PROJECT REPORT
ON

HEALTH MONITORING AND ALERT SYSTEM

In partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Electronics & Communication Engineering
Maulana Abul Kalam Azad University of Technology

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CERTIFICATE

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ABSTRACT

Smart healthcare systems should be used by those who require ongoing monitoring, which is not available outside of hospitals. In rural or village areas, it is essential that nearby clinics may consult with city hospitals on the health of their patients. This model functions as a smart health monitoring system that checks a patient’s condition using biomedical sensors and notifies those nearby using web technologies. Here, the biomedical senors are linked to an ESp32 controller, which reads the data and interfaces it with a web server to display the results. This “Health Monitoring and Alert System Using IoT” goal is to develop a system capable of monitoring important body signals such as body temperature, heart rate, and SpO2 level are among examples. The sensors are synced with the controller and the web. A cloud server will receive the readings from the sensor sent by the device, and the data gathered will progressively be made available for analysis. The reading is saved on a cloud server, and the doctor's web portal or smartphone are also notified. These readings serve as both an analysis of the patient's health status and an emergency health condition alarm system. The controller, the web, and the sensors are all in sync. The device will transmit sensor readings to a cloud server, where the data will be gradually made available for study. It stores the reading on a cloud server and then sends an alert to the doctor’s smartphone or web portal. These readings serve as both an analysis of the patient’s health status and an emergency health condition alarm system.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Hospitals are now heavily utilizing health care sensors. In recent years, researches have considered the use of medical sensors in clinical settings in remote health monitoring systems for long-term archiving, management, and clinical access to patient physiological data [1]-[4]. Patient checking monitoring is one of the main advantages of its inventive invention. A programmable remote health monitoring system is used to use an implanted device to measure the patient's body pulse and SpO2 level. The suggested system makes use of sensors such a pulse sensor, an oximeter and ECG sensor. These sensors are typically used to track sleeping habits, detect falls, and keep an eye on the patient's health.

Sensor units, coordinator units, remote server units, user interface units, and communication units are the main parts of health monitoring systems. A sensor unit consists of a number of battery-operated sensors for different health indicators, a computer for data processing, and an antenna for transmission [5]. To accomplish this, the system makes use of numerous sensors to keep track of vital indicators. These sensors can be connected to the doctor's smartphone or the internet. Sensor readings will be remotely transferred to the cloud via the gadget, and the resulting data will gradually become available for analysis. It has the ability to read and communicate emergency signs to the cloud, the doctor's smartphone, and eventually the doctor's website.These readings can be used to assess the patient's health and as an early warning system for a medical emergency.

1.2 STRUCTURE OF THE REPORT

The software used to perform simulation is Arduino IDE platform based on method of sensors. It analyses and controls different sensors simultaneously. It has been widely used in the design of prototype models ,embedded system , and other products. It can be used to take tracks of the data received from sensors and plot graphs and make changes according to it. This project shows a prototype model and analysis of the data with the help of WiFi module ESP32 micro-controller connected with discrete sensors. The project shows innovation of bio-medical platforms.

A total of 6 chapters make up the report. Beginning with the project's introduction, the second chapter explains the ESP32 microcontroller, its applications, advantages, and limitations. In the third chapter the sensors like LM35,Pulse Oximeter and AD8232 ECG. Sensors assembled with help of jumper wires and simulated using Arduino IDE software. Due to compact model these will be further modified and experimented in the coming future. In the fourth chapter, the model assembling , programming is done of discrete sensors with controller. In the fifth chapter, working of the prototype model is designed and simulated. Working on IOT sensors are described in this chapter. In the sixth chapter, impact assessment, risk issues, cost analysis are described.

CHAPTER 2
THEORY OF PROTOTYPE MODEL

This chapter provides background information regarding ESP32 controller. The structure of ESP32 module along with its advantages, disadvantages.

2.1 ESP32 Micro-controller

The ESP32 is a low-cost, low power micro-controller with built-in Bluetooth and Wi-Fi. It is an upgraded version a low-cost Wi-Fi microprocessor with a few features.

The power amplifier, filters, antenna, RF balun, low-noise amplifiers, and power management module are all combined into one unit. A very little part of the printed circuit board is used for the entire area. With the best RF and power characteristics, as well as being safe, dependable, and extensible to a variety of applications, this module employs TSMC 40nm low power 2.4Ghz dual-mode Wi-Fi and Bluetooth hips.

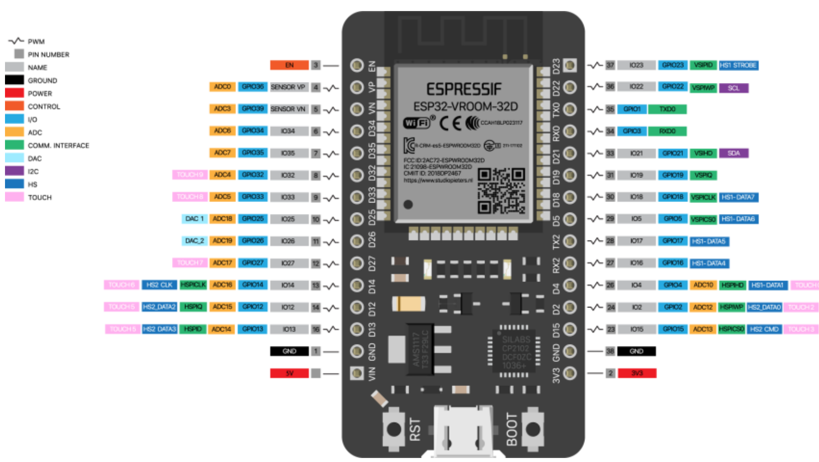


Fig: 2.1 ESP32 Module

The ESP32 Specifications-

1. Dual-Core 32-bit LX6 microprocessor ESP WROOM32
2. SRAM: 520KB, ROM: 448KB, and support up to: 16MB
3. CP21XX USB-to-UART(serial) Bridge built-in
4. 802.11b/g/n/e/I Wi-Fi
5. Bluetooth version 4.2 with BR/EDR and BLE.
6. 2 x 8-bit DACs
7. 9 x touch sensors total Note: [D0] represents touch sensor 1. However, this specific ESp32 module does not have it as a pin (version with 30 GPIOs). The 36-pin variant has access to the GPIO 0 pin.
8. Internal Temperature Sensor

Pros of ESP32 Module

1. Both development boards and independent chips are provided.
2. When each of the 36 I/O pins an be configured to perform various purposes, multiplexing.
3. Built in Wi-Fi module and Hall effect sensor.
4. Bluetooth 4.2 and Bluetooth low energy support.
5. Contacts that can be touched to jolt the micro-controller out of a dep sleep.
6. There are many resources available for developing firmware, including the Arduino IDE environment, Micro-Python, an environment for the ESP Home that does not require programming and is reasonably priced.

Cons of ESP32 Module

1. They won't connect to a contemporary 5 GHz network; instead, they only support 2.4 GHz Wi-Fi networks.
2. Require more GPIO pins for working with extra sensors.

CHAPTER 3

SENSORS

In this chapter MAX30100 pulse oximeter and I2C Interfaced 16X2 LCD background information will be provided along with specification.

3.1 MAX30100 Pulse Oximeter Sensor

To function, every organ system in the body needs oxygen. Cells start to malfunction and eventually perish when oxygen is not present. It may result in serious symptoms and, in the end, organ failure.

The oxygen is filtered by the lungs before being supplied to the organs. Following that, it is transferred into the blood by proteins in red blood cells known as haemoglobin, and further proteins give oxygen to the rest of the body [6].

The oxygen saturation level in haemoglobin proteins is measured by pulse oximeter. Saturation of oxygen is determined by how much oxygen is reaching the organs.

