A

Project Reporton

"Healthcare Monitoring Using Big Data Analytics and I.O.T"

Submitted in partial fulfillment of the requirements
for the award of the degree of

Bachelor of Technologyin
Computer Science and Engineering

by

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CERTIFICATE

This is to certify that the project report entitled "**Healthcare Monitoring using Big Data Analytics and I.O.T**" submitted by Mr. **Sparsh Verma (1900970100115),** Mr.**Nikhil Gupta (190097010075)** Mr. **Nikhil Varshney (1900970100076)** to the Galgotias College of Engineering & Technology, Greater Noida, Utter Pradesh, affiliated to Dr. A.P.J. Abdul Kalam Technical University Lucknow, Uttar Pradesh in partial fulfillment for the award of Degree of Bachelor of Technology in Computer Science & Engineering is a bonafide record of the project work carried out by them under my supervision during the year 2022-2023.

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ABSTRACT

The introduction of Big Data Analytics (BDA) in healthcare will allow to use new technologies both in treatment of patients and health management. The paper aims at analyzing the possibilities of using Big Data Analytics in healthcare. The research is based on a critical analysis of the literature, as well as the presentation of selected results of direct research on the use of Big Data Analytics in medical facilities. The direct research was carried out based on research questionnaire and conducted on a sample of 217 medical facilities .

Literature studies have shown that the use of Big Data Analytics can bring many benefits to medical facilities, while direct research has shown that medical facilities are moving towards data-based healthcare because they use structured and unstructured data, reach for analytics in the administrative, business and clinical area. The research positively confirmed that medical facilities are working on both structural data and unstructured data. The following kinds and sources of data can be distinguished: from databases, transaction data, unstructured content of emails and documents, data from devices and sensors. However, the use of data from social media is lower as in their activity they reach for analytics, not only in the administrative and business but also in the clinical area. It clearly shows that the decisions made in medical facilities are highly data-driven. The results of the study confirm what has been analyzed in the literature that medical facilities are moving towards data-based healthcare, together with its benefits.

KEYWORDS: Internet of things(I.O.T), Big Data Analytics, Data Analytics, Healthcare , Sensor, Arduino

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CHAPTER 1
INTRODUCTION

System health monitoring refers to a collection of tasks aimed at ensuring that a system remains operational. This may involve monitoring the current state of the system and conducting maintenance and repairs based on the observations made. To achieve this, multiple sensors may be necessary to provide real-time feedback for the integrated system health management (ISHM) system, which assesses the structural integrity of the system.This project enables us to idealize a cost-effective, informative and insightful precautionary technology using IOT to overcome the problem of late information of problems.

1.1Motivation

The healthcare costs are reduced by installing the IoT. With increase in high speed computing and processing, the quality of service is improved. The improvement is seen on a greater magnitude with health monitoring done, based on IoT system. The main advantage of using IoT in medical health care is to decrease barriers in monitoring important health parameters and reducing unnecessary health costs. Wearables are mostly in use in healthcare arena, through which it is the easiest and a comfortable way to gather the data, monitor health and communicate general their practitioners periodically.

The main contribution of this paper is to present an analytical overview of using structured and unstructured data (Big Data) analytics in medical facilities in Poland. Medical facilities use both structured and unstructured data in their practice. Structured data has a predetermined schema, it is extensive, freeform, and comes in variety of forms.

1.2Perspective

In contrast, unstructured data, referred to as Big Data (BD), does not fit into the typical data processing format. Big Data is a massive amount of data sets that cannot be stored, processed, or analyzed using traditional tools. It remains stored but not analyzed. Due to the lack of a well-defined schema, it is difficult to search and analyze such data and, therefore, it requires a specific technology and method to transform it into value . Integrating data stored in both structured and unstructured formats can add significant value to an organization .

Organizations must approach unstructured data in a different way. Therefore, the potential is seen in Big Data Analytics (BDA). Big Data Analytics are techniques and tools used to analyze and extract information from Big Data. The results of Big Data analysis can be usedto predict the future. They also help in creating trends about the past. When it comes to healthcare, it allows to analyze large datasets from thousands of patients, identifying clustersand correlation between datasets, as well as developing predictive models using data mining techniques .

This paper is the first study to consolidate and characterize the use of Big Data from different perspectives. The first part consists of a brief literature review of studies on Big Data (BD) and Big Data Analytics (BDA), while the second part presents results of direct research aimed at diagnosing the use of big data analyses in medical facilities.

The reflection of both effects, namely the increase in age and lower fertility rates, are demographic load indicators, which is constantly growing. Forecasts show that providing healthcare in the form it is provided today will become impossible in the next 20 years . It is especially visible now during the Covid-19 pandemic when healthcare faced quite a challenge related to the analysis of huge data amounts and the need to identify trends and predict the spread of the coronavirus. The

COVID-19 pandemic has highlighted the importance of providing patients with access to information about their health conditions, digital analysis of their health data, and reliable medical support online. By facilitating health monitoring and promoting cooperation with doctors to prevent diseases, we have the potential to revolutionize the healthcare system. However, achieving these goals requires more than just technology. We must also make changes at the management and design level, as well as in the business models of service providers. While Big Data Analytics has become common in many enterprises, medical organizations still struggle to meet the information needs of patients, clinicians, administrators, and policy makers. Implementing a Big Data approach would enable personalized and precise medicine based on individual patient information, delivered in real-time.

1.3Aim

In order to make data-driven decisions and provide better personalized healthcare, it is crucial to implement systems that can quickly learn from the data generated by individuals in clinical care And everyday life. This will allow for personalized predictions about prognosis and responses to treatment, a deeper understanding of the factors influencing health at the patient, system, and societal levels, improved drug and device safety monitoring, and more effective comparison of prevention, diagnostic, and treatment options.

While there is a lot of research on big data analysis in other industries, there is a lack of information on how healthcare facilities perform data analysis, what data they use, and what are as they analyze. This study aims to address this gap by presenting the results of research conducted in 217 medical facilities in Poland. The study involved a critical analysis of the literature as well as a research questionnaire. The results suggest that medical facilities in Poland are working with both structured and unstructured data and moving towards data-based healthcare. It is important to examine the maturity of healthcare facilities in the use of big data analytics to determine the potential future benefits and address the challenges the healthcare sector faces.

CHAPTER 2
LITERATURE SURVEY

Health monitoring has been a very prevalent topic in the past. The nature of these projects is to provide insights into the proper working of a system, be it the system of machinery or the complex biological creature such as a human being.

Although prevelant and having been developed in the past, the previous projects had been less in accordance with the accuracy of the topic. The sole purpose of delivering in-time, accurate caution signals on the basis of irregular data readings should be looked for. The following are the briefly described points which explain the drawbacks of the previously developed projects.

Inaccuracy- caution alarms were not used or sometimes falsely tiggered to point out irregularities.

Irregularity- datasets don't offer errors recognition based on the normal amomalities in the body thus triggering the alarm.

Datasets- datasets contain only the practically seen anomalities in the patients. Any anomaly in the body which is not in the dataset can't be pointed out.

2.1 Related Literature Review

The concept of big data analytics (BDA) encompasses various data-intensive techniques for analyzing and synthesizing large-scale data (Galetsi, Katsaliaki, and Kumar 2020; Mergel, Rethemeyer, and Isett 2016). This data, which is derived from information exchange among different systems, is often referred to as "big data" (Bahri et al. 2018; Khanra, Dhir, and Mäntymäki 2020).

Despite being referred to as "big," the significance of this data lies in its ability to capture intricate details about the subject under study (George, Haas, and Pentland 2014; McAfee et al. 2012). Kitchin (2014) summarized the characteristics of big data with seven "V's":

2.2 Project Evolution

The use of Big Data Analytics in healthcare is growing alongside the increasing amount of big data available in this field (Galetsi and Katsaliaki 2019; Kamble et al. 2019). Patient demographics, treatment history, and diagnostic reports are just a few examples of the heterogeneous and multi-spectral observations that contribute to big data in healthcare (Malik, Abdallah, and Ala'raj 2018; Ozminkowski et al. 2015; Amirian et al. 2017). This data may be structured (such as genotype, phenotype, or genomics data) or unstructured (such as clinical notes, prescriptions, or medical imaging), and it often requires the generation and collection of high-quality real-time data (Tang et al. 2019; Wang, Kung, and Byrd 2018). Decision-makers in healthcare organizations can derive valuable insights from big data to inform their actions (Prasser et al. 2019; Wang, Kung, and Byrd 2018). Technologies are being developed and deployed to manage the changing nature of big data in healthcare (Harerimana et al. 2018; Zhang et al. 2015). In addition, big data can connect different fields to comprehensively study a disease (Zhang, Simon, and Yu 2017). The characteristics of big data, such as its ability to capture small details and generate real-time data, are highly relevant in the context of healthcare.2.3Opportunities for BDA in healthcare

Hospital monitoring

The use of descriptive, predictive, and prescriptive analytics in healthcare can improve the quality of healthcare in various aspects (Kaur, Sharma, and Mittal 2018). The literature highlights several opportunities for BDA in the healthcare sector, including the ability of authorities to take preventive measures against predicted risks of chronic diseases and contagious disease outbreaks among a population (Antoine-Moussiaux et al. 2019).

