A PROJECT REPORT ON

Wireless HealthCare System using IoMT with integration of Big Data

BY

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UNDER THE GUIDANCE OF

Mrs. Vaishali Biradar

IN PARTIAL FULFILLMENT OF

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CERTIFICATE

This is to certify that the project entitled "**Wireless HealthCare System using Big Data integrated with IoMT**" submitted by

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are record of bonafide work carried out by them under my guidance, in partial fulfillment of requirement for the award of Final Year Engineering (Electronics & Telecommunication) of Savitribai Phule Pune University.

Date:

Place: Dr. D.Y.P.I.T., Pimpri, Pune-18

(Mrs.Vaishali Biradar)	**(Dr. D. G. Bhalke)**	**(Dr. Lalit Wadhwa)**
Project Guide	**H.O.D.**	**Principal**

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We are also thankful to our honorable **Principal Dr. Lalit Wadhwa** for giving us this opportunity.

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We are also thankful to all those who are directly or indirectly involve in the successful completion of this project work. Our greatest thanks are who wished us to success especially our parents, our brother and sisters. Above all we render our gratitude to the almighty who bestowed self-confidence, ability and strength in me to complete this project work.

Thanking You.

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ABSTRACT

Healthcare industry is an indispensable entity in the real world where large volumes of data is accumulated from time to time. Such data assumes characteristics of big data and it is desirable to analyze it and bring about latent relationships among variables in the healthcare data.The role of medical big data becomes a challenging task in the form of storage, required information retrieval within a limited time, cost efficient solutions in terms care, and many others. Scientific programming play a significant role to overcome the existing issues and future problems involved in the management of large scale data in healthcare, such as by assisting in the processing of huge data volumes, complex system modelling, and sourcing derivations from healthcare data and simulations. The advancement in IoT has enabled both patients and doctors to access real time data.The significant increase in the number of individuals with chronic ailments (including the elderly and disabled) has dictated an urgent need for an innovative model for healthcare systems.

The evolved model will be more personalized and less reliant on traditional brick-and-mortar healthcare institutions such as hospitals, nursing homes, and long-term healthcare centers. The smart healthcare system is a topic of recently growing interest and has become increasingly required due to major developments in modern technologies, especially artificial intelligence (AI) and machine learning (ML). In this project we propose a model which monitors , displaying and storing the health parameter which is heart rate of an individual. The collected data through the system is then transferred over the internet to a smartphone application of the patient. The SMS and Email notification will sent to the doctor as a well as patients provided credentials.

Chapter 1. INTRODUCTION AND LITERATURE SURVEY

1.1 Introduction

The Internet of Medical Things a part or updated version of Internet of Things (IoT) technologies, made inter-networked devices and applications used in medical and healthcare information technology. IoMT devices connect doctors, patients and medical devices including diagnostic gear, hospital equipment, and wearable technology by transmitting information over a secure network. It is a term which widely used and covers the complete set of sensors, special infrastructure, and data processing software. It is also helpful to care facilities to enhance their processes and financial indicators. The best advantage is of low hospital bills.

The emergence of cloud computing and virtualization opened the way for handling large voluminous data known as big data. Big data analytics has become an important area of research that contributes to have huge impact on different industries where business intelligence is to be derived from massive amounts of data.The primary aim of our system is to gather the information of individual health parameters based on WSN and to provide physicians with a clear data and readings which can be used monitor the diagnosis of health parameters through mobile communication. This can be utilized for individual investigation to help with rolling out conduct improvements, and to share with parental figures for early detection and treatment. The universal healthcare systems provide rich contextual information and alerting mechanisms against uneven or odd conditions with continuous monitoring. This reduces the need for caregivers and helps the chronically ill and elderly to survive an independent life.

Fig. 1: Healthcare Functionalities

1.2 Literature Survey

S.No.	Paper Title	Journal Name	Year	Contribution of the Paper
1	Big Data Analysis and Services: Visualization on Smart Data to Support Healthcare Analytics	International Conference on iThings and IEEE GreenCom and IEEE CPSCom and IEEE SmartData, Atlanta, GA, USA, 2019	2019	HSLviz system (hue-saturation-lightness (HSL) colour model based visualization system) is made which support for visualizing smart data as well as their related information from health data, which in turn supports healthcare analytics. Uses arranging patternsin different order facilitates exploration (e.g., quick search, easy observation) of patterns.
2	Internet of Medical Things (IoMT) - An overview	5th International Conference on (ICDCS), 2020	2020	An overview of IoMT based systems, tracking remote ingestible sensors, smart hospital, mobile health and IoMT based enhanced chronic disease treatment methods have been studied and presented in this manuscript.
3	A Sensor based Secured Health Monitoring and Alert Technique using IoMT	2nd International Conference on ICCT, Manipal university jaipur, 2019	2019	A novel sensor based secured health monitoring technique is proposed and discussed. by combining data compression and encryption algorithm provides a very strong result in terms of speed, storage capacity, network security and data protection. Huffman Compression Coding and Rivest Shamir Adleman (RSA) encryption techniques are used.
4	A Mobile Cloud based IoMT Framework for Automated Health Assessment and Management	IEEE, 2019	2019	This paper introduces a new automated clinical assessment system based on mobile cloud and IoMT technologies. With the interesting design characteristics, the proposed system can support early diagnosis of neurological conditions and improve the healthcare management.

5	Security Assessment as a Service Cross-Layered System for the Adoption of Digital, Personalised and Trusted Healthcare	IEEE 5th World Forum on Internet of Things (WF-IoT), Limerick, Ireland, 2019	2019	Designed SAaaS platform for eCare services. OpenVas framework (leveraging on the cloud-fogextreme-edge paradigm) is used for work. Intelligent Health and Care System Technology: SAaaSArchitecture.
6	A Comprehensive Analysis of Healthcare Big Data Management, Analytics and Scientific Programming	IEEE Access (Volume: 8), 2020	2020	Calculated feature map of the healthcare big data for identification of disease. Simple Linear Regression (SLR) process is used. Study Selection Process, Quality Assessment, Data Extraction Data Mining etc are used for addressing reviews of papers.
7	Big Data Analytics for Healthcare Recommendation Systems	International Conference on ICSCAN, Pondicherry, India, 2020	2020	Designed healthcare domain based on big data analytics recommender System. Big data analytics with machine learning and Artificial Intelligence Methodology: Intelligence–Based Health Recommender System. ANFIS model is used.
8	IoT Based Real-Time Remote Patient Monitoring System	International Conference on DASA, 2020	2020	ECG self-interpretation algorithm can be implemented into the system so that the system can detect the abnormal ECG signal and generate an alert. The performance of the system is not much accurate and does not store the data.

Table 1. Literature Survey

1. **Big Data Analysis and Services: Visualization on Smart Data to Support Healthcare Analytics**

   The paper focuses on the utilization of big data analysis and visualization techniques to enhance healthcare analytics. With the increasing availability of healthcare data from various sources such as electronic health records, medical imaging, wearable devices, and social media, there is a need for effective tools and methods to process and analyze this vast amount of data.The paper discusses various visualization techniques that can be used to represent healthcare data effectively. It emphasizes the importance of interactive and user-friendly visualizations that can enable healthcare professionals to explore and interpret complex data patterns. The authors also highlight the potential of utilizing smart data, which involves the integration of real-time data streams with existing data sources, to enhance the accuracy and timeliness of healthcare analytics.

2. **Internet of Medical Things (IoMT) - An overview**

   An overview of IoMT based remote monitoring systems, tracking ingestible sensors, mobile health smart, hospitaland IoMT based enhanced chronic disease treatment methods have been studied and presented in this manuscript. Security and privacy are the serious concerns which restricts the consumer level usage of IoMT. The health of a human being is very important to lead a peaceful and successful life. Healthcare is the process of maintaining or improving health with the help of prevention, diagnosis, treatment for illness and injury. Most of the conventional healthcare use manual management and maintenance of patient demographic data, case history, diagnostics, medication, billing, drug stock maintenance which leads to human errors and affect patients. Internet of things (IoT) based smart healthcare overcomes the human errors and helps the physician to diagnose the diseases more easily and accurately by interconnecting all the vital parameters monitoring devices over a network with a decision support system. The medical things which have the facility to send data over a network without demanding human to computer or human to human interaction are termed as Internet of Medical Things (IoMT).

3. A Sensor based Secured Health Monitoring and Alert Technique using IoMT

A novel sensor based secured health monitoring technique is proposed and discussed. Hybrid model of Huffman compression and RSA encryption provides two level of encoding which enhance the data protection thus they are preferred. Outcomes of this proposed technique is 155 expected to be effective because important and sensible physiological parameter is used as they are considering as the roots of basic normal parameter of health. Secondly, compression technique increases the storage capacity with low time delay. Thirdly, encryption algorithm secures the network path and without decryption key no one can reformed the actual data. Lastly, using four alert systems we will have a four alternate way to give message about emergency occurrence. So by combining data compression and encryption algorithm provides a very strong result in terms of speed, storage capacity, network security and data protection. Four alternate alert systems provide magnified and excellent performance in emergency. Existing system suffers from compression of data with data protection technique and having none or single alert mechanism.

4. A Mobile Cloud based IoMT Framework for Automated Health Assessment and Management

The paper introduces a new automated clinical assessment system based on mobile cloud and IoMT technologies. This research makes a contribution to the advance of intelligent clinical assessment systems for health monitoring on smartphones. Also, the mobile application incorporates a novel data sharing solution using a blockchain network which can achieve reliable data exchange among mobile users on mobile clouds. This also allows to connect patients, physicians and other healthcare providers in a more trustworthy and efficient manner. With the interesting design characteristics, the proposed system can support early diagnosis of neurological conditions and improve the healthcare management. In this paper, they deployed a mobile cloud-based IoMT scheme to monitor the progression of a neurological disorder using a test of motor coordination. The computing and storage capabilities of cloud server is employed to facilitate the estimation of the severity levels given by an established quantitative assessment. An Android application is used for data acquisition and communication with the cloud.

