

Development of Application based Health Monitoring System using GSM module



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DECLARATION

A Thesis Submission to the Department of Computer Science and Engineering, BRAC University, Bangladesh. We hereby declare that this thesis has the results entirely based on our findings. Assistance taken from any portion of work ideas conducted by other researchers are mentioned through reference. This thesis has not been previously submitted for any degree.

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TABLE OF CONTENTS

	<u>PAGE</u>
ABSTRACT.....	1
DEDICATION.....	2
ACKNOWLEDGMENTS.....	3
CHAPTERS	
CHAPTER 1 – Introduction.....	4
1.1 Motivation.....	5
1.2 Overview.....	6
1.3 Objectives.....	6
CHAPTER 2 – Background Study and Literature Review.....	8
2.1 Introduction.....	8
2.2 Microcontroller.....	8
2.3 GSM Technology.....	9
2.4 Wireless Body Area Network (WBAN)	10
2.5 Web Server.....	10
2.6 Literature Survey.....	12-17
CHAPTER 3 – Working Methodology.....	18
3.1 Introduction.....	18
3.2 System Model.....	19
3.3 Hardware Implementation.....	20-24

3.4 Connection Set-Up.....	25
3.5 Web Server Implementation.....	27
3.6 Mobile Application Implementation.....	31
3.7 Technical Specification.....	32
3.8 Work Flow of Mobile Application.....	32
3.9 Features.....	33
3.10 Feasibility Analysis.....	34
3.11 User Interface.....	35-44
3.12 Extracting Data from Blood Pressure Machine.....	44-48
CHAPTER 4 – Result and Data Analysis.....	49
4.1 Result Analysis	49
4.2 Result Display	50
4.3 BP measurement Issue.....	53
4.4 Cost Analysis.....	54
CHAPTER 5 – Conclusion.....	56
5.1 Challenges.....	56
5.2 Future Work.....	58
REFERENCES.....	60

List of Tables

Chapter Four	PAGE
Table 4.1: Comparing output with expected output.(Temperature).....	49
Table 4.2: Comparing output with expected output.(Pulse)	50
Table 4.3: Output from Digital BP machine.	54
Table 4.4: Output shown in the Serial Monitor.	54
Table 4.5: Initial Cost Calculation.....	55

List of Figure

Chapter Two

Figure 2.1 GSM History.....	9
Figure 2.2 Block Diagram of Transmission Section.....	13
Figure 2.3 Block Diagram of Receiver Section.....	13
Figure2.4 Block Diagram of Patient Monitoring and Alerting System Using GSM.....	14
Figure 2.5 Pulse Data Comparison between Industrial Sensor and Experimental Sensor.....	16
Figure 2.6 Body Temperature Data During Different Physical Activities.....	17

Chapter Three

Figure 3.1 Work Flow of the System.....	18
Figure 3.2 System Model of Patient Health Monitoring System.....	19
Figure 3.3 Arduino Uno.....	20
Figure 3.4 Temperature Sensor DS18B20.....	21
Figure 3.5 GSM Module.....	22

Figure 3.6 Pulse Sensor SEN11574.....	23
Figure 3.7 Arduino Uno Configured with DS18B20.....	25
Figure 3.8 Arduino Configured with Pulse Sensor.....	26
Figure 3.9 Hardware Connection Setup.....	26
Figure 3.10 Web Server Implementation work flow.....	28
Figure 3.11 User Table.....	29
Figure 3.12 User Table with Data.....	29
Figure 3.13 Owlsyard_gsm Table.....	30
Figure 3.14 Owlsyard_gsm Table with Data.....	31
Figure 3.15 Flowchart of Patient Application.....	36
Figure 3.16 Patient Registration and Login Interface.....	37
Figure 3.17 Patient Update Information.....	38
Figure 3.18 Patient's Information View Interface.....	39
Figure 3.19 Flowchart of Doctor Application.....	40
Figure 3.20 Doctor Registration and Login Interface.....	41
Figure 3.21 Patient List Interface.....	42

Figure 3.22 Doctor's Application View.....	43
Figure 3.23 Email Notification.....	44
Figure 3.24 Digital Blood Pressure Machine after Soldering.....	46
Figure 3.25 Connection with Arduino.....	47
Figure 3.26 Result Shown in Serial Monitor	48

Chapter Four

Figure 4.1 Result of temperature sensor and pulse sensor in Arduino serial monitor.....	50
Figure 4.2 Data sent by the GSM modem is received with confirmation message.....	51
Figure 4.3 Different Tabs of Application.....	51
Figure 4.4 Email Sent to Emergency Contact with Abnormal Readings.....	53

ABSTRACT

Ongoing patient health checking framework with remote sensor system using delicate registering is an innovative concept that has been already introduced in developed country in recent years. Body Area network is implemented by using compact sensors that gather and assess body parameter and development. The device gives few assistant capacities that satisfy the living request of patients. What's more it uses different sort of sensors to obtain ceaseless key signs of patients counting heart rate and body temperature. Transmission of these patients' records over web is done by GSM module to web server where database is stored. Moreover, it will produce a prediction on patient's wellbeing condition based on summation of all records of patient. Generated report will be shown on web application. With the assistance of web application both doctor and patient can have real time communication. The prototype has been effectively implemented where data has been obtained and shown. The purpose to build the prototype is to help people in developing countries as they still lack access to medical technology and proper diagnosis and treatment in proper time.

DEDICATION

We would like to dedicate our work to our Creator without Whom the existence of science let alone the existence of us was impossible. Since the enormity of science is expanding in every sector it gives us the chance to explore from the gazillion ideas yielding day to day. And Computer Science Engineering is just another sector of what science has provided us with.

We cannot question the formidable role of our parents in our life. Our supervisor, Dr. Amitabha Chakrabarty, who has supported us when we were in turmoil. Peers, who showed such inexplicable generosity and motivated us when we were almost at the verge of giving it up.

So, we dedicate our effort to our dear parents, our respectable supervisor, every other single being who have assisted us practically and impractically.

ACKNOWLEDGEMENTS

Without this thesis our undergraduate program is incomplete and this thesis has given us the opportunity to create a platform where we could demonstrate parts of what we have learned in the past years. This thesis project has introduced us with the idea of using GSM module in the most important the spot of our lives, which is health. Mahatma Gandhi once said, “It is health that is real wealth and not pieces of gold and silver”, which is merely to be proved wrong. We used the concept of GSM module’s wireless network connectivity to build a project which could be used by people of all ages and people, coming from different walks of life.

We want to thank our supervisor, Dr. Amitabha Chakrabarty, for his regulations. Without his directions we might not have been able to reach this far.

We do not want to miss this chance to give special gratitude to our dear brother, Md. Rayhan Alam, who has been a great support throughout our thesis period.

Lastly, we can never be too grateful to our loving parents for their blood, sweat and tears. We will always remain in debt of what our parents have provided us with. They have always encouraged us to gain knowledge despite the prejudices existing on our society for the girls. It is because of them and their effort we have reached this far.

Chapter One

Introduction

Advancement in medical technologies have made rapid changes in e-health care system. An innovative and effective e-health monitor model with wireless technology can be a great help for the people of developing countries.