Patient care

Customized patient care facilitated by BDA has the potential to provide rapid relief (Salomi and Balamurugan 2016) and reduce readmission rates in hospitals (Gowsalya, Krushitha, and Valliyammai 2014).

2.4Challenges of BDA in healthcare

The application of BDA to healthcare may face various challenges (Aiello et al. 2019;Amalina et al. 2019). Common challenges in this area include the following:

Initial investment

The deployment of the requisites to leverage the benefits of big data incurs huge initial costs for organisations providing healthcare (Szlezak et al. 2014; Wu et al. 2016).

Quality of data

The lack of trained personnel and resistance to change in organisational routines mayaffect the quality of big data accumulated by the organisation (Wang, Kung, and Byrd 2018; Zhang et al. 2015).

Quality of insights

The poor quality of heterogeneous biomedical data has the potential drawback of yielding inadequate insights and misleading suggestions (McNutt, Moore, and Quon2016; Sáez and García-Gómez 2018).

Privacy and security

Scholars warn about the privacy and security concerns of patients regarding exposureto unauthorised data access during intersystem exchanges (Mohammed, Far, and Naugler 2014; Weng and Kahn 2016).

CHAPTER 3
PROBLEM FORMULATION

3.1 Description of Problem Domain

People over the world suffer from chronic diseases. Some of the most commonly affected organs in the body are heart, respiratory system(lungs, diaphragm, etc), digestive system (inlcuding stomach disorders, intestinal disorders, etc) and mental health.

Also, majority of this population suffers from diseases such as diabetes, asthma, heart diseases and cancer, obesity and arthritis, etc.

Chronic disease patients go through a series of strokes, breakdowns and other problems during their lifetime, most of them as a result of unchecked vitals or lack of warning.

Hence, the population suffering from these chronic diseases, need to continuously bear the expenses and regularly get a health check-up so as to make sure their vitals are in check.

3.2Problem Statement

The healthcare industry is facing a major challenge in managing the cost of care delivery, as accounts for almost 18% of the US GDP. While efforts are being made to improve the efficiency of care delivery, newer payment and reimbursement models are putting significant pressure on revenue, making it difficult to maintain historical financial parity. To address this issue, there is a critical need to leverage data and analytics to identify trends that can help healthcare organizations increase the effectiveness of care, reduce errors, manage risk, lower costs, improve operational efficiency, and maximize reimbursements for care delivery. However, the healthcare industry has been slow in adopting modern data and analytics capabilities, which leaves healthcare leaders without the necessary information to make informed decisions and drive positive change.

3.3 Depiction of Problem Statement

Industry consolidation has become prevalent in the healthcare industry due to the need for increasing efficiencies. However, consolidation takes time to deliver operational efficiencies and provide insight. Healthcare organizations and payers are complex businesses, and their data and applications systems are subject to regulatory hurdles, especially regarding data security. Merging large players usually takes years to establish consistency and access to data, creating blind spots. To establish a common view of data across complex healthcare organizations, modern data and analytics programs can be utilized to increase efficiency and scale of data management and analytics systems. These programs can provide a consistent and trustworthy view of healthcare data at a lower cost compared to legacy programs and approaches.

3.4Problem Statement Conclusion

The healthcare indrustries is currently facing a significant challenge in managing the large amount of big data available to them ,and they lack the necessary architecture ,tools ,process and policies to efficiently mange and analyse it . this involve adopting modern business intelligence ,predictive analytics , and artificial intelligence system to provide actionable insights and drive inform decision making . additionally, there is a need to ensure consistency, security and trust in the data management process.

CHAPTER 4
PROPOSED WORK

Our proposed work covers IoT circuit building so as to help the administrator record the medical data of the patient to cover the basic needs of syncing and storing all the medicaldata.
This process is described briefly in the following paragraph which would give you a detailed description of what our proposed work is.
The constituting parts of our project are-
I Data Science Algorithm
II IoT Circuit
III Local Data Server
Our data science algorithm will cover the matching up of data in order to discover any abnormalities and irregularities regarding the patient's health status. Our system is designed to integrate all the latest developments in healthcare technology while remaining low cost and easy to implement. To store patient data, we have opted for a local server. Additionally, we have included sensors on the patient's body that can collect vital data which is then transmitted to the mobile phone registered in the GSM module. Our system uses low-cost sensors and is designed to minimize power consumption by directly transmitting data to the computer. For this purpose, we use a cheaper Arduino instead of a more expensive Raspberry Pi. Our proposed system includes a microcontroller (Arduino), a NodeMCU, a heartbeat sensor, a temperature sensor, and a high-definition camera for detecting blood groups. The system automatically senses and records the heart rate and body temperature. After processing the collected data, the information is sent to the server through the existing Local Area Network. Doctors can access the patient's health condition parameters through a web application developed using PHP.

- **Data Collection-** Data collection is the systematic process of collecting and analyzing information from various sources to obtain answers to research questions, identify trends and patterns, assess probabilities, and evaluate potential outcomes. This process involves gathering accurate and relevant data from a variety of sources, including surveys, interviews, observations, and existing databases, and using appropriate techniques to analyze and interpret the data to draw meaningful conclusions.

- **Algorithm Training-** Data training refers to the process of modifying the connection weights of an artificial neural network to achieve a desired output. Supervised training involves presenting the network with a training set and adjusting the weights to match the desired output for each input vector. This process may require multiple iterations to achieve the desired result. In unsupervised training, the weights are adjusted without specifying the correct output for any input vector.

- **IoT Circuit Making-** The circuit breaker system based on IoT has a quick response time and utilizes the internet for interconnection to manage electrical loads.

- **Arduino Training-** Arduino is a development board that is available as open hardware, which can be utilized by hobbyists, tinkerers, and makers to create and construct devices that have the ability to interact with the physical world.
- **Linking Dataset-** A collection of discrete and related data items that can be accessed individually or managed as a whole entity is known as a data set. It is usually organized into a specific data .

Deployment- Tools for deploying software can simplify and automate the distribution of software and updates, freeing up developers to focus on other important tasks. Such tools can also facilitate collaboration among developers, help track project progress, and manage changes effeectivelly.