5. **Security Assessment as a Service Cross-Layered System for the Adoption of Digital, Personalised and Trusted Healthcare**

The healthcare sector is exploring the incorporation of digital solutions in order to improve access, reduce costs, increase quality and enhance their capacity in reaching a higher number of citizens. However, this opens healthcare organisations' systems to external elements used within or beyond their premises, new risks and vulnerabilities in what regards cyber threats and incidents. Paper propose the creation of a Security Assessment as a Service (SAaaS) crosslayered system that is able to identify vulnerabilities and proactively assess and mitigate threats in an IT healthcare ecosystem exposed to external devices and interfaces, considering that most users are not experts (even technologically illiterate") in cyber security and, thus, unaware of security tactics or policies whatsoever. The SAaaS can be emerged in an IT healthcare environment allowing the monitoring of existing and new devices, the drawback of connectivity and privileges to new devices, assess a device's cybersecurity risk and based on the device's behaviour the assignment and taking back of privileges.

6. **A Comprehensive Analysis of Healthcare Big Data Management, Analytics and Scientific Programming**

Healthcare systems are transformed digitally with the help of medical technology, information systems, electronic medical records, wearable and smart devices, and handheld devices. The part of medical big data becomes a challenging task in the form of storage, required information retrieval within a limited time, cost efficient solutions in terms care, and many others. The reviewed reputed journals are choosed for the accumulated of published research work during the period ranges from 2015 – 2019 (a portion of 2020 is also included). A total count of 127 relevant articles (conference papers, journal papers, book section, and survey papers) are confirmed for the assessment and analysis purposes. The described research work organizes and summarizes the existing published research work depended on the research questions defined and keywords identified for the search process. This analysis or conclusion on the existed research work will help the practitioners and doctors to make more authentic decisions, which ultimately will help to use the study as evidence for treating patients and suggest medicines accordingly.

7. **Big Data Analytics for Healthcare Recommendation Systems**

Healthcare is an indispensable entity in the actual or real world where large amounts of data is accumulated from time to time. Information in healthcare industry is rich in more useful information. However, a comprehensive big data approach is essential to mine the data and acquire business intelligence. With the help of cloud computing, big data analytics has become a reality. Distributed programming frameworks like Hadoop and Spark, to mention few, are available with associated Distributed File System (DFS) to manage big data. Many researchers contributed towards developing algorithms based on machine learning which is part of Artificial Intelligence (AI). Since healthcare industry is one of the sources of big data, it needs distributed environments for processing. Big data analytics is essential to analyze healthcare data in a comprehensive manner. The cloud computing and big data ecosystem is playing favorable role in realizing big data analytics for healthcare recommendations. A typical recommender system in healthcare industry is supposed to produce recommendations in various aspects of the domain. This paper get into different recommenders in healthcare domain that use big data analytics to generate recommendations. It provides useful insights as well as discussed research gaps that can be used to investigate further to enhance the state of the art.

8. **IoT Based Real-Time Remote Patient Monitoring System**

Healthcare technology is one of the biggest popular studies nowadays. With the enhancement of healthcare technology, the lifespan of people has successfully extended. However, people in the rural side or area are still having a hard time to obtain professional healthcare services due to the barrier of distance and lack of doctors. A remote patient monitoring system is one of the best solutions to avoid or correct this issue. This paper proposes an IoT based real-time remote patient monitoring system that is able to guarantee the integrity of the real-time electrocardiogram (ECG). The doctor can check the web server via smart phone or computer to monitor the real time or recently recorded ECG data. The proposed model has been tested in both Wide Area Network and Local Area Network environments. The results show that the proposed model has no package loss and packet error in both networks.

Chapter 2. SYSTEM SPECIFICATION AND BLOCK SCHEMATIC

2.1 System Specification

A. Hardware

- Raspberry Pi 3A+
- MAX0102 Heart Rate Sensor
- MLX90614 Infrared Thermometer
- BMP180 Blood Pressure
- 0.96” OLED Display
- Jumper Wires
- Monitor
- 5v Power Supply

B. Software

- Hospital Management Software Website (For Patient, Doctor & Hospital)
- VScode
- Thonny

2.2 Block Schematic

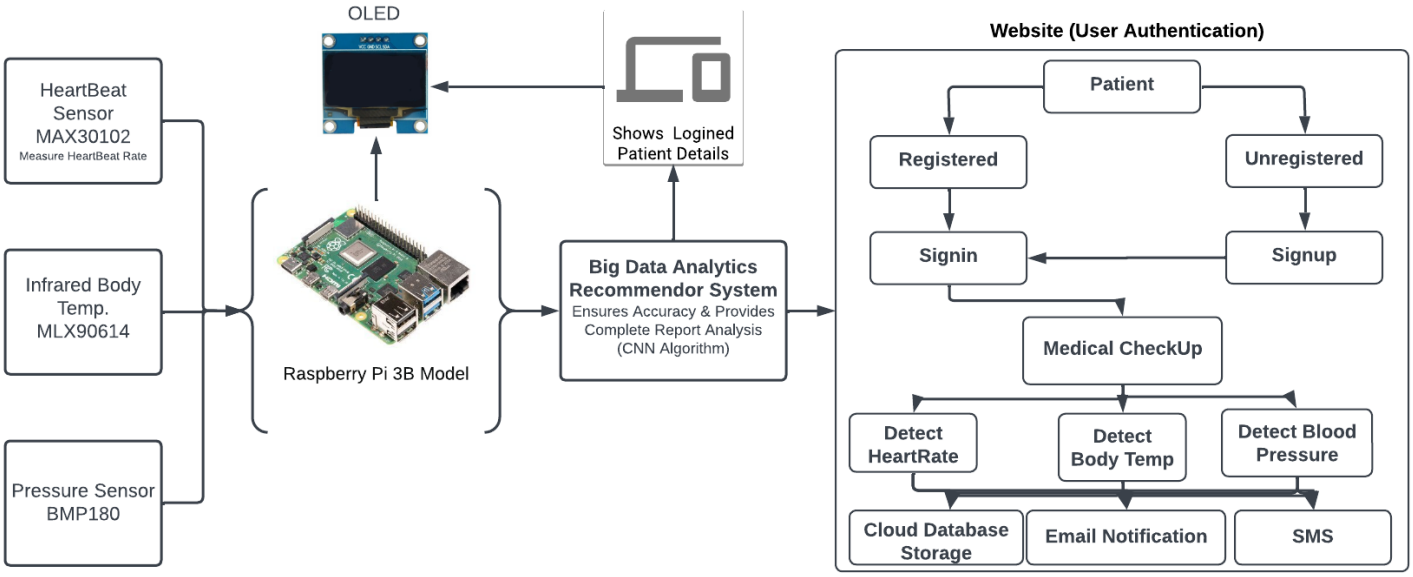

Figure 2.1 Block Diagram of System

Chapter 3 : HARDWARE DESIGN / TECHNICAL DETAILS

3.1 Power Supply Design

The power required for Raspberry Pi 3A+ is 5V/2.5A.2.5A. USB Type C 5V power supplies in the market have a high voltage drop when the full current is drawn from them which may cause the Raspberry Pi 3A+to reboot unexpectedly.

With this power supply, you can power the Raspberry Pi 3A+at full load as well as up to 1.2A across the four USB ports. The power supply still has about 0.5A of output power to spare, so even at the maximum current supported by the Raspberry Pi 3A+, the power supply is not at it's absolute maximum.

Raspberry Pi 3A+boards take in 5V from the Type C USB socket and have to generate the other required supplies from this. When 5V is first attached, each of these other supplies must 'start up', meaning go from 'off', or 0V, to their right or perfect voltage in some short period of time. The order of the supplies for starting up is often important: generally, there are structures inside a chip that form diodes between supply rails, and bringing supplies up in the wrong or defective order can sometimes 'turn on' these diodes, causing them to conduct, with undesirable consequences. Silicon chips come with a data sheet specifying what supplies are needed and whether they need to be low-noise, in what order they must power up or on (and in some cases down), and sometimes even the rate at which the voltages must power up and down.

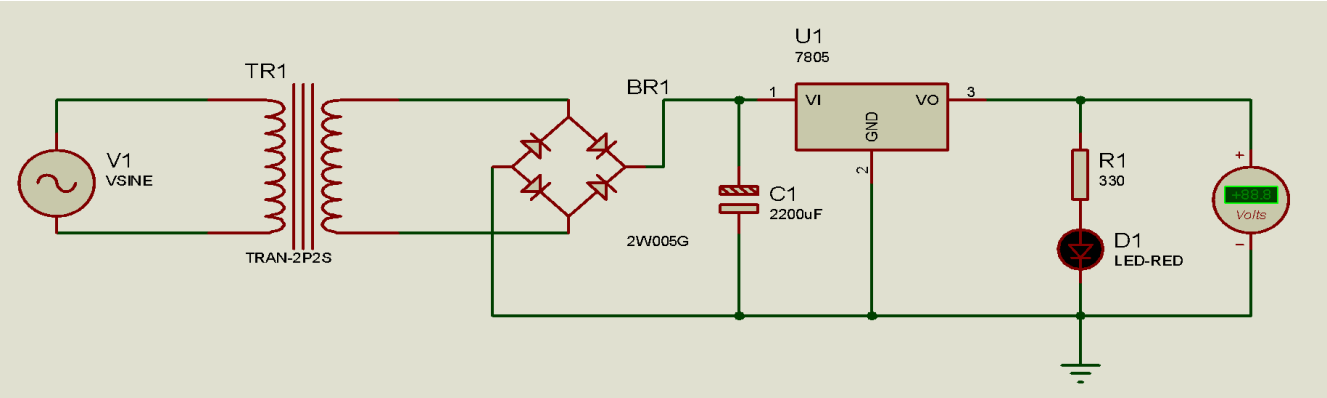

Figure 3.1 Power Supply

3.2 Power Supply Design Calculation

Vrms= 12 * √2

= 12 * 1.414

=16.968

After rectification

=16.968 – 1.4

=15.568

Vmin= 15.568 …….(after increasing 30% to 40%)

Required voltage = 20.23 V

Available = 25 V

Required voltage for voltage regulator 7-25

=15.568 – 7

=8.568

C = It/V

= 1* 10 msec/ 8.568

= 1167 uF

=1750 uF ……. Due to some problems to overcome it increase by 50%

So,

C=2200uF….required value

Voltage drop for Red LED lies between 1.6V to 2V

V = I R

R = V / I

= $(V_s – V_L)$ / I

= (5-2) / 16 mA

= 3*1000 / 16

=187.5

Required **R=330 ohm**

3.3 Technical Details

1. Raspberry Pi 3A+:

Figure 3.2.1 Raspberry Pi 3 Model A+.

