Health Monitoring in IOT using ESP 32 Microcontroller

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

in

Electronics and Communications Engineering (ECE)

by

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Under the guidance of

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VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

November 2024

DECLARATION

I hereby declare that the thesis entitled "Health monitoring in IOT using ESP32 Microcontroller " submitted by me, for the completion of the course "BECE497J – Project 1" to the school of electronics engineering, Vellore institute of technology, Vellore is bonafide work carried out by me under the supervision of Dr. Debashish Maji

I further declare that the work reported in this thesis has not been submitted previously to this institute or anywhere.

Place : Vellore

Date :13:11:2024

Signature of the Candidate

CERTIFICATE

This is to certify that the thesis entitled "Health monitoring in IOT using ESP32 Microcontroller" submitted by **Aditya Prem 21BEC0067, Deepanjali Das 21BEC0075, Akash 21BEC2436,** SENSE, VIT, for the completion of the course "BECE497J – Project 1", is a bonafide work carried out by him / her under my supervision during the period, 15.07.2024 to 4.11.2024, as per the VIT code of academic and research ethics.

I further declare that the work reported in this thesis has not been submitted previously to this institute or anywhere.

Place : Vellore

Date : 13/11/2024

Signature of the Guide

13/11/24

Internal Examiner

ACKNOWLEDGEMENTS

We would like to thank Vellore Institute of Technology for providing us with the necessary means and support for us to work on and complete this project. Each of the team members contributed equally to this project. We would also like to thank our project guide Dr. Debashish Maji , Associate Professor Grade 1, SENSE School , for guiding us throughout the entire project and helping us design the proposed prototype in the project.

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Akash 21BEC2436

Student Name

Executive Summary

The development of an IoT-based smart patient health monitoring system using the ESP32 represents a significant advancement in remote healthcare solutions, with the potential to impact patient care and medical facilities. With this main objective in our mind we aim to create an efficient yet cost-effective health care system using esp32 and multiple sensors. Some features of this system are : Real-time monitoring and data storage, contributing to improved patient care , remote patient monitoring offering key advantages in advancing smart healthcare solutions and Monitoring vital health parameters such as temperature, heart rate, and blood pressure remotely is crucial for proactive healthcare management. The components that we are going to use in this project are : ESP32 Dev board, Pulse-oximeter MAX30100 for measuring blood oxygen level , temperature sensor DB18B20 for measuring body temperature , pulse sensor for measuring beats per minute or bpm. The primary goal and objective of this project is to develop a cost effective yet useful and accurate health monitoring system using basic electronic components which are readily available in market.