Fig: 3.1 Pulse Oximeter

The range of normal oxygen saturation is from 95 to 100 percent. Oxygen saturation levels below 90% are regarded as excessively low and may indicate a clinical emergency.

3.2 Overview of the MAX30100 Module Hardware

The module includes an Analog Devices MAX30100 Pulse Sensor, a contemporary combined IC of pulse oximeter and heart sensor which uses two LED's, an improved optics system, a photo detector, and low-noise analogue signal processing to detect heart rate (HR) and pulse oximeter (SpO2) signals. The MAX30100 includes two LED's -a red and infrared LED-on the right and a highly sensitive photo detector on the left. According to the concept, blood oxygen levels and heart rates can be determined by emitting a single LED at a time, measuring the amount light that bounces back at the detector, and interpreting the signature [7].

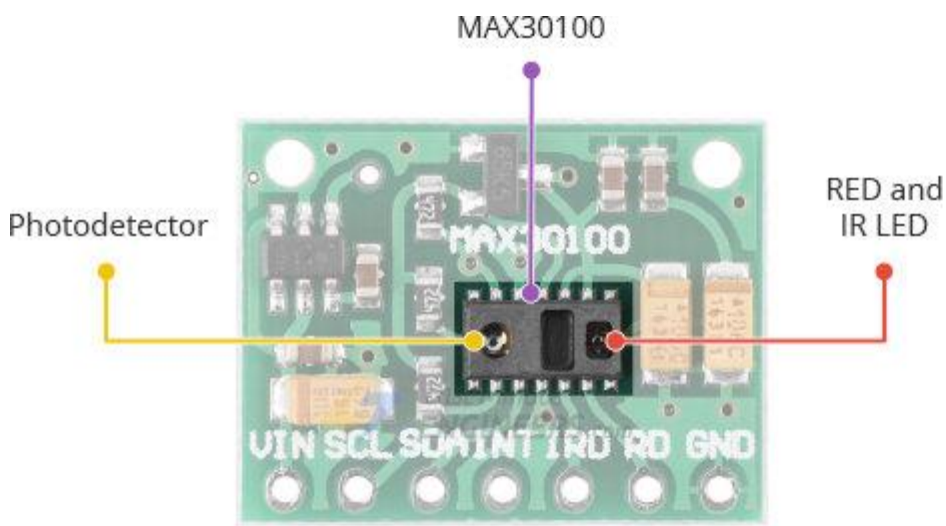


Fig: 3.2 Pulse Oximeter (Photo Detector)

Two supply voltages are needed by the MAX30100 chip: 1.8V for the IC and 3.3V for the RED and IR LED’s. So, the 3.3V and 1.8V regulators are included with the Pulse oximeter module. This enables you to connect the module to any micro-controller that has I/O at levels of 1.8V, 3.3V, or even 5V.

The Pulse oximeter’s (MAX30100) low power consumption, which is less than 600uA during measurement, is one of its most significant advantages. When the MAX30100 is operating in standby mode, it uses just 0.7uA. Implementation in battery-operated devices, such as phones, wearable, or smart watches, is simple due to minimal power consumption.

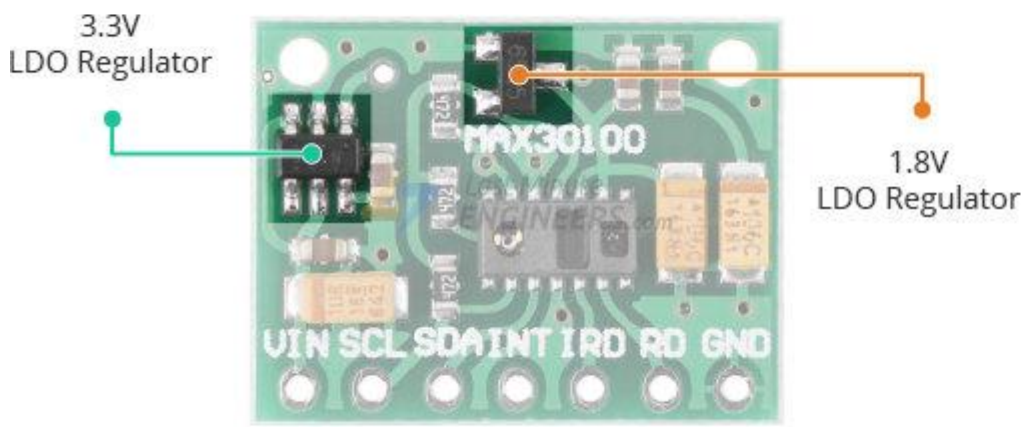


Fig: 3.2.1 Pulse Oximeter(Regulator)

3.3 MAX30100 Working

A pair of high-intensity LEDs (IR and RED, which have different wavelengths) and a photodetector are the main components of any optical pulse oximeter and cardiac sensor, including the MAX30100. The wavelengths of these LEDs are 880 nm and 660 nm, respectively.

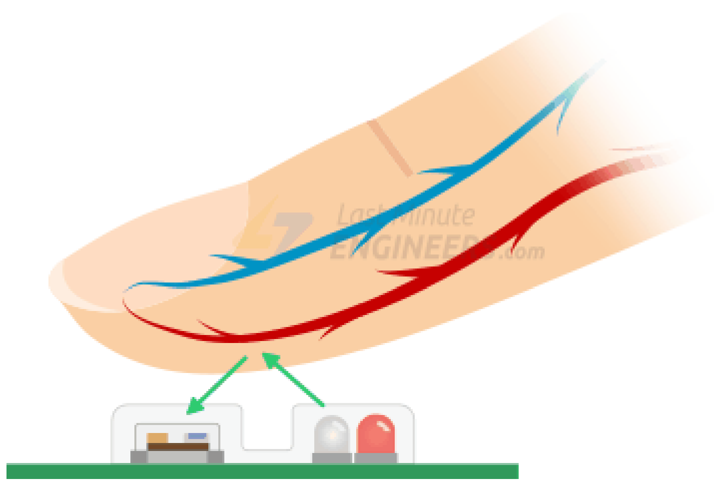


Fig: 3.3 MAX30100 Working

Once the MAX30100 emits both lights onto the finger or earlobe (or really anywhere the skin isn't too thick, allowing both lights to readily penetrate the tissue), a photo-detector is used to quantify the amount of reflected light.

The two elements that make up the MAX30100's operation are the pulse oximeter, which measures the blood's oxygen content, and heart rate measurement.

Heart Rate Sensor

The arterial blood contains oxygenated haemoglobin (HbO2), which has the ability to absorb IR radiation. The more the haemoglobin, which is shown by redder blood, the more IR radiation is absorbed. The amount of reflected light, which results in a waveform at the photo-detector's output, is caused by the blood pumping through the tips of fingers [9]. We rapidly begin to acquire of the heartbeat (HR) pulse thanks to the light generated by the LED and reflected by the tip of the finger.

