Post COVID Health Monitoring System

By

Shusmoy Chowdhury
ID: 18121041
Md. Sayeem Hossain
ID: 18221023
Abdullah Al Rashed Chowdhury
ID: 19221020
Atqiya Tahsin Tuba
ID: 16321080

A Final Year Design Project (FYDP) submitted to the Department of Electrical & Electronic Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science.

Academic Technical Committee (ATC) Panel Member:

Dr. Mohammed Belal Hossain Bhuian (Chair)
Associate Professor,Department of EEE, BRAC University

Md. Mahmudul Islam,
Lecturer,Department of EEE, BRAC University

Abdullah Hil Kafi,
Lecturer,Department of EEE, BRAC University

EEE Department
Brac University
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Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

Student's Full Name & Signature:

[Shusmoy Chowdhury] [18121041]	**[Md. Sayeem Hossain]** [18221023]
[Abdullah Al Rashed Chowdhury] [ID: 19221020]	**[Atqiya Tahsin Tuba]** [ID: 16321080]

Approval

The Final Year Design Project (FYDP) titled "[Post COVID Health Monitoring System - (OXY -Cardio Wristband)]" submitted by

1. [Md. Sayeem Hossain (ID: 18221023)]
2. [Shusmoy Chowdhury(ID: 18121041)]
3. [Abdullah Al Rashed Chowdhury (ID: 19221020)]
4. [Atqiya Tahsin Tuba (ID: 16321080)]

of [FALL], [2022] has been accepted as satisfactory in partial fulfillment of the requirement for the degree of [Bachelor in Electrical and Electronics Engineering] on [15-12-2022].

Examining Committee:

Academic Technical Committee (ATC) (Chair):

____

Dr. Mohammed Belal Hossain Bhuian,
Associate Professor,Department of EEE, BRAC University

Final Year Design Project Coordination Committee (Chair):

____

Dr.Abu.S.M.Mohsin
Associate Professor,Department of Electrical and Electronic Engineering,BRAC University

Department Chair:

____

Dr.Md.Mosaddequr Rahman
Chairperson,Department of Electrical and Electronic Engineering,BRAC University

Ethics Statement:

We, the four members of ATC panel (04) group (20) made a product that monitors post COVID patients 24/7 time being. We state that this product is our own invention. making this project we did not take any outsider help. This product is eco-friendly and very easy to use. all the team members participate in the project equally. We keep this project confidential. This project is harmless as well. This project was made by proper monitoring of our ATC panel members. We research as far as we can to build this project. We try to follow all the standards and rules to build up a project. all the supported links provided as panel recommended.

Abstract/ Executive Summary:

This report describes the implementation of a final year design project named "Post COVID Patient Health Monitoring System" which also contains report out lines, major design changes, testing data, final budget, project validation, working process of project. Motivation of this project comes from listening to a close family member of a friend who was 68 years of age who died because of lack of proper monitoring after being affected by COVID 19 in 2020. As we all know that COVID 19 is a breathing problem related to diseases which affect major organs in our body. Mainly affects the breathing system. Around 30% people died after coming from the hospital as they were Post COVID patients. This project helps people to look after their beloved ones when they are out of home or unavailable to look after. It can reduce patient monitoring costs. This project measures three parameters of the patient's body which are always needed to monitor. Heart rate/ Pulse Rate, Oxygen Level and Body temperature are the three parameters this project will measure. Firstly, we did a software test using the components we want to use in hardware. Software trials need proper coding for simulation. We modified code as our desired one then put the Hex file in simulation software and ran the software project. After getting clearance that software simulation is almost ok we recheck the codes and modify them where necessary then again put the Hex file in simulation software name proteus. Then exact results got by simulation it's like closer to the medical equipment value used in hospitals. Before making hardware we made a 3D design where all the hardware showed accurately. The next step is hardware implementation. In the hardware part running all the components at a time is very challenging for us because we are not professional on this. So we finalize the components then use soldering iron to join the components together. We try to run the components each time it burns out. Then we get a solution that uses a Li-On battery so that we can protect components from burning. Another challenge we face is to settle all these components in the same case so that we can fit this case in the wrist of a patient as our project is based on wristbands. We use ESP8266 D1 microcontroller for data processing, SIM800L for GSM module as communication, 6DOF MPU 6050 3 AXIS GYRO for patient movement monitoring for X, Y & Z axis, MAX30100 for measuring heart rate/ Pulse rate also oxygen level, NTC 103 this is a temperature sensor which will give body temperature this processing system store data to local server known tingspick. This server will process data and if it gets any uncertain issue then send S.M.S through the GSM sim module to patients, family members and doctors. This full process was done in PCB design which cost 4500 tk. The last edition update of this project is that we add a push button for emergency purposes only. When we figure out our component work is pretty much correct then we try to fit this in a plastic case so that we can make this project usable. so we order a 3CM*3CM*3CM plastic case from the market and a set of watch belts to make it wearable. Then we go for a test case. According to eight test cases we find out that six test case data is partially similar to exact data measured in hospital of a post covid patient. so this product will follow a good quality model and be cost friendly as well. Lastly, this project contains an additional budget of 1500 taka and a project budget of 8150 taka so the total costing of this "Post COVID Health Monitoring System - (OXY- Cardio Wristband)" is 8176 taka.

Dedication:

In this work and report, all the credit goes to the authors as well as the people and faculty who actually think about students and help them in every situation. also we give credit to our beloved ones, family members and friends, some faculties in BRAC UNIVERSITY (Electrical & Electronics Engineering)

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List of Acronyms:

GSM=Global System for Mobile communication

IOT=Internet of things

BPM=beats per minute

dF=degree Fahrenheit

Chapter 1: Introduction- [CO1, CO2, CO10]

1.1.1 Problem Statement:

COVID-19 is a global pandemic infecting human life. There are many patients who have recovered from this deadly virus but are still facing a lot of health complications. According to a research by healio(2021), more than 200 symptoms reported after recovering from COVID [1]. But these are long lists. Therefore, in order to find out the common problems of a post covid patient, we have talked with a doctor regarding the complications a post COVID patient undergoes. Some of the common problems are heart- MI, heart failure, Lungs- fibrosis, shortness of breath or difficulty in breathing, irregular heartbeat, oxygen level fluctuation, paralysis, multi-organ failure and so on. Covid can cause long-lasting damage to the immune system, which can affect organs and changes, particularly in the lungs, may last for long, in these conditions post COVID care is very important to avoid further reinfection or complications. So, it is not always possible for family members of a post covid patient to look after. For instance, we have talked with an elderly person who has just recovered from covid and lives with his son and daughter-in-law and both of them work outside. So, as per doctor's suggestion, the requirement of the patient is that they need a health monitoring system which will be able to notify the patient's family member in case of any irregularity. In order to fulfill the patients' demand, we thought about a project that can monitor patient's health parameters without staying with them every moment.

1.1.2 Background Study:

In the sphere of medical science, some significant work has been done to monitor patient health. The following is a list of works related to this field.Many of the applications for wearable IoT in healthcare have already been commercialized and are available on the market. Existing works frequently focus on supporting persons who have difficulty preserving their independence, such as the elderly or people with specific chronic disorders [2], such as heart disease. For instance, Tamilselvi et al. [3] built a health monitoring system that can track fundamental symptoms of a patient such as heart rate, oxygen saturation percentage, body temperature, and eye movement. Heartbeat, SpO2, Temperature, and Eye Blink sensors were employed as capturing elements, while an Arduino-UNO was used as a processing device. Although the developed system was introduced, there are no defined performance measures for any of the patients. In the IoT setting, Acharya et al. [4] created a healthcare monitoring kit. Heartbeat, ECG, body temperature, and respiration were among the basic health metrics tracked by the designed system. Pulse sensor, temperature sensor, blood pressure sensor, ECG sensor, and Raspberry Pi are the main hardware components employed here. Sensor data was captured and forwarded to a Raspberry Pi for processing before being sent back to the IoT network. The system's biggest flaw is that no data visualization interfaces have been created. So, we want to design a health monitoring system for post covid patients which will be able to overcome the drawbacks of those proposed projects. The three parameters we want to measure are very important for COVID 19 patients. Explanation is:

Parameters: (Heart Rate):

The inner surfaces of veins and arteries can become infected by the coronavirus, which can then lead to blood clots, very small blood vessel damage, and inflammation of surrounding blood vessels, all of which can impair blood flow to the heart and other organs.

Neurological symptoms:

- Difficulty thinking or concentrating sometimes referred to as brain fog
- Headache
- Sleep problems.
- Dizziness when you stand up (lightheadedness)
- Pins-and-needles feelings.
- Change in smell or taste.
- Depression or anxiety.

Your heart may beat quickly or irregularly as a result of Covid-19 when your body fights the infection and your heart works harder to pump more blood throughout your body. Although COVID-19 is primarily a respiratory or lung disease, the heart can also suffer. Temporary or lasting damage to heart tissue can be due to several factors.

Lack of oxygen: As a result of the virus's inflammation and the fluid that it generates to fill the lungs' air sacs, less oxygen may enter the bloodstream. Blood pumping through the body requires more effort from the heart, which can be problematic for those who already have heart disease. Overworked hearts can stop working, and other organs, including the heart, can suffer from cell death and tissue damage from a lack of oxygen.

Myocarditis: heart muscle inflammation. Like other viral illnesses, such as some flu strains, the coronavirus may directly infect and harm the heart's muscular tissue. The body's immune system's response could also indirectly harm and inflame the heart.

The inner surfaces of veins and arteries can become infected by the coronavirus, which can then lead to blood clots, very minor blood vessel damage, and inflammation of surrounding blood vessels, all of which can impair blood flow to the heart and other organs. According to Post, severe COVID-19 is a condition that affects endothelial cells, which line blood arteries.

Cardiomyopathy: a condition of the heart muscle that impairs the heart's ability to adequately pump blood, can be brought on by viral infections. The stress caused by a viral infection causes the body to release an excess of catecholamines, which can stop the heart. The stressor will end after the infection is gone, and the heart can then heal.

If your heartbeat is racing or you are having palpitations after receiving COVID-19, you should call your doctor. Dehydration is one of many factors that might lead to a brief rise in heart rate. Especially if you have a fever, make sure you are getting enough fluids

- Feeling your heart beat rapidly or irregularly in your chest (palpitations)
- Feeling lightheaded or dizzy, especially upon standing

- Chest discomfort

Chest pain, breathlessness, and alterations on their echocardiography (heart ultrasound) or EKG are just a few of the symptoms that people with COVID-19 may experience. When these individuals receive an angiogram, however, it is frequently found that there is no sign of a significant blockage in the heart's blood channels, which would suggest a heart attack in progress. Myocarditis symptoms can also resemble those of a heart attack. Additionally, very minute blood clots that form as a result of viral infections like COVID-19 have the potential to obstruct tiny blood arteries and cause pain. People who exhibit heart attack symptoms should seek immediate medical assistance rather than trying to treat themselves at home.

Depending on: According to Post, "heart attacks" can take many distinct shapes. It is uncommon to have a type 1 heart attack, which is brought on by a blood clot obstructing one of the heart's arteries, during or after contracting COVID-19. With COVID-19, type 2 heart attacks are more frequent, according to her. Because the heart muscle doesn't receive enough oxygen delivery in the blood to perform this additional job, a fast heartbeat, low blood oxygen levels, or anemia may be the cause of this heart attack. Although it is less frequent in those who have recovered from the illness, we have seen this in persons with acute coronavirus sickness. Blood testing has revealed that some individuals who experience COVID-19 also experience EKG abnormalities, chest pain, and high troponin levels. Troponin levels that are elevated indicate damaged heart tissue. Sometimes a heart attack causes this. After COVID-19, this is less frequently observed.

OXYGEN LEVEL MONITORING:

Individuals can be infected with COVID-19 but have no idea it because they display no symptoms. When COVID-19 infects your lungs, it can lead to a decrease in blood oxygen levels due to a lung infection. Low oxygen levels can cause fatigue, shortness of breath, or no noticeable change in your condition at all, any of which could be life-threatening. A fingertip oxygen meter should be used to monitor your oxygen levels until you begin to feel better. In the event that your oxygen levels drop, seek immediate medical attention. [14]
The amount of oxygen in your blood is indicated by your blood oxygen level. When you take a deep breath in, oxygen is drawn into your bloodstream. By breathing, oxygen enters the bloodstream. If you have a severe infection like COVID-19, your lungs may become inflamed, reducing the amount of oxygen you take in with each breath. In order for your body to carry out fundamental tasks, such as keeping your heart beating, you need a sufficient amount of oxygen in your bloodstream. Your cells' ability to generate energy is facilitated by

the oxygen in your blood. Your ability to think, move, and perform other daily activities depends on this energy. Percentages are used to describe the amount of oxygen in the blood. Oxygen saturation levels close to 100% indicate adequate oxygen supply to the body [15],[16]
A respiratory illness known as COVID-19. It may make breathing difficult and result in low oxygen levels in the blood. Your body cannot operate normally when there is little oxygen, which can be fatal. One option to track your COVID-19 infection and recovery at home is to monitor blood oxygen levels. A pulse oximeter, which costs little money and is simple to use, can be used to monitor the oxygen levels in your blood. Your blood oxygen level is displayed as a straightforward percentage using a pulse oximeter. If your pulse oximeter measurement is less than 90%, you should seek emergency medical attention.

TEMPERATURE:

In particular, in order for enzymes to be able to catalyze chemical processes, the cells of the body need to be at the appropriate temperature. The dangers of having a body temperature that is too high include the risk of dehydration, heat stroke, and even death if treatment is not received. The condition known as hypothermia can result in death if it is not addressed.

1.1.3 Literature Gap:

By offering real-time, unobtrusive monitoring of patients' physiological indicators through the deployment of numerous on-body and even intrabody biosensors, wearable health-monitoring systems (WHMSs) represent the future generation of healthcare. Continuous ambulatory monitoring of vital signs is anticipated to enable proactive personal health management and better treatment of patients suffering from chronic diseases, of the elderly population, and of emergency situations, even though WHMS still has a number of technological issues that need to be resolved in order to become more applicable in real-life scenarios. In this study, a physiological data fusion model for multisensor WHMS [27] was introduced.
This study introduces a wearable integrated health-monitoring system. The system's foundation is a multisensor fusion strategy[28]. A controller board, an electrocardiogram (ECG) sensor, a temperature sensor, an accelerometer, a vibration motor, a color-changing light-emitting diode (LED), and a push button are all embedded in the chest-worn device. Applications for biometric and medical monitoring are possible with this multi sensor gadget. Depending on the user's health, the inbuilt vibration motor can be used to activate various haptic feedback patterns. The wearer can receive additional intuitive visual indication of their current health status from the inbuilt color-changing LED. The user can use the given push-button to report a potential emergency situation. The gathered biometric data can be utilized to obtain sensitive data for later analysis for medical diagnosis or to obtain real-time monitoring of the subject's health status. The system architecture is presented in this early paper[28].

1.1.4 Relevance to current and future Industry:

We examine the possible use of wearable sensors in post-covid health monitoring. We outline a few health monitoring usage models and talk about the technical specifications for a system that uses wearable and ambient sensors to monitor users' or patients' daily environments for health-related data. The presentation is by no means exhaustive, but it seeks to provide a general overview of the system-level considerations for practical applications. Since this technology is evolving quickly, we can be sure that these applications will start to appear on the market in the upcoming years.

1.2 Objectives, Requirements, Specification and constant:

1.2.1. Objectives:

- To design a health monitoring system for post covid patients.
- To work as a first line safety for critical patients by giving warnings of early or severe deterioration
- To reduce health-care costs by lowering the number of visits to the doctor's office

1.2.2 Functional and Nonfunctional Requirements:

Functional Requirements	Non-functional Requirements
● Heart rate measuring(0 to 210 beats per minute) ● Blood Oxygen saturation (0 to 100 percent) ● Body Temperature measuring (0℉ to 105℉) ● Patient collapse measurement (X,Y or Z axis)(>5 meters)	● Alerting the family members & doctor with s.m.s/alarm ● Keeping health records of patient for one month ● Push button for emergency

1.2.3 Specifications:

Measurement System:
This project will measure different parameters (heart rate, oxygen level, temperature and fall detection of the patient).Then the project will alarm the family members & doctors about the patient's health.

Alerting System:
It will alert the patient's family member and doctor with sms or buzzer if the health parameters of the patient are not at normal level.

1.2.4 Technical and Non-technical consideration and constraint in design process:

First of all, patients must wear it every time since we need to measure body parameters. Therefore, employing it will make the patient uncomfortable. Second, it can only alert the doctor if there is a wifi connection. It cannot inform the doctor if the wifi is somehow down. Thirdly, if it somehow separates from the body while measuring body parameters, it is unable to measure anything. And finally, it isn't waterproof so patients cannot wash their hands wearing it.

1.2.5 Applicable compliance, standards, and codes:

It is necessary for engineers or professionals to follow international standards and codes. We also have maintained or abided by those standards in our Final Year Design Project. The standards and regulations which we have followed are given below:

Code	Name	Purpose
IEEE 802.6	Standard for information exchange between systems.	High speed shared medium access control protocol that is used over a bus network.
IEEE 802.11	Wireless networking - wifi.	To allow laptops, printers, smartphones, and other devices to communicate with each other and access the Internet without connecting wires.
IEEE 12207	Information technology -software life cycle process.	Defining, controlling, and improving software life cycle processes within an organization or a project.

IEEE 829	Software test documentation	Specified the form of a set of documents for use in eight defined stages of software testing and system testing.

1.3 Systematic Overview/summary of the proposed project:

Various parameters will be measured for this study (heart rate, oxygen level, temperature and fall detection of the patient). The initiative will then notify the patient's relatives and doctors about their condition. If the patient's health metrics are out of the ordinary, it will notify the patient's family and doctor via SMS or buzzer.

1.4 Conclusion:

The creation of a post-covid health monitoring system for patients who will recover from covid is the main objective of this project, as was already stated. They will benefit greatly from this project, which will help them specifically keep track of their health at all times. To do this, we first looked at the most common post-COVID problems that patients encounter. They need constant health monitoring, which is impossible for a human to provide. So, following international standards and codes our aim is to design a health monitoring system for post covid patients.

Chapter 2: Project Design Approach [CO5, CO6]

1.1 Introduction:

Since the COVID patient health monitoring system is the foundation of our project. Therefore, we look for a solution with a variety of designs. We want to monitor temperature, heart rate, and oxygen levels continuously or on a regular schedule for our monitoring project. As a result, we wish to measure it using a wristband that will be worn constantly. Since our client needs to keep an eye on patients away from home, the doctor will also be informed of the patient's status. In the first step, we create a wearable hand band with sensors for measuring oxygen levels, temperature, and heart rate. This band is connected to a monitoring device and a wifi module. The GSM module and the monitoring equipment are both connected, allowing data to be relayed to the patient's family and physician. We wish to use our wristband device to monitor a post-COVID patient in this manner.

For our second project design approach, we offer a project of scanning chambers that also follow the same operational procedure. When patients pass through the chamber, we attach all the sensors to certain areas of the chamber. These sensors will gather and save information. The chamber will be connected to a monitor and a gsm module, which will alert doctors and family members of the patients' conditions.

1.2 Identify multiple design approach:

We have two multiple design approaches for our project. One of the design is oxy-cardio band and the other is a scan-chamber

.