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List of Abbreviations

SPO2 : Saturation of peripheral oxygen

BPM : Heart beats per minute

OLED : Organic Light Emitting Diode

ESP32 : Espressif32

MAX30100 : integrated pulse oximetry and heart- rate monitor sensor solution

1. INTRODUCTION

1.1 Literature Review :

Shivleela Patil and Dr. Sanjay Pardeshi's paper, "Health Monitoring System using IoT," describes a system that uses an Arduino-based configuration combined with an LM35 temperature sensor and a pulse sensor to track heart rate and body temperature. An ESP8266 WiFi module is used to wirelessly transfer data to an IoT platform, allowing for ongoing monitoring and data visualization on ThingSpeak. By automating data collection and enabling remote access to health data, the system seeks to expedite health tracking, especially for rural healthcare. This could enhance prompt healthcare responses and facilitate data accessibility [1]. The paper Patient Health Monitoring using IoT by N. Deepak, Ch. Rajendra Prasad, and S. Sanjay Kumar presents an IoT-based system that continuously monitors patients' vital signs using temperature, pulse, and MEMS sensors. Data is transmitted to a smartphone via Bluetooth and to a cloud server via GPRS for remote access. This setup allows healthcare professionals to monitor patients in real-time, even from a distance, thereby improving response times in emergencies. The system, designed for both hospital and home use, highlights the advantages of cloud integration and IoT for healthcare efficiency and accessibility [2]. The IoT based Patient Health Monitoring System paper by D. Shiva Rama Krishnan, Subhash Chand Gupta, and Tanupriya Choudhury presents a health monitoring system that employs IoT for monitoring patients in real-time. Using sensors linked to an Arduino Uno, this system monitors essential signs such as temperature and heart rate, transmitting data through Wi-Fi to a web server. Notifications are sent out when readings stray from typical levels, allowing for remote observation by healthcare providers or loved ones. This technology decreases the necessity for in-person monitoring, improving access to timely healthcare and possibly lowering deaths caused by delayed medical attention [3]. P. Jebane, P. Anusuya, M. Suganya, S. Meena, and M. Diana Amutha Priya wrote the paper, which examines an Internet of Things-based health monitoring system that uses Arduino and ThingSpeak Cloud to track vital signs like blood pressure, temperature, and pulse. The system gathers information from sensors and sends it to healthcare providers in order to help patients and medical personnel. The study demonstrates how well IoT works for ongoing remote monitoring, allowing for prompt notifications of anomalous readings. This arrangement improves patient care and may lessen the strain on medical facilities while providing an affordable healthcare solution [4]. The paper, authored by Aditya Sharma, Anuj Kumar Singh, Khushi Saxena, and Abhinav Bansal, examines an IoT-based health monitoring system designed to improve healthcare delivery, especially in rural areas. Utilizing NodeMCU/ESP8266 and Arduino, the system collects data on vital signs like heart rate and temperature, which are transmitted to ThingSpeak for real-time access by healthcare providers. The authors emphasize the system's utility in reducing labour costs, enabling remote monitoring, and supporting timely responses to emergencies. This approach aims to address healthcare access disparities, promoting efficient, cost-effective patient care in under-resourced settings [5]. Wisana et al. (2021) developed an Internet of Things (IoT)-based health monitoring tool using a piezoelectric sensor to measure respiratory parameters. Their system, which included an ESP32 Wi-Fi module for real-time monitoring, aimed to provide accurate respiratory rate detection with cost-effective implementation. Prior research in the field, such as work by Setiyo et al., utilized piezoelectric sensors for respiration monitoring, showing potential for high accuracy and stability. This study builds on earlier systems, offering improvements in remote monitoring capabilities, a critical factor in modern healthcare solutions [6]. The ESP8266 health monitoring model presented by Manjupriya et al. (2024) monitors vital signs such as temperature and heart rate, enabling remote observation by transmitting real-time data to medical professionals. While Kakria et al. (2015) created a system using wearable sensors for cardiac patients, other studies, like Ding (2017), have concentrated on sensor networks for temperature monitoring. IoT is supported by Shalini (2021) for cost-effective monitoring that improves real-time diagnostics. These methods demonstrate how IoT can be used to seamlessly monitor healthcare and link professionals and patients from a distance [7]. In IoT-based health monitoring, Taştan (2018) developed a wearable system for tracking vital parameters like heart rate, leveraging the Arduino Pro Mini and Blynk application for real-time alerts to patients and family members. Other studies echo the need for wearable systems in continuous health monitoring. Goldberger et al. (2002) highlighted heart rate variability as an indicator for cardiac issues, while Patel et al. (2012) discussed wearable tech's role in patient rehabilitation. This convergence of IoT and wearable technology underscores a growing trend towards real-time, accessible healthcare monitoring solutions [8]. The paper "Health monitoring smart glove using ESP32 microcontroller" by T.S. Jahnavi, Naveen Thumma, Kolla Abhishek Reddy, Upadarsta V.R.S.S.H. Teja, M. Gunasree, and M. Kiran reviews various health monitoring systems. It highlights Priyanka Lokhande et al.'s sign language recognition glove, Amandeep Kaur and Ashish Jasuja's IoT-based health monitoring using Raspberry Pi, and Aniket Pramanik's GSM-based home automation. The authors propose a smart glove integrating health monitoring and gesture control, enhancing patient-caregiver communication and emergency response. This glove uses advanced sensors and ESP32 for real-time health data transmission and alerts [9]. IoT integration in healthcare is examined in the paper "Health Monitoring System of Patient Using IoT" by G. Joga Rao, P. Karthik, G. Sai Sameer Kumar, N. Ajay, K. Anil Kumar, and J. Durga Prasad1. It emphasizes how sensors are used to track vital signs like body temperature, pulse rate, and electrocardiogram (ECG), sending data to the cloud via Thingspeak so that medical personnel can monitor it in real time. This system seeks to increase the effectiveness of patient care while lessening the strain of medical personnel. The study emphasizes how IoT might improve patient monitoring and healthcare delivery [10]. The influence of IoT in healthcare monitoring is examined in the paper by Hoa Nguyen, Farhaan Mirza, M. Asif Naeem, and Minh Nguyen. Applications that support the elderly and help manage chronic diseases are the main focus. By examining IoT-enabled health systems, they point out advantages made possible by real-time data transfer and analysis, like better clinical feedback and less stress on hospitals. From sensors to storage, their suggested IoT Tiered Architecture (IoTTA) places a strong emphasis on effective data management. Notably, the study indicates that machine learning and self-care improvements in IoT healthcare can promote patient autonomy and lower false alarms, which will help create a more sustainable healthcare system [11]. Abdulmalek et al. (2022) present a comprehensive review on the use of IoT in healthcare, emphasizing how IoT-based monitoring can enhance patient quality of life. They discuss the advancements in remote healthcare, including the use of wearable sensors and real-time monitoring, and highlight benefits such as cost reduction, early disease detection, and improved patient outcomes. The review also examines the challenges of implementing IoT in healthcare, such as data privacy, security, and system scalability. By assessing recent studies, the authors outline potential improvements and suggest future directions for IoT-based healthcare applications [12]. An Internet of Things-based healthcare monitoring system was created by Islam, Rahaman, and Islam (2020) to continually monitor ambient factors and patient health indicators. The device uses five sensors to detect CO and CO_2 gas levels, body temperature, room temperature, and heart rate. For real-time monitoring, an ESP32 module processes the data before sending it over Wi-Fi to a web portal. With an accuracy rate of more than 95%, the system is useful for remote patient care and telemedicine. Potential future enhancements are suggested by the authors, including the use of video for consultations and the tracking of more health metrics [13]. A thorough analysis of IoT applications in healthcare is provided in the study "IoT-based Smart Healthcare Monitoring Systems: A Literature Review" by R. Alekya, Neelima Devi Boddeti, K. Salomi Monica, Dr. R. Prabha, and Dr. V. Venkatesh. The authors talk about how mobile healthcare management systems (HMS) allow for continuous, remote patient monitoring, which is made possible by IoT technology. They emphasize how wireless sensor networks (WSN) and the Internet of Things (IoT) can be integrated to enable data transmission and real-time health monitoring. IoT has the potential to improve patient care quality while lowering costs and the strain on healthcare facilities across a number of healthcare sectors, including wearable and implantable devices, according to the review [14]. The study "Smart Healthcare Monitoring using IoT" by Shubham Banka, Isha Madan, and S.S. Saranya investigates a Raspberry Pi microcontroller-based IoT-based health monitoring system that enables remote patient care. A cloud database receives real-time data from sensors in this system that monitor critical health factors like body temperature, blood pressure, and heart rate. Family members and medical professionals are notified in emergency situations. The system's data mining algorithms, according to the scientists, enable early chronic disease prediction, improving decision-making and possibly revolutionizing the efficiency and accessibility of healthcare [15].

1.2 Research Gap :

IoT applications in health monitoring face significant research gaps, including data privacy concerns due to weak encryption protocols, which leave patient information vulnerable. Interoperability is also challenging, as diverse devices often lack standardization, complicating data integration. Additionally, the reliability of sensors is limited, sometimes resulting in inconsistent readings that affect diagnostic accuracy. Battery life constraints reduce the sustainability of continuous monitoring, and the high costs of scalable infrastructure limit widespread adoption. Furthermore, there is a need to integrate AI for real-time predictive analysis, while improving accessibility and user compliance, particularly for elderly or less tech-savvy patients. Also the current available health monitoring devices in the market are costly and availability of cheaper yet accurate health monitoring devices is also very rare. With the aim of developing a smaller, cheaper and cost-effective health monitoring device, we have developed a small prototype which can constantly measure the real time data such as human heartbeat per minute, blood oxygen Spo2 level and body temperature in degree Celsius and display the real time data on the OLED display.

1.3 Problem statement :

To develop an accurate yet cost effective health monitoring system which can measure and display real time health parameters such as heart rate per minute, Blood oxygen Spo2 level and human body temperature in degree Celsius. Also to develop the device considering the cost parameters into effect such that the device can be made readily accessible in each and every corner of the country.

1.4 Relevance of the project with respect to the SDGs :

The project supports the following sustainable development goals or SDG's :

- **SDG 3: Good Health and Well-being** – By providing real-time health monitoring, it enhances healthcare accessibility and quality.
- **SDG 9: Industry, Innovation, and Infrastructure** – Uses IoT and digital infrastructure to innovate healthcare systems.
- **SDG 10: Reduced Inequalities** – By making healthcare accessible remotely, it bridges the gap for underserved populations.