The technology provide assistance physicians to better diagnose and treat patients not physically presence on spot as sometimes it's crucial to provide remedy or treat patients who are unluckily away from well treatment. In modern era advanced medical technology effectively contributing in our personal lives. This assists on improving and saving countless lives all around the world. Medical technology is a broad field where innovation plays a crucial role in sustaining health.

A Body Area System is characterized by IEEE 802.15 as, '*a communication standard optimized for low power devices and operation on, in or around the human body to serve a variety of applications including medical, consumer electronics/personal entertainment and other*'. [1] Wireless body area framework is a key technology of nonstop wellbeing observation which is more proactive and provides reasonable medical service. The point of remote body region system is to encourage consistently recording and checking of a man's wellbeing condition and exchange it over a long separation communication. [2]

The existing medical environment in developing countries allows patients to appear physically for regular health checkup or patient needs to get admitted for continuous observation. The system is non-flexible and time consuming. Today remote sensor system allows patients to control their daily lifestyle constantly from anywhere at any places. Hence, to support real time patient health monitoring, in this work we

propose constant health monitor of a person by transmitting one's body temperature and heart rate's data utilizing GSM module to a web server that is accessible to both doctor and patient. Potential utilization of remote e-health framework is useful for regular checkup, crisis alert to avoid further critical situation based on patient's constant record. According to American Heart Association treatment within first 12 minutes can bring positive rate about 45% to 60%. [3] Here it is mentionable that the proposed design is aimed for everyone including patients to keep their regular health condition's record and create a flexible environment between doctor and patient by checking persistent well-being of ones.

1.1 Motivation:

When we fall ill we go to doctors which is very time consuming and also expensive. In a developing country like Bangladesh, the only way to communicate with the doctor efficiently is to visit them. The patient visits the doctor then he gets few vital data and prescribes based on it or asks to run some tests if needed. But visiting doctor even for a simple matter is pretty time consuming and sometimes it is not easy to get his appointment. Then again, the doctor might need to monitor his regular patient from a remote area and it sounds expensive.

Our proposed system is the solution to this problem. The system is based on wireless body area network. WBAN also known as Body Sensor Network (BSN). This is basically a network of wearable computing device. Usage of GSM module has become very popular now a day. It is used to establish connection between a GPRS system and a computer. GPRS is used for data transmission and reception application. It could be done with transceiver which is used for data sending and receiving. But in our system we used GSM module which is GPRS enabled because of its area coverage. But RF transceiver does not cover a long area as GSM module.

Android is very popular because of its multipurpose applications. It is a mobile operating system developed by Google which is based on Linux kernel. It is designed for touchscreen devices such as mobiles, tablets etc. The source code of Android is owned by Google and it is open for development. Android is used because it is user friendly, of its low cost and it is also customizable. 71% of mobile developers are using Android to develop applications.

Our proposed system is a low cost wearable device with an web-based application for Android. Patient is monitored by the doctor from a remote area. The device will be used to take data/ vital signs from the patient and then it is sent to the database where it will be stored. Then the doctor can see the data through an Android application. This kind of application is used in developed countries. But in a developing country like Bangladesh, it is not seen yet due to cost issues. This will be a suitable prototype for health monitoring considering the cost and other environmental factors will be a fruitful project for a developing country like Bangladesh. Smartphone is now widely used among mass people in Bangladesh which can be used as a application development platform for remote health monitoring. Our thesis is an attempt to develop a system that will use GSM module to send data such as Pulse Rate, Temperature to the database.

1.2 Overview

Our system is the solution to monitor patient from a remote area which is cost efficient. We have built a device that will take pulse rate and temperature as inputs of a patient and then it will send data through GSM module to our database. We also have developed android based mobile application through which the user(doctor/patient) can see those information in a chart. The doctor thus can monitor his patient.

Any project needs to be cost efficient and it is very important for any project. In terms of our project there will only be a specific amount of cost for the device. The application is free for any user. To keep maintenance cost and operation cost lower but also to provide better service, we planned to use GSM module, pulse sensor SEN11574 and dallas temperature sensor.

1.3 The main objective of our thesis are:

- Create convenient communication among doctors and patients:**

Our system is a platform and through this system doctor and patient can communicate easily. Patients do not have to go through hassle to reach the doctors.

- **Monitoring multiple patients at a time:**

Doctor can monitor his patients continuously. He does not need to be present there physically to get the data. This is definitely a convincing reason.

- **Provides flexibility in health management:**

This system will provide flexibility in health management.

- **Saves time for both doctors and patients:**

As the doctor and patient can communicate and the doctor can monitor him from a remote area, it saves time for both doctors and patients.

- **Cost efficient for developing countries:**

Our system is cost efficient and it also gives almost accurate output. So, the project is efficient for developing countries like ours.

- **Reduce burden of traveling to doctor's chamber:**

The main purpose of our system is that the doctor can monitor the patient from remote area. Our device can also be used at home and there is an application through which the patient can communicate with the doctor.

- **User friendly interface:**

We have introduced an application for both users (doctor and patient). This application has a user friendly interface which is easy to use and that is very simple application.

Chapter Two

Background Study and Literature review

2.1 Introduction

GSM modem is a widely used gear among this generation's people. GSM modem's common features is that it does the job of sending/receiving texts, making/receiving calls just like any other cell phone with a SIM card in it. But it has also the property of being connected to the internet via GPRS enable.[1] With the GPRS mode on, GSM modem can be linked with a web server and can send data to that server. Above all in order to work with the GSM modem without connecting it directly to computer serial port, microcontrollers are used to configure with it.

2.2 Microcontroller

Microcontroller itself has the components of executing any task without the help of external devices. [2] Arduino is by far the most used microcontroller, especially by the people who like to experiment varieties of project ideas, some use it merely because of their hobbies as well. So basically microcontroller is a computer integrated in a single chip. This single chip contains a central processing unit, memory registers and input output peripherals. [4]

Arduino is very easy to operate and work with, even though it is a very powerful computer like gear. [3] Arduino is open source electronic gear meaning it costs an affordable price for its hardware and the software for running the microcontroller is free for everyone.

Arduino can be connected with various sensors or other electronic component to build a device, which will be able to do certain functionality.

2.3 GSM Technology

GSM stands for Global System for Mobile Communication, which was formerly named ‘Groupe Spéciale Mobile’. The European Conference of Postal and Telecommunications Administrations which is the CEPT committee, they first developed this GSM technology.

GSM History:

Time	Events
1982	CEPT establishes a GSM group in order to develop the standards for a pan-European cellular mobile system
1985	Adoption of a list of recommendations to be generated by the group
1986	Field tests were performed in order to test the different radio techniques proposed for the air interface
1987	TDMA is chosen as access method (in fact, it will be used with FDMA) Initial Memorandum of Understanding signed by the telecommunication operators (representing 12 countries)
1988	Validation of the GSM system
1989	The responsibility of the GSM specifications is passed to the ETSI
1990	Appearance of the phase I of the GSM specifications
1991	Set date for the ‘official’ commercial launch of the GSM service in Europe
1992	Actual launch of commercial service, and enlargement of the countries that signed the GSM – MoU > Coverage of Larger cities / airports
1993	Coverage of main roads GSM services start outside Europe
1995	Phase II of the GSM specifications Coverage of rural areas

Figure 2.1 GSM history [5][6]

GSM (Global System for Mobile communication) is a digital mobile telephony system that uses a variation of time division multiple access (TDMA). It is the most widely used among the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band. GSM, along with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio System (GPRS), Enhanced Data GSM Environment (EDGE), and Universal Mobile Telecommunications Service (UMTS).

