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PROPOSAL FORM

Section A – To be filled by the student

Name : SALINI PRADHAN

Student ID : 1102181006

Program : BCE

Semester : 7

Title of Project : IOT BASED PATIENTS'S HEALTH MONITORING DEVICE USING RASPBERRY PI

Section B – To be filled by the supervisor(s)

I hereby agree to supervise the above mention student on the project, the details of which are outline above.

Main Supervisor

Name : _____ROHILAH SAHAK_____

Signature & Official Stamp : _____

Date : _____20/04/2021_____

Co- Supervisor (if applicable)

Name : __DR.AHMAD ANWAR ZAINUDDIN_____

Signature & Official Stamp : _____

Date : _____ 19/4/2021

Section C – To be filled by the FYP Coordinator

Name : _____

Signature & Official Stamp : _____

Date : _____

MANIPAL
INTERNATIONAL UNIVERSITY

IoT BASED PATIENT'S HEALTH MONITORING DEVICE USING RASPBERRY PI

SALINI PRADHAN (1102181006)

THIS PROJECT REPORT IS SUBMITTED TO FULFILL
THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF
BACHELOR OF COMPUTER ENGINEERING WITH HONOURS
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SUPERVISOR: ROHILAH SAHAK

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ABSTRACT

The ongoing supervision of a clinical trial's progress is known as health monitoring. Which is to ensure that it is carried out in accordance with policy, best clinical practice, regulatory guidelines, and standard operating procedures. Monitoring is important in an part of the health facilities. This creates an environment where the doctor and patient can interact. The doctor can also be up to date with the patient's current health status. The sensor initialization is the first part of this system. This project consists of different types of sensors like blood pressure sensor, temperature sensor, and pulse rate sensor. The sensor is then connected to the Raspberry Pi 3 Model B+ that sends a signal through the internet which allows the doctor interact with the data of the patient. All the data form the sensor is stored in a cloud database. If the sensor value is greater than the threshold sensor value and alert email is sent to the doctor and care taker; then a precaution notification is sent to the patient. The doctor and patient can interact through a user application where the doctor can even write the prescription for the patient. Due to this procedure, many patients with critical condition can be monitored and time can be saved. This project, provides a low-cost monitoring from one's home itself. This is a safe and reliable project that help different patients around the world.

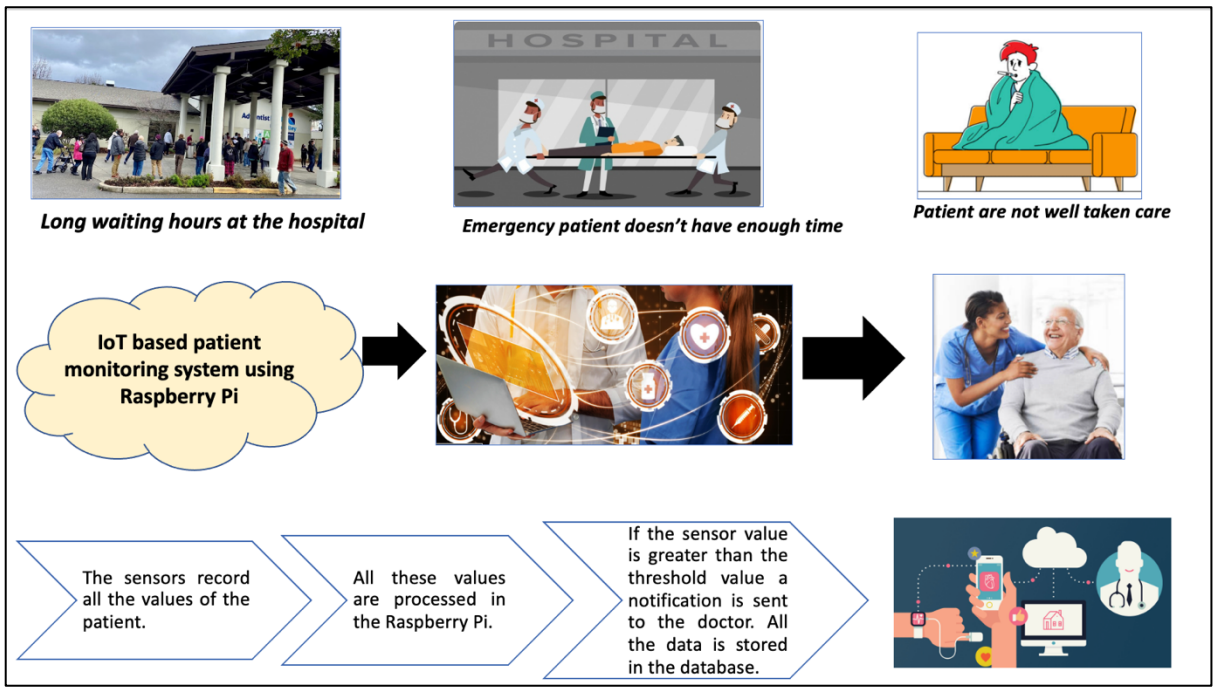

Figure 1: The Graphical Abstract of the IoT based Smart Healthcare device monitoring system.

CHAPTER 1

A. Introduction

People's desire for a better life is fundamentally linked to their health. Sadly, the global health crisis has produced a challenge due to a number of issues, including poor health services, vast inequalities between rural and urban areas, and physician and nurse shortages at critical times(Islam et al., 2020).All machines are interconnected as Internet technologies improve. We can make many things more effective and simpler for human life by advancing technology. The most up-to-date medical technology and communication techniques can assist in lowering healthcare costs(Mathivanan et al., 2018).

IoT has become increasingly important in daily life of people, and IOT technologies have advanced dramatically over the years. IoT is used to connect technology in a variety of industries, such as health monitoring, sensor networks,

artificial intelligence, smart homes, and so on, and to transmit the results. The idea behind IoT is to collect reliable data from things and communicate it effectively using existing infrastructure(Vithiya et al., 2019). Real-time analyzation is a vital of an IoT, thus the main motive of this proposed system is to establish a smart health device depending on the robust IoT tools, with the help of a microcontroller known as the Raspberry Pi Model B+ (Hamim et al., 2019).

The sensor nodes on the patient's side are to monitor the patient's symptoms(Jaiswal et al., 2017). Blood pressure, heart beat, temperature and blood oxygen are the used sensors. The data is collected by these sensors and sent to a server. The server will then process the acquired monitor data and make it available to other users, such as the cloud, doctors, and caregivers, in order to detect and monitor health issues (Jaiswal et al., 2017).

1.1. Problem Statement

When a patient visits a doctor there is always a long waiting line even in the emergency room to get checked. The developing technology has enhanced the way of the patient being treated. Most of the patients might be in a severe heart condition due to the amount of increasing pollution, eating habits etc. Each and every second are important for the heart patients. To solve this problem, health-care management technology lets clinicians take the proper measurements at the right moment on a patient's health and safeguards them from future problems(Naik & Sudarshan, 2019).

The patient uses the different sensor to measure the heart rate, blood oxygen level, blood pressure and temperature. The data collected from these sensors are stored in the cloud database. If security is not provided to go through the data by the doctor; anyone can prescribe any sort of medicine to the patient. By including security rules such as authentication by ID and password, network systems must confirm if the data created by IoT tools is only accessible by identified users(Kaur & Jasuja, 2017).So that, the patient’s life won’t be at risk.

In the previous system, patients had to go see the doctor every two days for a checkup so that the doctor could properly treat them. However, a real-time doctor is unable to assess the patient's health(Saip & Mohamed, 2018). This health monitoring system helps the patient from saving time to getting updated about his/her health status staying at home.

1.2. Research Objectives

- To implement an IoT based patient monitoring device that monitors the temperature of the body, pulse rate , and blood pressure.
- To measure the patient's pulse rate, temperature and blood pressure using Raspberry Pi.
- To store patients reading of the sensors in the cloud database using Raspberry Pi.

1.3. Scope of Study

IoT based patient's smart healthcare device, helps enhance the health of the patient by staying at home. Blood pressure, temperature, pulse rate and ECG are the sensors used.The sensor is then linked with the Raspberry Pi Model B+. The Raspberry Pi connects the reading of the patient with the database. This proposed system is detailed with its methodology and key components listed; along with its block diagram, circuit diagram and cloud computing. The flowchart of the research activity along with the project is elaborated. Then, the preliminary data is added with the budget of this project fully described. This project is then concluded with a Gantt chart for FYP 1 and FYP2.

1.4. Hypothesis

More parameters can be sensed and tracked as sensors become available or as biomedical trends evolve, dramatically improving the ability of the wireless detecting devices in biomedical field. In a graphical LCD display, the rate of change

of time can be shown with the different health variables. The healthcare device can be developed and enhanced into a small wristwatch. This device can be portable and easy to use. There can be additions of different sensor like ECG sensor, spo2 sensor, accelerometer sensor.

1.5. Research Questions

1. Explain requirements in getting an accurate reading.
2. Evaluate the possible challenges and limitations observed during the use of different kinds of sensor like heart sound, pulse rate and blood pressure.
3. Compute the message to the doctor get sent in the exact time.
4. Calculate the possible ways to have accuracy with the different measurement.
5. Explain if sensor collects the data and sends it to the cloud database.