Block diagram of design approach-1 which is Oxy-cardio band is given below:

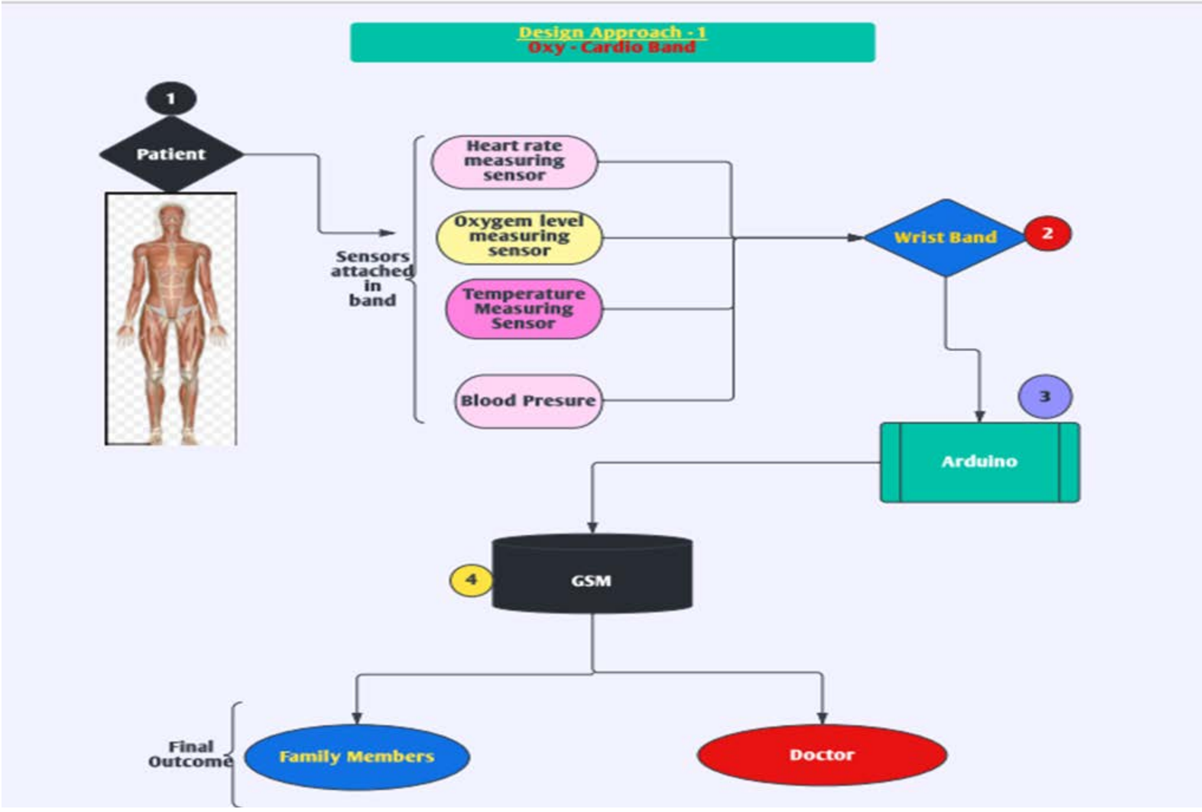

Fig 1: Block Diagram of Oxy-Cardio Band

Block diagram of design approach-2 which is Scan-chamber is given below:

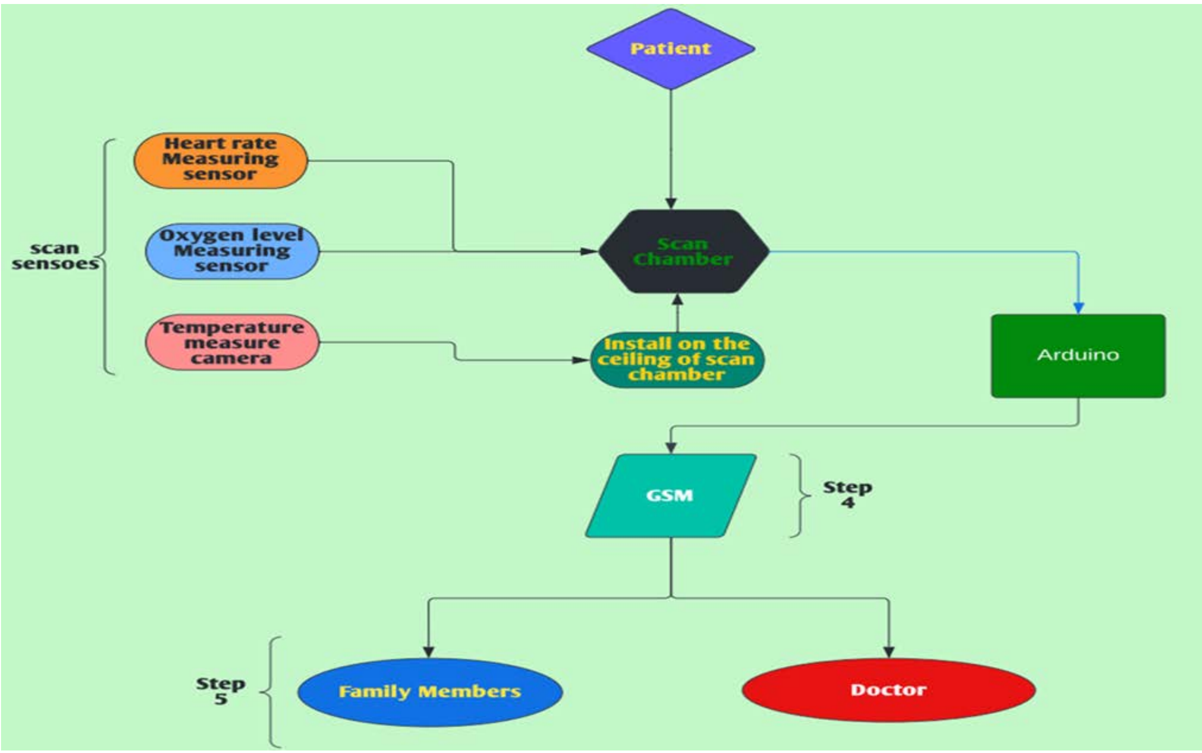

Fig 2: Block diagram of Scan Chamber

1.3 Describe multiple design approach

Design 1: (Oxy - Cardio Band):

This is our initial design strategy. The diagram shows that we are creating a wearable hand band for patients who underwent COVID 19 treatment.
There are six steps in this design. We require a post-COVID patient for the initial phase. In the next stage, we create a wristband with four distinct measurement sensors. (Heart rate, oxygen saturation, temperature, and blood pressure measurements) These sensors gather information about the human body. gathered data is transferred to Arduino in step 3 (microprocessor). The GSM module, which we employ as a notification module, receives data from Arduino. This GSM module sent SMS notifications to physicians and patients' families [5].
The band will be composed of soft rubber that is both comfortable to wear and waterproof over the whole machine body. There are three components to this device or watch. It has a mechanism for detecting pulse rate, to start. When the heart beats, the arteries dilate and contract, creating the pulse. From the wrist, we can quickly determine this rate. We therefore suggest wristbands while keeping those aspects in mind.

Fig 3 : Sample Wristband [29]

This device measures the pulse rate from the wrist, analyzes it, and stores the information in a database or the cloud. This watch has a method for counting oxygen levels. So we integrate an oximeter into our system. This chip analyzes the information stored in the cloud storage and counts the patient's oxygen saturation.
Here, a microprocessor is used for data processing. All data is processed by this chip, which then stores the results in a computer or processor. After processing the data, the processor in this device outputs two messages, one of which is sent to the patient's family and the other to the doctor who is monitoring the patient. This design's effectiveness lies in its inexpensive cost and versatility for use throughout the day.

Simulation For design 1:

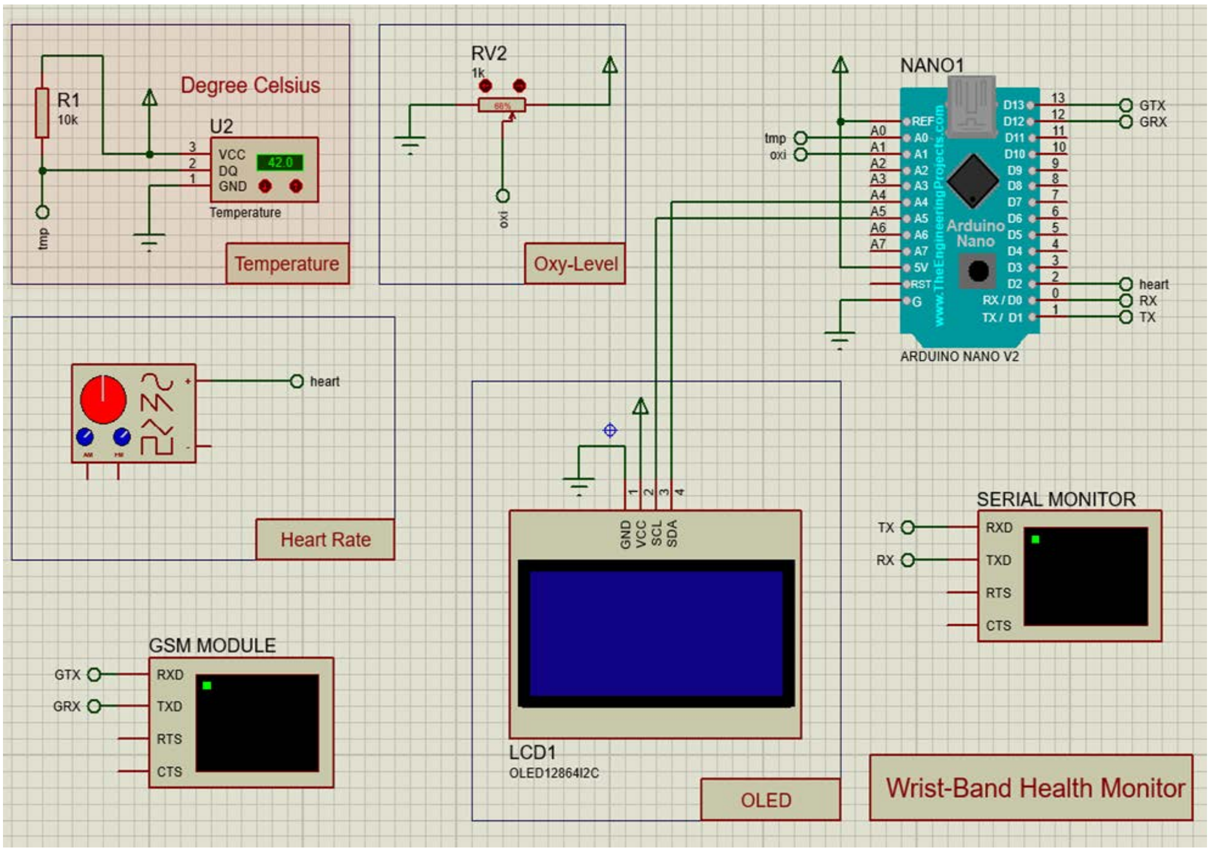

Fig 4: Simulation design of Oxy-Cardio Band

Design2: (Patient Scan chamber):

As you can see from the title, Design No. 2 is a scanning chamber for post COVID 19 patients.

Here, we wish to use chambers constructed of glass and plastic. We want to utilize plastic for the length side because it is portable and lightweight. Due to the usage of thermal cameras and touch response sensors, metal is not an option. We use plastic instead of metal because it is a better conductor of electricity and because it is less expensive. We use glass for the wide side.

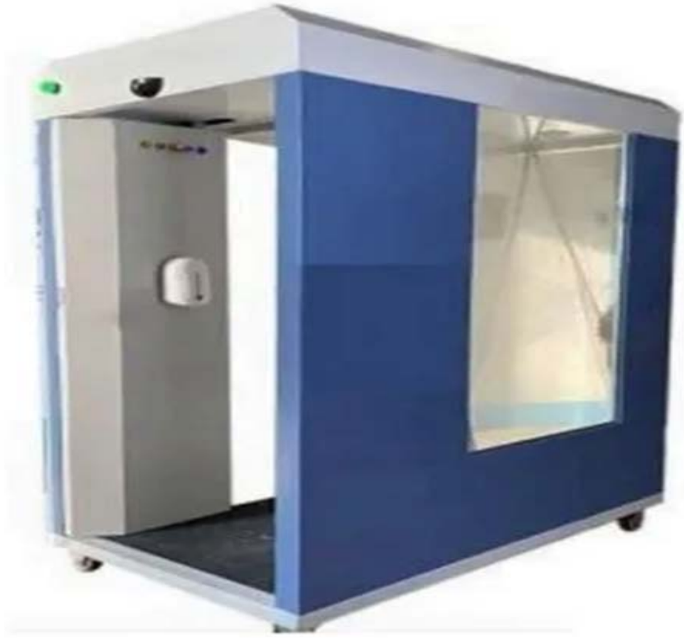

Fig 5: Sample of Scan chamber. [14]

This scan chamber is made up of a thermal camera on the top. This camera is used for sensing body temperature of patients. For calculating heart rate and oxygen level we need the touch or connection with the sensors. So what we do we attach heart rate sensor and oxygen level sensor to the length side wall of chamber and patient have to come inside the chamber close the door and give a touch to the sensors then sensors will collect data on the other hand, thermal camera sense the body temperature of patient and will collect data.

After collecting those data we store the data and use the GSM module to send notification to family members and doctors about the patient's condition.

Simulation for Design 2:

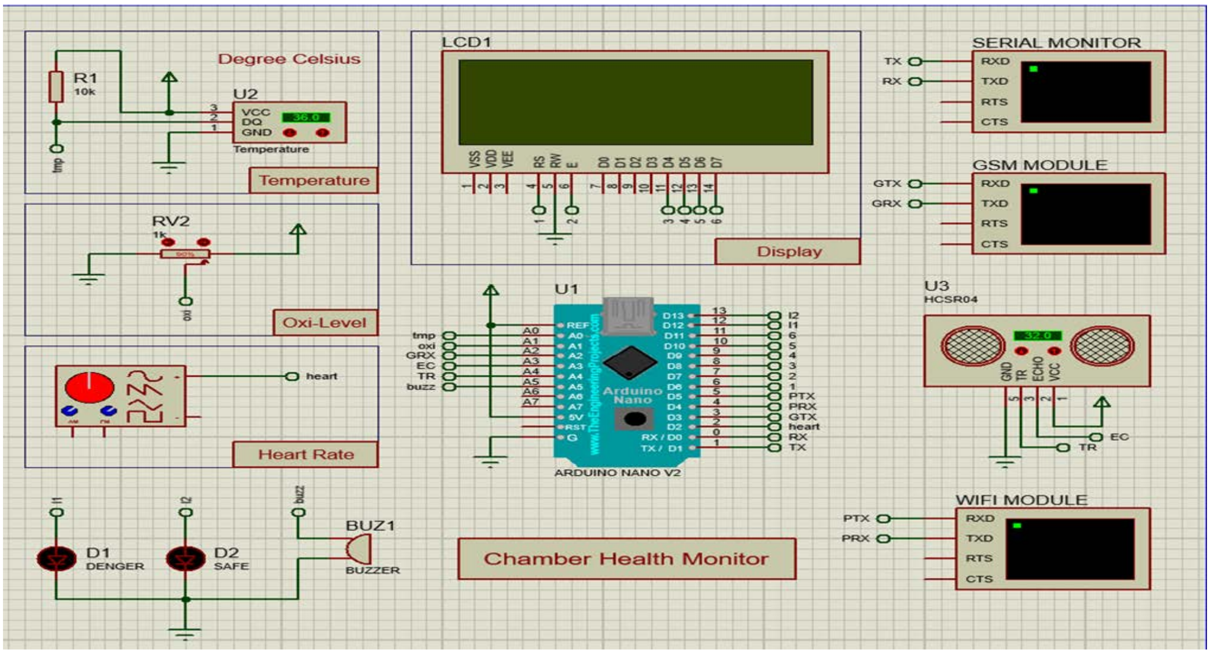

Fig 4 : Simulation design of Scan Chamber

1.4 Analysis of multiple design approach

Oxy-Cardio Band:

As our first design is a wearable wrist watch it is very easy for a patient to wear and maintain as well. For increased durability of the product we use water proof coating for the machine and for the belt we want to use soft rubber or silicon. These are comfortable and have no tension for damage as well. We give wireless connection to the band and gsm module so we store the patients health data in a safe place. This design is less expensive and easy to use.

Scan Chamber:

On the other hand if we want to see the other design it's a scan chamber where a patient needs to walk through the chamber and have to scan himself on his own. If the patient is not in walking condition so this design is useless in this case the first design will pass this case. We need to make the scan chamber sound proof otherwise the result will not be appropriate. To make it sound proof it becomes more costly than the oxy-cardio band.

1.5 Conclusion

Patients' health had to be kept under constant observation, which is impossible for a human to do. We suggested two possible implementation designs to address this issue. However, one of the designs cannot be put into practice due to specific limitations. So, we made the decision to use a single, highly effective design. Here, we are creating an Oxy-cardio band that will continuously monitor a patient's bodily functions. In order to measure the body parameters, we used various sensors. The patient's family and doctor will receive an automatic alert from this device if the patient falls ill in any way. They will learn by SMS that the patient's health is poor, and they should thereafter admit him to the hospital without delay. Since this project is so delicate, we made every effort to make it as effective as possible in order to guarantee the security of post-covid patients. We may conclude from the foregoing that this initiative will be extremely effective and serve a crucial part in the post-covid patients' health monitoring system.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

1.6 Introduction:

With the correct equipment, you can get more done in less time and with fewer errors. Having the proper equipment allows you to perform better. If you have the correct equipment, you can get the task done quickly and effectively. When working with, it's crucial to pick the appropriate equipment. Technology may improve students' skills, transform the way they learn and think, and open up new doors to the outside world. To ensure that your crew is working in a secure atmosphere and lowering the risk of workplace injuries, you must equip them with the right equipment and training on how to use it safely. It is crucial for all organizations to comprehend the rules and safety requirements they must adhere to on the job. Engineering has been greatly aided by technological advancements in the creation of products. All of these technologies together provide a collection of tools that allowed them to create outstanding. Artifacts and successes that you've made. However, the difficulties posed by modern developments mean that the methods of yesteryear are inadequate. Today's engineers can make great strides forward thanks to the proliferation of new technology. We'll look at what today's engineers require, and then evaluate established and developing technologies side by side. Engineers rarely work alone when developing new products. Democracy in design is on the rise. There needs to be input from a wide variety of technical roles and numerous stakeholders in order to lessen expenses while simultaneously boosting output and client pleasure. As a result, engineers need channels through which to disseminate plans and encourage communication among project participants. There have been substantial developments in this sector as well over the past few years. Today, we may instead use Direct Modeling to pull, push, and drag geometry to effect the required alterations. From what I've seen, this method is applicable to models from models exported from the same CAD program, where the characteristics are too difficult to alter, or models exported from a different CAD program entirely. [29]

1.7 Select appropriate engineering and IT tools:

We chose to think about three distinct techniques, and then we set out to find the best one in terms of efficacy and other factors. We must run simulations and assess how well the various techniques perform. We also take into account whether the hardware and software tools will be able to determine the parameter we're trying to monitor. We looked at YouTube videos, instructor consultations, and our academic level experience while looking for software. Additionally, when it comes to hardware, we strive to determine which components on the market will accurately deliver the measured items. The following qualities of our conclusion are therefore reached:

Table 1: Software and Hardware tools (used or we will use) identified as follows:

Name	Tool Type	Description	Task	Process
Proteus	Software	For circuit simulation test and verification of coding	Verify wire connection and code authenticity	1)Using build in library or updating the library of components 2)Connecting wires as per design 3)Upload code to ESP8266 D1 mini controller and Modules 4)Run simulation
ESP8266 D1 mini controller	Hardware	For processing received data and sending commands	Continuously running code in loop and send commands	1)Write code in Arduino IDE in PC 2)Upload the code in ESP8266 D1 mini controller via usb 3)Make necessary wire connection with components
GSM Module	Hardware	For sending text	Always connected to network, follow commands of Arduino	1)Insert SIM card 2)Wait for some time for making the connection with network 3)After connection is established LED will blink 4)Make necessary wire connection with Arduino
Sensor Module	Hardware	For collecting data	Oxygen Level sensor Heart Beat Sensor Temperature Sensor	All the sensors send data to the arduino.

1.8 Use of modern engineering and IT tools:

Proteus software:

As a proprietary software package, the Proteus Design Suite is largely put to use in the realm of electronic design automation. Electronic design experts and technicians use the program to make circuit board layouts and electronic prints. The primary functions of Proteus PCB software are schematic capture and board layout. This program is an all-in-one solution for PCB design, combining the traditionally separate tasks of PCB layout and schematic capture into a single, streamlined process. The software's convenient features make PCB design a breeze. Proteus has been a great partner for us; They came to us with innovative software that has helped us save a ton of money and streamline our processes. An absolute must-have! Our work routines are now more efficient thanks to the integrated timesheet system and project management features. The Proteus Cloud Platform is an all-encompassing suite of digital resources that helps businesses adapt to the ever-shifting requirements of digital This program is a one-stop shop for PCB design. It combines the tasks of PCB layout and schematic capture, which are usually done separately, into a single, streamlined process.transformation through the use of agility. The genus Proteus belongs to the family Enterobacteriaceae and is anaerobe that grows in a gram-negative environment without oxygen (Brooker 2008). It's rod-shaped, motile (it can move thanks to its flagella), and swarms characteristically, allowing it to traverse across catheter surfaces under the microscope (Armbruster 2013). Proteus Professional combines the features of two separate programs, ISIS for schematic capture and ARES for PCB layout. This is a robust and unified platform for creating software. This suite contains a number of simple-to-operate tools that may be put to excellent use both in the classroom and in the professional world of PCB design. [48]

ESP8266 D1 mini controller (Hardware):

The ESP8266 is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and capability, produced by Espressif Systems in Shanghai, China.

The microcontroller chip was popularized in the English-speaking maker community in August 2014 via the ESP-01 module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first, there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation.

The ESP8285 is a similar chip with a built-in 1 MiB flash memory, allowing the design of single-chip devices capable of connecting via Wi-Fi. These microcontroller chips have been succeeded by the ESP32 family of devices

Processor: L106 32-bit RISC microprocessor core based on the Tensilica Diamond Standard 106Micro running at 80 or 160 MHz

Memory:

- 32 KiB instruction RAM
- 32 KiB instruction cache RAM
- 80 KiB user-data RAM
- 16 KiB ETS system-data RAM

External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)

- Integrated TR switch, balun, LNA, power amplifier and matching network
- WEP or WPA/WPA2 authentication, or open networks
- 17 GPIO pins
- Serial Peripheral Interface Bus (SPI)
- I^2C (software implementation)
- I^2S interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC (successive approximation ADC)

The pinout is as follows for the common ESP-01 module:

1. GND, Ground (0 V)
2. GPIO 2, General-purpose input/output No. 2
3. GPIO 0, General-purpose input/output No. 0
4. RX, Receive data in, also GPIO3
5. VCC, Voltage (+3.3 V; can handle up to 3.6 V)
6. RST, Reset
7. CH_PD, Chip power-down
8. TX, Transmit data out, also GPIO1

The ESP8266 modules produced by the independent company Ai-Thinker in this first series are still the most frequently distributed. They are referred to as "ESP-xx modules" as a group. They need other parts to create a functional development system, particularly a serial TTL-to-USB adapter (also known as a USB-to-UART bridge) and an external 3.3 volt power source. Larger ESP8266 Wi-Fi development boards like the Node MCU, which comes with the USB-to-UART Bridge, a Micro-USB connector, and a 3.3 volt power regulator built into the board, are recommended for inexperienced ESP8266 developers. These less expensive ESP-xx modules provide a lower power, smaller footprint choice for production runs once project development is through and certain components are no longer required. [20]

SIM800L (GSM Module):

A customized Global System for Mobile Communication (GSM) module is created for Short Messaging Service wireless radiation monitoring (SMS). This module may send text SMS data to a host server after receiving serial data from radiation monitoring devices like survey meters and area monitors.

A3, A5, and A8 are three separate security algorithms used by GSM. A3 and A8 are typically implemented jointly in practice (also known as A3/A8). In GSM network Authentication Centers and Subscriber Identity Module (SIM) cards, an A3/A8 algorithm is used.

The SIM800L is a tiny cellular module that supports GPRS transmission, SMS sending and receiving, and voice calls making and receiving. This module is the ideal choice for any project that needs long distance connectivity because of its low cost, compact size, support for four bands of frequencies, and low cost.