A GSM technology has provided the users of it an solution to build projects consisting operations of a normal cell phone. With the advanced technology GSM has the option for GPRS enable as well which facilitates in wireless data communication.

2.4 Wireless Body Area Network (WBAN):

Wireless Body Area Network refers to such a network where data from sensor nodes are collected wirelessly and may be stored in database for further specification. In the medical sector wireless services play a formidable role. Patient Health Monitoring systems can be built under such concept. For remotely monitoring patient BAN(Body Area Network) provides a platform for the doctors . A doctor may not be able to monitor a patient being physically present all the time. But if a system is built using WBAN where there is going to be a part of sensors and then a part of web server to store data coming from the sensors part and the doctor has the access to view his patient information it will work wonders. Wireless communication without any laptop, computer in between the WBAN-based device and the web server is the main functionality of a WBAN system. Body Area Network is basically wearable computing devices. Such computing devices can work wirelessly. WBAN offers independent movement of the device. The sensors attached to body can be carried anywhere the patient moves. Such flexibility of the wireless body area network puts forward many other challenging applications of it.

2.5 Web Server:

Web server has become a very common criterion when building websites, mobile application etc. Web Server can be a computer or computer like device which works as a medium to store data, files and to provide services to other computers or network devices. Over the internet a web server offers service to end users. In order to that it has to have a gateway to connect it to the internet. There is software for the web server to assist it with the HTTP communications. So, the web server has a server, software for HTTP communications and an operating system to operate its functionality.

A website can contain all its information in a web server. The web server may have one or more databases to facilitate the functionality of a website.

Database:

Database is the most widely used component in web server. Database is referred to a collection of data which must have inherent meaning and there should be relevance of those data to the aspects of real world. [7] In order to manage a database there is a system called DBMS. DBMS stands for Database Management System. DBMS is a compilation of programs which facilitates the building of database system and the maintenance of a database. DBMS can be foreseen as an outline of three levels;

1. Storage Level
2. Internal Level
3. Conceptual Level

A DBMS provides the user of it the following utilities [7] -

Concurrency is allowed meaning the database can be used for different purposes at the very same time

DBMS gives the control over the security. A database can be used to build a user login-based website. The DBMS can be used to protect the security of such website as well as it can control the security of a database.

DBMS helps to maintain data integrity meaning the data from the database lack corruption and have internal consistency.

The biggest advantage of DBMS is that it reduces redundancy to a degree which makes the database quite efficient to use.

MySQL:

Any kind of database needs to be managed in order to get desired output for a system. MySQL is the most well recognized Database Management System in today's era.

MySQL is an open source Database Management System which gives any individual the opportunity to use this software. Open Source refers to being open to all users and the users of this software can modify and adjust the software based on their needs accordingly.

There can be multiple tables in a single database system managed by MySQL server. The relations can be modified by MySQL server. User can set up conditions for the data tables for one to one, many to many, one to many relations etc.

MySQL DBMS can be operated on any computer, laptop. Large database projects can be handled with ease. Such software facilitates the job of both client and server system. This management system offers better speed, connectivity in order to access a database over the internet.

2.6 Literature Survey

Since technology has reached in every corner of our day to day life, it is not an exception that it has entered in to the medical field too. The many work related to our thesis project have given us the confidence of being able to build a project for a better cause. Some of the works are discussed in the following:

This paper, “Patient Health Monitoring Using Wireless Body Area Network” [8], is proposed by Hsu Myat Thwe and Hla Myo Tun, where they made a proposal of a health monitoring system which would take temperature and pulse rate of a patient and display it on an LCD screen. At the same time the data would be transmitted through Radio Frequency network to a PC or Laptop. From that PC or Laptop data is sent to a database to store.

Their proposal includes the data transmission through sensor nodes which are built using transceivers. There will be one transceiver configured with one microcontroller at the patient end. Another one will be configured with another microcontroller and connected a PC/Laptop for a doctor to check. The patient end part consists of a microcontroller which will receive data from a

pulse sensor and Temperature sensor connected to it. The transceiver at this end will send data through the Radio Frequency network.

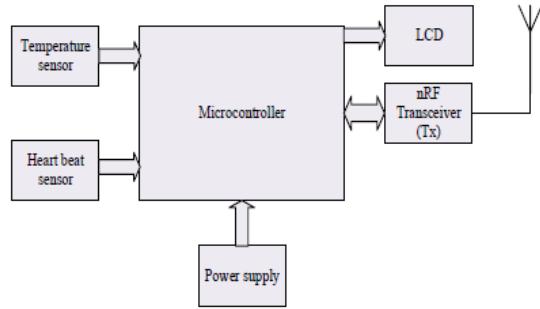


Figure2.2: Block Diagram of Transmission section[8]

In the LCD screen it will show the data received by the both sensors as well.

On the other end the receiver (another transceiver) will receive the data sent by the sender node. Since the microcontroller is configured with the PC, with the help of a GUI it stores the data in the database. A Graphical User Interface is designed in such a way that it will store the data after the microcontroller receives data of pulse and temperature sent by the transmission node.

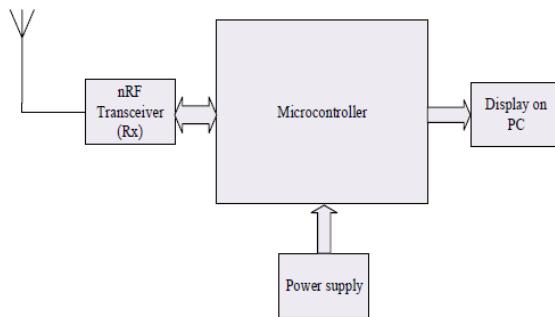


Figure2.3: Block Diagram of Receiver section[8]

One of the main components from this proposal is Nrf24L01 module. This module is most likely to be used in applications in order to communicate data wirelessly in ultra-low power.[8] Microcontroller is used to change the mode of this module's operation; Transmitter and Receiver.

The temperature has been taken using temperature sensor LM35, the pulse sensor is used to take the pulse rate. Lastly, the sensor nodes which are the sender nodes as well and the receiver nodes are configured with ATmega328. Alongside ATmega328 in the base station Arduino Promini is used as the programmer of the ATmega328 microcontrollers.

So this paper has published a way of transmitting data of a patient through Radio Frequency network at a remote PC. That PC has to stay within a range of the RF network. Further, a doctor can access the data from that PC and monitor patient health.

This paper, “*Patient Monitoring And Alerting System By Using Gsm*“, is published by Shrenik Suresh Sarade, Nitish Anandrao Jadhav, Mahesh D. Bhambure. Their paper is based on a Patient Monitoring and Alerting System using GSM module[9]. The main purpose of this paper is to build a system that will give an alert message to the doctor whenever there is seen abnormality in the patient vital signs.

As vital signs a patient’s heart rate and temperature is taken. Another data which they have taken is of a glucose level contained on a bottle.