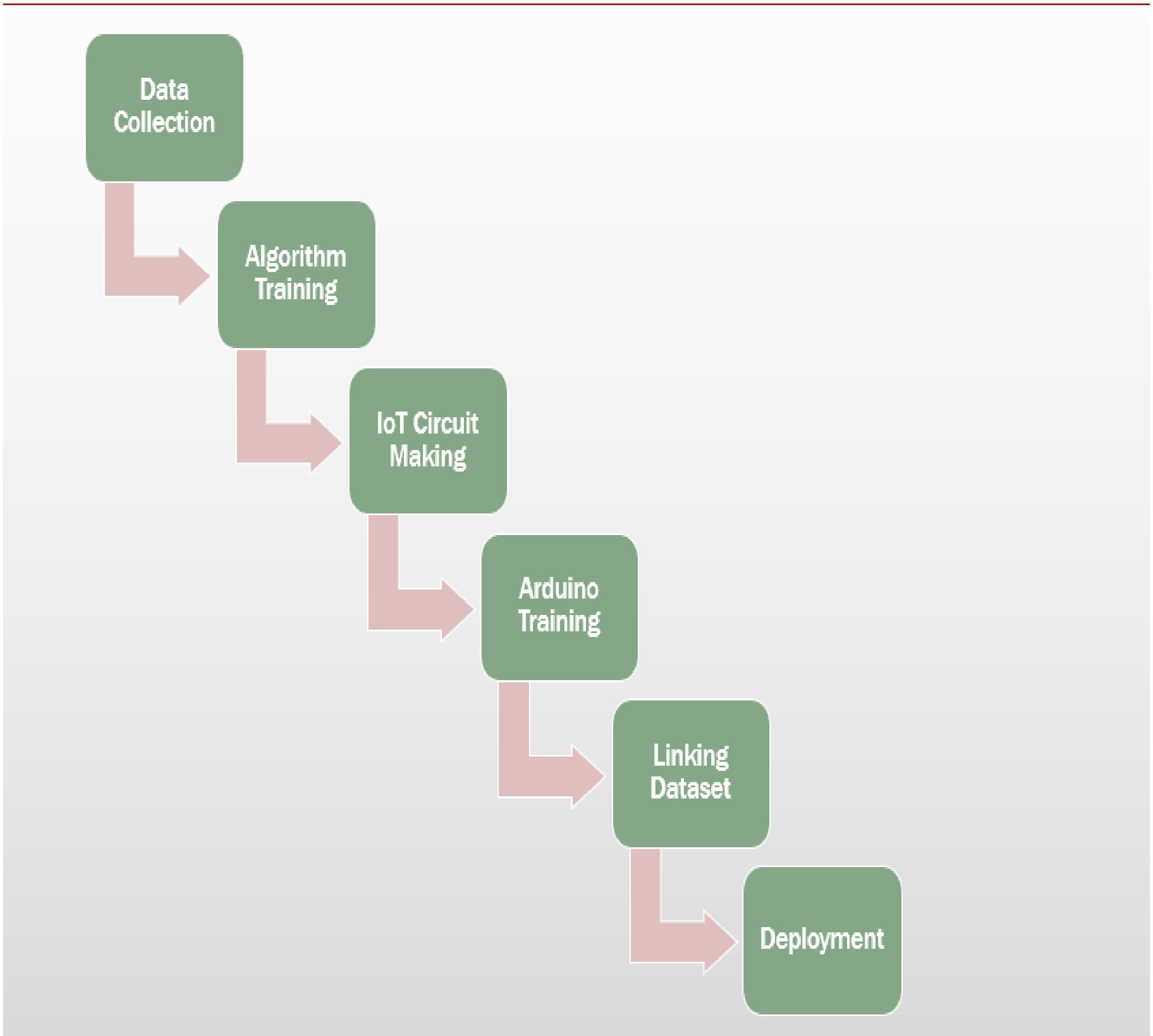

Figure 4.1 Project Problem Statement Life Cycle

CHAPTER 5
SYSTEM DESIGN

IoT has made significant changes in the healthcare industry, and this project describes an IoT-based Patient Health Monitoring System using ESP8266 and Arduino. This project utilizes the ThingSpeak IoT platform, an open-source application and API to store and retrieve data from IoT devices using HTTP protocol over the Internet or Local Area Network. The IoT device measures the pulse rate and surrounding temperature continuously and updates the data to the IoT platform. The Arduino sketch manages various functionalities of the project, such as reading sensor data, converting them into strings, sending data to the IoT platform, and displaying measured pulse rate and temperature on character LCD. System design defines the architecture, components, modules, interfaces, and data for a system to meet the requirements. It illustrates overall product architecture, subsystems, and allocation of subsystems to processors. UML, a standard object-oriented analysis and design language, is used to model system designs. The application's use case diagram and sequence diagram, both types of UML diagrams, are presented in the project.

5.1Use Case Diagram

A use case diagram is a visual representation of the interaction between an application and its users and external system . it outlines the various scenarios and action necessary to achieve the applications goal .the main components of a use case diagram are actors, use cases and there relationships. Actors are the users who interact with application, while use cases are the external actions or functions that the user performs to achieve there goals .

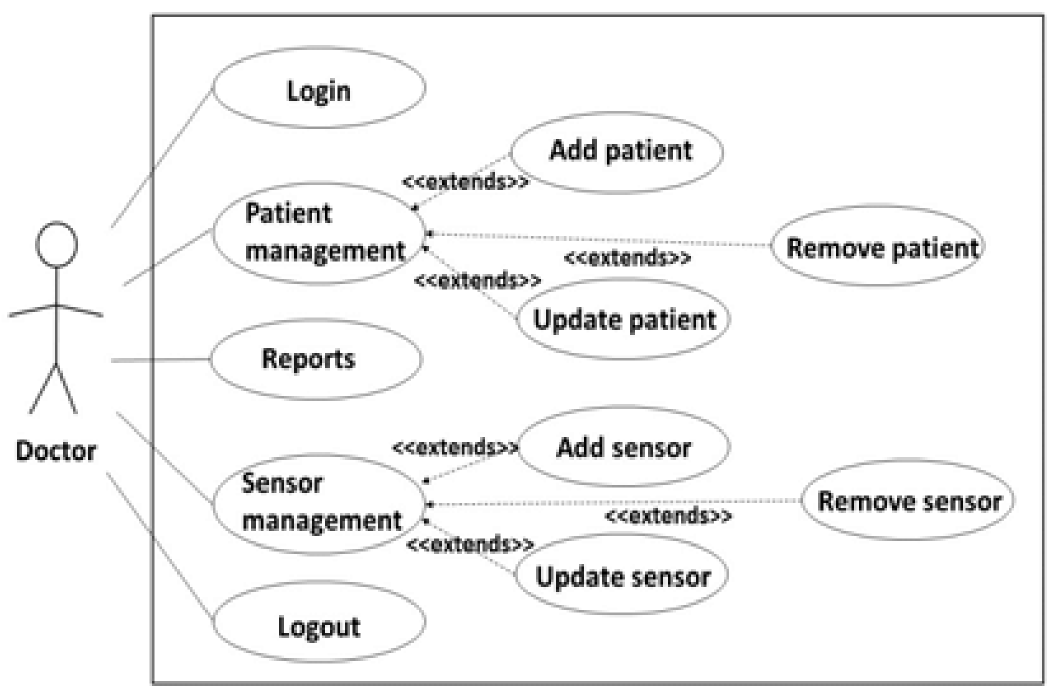

Figure 5.1: Use Case Diagram

*Actors:*The Actors of the system are Patient, Guardian and Doctor.

*Use cases:*I have identified a set of use cases based on the functionalities and goals of the application.

Login- This use case denotes a set of actions required for Subject to login into the application.

Call Service- This use case denotes a set of actions required by doctor to call a guardianor patient in case medical emergencies.

.*View Location*- This use case denotes a set of actions required by Guardian or Doctor to locate subject on map after receiving his location details.

Messaging Service- This use case denotes a set of actions required by Doctor to send a message to subject's guardian in case of emergencies.

5.2Sequence Diagram

Sequence diagrams model the flow of logic within your system in a visual manner, enablingyou both to document and validate your logic, and are commonly used for both analysis and designpurposes.

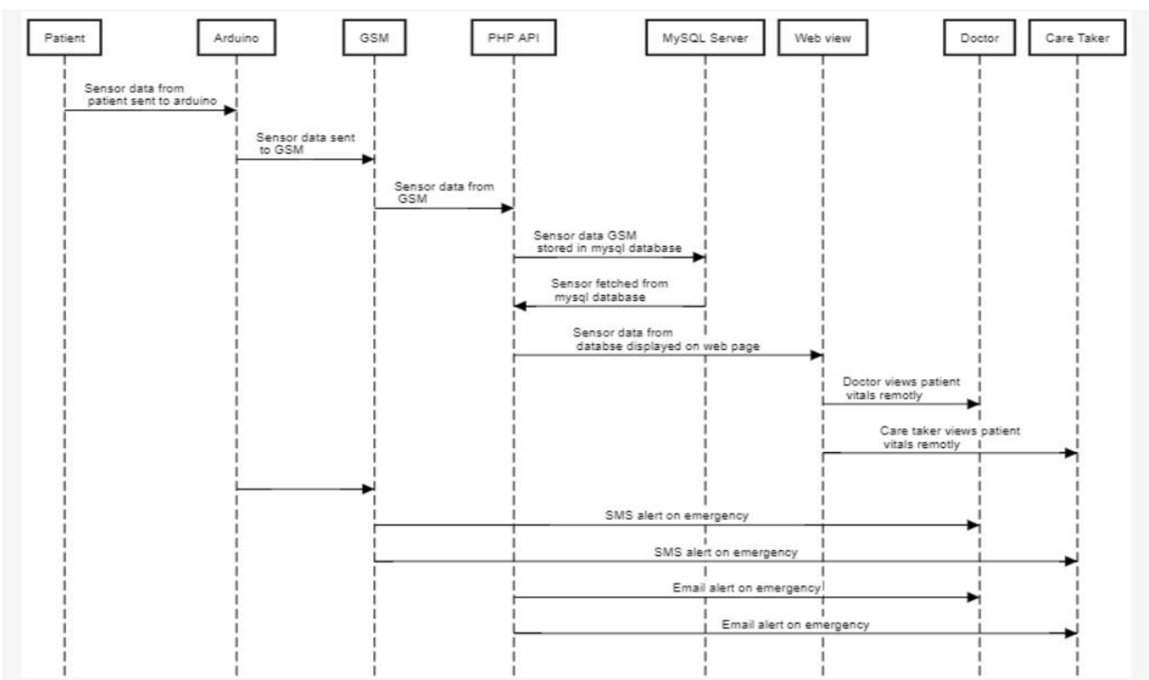

Figure 5.2: Sequence Diagram

5.3BLOCK DIAGRAM:

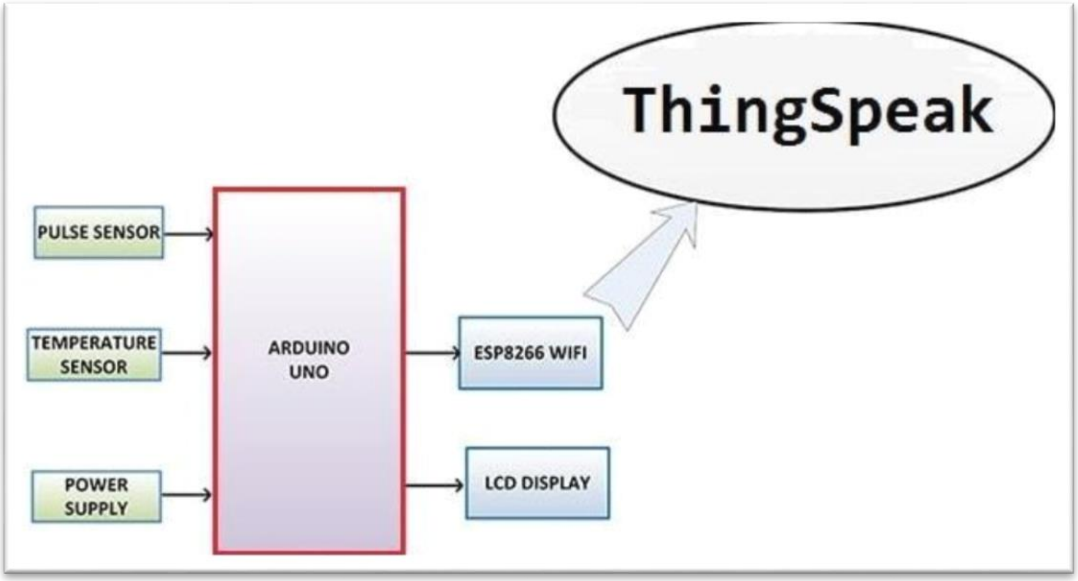

Figure 5.3 IoT Block Diagram

The block diagram illustrates the IoT Based Patient Health Monitoring System using ESP8266 & Arduino. The system uses Pulse Sensor and LM35 Temperature Sensors to measure BPM & Environmental Temperature, respectively. The code is processed by the Arduino and displayed on a 16*2 LCD Display. The ESP8266 Wi-Fi module connects to Wi-Fi and sends the data to an IoT device server. Thingspeak is the IoT server used in this project. The data can be monitored from anywhere in the world by accessing the Thingspeak channel.

5.4PULSE SENSOR:

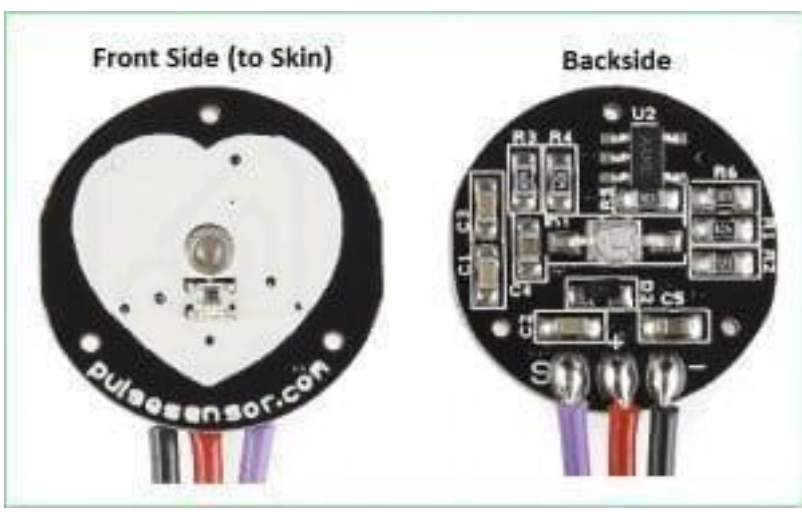

Figure 5.4 Pulse sensor Diagram

The **Pulse Sensor** is a plug-and-play **heart-rate sensor for Arduino**. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects. The essence is an integrated optical amplifying circuit and noise eliminating circuit sensor. Clip the **Pulse Sensor** to your earlobeor fingertip and plug it into your Arduino, you can ready to read heart rate. Also, it has an Arduino demo code that makes it easy to use.

The pulse sensor has three pins: VCC, GND & Analog Pin.

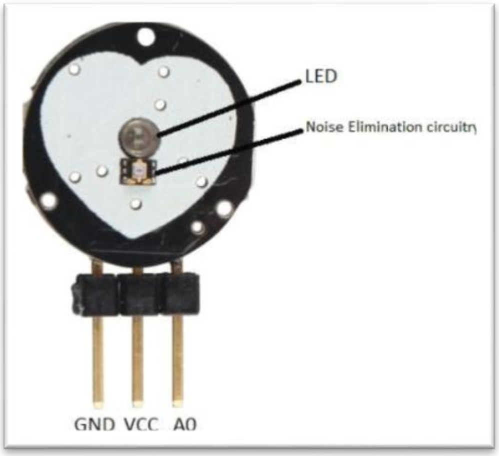

Figure 5.5 LED Part of Pulse sensor

5.5LM35 TEMPERATURE SENSOR:

The **LM35** series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature. The LM35 device has an advantage overlinear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

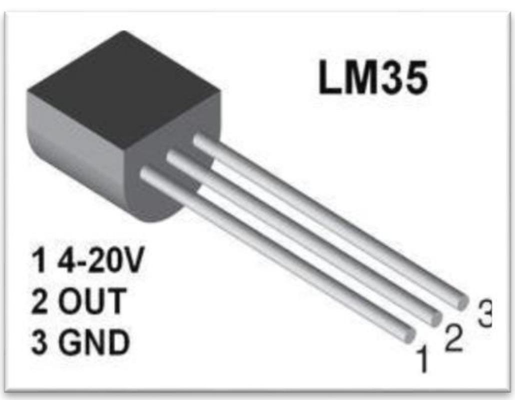

Figure 5.6 LM35 Design

5.6 ESP8266:

The ESP8266 is a low-cost and user-friendly device that provides internet connectivity to projects. It can function as both an access point (creating a hotspot) and a station (connecting to Wi-Fi), enabling easy data retrieval and upload to the internet, making IoT projects more accessible. Additionally, it can fetch data from the internet using APIs, allowing access to various information available online, making it even more versatile. Another attractive feature of this module is that it can be programmed using the Arduino IDE, making it more user-friendly.It is essential to note that the ESP8266 module operates with a voltage of 3.3V only, and anything higher then 3.7V may demise the module therefore, it is crucial to be careful with circuit connection here is a description of its pins.

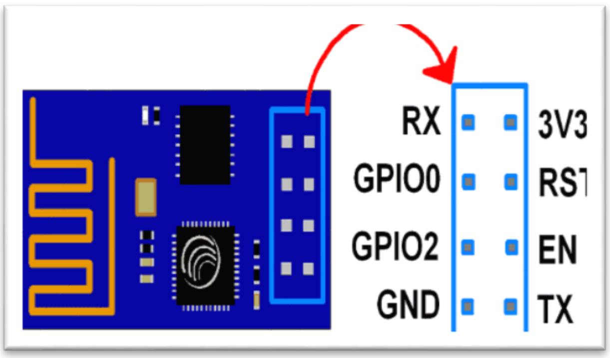

Figure 5.7 ESP8266 Circuit Diagram

5.7Arduino Circuits Diagram

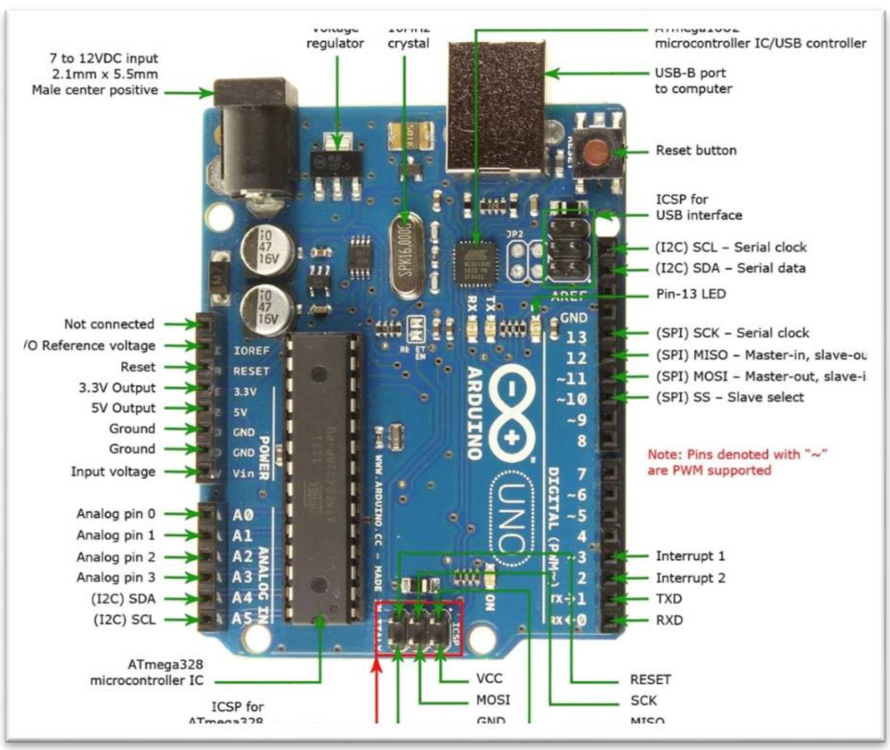

Figure 5.8 Arduino Circuit Diagram

Pin 1: Ground: Connected to the ground of the circuit
Pin 2: Tx/GPIO – 1: Connected to Rx pin of programmer/uC to upload program
Pin 3: GPIO – 2: General purpose Input/output pin
Pin 4 : CH_EN: Chip Enable/Active high
Pin 5: Flash/GPIO – 0: General purpose Input/output pin
Pin 6 : Reset: Resets the module
Pin 7: RX/GPIO – 3: General purpose Input/output pin
Pin 8: Vcc: Connect to +3.3V only

CONFIGURING THINGSPEAK TO RECORD PATIENT DATA ONLINE

ThingSpeak is a platform that offers great tools for IoT-based projects. It allows for the monitoring of data and control of systems over the internet by using the channels and webpages provided by ThingSpeak. ThingSpeak collects data from sensors, analyzes and visualizes the data, and triggers a reaction. This platform was used in the past for other projects, such as the weather station project using Raspberry Pi and using Arduino. For this IoT Patient Monitoring Project, we will use ThingSpeak to monitor the patient's heartbeat and temperature online. In addition, we will connect ThingSpeak to email/message services through the IFTTT platform, allowing for alert messages to be sent when the patient is in a critical state.