CHAPTER 2

a. Smart Healthcare Monitoring System

In hospitals, where a patient's condition must be monitored on a frequent basis, this is normally done by doctor or other paramedical personnel who constantly monitors critical metrics including body temperature, heartbeat, and blood pressure. As a result, after some time, this task becomes tedious. Many studies have attempted to communicate patient data from a sender device to a receiver device using SMS (shot message service) with GSM (global system for mobile communications) or RF (radio-frequency) module. Furthermore, the patient's history is not provided in these circumstances; only current data is provided. So, the goal of this project is to continually monitor the data of the patient and, if the sensor value is greater than the threshold value an alert message is sent to the doctor. The Raspberry Pi links the senor with the cloud database. All the sensor data will be able to get stored in the cloud database and make it accessible from anywhere in the globe with the help of the Raspberry Pi. As a result, clinicians will be able to view the patient's medical history at any time and from anywhere. Designers will be able to monitor patients remotely via mobile or PC (Muqeet & Quadri, 2019).

As a result of our fascination with the use of IoT and the work of other researchers, we will construct a prototype to monitor the patient's health condition locally and also from a webpage that can be managed from a mobile phone or PC. In this proposed system, Raspberry Pi Model B+ was used. We can verify these values from anywhere on our Smartphone by viewing this webpage from either the Smartphone or the PC. Raspberry Pi contains Wi-Fi from within those helps to communicate with the internet and the microprocessor. The patient's data is sent to a webpage via the cloud using a Raspberry Pi 3 in this project. This program displays the current status of the patient's health whenever we open it. They kept the gear with inbuilt Wi-Fi coupled to a sensor i.e., temperature, heartbeat on patient's side. Anyone can verify these values on our Smartphones from anyplace by viewing this webpage directly from the phone. The main processor utilized in this project is the Raspberry Pi 3, and communication between the internet and our hardware is established utilizing inbuilt Wi-Fi(Muqeet & Quadri, 2019).

b. Emerging of a Smart Healthcare Monitoring System in IoT Environment

The Internet of Things enables devices to be sensed and controlled remotely through network infrastructure, resulting in Direct Interaction with sensors over network architecture, which improves system accuracy and reliability while reducing human interaction(Saip & Mohamed, 2018). As the physical world is incorporated into computer-based systems, the Internet of Things presents enormous opportunity. As a result of this integration, human engagement is decreased, efficiency is increased, and accuracy is improved. Keeping a patient under close observation and monitoring vital indicators such as pulse rate, blood pressure, and core temperature is a critical occurrence in healthcare monitoring systems (Ahmed et al., 2018).

IoT sector is progressing to cut the price and patient experience while also ensuring that patients receive appropriate medications and live a long life. Undiagnosed health risks can be handled in traditional health care with IoT, that assures medical care through keeping a unique identification for every person, lowering the risk of issues. Through connectivity in between medical sensing element and your desktop or cellphone, that can interface using your

host via configuration, decreases overall total price also minimizes time consumption (Ganesh, 2019).

c. Opportunities and Difficulties of a Smart Healthcare Monitoring System

The volume, velocity, variety, veracity, and value are frequently used for the explanation of big data. The quantity of data produced is referred as volume, while rate at which it is produced is referred to as velocity. Variety is known as the wide range of the types of data available, whereas veracity is known as the unpredictability of what types of data that may be introduced in the future. Likewise, value is known as the quantity of data that can be obtained from a huge set of data. The cloud database is beneficial for preserving enormous quantities of data in a way that allows value to be extracted. In this approach, both clinical symptoms as well as the regularity of doctor appointments were tracked in the patient's medical records. The information can subsequently be used by algorithms to evaluate the health diagnosis(Baker et al., 2017).

Cloud technologies can handle a variety of data processing tasks, but computational offloading and machine learning are the most important. Complex data processing is sent to the cloud via computational offloading, which is beyond the capabilities of reduced wearable technology. By sending raw or partially processed sensor data to the cloud, the computing capacity of multiple devices can be utilized for processing. Using such a heavy computer network rather than loading on a singular smartphone has several benefits, including the ability to run more advanced analytics, produce results much quicker, as well as lengthen mobile device power consumption due to less embedding. Complex sensor nodes that quantify Emg signal, sugar levels, or accelerometers for object tracking would benefit greatly from parallel computing unloading. ECG signal, for example, have a consistent structure, and deviations from it can indicate a variety of heart problems, such as heart failure, cardiac infection, and even heart attack.

The difficulties in Smart Healthcare Monitoring System are that IoT allows for greater flexibility, for example, if a patient requires constant care, he or she can remain

at home rather than in a hospital and be monitored on a frequent basis utilizing IoT technology. Some wearable gadgets, such as sensors, make the patient's body unpleasant(Selvaraj & Sundaravaradhan, 2020). The data transferred from the sensor to the control device and then to the monitoring center will be affected by noise, lowering the data quality. A better architecture aids in the transmission of data without compromising its integrity. The use of a noise-reduction technology can also aid to improve the data signal. The majority of available ECG monitoring methods utilize a guided signal analysis. This raises the cost, and it may result in a detection error. Machine learning can be used to analyze signals, resulting in increased efficiency and lower costs. The quantity of energy required to process sensors and devices increases as the number of them increases, leading in greater power consumption and energy leakage. Energy consumption can be reduced using an optimization process.

2.1 Literature Overview

i. *A Personal Healthcare IoT System model using Raspberry Pi 3*(Yattinahalli & Savithramma, 2018)

This project is a system that updates the cloud data and gets the location information of the area that one wants to visit. This location-based system supports patients in identifying their location and protects pollutant-sensitive clients by offering and leading them to medical centers and specialist credentials. Then, the doctor monitors the patients' health likewise patient enter his/her location. The data is updated in the cloud server every time a new patient comes.

ii. *An IoT based patient monitoring system using raspberry Pi* (Kumar & Rajasekaran, 2016)

In this project, the system measures the temperature, movement, heart beat and respiration of the patient using all the required sensor. The data is sent to the Raspberry Pi through a signal. The Microcontroller Board is programmed via the internet to monitor the health of patients. After that, all the data is collected in the web database. The doctor or any caretaker can retrieve the information from the web database.

iii. *Automatic health monitoring system using raspberry pi.* (Prabha, n.d.)

This system consists of a heart beat sensor and temperature sensor which measures the patient. This system contains Raspberry Pi B+ to store the acquired data from the patient. The retrieved data is shown in the LCD display. If the data is not in the normal range the alarm gets triggered. GSM technology is used to send the stored values to the server. The most recent data is shown in the webpage. The doctor logins with his username and password to see the patient's data. Doctors have access to all of a patient's previous medical records and can recommend medications and prescription adjustments. To access personal health history, patients are also provided a unique login credentials.

iv. *IoT Based Health Monitoring System Using Raspberry Pi* (Gutte & Vadali, 2018)

In this system, it provides technical support to improve healthcare systems in an easier and faster way. This system collects a precise physical parameter of a patient and likewise makes required data available on the internet. All the data that is taken from the sensor is stored int the database through the raspberry. The outputs are also displayed in LCD. This speeds up the diagnosis and treatment of the patient. If the patients reding is greater than the sensor threshold value. Then, an SMS alert is sent to the doctor and a precaution notification is sent to the patient.

v. *Iot Based Health Monitoring System Using Raspberry PI – Review* (Rohit & Tank, 2018)

Different sensors, including as a heartbeat, body temperature , an ECG , a blood pressure , and a patient position, are mounted to the patients in this design, and the output signal is sequentially sent to the Raspberry Pi. On the Raspberry Pi, various signals are received consecutively or concurrently. Readings are displayed in the Raspberry Pi program window, and the readings of all these sensors can be checked by a specialist via the Ports connected of a Raspberry Pi connected to the internet. The Raspberry Pi is a payment card-

sized device powered by an Embedded controller. The Raspberry Pi is a little portable laptop that could be carried with you wherever you go.

vi. *Healthcare Monitoring System and transforming Monitored data into Real time Clinical Feedback based on IoT using Raspberry Pi* (khan et al., 2019)

Personalized healthcare systems must be portable, hence compact, light, and low-power equipment should be used. This system is comprised of an affordable and usable singular minicomputer Raspberry Pi and a compact microcontroller board Arduino. Analog data is sensed by ECG and pulse sensors, whereas digital data is sensed by temperature sensors. The sensing' information obtained to the Arduino Microcontroller through its input and output interfaces, and then transferred to the Raspberry Pi through the use of the USB wire that links the two systems. A 5mp Raspberry Pi webcam which is firmly connected towards the Raspberry Pi is utilized in filming.

vii. *Smart Healthcare Monitoring System Using Raspberry Pi On Iot Platform* (Naik & Sudarshan, 2019)

In this project, the following system structure discusses the relationship between the various elements. This system is divided into two components. The hardware unit is made up of transmitters and receivers, whereas the software unit is made up of programming languages like Python and MATLAB, as well as their interfaces. In this article, we discussed some relevant IoT applications for health monitoring. The simple functioning steps of an IoT application Collecting data, processing data, storing data, and transferring data are all steps in the data collection process. Although each program may handle the initial and end steps, storage does not apply to all or even some apps.

viii. *Health monitoring systems using IoT and Raspberry Pi—A review* (Pardeshi et al., 2017)

The fundamental functioning phases of an IoT system include data collecting, data interpretation ,data storage, and data transfer. Every application has the initial and last stages, although some applications may or may not have the processing and storage stages. Information gathering includes real direct

information transmission, raw data transfer, and real-time on-board procedures. The power usage of data capture can be reduced using MEMS technology. The data sparsity trait is present in many IoT applications, allowing them to benefit from the compressed sensing paradigm. In healthcare systems and body sensor connections, compacted sensing has indeed been widely researched and investigated.

ix. *IoT-based Health Monitoring System with Medicine Remainder using Raspberry Pi* (Amru et al., 2020)

This module has pulse and temperature sensors to measure the patient's pulse and temperature separately. If each of these parameters exceeds the set value, the system sends a pre-programmed notification to the doctor via IoT. At the end of the day, he is continually analyzing the patient. This project employs the Internet of Things (IoT) idea. The crisis transition connected with the basic module accommodates the user. Should he believe he requires emergency assistance from the experts, he can pinch this switch, and the Raspberry Pi will receive the feedback and transmit the predetermined message to the specialist.

x. *Monitoring System Heartbeat and Body Temperature Using Raspberry Pi* (Sollu et al., 2018)

In this project, the patient's BPM is first read. To the Raspberry Pi, there is Serial Communication. All of the information is kept in a database and shown on an LCD panel. The Raspberry Pi retrieves the sequential information from Arduino. The Microcontroller Board was also used to capture body temperature data. Acquire a unique identifier from a transportable or desktop pc. The Raspberry Pi module holds the results of patient’s information processing as well as object tracking reports. This module is responsible for storing and transmitting patient information to mobile or smartphone devices.