The GSM/GPRS SIM800L module operates on the GSM 850MHz, EGSM 900MHz, DCS 1800MHz, and PCS 1900MHz frequencies.

Any sort of speech or data connection using the module requires the usage of an antenna. Therefore, choosing an antenna might be quite important. The SIM800L module can accommodate an antenna in one of two ways. The first is a helical antenna that may be soldered directly onto the PCB and typically comes with the module.

Probably the most frequent problem with the SIM800L is power requirements. With an input voltage ranging from 3.7 V to 4.2 V, this board can only draw up to 2 A. This implies you can't just plug a 5 V Arduino into its pins! It cannot even function at 3.3 V. [23]

6DOF MPU 6050 3 AXIS GYRO: (Accelerometer):

Triaxial accelerometers gauge vibration along the X, Y, and Z axes. Three crystals are used, each of which is positioned so that it responds to vibration along a separate axis. Three signals are emitted, each of which represents a different axis' vibration. The MPU6050 is an internal 3-axis accelerometer and 3-axis gyroscope Micro-Electro-Mechanical Systems (MEMS) device. This facilitates the measurement of a system's or object's acceleration, velocity, orientation, displacement, and many other motion-related properties.

A micromachined microelectromechanical systems (MEMS) sensor called the three-axis acceleration switch determines whether an acceleration event has surpassed a set threshold. It is a tiny, compact gadget that measures acceleration in the x, y, and z axes, measuring only 5mm by 5mm. [24]

MAX30100 (Heart Rate Sensor (Heart rate + oxygen level sensor):

Two light-emitting diodes and one photodiode are present on the sensor. The light is produced by LEDs, and a photodiode is utilized to detect and gauge the received light's intensity. In MAX30100, one LED emits infrared light while the other emits monochromatic light. The MAX30100 is a sensor solution with integrated pulse oximetry and heart-rate monitoring. To detect pulse oximetry and heart rate signals, it incorporates two LEDs, a photodetector, improved optics, and low-noise analog signal processing.

Connect the MAX30100's Vin pin to the Arduino's 5V or 3.3V pin, and GND to GND. Connect the Arduino's A5 and A4 with the MAX30100's SCL and SDA I2C pins. Similarly, attach the LCD pins 1, 5, 16, and 2 to the Arduino's GND and 5V VCC, respectively.

Applications of MAX30100:

- Medical Oxygen measurement devices.
- Wearable Devices.
- Fitness Assistant systems.

When a finger is placed on heartbeat sensors, a digital output of the heartbeat is produced. The light emitting detector (LED) blinks in sync with each heartbeat as soon as the heart beat detector is operational.

The wave of blood in the artery caused by the left ventricle contracting during a cardiac cycle is the pulse or heart rate. The intensity or size of the pulse corresponds to the volume of blood expelled during cardiac contraction (stroke volume). Adults typically have pulse rates between 60 and 100 beats per minute. [25]

NTC 103 (Temperature Sensor):

Leaded epoxy-coated thermometer NTC 10K temperature sensor. The resistance of this NTC thermistor reduces as temperature rises because it is a transducer that converts heat energy into electrical energy. Any electronic application's temperature sensor is regarded as its most crucial component. The measurement of temperature is necessary to establish specific operating limits for domestic appliances and industrial equipment. There are many different sensors that can be used for this, but thermistors, semiconductor sensors, resistance temperature detectors, or RTDs, are some of the more prominent ones. Thermistor is a term used to describe a type of resistor whose resistance value is affected by changes in temperature. The circuit's passive element is represented by this. This was built with materials other than RTDs. Ceramic or plastic materials are used to create thermistors.

This thermistor accurately measures temperature and delivers reliable results. These are reasonably priced and durable. However, connecting it in really hot or cold temperatures doesn't work effectively. Thermistors are preferred when it becomes necessary to maintain a specific, constrained range. RTDs are utilized when a wide temperature range is required because of their all-metal construction. [26]

1.9 Conclusion:

It is difficult to design fresh things in the modern day. Only 15% of engineering projects are successful, meeting their release dates without a 10%+ change, according to data from The PLM Study. Resources. What makes it so challenging? Engineers' efficiency and output have been declining due to numerous trends. For the problems that engineers now encounter, the conventional engineering toolkit is insufficient. Fortunately, new engineering toolkits have and are still developing. Generative and modeling. They find superior items thanks to cloud-based design. Tracking design iterations and collaborating with other stakeholders is made easier by cloud-based CAD with embedded data management. Prototypes are created virtually and physically with the aid of 3D printing and CAD embedded simulation. Direct

Modeling and natively opening foreign models make it easier to work with supply chain designs. These technologies make up the new toolbox for the contemporary engineer. It's undeniable that engineers today are up against unprecedented challenges. Traditional engineering methods are insufficient at this point. Engineering that takes advantage of cutting-edge technology tool sets have a quantifiable effect on the efficiency of the organization. It is time to upgrade our current set of tools.[29]

Chapter 4: Optimization of Multiple Designs and Finding the Optimal Solution. [CO7]

4.1 Introduction:

The unique coronavirus sickness has made 2020 tough for everyone on the planet. The virus known as severe acute respiratory syndrome coronavirus 2 is what caused the COVID-19 epidemic (SARS-CoV-2). Because COVID-19 may spread by tiny droplets and aerosols from an infected person's mouth and nose, as well as sometimes through contaminated surfaces, it spreads when an infected person is in close contact with another individual. Both infected persons and those who do not feel alterations may spread the virus to another person up to two days before they exhibit symptoms. Fever, a persistent cough, exhaustion, respiratory issues, a loss of taste and smell, and even hypoxia are some of its symptoms (insufficient oxygen saturation levels). The World Health Organization and Chinese officials verified human-to-human transmission on 20 January 2020, with the first reported human cases occurring in Wuhan, China.The epidemic, which resulted in countless fatalities, has inflicted economic and emotional suffering over the whole planet. In India, there were 162,959 fatalities and 580,327 ongoing cases as of March 31, 2021. According to the WHO's weekly epidemiological report, there will be a 10% rise in new cases by March 16th, 2021, and the mortality rate will be close to 2.2% [2]. It caused a drastic decline in the economy and had an impact on the social and physical well-being of millions of people. Employment, healthcare facilities, the production of necessities, business, cultural life, relationships with peers and family members, education, etc. all suffered severe setbacks. The inability to travel and meet new people resulted in harmful behaviors and emotional discomfort, which affected interpersonal interactions. The health ministry recommended moderate exercise, good hand- and respiratory hygiene, mask use, and the use of immunity-stimulating medications provided by the AYUSH Ministry to keep preventative against this epidemic that has spread globally[55]. But after recovering from covid-19,it is very important to monitor the patients every time.Because when they recover from covid they can easily be the victim of chest discomfort and an accelerated or hammering heartbeat.Sudden oxygen level fluctuation which may result in their death also[54].

To solve this problem after consulting with our patient's family members & expert doctors,we decided to create a solution that can continuously monitor the post-covid patient. As it is not feasible for a family member to constantly watch the patient, they desired a design that could constantly measure the patient's physiological parameters and notify them of the patient's health status.We created two designs that track the patient's temperature, heart rate, oxygen saturation, and movement status. While making our design we always prioritized the comfortableness of the patients. In order to focus on the demands of our stakeholders, we thought of making an oxy-cardio band for wearing on the wrist & the other design is a scanning chamber. Both of the designs are designed in such a way that they can measure the body parameters of the patient every time which can not be done by any person. As per our requirements, we tried to show different sensor outputs in the simulations of our designs like a real-case scenario. After that, we matched the simulation data with the real-case scenario data collected from the patients by consulting with the doctors. We tried to show them in graphical figures. Then we compared both designs and found our optimal design.

4.2 Optimization of multiple design approach:

System 1:

Oxy Cardio-Band:

Our first idea, a worn wristwatch, is extremely simple for a patient to use and maintain. For the machine's water-resistant coating and the belt's soft rubber or silicon, we wish to boost the product's durability. These are cozy and also not vulnerable to harm. The band and gsm module get wireless connections, thus we keep them both in a secure location. This style is more affordable and simple to use.

System 1 Analysis:

Oxy-Cardio Band:

•**Efficiency:** More effective in any environment and location

•**Component Level Cost:** 12213.27 taka

•**Usability:** Practical approach for the problem with added new features for flood management; reliable system.

• **Manufacturability:** All the components are available in the market

• **Impact:** Along with other impacts, the system will also ensure the security of public data.

• **Sustainability:** System will be able to tackle harsh environments of disaster

• **Maintainability:** As a standalone project, will not be needing any update once at the beginning of implementation is calibrated.

Fig 5: 3D design of Oxy-Cardio Band

Simulation design:

We discovered that the components we intended to employ are not there in the program after the simulation process had begun. Later, we discovered those libraries, made the necessary software updates, and conducted our simulation.

Real-Time Sensors Data Design 1:

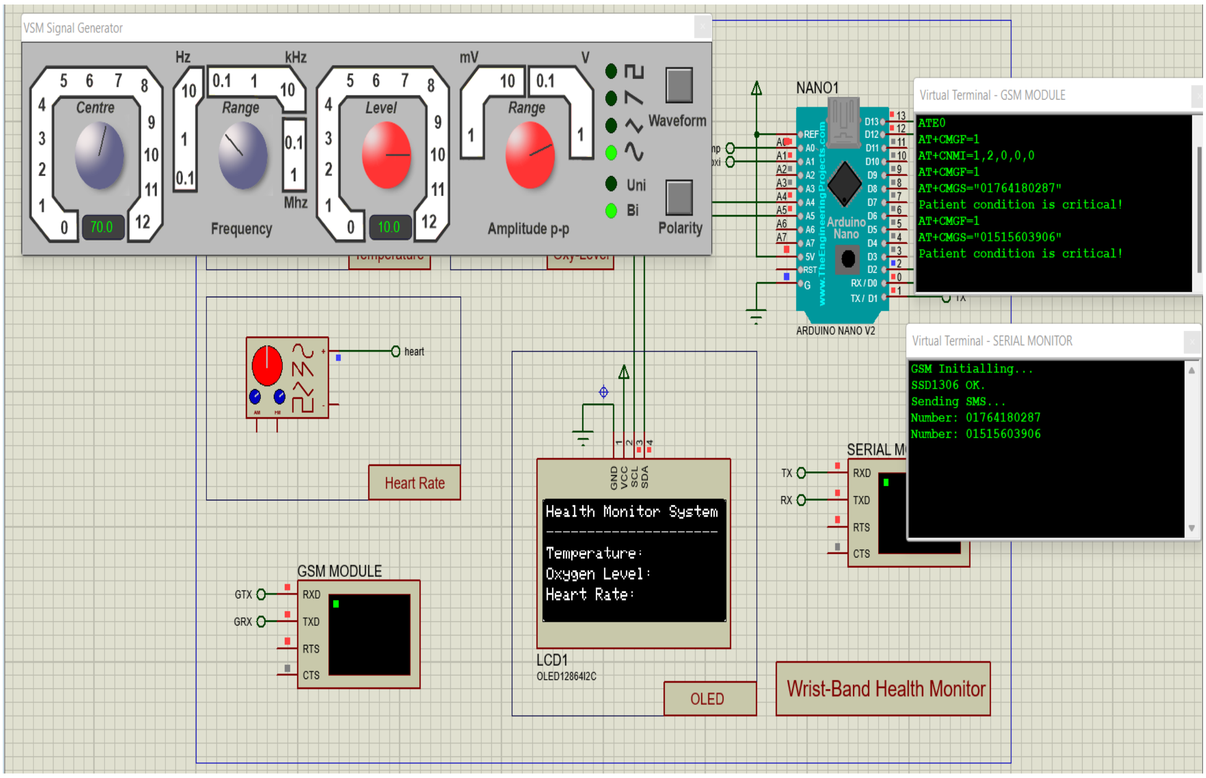

Fig 6: Proteus simulation for real-time sensors data

In this simulation design we have used an OLED display as a data representative, and a serial monitor for triggering the heart rate as we can not calculate heart rate directly in the simulation. Then we used an oxygen level sensor for measuring the oxygen level & heart rate. From this simulation design we tried to show the body parameters collected from the patient as a test case & also we have shown them in the graph against time. From the graph, we will get a clear idea about the patient's health. Then when the patient gets critical,we have used a GSM module for sending alerts to the doctor & family members.

Test Case for design 1:

After a patient recovers from Covid-19, he may be attacked by a number of disorders that may potentially be fatal, according to the post-covid health monitoring system. As a result, their health must constantly be examined. System 1 will thus continually monitor all of his body's parameters for 24 hours. The doctor and the patient's family will get SMS notifications if anything happens to the patient's health.

Different conditions of the patient wearing the Oxy-Cardio Band:

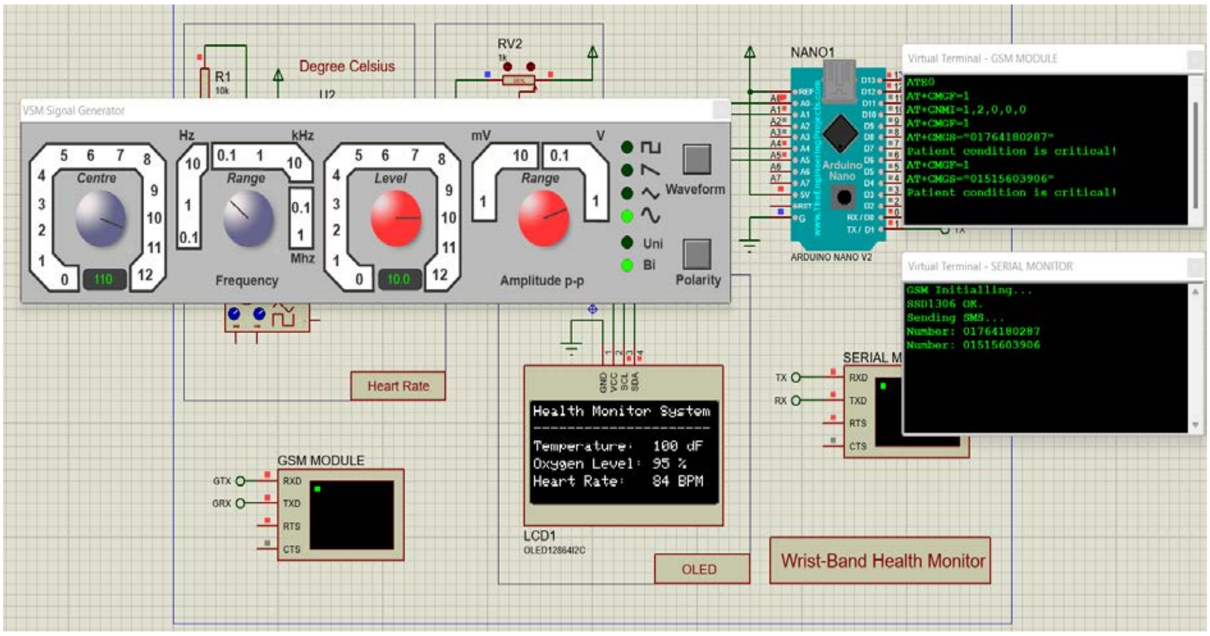

Fig 7: T=100dF(degree Fahrenheit), Oxygen level=95%, Heart Rate=84 BPM

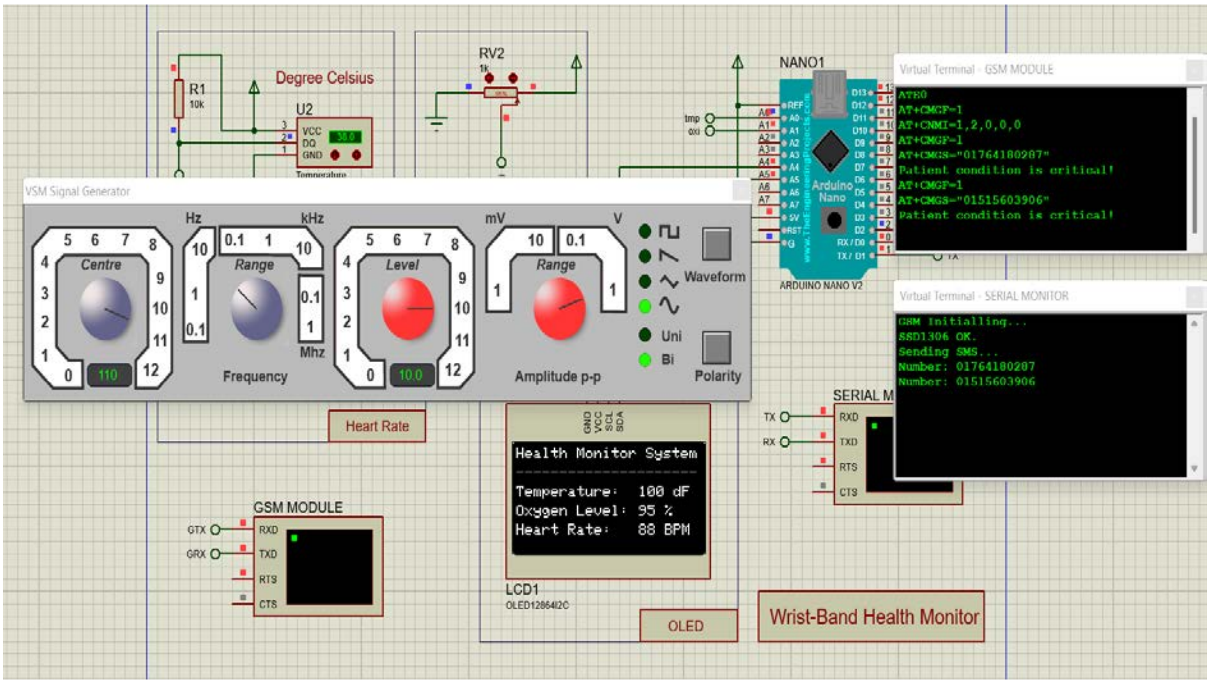

Fig 8: When T=100dF(degree Fahrenheit),Oxygen Level=95%, Heart Rate=89 BPM

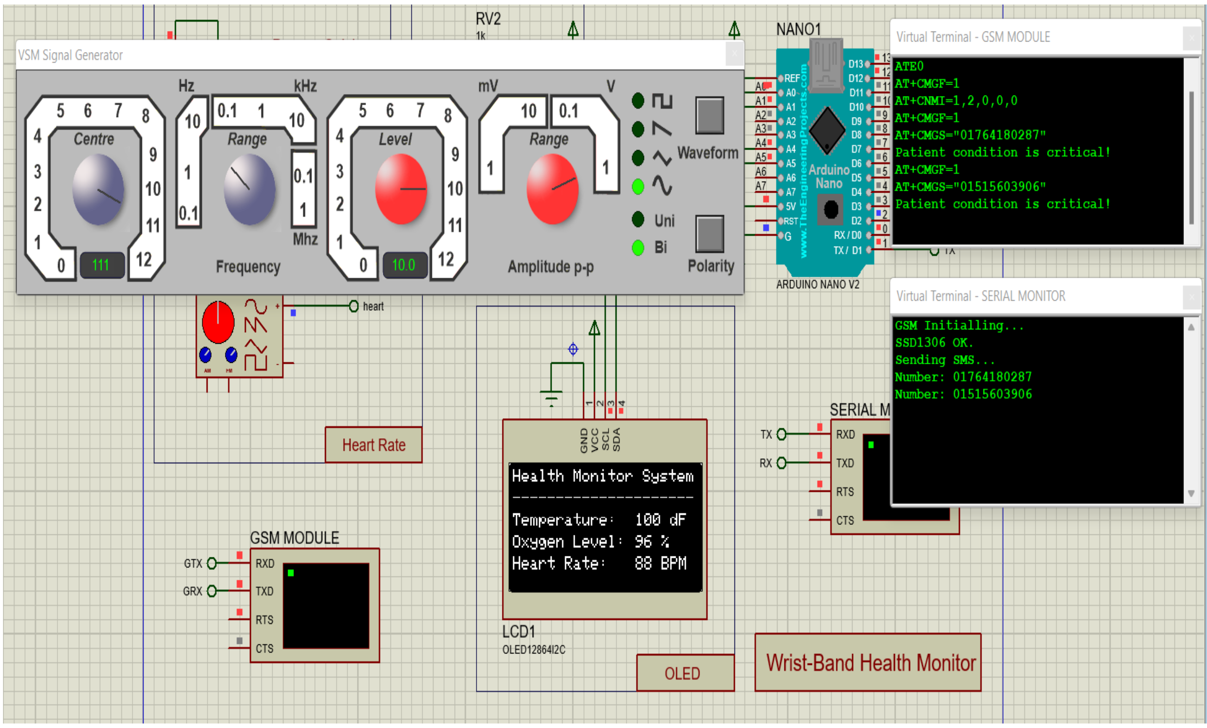

Fig 9: When T=100dF(degree Fahrenheit),Oxygen Level=96%,Heart Rate=88 BPM

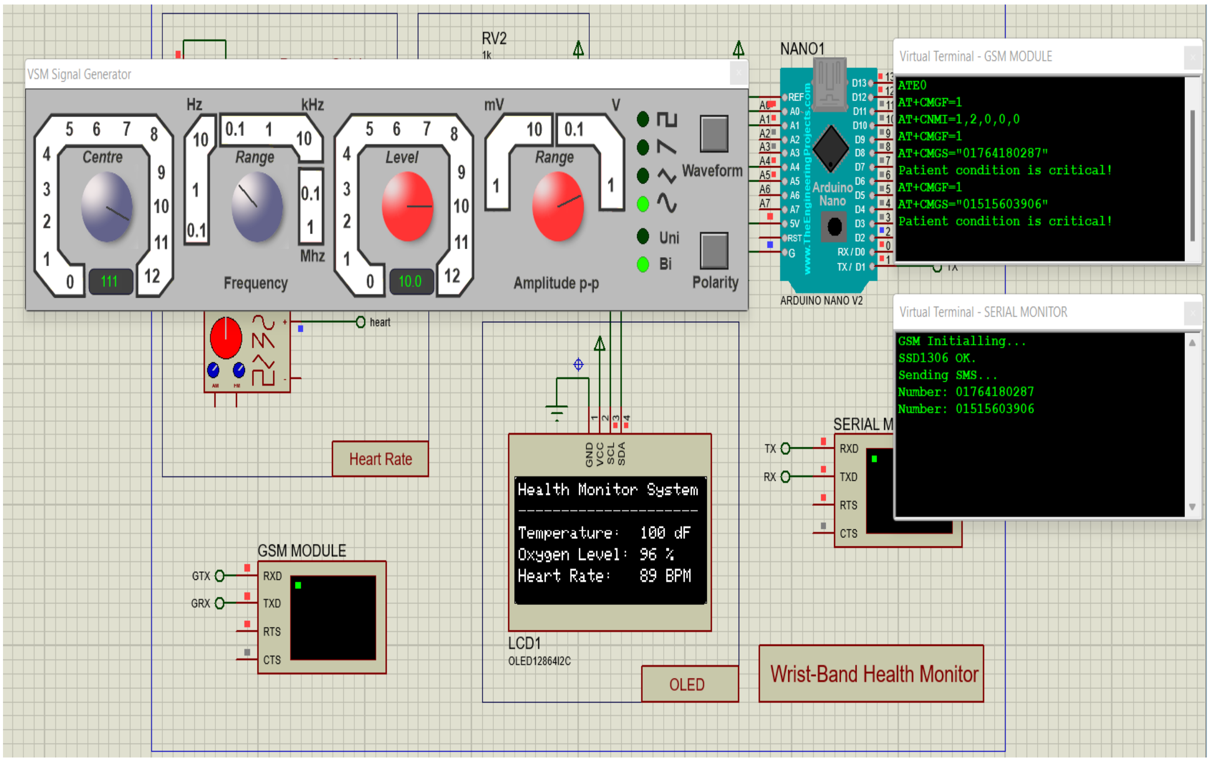

Fig 10: When T=100dF(degree fahrenheit),Oxygen Level=96%,Heart Rate=89 BPM

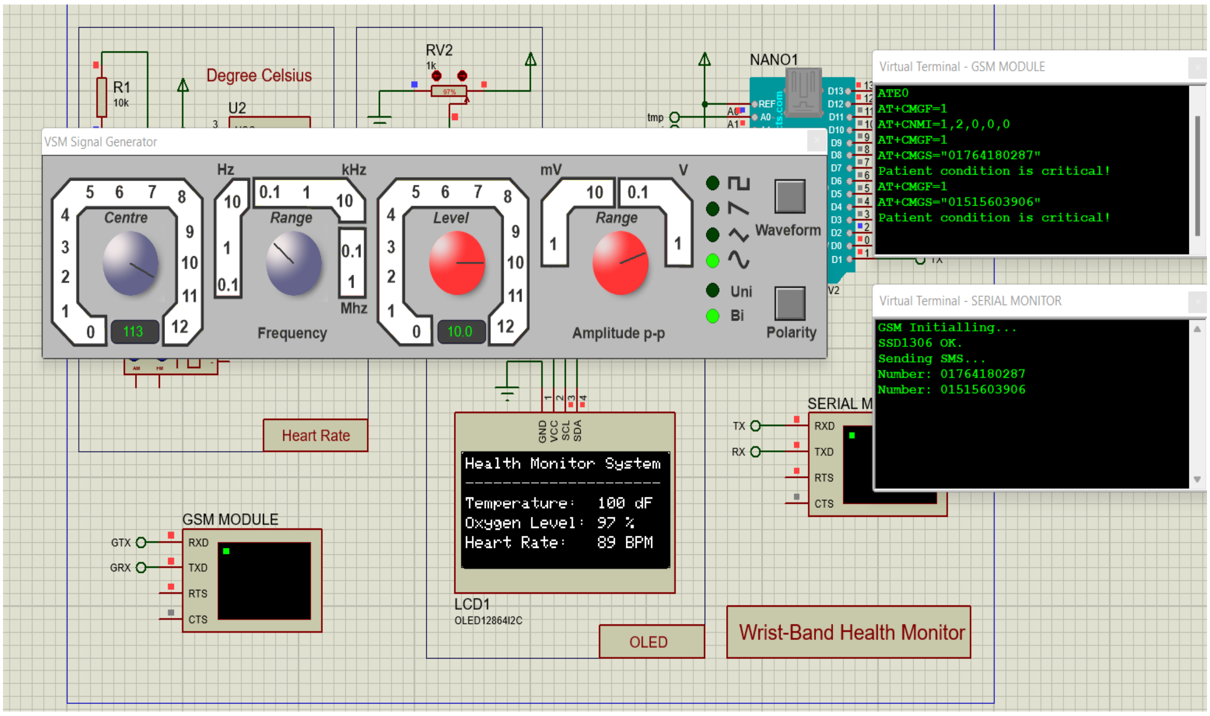

Fig 11: When T=100dF(degree fahrenheit),Oxygen Level=97%,Heart Rate=89 BPM

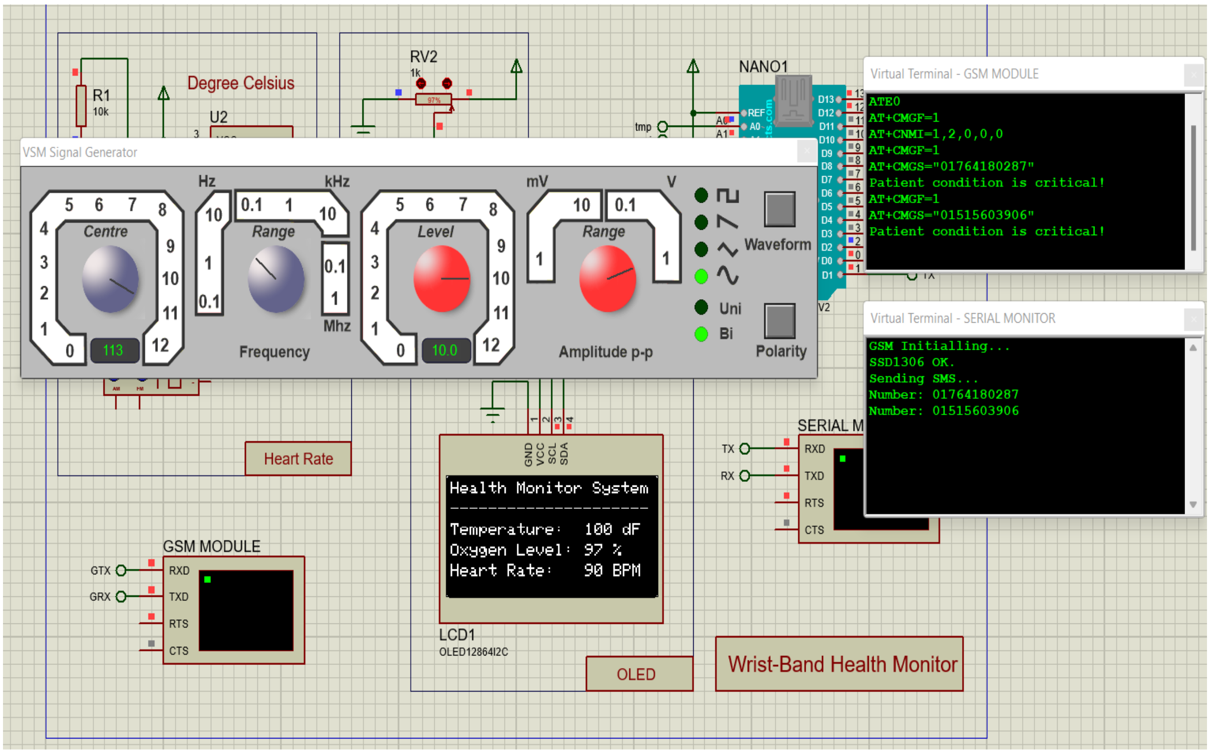

Fig 12: When T=100dF(degree fahrenheit),Oxygen Level=97%,Heart Rate=90 BPM

Table 2: Data Received From Design 1 Simulation

Time	Oxygen Level	Heart Rate	Temperature	Patient Condition
10sec	95%	84 bpm	100dF	Safe
20 sec	95%	89 bpm	100dF	“
30sec	96%	88 bpm	100dF	“
40sec	96%	89 bpm	100dF	“
50sec	97%	89 bpm	100dF	Danger
60sec	97%	90 bpm	100dF	Danger
70sec	93%	93 bpm	101dF	Danger
80sec	94%	100 bpm	102dF	“
90sec	94%	93 bpm	100dF	“

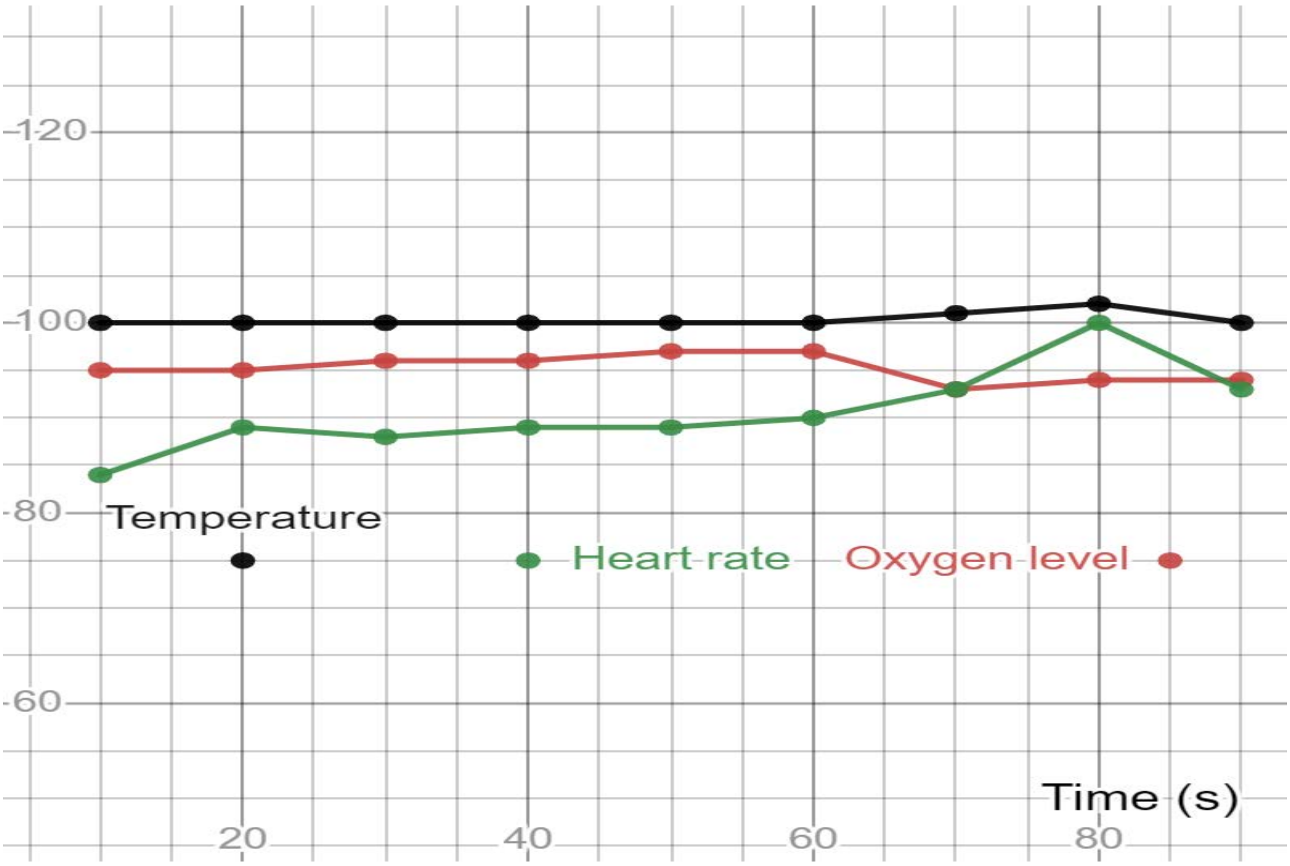

Fig 13: Graphical representation of design 1-data

System 2:
Patient Scan-Chamber:
On the other hand, if we want to view the alternate design, it is a scanning chamber where a patient must enter and scan themselves independently. If the patient is not capable of walking, the first design will work in this situation since the second one is ineffective. The scan room must be made soundproof in order for the results to be accurate. It costs more to make it soundproof than the oxy-cardio band.
Scan Chamber:
•**Efficiency:**70 percent effective at any environment and location as it needs to be soundproof.
•**Component Level Cost:** 86314.32 taka
•**Usability:** Although we manage to get 100 percent efficiency with images at day time, the system will break during the nighttime.
•**Manufacturability:** All the components are available in the market. But due to covid, Thermal camera prices increased because of a lack of production.
•**Impact:** System will not ensure the security of public data as it will capture images frequently. without everyone's concern.
•**Sustainability:** The system might be able to tackle harsh environments of disaster but the camera may get hampered or start taking blurry images after heavy rainfall or storms.
•**Maintainability:** After every month, the system needs to be updated with more image data to increase efficiency. Also, I have to check the camera is functioning properly as a standalone project, and will not be needing any update once the beginning of implementation is calibrated.
We discovered that the majority of the components we planned to employ are not there in the program after the simulation process had begun. Later, we attempted to display data by swapping out the components with other sensors as needed, followed by our simulation.

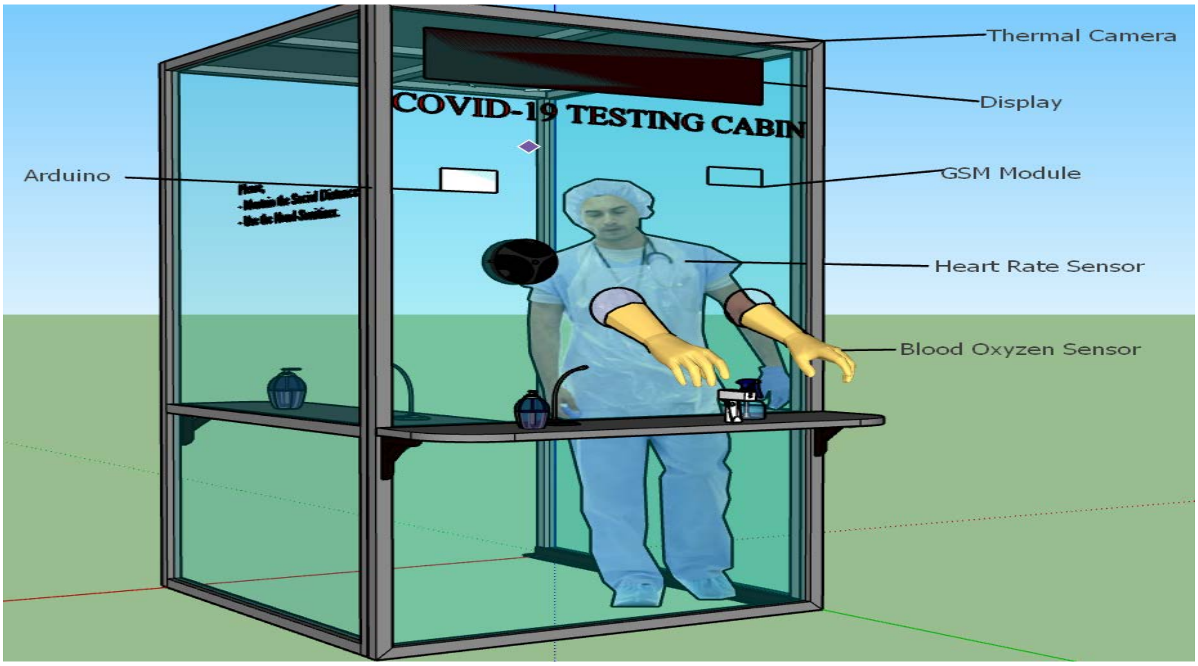

Fig 14: 3D design of Scan Chamber

Simulation Design:
After starting the simulation process we realized that most of the components we are planning to use are not available in the software. We, later on, tried to show data by replacing the components with some sensors as per need and then did our simulation.

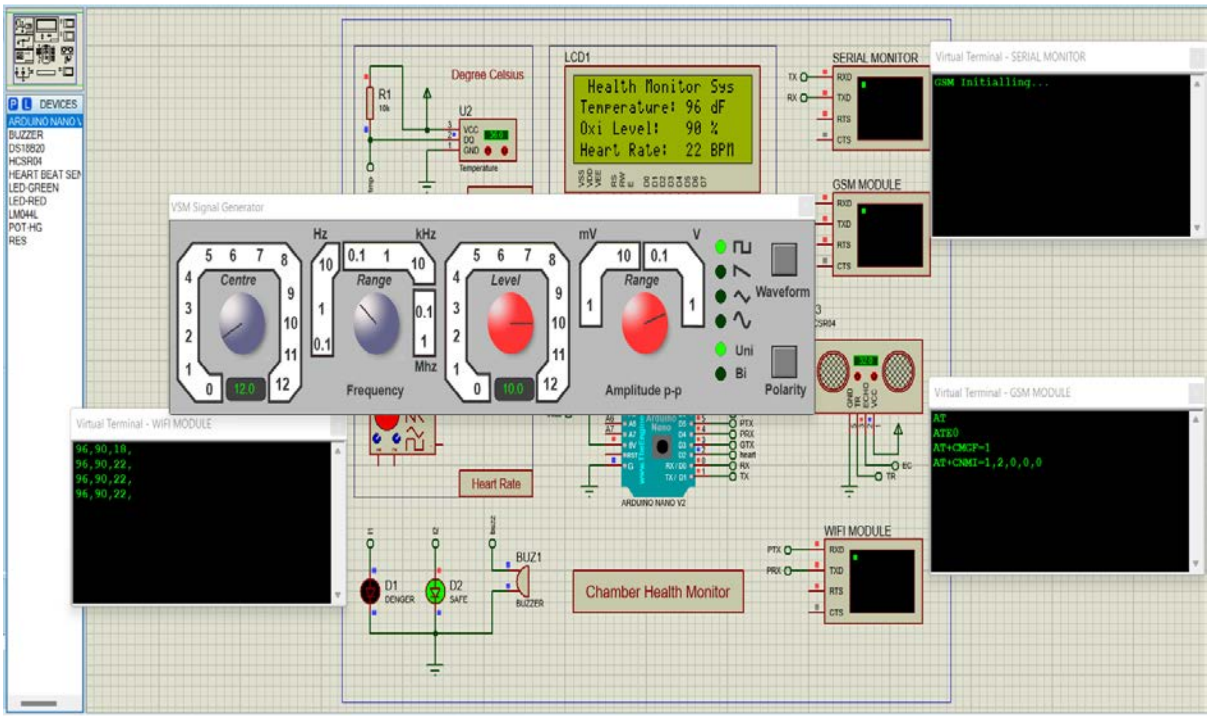

Fig 15: Proteus simulation for real-time sensors data

We have extracted some data with a 1-second delay from this design. The information is then shown in the table below, which will illustrate the patient's state when he enters the scanning chamber.This scan chamber contains a thermal camera,a oxygen sensor & a heart rate sensor.But in simulation we can not show them.That's why we only tried to show the output of the sensors compared to the real life scenario.So,like the 1st design we have added a serial monitor for heart rate input,a temperature sensor for temperature input, a oxygen level sensor & a LCD display.Also we have a buzzer & a LED here for the alert system.When the patient gets critical through the GSM module the patient & family members will get a S.M.S. His bodily characteristics are automatically detected by the scan chamber and shown on the screen. We gathered the information from the display and presented it in the table below.

Test Case for Design 2:

Our second idea is an attached scan chamber for the patient's room. The patient must pass through the chamber whenever he wants to test his bodily parameters, and then a thermal camera and touch sensors will record all of the information. A text message will be sent to the doctor and the patient's family members if anything concerning his health occurs.