2. PROJECT OBJECTIVE

An important development in remote healthcare solutions that could have an effect on patient care and medical facilities is the creation of an Internet of Things (IoT)-based smart patient health monitoring system employing the ESP32. With this primary goal in mind, we want to use esp32 to develop a health care system that is both effective and economical. This system has several capabilities, including remote patient monitoring that offers significant benefits in developing intelligent healthcare solutions, real-time monitoring and data storage that improves patient care, and For proactive healthcare management, remote monitoring of critical health metrics including blood pressure, heart rate, and temperature is essential. Hence the main objective is to develop a small health monitoring prototype to measure and continuously monitor the real time health parameters such as blood oxygen level Spo2, body temperature in degree Celsius and heart beats per minute (BPM) and display it on an OLED display.

3. PROPOSED WORK

3.1 Design Approach / System Model / Algorithm :

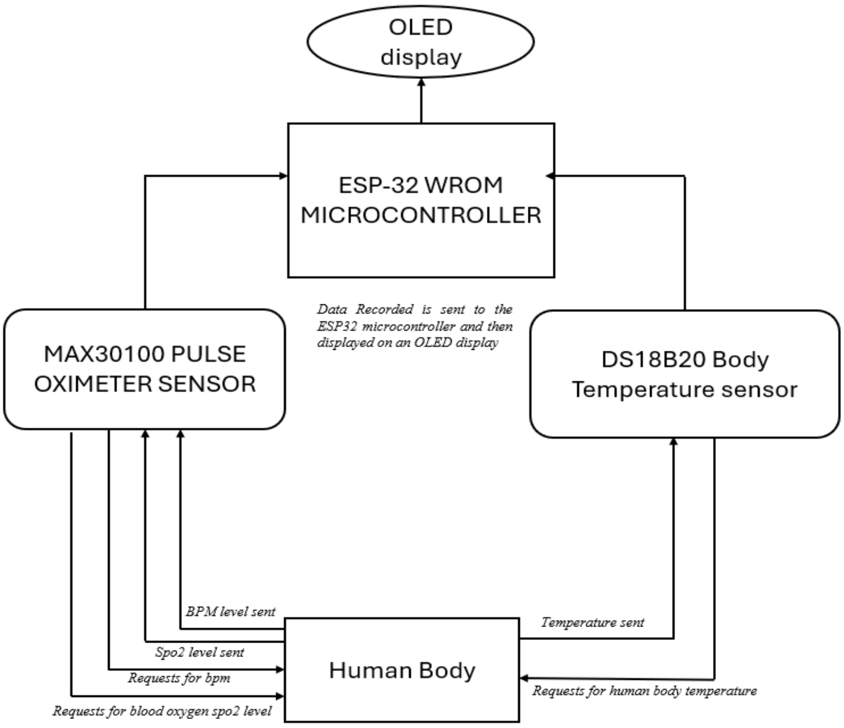

Fig 1. Algorithm

3.2 Technical Description :

The primary components that we are using in this project are MAX30100 sensor , DS18B20 body temperature , breadboard , OLED display , jumper wires and ESP32 WROM microcontroller. Th main use of the MAX30100 sensor is that it can be used for recording the real time data such as heart beats per minute (BPM) and the Spo2 level (the blood oxygen level) of the blood. The DS18B20 sensor is used for measuring and recording the real time human body temperature . The DS18B20 sensor is available in two forms: one in the form of a transistor and another in the form of waterproof wire based sensor .We are using the waterproof version. Also we are using ESP32 microcontroller because it is very compact in size and has additional features such as connection to the Wi-Fi and Bluetooth. Also we are using the OLED display for displaying the recorded real time heath parameters such as Heart beats per minute (bpm) , blood oxygen Spo2 level and body temperature in degree Celsius. We are integrating and programming the entire hardware setup using embedded C language.

4. HARDWARE/ SOFTWARE DETAILS

4.1 Hardware Design :

The components that we have used in this project are MAX30100 sensor , DS18B20 body temperature , breadboard , OLED display , jumper wires and ESP32 WROM microcontroller. We have placed all these components in the breadboarding an appropriate manner and integrated and established electrical connections between the components with the help of jumper wires.

Fig 2. MAX30100 sensor [16]

Fig 3. DS18B20 temperature sensor [17]

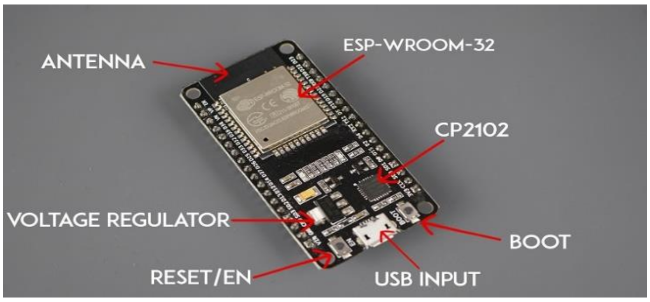

Fig 4. ESP32 Microcontroller [18]

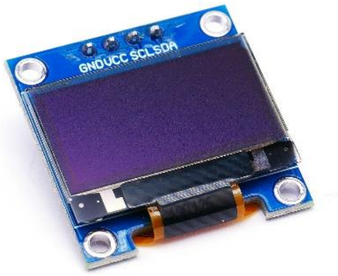

Fig 5. OLED Display [19]

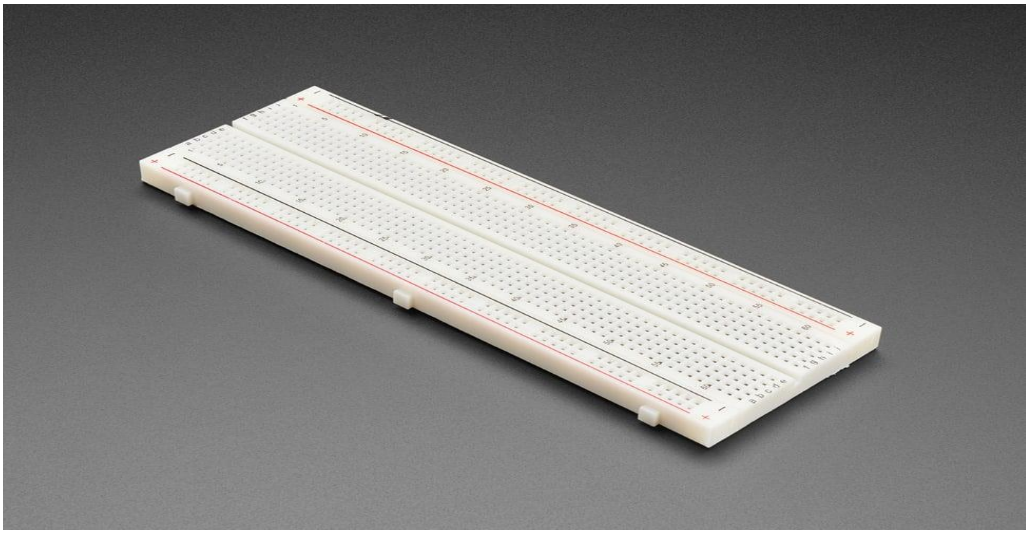

Fig 6. Breadboard [20]