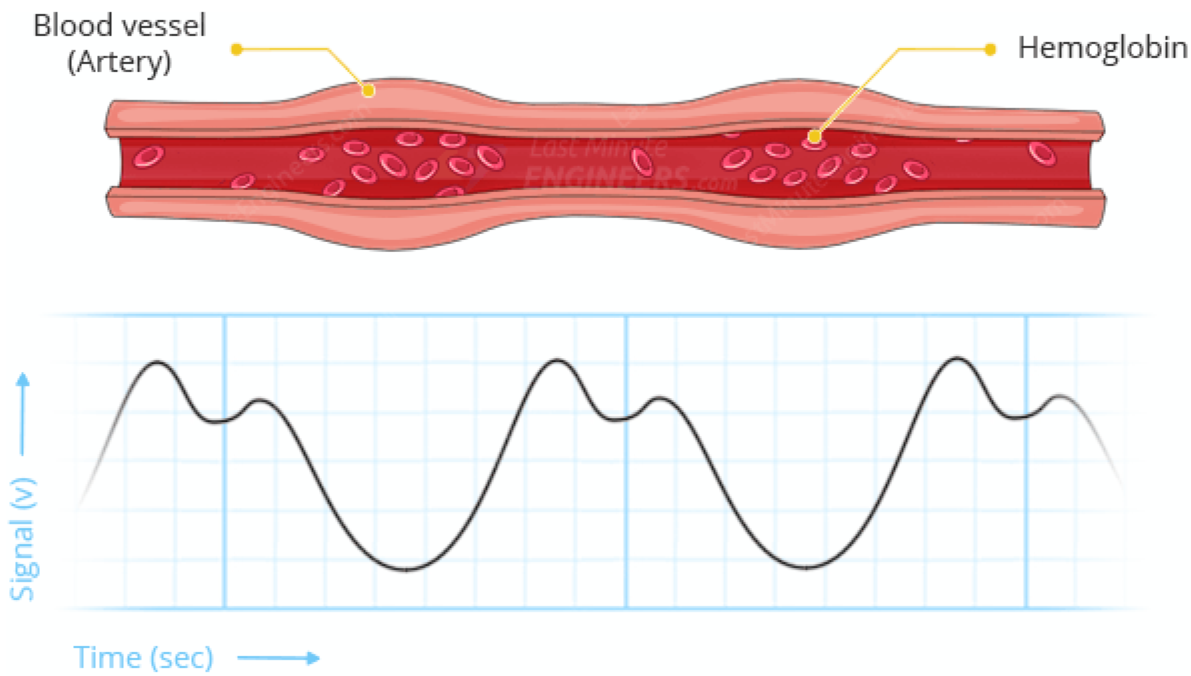


Fig: 3.3.1 Blood Vessel

Pulse Oximetry

Working on the theory that the amount of RED and IR light absorbed varies with blood oxygen levels. The absorbance spectra of oxygenated and deoxygenated haemoglobin is shown in the graph below (Hb).

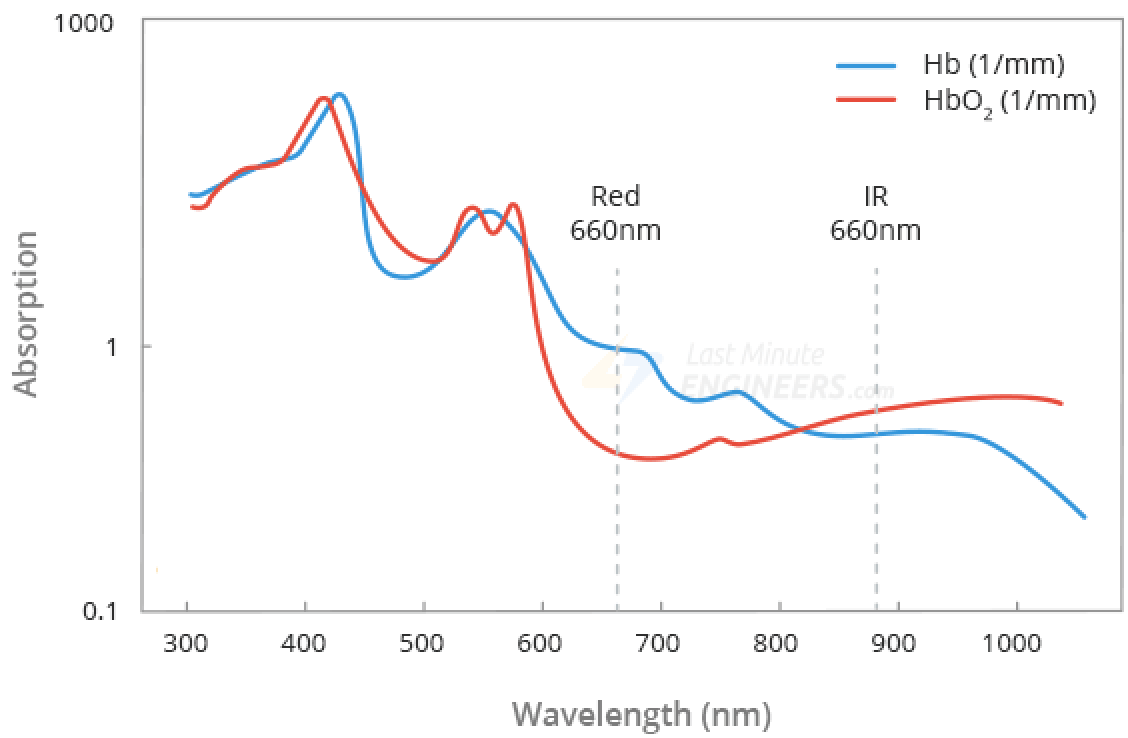


Fig: 3.3.2 Absorption vs Wavelength

Deoxygenated blood, as depicted in the graph, absorbs more red light (660nm), but oxygenated blood absorbs more infrared light (880nm). The oxygen content (SpO2) of the blood is determined after assessing the photo-detector's sensitivity to IR and RED light.

3.4 Pin-out for MAX30100 Module

The connections below are produced by the MAX30100 module.

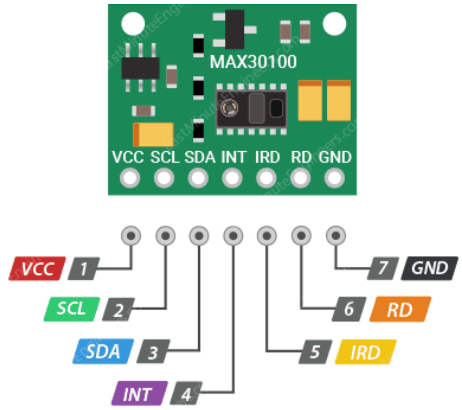


Fig: 3.4 MAX30100 Pin-out

VIN The power pin is VIN. It can be connected to your ESP32 module's 3.3V or 5V output.

SCL Connect your ESP32's I2C clock line to the SCL pin, which is the I2C clock pin.

SDA Connect your ESP32's I2C data line to the SDA pin, which is the I2C data pin.

INT For each pulse, the pin can be programmed to produce an interrupt. Sine this line has an open drain, the internal resistor pulls it HIGH. The pin becomes low when an interrupt happens and remains low until the interrupt is cleared.

IRD In order to drive LED pulses for SpO2 and Pulse Rate(HR) measurements, the MAX30100 includes an LED driver. If you don't want to run the IR LED, leave it unplugged.

RD The IRD pin and the RD pin are quite similar, but the RD pin is used to drive the RED LED. If you don't want to drive the RED LED, leave I unplugged.

GND The ground is GND.

3.5 I2C 16X2 LCD

An I2C 16x2 LCD screen with an I2C interface is seen here. It can show 16 characters by 2rows, each with a white character on a blue background. I2C 16x2 LCD is favoured since projects involving Arduino LCD demand more pins and are difficult to connect and solder. I2C is the communication protocol used by this 16x2 Arduino LCD screen. It means that VCC, GND, SDA, and SCL are the only pins required for the LCD display. It will conserve at least 4 ESP32 digital or analogue pins. Every connector is an XH2.54 standards (Breadboard type). You can immediately connect to the jumper wire.

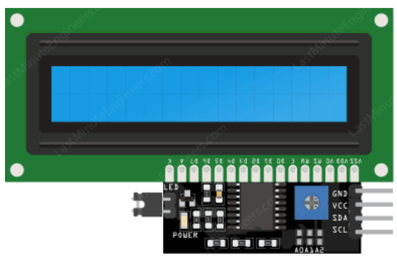


Fig: 3.5 I2C 16X2 LCD

3.6 Pin-out for I2C LCD Display

Only 4 pins connect an I2C 16x2 LCD to the outside world. Following are the connections:

GND stands for ground pin. Connect it to the ESP32 module's ground.