Step 1:- First of all, user needs to Create a Account on ThingSpeak.com, then Sign In and click on Get Started.

Step 2:- Now go to the ‘Channels’ menu and click on New Channel option on the same page for further process.

Step 3:- To create a new ThingSpeak channel, you need to fill out a form with some basic information. First, choose a name and description for your channel. Next, label Field 1 as "Pulse Rate", Field 2 as "Temperature", and Field 3 as "Panic". Don't forget to check the boxes next to each field to enable them. Lastly, select the "Make Public" option and click "Save Channel" to complete the process. Congratulations, your new channel is now ready to use!

Step 4:- You will see three charts as shown below. Note the Write API key, we will use this key in our code.

Step 5:- Now, we will use ThingHTTP app of the server to trigger the IFTTT applet for data entry to Google sheets and send email/sms. ThingHTTP enables communication among devices, websites, and web services without having to implement the protocol on the device level. You can specify actions in ThingHTTP, which you want to trigger using other ThingSpeak apps such as React.

CONFIGURING IFTTT FOR TRIGGERING MAIL/SMS BASED ON THINGSPEAK VALUES

Step 1:- Login to IFTTT and search for Webhooks and click on it.

Step 2:- Click on Documentation.

Step 3:- Type "Patient_Info" in the event box and copy the URL. We will use this URL in ThingHTTP.

Step 4:- Click on New Applete in My Applete option.

Step 5:- Click on "+this" and search for Webhooks and click on it. choose trigger as "Receive a Web request.

Step 6:- Type the Event Name which is same as you write in the event box in webhooks URL. Click on Create Trigger.

Step 7:- Click on "+that" and search for Google Sheets and click on it.

Step 8:- Give any name to your sheet. In formatted row box, you have date and time, event name, BPM value and body temperature which will be written as shown.

Step 9:- Review your applet and click on finish.

5.8CIRCUIT DIAGRAM & CONNECTIONS:

For designing IoT Based Patient Health Monitoring System using ESP8266 & Arduino, assemble the circuit as shown in the figure below.

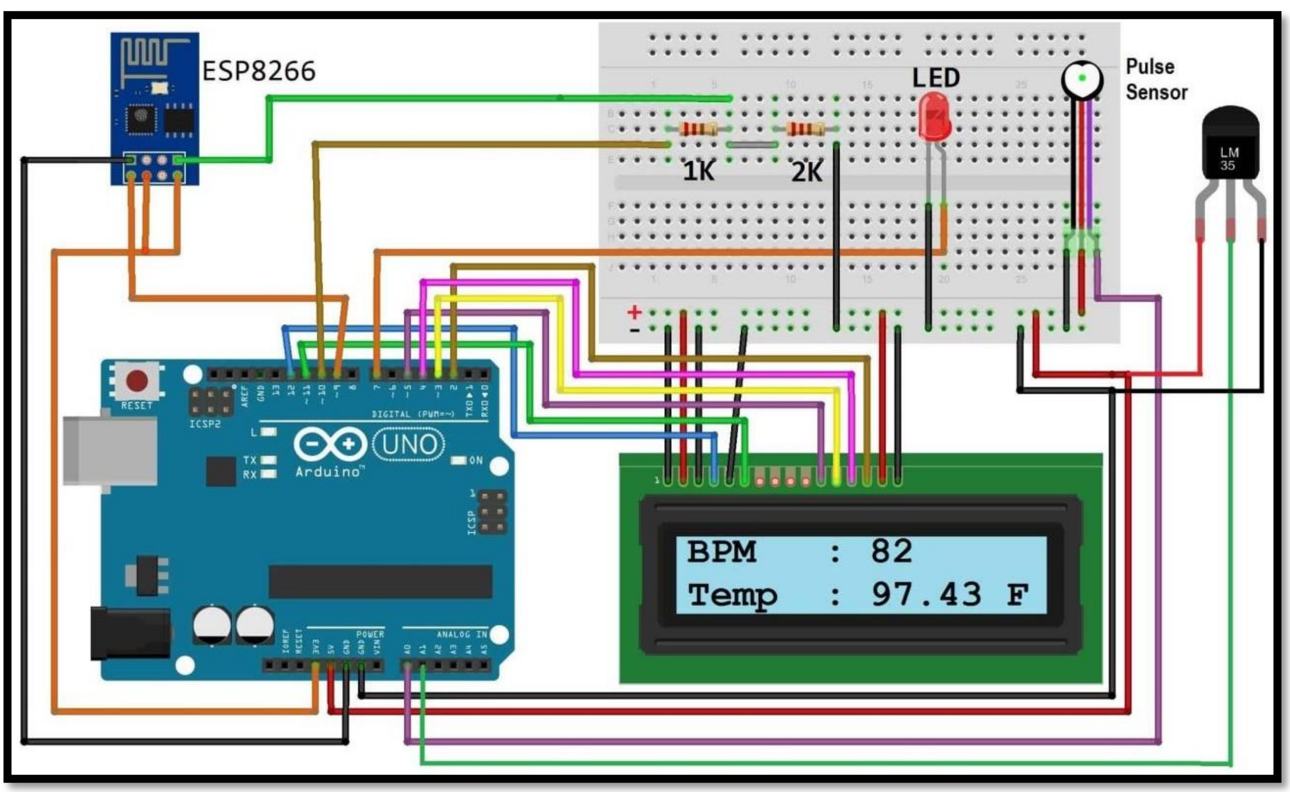

Figure 5.9 Circuit Diagram and Conncections

1. Connect Pulse Sensor output pin to A0 of Arduino and other two pins to VCC & GND.
2. Connect LM35 Temperature Sensor output pin to A1 of Arduino and other two pins to VCC & GND.
3. Connect the LED to Digital Pin 7 of Arduino via a 220-ohm resistor.
4. Connect Pin 1,3,5,16 of LCD to GND.
5. Connect Pin 2,15 of LCD to VCC.
6. Connect Pin 4,6,11,12,13,14 of LCD to Digital Pin12,11,5,4,3,2 of Arduino.
7. The RX pin of ESP8266 works on 3.3V and it will not communicate with the Arduino when we will connect it directly to the Arduino. So, we will have to makea voltage divider for it which will convert the 5V into 3.3V. This can be done by connecting the 2.2K & 1K resistor. Thus the RX pin of the ESP8266 is connectedto pin 10 of Arduino through the resistors.
8. Connect the TX pin of the ESP8266 to pin 9 of the Arduino.

Here is another version of the Schematic designed using EasyEDA software. Instead of using Arduino UNO, you can use Arduino Nano for this project.