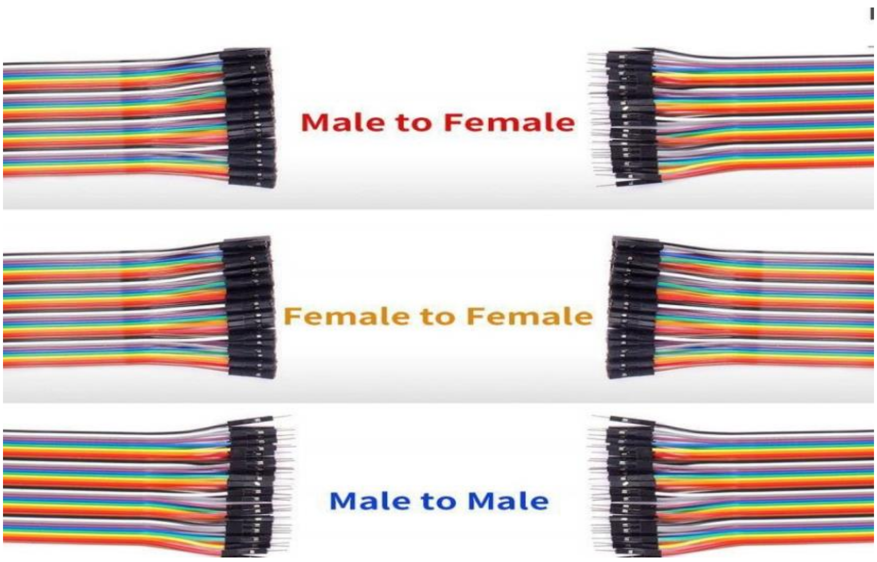

Fig 7. Jumper wires [21]

