500);
Serial2.print("       HB: "); Serial2.println(BPM); Serial2.print("\r\n");
delay(500);
Serial2.print("    SPO2: "); Serial2.println(SpO2);  Serial2.print("\r\n");
delay(500);

Serial2.print("www.google.com/maps/@");
Serial2.print(gps.location.lat(), 6);
Serial2.print(",");
```

```
        Serial2.print(gps.location.lng(), 6);
        Serial2.print(",299m/data=!3m1!1e3");
        Serial2.println("\r\n");
        delay(500);

        Serial2.write(26);

        beep();

 delay(2000);
        pox.begin();
        if (!pox.begin())
  {
        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("     Failed     ");
        for(;;);
    }

    lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("Make  Switch Off");    // lcd print
        lcd.setCursor(0,1);
        lcd.print("   to  enable   ");    // lcd print
        delay(5000);

  resetFunc();  //call reset
    }
 //delay(10);
    }

wait++;

  if(wait==1000)
```

```
{
  // updateSerial();
    while (Serial2.available() > 0)

      if (gps.encode(Serial2.read()))
      {
        //displayInfo();
      }

      if (gps.location.isValid())
      {
        lati1=gps.location.lat(); delay(200);
        long1=gps.location.lng(); delay(200);

        lati1=gps.location.lat(); delay(200);
        long1=gps.location.lng(); delay(200);
      }

  beep();

 // set the fields with the values
    ThingSpeak.setField(1, avgtemp);
    ThingSpeak.setField(2, BPM);
    ThingSpeak.setField(3, SpO2);
     ThingSpeak.setField(4, long1);
    ThingSpeak.setField(5, lati1);

 // Write to ThingSpeak. There are up to 8 fields in a channel, allowing you to store up to 8
different
  // pieces of information in a channel.  Here, we write to field 1.
  int x = ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);
    delay(1100);
  //uncomment if you want to get temperature in Fahrenheit
  //int x = ThingSpeak.writeField(myChannelNumber, 1, temperatureF, myWriteAPIKey);
```

```
    if(x == 200){
      lcd.clear();
      lcd.setCursor(0,0);
      lcd.print("Sending-> Server");    // lcd print
      delay(1000);
    }
    else{
      lcd.clear();
      lcd.setCursor(0,0);
      lcd.print("    Error...    ");    // lcd print
      delay(1000);
    }
    wait=0;
    beep();

    pox.begin();
        if (!pox.begin())
    {
        lcd.clear();
        lcd.setCursor(0,0);
        lcd.print("     Failed     ");
        for(;;);
    }