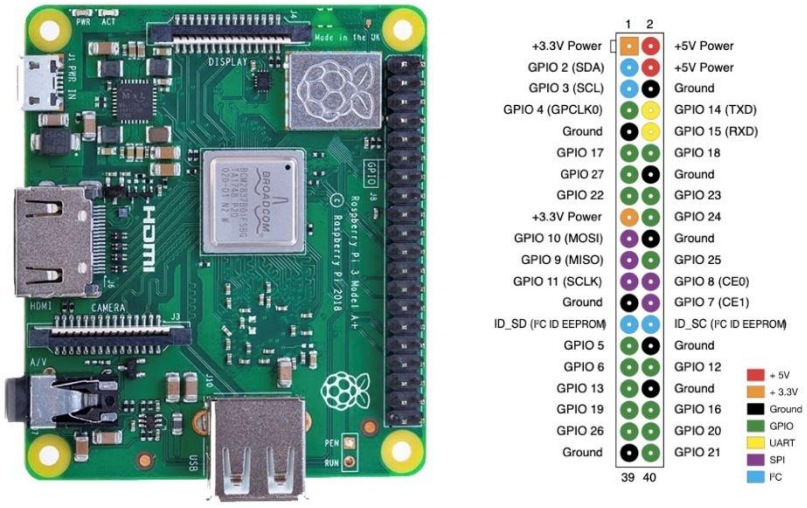

Figure 3.2.2 Raspberry Pi 3A+Pin Layout

➢ Specifications:

- **Processor**: Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4 GHz
- **Memory**: 512MB LPDDR2 SDRAM
- **Connectivity**: 2.4 GHz and 5 GHz IEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2/BLE
- **Access**: Extended 40-pin GPIO header
- **Video & sound**: 1 × full size HDMI MIPI DSI display port MIPI CSI camera port 4 pole stereo output and composite video port
- **Multimedia**: H.264, MPEG-4 decode (1080p30); H.264 encode (1080p30); OpenGL ES 1.1, 2.0 graphics
- **SD card support**: Micro SD format for loading operating system and data storage
- **Input power**: 5 V/2.5 A DC via micro USB connector 5 V DC via GPIO header
- **Environment**: Operating temperature, 0–50°C
- **Production lifetime**: The Raspberry Pi 3 Model A+ will remain in production until at least January 2023

➢ Features:

- ✓ **CPU**: 1.4 GHz quad core ARM Cortex-A53 CPU
- ✓ **GPU**: 250MHz Broadcom VideoCore IV
- ✓ **RAM**: 512mb (Shared with GPU)
- ✓ **Storage**: Micro SD
- ✓ **USB 2.0 Ports**: 1
- ✓ **Networking**: 802.11b/g/n/ac dual band 2.4/5 GHz wireless, Bluetooth 4.2 LS BLE
- ✓ **Video Input**: 15-pin MIPI camera interface (CSI) connector
- ✓ **Video Ouputs**: HDMI 1.3, MIPI display interface, DSI
- ✓ **Audio Inputs**: Audio over I2S
- ✓ **Audio Outputs**: 3.5mm phone jack, Digital Audio via HDMI
- ✓ **Low-Level peripherals**: 17 x GPIO, +3.3v, +5v, ground, Plus the following that can be used as GPIO: UART, I2C Bus, SPI bus with two chip select, I2S audio
- ✓ **Power Source**: 5v via MicroUSB or GPIO header
- ✓ **Size**: 65.00mm x 56.50mm x 17mm
- ✓ **Weight**: 23 g (0.81 oz)

2. MAX0102HeartBeat Sensor:

Figure 3.3.1 MAX30102

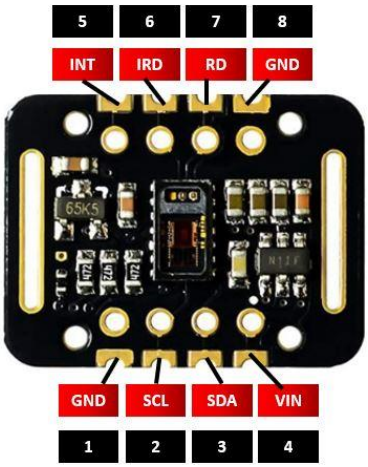

Figure 3.3.2 MAX30102 Pin Layout

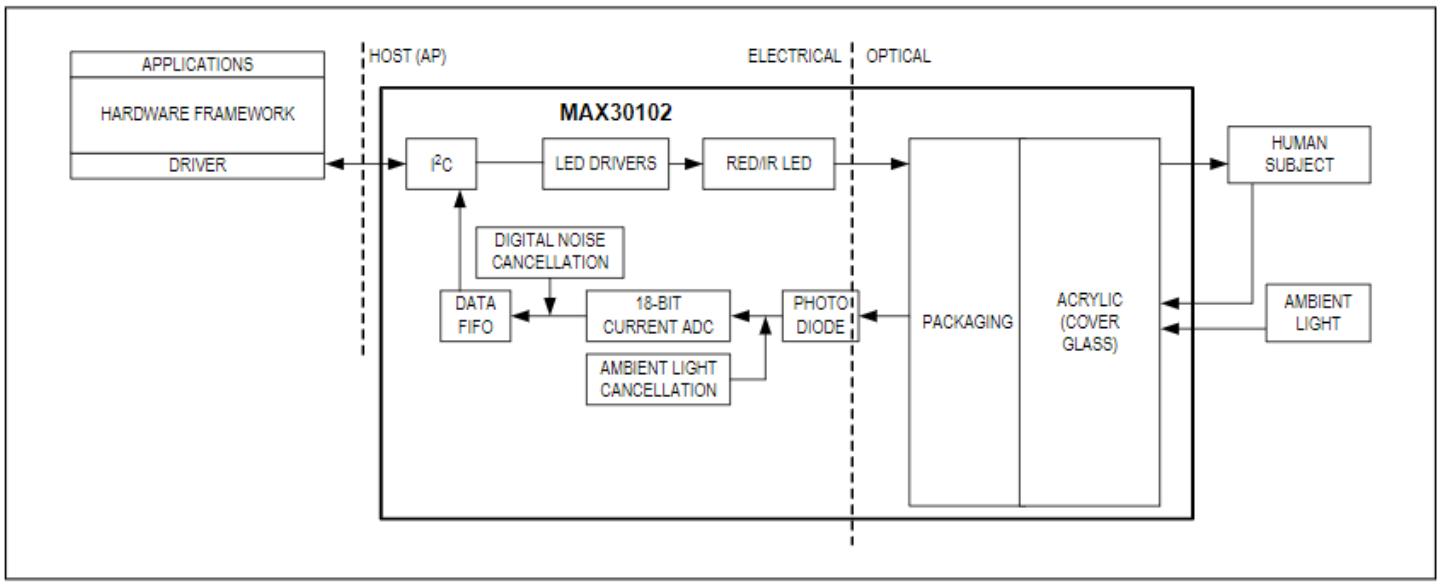

Figure 3.3.3 MAX30102 Functional layout

➢ Specifications:

Item	Value
Power supply	3.3V to 5.5V
Current draw	~600µA (during measurements)
Red LED Wavelength	660nm
IR LED Wavelength	880nm

Table 2. MAX30102 Specifications Table

➢ Features:

- ✓ Heart-Rate Monitor and Pulse Oximeter Sensor in
- ✓ LED Reflective Solution
- ✓ Tiny 5.6mm x 3.3mm x 1.55mm 14-Pin Optical Module
  - ✓ Integrated Cover Glass for Optimal, Robust
- ✓ Performance
- ✓ Ultra-Low Power Operation for Mobile Devices
  - ✓ Programmable Sample Rate and LED Current for
- ✓ Power Savings
  - ✓ Low-Power Heart-Rate Monitor (< 1mW)
  - ✓ Ultra-Low Shutdown Current (0.7µA, typ)
- ✓ Fast Data Output Capability
  - ✓ High Sample Rates
- ✓ Robust Motion Artifact Resilience
  - ✓ High SNR
- ✓ -40°C to +85°C Operating Temperature Range

3. MLX90614 Infrared Thermometer:

Figure 3.4.1 MLX90614

Figure 3.4.2 MAX90614 Pin Layout

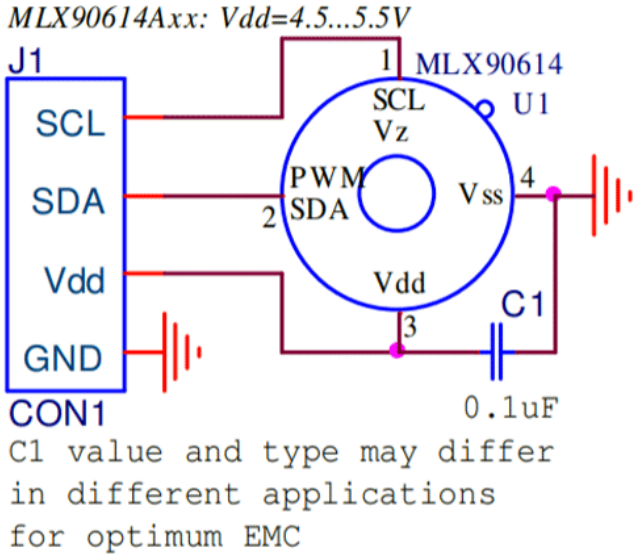

Figure 3.4.3 MLX90614 Functional layout

➢ Specifications:

Item	Value
Operating Voltage	3.3V to 5.5V
Supply Current	1.5mA
Object Temperature Range	-70 C to 382.2 C
Ambient Temperature Range	-40 C to 125 C
Field of View	80 Degree
Distance Between Object and Sensor	2 cm to 5 cm

Table 3. MLX90614 Specifications Table

➢ Features:

- ✓ Small size and low cost
- ✓ Easy to integrate
- ✓ Factory calibrated in wide temperature range: -40 to 125°C for sensor temperature and -70 to 380°C for object temperature
- ✓ High accuracy of 0.5°C over wide temperature range (0..+50 C for both Ta and To)
- ✓ Medical accuracy of 0.1°C in a limited temperature range available on request
- ✓ Measurement resolution of 0.02°C
- ✓ Single and dual zone versions

4. BMP180 Blood Pressure:

Figure 3.5.1 BMP180

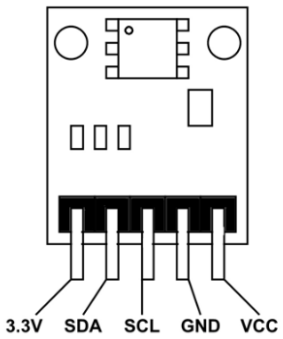

Figure 3.5.2 BMP180 Pin Layout

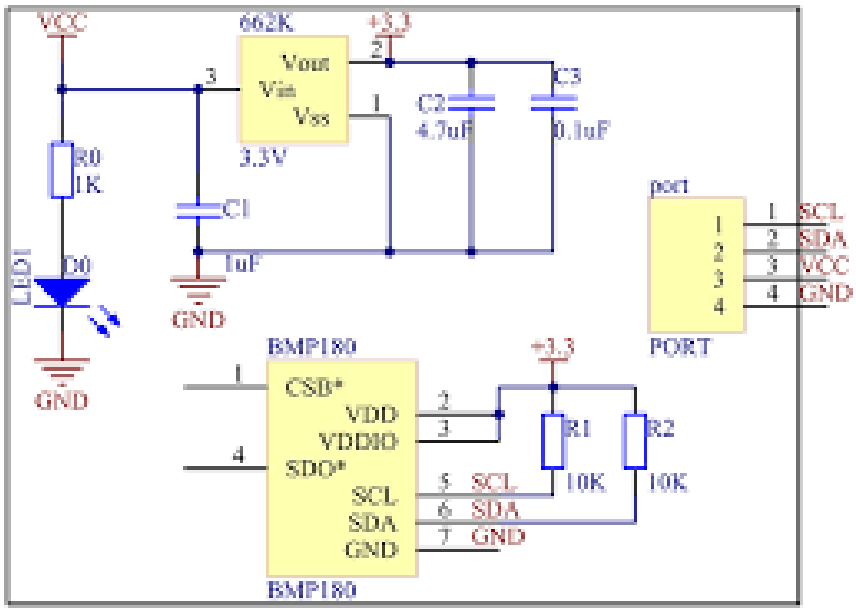

Figure 3.5.3 BMP180 Functional layout

➢ Specifications:

Item	Value
Operating Voltage	1.3V to 3.6V
Input Voltage	3.3V to 5.5V
Peak Current	1000uA
Max Voltage at SDA & SCA	0.3V
Operating Temperature	-40 C to 80C

Table 4. BMP180 Specifications Table

➢ Features:

- ✓ Can measure temperature and altitude.
- ✓ Pressure range: 300 to 1100hPa
- ✓ High relative accuracy of ±0.12hPa
- ✓ Can work on low voltages
- ✓ 3.4Mhz I2C interface
- ✓ Low power consumption (3uA)
- ✓ Pressure conversion time: 5msec
- ✓ Potable size

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5. 128 x 64 Graphic OLED:

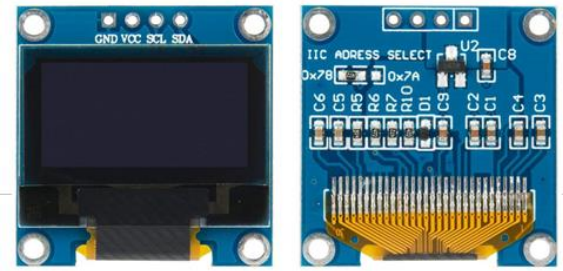


Figure 3.6.1: 128 x 64 Graphic OLED

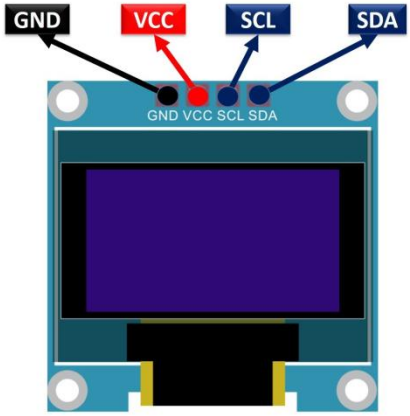


Figure 3.6.2: 128 x 64 Graphic OLED Pin Layout

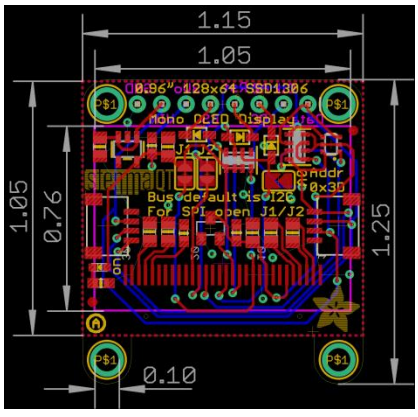


Figure 3.6.3: 128 x 64 Graphic OLED Circuit Layout

➢ Specifications:

Item	Value
Input Power	3.3V - 5V
Pixel	128*64
Display Size	0.96 inch
Operating temperature	-40 degree C to +80 degree C
Driver IC	SSD1306
Visual Angle	>160 degree C

Table 5. OLED Specifications Table

➢ Features:

- ✓ Type: graphic
- ✓ Display format: 128 x 64 dots
- ✓ Built-in controller: SSD1306BZ
- ✓ Duty cycle: 1/64
- ✓ +3 V power supply
- ✓ Interface: 6800, 8080, serial, and I2C

3.4 Circuit Diagram:

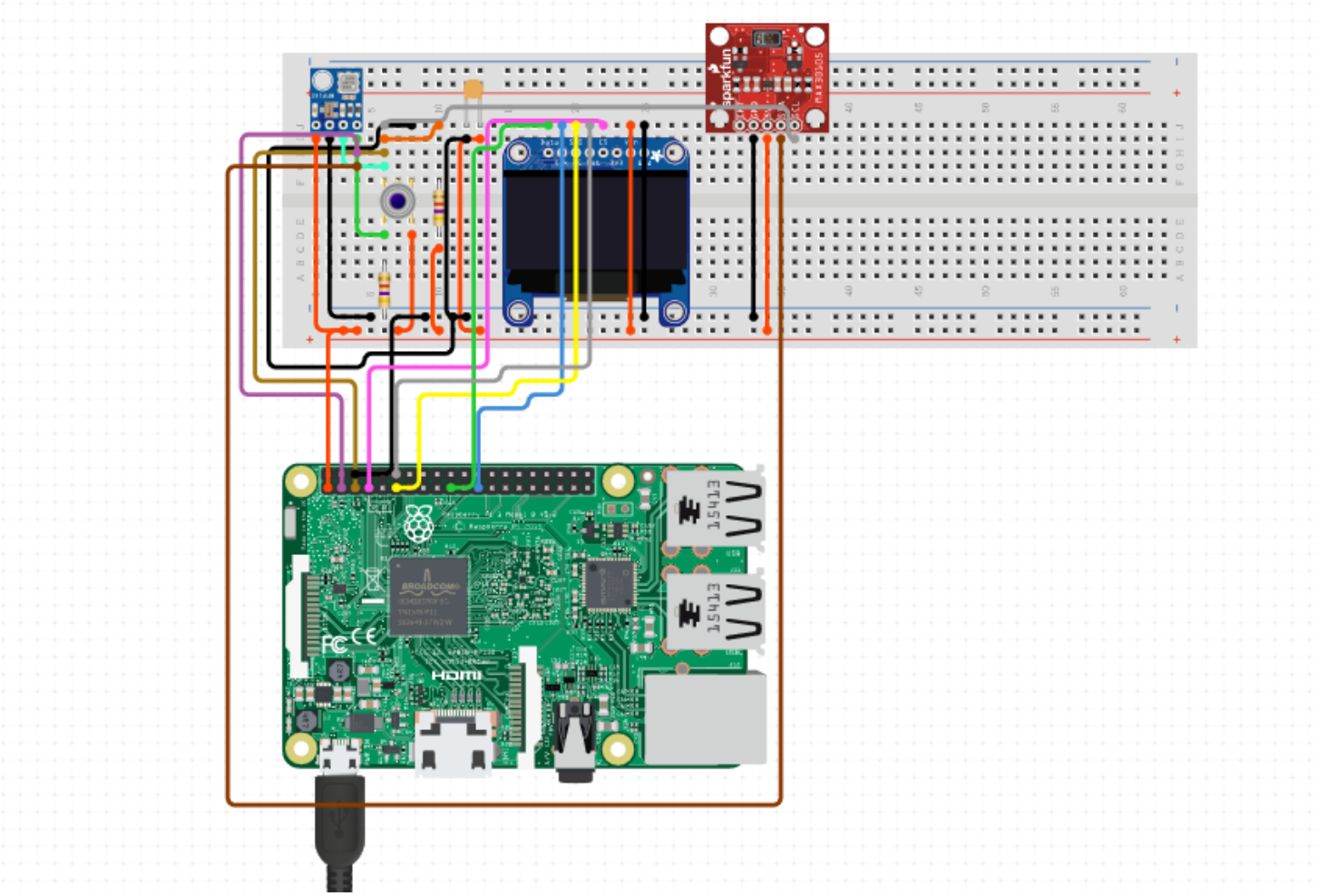


Figure 3.7 Circuit Diagram

We used RasbperryPi 3A+ to design our circuit and make sure to make proper connections before moving to the hardware building process. Using Proteus, we made sure that we didn't make any mistake in the circuit building. After some trials, we finally made the right connections, and we successfully ran the simulation inside the proteus software.