Table 1 describes the literature review of the different paper. These paper all give a background research of the developed paper itself. The author's name, the title of the publication, the research design, the equipment utilized, the key findings, the study's limitations, and future research are all covered. The major discoveries, study limitations, and

research gaps are all interconnected. All the papers are analyzed critically to get the results. Table 1 emphasizes of the main points of the all the reach paper.

2.2 Literature Review

Table 1: Literature Review

S. No.	Author(s) & Year	Title of Research Paper	Variables Studied/ Research Design	Equipment/ Instruments/ Apparatus used for Experiments/Analysis/ Characterization, etc.	Important Findings	Limitations of Study	Research Gap/ Novelty of Research Study
1.	(Yattinahalli & Savithramma, 2018)	A Personal Healthcare IoT System model using Raspberry Pi 3	Availability of physician Availability of hospitals nearby	Raspberry Pi 3, Cloud computing, Internet of things	The system concept includes sensors, databases, gateway devices, medical accessibility and hospital data to help the health-related IoT network patrician.	There are no notification services available.	GSM module can be installed.
2.	(Kumar & Rajasekaran, 2016)	An IoT based patient monitoring system using raspberry Pi.	Rate of respiration of the patient Temperature of the patient Rate of heartbeat of the patient, Rate of acceleration of the patient	Raspberry Pi board Respiration Sensor Accelerometer Sensor Temperature Sensor Internet of things	Patients can record their health status in their own mobile phone and then store the information using this technology advancement.	There are no provisions for a checkup.	Check of provisions can be developed.
3.	(Naik & Sudarshan, 2019)	Smart Healthcare Monitoring System Using Raspberry Pi on Iot Platform	patient's body temperature, ECG, heart rate parameter, blood pressure, Electrical activity of the heart, Rate of movement	temperature sensor, BP sensor, heart rate sensor, an ECG sensor, acceleration sensor, raspberry Pi with GSM	A doctor can review a patient's medical history and recommend medicine and prescription adjustments. Patients with special IDs and passwords have access to their records.	Data transmission is contingent on the presence of a smartphone.	Build up a website for the data transmission.
4.	(Prabha, n.d.)	Automatic health monitoring system using raspberry pi.	Rate of respiration of the patient, Temperature of the patient,	Raspberry Pi board, Respiration sensor, Accelerometer sensor, Temperature sensor,	The alarm system, which comprises of a buzzer and LED, warns the doctors when the threshold value is reached.	There are no notification services available.	GSM module can be installed.

			Rate of heartbeat of the patient, Rate of acceleration of the patient				
5.	(Kirankumar & Prabhakaran, 2017)	Design and implementation of low-cost web based human health monitoring system using Raspberry Pi 2	Blood pressure measurement of the patient, Heart beat rate of the patient, Alcohol detection, Electrical activity of the heart	Raspberry Pi 2, Blood pressure machine, Heart beat sensor, Alcohol sensor, EMG sensor, Sound sensor, ECG sensor, Video camera	The system has two modes of operation: adult patient monitoring and infant monitoring. The acquired data can be seen locally as well as globally over the internet.	There are no notification services available.	GSM module can be installed.
6.	(Gutte & Vadali, 2018)	IoT Based Health Monitoring System Using Raspberry Pi	Heart beat rate of the patient, Temperature of the patient, Electrical activity of the heart	Temperature sensor, Pulse rate sensor, ECG sensor Raspberry Pi Module,	The suggested system uses IoT devices to monitor the health of older individuals and store the acquired data on an IoT server.	Built only for elderly people. There are no provisions for a checkup.	This can be focused on all types of patients.
7.	(Gupta et al., 2015)	Healthcare based on IoT using Raspberry Pi	Electrical activity of the heart, Heart beat rate	ECG sensor Raspberry Pi Module, GSM Module, Buzzer	If the heart rate is out of the usual range, send an SMS to the designated person via the GSM module, and notify the hospital via a buzzer sound.	Only a few parameters are being tracked.	More parameter can be added such as temperature sensor, blood pressure sensor etc.
8.	(Mehta et al., 2018)	IoT Based Patient Health Monitoring System	Temperature, ECG, Pulse Rate, Spo2 level	Heart pulse sensor, temperature sensor, ECG sensor, spo2 sensor, Raspberry Pi	Any changes in the patient's health are promptly identified, and the doctor is notified through SMS using the GSM module.	Only a few parameters are being tracked.	More parameter can be added such as accelerometer sensor , blood pressure sensor etc.
9.	(Rohit & Tank, 2018)	Iot Based Health Monitoring System Using	Electrical activity of the heart, Heart beat rate, Temperature, blood	Pulse/Heart beat sensor, ECG sensor, Body temperature sensor, Blood pressure sensor, Patient	This entire health monitoring system fits into a small compact gadget the size of a cell phone or wrist watch.	Monitoring isn't personalized for each patient.	The monitoring can be personalized to each patient.

		Raspberry PI - Review	pressure, Position of the patient	position sensor, Raspberry Pi			
10.	(Sankaran et al., 2020)	Design of IoT based Health Care Monitoring Systems using Raspberry Pi: A Review of the Latest Technologies and Limitations	Body Temperature, Fetus movement, blood pressure, Patient movement	temperature sensor, blood pressure sensor, Accelerometer sensor, fetus movement, Raspberry Pi	Sensor signals that are sent the raspberry pi can accurately check where the fetus is present at the current moment.	Only a few parameters are being tracked.	More parameter can be added such as temperature sensor, blood pressure sensor etc.
11.	(khan et al., 2019)	Healthcare Monitoring System and transforming Monitored data into Real time Clinical Feedback based on IoT using Raspberry Pi	Heart beat rate, Body Temperature, Electrical activity of the heart	Raspberry pi 2, heartbeat sensor, ECG sensor, temperature sensor, pi camera, Arduino Nano (used as ADC), Power supply, LCD, Key board, Wi-Fi Dongle	The method can be made more patient-friendly by having a video interaction between the patient and the doctor. When patient sensor data approaches abnormalities, the GSM/GPRS module can be used to generate an SMS alarm.	Monitoring isn't personalized for each patient.	The monitoring can be personalized to each patient.
12.	(Amru et al., 2020)	IoT-based Health Monitoring System with Medicine Remainder using Raspberry Pi	Heart beat rate, Body Temperature,	Heart beat sensor, temperature sensor, raspberry pi, RTC (DS1307), a buzzer and LCD monitor, APR9600, speaker and IR receptor	In regard to genius urban inhabitants, the key components of urban shrewd regions are coordinated with knowledgeable home human services, such as high-prescription, clever homeland, intelligent living, and safety.	Only a few parameters are being tracked.	More parameter can be added.
13.	(Pardeshi et al., 2017)	Health monitoring systems using IoT and Raspberry Pi—A review	Heart beat rate, Body Temperature, blood pressure, Electrical activity of the heart	temperature sensor LM-35, blood pressure sensor, heartbeat sensor, ECG sensor, raspberry pi and GSM module.	Any irregularities in the health conditions can be directly detected and communicated to the individual using GSM technology or the internet.	Data transmission is contingent on the presence of a smartphone. Notification that only goes one direction (patient to doctor).	Build up a website for the data transmission

14.	(Sollu et al., 2018)	Monitoring System Heartbeat and Body Temperature Using Raspberry Pi	Heart beat rate, Body Temperature	Heart beat sensor, Body temperature sensor, LCD display, Raspberry pi, Arduino UNO, PC	Any patient data contained in the database can be retrieved using the id number or the name of the patient.	There are no notification services available.	GSM module can be installed.
15.	(Neyja et al., 2017)	An IoT-Based E-Health Monitoring System Using ECG Signal	The path patient has travelled, Result of the ECG of the patient, Alert signal of the hospital, Electrical activity of the heart	Electrocardiogram (ECG) sensors Hidden Markov Model (HMM) Predictor Hospital alert management Patient Table Management	A system for the installation of the IoT ecosystem to allow an ECG signal to be monitored in instantaneously and foreseen in the following path for the patient with CVD.	Only a few parameters are being tracked.	More parameter can be added such as temperature sensor, blood pressure sensor etc.
16.	(Rahman et al., 2019)	IoT Based Patient Monitoring System Using ECG Sensor	Heart beat rate, Body Temperature	Raspberry Pi 3 Model B, Raspberry Pi Camera Module, Arduino Uno, 20x4 LCD display, temperature sensor, pulse rate sensor	Unless the ECG signals or temperature measurements exceed or fall below target value, the system will send an electronic text message to the physicians or families.	Hardly a few metrics are monitored.	More parameter can be added such as ECG sensor, blood pressure sensor etc.
17.	(Vineetha et al., 2020)	A real time IoT based patient Health monitoring system Using machine learning algorithms	Heart beat rate, Body Temperature, humidity detector, bomb detector, rate of acceleration	temperature sensor, humidity sensor, pulse sensor ECG module GPS module LoRa WAN module bomb detector, accelerometer, Zig Bee module, raspberry pi	It is highly beneficial for armed troops during conflicts and rescue operations because it may be used without a network.	Limited checkups available.	This system can be modified into full body monitoring system.
18.	(Ganesh, 2019)	Health Monitoring System using	Blood pressure, heart sound, pulse rate	Heart beat sensor, Heart sound sensor, blood pressure sensor, raspberry	The system provides efficient medical care for patients, and the	Only a few parameters are being tracked.	More parameter can be added such as temperature sensor, ECG sensor etc.