Different conditions of patient at the Scan Chamber:

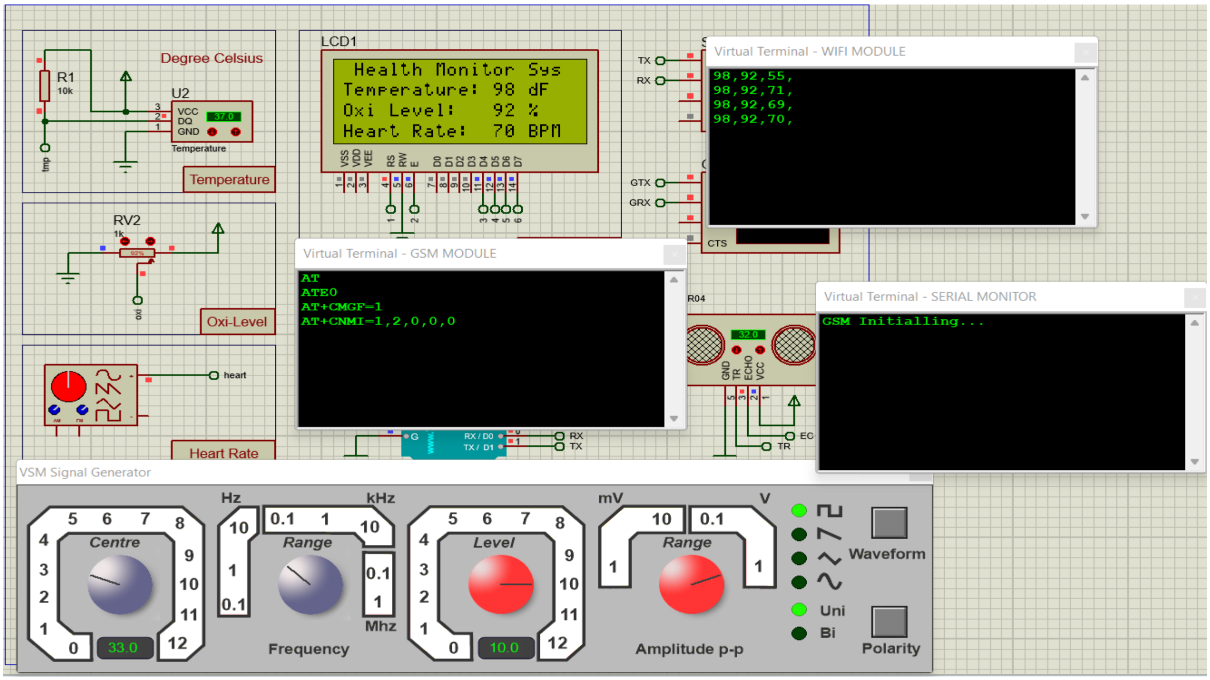

Fig 16: Data of patient at 1st second

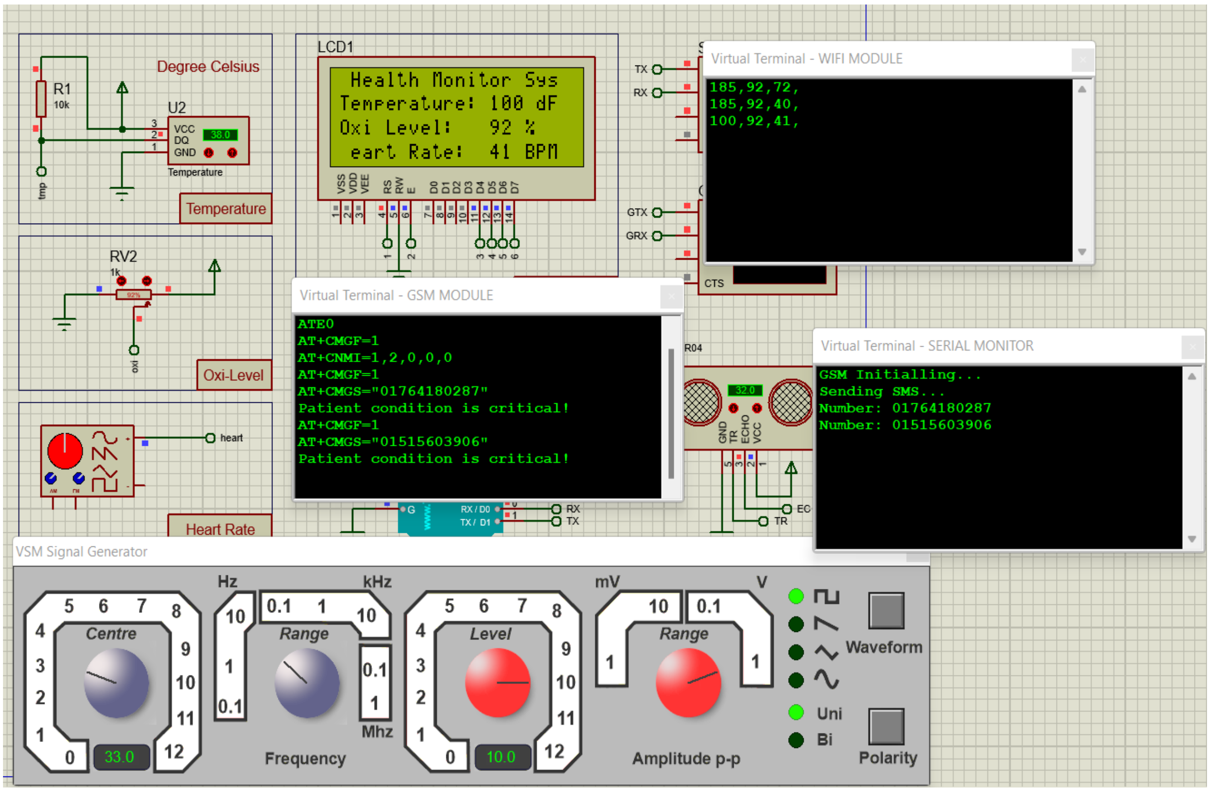

Fig 17: Data of patient at 2nd second

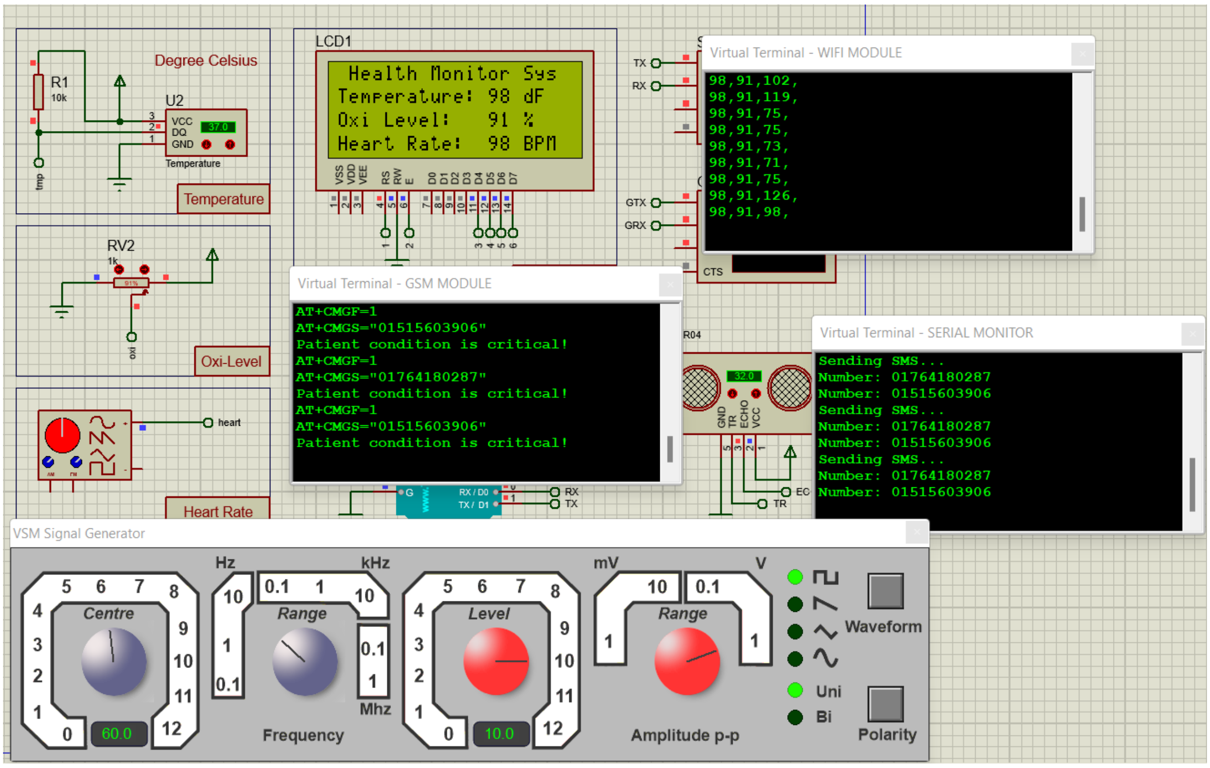

Fig 18: Data of patient at 3rd second

Table 3: DATA TABLE of Patients Body parameters in Design 2

Time Interval	Oxygen Level (%)	Heart Rate (BPM)	Temperature (dF)	Patient Condition
1sec	96	91	104	Danger
2 sec	98	91	103	Danger
3sec	98	91	101	Danger
4sec	98	91	102	Danger
5 sec	98	91	101	Danger
6sec	98	91	99	Safe
7 sec	98	91	102	Danger
8 sec	98	91	101	Danger
9Sec	98	91	102	Danger
10sec	98	91	103	Danger
11sec	98	89	99	Danger
12sec	98	89	102	Danger
13sec	98	89	103	Danger
14sec	98	89	103	Danger
15sec	98	89	101	Danger
16sec	98	89	100	Danger
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18sec	98	89	104	Danger
19sec	98	89	101	Danger
20sec	98	89	104	Danger

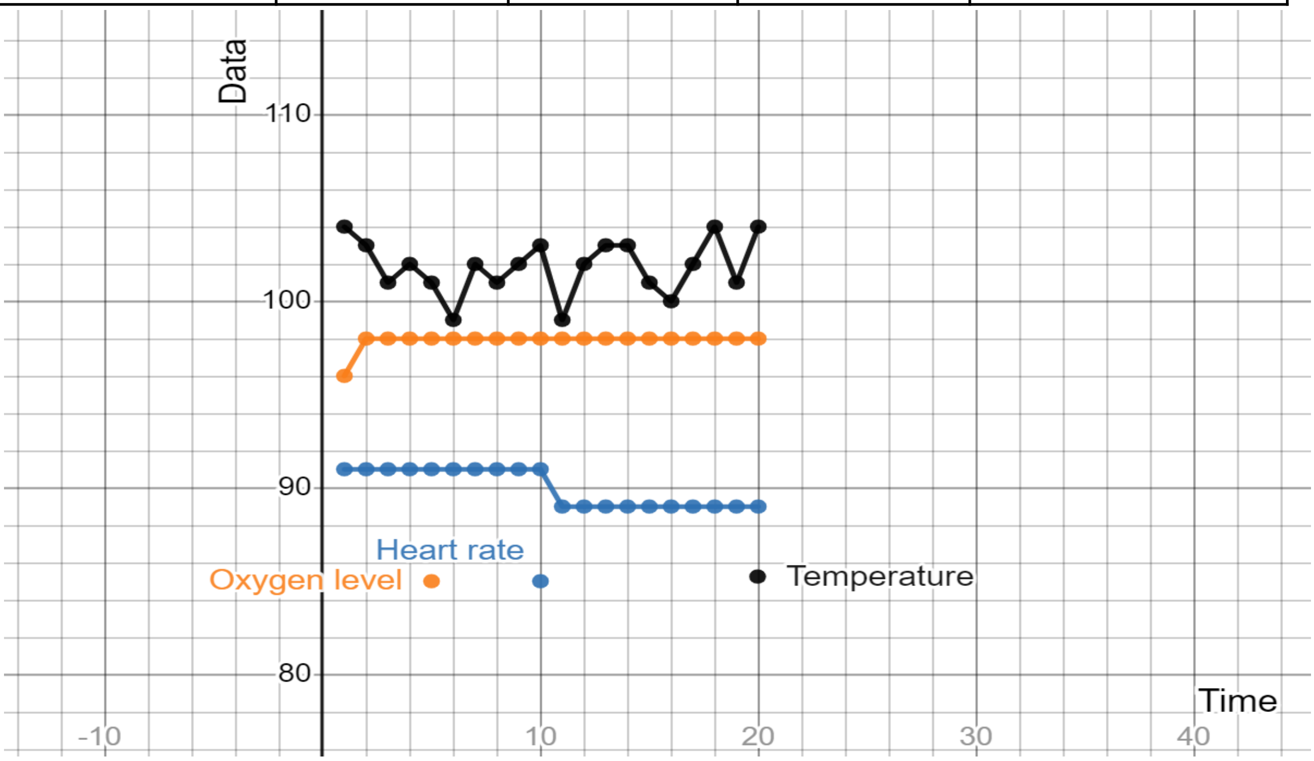

Fig 19; Graphical Representation of design-2 data

Table: Selection of optimal solution

Table: Functional verification comparison of three systems after going through simulation.

System	Oxygen level measurement	Heart Beat Measurement	Temperature measurement	Sending SMS	24 hours usable	Costly
System 1	✓	✓	✓	✓	✓	
System 2	✓	✓	✓	✓		✓

Constraints:

1.Uncomfortable: It is uncomfortable to wear as we have to monitor the patient's body for 24 hours. So, the patient has to wear that every time.

2.Space measurement of this Design: It is difficult to connect all the sensors in a small area.

3.Network Connectivity: As this design approach needs a mandatory network connectivity, if the network connection fluctuates with time then it will be a big problem for our design. As nowadays load shedding is a big issue.

4)Sensor Efficiency: As these sensors are very light,they can not give accurate results every time.

5) **3D Design Lackings:** for 3D design we didn't get exact data.

Budget:

The cost estimates for the parts came from several national and international marketing sources. Shipping and handling fees might come into play in certain circumstances. However, it is challenging for us to estimate that sum at this time. Because of this, we have worked with the projected value after consulting with patients and physicians. We looked through other marketplaces and picked the finest one based on pricing and effectiveness as determined by the physicians. If we compare the prices of the two design methods that we have presented, design approach 1 is more cost-effective and takes less equipment to set up than design approach 2.

Table 4: Budget Comparison

Budget For Design Approach 1: **Budget for design approach 2:**

Component Name	Unit	Price	Component Name	Unit	Price
Arduino Uno R3 SMD	1	738.95	UTi165K Thermal Imager	1	58,500
Pulse Oximeter Heart rate sensor MAX30100	1	298	4 In 1 Manual Treadmill with Stepper	1	16340
MLX90614 Infrared Temperature sensor	1	700	Pulse Oximeter Heart rate sensor MAX30100	1	298
3.5-inch arduino display uno	1	1480	MLX90614 Infrared Temperature sensor	1	700
SIM900 GSM GPRS shield	1	2499.2	3.5-inch arduino display uno	1	1480
Arduino Mega 2560 R3	1	5497.12	SIM900 GSM GPRS shield	1	2499.2
Miscellaneous		1000	Arduino Mega 2560 R3	1	5497.12
			Miscellaneous		1000
Total		12213.27	**Total**		86314.32

4.3 Optimal design approach:

After comparing all the analysis of the three systems through various simulation and other stated above factors, we choose **System 1: Oxy-Cardio Band.**

Table 5: Optimal Design selection

Analysis	System 1	System 2	Optimal Solution
Efficiency	More Effective	Less effective	More Effective
Component Level Cost	8176 taka	86314.32 taka	8176 taka
Usability	Reliable system	During night time, not effective system	Reliable system
Manufacturability	Components are available	Components are available	Components are available
Impact	Along other impacts, secure privacy	Not ensure privacy	Secure privacy
Sustainability	Tackle harsh environment	Might tackle harsh environment	Tackle harsh environment
Maintainability	No need of regular maintenance after installment	Model needs to be updated after every month	Model will update itself, no need of regular maintenance

Updated Budget For selected optimal design:

Table 6: Updated Budget comparison

Previous Budget			**Updated Budget**		
Component Name	**Unit**	**Price**	**Component Name**	**Unit**	**Price**
Arduino Uno R3 SMD	1	738.95	ESP8266 D1 mini controller	1	270
Pulse Oximeter Heart rate sensor MAX30100	1	298	MAX30100 Oximeter Heart Rate monitor	1	380
MLX90614 Infrared Temperature sensor	1	700	NTC103 Thermistor Temperature Sensor	1	100
3.5-inch arduino display uno	1	1480	SH1106 LCD Display	1	600
SIM900 GSM GPRS shield	1	2499.2	SIM800L GSM Module	1	500
Arduino Mega 2560 R3		5497.12	3D Printed Watch case	2	2000
			PCB Design & printing	2	2000
	1		TP4056 Lithium Battery Charger	1	50
			6DOF MPU 6050 3 axis Gyro	`1	290
			Push Button switch (2pin)	1	6
			Watch Belt	2	480
Miscellaneous		1000	Miscellaneous	1	1500
Total		12213.27/-	**Total**		8176/-

4.4 Performance evaluation of developed solution:

Design:

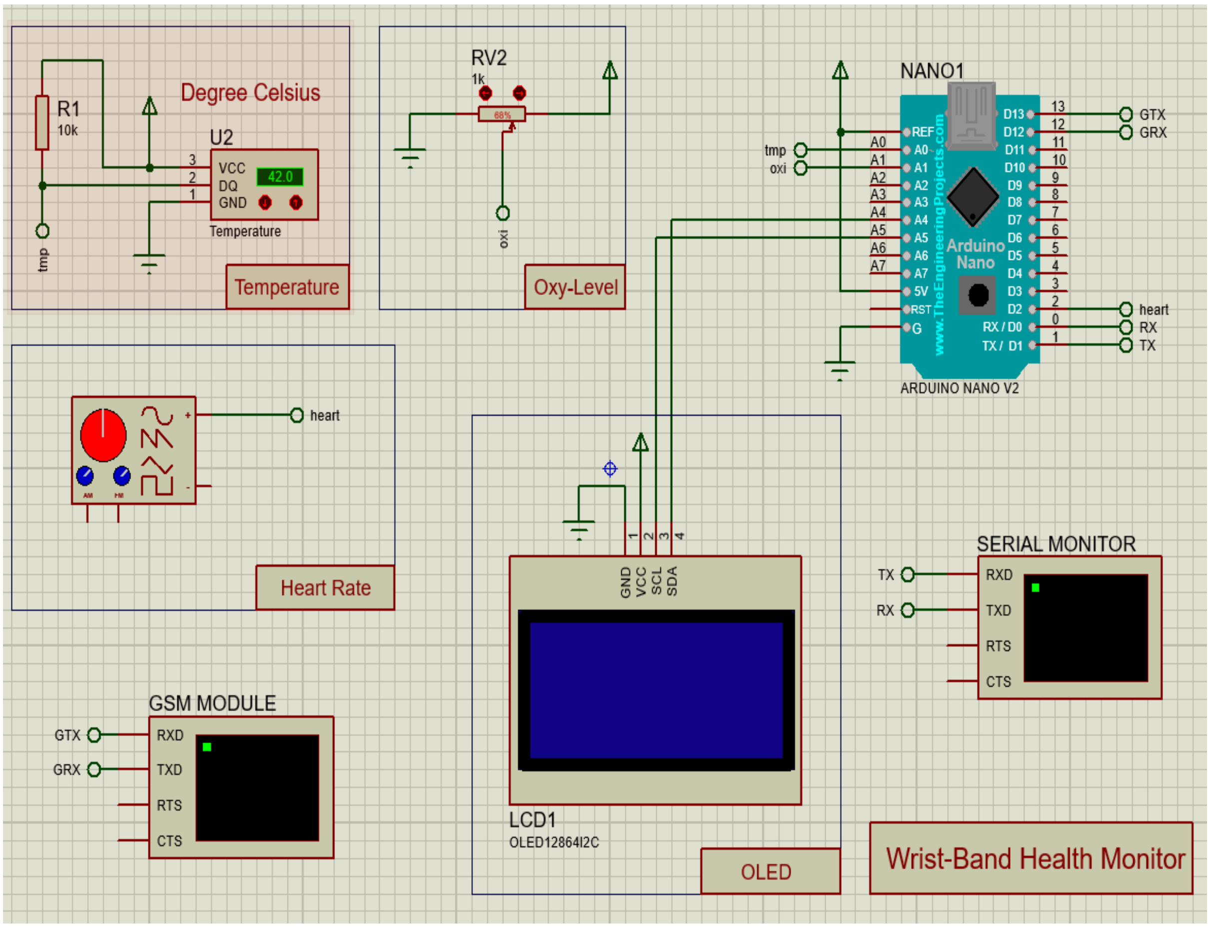

Fig 20: Simulation of selected design

Table 7: Data Received From patients

Time	Oxygen Level	Heart Rate	Temperature	Patient Condition
10sec	94%	93 bpm	99dF	Safe
20 sec	95%	95 bpm	100dF	“
30sec	94%	96 bpm	99dF	“
40sec	95%	93 bpm	100dF	“
50sec	97%	95 bpm	100dF	Danger
60sec	97%	93 bpm	100dF	Danger
70sec	94%	95 bpm	101dF	Danger
80sec	95%	100 bpm	102dF	“
90sec	95%	97 bpm	99dF	“

Test Case:

Oxygen level Comparison:

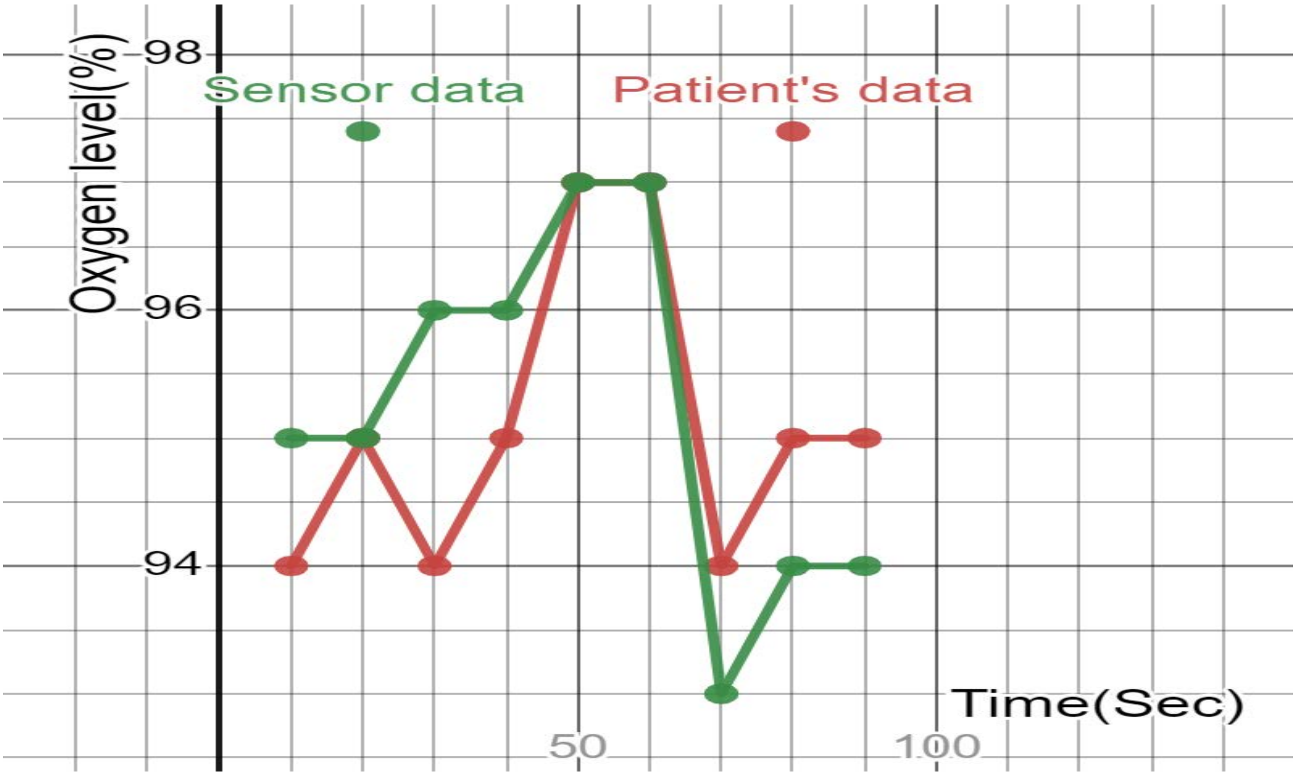

Fig 21: Comparison of Oxygen level data of selected design & patient’s data

Heart Rate comparison:

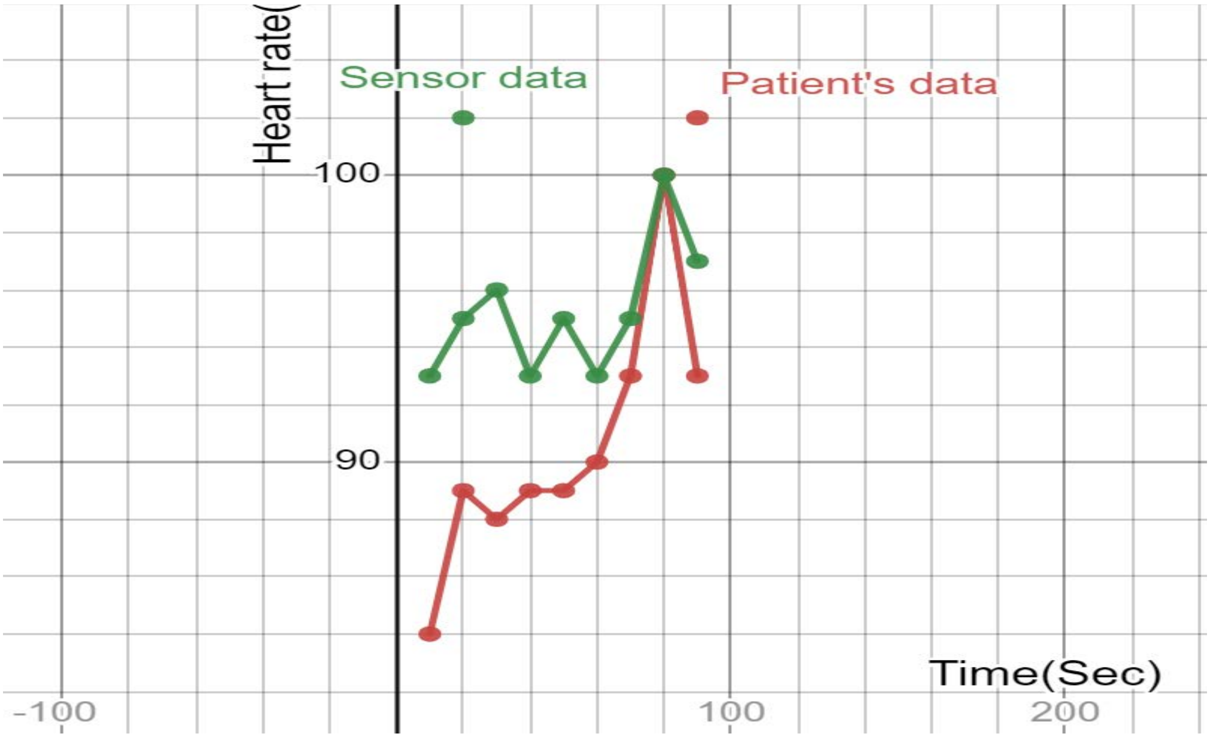

Fig 22: Comparison of Heart rate data of selected design & patient's data

Temperature Comparison:

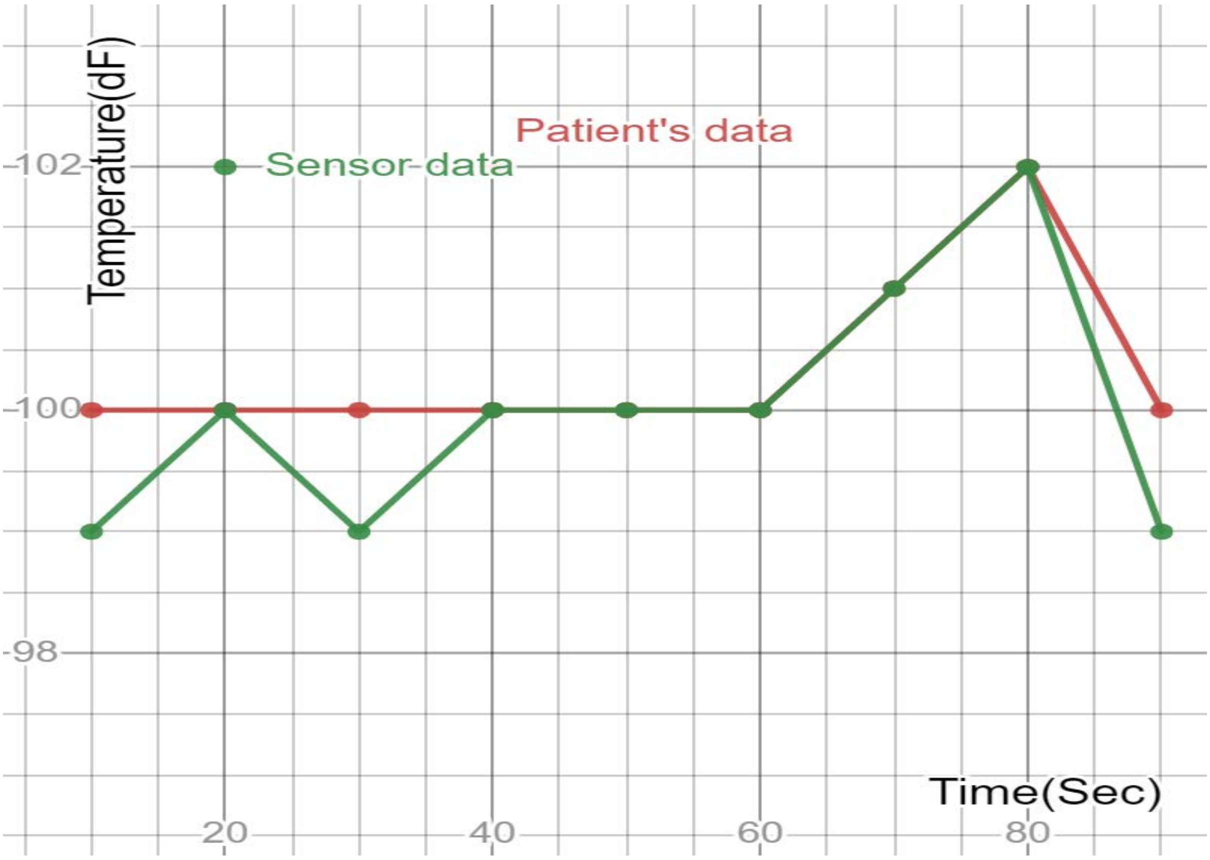

Fig 23: Comparison of temperature data of selected design & patient's data

4.5 Conclusion:

In this chapter we only work about Software simulation systems, process data as software case compared with real case. We place the components in software as we want to measure the parameters. we modified the desired code then put the Hex file in a software run simulation file then we got the result. For both design 1 & design 2 we process our code as required. simulate it and get data. In both simulation cases we consider almost 6-7 cases where 5 cases are partially accurate to the real data as measured in hospital for the patient. Then we work with a budget. calculating all the components we saw that design 1 cost me not more than 20,000 taka one the otherside cost of design 2 will cross almost 85,000 taka. though design 2 will give us far more accurate data on the other side design 1 has some limitations. but design 1 has more longevity and is easy to use. maintaining cost is very low for design 1. a patient can easily use design 1 rather than design 2. keep all the comparisons in mind and compare all the advantages and disadvantages we decide to implement design 1 because of its cost effectiveness, longevity, durability and eco friendly design.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1 Introduction:

In this chapter we focus on hardware implementation systems. chapter 4 we mention that keep all the comparisons in mind and compare all the advantages and disadvantages we decide to implement design 1 because of its cost effectiveness, longevity, durability and eco friendly design. design 1 is very much crucial to use. In this design we first find out the hardware running code like here ESP8266 D1 is the heart of this device so we figure out how to run this controller then find out how to modify the code as we need. We follow a 3D design system to make an exact clone of the design. After fulfilling all requirements we hope our project will run very well as customers require.

5.2 Completion of final design:

Design (proteus): here in the design figure we can see that MAX30100 connected with microcontroller pin 1,2 connected with pin 15 and 16 of the microcontroller. pin 3 & 4 connected with pin 11 & 12 of the microcontroller. TP4056 PIN 2 &3 connected with battery. pin 4 connected with pin 15 of the microcontroller. GSM module (sim600L) pin 2 & 3 connected with pin 9 & 10 of the controller. 1 & 4 connected with the pin 1 & 3 of MAX30100.

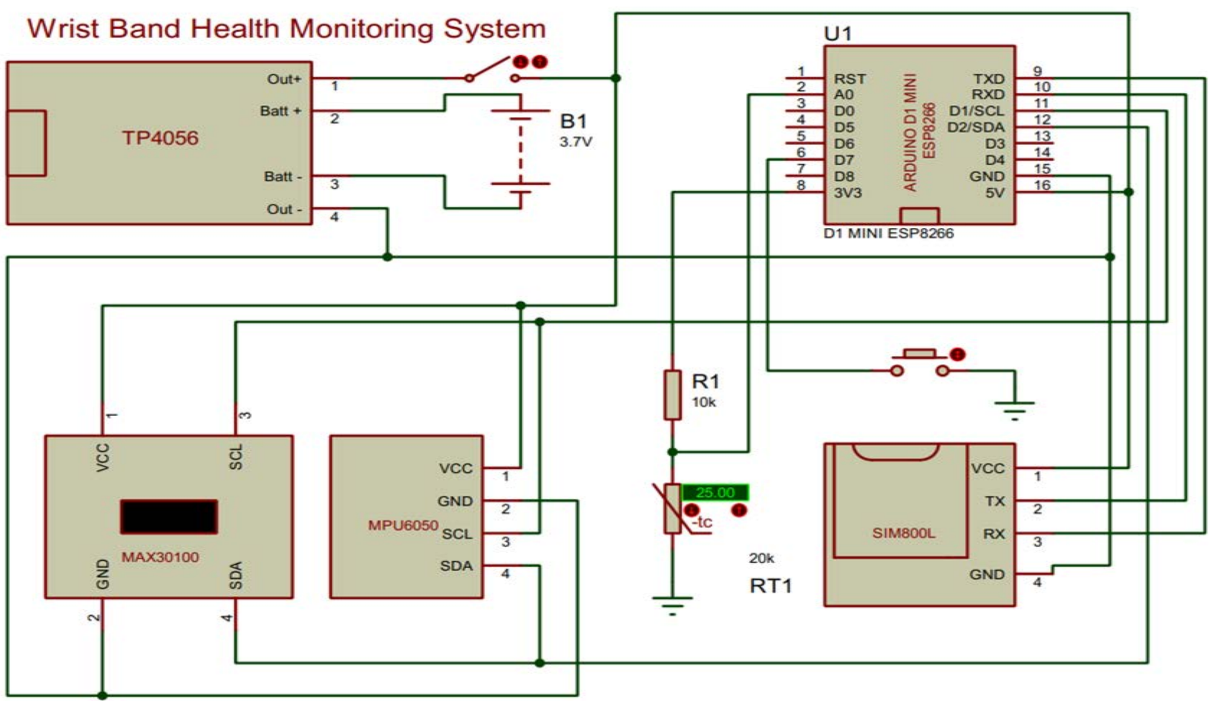

Fig 24: Circuit diagram of Hardware design

PCB design: PCB design is a hardware joining board where we join our required components with PCB. This design doesn't need to connect wire but its features work like wire. PCB design is a very important tool for our project.

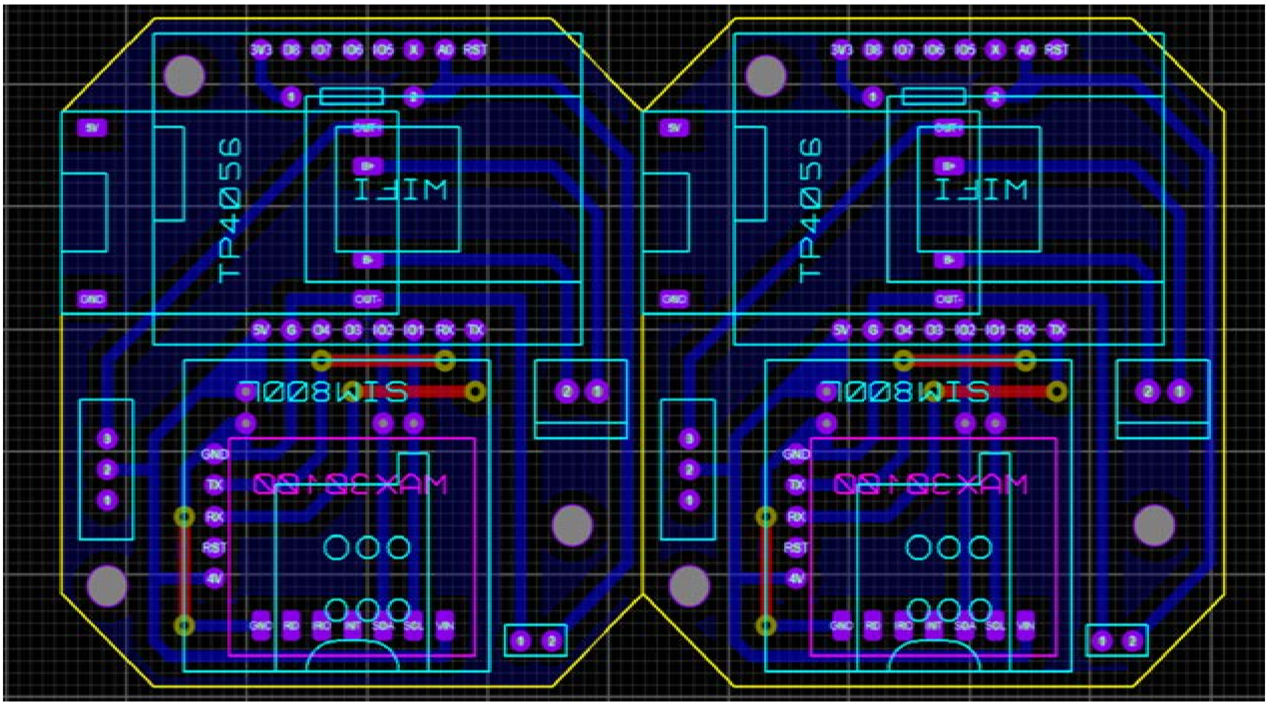

Fig 25:PCB design of hardware design

Hardware Setup:

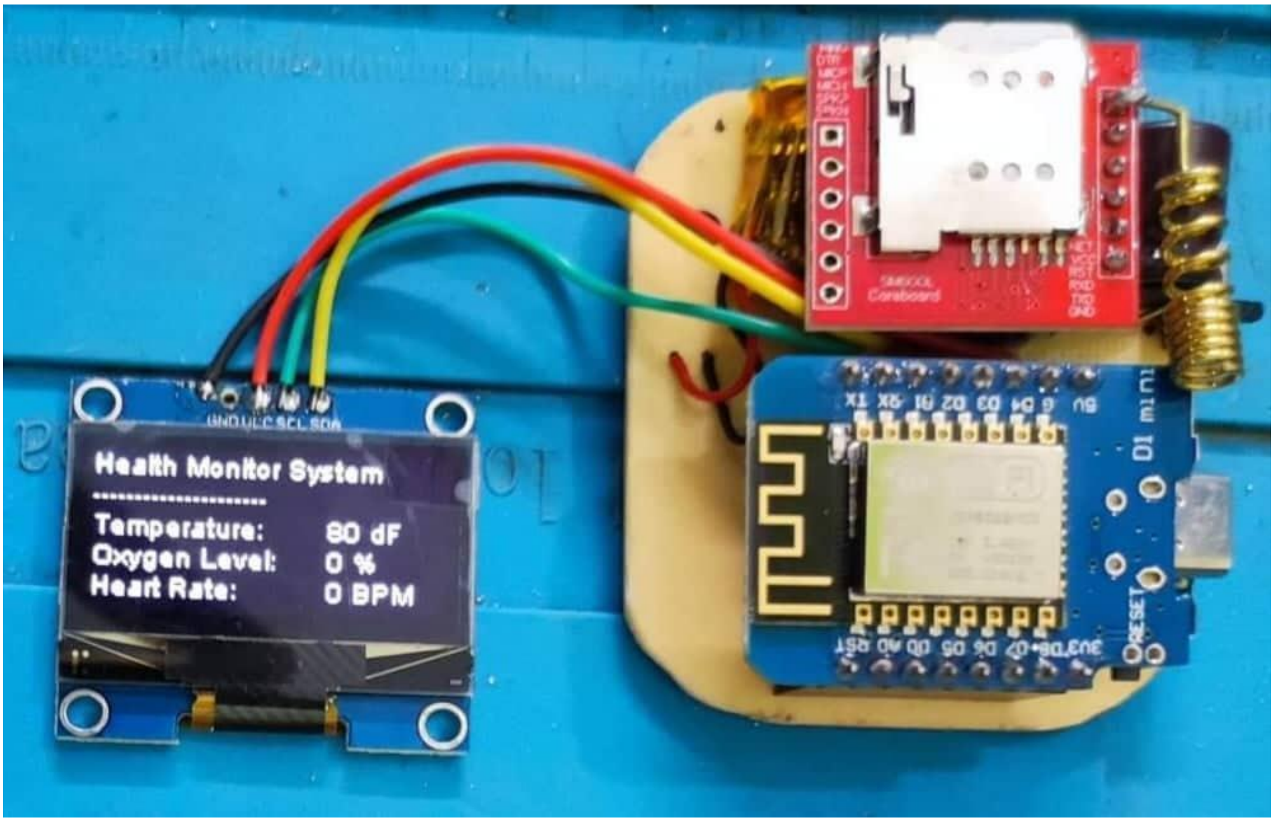

Fig 26: Hardware setup of design-1

Furnished product: The image below depicts our finished result. Here, a display that is housed in a plastic case is seen. A leather belt is attached to a plastic casing, which is worn around the wrist. Our hardware, which includes a microcontroller, GSM sim module, MAX30100 heart rate and oxygen sensor, TP4056 temperature sensor, and PCB design for wairing, is installed within the plastic enclosure. A push button can be seen on the case's body as well. Only use this button in an emergency. When a patient encounters any challenges, they can use it. We employ an accelerometer to track patients' movements within a 5-meter range.

Fig 27: Hardware design

5.3 Evaluate the solution to meet desired need:

Test Case:

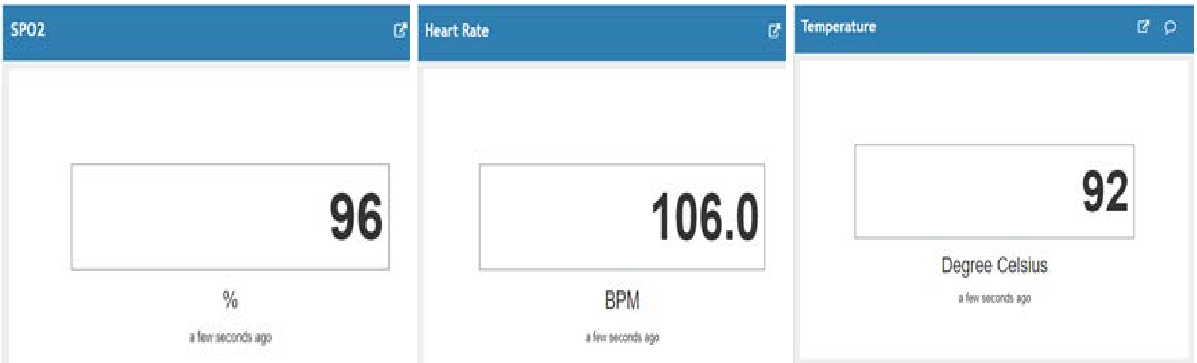

Fig 28: Data collected from the website

Fig 29: Graphical representation of sensor data from the hardware setup

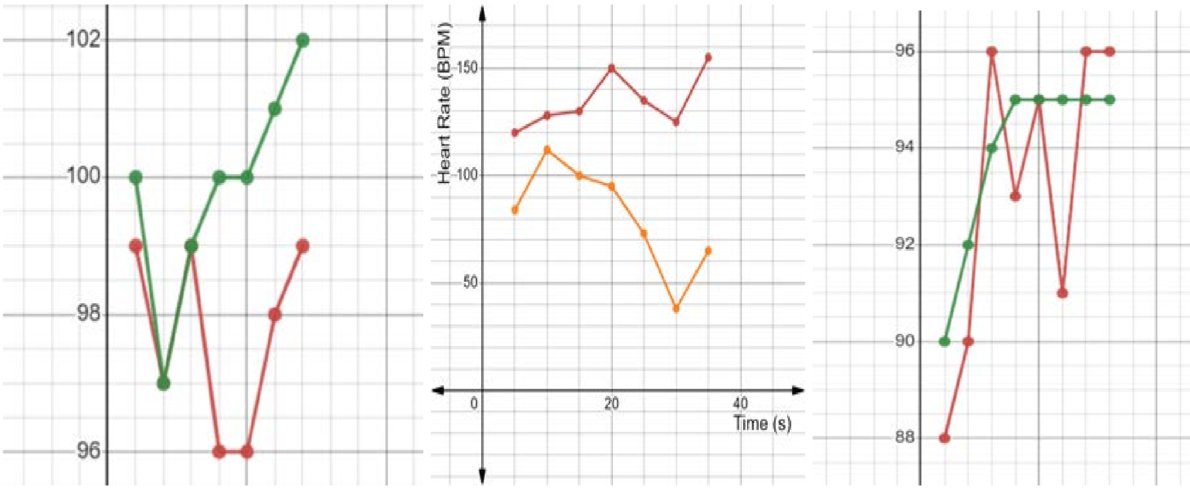

Fig 30: Comparison between the hardware and software data

5.4 Conclusion: In the end, our hardware design will provide data that is virtually exactly what our customer wants. We developed this technique to keep an eye on the patient's health. when their family members are away at work or unable to take care of them. despite the fact that most of the time we have trouble soldering components together. Hardware implementation is far more difficult than we anticipated. However, we eventually succeed in producing the intended result.