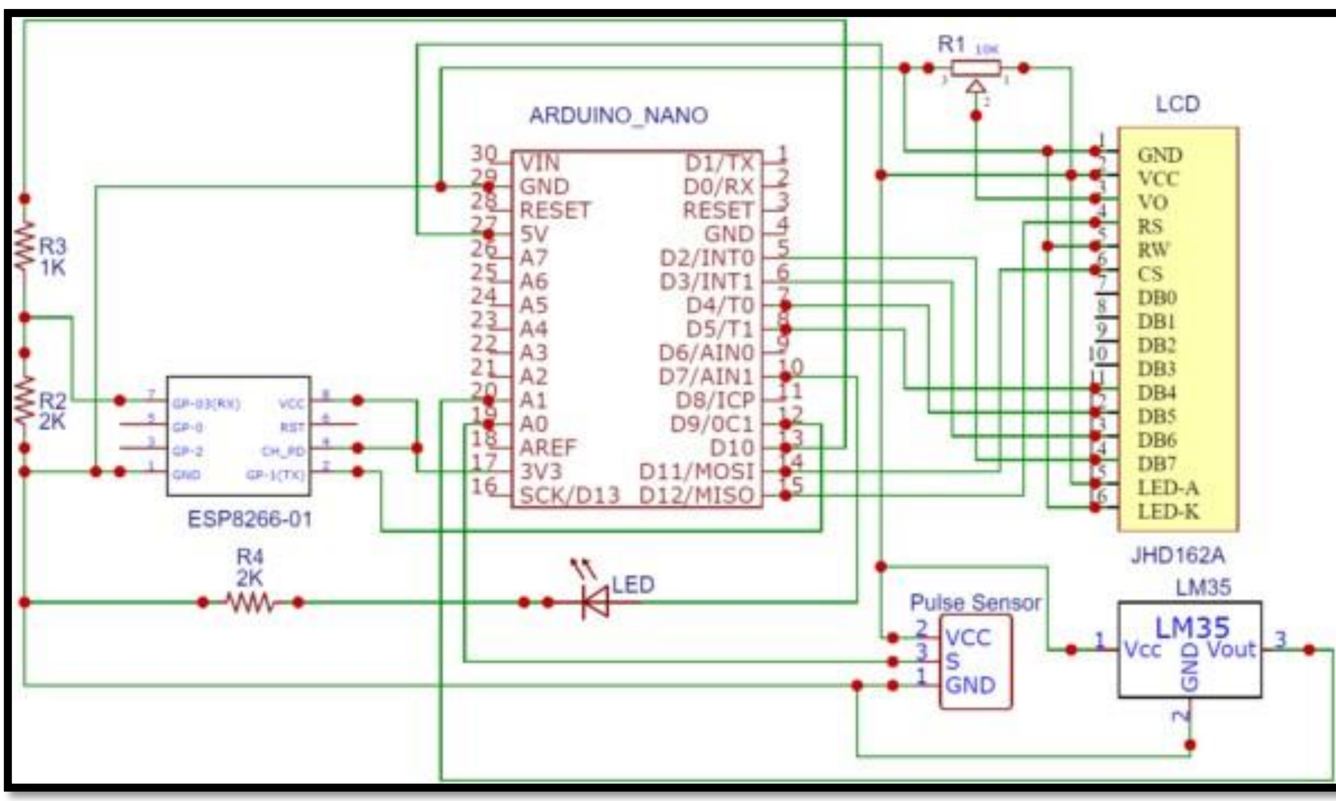

Figure 5.10 Circuit Pins Diagram

CHAPTER 6
IMPLEMENTATION

This project involves using an Arduino microcontroller to collect data from various sensors attached to a patient, such as pulse rate and temperature. The data is then sent to a MySQL database stored in the cloud. A web portal allows doctors or guardians to log in and monitor the patient's data, including their location. In case of emergencies, such as spikes in temperature or heart rate, or detection of toxic gas, SMS and email alerts are sent to the doctor and guardian's mobile devices and email accounts. This allows for quick response and appropriate help in case of emergencies.

6.1Arduino Micro controller Init

Gsm_init(): With this event, Arduino board checks out network connectivity before sensor data and relay it to cloud. Below Algorithm in Arduino board executes series of AT commands which would check network connectivity and enables internet.

```
void gsm_init()
{
lcd.clear();
lcd.print ("GSH TESTING..");
boolean at flag=1;
while (at_flag)
(Serial.println("AT"); while (Serial.available ()>0) (if (Serial.find("OR"))at_flag=0;} delay(1000);}
lcd.clear(); lcd.print ("GSH CONNECTED"); delay(1000); led.clear();
///////////////////////////////////////////////////////
lcd.print ("Disabling ECHO");
boolean echo flag-1;
while (echo_flag)
{Serial.println("ATEO"); while (Serial.failable ()>0) (if (Serial.find("OR")) echo flag=0;
delay(1000);}
lcd.clear(); lcd.print ("Echo OFF"); delay(1000);lcd.clear();
//////////////////////////////////////
lcd.print ("Finding Network..");
boolean net flag=1; while (net_flag) (Serial.println("AT+CPIN?");
while (Serial.available ()>0) (if (Serial.find("+CPIN: READY")) net flag-Q;) delay(1000);)
lcd.clear(); lcd.print ("Network Found..");
/////////////////////////////////////
lcd.setCursor (0,1); lcd.print ("GSM NETWORK"); delay(1000); led.clear();
///////////////////////////////////
lcd.clear(); lcd.print("TEST MESS")
boolean test flag-1; while (test_flag) (Serial.println("AT+CMGP=1"); while (Serial.available ()>0)
(if (Serial.find("OR")) test_flag=0;) delay(1000);1
led.clear(); lcd.print ("TEST MESSAGE"); delay(1000);
///////////////////////////////////////
```

led.clear(); lcd.print ("CGATT");
boolean testi flag-1; while (testl_flag) (Serial.println("AT+CGATT=1") while (Serial.available ()>0) (if (Serial.Find("OK")) testi flag=0;) delay(1000);)
lcd.clear(); lcd.print("AT+CGATTE1"); delay(1000);
lcd.clear();
lcd.print ("GPRS1");
boolean test2_flag=1; while (test2_flag) (Serial.print ("AT+SAPBR=3, 1,\"CONTYPE\", \"GPRS\"\r\n");
while (Serial.available ()>0) (if (Serial. find ("OK")) test2_flag=0;) delay(1000);} lcd.clear(); lcd.print ("GPRS START1"); delay(1000);
/////////////////////////
lcd.clear(); lcd.print ("GPRS2");
boolean test3_flag=1; while (test3_flag) (Serial.print ("AT+SAPBR=3, 1, \"APN\",\"internet\"\r\n"); while (Serial.available ()>0) (if (Serial.d("OK")) test3_flag=0; } delay(1000);}
lcd.clear(); lcd.print ("GPRS START2"); delay(1000);
////////////////////
lcd.clear(); lcd.print ("GPRS MAIN");
boolean test4_flag-1; while (test4_flag) (Serial.print("AT+SAPBR=1, 1\r\n");
while (Serial.available ()>0) (if (Serial.find("OR")) test4_flag=0; delay(1000);}
lcd.clear(); lcd.print ("GPRS CAME"); delay(1000);
///////////////////
lcd.clear(); lcd.print ("HTTP1");
boolean test5_flag-1; while (test5_flag) (Serial.print("AT+HTTPINIT\r\n");
while (Serial.available ()>0) (if (Serial.find("OR")) test5_flag=0;} delay(1000);}
lcd.clear(); lcd.print ("HTTP1"); delay(1000);
//////////////////////
lcd.clear(); lcd.print ("HTTP2");
boolean testé flag-1; while (test6_flag) (Serial.print("AT+HTTPPARA=\"CID\", 1\r\n");
while (Serial.available()>0) (if (Serial, find("OK")) test6_flag=0;}delay(1000);}
lcd.clear(); lcd.print ("HTTP2"); delay(1000);

6.2Location Tracking

GpsEvent(): With this event, GPRS module in board fetch’s current location coordinates.In this algorithm below, gpsEvent fetch’s data from GPRS module and parse it to get extralocation coordinates.GPS module sends the data related to tracking position in real time, and it sends so many data in NMEA format (see the screenshot below). NMEA format consist several sentences, in which we only need one sentence. This sentence starts from $GPGGA and contains the coordinates, time and other useful information. This GPGGA is referred to Global Positioning System Fix Data.

gpsEvent();
int str_lenth ==i;
latitude ="";
longitude = "";
int comma = 0;
while (x < str_lenth)

```
{
if (gpsString [x] ==', ')
comma++;
if (comma == 2) //extract latitude from string
latitude + gpsString [x + 1];0
else if (comma == 4) //extract longitude from string
longitude gpsString [x+11];
int 11= latitude.length();
latitude [11-1]=' ';
11 =longitude.length();
longitude[11-1]=’';

void gpsEvent ()
{
gpsString="";
while (1)
{
while (gpa.available() > 0)
{
//checking serial data from GPS
char inChar = (char) gps.read();
gpsString += inchar;       //store data from GPS into gpsstring
i++;
if (i < 7)
{
if (gpsString[i -1]!= test [i-1]).     //checkingfor SGPGGA sentence
{
i=0;
gpsString=" ";
}}
if (inCharr=='\r')
{
if(i>65)
{
gps_status=1;
break;
}
else
{
i=0;
}}}
if(gps status)
break;}}
```

Gprs_gsm_send(): This event sends the location coordinates using GSM module to cloud through AT+HTTPPARA command. Here once gpsEvent parse the location information into coordinates, gprs_GPS_send event immediately sends coordinates to MySQL database server. PHP API fetch location coordinates from server and using Google maps API, pin points the location of the patient.

```
void gprs_GPS_send()
{
lcd.clear(); lcd.print (
"WEBSITE LINK");
boolean test7_flag-1;
while (test7_flag) {
Serial.print ("AT+HTTPPARA=\"URL\", http://rpihealth.com/iot_patientmnr/putdata.php");
Serial.print ("?lat="); send_data (latitude);
Serial.print ("&lon="); send_data (longitude); Serial.print ("narasimharao");
Serial.print("\""); Serial.print ("\r\n");
while (Serial.available ()>0) { if (Serial.find("OK")) test7_flag=0;} delay(1000);}
lcd.clear(); lcd.print ("LINK OR")
//////////////////////////////
lcd.clear(); lcd.print ("ACTION");
boolean test8_flag-1; while (test8_flag) (Serial.print ("AT+HTTPACTION=0\r\n"); while (Serial.available ()>0) { if (Serial.find("OK")) test8_flag=0;} delay(1000);}
lcd.clear(); lcd.print ("ACTION OR"); delay(2000);
}
```