Chapter 4. SOFTWARE DESIGN

4.1 Website Architecture:

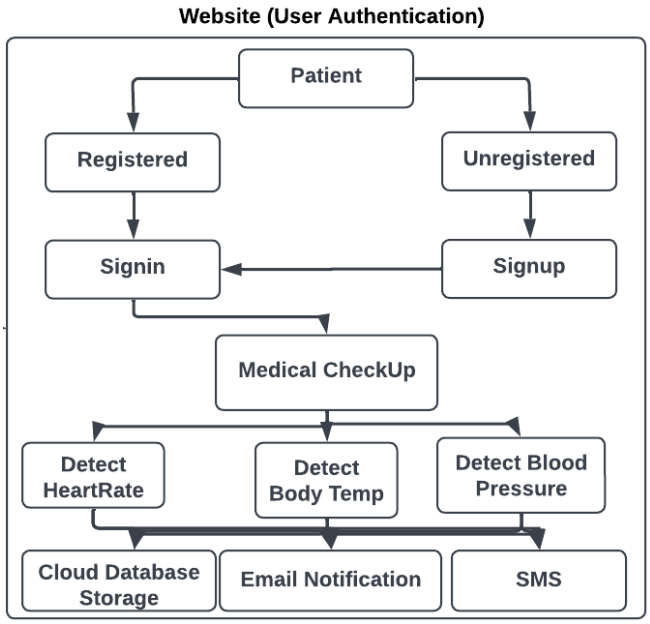


Figure 4.1 Website Architecture

4.2 Website Tech Stack Used:

- ✓ HTML
- ✓ CSS
- ✓ JAVASCRIPT
- ✓ PHP
- ✓ SMTP
- ✓ GOOGLE SHEET

4.3 Website Features:

Patient Portal

- ✓ Signup (Email Notification)
- ✓ Login(Email Notification)
- ✓ Medical Checkup
- ✓ HeartRate Report (With Graph)
- ✓ Body Temperature Report (With Graph)
- ✓ Blood Pressure Report (With Graph)
- ✓ Book Appointment
- ✓ Appointment History
- ✓ Prescriptions

Doctors Portal

- ✓ Login
- ✓ View Appointments
- ✓ Add Prescriptions

Admin Portal

- ✓ Doctor List
- ✓ Patient List
- ✓ Add Doctor
- ✓ Delete Doctor
- ✓ Complete Access

4.4 CNN Algorithm:

Big Data Analytics Recommender System (CNN Algorithm)

A Convolutional Neural Network (CNN) is a part of Deep Learning neural network architecture generally used in Computer Vision. Computer vision is a site of Artificial Intelligence that enables a computer to understand and interpret the visual or image data.

Convolutional Neural Network (CNN) is the extended version of artificial neural networks (ANN) which is predominantly used to extract the feature from the grid like matrix dataset. For example visual datasets like images or videos where data patterns play an extensive role.

CNN architecture

Convolutional Neural Network consists of multiple layers like the input layer, Convolutional layer, Pooling layer, and fully connected layers.

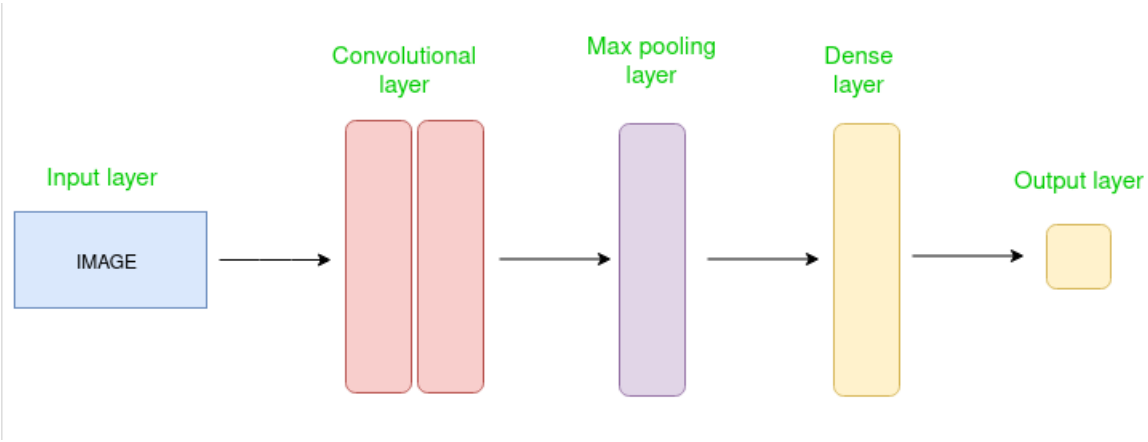


Figure 4.2CNN Architecture

The Convolutional layer applies filters to the given input image to extract features, the Pooling layer downsamples the image to reduce computation, and the fully connected layer makes the final prediction. The network learns the optimal filters through backpropagation and gradient descent.

4.5 SOURCE CODE (For Hardware Program)

```
import subprocess
from PIL import ImageFont
from PIL import ImageDraw
from PIL import Image
import Adafruit_SSD1306
import Adafruit_GPIO.SPI as SPI
import time
import hrcalc
import max30102
from mlx90614 import MLX90614
from smbus2 import SMBus
import os
import tkinter
import gspread
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)
GPIO.setup(18, GPIO.IN)

RST = 0
disp = Adafruit_SSD1306.SSD1306_128_64(rst=RST)

print("[INFO] MAX30102 Channel & I2C Address.")
m = max30102.MAX30102()
hr2 = 0
sp2 = 0

bus = SMBus(1)
sensor = MLX90614(bus, address=0x5A)

gc = gspread.service_account("credentials.json")
spreadsheet = gc.open_by_key('1VEVOIKqIWC7CTGTPGrdj27JuAiufwDUQl6Zht-cnvE0')

disp.begin()
disp.clear()
disp.display()
width = disp.width
```

```
height = disp.height
image1 = Image.new('1', (width, height))
draw = ImageDraw.Draw(image1)
draw.rectangle((0, 0, width, height), outline=0, fill=0)
padding = -2
top = padding
bottom = height-padding
x = 0
font = ImageFont.load_default()
draw.rectangle((0, 0, width, height), outline=0, fill=0)
draw.text((x, top),       "Welcome To",  font=font, fill=255)
draw.text((x, top+8),     "Health Monitoring System", font=font, fill=255)
draw.text((x, top+16),    "BE Project",  font=font, fill=255)
disp.image(image1)
disp.display()
time.sleep(2)

def detect_heartrate(Pid, detect_cell):
    heartrate = 0
    saturation=0
    n = 10
    while n > 0:
        draw.rectangle((0, 0, width, height), outline=0, fill=0)
        if (GPIO.input(18) == 0):
            red, ir = m.read_sequential()
            hr, hrb, sp, spb = hrcalc.calc_hr_and_spo2(ir, red)
            if (hrb == True and hr != -999 and hr < 105):
                hr2 = int(hr)
                heartrate+=hr2
                print("Heart Rate : ",hr2)
                draw.text((x, top),       "",  font=font, fill=255)
                 draw.text((x, top+8),     "[Heart Pulse Rate: "+str(hr2)+"
bpm]", font=font, fill=255)
                draw.text((x, top+16),    "",  font=font, fill=255)
            if (spb == True and sp != -999 and sp< 100):
                sp2 = int(sp)
                saturation+=sp2
```

```
                print("SPO2       : ",sp2)
                  draw.text((x, top+25),      "[Oxygen Sat.: "+str(sp2)+"%]",
font=font, fill=255)
                draw.text((x, top+34),    "",  font=font, fill=255)
            disp.image(image1)
            disp.display()
            time.sleep(.1)
        n=n-1
    draw.rectangle((0, 0, width, height), outline=0, fill=0)
    draw.text((x, top),        "Pid: "+str(Pid[detect_cell][1]),  font=font,
fill=255)
       draw.text((x,   top+8),          "Name:   "+str(Pid[detect_cell][2])+"
"+str(Pid[detect_cell][3]), font=font, fill=255)
    draw.text((x, top+16),    "[Heart Pulse Rate: "+str(int(heartrate/10))+"
bpm]",  font=font, fill=255)
             draw.text((x,      top+25),                    "[Oxygen      Sat.:
"+str(int(saturation/10))+"%]", font=font, fill=255)
    draw.text((x, top+34),    "",  font=font, fill=255)
    disp.image(image1)
    disp.display()
    print(heartrate)
      spreadsheet.worksheet(Pid[detect_cell][1]).update_cell(detect_cell,  8,
str(heartrate/10))
    time.sleep(2)

def detect_bodyTemp(Pid, detect_cell):
    bodytemp=0
    ambienttemp=0
    n = 10
    while n > 0:
        if (GPIO.input(18) == 0):
            celcius = sensor.get_object_1()
            faren = (celcius*1.8)+32
            ambient = sensor.get_ambient()
            draw.rectangle((0, 0, width, height), outline=0, fill=0)
               draw.text((x,  top),         "Pid:  "+str(Pid[detect_cell][1]),
 font=font, fill=255)
```

```
            draw.text((x, top+8),      "Name: "+str(Pid[detect_cell][2])+"
"+str(Pid[detect_cell][3]), font=font, fill=255)
            draw.text((x, top+16),     "[BodyTemp: "+str(round(faren, 2))+"
F]",  font=font, fill=255)
            draw.text((x, top+25),      "[AmbientTemp: "+str(round(ambient,
2))+"C]", font=font, fill=255)
            draw.text((x, top+34),    "",  font=font, fill=255)
            disp.image(image1)
            disp.display()
            bodytemp+=faren
            ambienttemp+=ambient
        time.sleep(.1)
        n=n-1
    draw.rectangle((0, 0, width, height), outline=0, fill=0)
    draw.text((x, top),       "Pid: "+str(Pid),  font=font, fill=255)
       draw.text((x,   top+8),          "Name:   "+str(Pid[detect_cell][2])+"
"+str(Pid[detect_cell][3]), font=font, fill=255)
     draw.text((x,  top+16),     "[BodyTemp:  "+str(round(bodytemp/10,  2))+"
F]",  font=font, fill=255)
     draw.text((x,  top+25),      "[Oxygen  Sat.:  "+str(round(ambienttemp/10,
2))+"C]", font=font, fill=255)
    draw.text((x, top+34),    "",  font=font, fill=255)
    disp.image(image1)
    disp.display()
    spreadsheet.worksheet(Pid[detect_cell][1]).update_cell(detect_cell+1, 9,
str(bodytemp/10))
    time.sleep(2)




def no_active_user():
    draw.rectangle((0, 0, width, height), outline=0, fill=0)
    draw.text((x, top),       "Welcome To",  font=font, fill=255)
      draw.text((x,  top+8),        "Health  Monitoring  System",  font=font,
fill=255)
    draw.text((x, top+16),    "BE Project",  font=font, fill=255)
```

```
    draw.text((x, top+25),     "No Active User", font=font, fill=255)
    draw.text((x, top+34),    "Please Login",  font=font, fill=255)
    disp.image(image1)
    disp.display()

def active_user(LoginDetails, active_row):
    draw.rectangle((0, 0, width, height), outline=0, fill=0)
    draw.text((x, top),       "Welcome ",  font=font, fill=255)
    draw.text((x, top+8),     "Pid : " +
              str(LoginDetails[active_row]['Pid']), font=font, fill=255)
    draw.text((x, top+16),    "Name : " +
                                      str(LoginDetails[active_row]['Fname']+"
"+LoginDetails[active_row]['Lname']),  font=font, fill=255)
    draw.text((x, top+25),     "Email: " +
              str(LoginDetails[active_row]['Email']), font=font, fill=255)
    draw.text((x, top+34),    "Contact: " +
                        str(LoginDetails[active_row]['Contact']),   font=font,
fill=255)
    draw.text((x, top+43),    "Please Select Device",  font=font, fill=255)
    disp.image(image1)
    disp.display()
    time.sleep(2)
                                                    Pid                         =
spreadsheet.worksheet(LoginDetails[active_row]['Pid']).get_values()
    print(Pid)
    detect = ""
    detect_cell = -1
    for i in range(len(Pid)-1, -1, -1):
        if (Pid[i][8] == "Ready"):
            detect = Pid[i][7]
            detect_cell = i
            break
    if detect == "":
        print()
    else:
        print(detect)
        disp.clear()
```

```
        disp.display()
        draw.text((x, top),       "Ready to",  font=font, fill=255)
        draw.text((x, top+8),     "Detect", font=font, fill=255)
        draw.text((x, top+16),    str(detect),  font=font, fill=255)
        disp.image(image1)
        disp.display()
        time.sleep(2)
        if detect == "HeartRate":
            detect_heartrate(Pid, detect_cell)
        elif detect == "BodyTemp":
            detect_bodyTemp(Pid, detect_cell)
        else:
            print()
            #detect_smoke(Pid, detect_cell)

while True:
    LoginDetails = spreadsheet.worksheet("LoginDetails").get_all_records()
    print(LoginDetails)
    active_row = -1
    for i in range(len(LoginDetails)-1, -1, -1):
        if (LoginDetails[i]['Status'] == "Active"):
            active_row = i
            break
    if active_row == -1:
        no_active_user()
    else:
        active_user(LoginDetails, active_row)
    time.sleep(2)
```