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction:

The global death toll from the COVID-19 epidemic is shocking, and the threat it poses to public health, food systems, and the economy is unparalleled. The economic and social disruption caused by the pandemic is devastating, putting tens of millions of people at risk of falling into extreme poverty and increasing the number of undernourished people, which is estimated to be nearly 690 million at the moment, by as much as 132 million by the end of the year.

Threats to the very existence of millions of businesses worldwide. There is a threat of unemployment for about half of the world's 3.3 billion workers. The bulk of workers in the informal economy lack social security, access to excellent health care, and access to productive assets, making them particularly vulnerable. As a result of being unable to provide for themselves and their family, many people go hungry during lockdowns. Most people can't afford to eat, and those who do have access to food tend to eat less of it, or food that isn't as healthy.[5]

Currently, the COVID-19 pandemic is one of the major global issues faced by health organizations. As of November 19, 2020, the total number of people worldwide confirmed to have been infected with SARS-COV-2 is more than 56.4 million, while the total number of fatalities from the coronavirus is more than 1.35 million, thereby proving that COVID-19 cases are surging worldwide.nowadays affecting rate is going down.but the after affect of the pandemic is not gone yet . The majority of COVID-19 patients ultimately recover, however according to the most recent research, 10% to 20% of patients may continue to have mid- or long-term consequences after their original sickness has passed. The term "post COVID-19 state" or "long COVID" refers to these effects' combined short- and long-term consequences. This monitoring system will help to minimize this effect as much as possible in many perspectives. So the outcomes are really important for fulfilling our desired expectations on this system.

6.2 Assess the impact of solution:

Socially: First of all our system will monitor those patients who are unable to take care of themselves and there is nobody to check his health condition from time to time. Such as measuring pulse rate, oxygen level and temperature .So we found that this is a social problem which we need to overcome. By using this device people can avoid some unwanted emergencies . like anyone who is unable to take care of his father ,mother or any older people in their family who needs a 24 hour observation ,then they can use this device.This device will send an alarming message to family members and also to the doctor if it finds any irregularity on the patient’s body. so this is how it is also building a connection among the doctor ,patient and the family. Which is a very important social need for this after the pandemic situation.

Health : It becomes increasingly vital for those people who are affected by covid 19 to undergo standard medical health checkups,especially for those who are aged people. Since it may be time-consuming and difficult for most people to get regular health checkup appointments. In this case our device is beneficial for health checkup [6]. Specifically, it is a system of physical devices that obtain and monitor the pulse rate ,oxygen level and body temperature .Not only that it also exchanges information over wireless systems without human mediation. Patients being discharged from the hospital could be ideal candidates for such an approach. Moreover, the majority of COVID-19 cases are either asymptomatic or have mild symptoms[6]. These symptoms do not always come out but gradually affect the patient's body .This system will detect the inner condition of the patient which will help to avoid a sudden loss or a sudden attack.

Safety and legality : This device is mainly designed for individual uses. It is very environmentally friendly and not risky for the user because we did not use any harmful element in these devices,we used some sensors which are safe for the patient. We also took guidance from the doctor as this is a health issue we must need proper accuracy in our system. Here, we are trying to help people to take care of their health and minimize the unwanted attacks. By this system we ensure that we don't harm any animal, environment and do not break any rules and laws which are related to healthcare developments.

Culture : We are Bangladeshi, we maintain some kind of culture in our country.our majority people are muslim and they follow muslim culture mostly.our project is mainly a monitoring based project which has less relativity with culture. If we think about monitoring, sometimes women patients need a nurse or another woman's help but with this device they have to wear this product in their wrist so they don't need any women's help to monitor or wear this thing. In their wrist It will not have any major effect on our cultural activity as it is used for health purpose.so we can say that our project is also very culturally friendly.

6.3 Evaluate sustainability:

Health and care services must be continuously improved on a global scale. Numerous healthcare organizations are working on a variety of improvement projects to help with this. Numerous attractive efforts fail to last and do not result in long-term advantages, despite the large commitment of staff time and other resources. Those leading improvement initiatives face a problem in maintaining worthwhile changes. A comprehensive evaluation of 125 studies that looked at advances in healthcare found that less than half of the initiatives continued their interventions with high levels of fidelity. Similar findings were made when program activities were reviewed; only 60% of the sites reported keeping at least one program component.[2].

Environment:

Environmental impact assessment (EIA) relies on monitoring to evaluate compliance with standards and support management alternatives. The use of indicators ensures that a monitoring program only covers the crucial factors linked to substantial environmental consequences and enhances the communication and reporting processes for monitoring. IndicAMP, an environmental post-decision monitoring program, is designed and evaluated in this article using a conceptual framework developed in accordance with EIA processes. It also covers the use of current indicator frameworks for project design and performance evaluation of environmental monitoring programs. The value of this methodology is demonstrated by a case study on coastal infrastructure.[3] this project is very much environmentally friendly. The component we are using does not extract any harmful rays to the environment.despite of that, this monitoring watch will try to keep a healthy environment and will not have any unwanted situation.

6.4 Conclusion:

Wearable technology that can gather different kinds of physiological data is becoming more and more incorporated into peoples' daily lives. Due to the growing demand for ambulatory patient monitoring, many of these gadgets in the electronic health (eHealth) sector offer remote transfer of health data. Due to prevention and early identification, this may lower the cost of care.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction:

In order to complete this project we have made some plans & strategies according to the date. Our work process of FYDP-P starts with an introduction meeting of knowing group members & selection of a research topic. According to our plan, we tried to find some topics & started our research about the topic. Then we discussed among ourselves and selected a problem statement & consulted with our ATC. Then we started to specify the problem. Then after specifying the problem, we made a design flow diagram to solve the problem. After starting to solve the problem, we faced many weaknesses of our project by analyzing the project deeply. We noted all the difficulties & weaknesses.Then we started our documentation. Then we consulted with our ATC about the documentation process. They checked our document. Then we presented our project documentation in front of the FYDP panel members.Then we changed our plan according to our time & date.Then we started designing the simulation. Then we started the testing process.Then we found out the impact of our project.Then we completed our final testing.Then we showcased our project.Then we started our documentation of the report. Then finally our ATC checked our design simulation & our documentation.

7.2 Define, plan and manage engineering project:

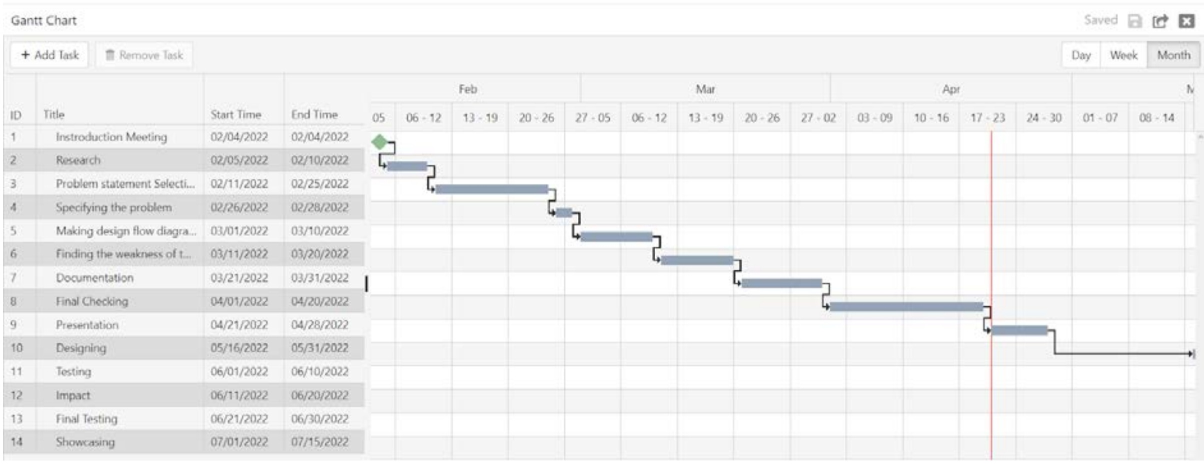

Fig 31: Previous Project plan

7.3 Evaluate project progress:

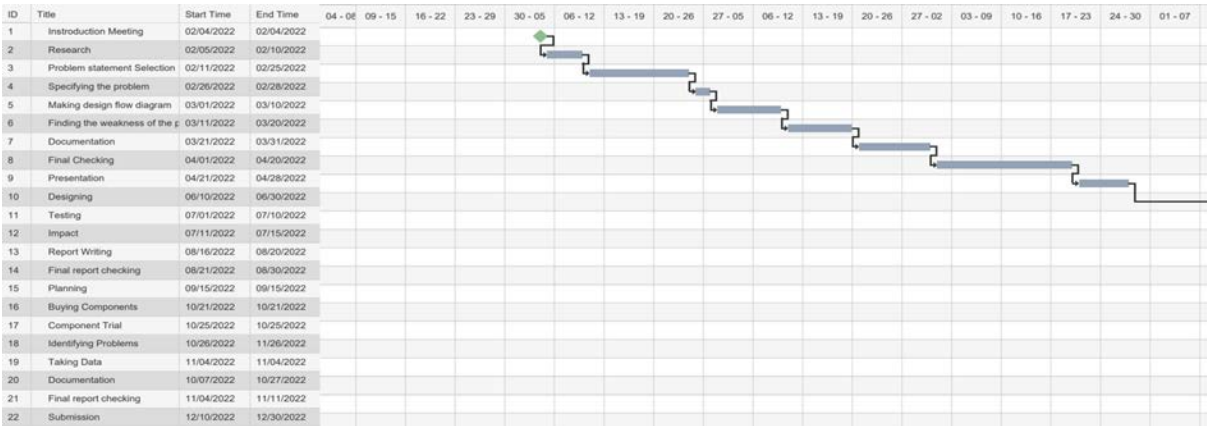

Fig 32: Revised Project Plan

7.4 Conclusion:

In this project, we made a pre-plan for completing it timely.Our previous plan was to start working at the project from 4/02/2022 and after approaching accordingly step by step,we wanted to finish the project at 15/07/2022.But as we had some complications & difficulties regarding our project we changed our plan accordingly.It took some delay in the plan.After changing our plan some new changes also came to our project plan.But finally we came a conclusion that we will conclude our project at 30/12/22 after submitting our final report of this project.Our planning contains research,analysis,problem statement selection,specifying the problem,making design flow diagram,finding the weakness of the project,documentation, presentation, document submission,designing,testing,hardware designing,hardware testing,making necessary changes according to the constraints.After making all the changes we came to the conclusion & submitted our project & final report.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction:

Wearable health devices (WHDs) are increasingly assisting people in better monitoring their health status, both at an activity/fitness level for tracking one's own health and at a medical level by giving professionals additional data with the potential for early diagnosis and treatment recommendations. A global shift in the approach to health monitoring is being brought about by the technological revolution in the shrinking of electronic devices, which makes it possible to develop wearables that are more dependable and adaptable. The state-of-the-art wearable vital signs sensing technologies, along with their system topologies and specifications, are listed in this paper's analysis of key WHDs issues.[6]According to Statista , the wearable devices market is currently having a worldwide revenue of around $26 billion, and is expected to reach almost $34 billion in 2019. Regarding healthcare and medical environments, it is expected to grow almost to $15 billion worldwide value in 2019.[5]

8.2 Economic analysis:

Economic analysis seeks to ensure that limited resources are distributed effectively and that investment benefits a nation and improves the welfare of its people.It emphasizes that analysis starts when projects are identified during country strategy studies and programming and continues iteratively throughout the project cycle. An essential component of investment appraisal is the coordination of economic analysis with institutional, financial, environmental, social, and poverty analyses.[7] After the post covid situation, people of our country are a little bit economically unstable. While making this project we only focused on ensuring peoples health issues. We tried to make a system which is helpful for people who already suffer from covid and they may have some after covid effect which is dangerous. So as i said, the economical condition of our country is not so good. We tried our level best to make this system as budget-friendly as possible. Everyone who needs it can buy it. Other than that , by making this system and marketing it on different gadget shops will also help people to better their economic condition.This does not give a big effect to society but it will do an average effect on economic perspective.

Health economics employs economic principles and methodologies to study and explain how people make decisions regarding their health behaviors and use of health care.

Full economic evaluation encompasses the examination of both costs and results and is appropriate for evaluating the efficiency of treatments. Partial evaluations can also provide useful information on the contribution of component costs to treatment costs as a whole.

Social and economic factors, such as income, education, work, neighborhood safety, and social support can considerably affect how well and how long we live. These factors affect our capacity to make healthy choices, afford medical treatment and housing, manage stress, and more.

The standard model of supply and demand taught in introductory economics is a solid example of a practical economic model. Its fundamental objective is to describe and analyze prices and quantities traded in a competitive market. [18]

8.3 Cost benefit analysis:

When choosing the appropriate method to track health program expenses, it is crucial to look at a number of cost assessments. This is applicable to small businesses, big firms, and even systems at the national level. To observe how health development and performance are impacted and to validate accountability for health programs, a solid monitoring and evaluation plan is required.There are three different cost analysis methods. The cost of the program while it is still in development is the subject of a projected cost analysis. After the program has begun, the costs are evaluated through a retrospective cost analysis. A thorough cost analysis examines the program after it has been implemented and provides more general information, such as how costs vary by populations and places, as well as program flaws relating to resource utilization and cost.[8].when we started to do the project we thought about two designs. Then we estimated the cost of those products which have significant differences from one to another. Then we chose the cheaper one and the user-friendly one for the sake of normal people. we estimated that we will need around 12 thousand to make that system.but while we were making the system we always tried to make it cheaper.but for costing we never compromise the quality.we want best quality with affordable prices.so we choose our component according to that.we always keep in our mind that how this project will cost to the normal people and how the system will affect their body.we finished our project within 8 thousand taka.

Sensor-based structural health monitoring is a very broad topic that includes a variety of projects and developments, such as the creation of cutting-edge sensors, signal processing, data analysis, and actuation and control technologies. Additionally, it embraces the idea of the accessibility of computational tools, hardware, and software resources, as well as low-cost, high-quality contributing technologies that allow for the practical realization of reliable health monitoring systems. The implementation and usage of sensor-based technologies for use in aircraft structural health monitoring are discussed in length in this study, along with additional logistical and operational aspects. The objective of this volume is to evaluate the financial effects of implementing health monitoring technology on three structures from the viewpoint of the end user. The influence on upkeep and support of these structures, both with and without health monitoring capacity, is evaluated specifically.[9]

8.4 Evaluate economic and financial aspects:

The evaluation of the financial components of the healthcare system is crucial to the monitoring of health. Both within a single nation and in terms of global comparison, the evaluation of health status and quality of life is crucial. A nation's development is influenced by its population's health and education levels. Consumption of tobacco and alcohol can have an impact on a nation's development in addition to having negative health effects such as higher mortality and having an impact on household finances economically.

Examining the financial returns to project participants (beneficiaries, project entity, institutions, and governments) is the core objective of financial analysis (FA), which aims to show that all players have sufficient financial incentives to participate. An EA is conducted to evaluate a project's effectiveness in terms of its net contribution to the national economy and welfare.Most governments and International Financing Institutions have an appraisal requirement for FEA of investment projects (IFIs). Based on a project's financial and economic viability, it offers the justification for decisions about investment finance. While IFIs and governments mandate the completion of FEAs during the project assessment stage, it is also becoming more and more recognized as a crucial tool for the identification, design, execution, and ex-post evaluation of investment programmes and projects.

8.5 Conclusion:

To demonstrate a realistic predicted return on investment to potential investors, financial analysis is used. The project's overall net benefit to society is demonstrated by the economic analysis; this is particularly intriguing in the context of public investments.

Chapter 9: [Ethics and Professional Responsibilities [CO13,CO2]]

9.1 Introduction:

There are a lot of ethical policies a researcher must follow to set a good example for the future researchers. Ethical policies ensure the legality of the research and boost the morale of involved participants and colleague.Engineers are responsible for honesty and integrity in their professional work,the confidentiality of proprietary knowledge, collegiality in mentoring and peer review, and, most importantly, the protection and health of the public, because their actions have a direct impact on society and the community. So,we need to take this part seriously as it is also an important part of doing any scientific studyhapter 10: Conclusion and Future Work.

9.2 Identify ethical issues and professional responsibility

There are several areas of ethical scrutiny in our proposed project. Because our study works only with health-related components of the human body, ethical considerations are at the top of the list of things that must be considered. Arduino, tiny batteries, and other hardware components are regularly used and available in markets for our proposed project. Proper measurements must be maintained so that various sorts of damaged parts may be checked on a regular basis. Because they are widely distributed, it is very likely that faulty products will be found on the market. We must not be stingy when using high grade materials and equipment for our project.

Our project features a mobile application from which users are able to get the notification about patient health. The data is collected into a server which must be situated in a secured place for privacy control. All the specifications to use our service must be clearly stated in a constructive Terms and Conditions Agreement. As of now our project is in the early development stage. So, we are going to provide user service by some sellers who are trusted and can give products to the remote area.

9.3 Apply ethical issues and professional responsibility

This project will be measuring several vital aspects of the human body, it will necessitate correct interaction with our gadgets. It is critical and ethical to safeguard the health and safety of those who will use this. Ethics are the guiding principles that should be followed by individuals, professionals, businesses, and governments. It is not always simple to reach an ethical consensus about what is right to do and good to be, in criminal justice systems or anyplace else, because there are many different theories of ethics held by philosophers, and these theories have quite different implications for practice in the actual world. In fact, there are two main areas of ethical consideration that are pertinent to discussions on EM.[4]

9.4 Conclusion:

The area of philosophy known as ethics is concerned with organizing, supporting, and advising conceptions of good and wrong behavior. The quality of ethics. With time, context, and environment, it might alter. Ethics must be applied with a thorough awareness of the timeline. The members of many professional engineering organizations are governed or advised by a set of codes of ethics or practices. The common themes are public welfare, sustainable development, professional competence, honesty, faithfulness, and acting honorably, responsibly, and within the law. The success of engineering projects is intimately tied to other non-engineering professions as well as the engineering profession.

Chapter 10: Conclusion and Future Work:

10.1 Project summary/Conclusion:

Outlines, key design revisions, testing data, the final budget, project validation, and the working process of the project are all included in this report, which details the implementation of a senior design project titled "Post COVID Patient Health Monitoring System." The inspiration for this research came from speaking with the relative of a 68-year-old friend who succumbed to COVID 19 in 2020 because of a lack of adequate surveillance. We all know by now that COVID 19 is a respiratory illness connected to diseases that strike key bodily systems. Influences the respiratory system the most. Post-COVID hospital mortality rates were estimated to be around 30%. When loved ones are away from home or unable to be cared for, this project might help fill the void. Spending on patient monitoring can be lowered. This study monitors three vital signs that are constantly important to track for a patient. The parameters that will be measured in this study are heart rate/pulse rate, oxygen level, and core body temperature. We started by testing the physical components in software. Correct coding is required for simulation in software trials. After making some changes to the code, we loaded the resulting Hex file into some simulation software and put it through its paces. Once we've received confirmation that the software simulation is nearly good to go, we'll double-check the codes, make any necessary changes, and load the Hex file into the simulation software known as proteus for a last run. The simulation results are more in line with the actual value of hospital-grade medical equipment. We created a 3D model before building the actual hardware to ensure that everything would fit together properly. The next phase is to actually build the hardware. Due to our lack of expertise in this area, getting all the hardware components to work together simultaneously is a major challenge for us. After everything is finished, we use a soldering iron to connect it. As often as possible once a bulb burns out, we put the components to use. Then, we have a plan B that involves a LI-on battery to prevent damage to electronic parts from overheating. Since our concept is built on wristbands, another difficulty is settling all these components in the same case so that it can fit in the wrist of a patient. We employ an ESP8266 D1 microcontroller for processing data, a SIM800L GSM module for communication, a 6DOF MPU 6050 3-axis gyroscope for tracking where a patient is in three dimensions (X, Y, and Z), a MAX30100 heart-rate and oxygen-level sensor, and an NTC 103 temperature sensor. Indicating one's core body temperature, this device The data processing system uses a local server called Tingspick to save the information. In the event of an uncertain issue, this server will process the data and notify the appropriate parties (physicians, loved ones, etc.) via the GSM sim module. For a total of 4500 tk, this project was completed using PCB design. Adding a panic button was the project's last major revision. Once we verify the accuracy of our component assembly, we try to squeeze everything into a plastic case. To make it wearable, we had to get a 3cm * 3cm * 3cm plastic case from the store and a bunch of watch straps. The next step is to use a test case. When we compare the results from the eight cases, we discover that the data from six of the cases is very close to the identical data measured in the hospital of a post-covid patient. So, it's safe to assume that this product will be of high quality and reasonable price. The overall cost of the "Post COVID Health Monitoring System - (OXY- Cardio Wristband)" is 8176 taka, made up of the project budget of 8150 taka plus an extra budget of 1500 taka. In this report we also describe our design 2 which was a scan chamber that can calculate the same parameters but different components. A thermal camera is an additional component that can calculate temperature. but design 2 has a major disadvantage which is budget issue and user manual. Lastly, we design this OXY - Cardio band as our finalized project for our final year project.