    lastTime = millis();
  }
}
```

4.6 PROJECT DIAGRAM

The complete project hardware of our project is shown in Figure 4.6.

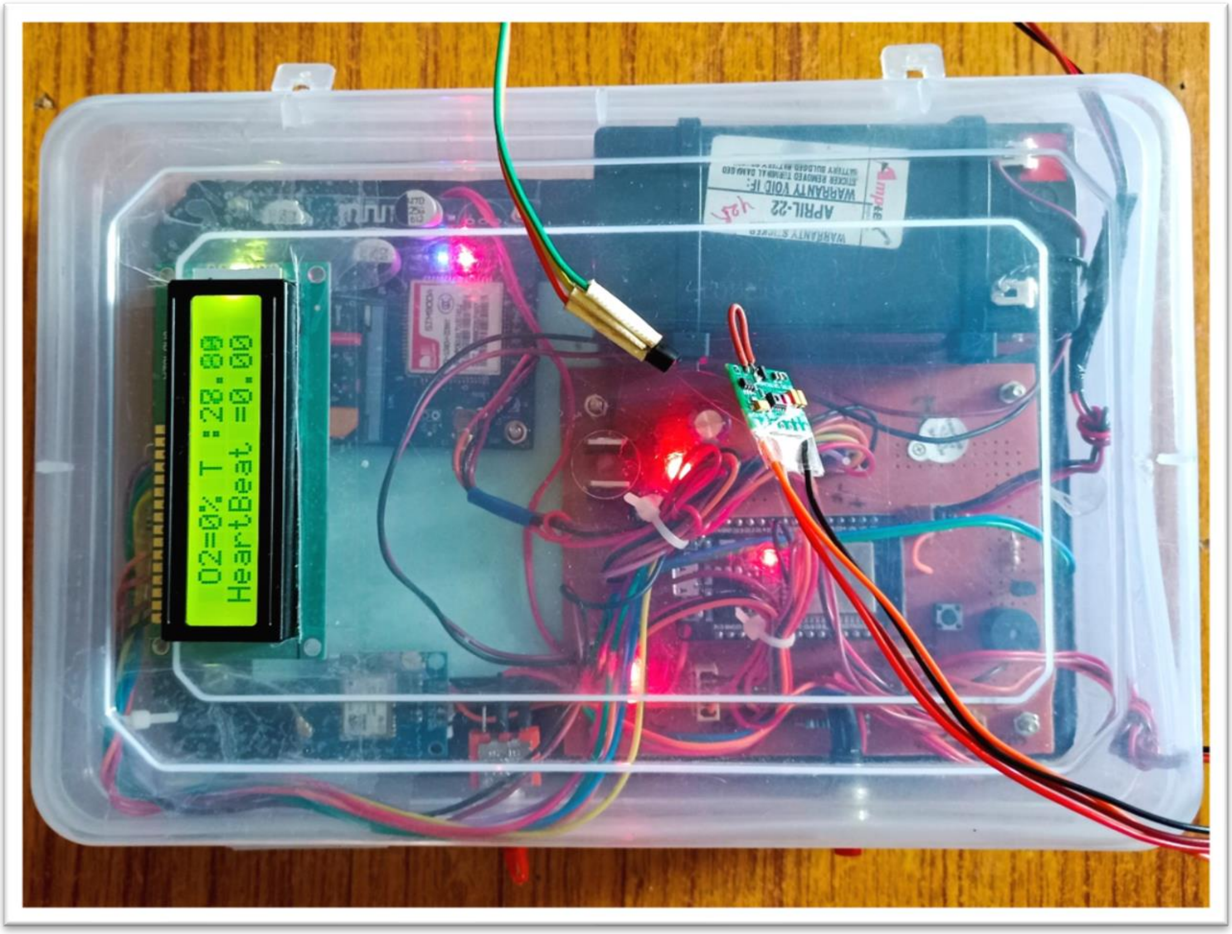

Figure 4.6: Complete project hardware

CHAPTER 5

RESULTS

The final results of project are described here. However, the main focus is on base station results that how these results are used to the health status and location of the soldier as well.

5.1 BASE STATION RESULTS

At base station, Android smartphone and ThingSpeak server is used to monitoring the soldier health status and locating the soldier position.

Figure 5.1: Soldier report at base station

Figure 5.1. shows the full soldier report which will be displayed at base station given by the system. By clicking on link, we will go on Google Map.

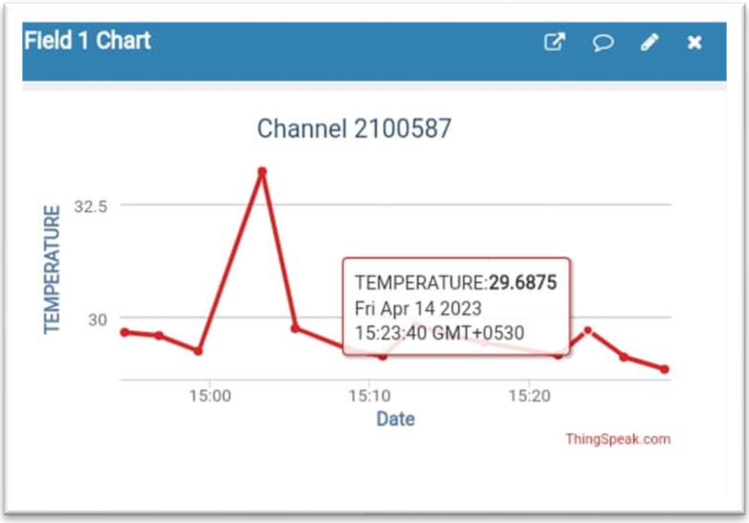

Chart 5.1: Graph of Temperature sensor

Chart 5.1 shows the graph of soldier body temperature on ThingSpeak server and monitored by the commanding officers at base station.

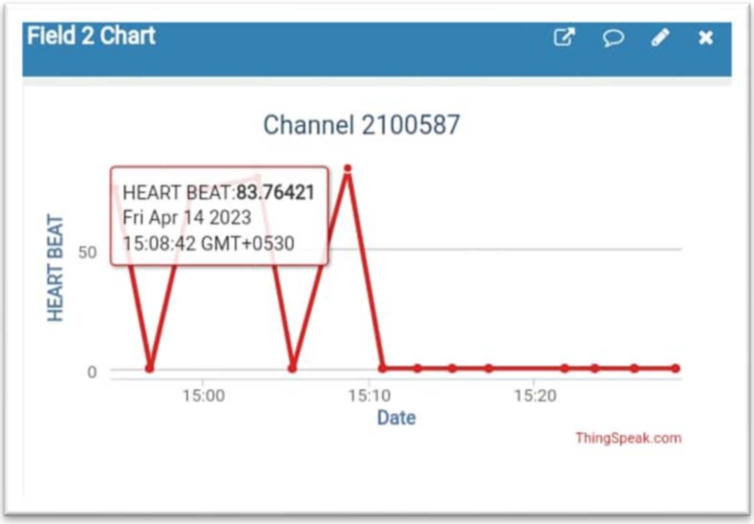

Chart 5.2: Graph of heart beat sensor

Chart 5.2 shows the graph of soldier heart beat on ThingSpeak server and monitored by the commanding officers at base station.

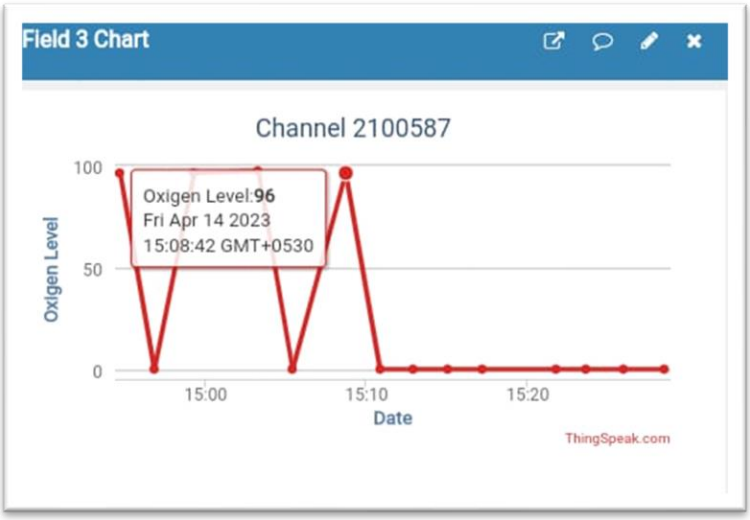

Chart 5.3: Graph of oxygen level sensor

Chart 5.3. shows the data of oxygen level sensor which indicates the oxygen level of soldier.

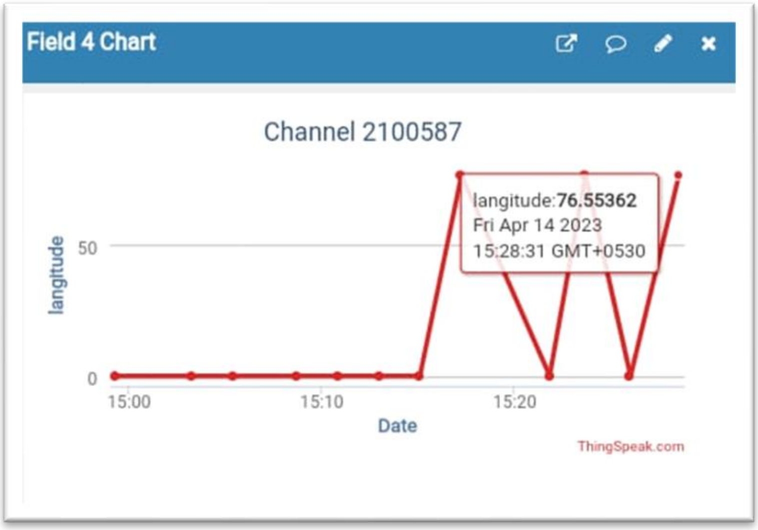

Chart 5.4: Graph of longitude coordinate

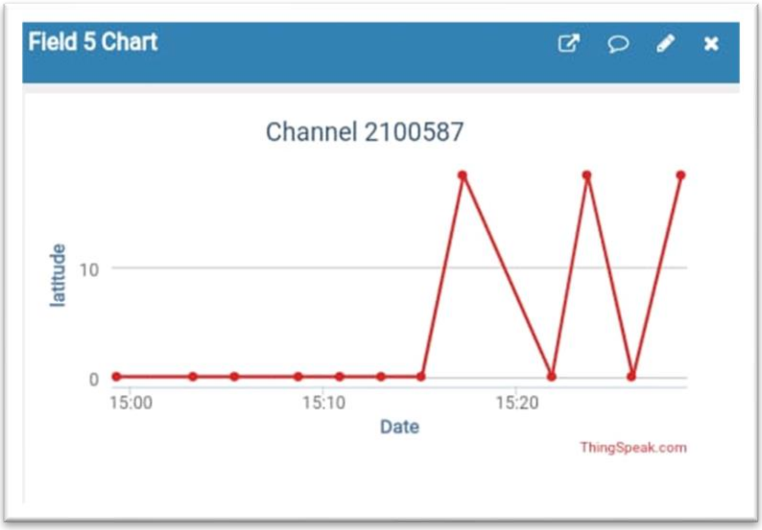