VCC The module and LCD are powered by VCC. Connect it to a 5V external power supply or the ESP32's output.

SDA The I2C data pin is SDA. Connect it to the I2C data pin on the ESP32 module.

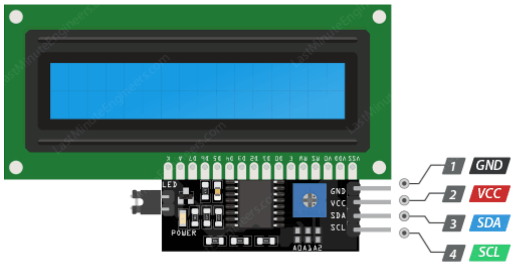


Fig: 3.6 I2C Pin-out

3.7 Hardware Overview I2C LCD

An I2C LCD adapter and a character LCD display powered by the HD44780 comprise the I2C 16x2 LCD display.

Character LCD Display

These LCD's are perfect for showing solely text or characters, as the name implies.

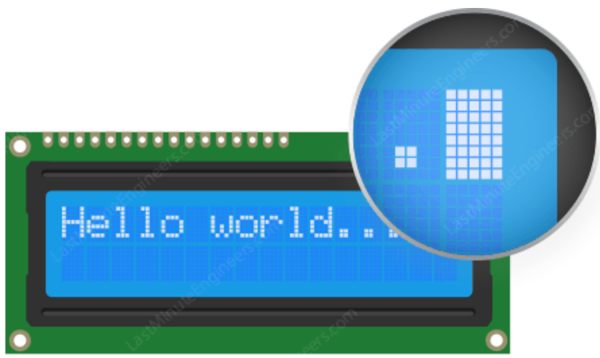


Fig: 3.7 I2C LCD

For instance, a 16x2 I2C LCD can show up to 32 ASCII letters in two rows of 16 each

And has an LED backlight.

I2C LCD Adapter

The core of the adapter is the expanded chip, the PCF8574 8-bit I/O. This chip transforms the I2C data from the ESP32 into the parallel data needed for an LCD display.

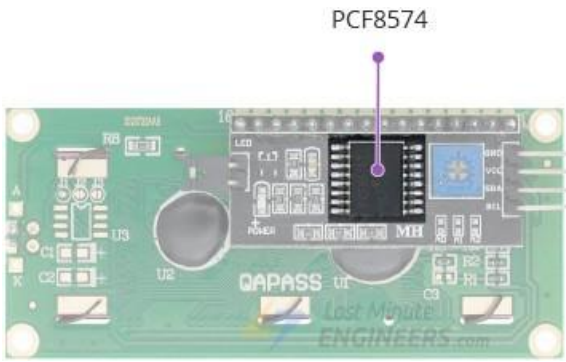


Fig: 3.7.1 LCD CHIP

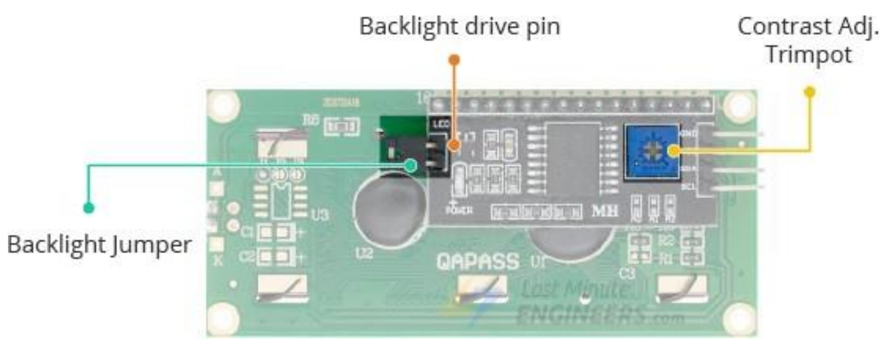


Fig: 3.7.2 LCD CHIP

A tiny Contrast Adj.trim-pot is also included on the board to allow for precise contrast alterations. The jumper pin on the PCB that powers the backlight is also there. You can take off the jumper pin and use an external voltage source to adjust the back-light's brightness by connecting it to the header pin with the designation “LED”.

3.8 AD8232 ECG SENSOR

The electrocardiography, also known as the ECG, is a method for collecting electrical impulses produced by the human heart. The ECG sensor allows us to identify the degree of physiological arousal when a person experiences it, but it is also used to comprehend a person's psychological state. In order to determine the electrical action of the heart, an AD8232 sensor is employed. This is a tiny chip, and its electrical behavior can be visualized using an ECG-like graphic.

The AD8232 ECG monitor is a commercial board that measures the electrical activity of the human heart. This activity yields an analogue reading that can be shown on a chart that resembles an ECG. Electrocardiograms can be highly loud, so the AD8232 chip can be used to reduce the noise. To help extract a clear signal from the intervals, the ECG sensor performs similarly to an operational amplifier. The AD8232 sensor is utilised in ECG signal conditioning and biopotential measuring applications. The main purpose of this chip is to improve, retrieve, and filter weak bio-potential signals in noisy situations, such as those produced by removing a remote electrode and motion.

3.9 AD8232 Pin Configuration

The heart rate tracking sensor, like the AD8232, has the pins SDN pin, LO+ pin, LO-pin, OUTPUT pin, 3.3V pin, and GND pin. So that we may connect this IC to development boards like Arduino by attaching pins to them. The right arm (RA) and left arm (RL) pins, among other custom sensors, have connectors on this board. The human pulse rhythm is displayed on this board using an LED indication.

The AD8232 sensor has a fast restore feature that is used to shorten the HPFs' lengthy resolving tails. This sensor is available in a 4mm x 4mm dimension, and it comes in a

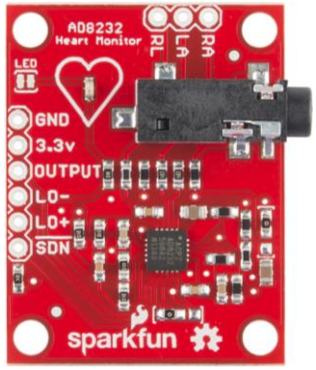


Fig: 3.9 AD8232 ECG

20-lead LFCSP package. Although it can work between -40 and +85 degree Celsius, its performance range is 0 to 70 degrees.

3.10 AD8232 Applications

The following are some examples of the AD8232 ECG sensor's applications:

- Monitoring heart rate and physical activity
- Simple ECG
- Capturing a bio-potential signal
- Biomedical instrument prototyping
- Human-computer interaction
- Fluctuation in heart rate
- Bio-metrics

As a result, the AD8232 ECG sensor is a sensitive, tiny chip used to monitor the electrical activity of the heart and measure it (ECG).

CHAPTER 4

PROGRAMMING ESP32 MODULE

In this chapter we are working on the coding part of the ESP32 module interfaced with sensor MAX30100 Pulse Oximeter Sensor, AD8232 ECG and I2C Interfaced 16X2 LCD using jumper wires. The libraries required to download before writing the code are PubSubClient ,Ubidots ESP MQTT and LiquidCrystal I2C. We have used Arduino support programming language coded in Arduino IDE platform an easy IDE platform for simulation and working.