Chapter 5. TEST SETUP and TESTING PROCEDURE

5.1 Test Setup:

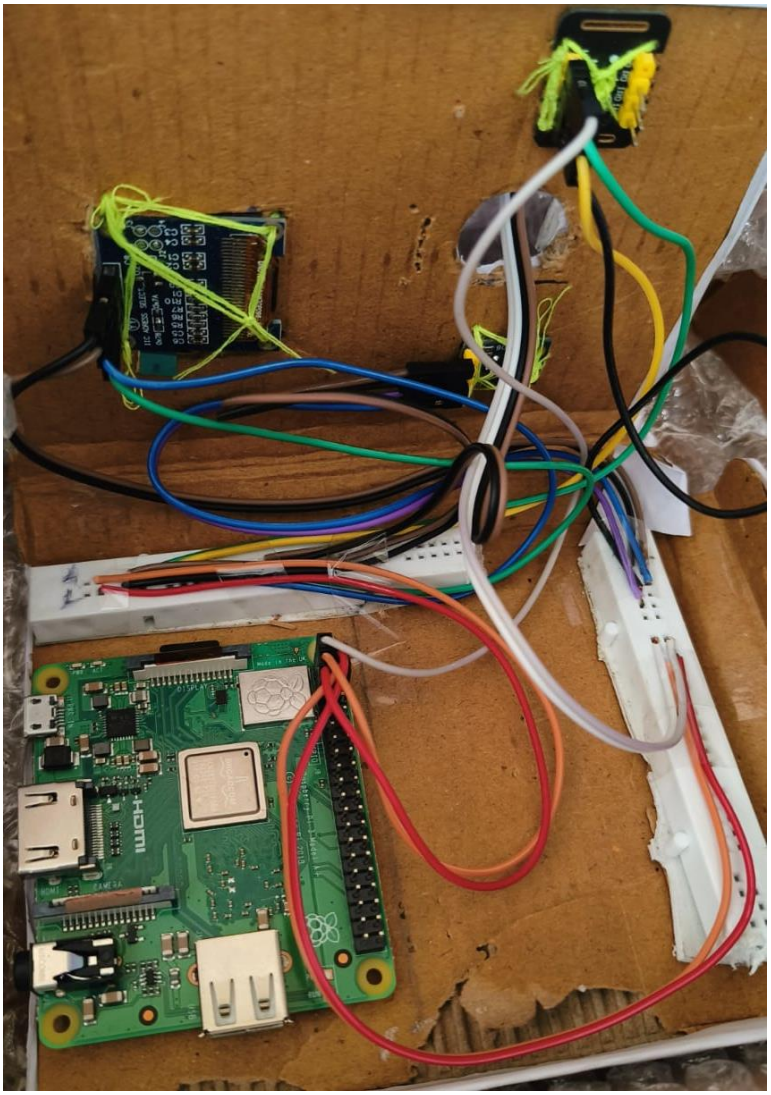


Figure 5.1 Test Setup (Hardware)

5.2 Testing Procedure:

Step 1 - First, we checked if all the components are connected properly or not.

Step 2 - Make sure that no short circuit problem could be occurred.

Step 3- Once all of our components were in working condition, we proceeded to make the connections as per the circuit diagram.

Step 4 - We connected RaspberryPi 3A+ to the OLED display and MAX30102 sensor along with MLX90102 & BMP180 by using jumper wires as shown in the circuit diagram.

Step 5 - We then connected a monitor to the Type B USB Power Supply

Step 6 - Once the connections were being made, we gave it a power supply of 5V through mobile charger.

Step 7 - We checked the Heart rate , Body Temp & Blood Pressure shown on OLED Display.

Chapter 6. RESULT AND ANALYSIS

6.1 Result:

IoMT devices allow real-time remote patient monitoring. This reduces in-person visits, and fewer hospital stays and readmissions. By this project we are able to monitor patients' heartbeat, Body Temperature & Blood Pressure. Here, message has been sent to drive storage as well as displayed on oled screen with the information about patients heartbeat as well as stored in Cloud Database and a confirmation email is also sent. Big Data is used to predict the accuracy of result with integrated algorithm.