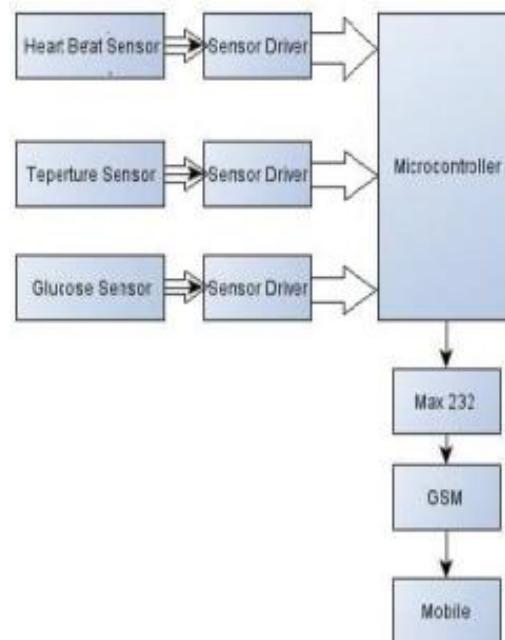


Figure2.4: Block Diagram of Patient Monitoring and Alerting System using GSM[9]

The paper is based on a microcontroller configured with GSM module and some sensors. Heart beat rate is measured using IRD sensors, where IRD refers to Infra Red Device. A threshold value will be set in the program by the programmer. If the value of heart beat rate sensor or temperature sensor exceed the threshold values prescribed then the GSM module sends a text message to the doctor's phone number. Doctor receiving the text can take certain measurements needed for the alert situation afterwards.

Another paper "*Bluetooth Based Patient Monitoring System*" was proposed by P. Vignesh. Their proposal is to monitor patient's conditions using Bluetooth. The vital signs are acquired by sensors. The output is transmitted via Bluetooth. There would be a remote wireless monitor to monitor patient. It is constructed of monitor and Bluetooth.

The present monitor system allows continuous monitoring of patient's vital signs. It requires sensors to be placed nearby and the patient needs to stay on bed. An assistant needs to be there to record all the data manually. This is a very complicated method and also error prone. In their current proposed system patient's health is monitored continuously and the acquired data is sent to a centralized microcontroller using Wireless Sensor Network. In this system a Bluetooth transceiver is connected to patient monitor system which consumes low power and is very small. The Bluetooth that they used in their system covers 10m of area. For efficiency and accuracy, they used centralized microcontroller that is integrated with Bluetooth. In their system vital parameters of patients are logged automatically for easy access. Doctors can access records through mobile phone. Their system has several nodes for transmission and acquisition which are:

- a. Signal acquisition node
- b. Microcontroller processing node
- c. Bluetooth transfer node
- d. PC monitoring node

The signal acquisition node is used to collect the vital data from the patients. The collected data are processed by the microcontrollers in microcontroller processing node. Bluetooth transmitters

were used to transmit signals and Bluetooth receivers were used to receive them by the end. This is called Bluetooth transfer node. Then for monitoring they used real time purpose computer.

Wireless network has become a vast area to explore. Already numerous projects are done based on wireless sensor network. Few of them includes patients' health monitoring continuously at home or hospital. Some researches based on health monitoring are discussed on the following section.

A paper *Implementation of wireless body area network for healthcare monitor* is published by Aime V. Mbkop, Ashenafi based on using Wireless Body Area Network in an inexpensive way to collect vital signs of a patient and display them. The network architecture of this paper is based on single hop star topology that is sending continuous data without any interruption. Authors proposed the system in a way where the system consist of two nodes and base station. They have worked on temperature, pulse rate sensor and to detect patient's location. According to the proposed system each node includes sensors, GPS module and ZigBee wireless module. They have used one wearable pulse sensor that consume 4mA, one TMP36 analog temperature sensor, one GTPA013GPS module that consume 20mA current, a battery, a arduino Uno microcontroller and a ZigBee wireless module. The nodes served as transmitters to collect data and then transmit them to base station. The main task of the base station is mainly to coordinate two transmitting nodes by sending data request periodically.

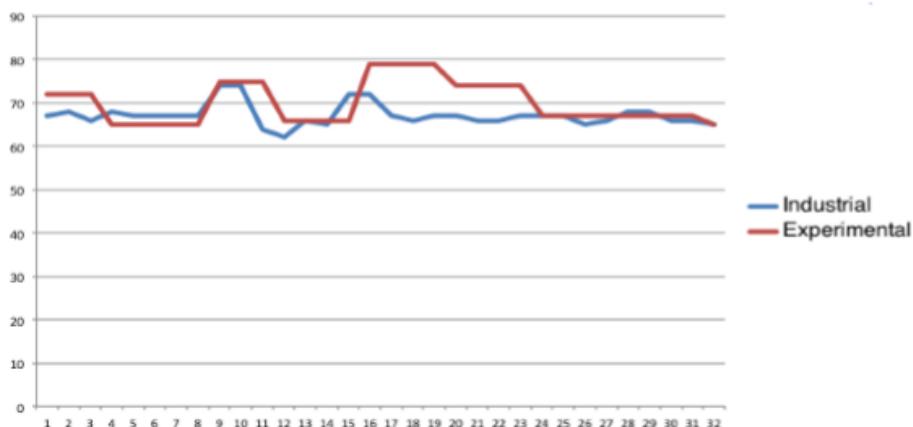


Figure 2.5 Pulse Data comparison between industrial sensor and experimental sensor

Base station includes an Arduino Uno microcontroller, a receiving ZigBee module and a Wi-Fi module. [4] They have designed the system where system will operate only within 30m range from base station. They have designed a website to display result using php and html. MySQL has been used to prepare database. The data from sensors have transmitted to website wirelessly through Wi-Fi shield. Whenever a new record is found, by refreshing it is displayed to the users. The server also keeps the previous data saved for any kind of future necessity. The paper also contained reliability by comparing accuracy using industrial sensors and experimental sensors where both gave almost similar result. Authors have shown the data analysis through the graphs which are given below [4].

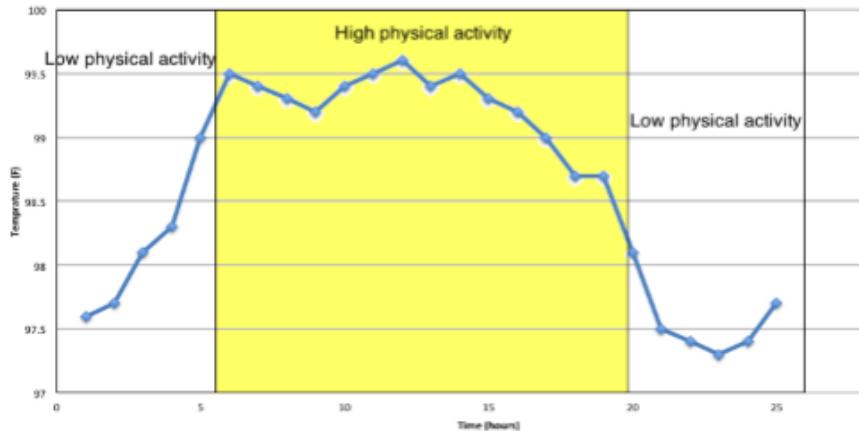


Figure 2.6 body temperature data during different physical activities

Chapter Three

Working Methodology

3.1 Introduction:

There will be few sensors like temperature sensor, pulse sensor to detect patient's temperature and heart rate. For this we will need sensors, arduino uno and a power source. After taking the reading from the patient, the data will be sent to the database through GSM module. All data along with patient's other information such as name, age etc. would be stored in the database. Doctor can see the reading from a distant area only by logging into his/her account. Both the patient and doctor mobile application will show the patient's, data.. Internet connection is mandatory to use this system. GSM modem is used to make the device wearable. The patient can move from one place to another with the device and this will not cause the doctor any problem to monitor.