Coding ESP32 Module

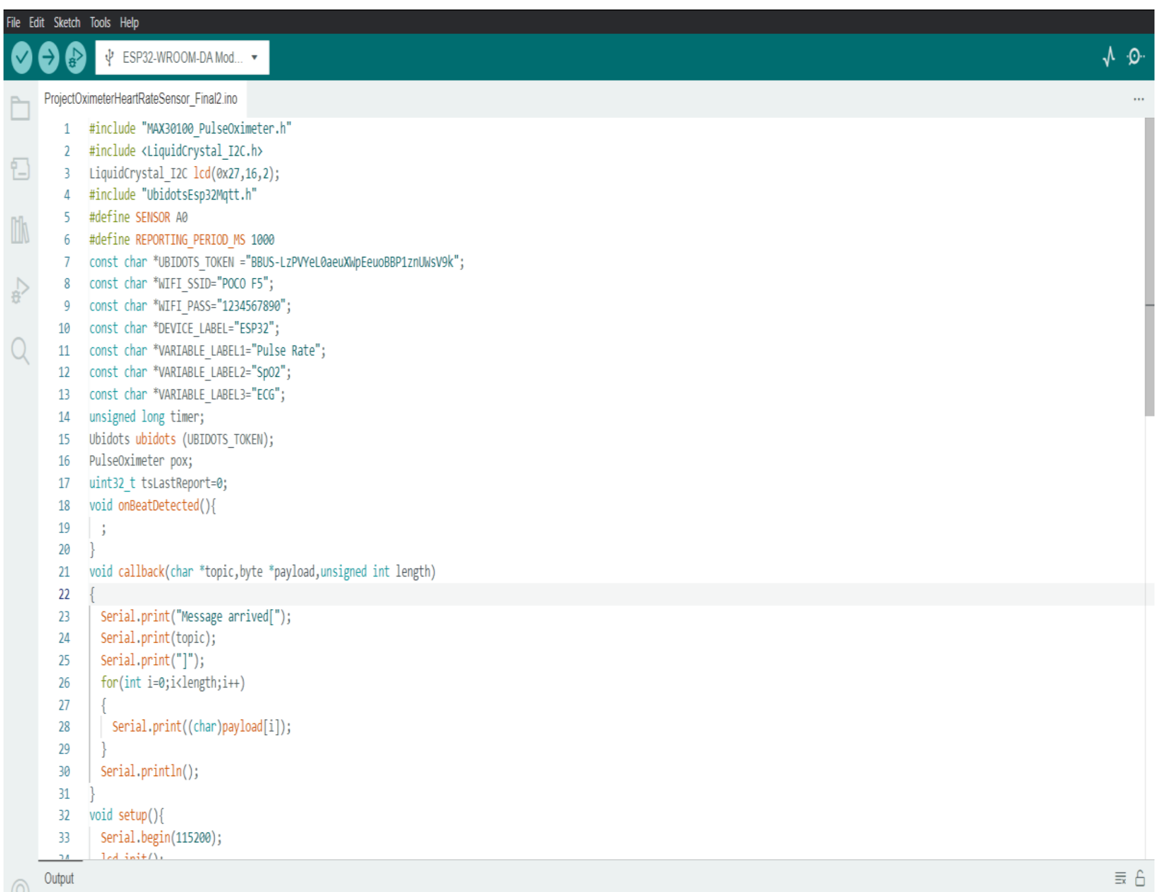


Fig: 4.1 Coding 1

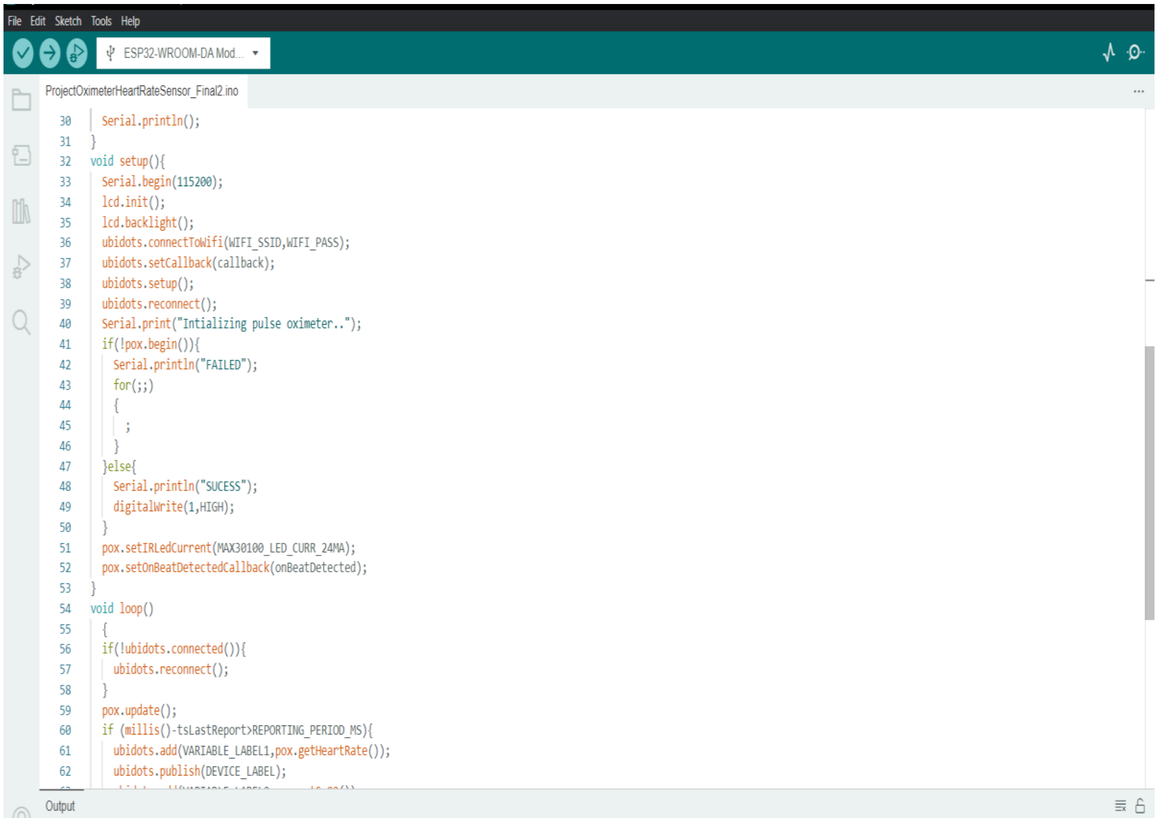


Fig: 4.2 Coding 2

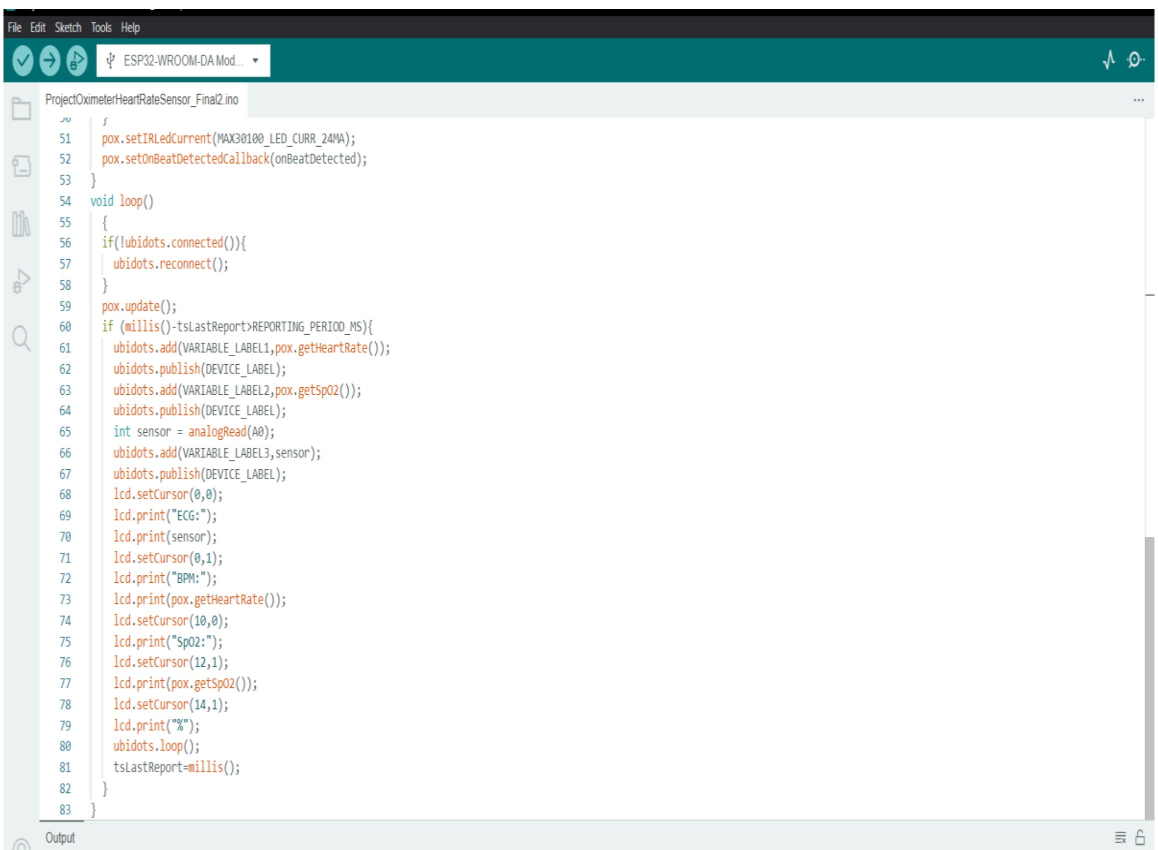


Fig: 4.3 Coding 3

CHAPTER 5
WORKING OF PROTOTYPE MODULE

In this chapter we have designed the working of prototype model along with their data analysis is shown how the micro-controller are synced interfaced with MAX30100 sensors, AD8232 ECG and I2C LCD in which the data is fetched and send to the web-server for visualization of the data here we have also used an alert SMS/Email system which notifies their concerned ones and also notifies the doctor to take immediate action.

5.1 CIRCUIT DIAGRAM OF PROTOTYPE MODEL