Figure 6.1 Hardware Output

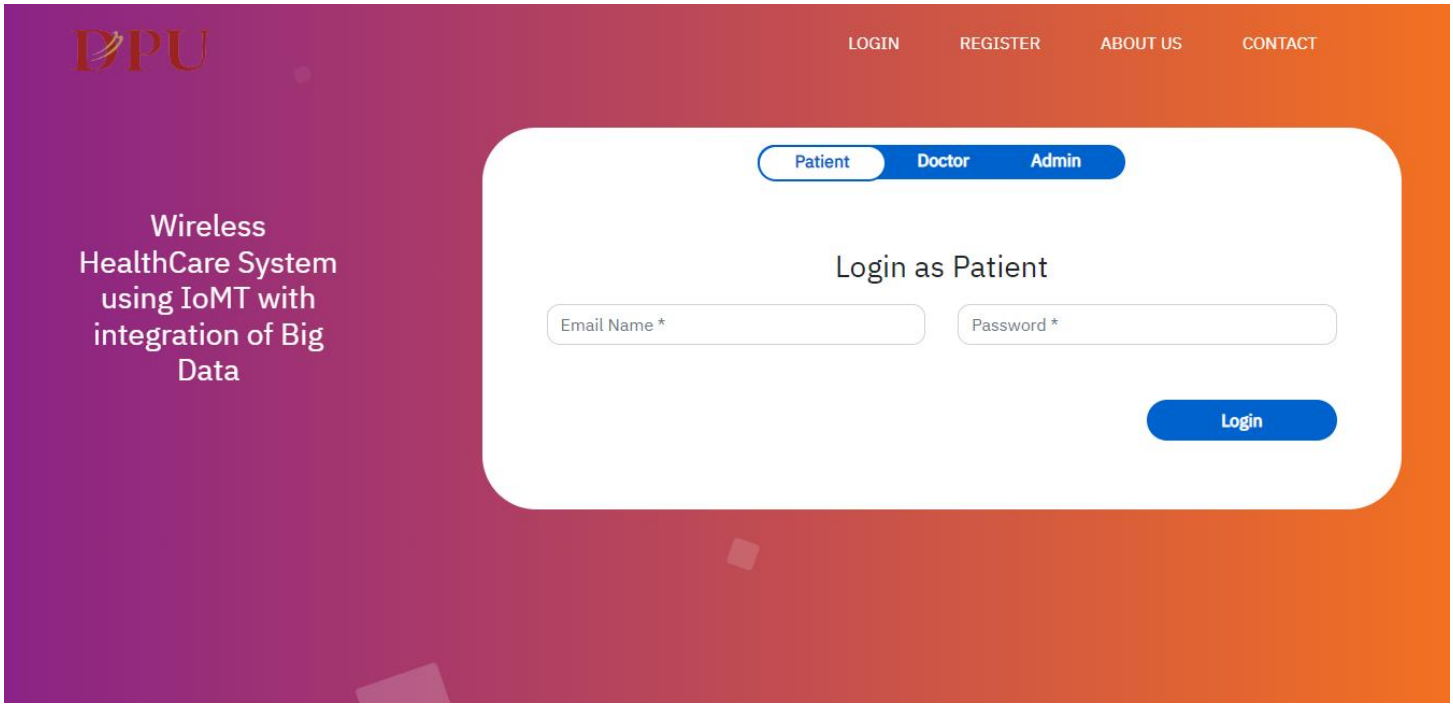


Figure 6.2 Login Window

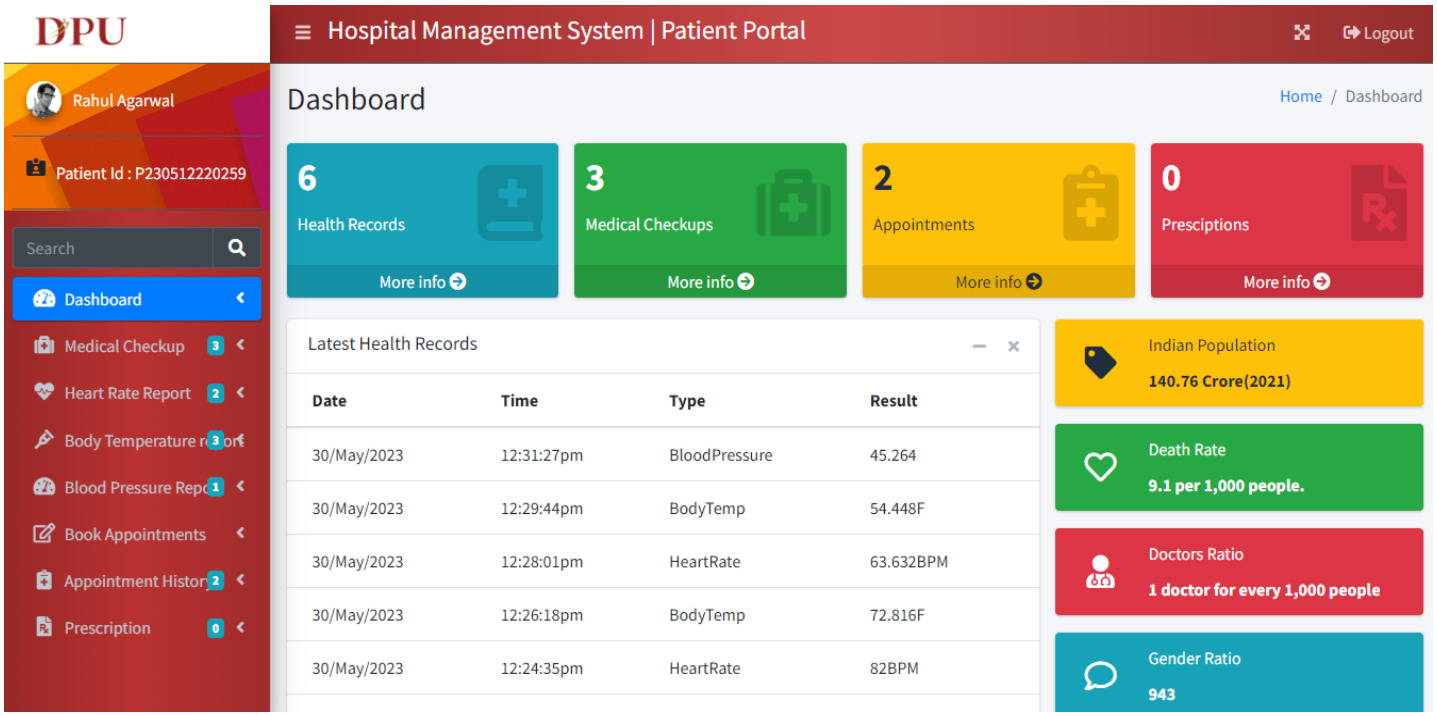


Figure 6.3 Patient Portal Dashboard

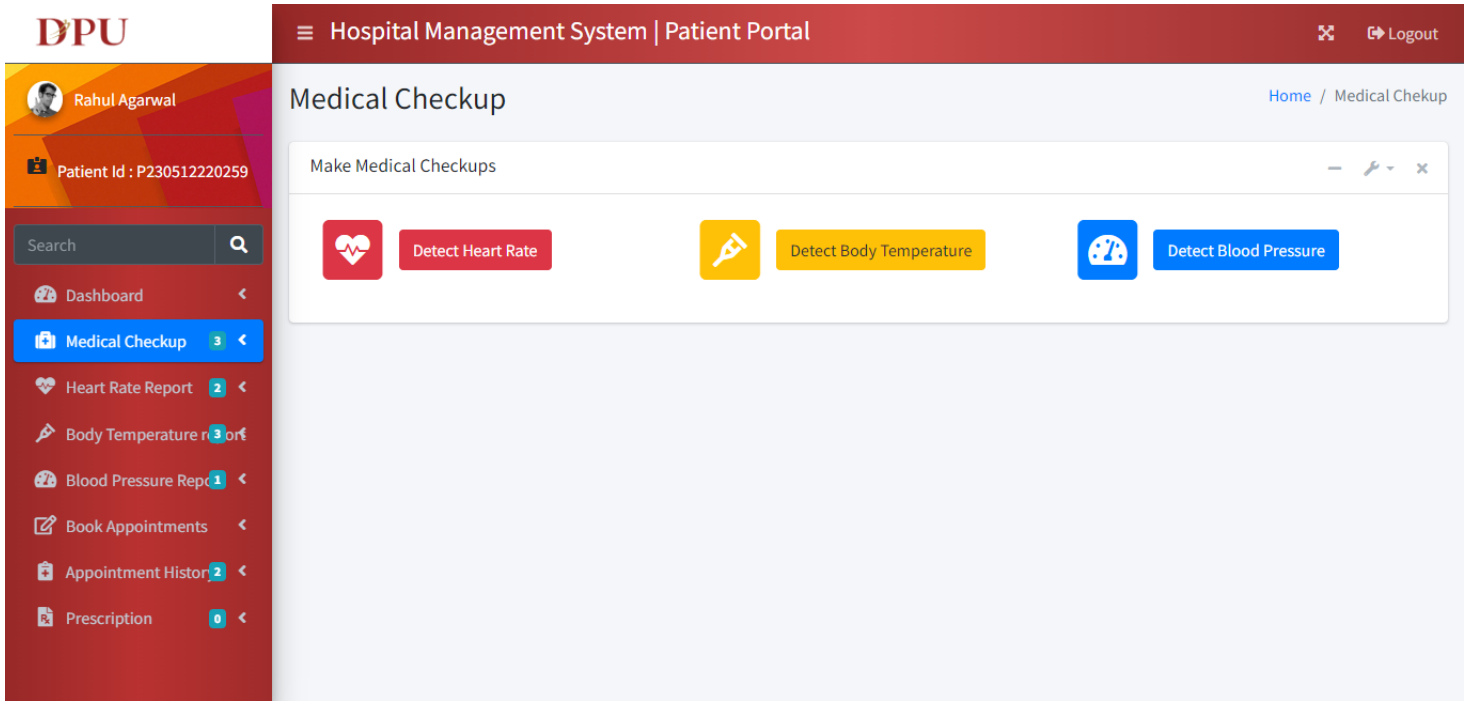
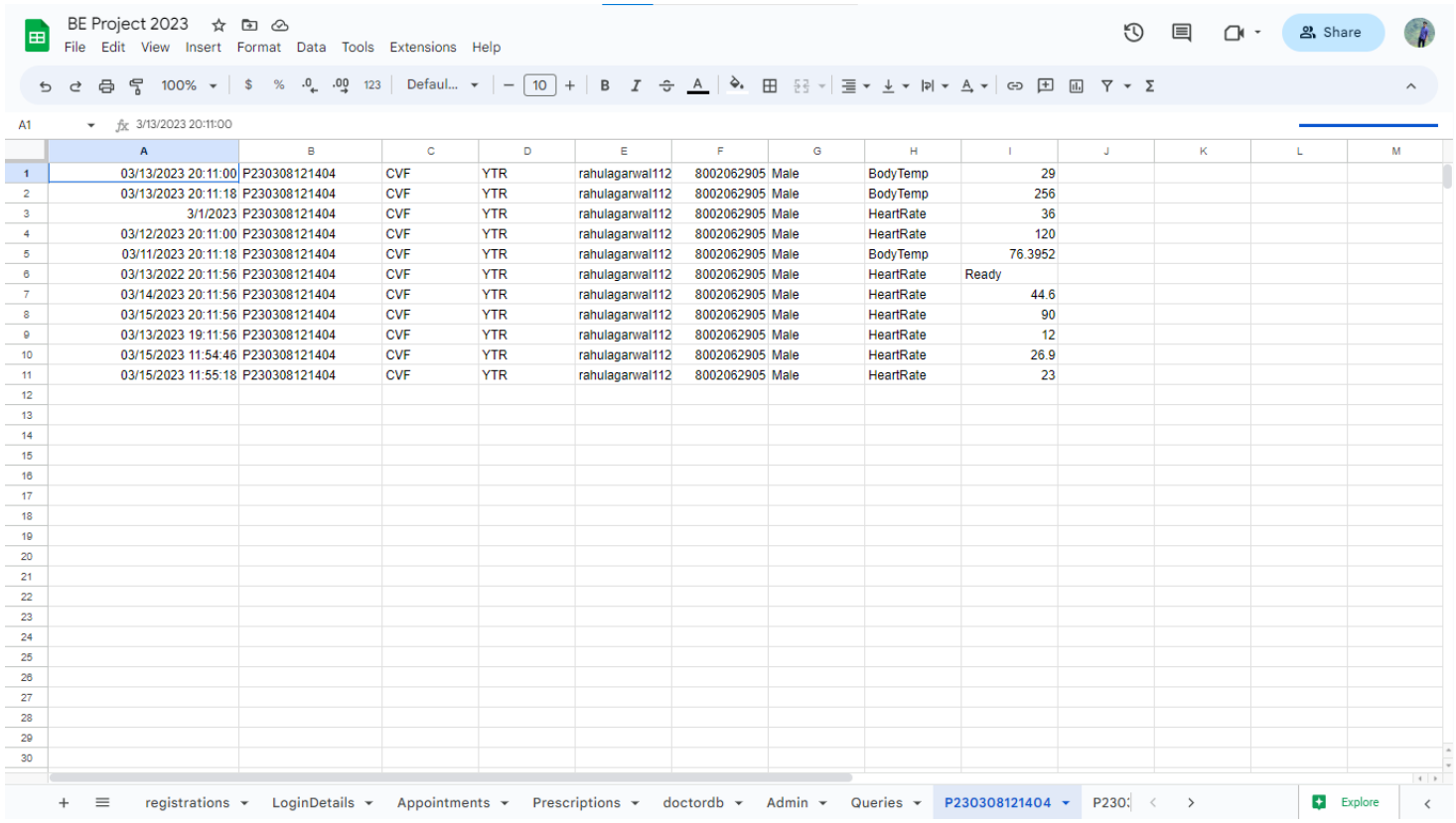