10.2 Future work:

A wearable sensor gadget invented by Vedaei can track and analyze the actions of patients. An IoT system that measures social distance might help prevent a COVID-19 sufferer from becoming sick. Three layers of IoT sensors, machine learning algorithms, and smartphone apps are utilized to monitor BP, SpO2, cough rate, and temperature daily. The frameworks specified by the authors let the users establish a safe distance between themselves and the transmission of the virus and update their information often. A distance-monitoring system based on Radio Frequency (RF) was also provided in the research, which may be used in both indoor and outdoor environments. In order to compare the findings under environmental limits, the scientists looked at two alternative conditions. Those who wrote the essay claim to have helped uncover COVID-19. [56]

To keep down on repair bills and unexpected breakdowns, health monitoring is an approach that doesn't involve destroying anything. Utilizing IoT technology, a sophisticated health monitoring system is being built to track vital signs like a person's BP, HR, O2, and body temperature. To use past events as a springboard for future progress; To provide both internal and external transparency on the allocation of resources and the output produced via those efforts; For making well-informed choices about the project's future; The goal is to give the program's recipients more control over their lives. It is possible that wearable gadgets may be used in the healthcare industry to record and store data on patients' activities and vitals in real time. Each sensor node in such a system typically consists of a radio transceiver, a slow processing unit, and limited storage space. Electrodermal activity (EDA), electrocardiography (ECG), electromyography (EMG), heart rate (HR), and respiratory rate (RR) are only some of the physiological characteristics and activities that can be measured by the sensors. [57,58,59]

The future of “Post COVID Health Monitoring System (OXY - Cardio Band)” has a huge opportunity to monitor patients from all ages especially we focus on the old aged people who are sometimes unable to move by themselves or they need someone to look after all day long. This project will solve the problem they face and will be helpful for their family members.

If this project is launched by any well known industry or company of Bangladesh then we hope that at a cheap rate people of all parts of life will buy it and get accurate data from it. Also, remote areas of Bangladesh where hospitals or doctors are not available for 24/7 those areas doctors can use this device to monitor Post COVID patients.

We actually develop a project as this is the final year project for us. More industrial development can make this project more accurate and more helpful for all human beings. After all, industrial development can make this product so popular that we can earn foreign money by exporting them abroad and so on.

Chapter 11: Identification of Complex Engineering Problems and Activities::

11.1: Attribute of complex engineering problem (EP):

	Attributes	**Put tick (√) as appropriate**
P1	Depth of knowledge required	√
P2	Range of conflicting requirements	
P3	Depth of analysis required	√
P4	Familiarity of issues	
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and needs	
P7	Interdependence	√

11.2: Provide reasoning how the project address selected attribute (EP):

Depth of knowledge: It refers to how thoroughly we must comprehend what we are learning in order to arrive at and adequately describe the solutions, conclusions, and answers. To identify our needs and answers in these projects, we required depth of knowledge from conference papers , journals, videos and other projects from the relevant industry.

Depth of analysis required: Doing an in-depth analysis is the process of investigating a subject or situation in great depth. Sometimes a new perspective on data or information is all that's needed to see previously undetected patterns or connections. Since we know so little about this area, we had to do a lot of research to learn about it.

Interdependence: This project has interdependence. For instance, though every sensor of our device measures body parameters independently still it will not work if other components fail such as if the battery is low or GSM module not working then it won't be able to send SMS or alert to the patient's family member or doctor.

11.3 Identify the attribute of complex engineering activities (EA):

	Attributes	**Put tick (√) as appropriate**
A1	Range of resource	√
A2	Level of interaction	√
A3	Innovation	
A4	Consequences for society and the environment	
A5	Familiarity	

11.4 Provide reasoning how the project address selected attribute (EA):

Range of resource: For this project,we needed to find a lot of information & data.So we had to read a lot of informations & research papers.Also we gathered data from the doctors.We also took help from google and youtube.So,our range of resource was very high.

Level of interaction: For this project,we had to interact with different people like doctors, patients, and patients' family members. In order for us to develop a high-quality health monitoring system, effective patient-doctor communication was crucial. Both the patient's and the doctor's attitudes are essential. Positive interactions foster relationship development, trust-building, and the exchange of accurate and pertinent information.

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Appendix:

Logbook:

FYDP (C) Fall/2022 Summary of Team Log Book/ Journal

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
2/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	1. Knowing deeply about FYDP-D	1. ALL	
4/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	1. Making shortlist of equipments 2. Finding specific way to connect the equipments	1. ALL	
6/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	1. Finding the way to complete the hardware design	1. ALL	
9/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	1. Buying the components	1.ALL	
15/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	1. Giving 1st week updates to ATC	1.ALL	Showed us our lackings & the way to approach efficiently
18/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Completing Hardware design simulation	1. All	

21/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Finding the problems in the design	1.All	
24/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Planning for taking data from design	All	
26/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	ATC meeting	ALl	Our approaching way was wrong. So, they told us to research more analytically & deeply.
28/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Making Rough design after more deep research	All	
30/10/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Made some changes in the design	All	
1/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Found some difficulties regarding sensors & informing the ATC	All	Told us to change the sensors & change the way of data collection
3/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Progress Presentation	ALL	Told us to compare the product with the same type of product available in the market.
8/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	ATC meeting	All	Suggested us to research more about the topic as our conception about heart rate was wrong.

12/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	Researched more about the topic	All	
15/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	ATC meeting	All	Still our conception about heart rate was wrong. So they suggested us to change our way of research.
18/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	Made necessary changes, Took data & Putting data on graph for design 1	All	
22/11/22	1. Shusmoy 2. Sayeem 3. Rashed 4.Atqiya	ATC meeting	All	Suggested us to add an accelerometer to measure the patient's movement.
25/11/22	11. Shusmoy 2. Sayeem 3. Rashed 4 .Atqiya	Added accelerometer in the design	All	
29/11/22	1. Shusmoy 2. Sayeem 3.Atqiya 4.Rashed	ATC meeting	All	Suggested us to boost up our speed of work.
3/12/22	1. Shusmoy 2. Sayeem 3. Rashed	Completed hardware design	All	
6/12/22	1. Shusmoy 2. Sayeem 3. Rashed	ATC meeting	All	Told us that our data from the hardware was wrong, so they told us to change the way of data collection.
10/12/22	1. Shusmoy 2. Sayeem	Data collection from the changes after ATC update	All	

13/12/22	1. Shusmoy 2. Sayeem	ATC meeting	All	Slide checking for the presentation & told us to add video of hardware.
15/12/22	1. Shusmoy 2. Sayeem 3. Rashed	Final presentation	All	
20/12/22	1. Shusmoy 2. Sayeem 3. Rashed	ATC meeting	All	They are not satisfied with our progress. Suggested to complete the report strongly.

Related code/theory:
Code for design 1:
Code:

```
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <SoftwareSerial.h>

const char doctor[] = "01764180287";
const char family[] = "01515603906";
const char message[] = "Patient condition is critical!";

#define bpm 2

#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64
#define SCREEN_ADDRESS 0x3C
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);
OneWire oneWire(A0);
DallasTemperature sensor(&oneWire);
SoftwareSerial gsm(12, 13);

int temp, oxi, heart, count;
bool isSent;
long prevMs;
```

```
void BPMCounter() {
  count++;
}

void setup() {
  gsm.begin(9600);
  Serial.begin(9600);
  pinMode(bpm, INPUT);
  attachInterrupt(0, BPMCounter, RISING);
  gsmInit();

  if (!display.begin(SSD1306_SWITCHCAPVCC, SCREEN_ADDRESS)) {
    Serial.println(F("SSD1306 failed!"));
    while (1);
  }
  Serial.println(F("SSD1306 OK."));
  sensor.begin();

  display.clearDisplay();
  display.setTextSize(1);
  display.setTextColor(SSD1306_WHITE);
  display.setCursor(0, 0);
  display.print(F("Health Monitor System"));
  display.setCursor(0, 12);
  display.print(F("---------------------"));
  display.setCursor(0, 24);
  display.print(F("Temperature: "));
  display.setCursor(0, 36);
  display.print(F("Oxygen Level:"));
  display.setCursor(0, 48);
  display.print(F("Heart Rate:  "));
  display.display();
  prevMs = millis();
}

void loop() {
  sensor.requestTemperatures();
  int tmpF = sensor.getTempFByIndex(0);
  if (tmpF > 0 && tmpF != DEVICE_DISCONNECTED_F) temp = tmpF;
  oxi = analogRead(A1);
  oxi = map(oxi, 0, 1023, 0, 100);

  if (temp > 100 || heart > 100 || oxi < 90) {
```

```
    if (isSent == false) {
      Serial.println(F("Sending SMS..."));
      sendSMS(doctor, message);
      sendSMS(family, message);
      isSent = true;
    }
  }
  else isSent = false;

  if (millis() - prevMs >= 500) {
    showDisplay();
    heart = count;
    count = 0;
    prevMs = millis();
  }
}

void gsmInit() {
  Serial.println(F("GSM Initialing..."));
  gsm.print(F("AT\r\n"));
  delay(100);
  gsm.print(F("ATE0\r\n"));
  delay(100);
  gsm.print(F("AT+CMGF=1\r\n"));
  delay(100);
  gsm.print(F("AT+CNMI=1,2,0,0,0\r\n"));
  delay(100);
}

void sendSMS(const char num[], const char msg[]) {
  Serial.print("Number: ");
  Serial.println(num);
  gsm.print(F("AT+CMGF=1\r\n"));
  delay(200);
  gsm.print("AT+CMGS=\"");
  gsm.print(num);
  gsm.print("\"\r\n");
  delay(200);
  gsm.print(msg);
  gsm.write(0x1A);
  gsm.print("\r\n");
  delay(300);
}
```

```
void showDisplay() {
  display.fillRect(85, 24, 43, 40, SSD1306_BLACK);
  display.setCursor(85, 24);
  display.print(temp);
  display.print(F(" dF"));
  display.setCursor(85, 36);
  display.print(oxi);
  display.print(F(" %"));
  display.setCursor(85, 48);
  display.print(heart);
  display.print(F(" BPM"));
  display.display();
}
```

Code for design 2:

Code:

```
#include <LiquidCrystal.h>
#include <SPI.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <SoftwareSerial.h>
#include <NewPing.h>

const char doctor[] = "01764180287";
const char family[] = "01515603906";
const char message[] = "Patient condition is critical!";

#define red   12
#define green 13
#define buzz  A5
#define bpm    2

LiquidCrystal lcd(6, 7, 8, 9, 10, 11);
OneWire oneWire(A0);
DallasTemperature sensor(&oneWire);
NewPing sonar(A4, A3, 200);
SoftwareSerial gsm(A2, 3);
SoftwareSerial wifi(4, 5);

int temp, oxi, heart, dist, count;
bool isSent, personDetect;
long prevMs;
```

```
void BPMCounter() {
  count++;
}

void setup() {
  gsm.begin(9600);
  wifi.begin(9600);
  Serial.begin(9600);
  lcd.begin(20, 4);
  show lcd();

  pinMode(red, OUTPUT);
  pinMode(green, OUTPUT);
  pinMode(buzz, OUTPUT);
  pinMode(bpm, INPUT);
  attachInterrupt(0, BPMCounter, RISING);

  sensor.begin();
  gsmInit();
  prevMs = millis();
}

void loop() {
  delay(50);
  dist = sonar.ping_cm();
  sensor.requestTemperatures();
  int temp = sensor.getTempFByIndex(0);
  if (tmpF > 0) temp = tmpF;
  oxi = analogRead(A1);
  oxi = map(oxi, 0, 1023, 0, 100);

  if (dist > 30 && personDetect == 0) {
    lcd.clear();
    personDetect = 1;
  }
  else if (dist < 30 && personDetect == 1) {
    lcd.clear();
    personDetect = 0;
  }

  if (personDetect == 1) {
    if (temp > 100 || heart > 100 || oxi < 90) {
      digitalWrite(red, 1);
```

```
      digitalWrite(green, 0);
      digitalWrite(buzz, 1);
      if (isSent == false) {
        Serial.println(F("Sending SMS..."));
        sendSMS(doctor, message);
        sendSMS(family, message);
        isSent = true;
      }
    }
    else {
      isSent = false;
      digitalWrite(red, 0);
      digitalWrite(green, 1);
      digitalWrite(buzz, 0);
    }
  }

  if (millis() - prevMs >= 1000) {
    heart = count;
    count = 0;
    show lcd();
    String data = (String)temp + "," + oxi + "," + heart + ",";
    wifi.println(data);
    prevMs = millis();
  }
}
void gsmInit() {
  Serial.println(F("GSM Initialing..."));
  gsm.print(F("AT\r\n"));
  delay(100);
  gsm.print(F("ATE0\r\n"));
  delay(100);
  gsm.print(F("AT+CMGF=1\r\n"));
  delay(100);
  gsm.print(F("AT+CNMI=1,2,0,0,0\r\n"));
  delay(100);
}
void sendSMS(const char num[], const char msg[]) {
  Serial.print("Number: ");
  Serial.println(num);
  gsm.print(F("AT+CMGF=1\r\n"));
  delay(200);
  gsm.print("AT+CMGS=\"");
```

```
  gsm.print(num);
  gsm.print("\"\r\n");
  delay(200);
  gsm.print(msg);
  gsm.write(0x1A);
  gsm.print("\r\n");
  delay(300);
}
void showlcd() {
  if (personDetect == 0) {
    lcd.setCursor(0, 1);
    lcd.print(F(" Health Monitor Sys"));
    lcd.setCursor(0, 2);
    lcd.print(F("Waiting for human.."));
  }
  else if (personDetect == 1) {
    lcd.setCursor(0, 0);
    lcd.print(F(" Health Monitor Sys"));
    lcd.setCursor(0, 1);
    lcd.print(F("Temperature: "));
    lcd.setCursor(0, 2);
    lcd.print(F("Oxi Level:   "));
    lcd.setCursor(0, 3);
    lcd.print(F("Heart Rate:  "));
    lcd.setCursor(13, 1);
    lcd.print(temp);
    lcd.print(F(" dF  "));
    lcd.setCursor(13, 2);
    lcd.print(oxi);
    lcd.print(F(" %  "));
    lcd.setCursor(13, 3);
    lcd.print(heart);
    lcd.print(F(" BPM  "));
  }
}
```

Hardware Code:

```
#include "SH1106.h"
#include "MAX30100_PulseOximeter.h"
#include <Adafruit_MPU6050.h>
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>

#define SAMPLE_TIME 10  // second

const char ssid[] = "Hello";
const char pass[] = "11223344";

const char doctor[] = "01621200193";
const char family[] = "01819009991";
const char message[] = "Patient condition is critical!";
const char fallMsg[] = "Patient is falling down!";

const char host[] = "http://api.thingspeak.com/update?api_key=MI3YEUPNR3ROYENF";

#define BUTT D7
SH1106 display(0x3C, SDA, SCL);
PulseOximeter pox;
Adafruit_MPU6050 mpu;
WiFiClient client;
HTTPClient http;

byte cp, sec;
double x, y, z;
double prevX, prevY, prevZ;
int temp, oxi, heart;
long tempAvg, oxiAvg, heartAvg;
int minT, maxT;
bool isSent, isFall, button;
long prevMs;

void setup() {
  Wire.begin(D2, D1);
  Serial.begin(9600);
```

```
pinMode(LED_BUILTIN, OUTPUT);
pinMode(BUTT, INPUT_PULLUP);

display.init();
display.flipScreenVertically();
display.setColor(WHITE);
display.clear();

WiFi.begin(ssid, pass);
display.drawString(0, 24, "Connecting WIFI");
display.display();
while (WiFi.status() != WL_CONNECTED) {
  delay(500);
}

display.clear();
gsmInit();
calibrateTemp();

if (!mpu.begin()) {
  display.drawString(0, 24, "MPU FAILED!");
} else {
  mpu.setHighPassFilter(MPU6050_HIGHPASS_0_63_HZ);
  mpu.setMotionDetectionThreshold(1);
  mpu.setMotionDetectionDuration(20);
  mpu.setInterruptPinLatch(true);
  mpu.setInterruptPinPolarity(true);
  mpu.setMotionInterrupt(true);
  display.drawString(0, 24, "MPU SUCCESS!");
}

if (!pox.begin()) {
  display.drawString(0, 36, "SENSOR FAILED!");
  display.display();
  delay(1500);
  ESP.restart();
} else display.drawString(0, 36, "SENSOR SUCCESS");
display.display();
delay(1500);

home();
cp = 0;
isSent = 0;
```

```
  prevMs = millis();
}

void loop() {
  ESP.wdtFeed();
  pox.update();

  if (millis() - prevMs >= 1000) {  // 1 second check
    pox.shutdown();
    heart = pox.getHeartRate();
    oxi = pox.getSpO2();
    temp = analogRead(A0);
    temp = map(temp, minT, maxT, 110, 75);  // calibrate Temp HERE
    button = digitalRead(BUTT);

    tempAvg += temp;
    heartAvg += heart;
    oxiAvg += oxi;

    if (mpu.getMotionInterruptStatus()) {
      sensors_event_t a, g, temp;
      mpu.getEvent(&a, &g, &temp);
      x = a.acceleration.x;
      y = a.acceleration.y;
      z = a.acceleration.z;

      if (prevX != x) {
        if (prevX - 5 < x || prevX + 5 > x) isFall = true;
        prevX = x;
      } else if (prevY != y) {
        if (prevY - 5 < y || prevY + 5 > y) isFall = true;
        prevY = y;
      } else if (prevZ != z) {
        if (prevZ - 5 < z || prevZ + 5 > z) isFall = true;
        prevZ = z;
      } else isFall = false;
    }

    if (button == 0 && cp == 0) cp = 1;
    if (isFall == 1 && cp == 0) cp = 1;

    sec++;
    if (sec == SAMPLE_TIME) {
```

```
      tempAvg /= SAMPLE_TIME;
      heartAvg /= SAMPLE_TIME;
      oxiAvg /= SAMPLE_TIME;

      if (tempAvg > 100 || heartAvg > 100 || (oxiAvg > 20 && oxiAvg < 90)) {
        if (cp == 0 && isSent == 0) cp = 1;
      } else if (cp == 0) isSent = 0;

      sec = 0;
      tempAvg = 0;
      heartAvg = 0;
      oxiAvg = 0;
    }

    if (isSent == 0) sendSMS();
    if (cp == 0) showDisplay();

    String link = (String)host + "&field1=" + heart;
    link += (String) "&field2=" + oxi;
    link += (String) "&field3=" + temp;
    link += (String) "&field4=" + x;
    link += (String) "&field5=" + y;
    link += (String) "&field6=" + z;
    if (http.begin(client, link.c_str())) http.GET();
    else if (http.begin(client, link.c_str())) http.GET();  // RETRY

    digitalWrite(LED_BUILTIN, !digitalRead(LED_BUILTIN));
    pox.resume();
    prevMs = millis();
  }
}

void showDisplay() {
  display.setColor(BLACK);
  display.fillRect(85, 24, 43, 40);
  display.fillRect(0, 13, 128, 10);
  display.setColor(WHITE);
  display.drawString(0, 12, (String) "X:" + x + ", Y:" + y + ", Z:" + z);
  display.drawString(85, 24, (String)temp + " dF");
  display.drawString(85, 36, (String)oxi + " %");
  display.drawString(85, 48, (String)heart + " BPM");
  display.display();
}
```

```
void home() {
  display.clear();
  display.drawString(0, 0, "Health Monitor System");
  display.drawString(0, 24, "Temperature: ");
  display.drawString(0, 36, "Oxygen Level:");
  display.drawString(0, 48, "Heart Rate:  ");
  display.display();
}

void calibrateTemp() {
  display.drawString(0, 12, "Reading Temp..");
  display.display();
  temp = 0;
  for (byte i = 0; i < 200; i++) {
    temp += analogRead(A0);
    delay(1);
  }
  temp /= 200;
  minT = temp - 80;
  maxT = temp + 50;
}

void gsmInit() {
  display.drawString(0, 0, "GSM Initiallizing..");
  display.display();
  Serial.print("AT\r\n");
  delay(200);
  Serial.print("ATE0\r\n");
  delay(200);
  Serial.print("AT+CMGF=1\r\n");
  delay(200);
  Serial.print("AT+CNMI=1,2,0,0,0\r\n");
  delay(200);
}

void sendSMS() {
  if (cp == 0) return;
  else if (cp == 1) {
    display.clear();
    display.drawString(0, 12, "SENDING SMS...");
    display.display();
    Serial.print("AT+CMGF=1\r\n");
```

```
    cp = 2;
  } else if (cp == 2) {
    display.drawString(0, 24, doctor);
    display.display();
    Serial.print("AT+CMGS=\"");
    Serial.print(doctor);
    Serial.print("\"\r\n");
    cp = 3;
  } else if (cp == 3) {
    Serial.print(message);
    Serial.write(0x1A);
    Serial.print("\r\n");
    cp = 4;
  } else if (cp == 4) cp = 5;
  else if (cp == 5) cp = 6;
  else if (cp == 6) cp = 7;
  else if (cp == 7) cp = 8;
  else if (cp == 8) {
    Serial.print("AT+CMGF=1\r\n");
    cp = 9;
  } else if (cp == 9) {
    display.drawString(0, 36, family);
    display.display();
    Serial.print("AT+CMGS=\"");
    Serial.print(family);
    Serial.print("\"\r\n");
    cp = 10;
  } else if (cp == 10) {
    isFall ? Serial.print(fallMsg) : Serial.print(message);
    Serial.write(0x1A);
    Serial.print("\r\n");
    cp = 11;
  } else if (cp == 11) cp = 12;
  else if (cp == 12) {
    cp = 0;
    isSent = 1;
    home();
  }
}
```

THANK YOU SO MUCH FOR BEING WITH US