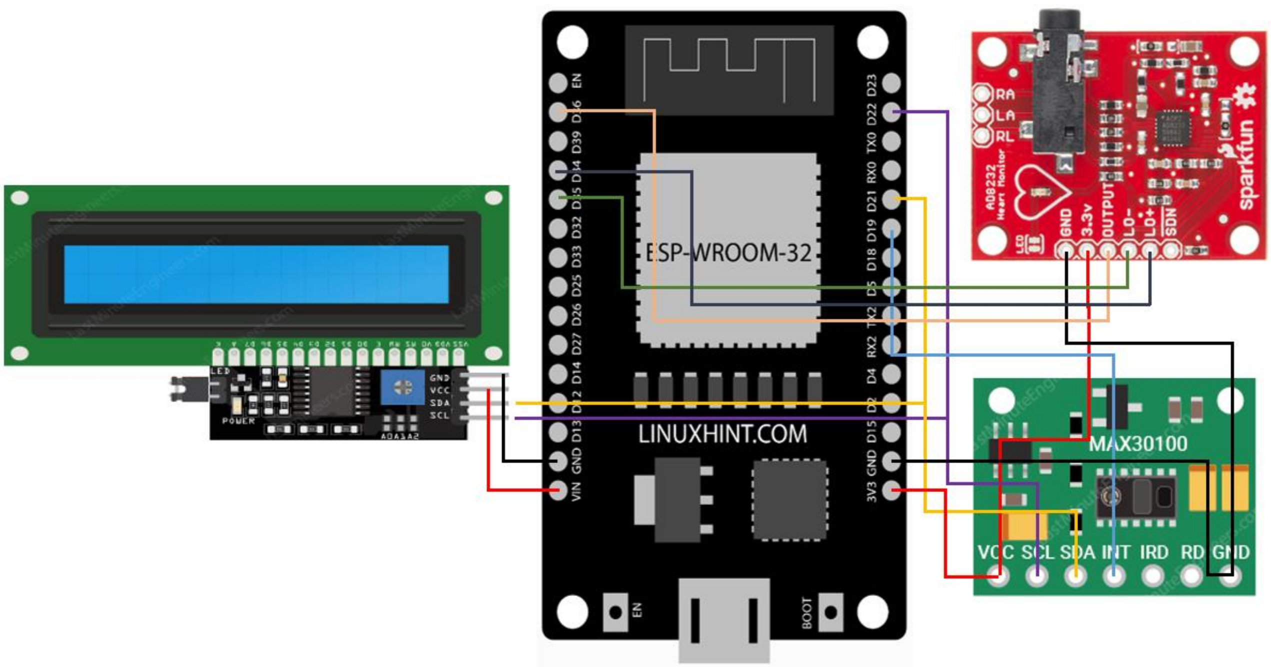


Fig: 5.1 E-Circuit Diagram

5.2 WORKING

The process behind the working of Health Monitoring system is end to end communication.Here are the steps of connection as shown in the Fig.5.1:-

1. ESP32 pins D19,D21 ,D22,3.3V,5V and two GND pins are used.

2. MAX30100 consist of 7 pins but for this project we require 5 pins -VIN with 3.3V, SCL with D21 of ESP32 ,SDA with D22,INT with D19 and GND with GND of ESP32 module.

3. I2C 16X2 LCD pins VIN is connected with 5V,GND with GND of ESP32 module, SDA and SCL pins are shared by MAX30100.

4. AD8232 consists of 6 pins but we require 5 pins -3.3V connected to 3.3V, OUTPUT- D36 (VP), LO- with D35, LO+ with D34 and GND - GND of ESP32 module.