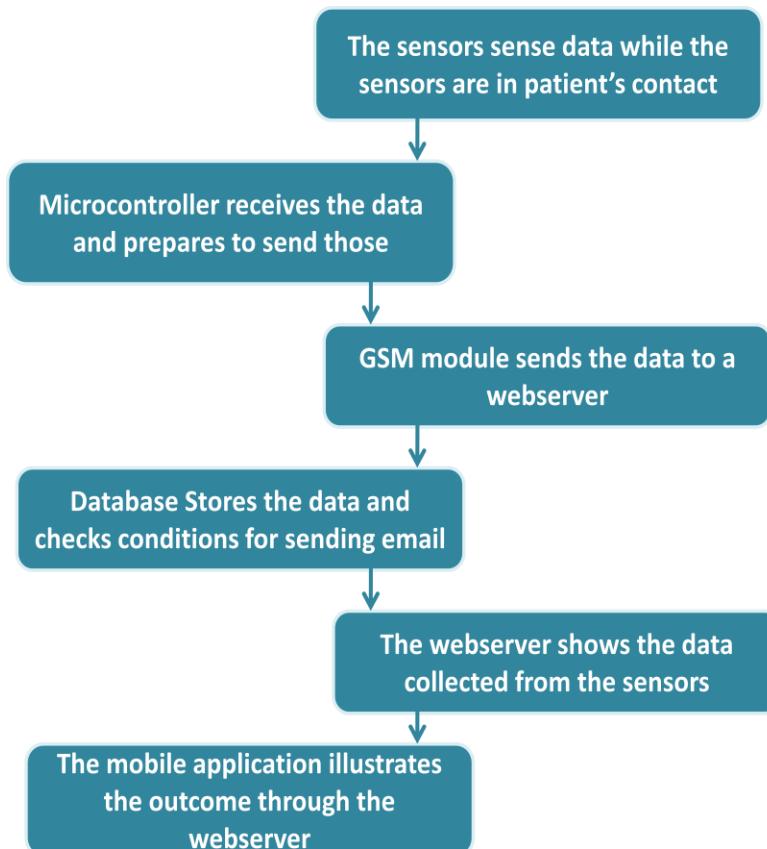


Figure3.1: Work Flow of the System

For the work flow of our system we can articulate that this Patient Health Monitoring system comprises of both a hardware part and a software part. Along with the software part we are using a database in a web server as a storage for the accumulated data from the hardware implementation. A web-based Mobile Application is also a part of the system.

3.2 System Model:

Our system model proposes a system where the vital signs from a patient are collected using temperature sensor and pulse sensor. The arduino receives the data from both the sensors. The GSM modem is turned on and the network connectivity is established by activating the internet connection. The wireless transmission of data is stored then in the database

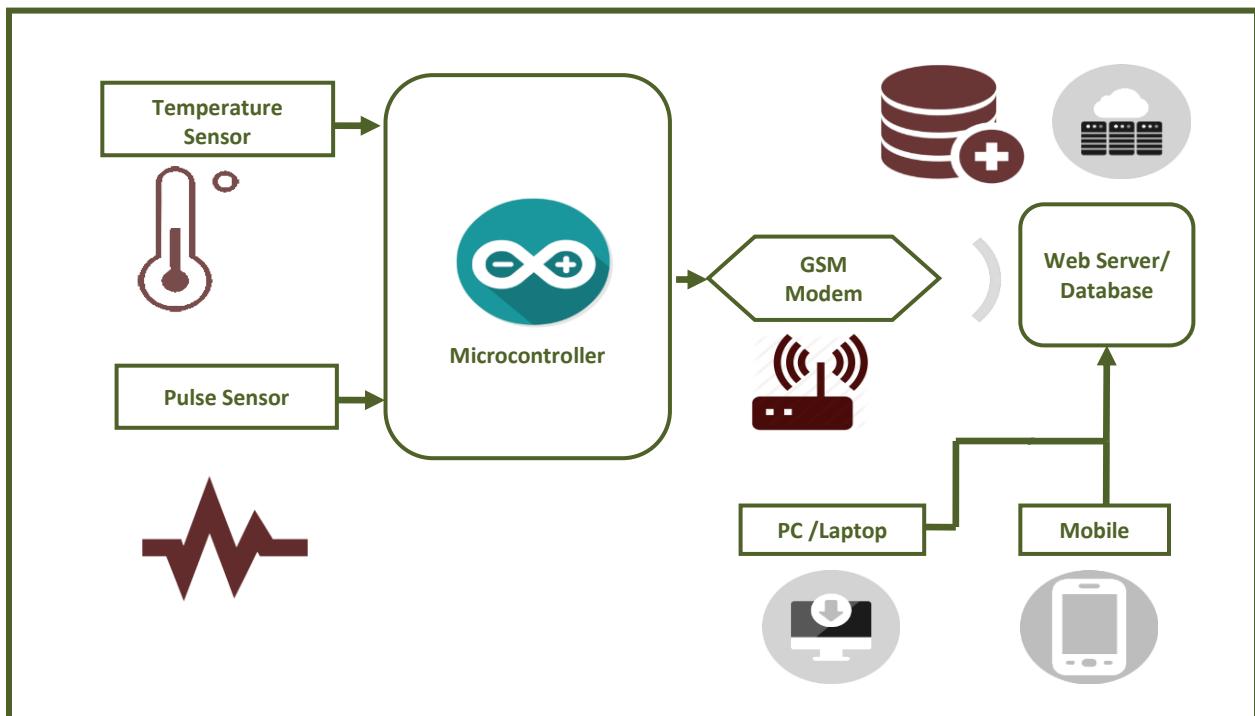


Figure3.2: System Model of Patient Health Monitoring System

3.3 Hardware Implementation:

In hardware portion we have used sensors, a microcontroller, a GSM modem to establish a wireless body area network. The device can be attached to a patient's body and the collected data will be sent to the webserver continuously. The device can be configured in such a way that it sends data after a time period prescribed. Following is a discussion based on the overview of the components used in our system.

Hardware Overview Of The System:

- Microcontroller
- Sensors
- GSM Module
- Laptop/pc

The components of the Hardware part are briefly discussed in the following:

- **Microcontroller:**

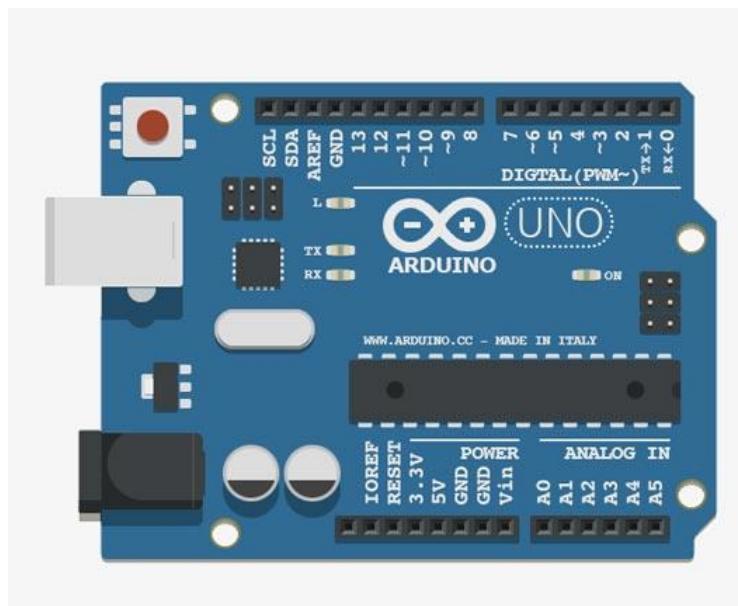


Figure 3.3ARDUINO UNO

A microcontroller does the job of a small computer (also called a microcomputer). It can conduct the operation of embedded systems. It consists of a processor core, memory and several input/output peripherals. We are using ARDUINO UNO as a microcontroller. Arduino is a very simple, flexible and open source platform yet very refined device for researching purposes. Arduino board acts as a master unit of system as it is responsible for controlling other parts.