		Raspberry Pi and IOT		pi 3 Model B, Pi camera, Monitor	information gathered is networked globally via the internet, which are then linked to cloud storage, so that doctors may use this data to provide a prompt and efficient solution.		
19.	(Hamim et al., 2019)	IoT Based Remote Health Monitoring System for Patients and Elderly People	Heart beat rate of the patient, Temperature of the patient, Galvanic Skin Response (GSR)	Heart beat sensor, Body temperature sensor, Galvanic Skin Response (GSR) sensor, Raspberry Pi, Arduino Uno	The goal of this project was to create a long-term solution. Patients can use a continuous patient monitoring system.	Hardly a few metrics are monitored.	A larger number sensors, such as respiration rate, might be integrated monitor, blood sugar detector, and heart rate detector
20.	(Jaiswal et al., 2017)	IoT-cloud based framework for patient's data collection in smart healthcare system using raspberry-pi	Temperature of the patient, Electrical activity of the heart, Blood pressure	Raspberry Pi, Electrocardiogram (ECG) sensors, Body temperature sensor	Our present study is focused on how information is connected with an IoT-based public health system that used a Raspberry Pi and a Docker container.	There are no notification services available.	GSM module can be installed.
21.	(Kaur & Jasuja, 2017)	Health monitoring based on IoT using Raspberry PI	Temperature of the patient, Heart beat rate of the patient	Body temperature sensor, Heart beat sensors, Raspberry Pi, Arduino UNO, Node-RED, MQTT protocol	This platform employs a single-board minicomputer Raspberry Pi with IBM Bluemix cloud, as well as the MQTT protocol for dependable applications.	Limited checkups available.	This system can be modified into full body monitoring system.
22.	(Mathivanan et al., 2018)	IoT based continuous monitoring of cardiac patients using Raspberry Pi	Heart beat rate of the patient, Electrical activity of the heart	ECG sensor, Heart beat sensors, Raspberry Pi, Arduino UNO	By utilizing data analytics, it creates potential and improves the quality of care provided by providing modern technology.	Hardly a few metrics are monitored.	A larger number sensors, such as respiration rate, might be integrated monitor, blood sugar detector, and EEG detector

23.	(Saip & Mohamed, 2018)	Smart Health Monitoring and Controlling using Raspberry Pi	Heart beat rate of the patient, Temperature of the patient, Blood pressure	Body temperature sensor, Heart beat sensors, Blood pressure sensor, Arduino Uno, Bluetooth module, Motor driver, Raspberry Pi,	The system receives information from the patient such as temperature, blood pressure, and pulse rate and displays it on the GUI.	There are no notification services available.	GSM module can be installed.
24.	(Muqeet & Quadri, 2019)	IoT based Patient Monitoring System Using Raspberry Pi	Heart beat rate of the patient, Temperature of the patient	Raspberry Pi 3 Microprocessor, PIC Microcontroller (PIC16F72), Heartbeat sensor, Temperature sensor (LM35), LCD with the driver board, Power supply adapter	This system is to constantly monitor patient data and, if necessary, to issue an emergency button, utilizing various technology such as the Internet of Things (IoT)	The programming language is not that advanced programming interface. Hardly a few metrics are monitored.	This intelligent operation can be carried out with the help of the Embedded LINUX programming language. In the future, we may be able to integrate a variety of many other health-related sensors, such as ECG and EMG sensors.
25.	(Yadavalli et al., 2020)	Secured IoT Based Health Monitoring System	Respiratory tracker, Electrical activity of the heart, Heart beat rate of the patient, fall detection tracker	Respiratory sensor, ECG Sensor, Heartbeat sensor, fall detection sensor, Raspberry Pi, GSM kit	Data security is offered, and this technology can be installed in clinics, allowing for large amounts of data to also be acquired and safeguarded in a cloud-based system.	Data transmission is contingent on the presence of a smartphone. Notification that only goes one direction (patient to doctor).	Build up a website for the data transmission
26.	(Vithiya et al., 2019)	Detection, Monitoring and Tracking of Survivors under Critical Condition Using Raspberry-Pi	Pulse rate, Temperature of the patient, Gas detection, tracking the GPS	Heartbeat sensor, GP sensor, Gas sensor, Arduino controller, Bluetooth module, Body temperature sensor, Raspberry Pi 3	This system is sensing the temperature, heartbeat, and neighboring dangerous chemicals in the nearby region, as well as the soldiers' precise address, and presenting the situation on either a web page	Limited checkups available.	This system can be modified into full body monitoring system.
27.	(Singh et al., n.d.)	IoT Based Health Monitoring System for Persons with	Temperature of the patient, Pulse rate, uses microscopic metal discs to monitor electrical activity in the brain	Arduino Uno, Temperature sensor, LM35 Pulse sensor, EEG sensor, Bluetooth	The mentally handicapped patients should be monitored on a regular basis, and their loved ones should be kept up to date	There are no notification services available.	GSM module can be installed.

		Intellectual Disabilities		module HC 05, Raspberry Pi 3	on their health state while they are at work.		
28.	(Chakravorty et al., 2018)	IoT Based Patient Guidance System using Raspberry Pi	Temperature of the patient, Electrical activity of the heart, Blood pressure, pulse rate	Raspberry Pi 3, Electrocardiogram (ECG) sensors, Body temperature sensor, one touch switch, LCD display,	It is to create a close to zero, reduced, dependable, non-intrusive, as well as non-invasive heart rhythm monitoring that receives and analyzes sensor results to discover if it is within such a "normal" range and transmits such data to the user's cell phone utilizing.	There are no notification services available.	GSM module can be installed.
29.	(Pandey & Chinnamuthu, 2018)	IOT Based Patient Monitoring System utilizing Raspberry Pi and Web-Page	Temperature of the patient, Electrical activity of the heart, Blood pressure	Raspberry Pi 3, Electrocardiogram (ECG) sensors, Body temperature sensor, Temperature sensor, GPRS Module, LCD display, Buzzer alarm,	This is an auto-running mode architecture, we should not be using Linux OS to run the application. All we should do is connect the Raspberry Pi to electricity, and it will restart at a certain time. Insert the SIM card further into GSM module then activate the component's capability.	Hardly a few metrics are monitored.	Include additional factors for screening not just the patient's health but also the Satisfaction with Life Index, such as EEG (Electro-encephalogram), stickiness sensors, and richness checking sensors.
30.	(Mathew & Abubeker, 2017)	IoT based Real Time Patient Monitoring and Analysis using Raspberry Pi 3	Temperature of the patient, Electrical activity of the heart, Blood pressure	Raspberry Pi 3, Electrocardiogram (ECG) sensors, Body temperature sensor, Temperature sensor, GSM Module-SIM 800C	Those parameters can be accessed and diagnosed by a health professional everywhere in the world. Whether there is any modification in all these parameters, a notification should be sent to the pre-defined number as well.	Data transmission is contingent on the presence of a smartphone. Notification that only goes one direction (patient to doctor).	Build up a website for the data transmission

CHAPTER 3

3.1. Description of Methodology

This section explains the research methodology that has been used for this project. The initial task of an IoT based smart healthcare monitoring system, according to the workflow, is to collect data from patients via sensors. Temperature, ECG, blood pressure, and heartbeat rate are examples of health parameters. Low-power sensors are placed in such systems. They gather information from patients on a regular basis. The health state of a particular patient is observed using this often-collected data, and necessary medicines are given. This data is displayed on a Raspberry Pi board-connected LCD display, and if necessary, it is processed before being transferred to an IoT server for storage, from which it is accessible to the system's intended clients. As a result, this system is based on the client-server model of computer networking. The data acquired on the IoT server is saved for all peers in the system's reference and delivered to them as needed(Gutte & Vadali, 2018). Figure 2 shows how the Smart Healtcare system works with the basic steps.These steps are implemented to develop this Smart Helaathcare Device using Raspberry Pi.

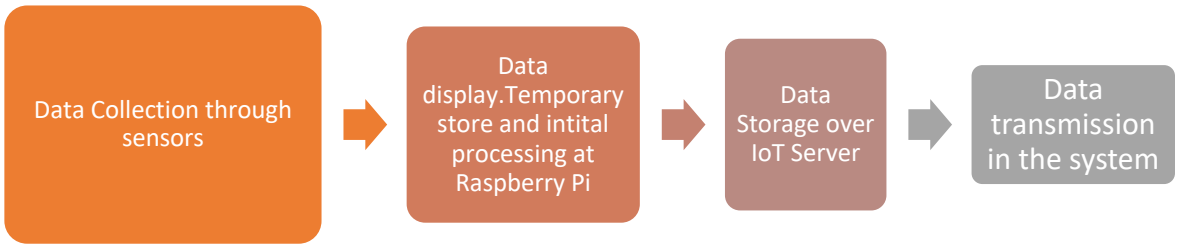

Figure2: The basic outline of the proposed system

As illustrated in Figure 2, the suggested system is made up of three primary blocks. Instruments such as a temperature detector, a blood pressure detector, an ECG detector and a detector for the pulse rate collecting patient information. One block of the Raspberry Pi model includes built-in wireless connectivity and no additional Wi-Fi module is required. This side collects data and sends it to the IoT server. The total system's data is stored on the IoT server. That data is accessible to doctors, who can use it to obtain patient information and write appropriate prescriptions.