6.3Sending data to MySQL database server

Gprs_send(): This event sends the sensor data using GSM module to cloud through AT+HTTPPARA command i.e. this event sends all the sensor data to MySQL database server which later PHP API fetch’s data from server and relays information on web page.

```
void gprs_send()
{
lcd.clear(); lcd.print ("WEBSITE LINK");
boolean test7_flag=1;
while (test7_flag) {
Serial.print ("AT+HTTPPARA=\"URL\",\"http://rpihealth.com/iot_patientmnr/put_data.php");
Serial.print ("?temp="); Serial.print (TEMP);
Serial.print ("&hbt="); Serial.print (jj);
Serial.print ("&ecg="); Serial.print (ECG);
Serial.print ("&hum="); Serial.print (HUM);
```

```
Serial.print ("&pre="); Serial.print (PRE);
Serial.print ("&tox="); Serial.print (TOX); Serial.print ("&air="); Serial.print (AIR);
//Serial.print ("&fal="); Serial.print (jj);
if (a==0) (Serial.print ("&fal="); Serial.print ("NO"); } //8
if (a==1) (Serial.print ("&fal="); Serial.print ("YES"); } Serial.print ("\""); Serial.print ("\r\n");
while (Serial.available ()>0) (if (Serial.find("OR")) test7_flag=0;) delay(1000); }
lcd.clear(); lcd.print ("LINK OR");
//////////////////
lcd.clear(); lcd.print ("ACTION");
boolean test8_flag-1; while (test8_flag) (Serial.print ("AT+HTTPACTION=0\r\n"); while (Serial.available ()>0) (if (Serial.find("OR")) tests_flag=0;) delay(1000);}
lcd.clear(); lcd.print ("ACTION OK"); delay (2000);
}
```

6.4Sending SMS alert

AT+CMGS command: Arduino board sends SMS alert using GSM module

```
if (TEMP>37)
{
digitalWrite (buzz, HIGH); gprs_send(); digitalWrite (buzz, LOW);
lcd.clear(); lcd.setCursor (0, 0); lcd.print ("SENDING SMS"); lcd.setCursor (0,1); lcd.print ("TEMP ALERT");
Serial.println("AT+CMGF=1"); delay (400);
Serial.println("AT+CMGS=\"+15158509488\""); delay (400);
Serial.println("High body Temperature \n"); delay(100);
Serial.print ("Temp="); delay(100);
Serial.print (TEMP); delay(100);
Serial.println("http://rpihealth.com/iot_patientmnr/index.php"); delay(100); Serial.write (26); delay(100);
lcd.clear();
}
```

6.5Sending Email alert

Mail(): PHP code analyses the data from server and sends email alert on emergencies while relaying patient data to server. Email alert consists of message about condition which failed like temperature spikes, fall detection, heartbeat failure etc. along with link to patient webpage. On click link will be redirected to patient web page where doctor and care taker can view patient vitals and current location of patient.

```php
if($temp > 37)
{

$to      = 'madhunarasimharao@gmail.com';
$subject = ' BODY TEMPERATURE ALERT';
$message = 'Temp='.$temp;
$message .= "Deg      High  BODY TEMPERATURE Alert.";
$headers = 'From: narasimharaojm@gmail.com' . "\r\n" .
    'Reply-To: narasimharaojm@gmail.com' . "\r\n" .
    'X-Mailer: PHP/' . phpversion();
    mail($to, $subject, $message, $headers);
}
```

6.6 Methodology

In this paper, we propose an automatic system to monitor patient's body temperature, heart rate, body movements and blood pressure. Further we extend the existing system to predict if the patient is suffering from any chronic disorder or disease using the various health parameter and various other symptoms that are obtained by the system.

This system uses sensors to measure the patient's physiological parameters, including HR, BT, BP, and SpO2. The patient's data are collected via Wi-Fi from a remote location and stored in a cloud server, and the health parameters are continuously monitored

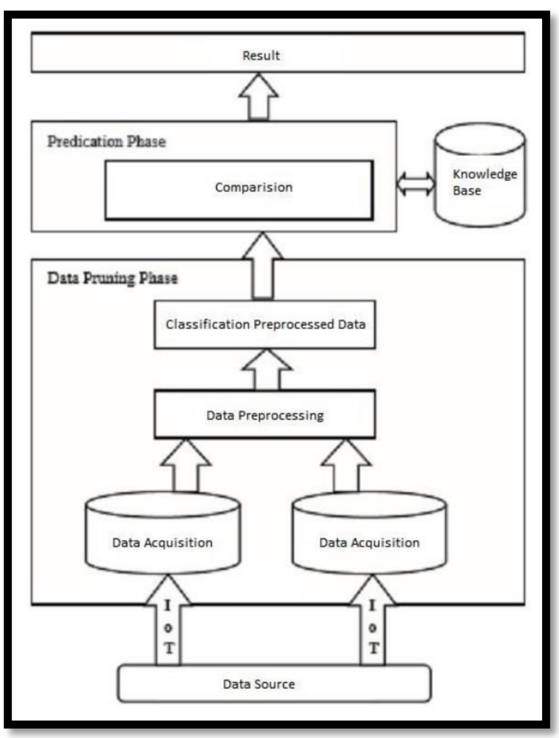

Figure 6.1Methodology Block Diagram

CHAPTER 7
RESULT AND ANALYSIS

7.1 Result

Here email alert has been sent to registered email with the information about patient vitals and link topatient monitoring page.

Figure 7.1 Email Alert

Here SMS alert has been sent to registered email with the information about patient vitals and link topatient monitoring page.

Figure 7.2 Message Alert

7.2 Analysis

Concluding our report, we have shown that the program works properly and successfully alerts the user about the abnormality that occurs while the device is still on the user.

7.3 Testing Levels

Software Testing is a process of executing the application with an intent to find any software bugs. It is used to check whether the application met its expectations and all the functionalities of the application is working. The final goal of testing is to check whether the application is behaving in the way it is supposed to under specified conditions. All aspects of the code are examined to check the quality of application. The primary purpose of testing is to detectsoftware failures so that defects may be uncovered and corrected. The test cases are designed in such way that scope of finding the bugs is maximum.

There are various testing levels based on the specificity of test.

7.3.1 Unit testing: Unit testing refers to tests conducted on a section of code in order to verify the functionality of that piece of code. This is done at the function level.

7.3.2 Integration Testing: Integration testing is any type of software testing that seeks to verify the interfaces between components against a software design. Its primary purpose is to expose the defects associated with the interfacing of modules.

7.3.3 System Testing: System testing tests a completely integrated system to verify that the system meets its requirements.

7.3.4 Acceptance testing: Acceptance testing tests the readiness of application, satisfying all requirements.

*7.3.5 Performance testing**:*** Performance testing is the process of determining the speed or effectiveness of a computer, network, software program or device such as response time or millions of instructions per second etc.

7.4System Test Cases

A test case is a set of test data, preconditions, expected results and post conditions, developed for a test scenario to verify compliance against a specific requirement. I have designedand executed a few test cases to check if the project meets the functional requirements.

Test Objectives: Microcontroller sends SMS alert

TEST CONDITION	INPUT SPECIFICATION	OUTPUT SPECIFICATION	PASS/FAIL
Any of the patient's vital exceeds above or below required condition	Vitals values	System sends SMS alert immediately to doctor and guardian	PASS

Table7. 1: *Test case for system sending SMS alert*

Test Objectives: System sends emails alert

TEST CONDITION	INPUT SPECIFICATION	OUTPUT SPECIFICATION	PASS/FAIL
Any of the patient's vital exceeds above or below required condition	Vitals values	System sends email alert immediately to doctor and guardian	PASS

Table7. 2: *Test case for system sending email alert*

7.5Performance Testing Challenges in IoT

Performance of the system can be determined based on the system/application responsiveness under all kinds of load. Performance testing in IoT framework is little different than traditional performance testing. IoT devices generates a lot of data which is saved in server and analyzed for immediate decisions. Hence IoT system must be built for high performance and scalability. And to measure these two key attributes, it is important to understand the business value for which it is build i.e. in our case patient health data. Hence it is necessary to simulate real world models, network conditions etc.

IoT does not have a standard protocol set to establish a connection between IoT application and IoT protocols used range from HTTP, MQTT, AMQP and more. These protocols are still in early phases of development and different IoT vendors come up specific protocol standards. Since these are new protocols, current performance testing tools may or may not support them.

1.IoT devices or sensors spread across different places and use different network to connect to servers to send and receive data. As a part of PT, we can simulate devices from different locations using different networks such as 2G, 3G, 4G, Bluetooth, WIFI etc.

2.Sometimes IoT implementations require the data from device that needs to be processed at runtime and based on data received, corresponding decision to be made. These decisions are generally notifications or alerts. As a part of PT, these notifications are to be monitored i.e. time taken to generate the notification.