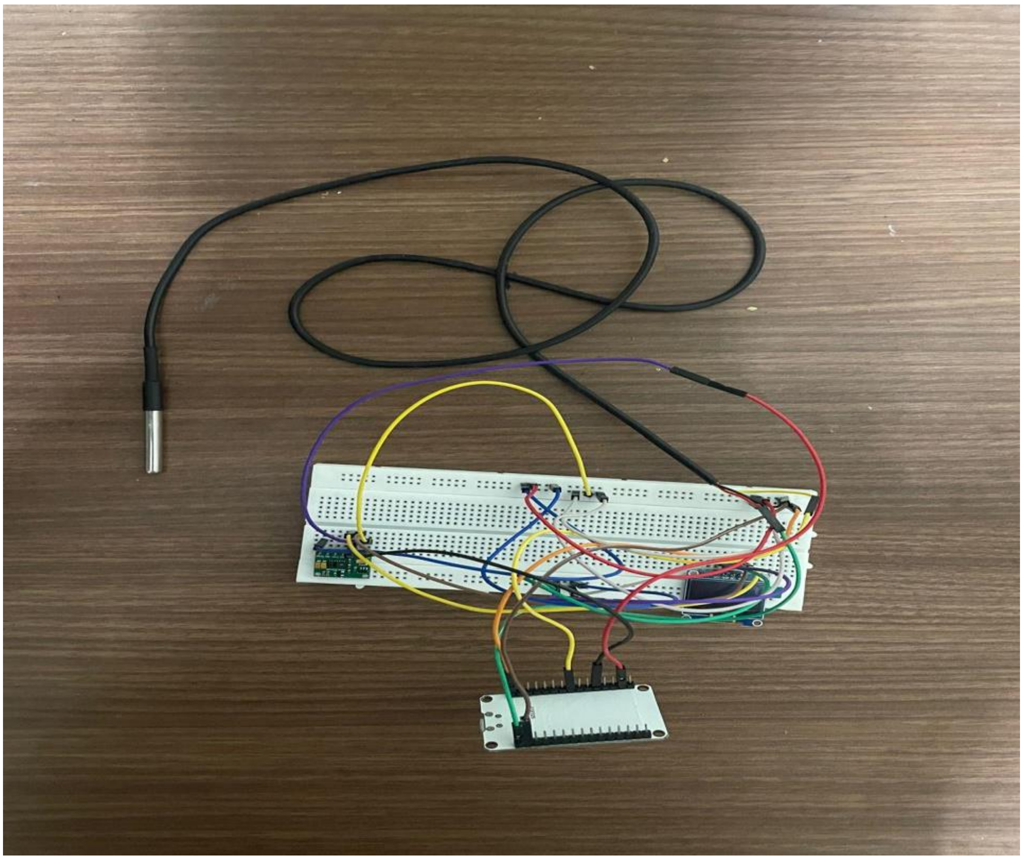

Fig 8. Proposed Model and Hardware designed by us

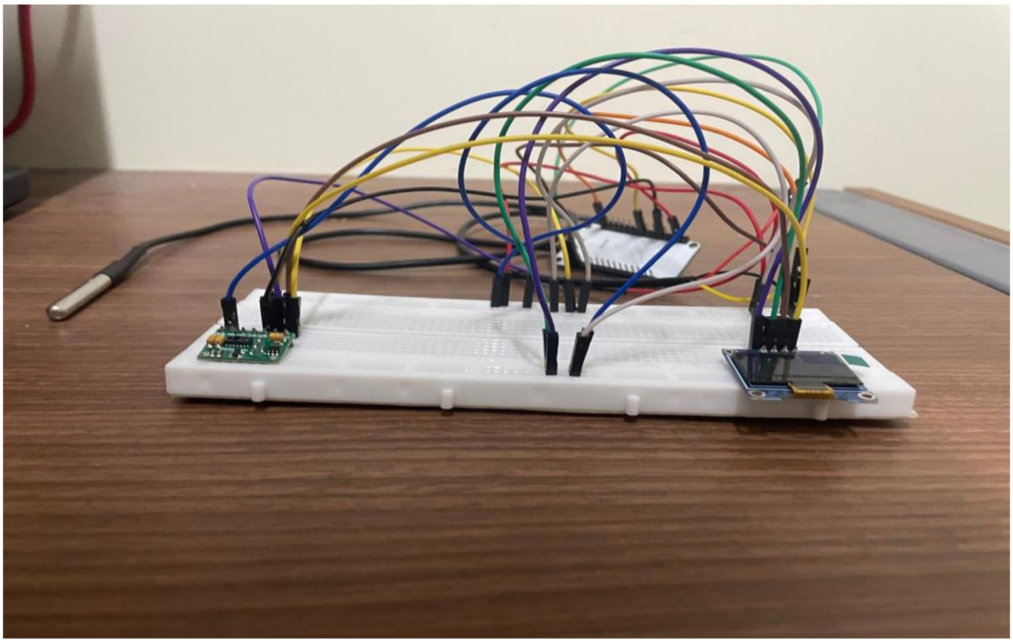

Fig 9. Our Proposed Prototype

4.2 Software Design:

Once we designed , placed and established the electrical connections between different sensors on the breadboard in the hardware setup . we embedded and integrated all these components and gave them their respective functionality using program written in embedded C language. We implemented the program on the Arduino IDE platform. The proposed/designed program is given below :

```
 #include <Wire.h>
#include <Adafruit_GFX.h>                    //     needed for OLED display
#include <Adafruit_SSD1306.h>                //     needed for OLED display
#include "MAX30100_PulseOximeter.h"
#include <OneWire.h>
#include <DallasTemperature.h>
#define DS18B20 5
#define REPORTING_PERIOD_MS     1000
float  BPM, SpO2, tempC,tempF;
PulseOximeter pox;
Adafruit_SSD1306 OLED = Adafruit_SSD1306(128, 64, &Wire);
uint32_t tsLastReport = 0;
OneWire oneWire(DS18B20);
DallasTemperature sensors(&oneWire);

const unsigned char bitmap [] PROGMEM=
{
0x00, 0x00, 0x00, 0x00, 0x01, 0x80, 0x18, 0x00, 0x0f, 0xe0, 0x7f, 0x00, 0x3f, 0xf9, 0xff, 0xc0,
0x7f, 0xf9, 0xff, 0xc0, 0x7f, 0xff, 0xff, 0xe0, 0x7f, 0xff, 0xff, 0xe0, 0xff, 0xff, 0xff, 0xf0,
0xff, 0xf7, 0xff, 0xf0, 0xff, 0xe7, 0xff, 0xf0, 0xff, 0xe7, 0xff, 0xf0, 0x7f, 0xdb, 0xff, 0xe0,
0x7f, 0x9b, 0xff, 0xe0, 0x00, 0x3b, 0xc0, 0x00, 0x3f, 0xf9, 0x9f, 0xc0, 0x3f, 0xfd, 0xbf, 0xc0,
0x1f, 0xfd, 0xbf, 0x80, 0x0f, 0xfd, 0x7f, 0x00, 0x07, 0xfe, 0x7e, 0x00, 0x03, 0xfe, 0xfc, 0x00,
0x01, 0xff, 0xf8, 0x00, 0x00, 0xff, 0xf0, 0x00, 0x00, 0x7f, 0xe0, 0x00, 0x00, 0x3f, 0xc0, 0x00,
0x00, 0x0f, 0x00, 0x00, 0x00, 0x06, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00
};
void setup() {
  OLED.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  Serial.begin(115200);
  OLED.display();
```

```
 OLED.clearDisplay();
 OLED.setTextSize(1.5);
 OLED.setTextColor(SSD1306_WHITE);
 OLED.setCursor(0,0);
 OLED.display();
 delay(1000);
  Serial.print("Initializing pulse oximeter..");
  if (!pox.begin()) {
    Serial.println("FAILED");
    for (;;);
  } else {
    Serial.println("SUCCESS");
  }
}
void loop() {
  pox.update();
  BPM = pox.getHeartRate();
  SpO2 = pox.getSpO2();
  sensors.setWaitForConversion(false);
  sensors.requestTemperatures();
  sensors.setWaitForConversion(true);
  tempC = sensors.getTempCByIndex(0);
  tempF = tempC * 9 / 5 + 32;
  if (millis() - tsLastReport > REPORTING_PERIOD_MS)
  {
     String Message="BPM : "+String(BPM)+" SPO2 : "+String(SpO2)+" Temperature : "+String(tempC)+" C "+String(tempF)+" F";
    Serial.println(Message);
    OLED.clearDisplay();
     OLED.drawBitmap( 80, 25, bitmap, 28, 28, 1);
      OLED.setCursor(0,0);
      OLED.print("H:");
      OLED.print(BPM);
      OLED.println(" bpm");
      OLED.println();
      OLED.print("SpO2:");
```

```
      OLED.print(SpO2);
      OLED.println(" %");
      OLED.println();
      OLED.print("Temp:");
      OLED.print(tempC);
      OLED.println(" C");
    tsLastReport = millis();
  }
  OLED.display();
}
```