The design process for this system has been depicted in Figure 2. This indicates that if the value of the sensor is higher than the value, a notification will be sent via the user application to the physician and the caregiver and the physician and caregiver is even sending an alert message. The value is entered in the database using the Raspberry pi if the sensor result is below the predefined threshold; the data can be retrieved through the user application by logging in with the user authentication by the doctor or the patient. The doctor will be able to write the prescription by going through the data and make changes if necessary.

The software tools that will be used are RASPBIAN OS, Python language, embedded c language and WiringPi. This will help us in interacting with the Raspberry Pi, getting the data stored in the database and sending alert messages to the doctor as well as the care taker.

Figure 3 shows the flow chart of the smart health care device using Raspberry Pi.Firstly ,all the sensors are intialialized. The read sensors are then transferred to the Micro Controller. Whereas if sensor value is higher, then perhaps the threshold value; patient and caregiver will receive an alert notification. All the associated sensor value is then stored in the database stored. An application can collect all the data.The doctor can write a prescription for the patient .The patient can follow up with this information.

Figure 4 shows an outline of the system itself with the connection of temperature senor ,blood presure senor and heartbeat sensor.This is connected to th raspberry pi nthe output is shown in the LCD display.All the sensor values are stored in the databse through the internet.The doctor and the patient can retrive this information through an duser authentication.The cloud storage is built in that stores all the information of the senor values.

Figure 5 shows the circuit diagram of the Smart Healthcare Device using Raspberry Pi. All of the sensors attached to the Raspberry Pi have this network design. The 16*2 LCD display shows all data.

Figure 6 shows how th cloud storage works with microcontroller.Firstly all the data is collected from the sensor values then proccesed in to the rapberry pi microcontroller.Then ,tis microcontroller sends signal via wriresless transcievrs into the computer.The raspberry pi can be connected to the internet directly.All the data is stored in the computer.The patient and the doctor can access in information through the GSM (Global System for Mobile Communications) signal. The GSM MODEM(Modulator-Demodulator) sends the GSM signal to the doctor and the patient.