- **Temperature sensor:**

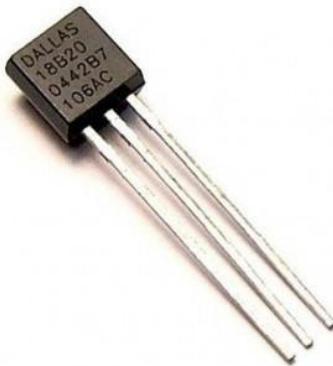


Figure 3.4: Temperature sensor DS18B20

Temperature sensor helps in detecting temperature of a surface, may it be an object or the environment in contact with it. For taking body temperature measurement we are using Dallas Temperature sensor which is widely used for evaluating temperature reading. Dallas Temperature can be configured with Arduino UNO and provide outputs of temperature reading.

- **GSM Module:**



Figure 3.5: GSM Module

We are using GSM (Global System for Mobile Communication) module SIM900A. SIM900 is in control for communicating between microcontroller unit and mobile station. SIM900A is a complete dual-band GSM module in a SMT (Surface Mount Technology) type which is beneficial for small dimensions and cost-effective solutions. With a tiny configuration of $24\text{mm} \times 24\text{mm} \times 3\text{mm}$ and low power consumption, SIM900A can fit almost all space requirements especially for slim and compact demand design.

- **Pulse Sensor:**



Figure 3.6: Pulse sensor SEN11574

Pulse sensor SEN 11574 is a very common sensor for measuring pulse rate. It is a plug and play sensor when configured with Arduino. By just simply clipping the sensor to fingertip we can collect heart rate data.

- **Laptop/PC/Smart Phone:**



- In order to access the data sent to the database from the sensors through GSM there has to be a medium. There can be multiple mediums in this world full of assistive technology devices; Such as laptop, computer, smart Phones.
- Some other hardware devices we need are adapter to give power source to the GSM module. Arduino can be connected to a PC/Laptop and get its power from that.

3.4 Connection Set-Up:

The temperature sensor, DS18B20 and the pulse sensor, SEN11574 are first configured with the Arduino Uno Board in order to get these two vital measurements from a patient.

The Dallas temperature sensor has three pins, the first pin is connected with the ground, the second pin is connected with a 4.7K ohms and then with the output pin in the Arduino board., which basically gives the temperature result. The last pin is connected with the 5volt pin in the arduino. Dallas Temperature requires OneWire and DallasTemperature libraries in the arduino library folder as well.

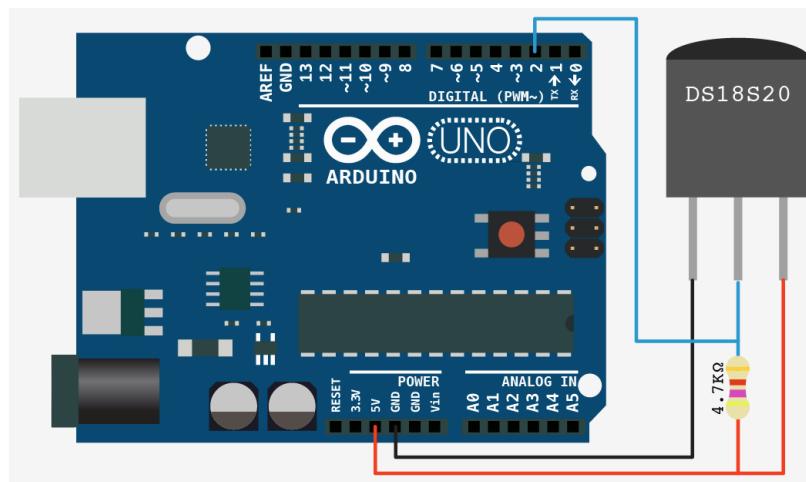


Figure 3.7 : Arduino Uno configured with DS18B20

Since the pulse sensor is simply a plug and play sensor it does not require much calculation after the data is received. The pulse sensor has three pins as well. One pin is for the signal coming from the sensed data and the other two pins are 5volts and Ground.

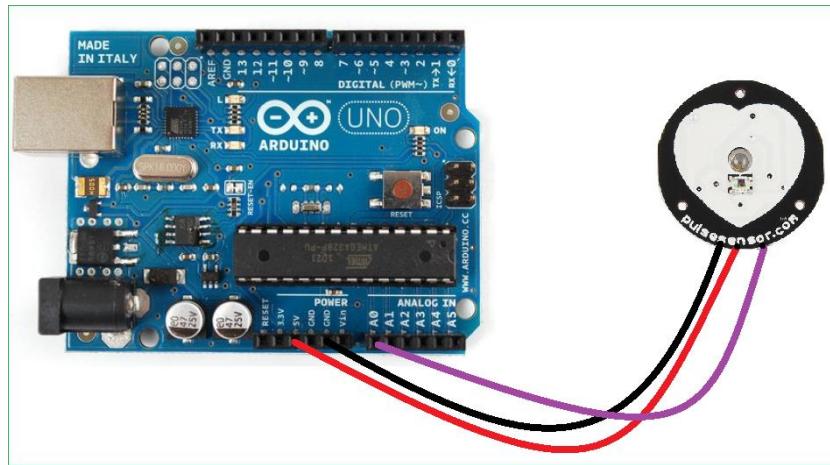


Figure 3.8: Arduino configured with Pulse Sensor

The GSM modem, SIM900A used in our project is first configured with the arduino so that it is able to send data over the internet connectivity.