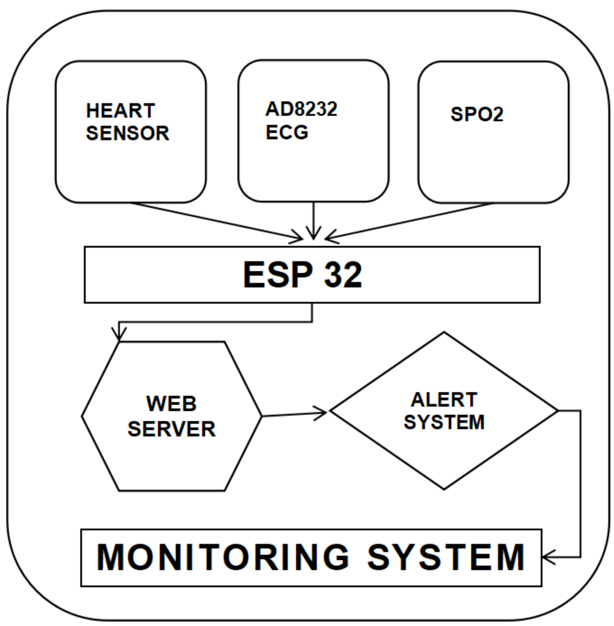


Fig: 5.2 END TO END COMMUNICATION

5.3 DATA VISUALIZATION

Prototype Model

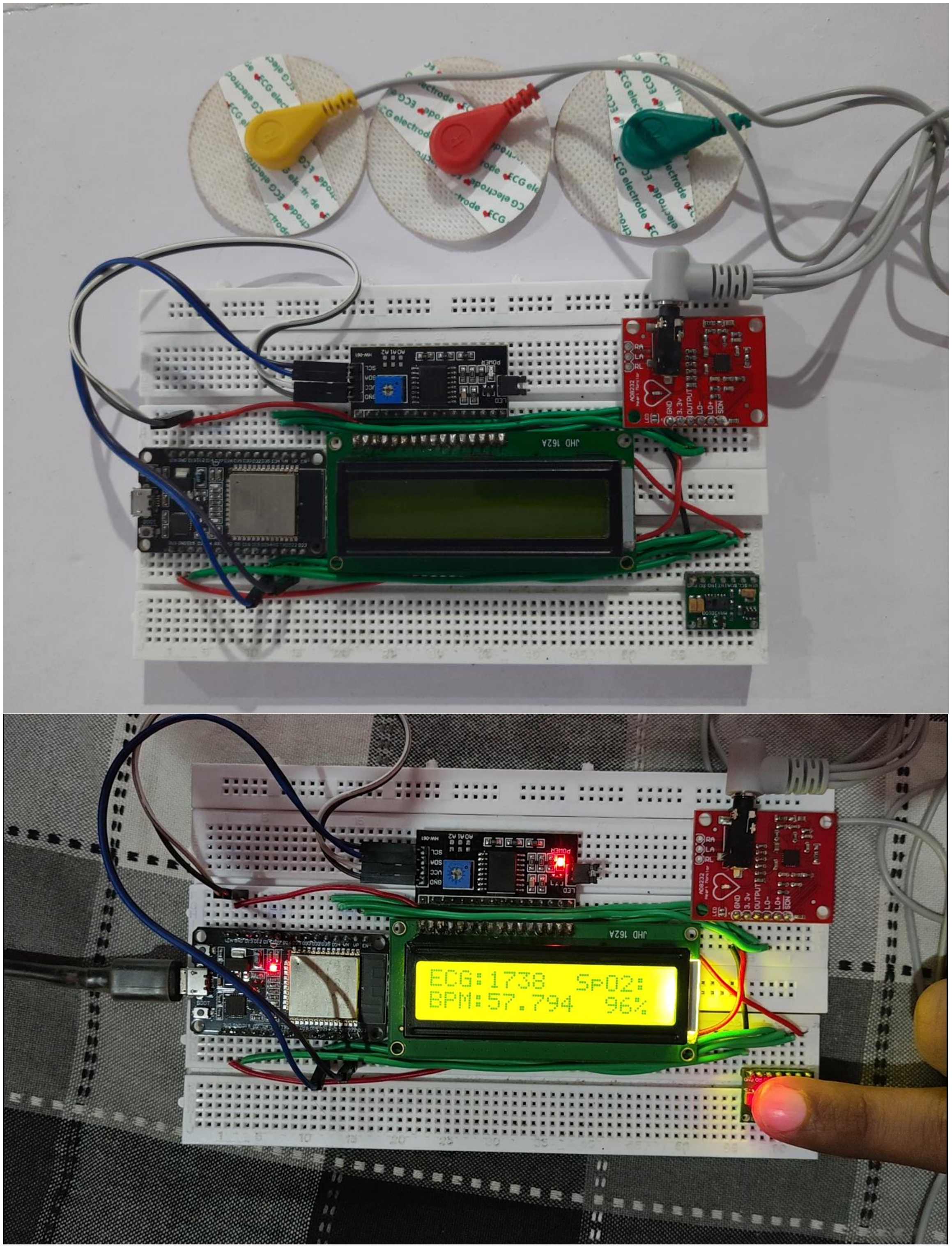


Fig: 5.3 Prototype Model

Web-Server Data Visualization

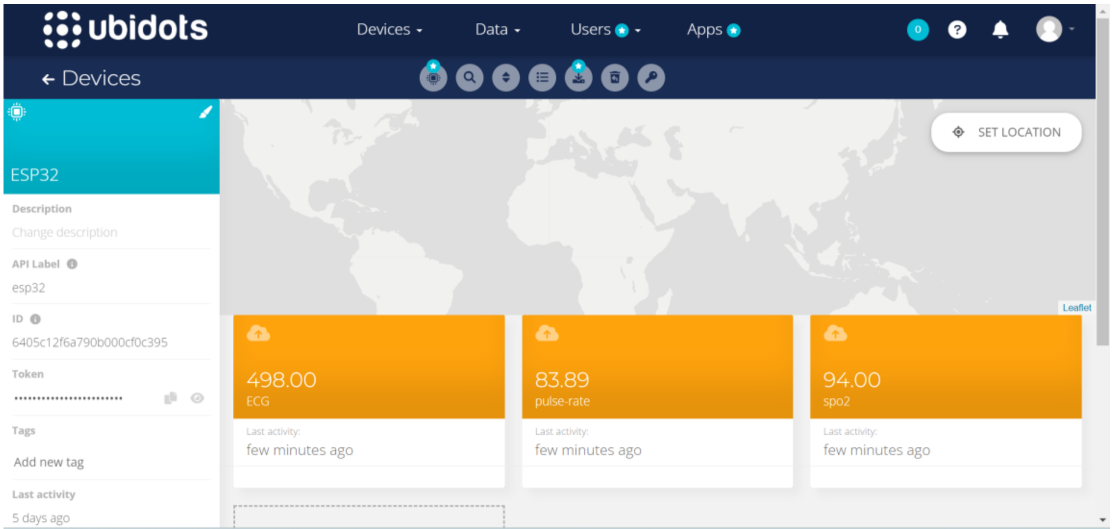


Fig: 5.3.2 Server Data

Fig: 5.3.4 BPM Chart

Fig: 5.3.6 SpO2 Level Chart

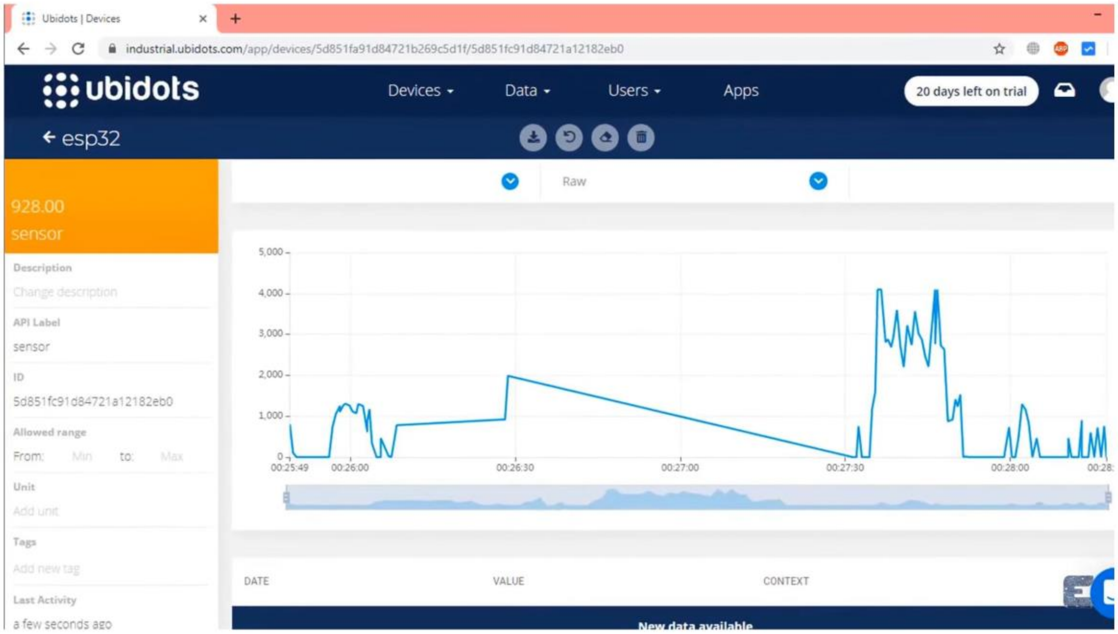
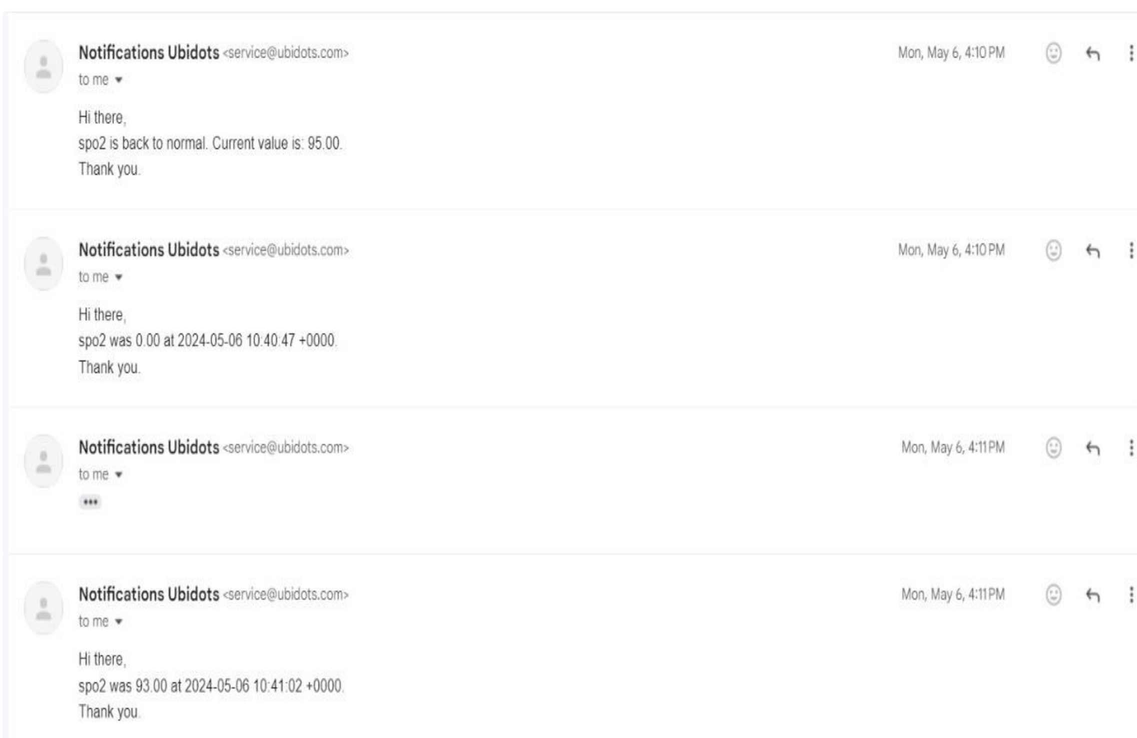