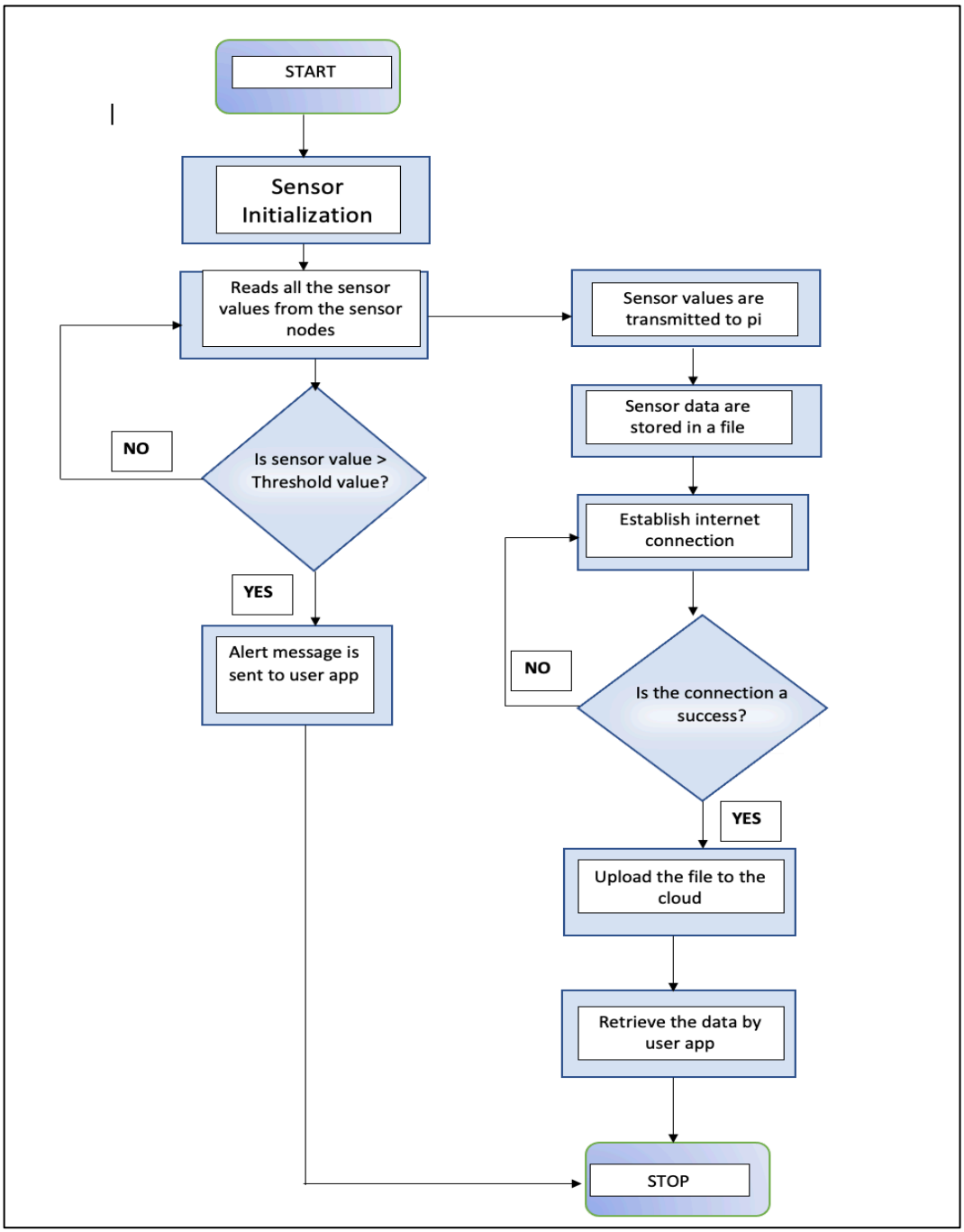

Figure 3: Flowchart of The Smart Healthcare Monitoring Device

a. Block Diagram

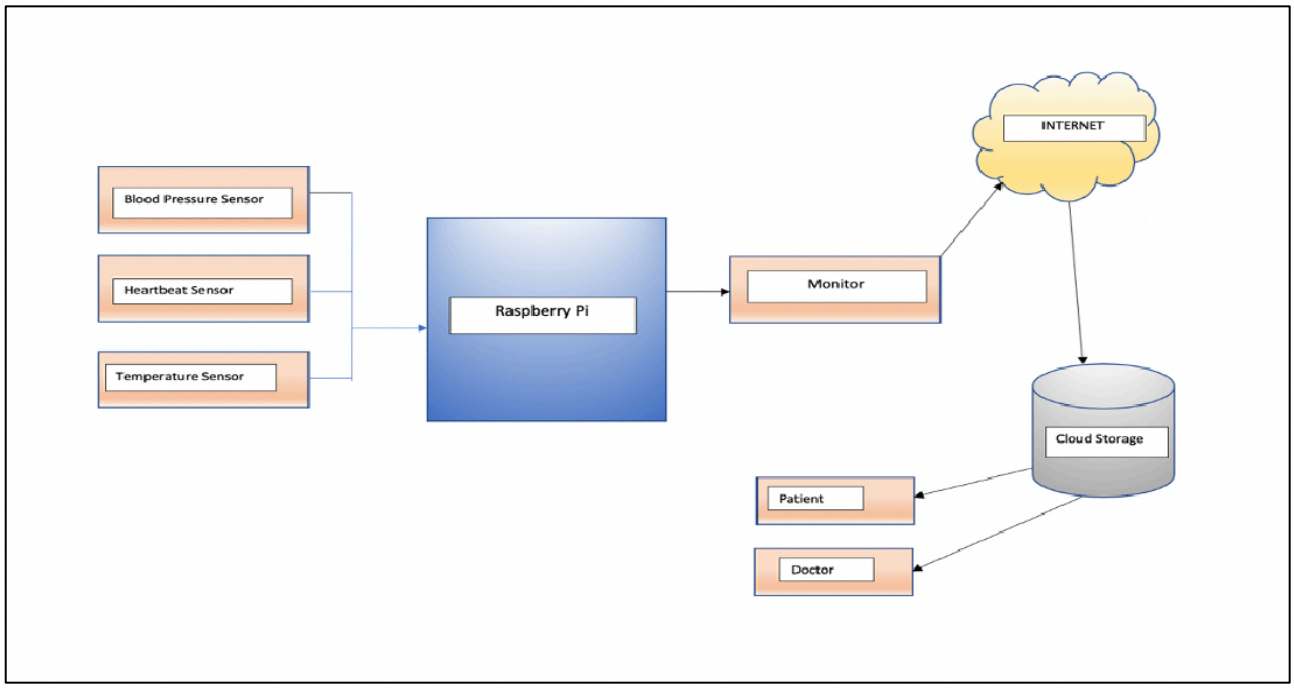

Figure 4: Smart Healthcare Device Block Diagram

b. Circuit diagram

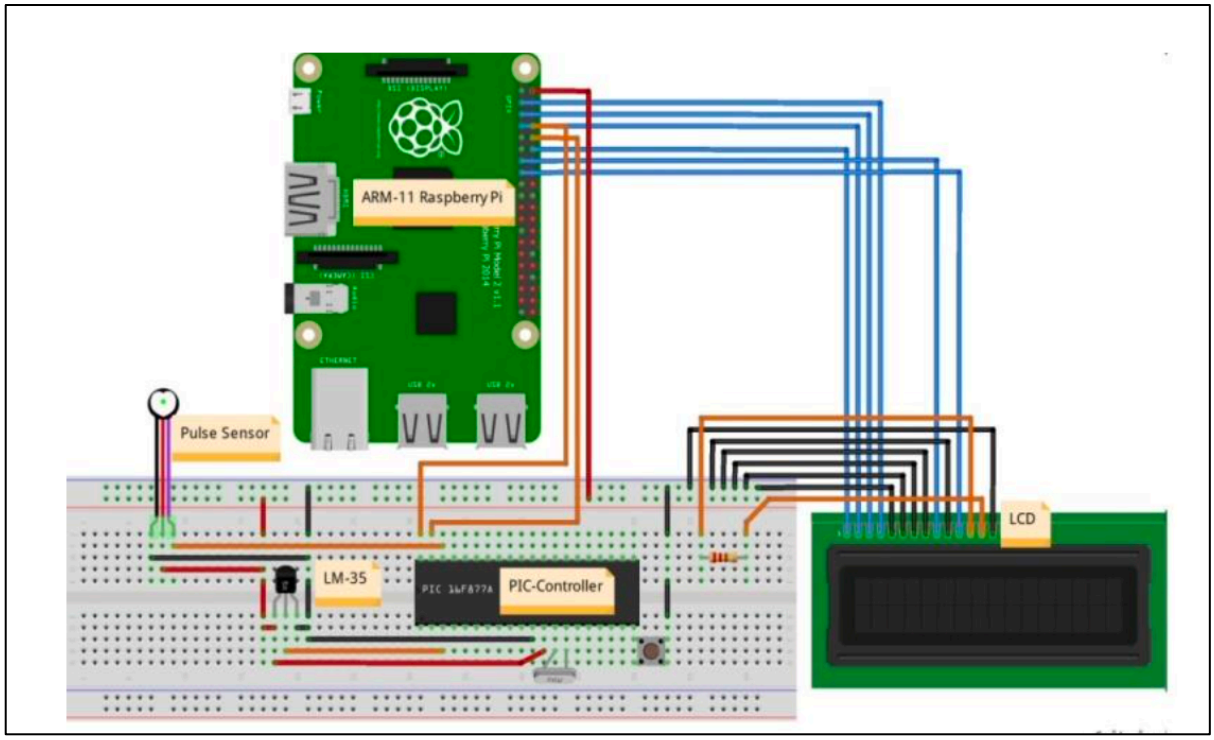

Figure 4. : Smart Healthcare Device Circuit Diagram

c. Cloud Computing

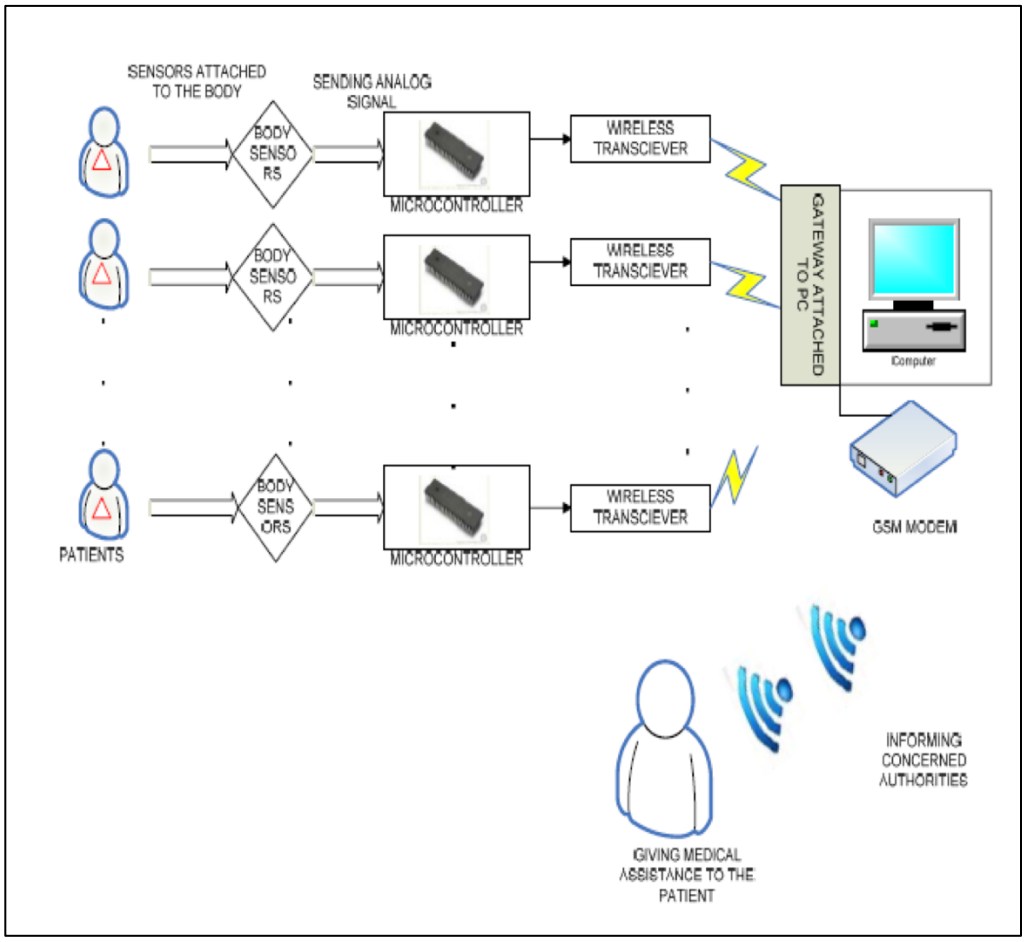

Figure 6: Cloud Computing in Smart Health care Device

3.2. Flowchart of Research Activities

Figure 6 shows the descriptive analysis on how the research activity was conducted with the research, desgining and modeling.This project was briefly evaluated with any errors.It was checked if it fulfills the objective.If it doesn't again the research was re-evaluated.Likewise,the final report was obtained.

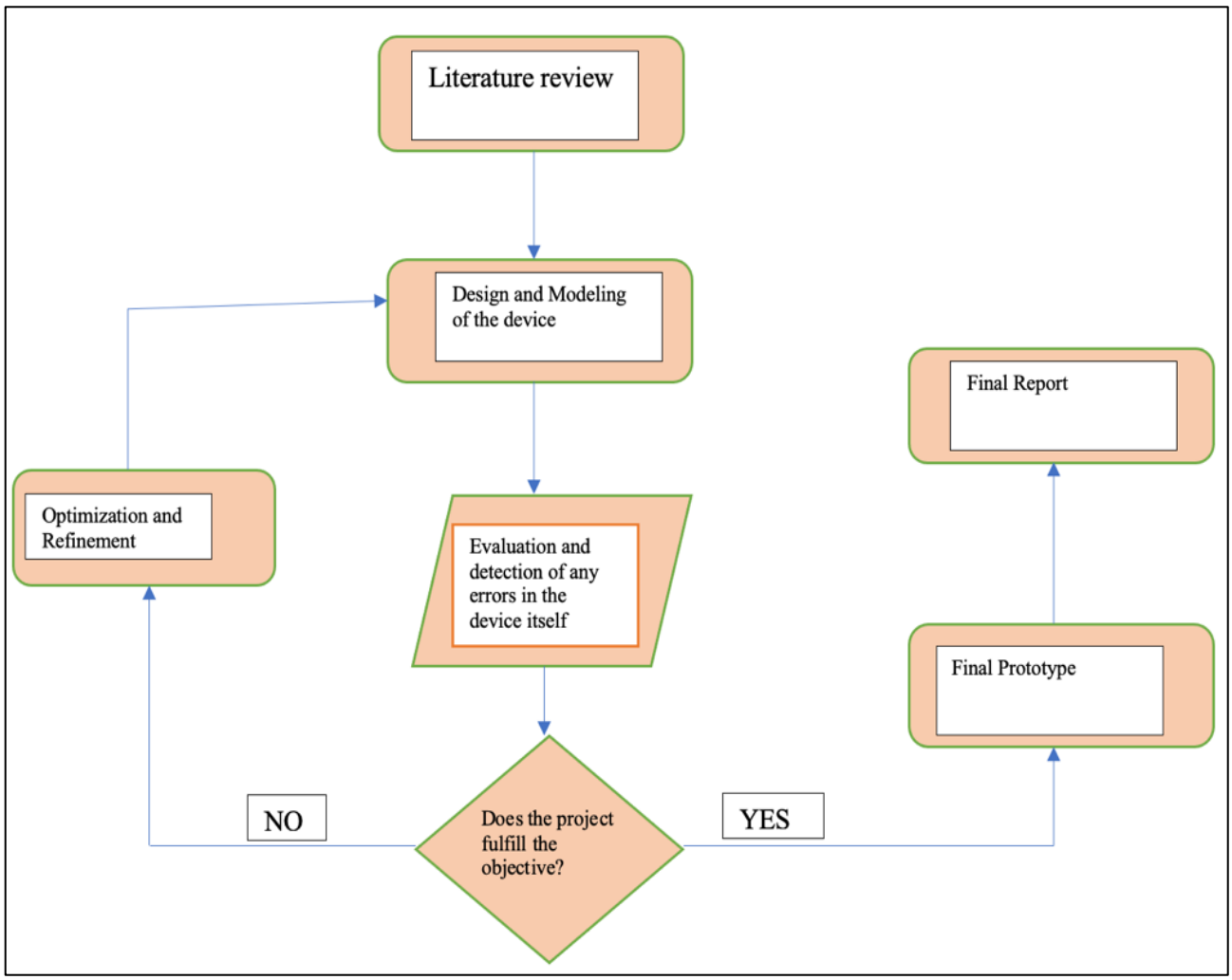

Figure 7: Smart Healthcare Device Research Activity Flowchart

3.3. Key Components

1) Raspberry Pi Model B+

Raspberry Pi is a single microcontroller board with a CPU, a gpu and a storage device. The gadget was established in the Uk approximately the dimensions of a bank card. For all those who did not even want computers or any other system software to use this program, this board was developed. Excluding the microcontroller board that needs a supply of power, the system design can be run with just this board. The Raspberry Pi features a BCM2837 chip-based Broadband systems, including an ARM Core A53 1.2 GHz processors, Video Core IV GPU, and 1GB RAM. There is no integrated hard drive, rather it launches and retains information through an SD card. The OS , applications and data needed to run the Raspberry Pi all have to be saved mostly on SD card. The microcontroller works with the operating system. The operating system is responsible for systems integration and input management.