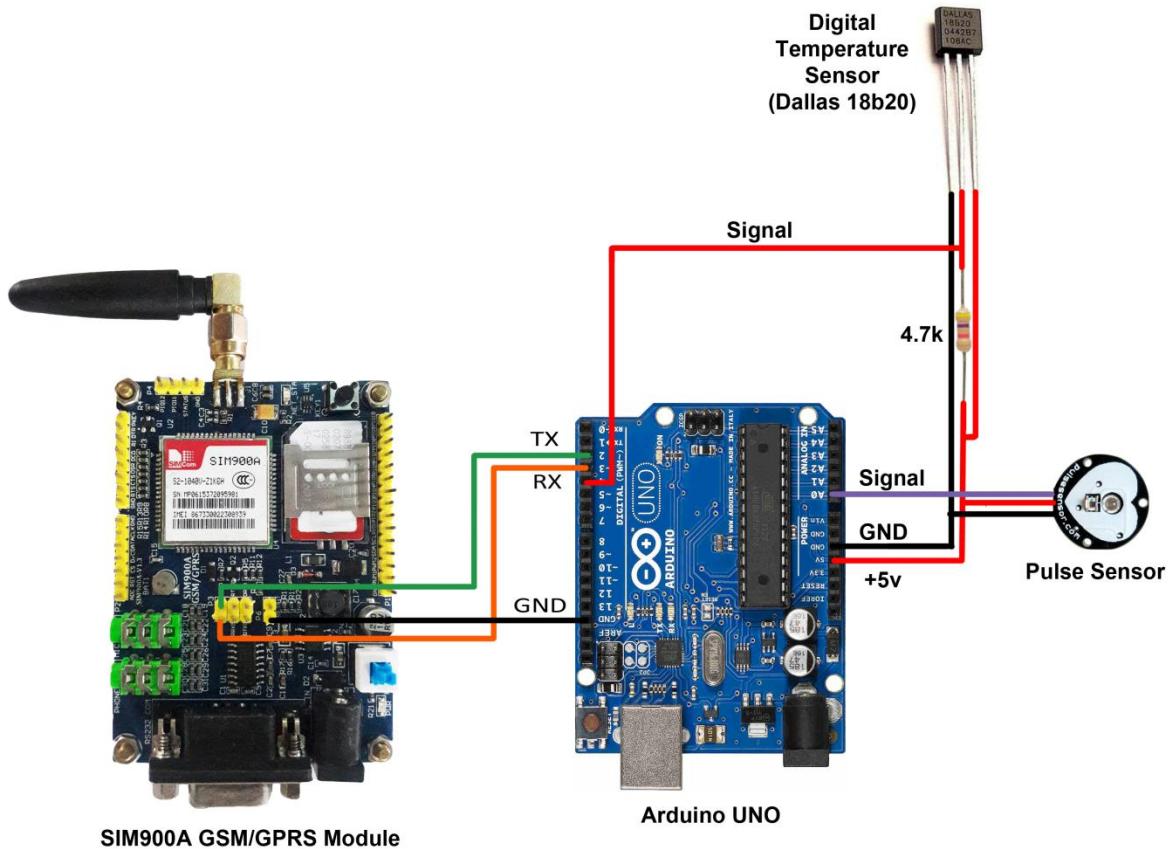


Figure 3.9: Hardware connection set-up

A GSM modem works like any other typical mobile phone. Since our GSM SIM900A also comes with GPRS enable it has the criterion to provide inter connectivity. We have inserted a sim card activated with internet connectivity in the GSM modem. GSM modem sends data over the internet connection to a database created by us. The database is stored in a webserver which has a particular address. When the GSM modem is put together with the arduino in the Arduino IDE software, the address of that particular webserver is mentioned there so that the data can be transmitted to exactly the webserver we want it to. The ground pin is connected with the ground. Pin coming from arduino. The arduino and GSM modem need to be supplied power which can be given by either connecting those to batteries or using adapters.

3.5 Web server implementation:

A web server is a pc frame work that processes requests by means of http, which is the fundamental network protocol to circulate data on World Wide Web [5]. One of the main functions of web server are to store, process and deliver the data to client. On our project we have used GSM to send data and used web server to store data.

We have used MySQL database management system for our project. The reason to use of MySQL database is because it is open source, widely used and most popular SQL database management system which is distributed, developed and supported by Oracle Corporation [6]. Again, another reason to choose MySQL is it supports relational database. Therefore it is very flexible to use since we can put information in different table rather than to put all information in one table.

Initially we have used our localhost for the development, creation, manipulation of databases and testing our project and ensure the quality assurance checking since it is difficult sometimes to identify bug in online and live.

We have used agile approach, since it is helpful method for flexible changes and to make it robust and fast. After the successful implementation on localhost, we purchased paid hosting and upload our application for real time testing.

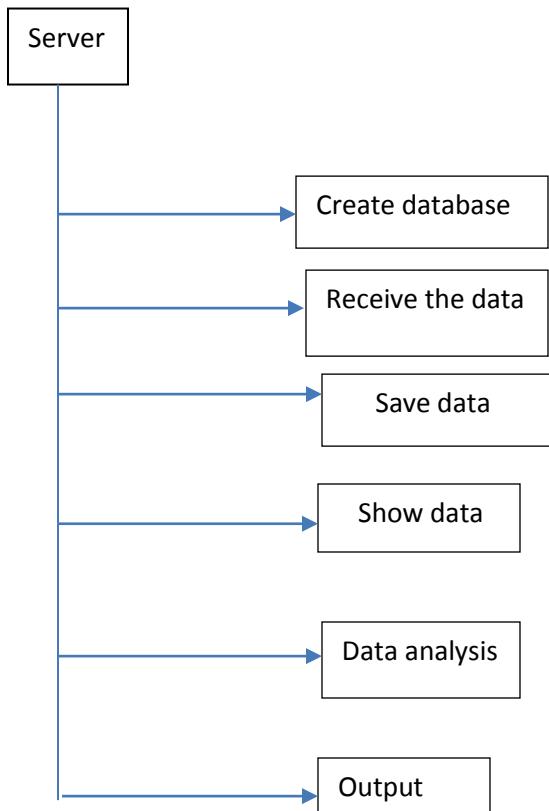


Figure 3.10: web server implementation work flow

In the following sections we will thoroughly discuss about the database creation and data manipulation. It is mentionable that in our system one device is applicable for only one patient. The system is basically designed based on one to many relationship where many patients will get treatment under one doctor. The device will have a device id which will be unique for each patient and the device will be provided by doctor to his patients.

Database table creation on web server:

For our database we have first created a table named “users”. This table contained the information of all users regarding both doctor and patient. The purpose of the table is to save data of registered people and help users while login to account. Here we will store the data of users such as username, first name, last name, password and email.

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	<code>id</code>	int(11)			No	None	AUTO_INCREMENT	
2	<code>username</code>	varchar(255)			No	None		
3	<code>password</code>	varchar(255)			No	None		
4	<code>first_name</code>	varchar(255)			No	None		
5	<code>last_name</code>	varchar(255)			No	None		
6	<code>email</code>	varchar(255)			No	None		

Check all With selected:

Figure 3.11 User Table

		<code>id</code>	<code>username</code>	<code>password</code>	<code>first_name</code>	<code>last_name</code>	<code>email</code>
			8	Ani	ani	Ani	ani@com
			9	Meenie	meenie	Meenie	m@com
			10	raj	raj	raj	r@com
			11	Hia	hia	Hia	hia@gmail.com
			12	mars	mars	shal	mm@com
			13	Eugene	eugene	Fitz	eugene@gmail.com
			14	tasniem	tasniem	eenie	tt@com
			15	Nura	nura	Jamil	nura5277@gmail.com
			16	Marshal	marshal	Shal	sleepingbeautyeenie@gmail.com
			17	45	45	234	asd@gmail.com
			18	Shihab	shihab	L	shihab@gmail.com

Figure 3.12 User table with data

The second table we have created is “owlseyard_gsm”. This table contains the information about patients’ vital signs. The columns are temperature and pulse rate, name of patients, age, phone symptoms, prescription, message, an email and unid. Here the column named unid will actually indicate the unique id of each device that distinguishes one patient from another. Whenever a patient record data, the data immediately store in this table.