Figure 6.4 Patient Portal Medical Checkup



	A	B	C	D	E	F	G	H	I
1	03/13/2023 20:11:00	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	BodyTemp	29
2	03/13/2023 20:11:18	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	BodyTemp	256
3	3/1/2023	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	36
4	03/12/2023 20:11:00	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	120
5	03/11/2023 20:11:18	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	BodyTemp	76.3952
6	03/13/2022 20:11:56	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	Ready
7	03/14/2023 20:11:56	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	44.6
8	03/15/2023 20:11:56	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	90
9	03/13/2023 19:11:56	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	12
10	03/15/2023 11:54:46	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	26.9
11	03/15/2023 11:55:18	P230308121404	CVF	YTR	rahulagarwal112	8002062905	Male	HeartRate	23

Figure 6.5 Output Window(Cloud Database)

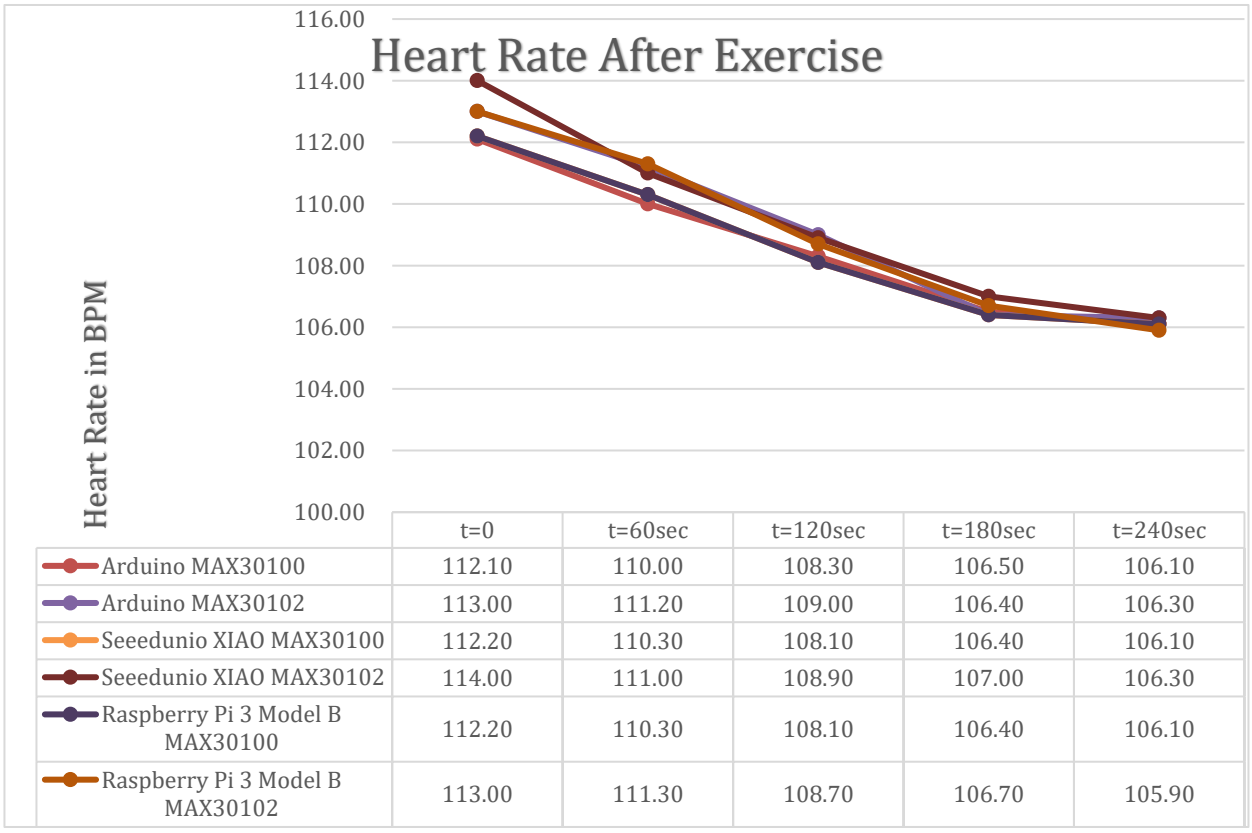
6.2 Analysis:

Heart Rate after Exercise

Measuring Conditions:

Person	Rahul Agarwal
Gender	Male
Age	22
Weight	85 kgs
Height	182.88 cm
Room Temperature	21 C
Jogging	30 min

Readings	t=0sec	t=60sec	t=120sec	t=180sec	t=240sec
Arduino MAX30100	112.10	110.00	108.30	106.50	106.10
Arduino MAX30102	113.00	111.20	109.00	106.40	106.30
Seeedunio XIAO MAX30100	112.20	110.30	108.10	106.40	106.10
Seeedunio XIAO MAX30102	114.00	111.00	108.90	107.00	106.30
Raspberry Pi 3 Model A MAX30100	112.20	110.30	108.10	106.40	106.10
Raspberry Pi 3 Model A MAX30102	113.00	111.30	108.70	106.70	105.90



After successful Analysis, our observation is that **MAX30102 is more accurate and give stable reading with Raspbery pi 3A+ of our project**, we started the work of main implementation of project. We were successfully made connections as per circuit diagram shown earlier. After that we were tried to sense all the sensors are connected properly. At that time we just tried it over to oled screen as there was some issues to showing on system. Then we corrected it and now finally the project is in working condition.

We sent data which was shown over lcd display to google sheet via **google cloud** and email notification sent to the patient as well as doctor. During the process we got to know that wifi connection is needed to send data over email and google sheet which will be helpful for future reference.

During the time we are cleared with the thought that such type of implementation is very beneficial and need to be updated earlier in real time so that we will improve our health system with the help of IoMT.

Chapter 7. CONCLUSION AND FUTURE SCOPE

7.1 Conclusion:

The main objective of the experiment was successfully achieved. The module gave out the intended results. The Web UI allows user to authenticate their device and get the readings into the website easily and quickly. The calculation of data for medical health parameters using Wireless Sensor Networks is not a new idea, but rather this application concentrates on calculating parameters like HeartBeat, Blood Pressure, Monitoring and temperature altogether in a single calibrated kit which poses to the user as a single system when interfaced with computer application providing higher usability both to doctors as well as patients. With the correct information at the right time, the sensor based medical system can help medical patient to easily track and monitor their health record. The system will curb the menace of visiting doctor every time for diagnosis and will help registered patients of the doctors to gain treatment effectively.

7.2 Future Scope :-

a) IoT based Remote Patient Monitoring System can be enhanced to detect and collect data of several anomalies for monitoring purpose such as Brain signal monitoring, home ultrasound, Tumor detection etc.

BILL OF MATERIAL

Component Name	Reference Number	Ratings	Quantity	Price
Raspberry Pi 3A+	896-8660	5V/3.3V	1	5500
MAX30102	HW-596	3V-5V	1	350
MLX90102	-	3V-5V	1	900
BMP180	-	3V-5V	1	150
128 x 64 Graphic OLED	Sun162A	4.7V-5.3V	1	350
Jumper Wires	-	-	40	120
			TOTAL	**7370**

Table 6. Bill of Material

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APPENDIX

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CERTIFICATE

This is to certify that,

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Participated in "National Level Project Competition 2023" arranged by The Institution of Electronics and Telecommunication Engineers, Pune on 25th April, 2023 at Dr.D.Y. Patil Institute of Technology, Pimpri, Pune 411018

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Hon. Secretary

Dr. Virendra V. Shete
Chairman

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Chairman

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