This model offers characteristics including streaming video in HD. It also gives the possibility of playing 3D games with high-definition audio. This gadget uses the ARM CPU. In the healthcare sector, the type Raspberry Pi B+, that may be connected to a variety of metered equipment. The microcontroller is a digital information system.

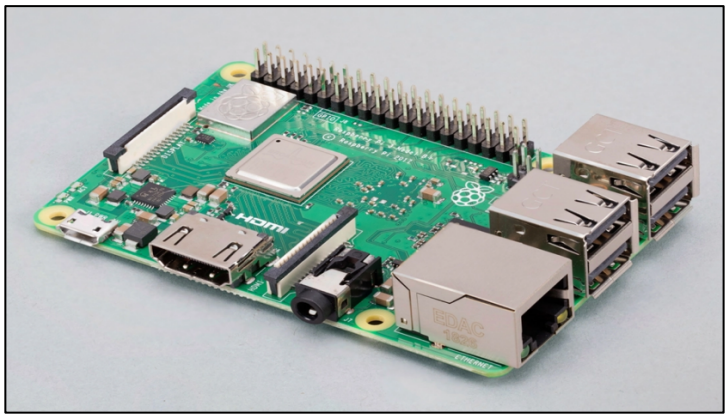

Figure 8: Raspberry Pi

2) Lm358 Heart beat sensor

If users create or analyze a fitness regime, the pulse rate information is somewhat valuable. The problem is that it could be hard to physically measure the pulse rate. Fortunately, this can be helped also with pulse detector. The software may be used by sportsmen, fitness professionals and cellphone designers that require a real-time cardiac beater sensor. The optical sensor with amplifier is easy to filter out street

sounds, which allows precise pulse recordings to be produced quickly and easily. The energy consumption can be reduced, consuming just 4 mA at 3.3V, which makes it even better overall portable use.

Just click on the pulse rate sensor and attach the Heart beat sensor to the ears or the fingertips and the heart rate may be measured around 3 or 5.5 volts. The 24-inch Pulse Sensor wire is connected to normal male headers, thereby avoiding soldering requirement.

For most individuals, the cardiac cycle is between 60 and 80 beats per minute. A normal heart rate for well-trained athletes is 40 to 60 beats per minute.

Age	Pulse rate
< 1 month	120 to 160
1to 12 months	80 to 140
12 months to 2 years	80 to 130
2to 6 years	75 to 120
6 to 12 years	75 to 110
> 12 years	60 to 100

Table 1:Normal Pulse Rate Of Different Ages

Figure 9: Heart beat Sensor

3) Blood Pressure sensor

The sensor is used to determine how high or low a person's blood pressure is. The systolic and diastolic pressures, as well as the pulse rate, are all measured by this sensor. A sphygmomanometer is less precise and trustworthy as it is used to monitor the blood pressure in the arteries with a stethoscope, coupled to an inflatable air bladder cuff. Blood pressure sensors measure blood pressure on vascular or artery.

- Mild hypertension (stage 1) is defined by systolic in-between 140 to 159 mmHg and diastolic in-between 90 to 99 mmHg.
- Moderate hypertension is defined as systolic in-between 160 to 179 mmHg and diastolic in-between 100 to 109 mmHg (stage 2).
- Severe hypertension is indicated by systolic levels above 180 and diastolic levels above 110 mmHg (stage 3).

Figure 10: Blood Pressure Sensor

4) Lm35 Temperature Sensor

The LM35 temperature sensor is measured in Celsius. In comparison to a thermistor, the LM35 temperature sensor can more accurately monitor temperature. Because it produces a larger power output than temperature sensors, the output power may not be needed. The sensor has just 60 microamps from its power source and has minimal self-heating ability, which is a remarkable attribute of this sensor. The operating rated voltage of this LM35 is -55 up to +150 C and has a low temperature of self-heating. The output voltage is between 4 and 30 volts.

Normal	37°C = normal temperature..
Abnormal	Fever: 38°C - 39.9°C High fever: 40°C >

	Armpit(auxiliary) temperature Fever: 37.4°C - 39.4°C High fever:39.5°C >
	<36.1°C means a low body

Table 2.: Body Temperature

Figure 11: Temperature Sensor

5) SIM 800l GPRS GSM module

The SIM800L is a tiny device for sending or receiving GPRS, transmitting but also receiving text messages, and making as well as receiving voice calls. The reduced price, small size and four spectrum bandwidth characteristics of this Module makes it perfect for any long-range communication projects.

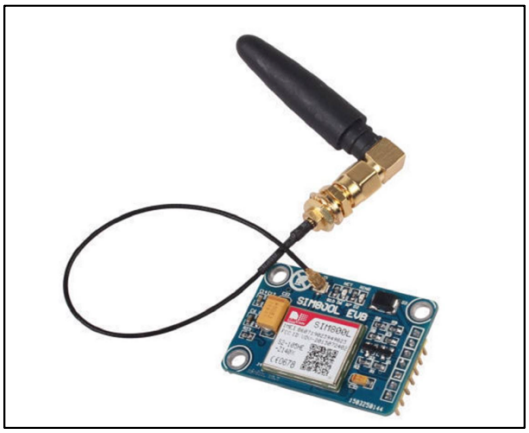

Figure 12: SIM800L

6) MCP 3208

Microchip Technology Inc.'s MCP3204/3208 processors were 12-bit A/D estimation conversions and on sampling as well as support circuits. The MCP3204 may be configured to have two plantation input pairings or four single connections. The MCP3208 contains four pseudo-differential input pairs and 8 individually programmable inputs.

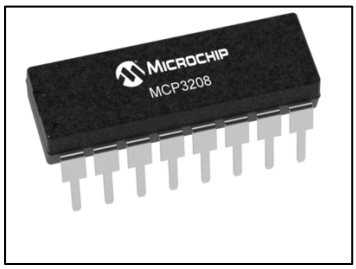

Figure 13: MCP3204/3208

7) 16 * 2 LCD display

The deliberate information is displayed on a liquid crystal display. Here on Alpha-numerical digital display, the sensor data and Raspberry Pi procedure can be shown in a single line over two lines with more extraordinary of 16 characters.

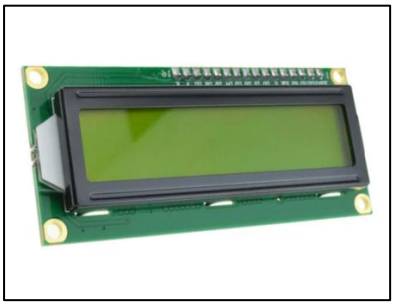

*Figure 14: 16 * 2 LCD display*

Preliminary Data

Budget of Proposed System

HARDWARE			
NUM.	**ITEM**	**QUANTITY**	**PRICE (RM)**

1.	Raspberry Pi 3 Model B+	1	220.00
2.	Jumper Cables	1	2.00
3.	Lm358 Heart beat Sensor	1	17.00
5.	LCD Display	4	10.00
6.	Lm35 Temperature Sensor	1	17.00
7.	ECG sensor	1	42.00
8.	Breadboard	1	
9.	SIM 800l GPRS GSM module	1	
10	MCP 320	1	
TOTAL			79.30
SOFTWARE			
1.	Python language		Free
2.	RASPBIAN OS		Free
3.	embedded c language		Free
4.	wiringPi		Free

CHAPTER 4

CONCLUSION

In the FYP 1, there is more research on the theory part where all the cost of the hardware components are covered. The proposed smart health monitoring components is briefly studied. This summarizes how the raspberry pi works in connecting the sensor with database. Likewise going in depths with the FYP1 Project and learning about the basics of the hardware and software tool. Eventually, after the completion of the FYP1 report we move forward to the FYP 2 where we assemble all the hardware components utilizing the software tool. This framework of the FYP1 report helps us develop the

prototype of this report we are working on. The cost has already been separated for the development of the prototype.

In FYP2, Raspberry Pi will be the prototype for an IoT based intelligent health system. The necessary hardware components will be ordered and put together. All the sensors i.e., temperature, blood pressure, and heart rate, LCD, and other hardware components are included. The Raspberry Pi will then be programmed using RASPBIAN OS in several programming languages such as embedded c and python. It will be tested and run again if there are any bugs. After that, final paperwork will be completed before the final prototype is presented.