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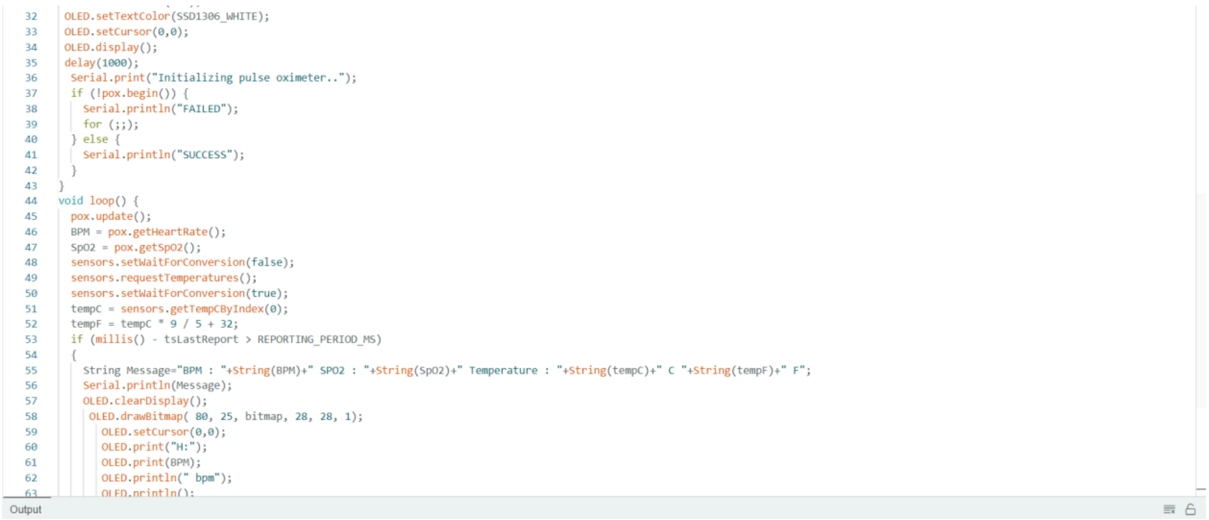
```
#include <Wire.h>
#include <Adafruit_GFX.h>                    //     needed for OLED display
#include <Adafruit_SSD1306.h>                //     needed for OLED display
#include "MAX30100_PulseOximeter.h"
#include <OneWire.h>
#include <DallasTemperature.h>
#define DS18B20 5
#define REPORTING_PERIOD_MS     1000
float  BPM, SpO2, tempC,tempF;
PulseOximeter pox;
Adafruit_SSD1306 OLED = Adafruit_SSD1306(128, 64, &Wire);
uint32_t tsLastReport = 0;
OneWire oneWire(DS18B20);
DallasTemperature sensors(&oneWire);

const unsigned char bitmap [] PROGMEM=
{
0x00, 0x00, 0x00, 0x00, 0x01, 0x80, 0x18, 0x00, 0x0f, 0xe0, 0x7f, 0x00, 0x3f, 0xf9, 0xff, 0xc0,
0x7f, 0xf9, 0xff, 0xc0, 0x7f, 0xff, 0xff, 0xe0, 0x7f, 0xff, 0xff, 0xe0, 0xff, 0xff, 0xff, 0xf0,
0xff, 0xf7, 0xff, 0xf0, 0xff, 0xe7, 0xff, 0xf0, 0xff, 0xe7, 0xff, 0xf0, 0x7f, 0xdb, 0xff, 0xe0,
0x7f, 0x9b, 0xff, 0xe0, 0x00, 0x3b, 0xc0, 0x00, 0x3f, 0xf9, 0x9f, 0xc0, 0x3f, 0xfd, 0xbf, 0xc0,
0x1f, 0xfd, 0xbf, 0x80, 0x0f, 0xfd, 0x7f, 0x00, 0x07, 0xfe, 0x7e, 0x00, 0x03, 0xfe, 0xfc, 0x00,
0x01, 0xff, 0xf8, 0x00, 0x00, 0xff, 0xf0, 0x00, 0x00, 0x7f, 0xe0, 0x00, 0x00, 0x3f, 0xc0, 0x00,
0x00, 0x0f, 0x00, 0x00, 0x00, 0x06, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00
};
void setup() {
  OLED.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  Serial.begin(115200);
  OLED.display();
 OLED.clearDisplay();
 OLED.setTextSize(1.5);
 OLED.setTextColor(SSD1306_WHITE);
 OLED.setCursor(0,0);
```

Output

Downloading i

Fig 10. Code designed in the Arduino IDE Platform



```
 OLED.setTextColor(SSD1306_WHITE);
 OLED.setCursor(0,0);
 OLED.display();
 delay(1000);
  Serial.print("Initializing pulse oximeter..");
  if (!pox.begin()) {
    Serial.println("FAILED");
    for (;;);
  } else {
    Serial.println("SUCCESS");
  }
}
void loop() {
  pox.update();
  BPM = pox.getHeartRate();
  SpO2 = pox.getSpO2();
  sensors.setWaitForConversion(false);
  sensors.requestTemperatures();
  sensors.setWaitForConversion(true);
  tempC = sensors.getTempCByIndex(0);
  tempF = tempC * 9 / 5 + 32;
  if (millis() - tsLastReport > REPORTING_PERIOD_MS)
  {
    String Message="BPM : "+String(BPM)+" SPO2 : "+String(SpO2)+" Temperature : "+String(tempC)+" C "+String(tempF)+" F";
    Serial.println(Message);
    OLED.clearDisplay();
     OLED.drawBitmap( 80, 25, bitmap, 28, 28, 1);
      OLED.setCursor(0,0);
      OLED.print("H:");
      OLED.print(BPM);
      OLED.println(" bpm");
      OLED.println();
```

Output

Fig 11. Code designed in the Arduino IDE Platform

```
      OLED.println(" bpm");
      OLED.println();
      OLED.print("SpO2:");
      OLED.print(SpO2);
      OLED.println(" %");
      OLED.println();
      OLED.print("Temp:");
      OLED.print(tempC);
      OLED.println(" C");
    tsLastReport = millis();
  }
  OLED.display();
}


```

Output

Fig 12. Code designed in the Arduino IDE Platform

5. RESULT ANALYSIS

Hence we were successfully able to implement the above proposed prototype of health monitoring system, and we were able to monitor the real time health monitoring parameters of human body such as Heart rate per minute (bpm) , Blood oxygen level Spo2 , body temperature in degree Celsius. Given below are images of the working of our designed prototype.