Performance testing approach on IoT Framework	
Section	**IoT PT**
Simulation	On devices or sensors
Scale	Few devices to thousands of devices
Protocols	IoT uses non-standard and new protocols to communicate
Requests/Response	IoT devices create the requests and receive response as well as request and provide response
Amount of data	Sends and receives minimal data per request but data is shared continuously with time interval

Table 7.3: *Performance test on IoT framework*

7.6Performance Test Cases

Following are the scenarios where performance testing can be performed on IoT framework.
Device to device communication
Device to server communication
Server to server communication
Network bandwidth, latency and packet loss
Based on above scenarios and focusing the scope of this project, below are the performance test cases that are tested on this project.

Test Objectives: Time taken to send data to cloud

TEST CONDITION	OUTPUT SPECIFICATION	OPTIMAL
Time taken to send sensor data to MySQL database in cloud.	Micro controller sends data every 15 seconds to cloud. Here network plays important role and time taken to send each record is <200ms including response time. But if there is issue with network bandwidth then performance will be deteriorated as system takes additional to check network connectivity and send data to cloud.	TRUE

Table 7.4: Test case checking time taken to send data to cloud

Test Objectives: Time taken to initialize GSM Module

TEST CONDITION	OUTPUT SPECIFICATION	OPTIMAL
Time taken to initialize GSM module to identify network and enable internet	Micro controller executes set of commands on GSM module which takes 2min to 5min once the system powered on. And once network is found and connected, system would be able to send data in a real time.	TRUE

Table 7.5: *Test case for checking time taken to initialize GSM*

Test Objectives: Time taken to initialize GPRS Module

TEST CONDITION	OUTPUT SPECIFICATION	OPTIMAL
Time taken to initialize GPRS module to identify location coordinates	Micro controller GPRS module takes 5min to 15min to identify coordinates once system powered on. Once GPRS module fetch coordinates, data is sent in real time.	TRUE

Table 7.6: *Test case for checking time taken to initialize GPRS*

Test Objectives: Time taken to relay patient data on web page

TEST CONDITION	OUTPUT SPECIFICATION	OPTIMAL
Time taken to fetch data from cloud and view it on web	Time taken to run query and relay information on web page is <500ms	TRUE

Table 7.7: *Test case for checking time taken to fetch data from cloud and relay on web*

Test Objectives: Time taken to relay patient data to Micro controller

TEST CONDITION	**OUTPUT SPECIFICATION**	**OPTIMAL**
Time taken to fetch data from sensors to Micro controller	Time taken to fetch data from sensor and relay information to Micro controller is <50ms	TRUE

Table 7.8: *Test case for checking time taken to fetch data from sensor to Micro controller*

Test Objectives: Time taken to send SMS alert by GSM Module

TEST CONDITION	**OUTPUT SPECIFICATION**	**OPTIMAL**
Time taken to send SMS alert.	GSM Module sends SMS alert to doctor and caretaker in real time.	TRUE

Table 7.9: *Test case for checking time taken to send SMS alert*

Test Objectives: Time taken to send Email alert by GSM Module

TEST CONDITION	**OUTPUT SPECIFICATION**	**OPTIMAL**
Time taken to send Email alert.	PHP API sends email alert to doctor and caretaker in real time.	TRUE

Table 7.10: *Test case for checking time taken to send email aler*

Test Objectives: Time taken to display patient history data on web page

TEST CONDITION	**OUTPUT SPECIFICATION**	**OPTIMAL**
Time taken to display patient vitals history data.	PHP API displays history of patient's data in real time. This scenario has been tested with mock data dump of >100000 records and system is able to relay data on web page in one second.	TRUE

Table 7.11: *Test case for checking time taken to display patient history*

7.5Fault Tolerance

There is chance that any of the above test cases fails in this architecture. Sometimes sensors may get damaged, run out of power, communication between GSM module and server may be interrupted due to unavailability of network, GPRS module may not fetch location coordinates or relaying information from board to server may delayed due to network unavailability. Fault tolerance is an ability to sustain sensor network functionalities without any interruptions due to failures in sensors, network etc.

In case sensor failures, data fetched from other sensors would be sent to server along with notification of failure in any of sensor. And if there is any GSM network failures, WIFI module can be installed along with GSM module which would effectively send the data to server without any failures in delaying and sends an email alerts in case of emergencies but not SMS alerts. In case of GPRS module failure, only last known location will be shown on web page, and SOS feature can be implemented in the device which would be used to find location of the patient

CHAPTER 8
CONCLUSION, LIMITATION, AND FUTURE SCOPE

The authors of this work proposed a remote patient monitoring system based on the internet of things. The system collects various psycho;ogical data from patient such as heartrate, temperature, humidity, toxic gas air quality and pressure with the goal of simulating fault detection and providing early warnings. In case of emergency. The data is stroed in a cloud based database that can be accessed remotely by health care providers and can also be used for medical researxh. To protect patient data, the database is secured with the advanced encryption standards which generate a secret key for decryption, This ensures that only authorized person can access the data thus, preventing unauthorized accesses by hackers.

8.1Conclusion:

The experiment successfully achieved its main objective. All individual modules, such as the Heartbeat detection module and the fall detection module, gave the intended results, as did the remote viewing module. All circuit components used in the remote health detection system are easily available, which is an essential aspect of its design. The development of Micro Electro Mechanical Systems (MEMs) and microcontrollers, and the increased internet penetration through mobile phones and the Internet of Things (IoT), has led to more embedded systems in healthcare, which specialists are adopting. The Remote Health Care system utilizes these concepts to improve people's quality of life. The project applied the concepts learned during the computer science and embedded study period, such as Electric circuit analysis, Electromagnetic fields analysis, and Software programming to design and fabricate individual modules and create a finished circuit system.

8.2Limitation:

In this paper, we conducted a comprehensive survey of big data analytics in the IoT healthcare domain. We conducted a thorough study of the literature and identified relevant and up-to-date surveys to identify research gaps. Additionally, we provided a detailed discussion of the state-of-the-art literature on machine learning-based techniques for big data analytics in IoT smart health, including their strengths and weaknesses. This provides insight to readers in this domain and enables them to choose a topic from the available pool of techniques. We also discussed various research issues and challenges, which motivate researchers to further explore this domain. Furthermore, we thoroughly discussed issues that arise due to emerging cross-domain architectures of IoT, such as the Internet of Nano-Things (IoNT) and the Web of Things (WoT), to enable a universal IoT vision that successfully integrates this technology in almost all domains, and hopefully improves our daily lives in the future.

Security and privacy: Security and privacy remain a major concern deterring users from using IoT technology for medical purposes, as healthcare monitoring solutions have the potential to be breached or hacked. The leak of sensitive information about the patient’s health and location and meddling with sensor data can have grave consequences, which would counter the benefits of IoT.

Risk of failure: Possible plagiarism-free rephrased version: Issues such as hardware malfunction or power outage can affect the functioning of sensors and other connected equipment, leading to risks in healthcare operations. Moreover, neglecting scheduled software updates can be more dangerous than missing a doctor's appointment.

Integration: There’s no consensus regarding IoT protocols and standards, so devices produced by different manufacturers may not work well together. The lack of uniformity prevents full-scale integration of IoT, therefore limiting its potential effectiveness.

Cost: While IoT promises to reduce the cost of healthcare in the long term, the cost of its implementation in hospitals and staff training is quite high.

8.3Future Scope:

The use of IoT in healthcare is growing rapidly and projected to continue increasing in the future. Medical experts are continuously seeking to improve healthcare and medical services by leveraging advanced technical solutions, including IoT. According to a report by Straits Research, the market for IoT healthcare technology is expected to rise to $486 billion by 2031 due to factors such as increasing demand, improvements in 5G connectivity and IoT technology, and growing acceptance of healthcare IT software. Tech giants such as Apple, Google, and Samsung are also investing in bridging the gap between fitness-tracking apps and medical care. The market revenue of IoT in the healthcare sector was $74.31 billion in 2022 and is projected to reach $135.87 billion by 2025. However, while the growth of IoT in healthcare is impressive, potential security and privacy concerns should also be taken into consideration.

From virtual healthcare assistance to enhanced medical examination, the applications of IoT in healthcare are constantly expanding.

Data collection- Automated and original data collection from circuits across the world

Scope of Study- Data collected can be used for studying further

Applications and future inspiration-

Home Ultrasound

Brain signal monitoring

Remote viewing of data

Physiological data collection

Home Ultrasound

Brain signal monitoring

Remote viewing of data

Problems associated with having data online. Tackle Distributed denial of service. DDOS, and Data privacy/security especially of medical systems.IoT based Remote Patient Monitoring System can be enhanced to detect and collect data of several anomalies for monitoring purpose such as home ultrasound, Brain signal monitoring, Tumor detection etc More research on problems associated with having data online, data privacy as IoT is managed and run by multiple technologies and multiple vendors are involved in it. Security algorithms and certain precautions by the users will help avoid any security related threats in IoT network.The interface can be designed to control which sensors can be used by consumers according to their needs.Web UI can be enhanced to perform

several activities which include controlling the hardware, real-time graphs, history and analysis graphs to observe anomalies etc

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