ACTIVITIES	TIMELINE										
	FYP 1 (2021)					ACTIVITIES	FYP 2 (2021 – 2022)				
	APRIL	MAY	JUNE	JULY	AUGUST		OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY
Literature Review.						**Implementation and Development.**					
Research Proposal.						**System Testing.**					
Research Proposal Presentation.						**Submission of Progress Report and Presentation.**					
Research Proposal Report Submission.						**Modification.**					
Research on the Existing Systems and Required Components.						**Testing.**					
Project Progress Presentation.						**Documentation.**					
FYP 1 Presentation.						**Final Presentation.**					
Final version report submission.						**Final Report submission.**					

Table 3: Gantt Chart for FYP1 and FYP2

References

Ahmed, Z. U., Mortuza, M. G., Uddin, M. J., Kabir, Md. H., Mahiuddin, Md., & Hoque, MD. J. (2018). Internet of Things Based Patient Health Monitoring System Using Wearable Biomedical Device. *2018 International Conference on Innovation in Engineering and Technology (ICIET)*, 1–5. https://doi.org/10.1109/CIET.2018.8660846

Amru, M., Mahesh, A. V. N., & Ramesh, P. (2020). IoT-based Health Monitoring System with Medicine Remainder using Raspberry Pi. *IOP Conference Series: Materials Science and Engineering*, *981*, 042081. https://doi.org/10.1088/1757-899X/981/4/042081

Baker, S. B., Xiang, W., & Atkinson, I. (2017). Internet of Things for Smart Healthcare: Technologies, Challenges, and Opportunities. *IEEE Access*, *5*, 26521–26544. https://doi.org/10.1109/ACCESS.2017.2775180

Chakravorty, D., Islam, S., & Rana, T. K. (2018). IoT Based Patient Guidance System using Raspberrypi. *2018 2nd International Conference on Electronics, Materials Engineering & Nano-Technology (IEMENTech)*, 1–4. https://doi.org/10.1109/IEMENTECH.2018.8465190

Ganesh, E. N. (2019). Health Monitoring System using Raspberry Pi and IOT. *Oriental Journal of Computer Science and Technology*, *12*(1), 08–13. https://doi.org/10.13005/ojcst12.01.03

Gupta, M. S. D., Patchava, V., & Menezes, V. (2015). Healthcare based on IoT using Raspberry Pi. *2015 International Conference on Green Computing and Internet of Things (ICGCIoT)*, 796–799. https://doi.org/10.1109/ICGCIoT.2015.7380571

Gutte, A., & Vadali, R. (2018). IoT Based Health Monitoring System Using Raspberry Pi. *2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA)*, 1–5. https://doi.org/10.1109/ICCUBEA.2018.8697681

Hamim, Mohd., Paul, S., Hoque, S. I., Rahman, Md. N., & Baqee, I.-A. (2019). IoT Based Remote Health Monitoring System for Patients and Elderly People. *2019 International Conference on Robotics,Electrical and Signal Processing Techniques (ICREST)*, 533–538. https://doi.org/10.1109/ICREST.2019.8644514

Islam, Md. M., Rahaman, A., & Islam, Md. R. (2020). Development of Smart Healthcare Monitoring System in IoT Environment. *SN Computer Science*, *1*(3), 185. https://doi.org/10.1007/s42979-020-00195-y

Jaiswal, K., Sobhanayak, S., Mohanta, B. K., & Jena, D. (2017). IoT-cloud based framework for patient's data collection in smart healthcare system using raspberry-pi. *2017 International Conference on Electrical and Computing Technologies and Applications (ICECTA)*, 1–4. https://doi.org/10.1109/ICECTA.2017.8251967

Kaur, A., & Jasuja, A. (2017). Health monitoring based on IoT using Raspberry PI. *2017 International Conference on Computing, Communication and Automation (ICCCA)*, 1335–1340. https://doi.org/10.1109/CCAA.2017.8230004

khan, I., Zeb, K., Mahmood, A., Uddin, W., Khan, M. A., Saif-ul-Islam, & Kim, H. J. (2019). Healthcare Monitoring System and transforming Monitored data into Real time Clinical Feedback based on IoT using Raspberry Pi. *2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (ICoMET)*, 1–6. https://doi.org/10.1109/ICOMET.2019.8673393

Kirankumar, C. K. R., & Prabhakaran, M. (2017). Design and implementation of low cost web based human health monitoring system using Raspberry Pi 2. *2017 IEEE*

International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE), 1–5. https://doi.org/10.1109/ICEICE.2017.8191881

Kumar, R., & Rajasekaran, M. P. (2016). An IoT based patient monitoring system using raspberry Pi. *2016 International Conference on Computing Technologies and Intelligent Data Engineering (ICCTIDE'16)*, 1–4. https://doi.org/10.1109/ICCTIDE.2016.7725378

Mathew, N. A., & Abubeker, K. M. (2017). IoT based real time patient monitoring and analysis using Raspberry Pi 3. *2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, 2638–2640. https://doi.org/10.1109/ICECDS.2017.8389932

Mathivanan, M., Balamurugan, M., L., H., Nandini, & Reddy, M. (2018). *IoT based continuous monitoring of cardiac patients using Raspberry Pi*. 020025. https://doi.org/10.1063/1.5078984

Mehta, A., Mehta, B., Joshi, M., Gohil, S., & Mahadik, S. (2018). *IoT Based Patient Health Monitoring System*. *3*(10), 3.

Muqeet, M. A., & Quadri, M. U. (2019). *IoT based Patient Monitoring System Using Raspberry Pi*. *7*(2), 6.

Naik, K. S., & Sudarshan, E. (2019). *SMART HEALTHCARE MONITORING SYSTEM USING RASPBERRY Pi ON IoT PLATFORM*. *14*(4), 5.

Neyja, M., Mumtaz, S., Huq, K. M. S., Busari, S. A., Rodriguez, J., & Zhou, Z. (2017). An IoT-Based E-Health Monitoring System Using ECG Signal. *GLOBECOM 2017 - 2017 IEEE Global Communications Conference*, 1–6. https://doi.org/10.1109/GLOCOM.2017.8255023

Pandey, G. K., & Chinnamuthu, P. (2018). IOT Based Patient Monitoring System utilizing Raspberry Pi and Web-Page. *2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, 2140–2144. https://doi.org/10.1109/RTEICT42901.2018.9012153

Pardeshi, V., Sagar, S., Murmurwar, S., & Hage, P. (2017). Health monitoring systems using IoT and Raspberry Pi—A review. *2017 International Conference on Innovative Mechanisms for Industry Applications (ICIMIA)*, 134–137. https://doi.org/10.1109/ICIMIA.2017.7975587

Prabha, M. G. M. (n.d.). *AUTOMATIC HEALTH MONITORING SYSTEM USING RASPBERRY PI*. 8.

Rahman, A., Rahman, T., Ghani, N. H., Hossain, S., & Uddin, J. (2019). IoT Based Patient Monitoring System Using ECG Sensor. *2019 International Conference on Robotics,Electrical and Signal Processing Techniques (ICREST)*, 378–382. https://doi.org/10.1109/ICREST.2019.8644065

Rohit, S. L., & Tank, B. V. (2018). Iot Based Health Monitoring System Using Raspberry PI - Review. *2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT)*, 997–1002. https://doi.org/10.1109/ICICCT.2018.8472957

Saip, M. A., & Mohamed, A. S. (2018). Smart Health Monitoring and Controlling using Raspberry Pi3. *International Innovative Research Journal of Engineering and Technology*, *4*(1), 24–28. https://doi.org/10.32595/iirjet.org/v4i1.2018.70

Sankaran, S., Murugan, P. R., Chandrasekaran, D., Murugan, V., Alaguramesh, K., Britto, P. I., & Govindaraj, V. (2020). Design of IoT based Health Care Monitoring Systems using Raspberry Pi: A Review of the Latest Technologies and Limitations. *2020*

International Conference on Communication and Signal Processing (ICCSP), 0028–0032. https://doi.org/10.1109/ICCSP48568.2020.9182325

Selvaraj, S., & Sundaravaradhan, S. (2020). Challenges and opportunities in IoT healthcare systems: A systematic review. *SN Applied Sciences*, *2*(1), 139. https://doi.org/10.1007/s42452-019-1925-y

Singh, D. N., Sharma, S. K., & Hashmi, D. F. (n.d.). Iot Based Health Monitoring System for Persons with Intellectual Disabilities. *International Journal of Engineering*, 7.

Sollu, T. S., Alamsyah, Bachtiar, M., & Bontong, B. (2018). Monitoring System Heartbeat and Body Temperature Using Raspberry Pi. *E3S Web of Conferences*, *73*, 12003. https://doi.org/10.1051/e3sconf/20187312003

Vineetha, Y., Misra, Y., & Kishore, K. K. (2020). A REAL TIME IOT BASED PATIENT HEALTH MONITORING SYSTEM USING MACHINE LEARNING ALGORITHMS. *Clinical Medicine*, *7*(4), 14.

Vithiya, R., Karthika, S., & Sharmila, G. (2019). Detection, Monitoring and Tracking Of Survivors under Critical Condition Using Raspberry-Pi. *2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN)*, 1–5. https://doi.org/10.1109/ICSCAN.2019.8878711

Yadavalli, P. K., Mandapaka, S. T., Patchipala, K. S., Maddala, S., & Tumati, S. (2020). Secured IoT Based Health Monitoring System. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3643863

Yattinahalli, S., & Savithramma, R. M. (2018). A Personal Healthcare IoT System model using Raspberry Pi 3. *2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT)*, 569–573. https://doi.org/10.1109/ICICCT.2018.8473184