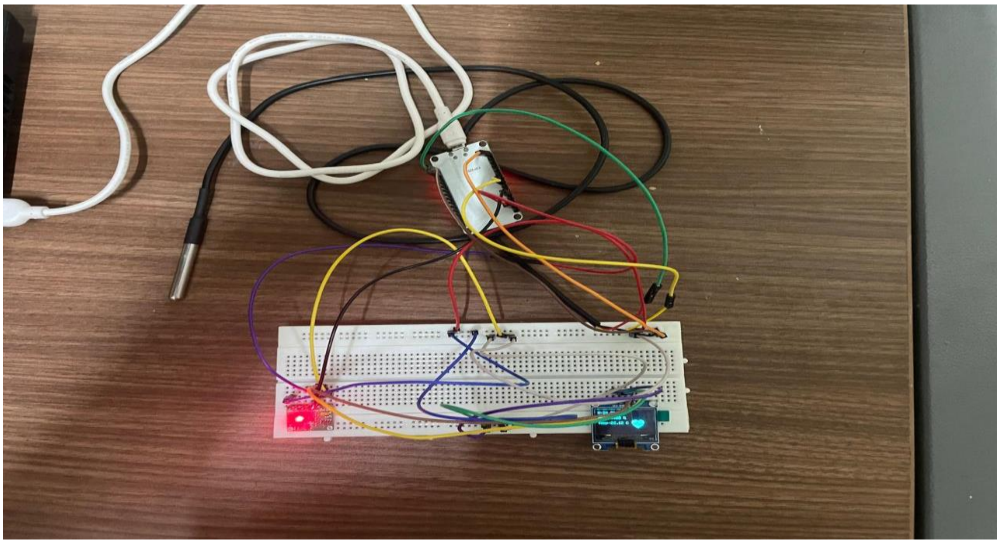


Fig 13. Working of our Health monitoring system prototype

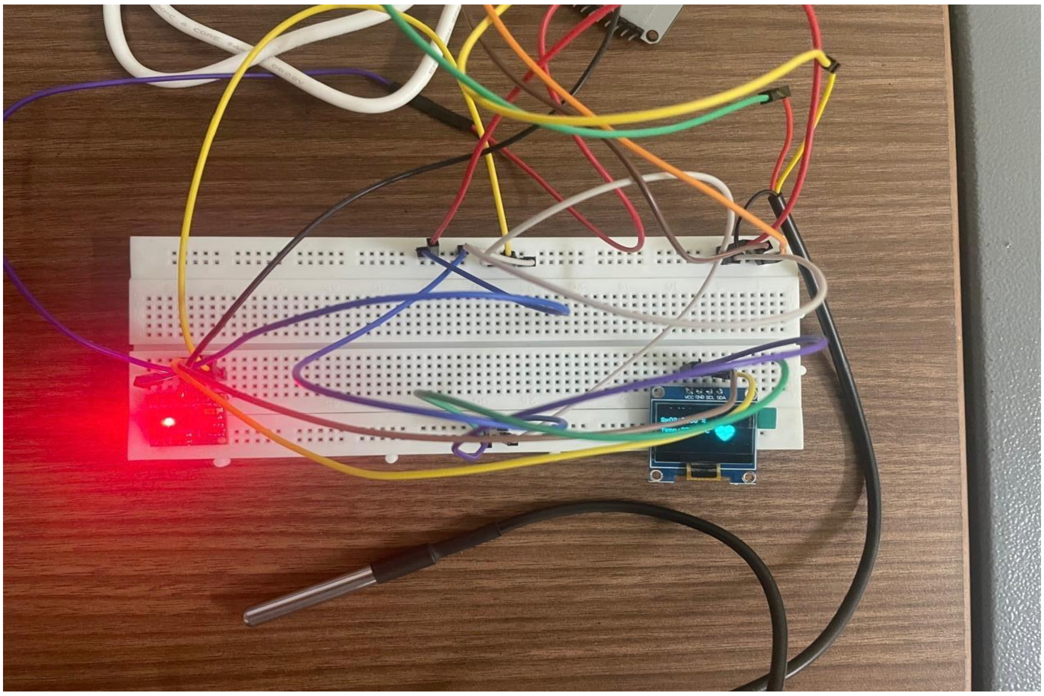


Fig 14. Our Health monitoring system in operation

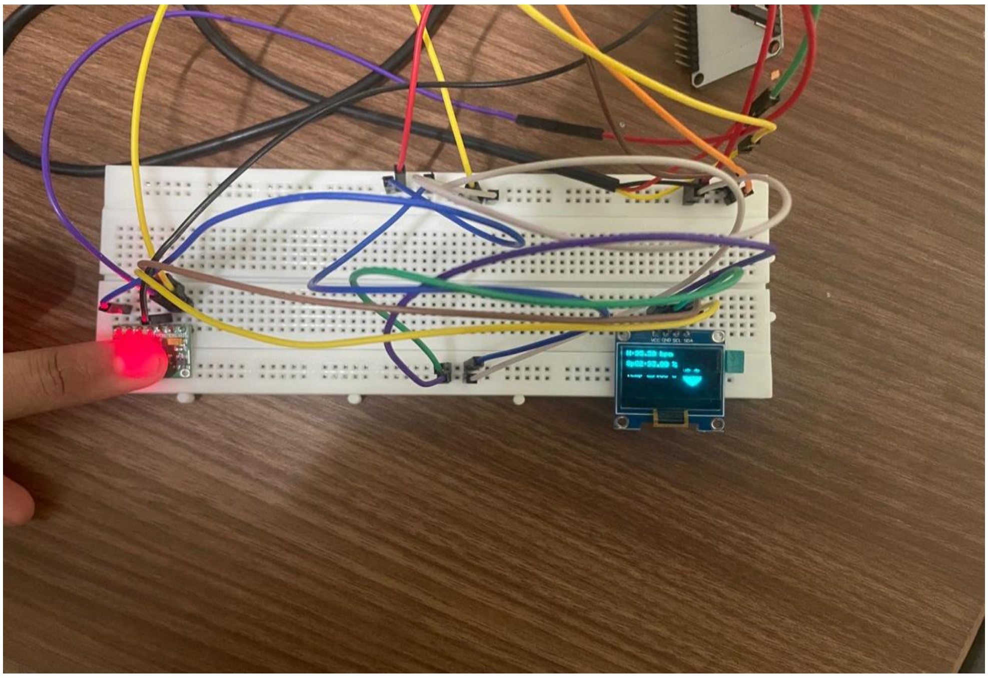


Fig 15. Process of monitoring and displaying real time health parameters

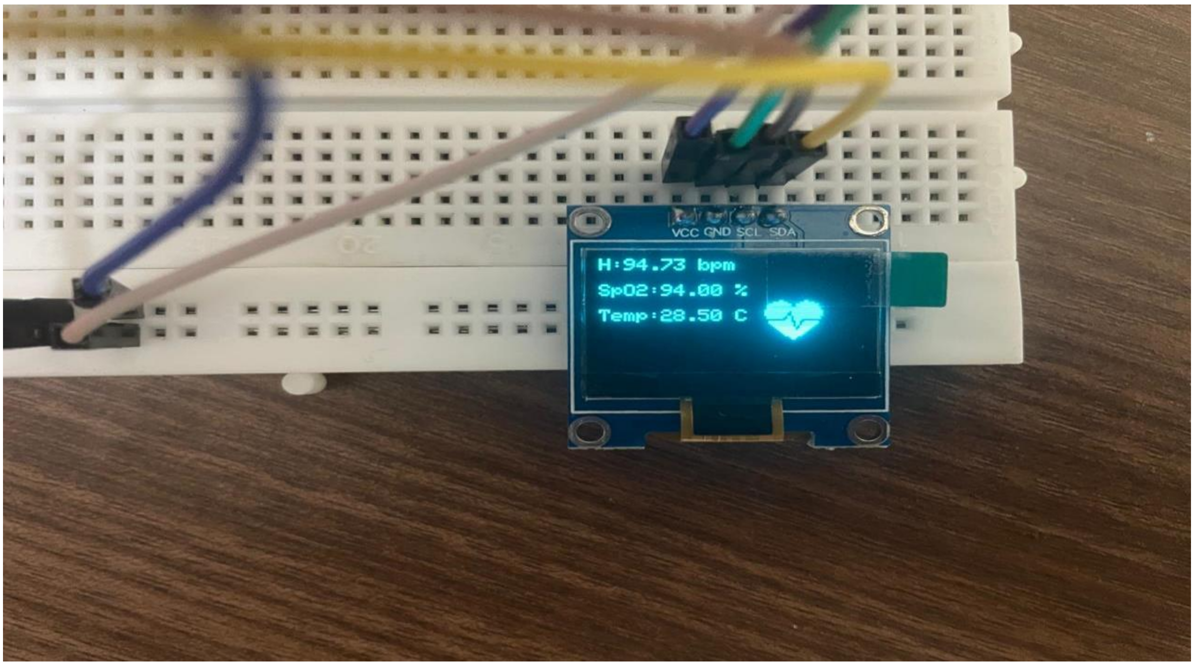


Fig 16. Real time monitoring and displaying of health parameters

Given below are tables of recorded/monitored real time health parameter data :

bpm	time in hours
72.8	08:00
75.4	10:00
78.2	12:00
84.2	14:00
68.8	16:00
74.4	18:00

Table 1 : Beats per minute (bpm) vs time in hours

SpO2 level	time
94	08:00
95.2	10:00
96	12:00
98	14:00
94.8	16:00
96.8	18:00

Table 2 : Blood oxygen level (SPO2) vs time in hours

Body Temp	Time
28	08:00
28.5	10:00
28.8	12:00
29.4	14:00
29.6	16:00
31.4	18:00

Table 3 : Body Temperature in degree Celsius vs time in hours

6. CONCLUSION AND FUTURE WORK

6.1 Summary :

The project aims to develop an IoT-based health monitoring system that utilizes an ESP32 microcontroller along with various sensors—specifically a body temperature sensor and pulse oximeter—to monitor and transmit health data in real-time.

This IoT-based health monitoring system offers a comprehensive solution for tracking vital health parameters, leveraging modern technology to improve health outcomes and facilitate remote patient care.

The system continuously collects vital health metrics, such as body temperature and blood oxygen levels, while also displaying these health parameters on an OLED display.

The project's primary aim is to enhance patient care by enabling remote health monitoring, facilitating early detection of potential health issues, and promoting proactive health management. By leveraging modern IoT technology, this system provides an effective means for continuous health monitoring, ultimately improving health outcomes and supporting timely interventions.

6.2 Future Scope :

Certain other features which can be considered for the future scope of the project include creating a wearable version of this prototype using a conducting polymer and integrating the device with thingspeak/cloud for further analysis of data.

6.3 Limitation and constraint :

While the IoT-based health monitoring system using the ESP32 and various sensors offers significant advantages, it also has several limitations and constraints.

1)One primary concern is the reliability of sensor data, as inaccuracies or malfunctions in the body temperature sensor, pulse oximeter can lead to erroneous health assessments.

2)Additionally, the system's dependence on a stable internet connection poses challenges; disruptions in connectivity can hinder real-time data transmission and monitoring.

3)Power consumption is another critical issue, as continuous operation of the ESP32 and sensors may require frequent battery replacements or a reliable power source, particularly for mobile applications.

4) data security and privacy are major concerns, as sensitive health information transmitted over the internet must be adequately protected to prevent unauthorized access.

5) user accessibility can be a limitation, as the effectiveness of the system relies on users' technical proficiency to operate the devices and interpret the data, which may not be the case for all demographics.

6.4. Improvement :

The IoT-based health monitoring system using the ESP32, body temperature sensor, pulse oximeter presents several opportunities for improvement. Enhancing sensor accuracy and reliability could significantly increase the system's overall effectiveness.