Chart 5.5: Graph of latitude coordinate

Chart 5.4 and 5.5 shows the longitude and latitude coordinates of actual position of soldier. These coordinates taken by the four satellites which is used to get actual physical location of soldier.

CHAPTER 6

ADVANTAGES, APPLICATION

Advantages:

- Improve situational awareness.
- Early detection of health issues.
- enhanced soldier safety.
- Optimal performance.
- Improved communication.
- The circuit is compact in size, so small space is required.
- The circuit required power supply is very less, (12V, 750mAh) provides more backup to the circuit.

Application:

- It can be used in security or protection unit in vehicles
- It can be used in military purpose to tress location of soldier.
- It can be used in protect violence against women, in panic switch.
- It can be used in boarder alert system for fishermen.

CHAPTER 7

CONCLUSIONS

An IoT-based soldier health monitoring and position tracking system can greatly improve the safety and efficiency of military operations. By utilizing sensors and other IoT devices, soldiers can be tracked and monitored in real-time, allowing for quick and accurate responses in the event of an emergency. The system can also provide valuable data on soldier health and performance, allowing for more effective training and better overall performance. However, it is important to consider the privacy and security implications of such a system, as well as the potential for technical difficulties and malfunctions. Overall, an IoT-based soldier health monitoring and position tracking system has the potential to greatly benefit the military, but must be carefully implemented and monitored.