Fig: 5.3.7 ECG Level Chart

ALERT



CHAPTER 6
MERITS AND DEMERITS

Remote Patient Monitoring systems are especially useful because they let the patients live their life while at the same time afford constant medical attention. The need for visiting the clinic/doctor is pushed to only deserving cases. Offline or online RPM devices are effective patient companions at all times.RPM systems can be used by even seemingly healthy people who may foresee health problems in the future. RPM systems will continue to evolve with increasing awareness, utilization and improving technologies.

The progress in bio medical engineering, science and technology paved way for new inventions and technologies. As we are moving towards miniaturization, handy electronic components are in need. New products and new technology are being invented. ARDUINO was found to be more compact, user friendly and less complex, which could readily be used in order to perform several tedious and repetitive tasks. Simulation is performed using Arduino software by placing appropriate sensors like temperature and heart beat rate for sensing the health condition and the results are analyzed under normal conditions and abnormality conditions.

This project can be further enhanced by sensing and displaying other vital statistics of a patient like ECG, blood pressure, glucose level etc. the other thing which is to add is presently we are monitoring the data in Arduino IDE in future we can monitor data in web page using internet of thing technology.

In future, a portable health monitoring system can be designed using Arduino.

Remote Patient Monitoring comes with a lot of promise and has evolved into a finer service than Telehealth. It is going to continue evolving with time in terms of growth and innovation. The following trends are foreseen in the future for Remote Patient Monitoring:

• Increased adoption of Remote Patient Monitoring in Practice Management and Research.
• Consolidation and convergence of technologies participating in RPM.
• Increasing patient participation in RPM adoption and utilization.

• Improvements in devices and technologies with increasing utilization and information share.

• Application of analytics leading to a better study of patient condition information and the related assessments.

RPM system could find applications in numerous healthcare cases some of which are quoted below:

Heart Patients:

Recovering heart patients could require continuous monitoring to assess the conditions and quick care/medication. Devices which include heart resynchronization therapy and pacemakers are especially useful in preventing problems for heart patients. The diagnostic software combined with the device capabilities could almost double-up as a doctor in the vicinity.

Senility or Dementia Problems:

Old age people often suffer from senility and forgetfulness; this could bring some problems such as losing the way or such people falling down at some places. The surveillance and assistance provided by RPM devices could help such people; if these are GPS enabled, they could even help track their locations.

Diabetes and Hypertension Control:

Diabetic or high BP patients require continuous monitoring and control of blood pressure and blood sugar; this can be achieved by an RPM system that not only monitors but could also provide alerts for controlling them. The diagnostic software could provide not only the condition but even advice the diet control or medication necessary to bring the blood sugar to acceptable levels.

Clinical Trials:

In specific clinical trials, which may require long-term observation of the subjects during and after the trials, this may be achieved with the RPM systems.

CHAPTER 7
CONCLUSION

7.1 SUMMARY

The major goal of the project was to design a system that could gather readings of the patient's numerous symptoms, analyse them in the cloud, and then alert the doctor or other concerned parties about the patient's health. This was achieved by developing a system that is implanted and relies on sensors to communicate the reading of significant indicators to cloud administrations provided by Ubidots Web-Server. The readings fetched are seen in the LCD display in the presence and the data can be shown by logic into the Ubidots Web-Server. The results of the data analysis performed on the model are shown in the above-mentioned figure. The sensor data are utilised to keep track of any changes in a patient's heart rate and oxygen saturation level, and the new status is relayed to the Ubidots Server using MQTT. Thus, the suggested system is capable of storing readings of several patient indicators including heart rate, ECG track and SpO2. It monitors the change in values and monitors abnormalities. These anomalies raise awareness among the medical staff, the treating physician, and the patient's family, which lessens the need for manual monitoring. To communicate the data to the cloud platform, the system employs MQTT communication. This messaging protocol aids the concerned parties and the doctor by transmitting the readings of significant patients' vital signs.

7.2 IMPACT ASSESSMENT

Application of IOT based Health Monitoring System working at 2 to 3.6V supply at max 5V using USB port.

Communication based application: This ESP32 Module micro-controller has several application in wireless communication.These are used in the fields of health care and communication and many other new prototype models. It uses a minimum of 2 to 3.6V supply to operate and also provide WiFi communication.

Medical applications: This micro-controller not only used in robotics but also used in medical purposes also. We have track the patient's pulses and oxygen level, along with AD8232 ECG sensors interfaced with the ESP32 micro-controller.

7.3 COST ANALYSIS

Since the project work is made a type of prototype, there is procurement cost required. According to Amazon, an e-commerce site, the cost of procurement of Jumper Wires,MAX30100 Pulse Oximeter, AD8232, ESP32 WiFi Module,PCB Board,Breadboard and I2C 16X2 LCD is 2262.81 Rs.

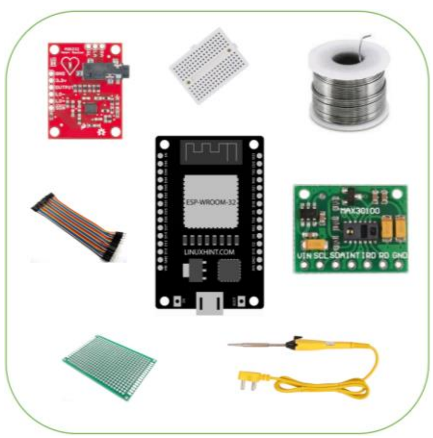


Fig: 7.3 Components

APPENDIX – COMPONENT LIST & DATA SHEETS

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