Improving the system's connectivity resilience is crucial, perhaps by incorporating alternative communication protocols such as LoRa or using mesh networks to ensure data transmission even in low-signal areas.

Additionally, optimizing power management through energy-efficient designs or the use of solar panels could extend the operational lifespan of the devices, making them more practical for long-term use.

Integrating machine learning algorithms for data analysis could provide predictive insights, allowing for proactive health management and early intervention, thus expanding the system's overall impact on healthcare.

Developing user-friendly interfaces and providing educational resources could enhance accessibility, allowing a broader demographic to benefit from the system.

7. SOCIAL AND ENVIRONMENTAL IMPACT

Socially, the system enhances access to healthcare, particularly for individuals in remote or underserved areas, enabling continuous monitoring and timely interventions that can improve health outcomes. This can lead to reduced hospital visits and better management of chronic conditions, ultimately promoting overall community health and well-being.

Environmentally, the system can contribute to sustainability by reducing the carbon footprint associated with frequent hospital visits and medical transportation.

By facilitating remote monitoring, it minimizes the need for physical travel, thereby lowering greenhouse gas emissions.

Furthermore, as the system can be designed with energy-efficient components, it supports eco-friendly practices by reducing overall energy consumption.

Overall, the implementation of this IoT health monitoring system not only advances healthcare accessibility but also aligns with environmental sustainability goals.

8. WORKPLAN

8.1 Timeline :

August 2024 to October 2024: Complete sensor integration and initial testing and OLED display.

November 2024: Final testing, documentation, and project presentation.

8.2 Individual Contribution :

Akash(21BEC2436)- Report Preparation along with hardware Integration

Aditya Prem(21BEC0067)- Coding process , Hardware Integration along with Report Preparation.

Deepanjali Das(21BEC0075)-PPT presentation along with the Hardware Integration.

9. COST ANALYSIS

COMPONENTS	COST
ESP32 BOARD	284/-
MAX30100 SENSOR	423/-
DS18b20 SENSOR	335/-
DHT11 SENSOR	50/-
JUMPER WIRES	180/-
RESISTANCES	170/-
BREADBOARD	240/-

10. PROJECT OUTCOME

The project outcome of the IoT-based health monitoring system utilizing the ESP32, body temperature sensor, pulse oximeter is a comprehensive and user-friendly platform for real-time health monitoring.

The system successfully demonstrates the ability to collect and transmit vital health data, including body temperature, blood oxygen levels, and environmental conditions and display these vital parameters on an OLED display , This enables users and healthcare providers to monitor health parameters continuously, facilitating timely interventions when necessary.

Additionally, the project highlights the importance of data security and privacy, ensuring that sensitive information is adequately protected.

Ultimately, the outcome showcases the potential for IoT technology to enhance patient care, improve health outcomes, and contribute to more efficient healthcare systems, paving the way for future advancements in telemedicine and remote health monitoring solutions.

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