BUDGET AND COMPONENTS LIST

The budget list of our project is shown in Table 9.2.1.

Table 7.1: Cost Analysis

Sr. No	Components	Quantity	Cost
1	ESP32	1	550
2	LM7805	2	30
3	Connector	10	150
4	1N4007	3	06
5	Resistor 1K,10K	4	08
6	Burg strip	2	40
7	Main’s cord	15	75
8	Transformer	1	180
9	Temperature sensor	1	175
10	MAX30100	1	750
11	GPS	1	450
12	PCB	-	720
13	Components	-	250
14	Setup	-	600
15	LCD 16*2	1	350
16	Battery	1	640

CHAPTER 8

FUTURE SCOPE

The future scope of IoT-based soldier health monitoring and position tracking system is vast, with many advancements on the horizon. Utilizing edge computing, sensor fusion, machine learning, predictive analytics, and smart wearables, the system can enhance accuracy, speed, and safety, ensuring the health and well-being of soldiers. Edge computing can enable real-time data processing, while sensor fusion can provide more comprehensive views of soldier's health and positions. Machine learning algorithms can analyze large data sets for insights, and predictive analytics can help anticipate health risks. Smart wearables can also offer real-time feedback and training. Together, these advancements will help optimize soldiers' health and improve decision-making processes for commanders.

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