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	id	int(4)			No	None	AUTO_INCREMENT	Change Drop Primary Unique Index Spatial Fulltext More
2	temp	varchar(65)			No			Change Drop Primary Unique Index Spatial Fulltext More
3	bpm	varchar(65)			No			Change Drop Primary Unique Index Spatial Fulltext More
4	name	varchar(65)			No			Change Drop Primary Unique Index Spatial Fulltext More
5	age	varchar(65)			No			Change Drop Primary Unique Index Spatial Fulltext More
6	phone	varchar(255)			No	None		Change Drop Primary Unique Index Spatial Fulltext More
7	symptoms	text			No	None		Change Drop Primary Unique Index Spatial Fulltext More
8	message	varchar(255)			No	None		Change Drop Primary Unique Index Spatial Fulltext More
9	prescription	varchar(255)			No	None		Change Drop Primary Unique Index Spatial Fulltext More
10	unid	int(65)			No	None		Change Drop Primary Unique Index Spatial Fulltext More
11	email	varchar(64)			No	None		Change Drop Primary Unique Index Spatial Fulltext More

Figure 3.13 Owlseyard_gsm table

This table will help us to store data and retrieve data of individual patients against of each patient’s unique device id.

This table also contains a column name “symptoms”. This table will store symptoms selected by patients. Another column named “prescription” that will store data of any kind of prescription suggested by doctor to the particular patients. Again we have another column named “message”. This column stores any kind of message send by patients to the doctor.

The following figure describes the data sent by different patients on database by GSM module using their devices.

	<input type="button" value="←"/>	<input type="button" value="→"/>	id	temp	bpm	name	age	phone	symptoms	message	prescription	unid	email	
<input type="checkbox"/>				122	99	86	Anika	22	2090211597	Chest pain Nausea Headache	I am feeling headache		200637	sleepingbeautyeenie@gmail.com
<input type="checkbox"/>				121	98	89	Anika	22	78668137	Chest pain Nausea Headache	I am feeling headache		200637	sleepingbeautyeenie@gmail.com
<input type="checkbox"/>				120	98	79	Hia	23	431550009	Blurry vision Nausea	I am felling Nausea from yesterday evening.		200635	hiakhan12@gmail.com
<input type="checkbox"/>				119	101	80	Hia	23	157379411	Blurry vision Nausea	I am felling Nausea from yesterday evening.		200635	hiakhan12@gmail.com
<input type="checkbox"/>				118	96	79	Hia	23	1765358903	Blurry vision Nausea	I am felling Nausea from yesterday evening.		200635	hiakhan12@gmail.com
<input type="checkbox"/>				117	96	78	Hia	23	853665940	Blurry vision Nausea	I am felling Nausea from yesterday evening.		200635	hiakhan12@gmail.com
<input type="checkbox"/>				116	98	84	Nura	22	2107870422	 Chest pain Headache	I am having chest pain since		200636	nura52772@gmail.com

Figure 3.14 Owlsyard_gsm table with data

The desired output of the system is to show the current situation of a patient to doctor and to have a primary basic communication between doctor and patient. Using phpMyAdmin we have created website and fetched data. Before showing the data on mobile application, we have first upload the data on online web and tested the data live to ensure quality assurance and to check whether the data that we are getting from sensors through GSM module is reliable.

3.6 Mobile Application Implementation:

The primary task of our project was to take data from sensors and send those data using GSM module to a server. However, after that we came up with an idea to make a mobile application. For the mobile application we have chosen android platform. Android gives one a world-class stage for making applications and recreations for Android clients all over, and in addition an open commercial center for circulating to them right away. Expanding on the Linux community with more than 300 hardwares, software equipment, Android has quickly turned into the quickest developing portable operating system. Our basic goal was to provide a platform for both patient and doctor to communicate in an easier way even without being present by physical. We have mainly focused on developing countries people where majority use Android device. Therefore it was another

reason to choose Android mobile application. The name we select for our application is “**HealthPal**” which signifies that “an application that is as helpful as a friend for both patient and doctor”.

3.7 Technical Specifications:

- Jdk Jre 8.0
- Min Sdk version 15
- Target Sdk version 24

3.8 Work Flow of mobile application:

We have created an android based application for our project. Our application contains a webview option to a specific link so we can see our whole project which is stored in a live server from our application. Our application only runs in android phone. In below we are going to describe the source code part.

When our application starts to create the onCreate method is being called and we have initialized webview by using auto generated class R.java class and set the content the layout of our application. AS webview attribute also need various enable issues we need to enable those stuffs like JavaScript, wideview port enable and etc.

After the initializations in onCreate method the onResume method is being called and immediate after that onPause method is called. Actually we didn't use onResume method so we wrote our main program in onPause method. At first we check internet connectivity through isOnline method by the help of android built in ConnectivityManager class. So if internet connectivity is off then show SettingsAlert method is called which contains alert message that internet connectivity is disabled and start the settings activity if necessary through onClick method inside it.

But if the internet connectivity is on through HelloWebViewClient class webview is shown by the specific URL which is given. In HelloWebViewClient class we have managed system class going backward pages by using key actions id. Before that we have checked that is it possible to go back either. If it can't go back page then we finished the main activity then our activity will get finished by calling finish method.

3.9 Features:

The features of our application are:

- User login system for patient:**

This is an application for the patient. They will have to register first with first name, last name, age, id, email, username and password. Then they can login with username and password.

- User login system for doctor:**

There is also an application for the doctors. They also have to register similarly.

- Doctor can see “Patient List”:**

When a doctor logs in the application, he can see a list of patients. He can tap on any of the names and the information will show up in the next page.

- Patient’s temperature and pulse rate shown in a table:**

The device collects data which are stored in the database. These data/information are shown in a table.

- **Doctor can see the table to monitor:**

Doctor uses this table to keep track on the patient's condition.

- **Symptom Checkbox:**

In the patient's account there is a button which is called "Symptoms". This button contains few symptoms. The patient can check the box or uncheck it and then it gets saved. The doctor then can see the selected symptoms too.

- **Email Notification:**

If the temperature or pulse rate is very high or low then an email will be sent to the emergency email address. This is how the patient's condition will be notified.

- **Data Updating:**

Data is updated continuously. It also can be updated based on time interval.

3.10 Feasibility Analysis:

Feasibility analysis is used to aid the decision of whether or not to proceed with the proposed system. Our system is independent and easy to use. This is why it can be used at home or in hospitals. In our country the government and NGO's allocate a specific amount of money for healthcare development purpose. If we use this device, that will be very cost efficient for a developing country like ours. So this project will be very feasible for our country.

3.11 Technical Feasibility:

In our system we have built an Android application because android phones are easy to use. Smartphones are most popular devices and mostly used device. There are many android

phone users in our country. This is the reason we chose to build an android application. For the device, we used Dallas Temperature sensor, Pulse sensor, GSM module sim900A and Arduino uno. These are the components that we used to build the device. We used these components because they gave almost accurate output.

Economic Feasibility: A system will be economically feasible if it is cost efficient along with its accuracy. Our system is cost efficient because of the tools that we used to build it. The device cost is very low which is efficient for a developing country.

3.12 User Interface:

The user interface of our application named “HealthPal” is simple and easy to operate. We have two different application:

- One for patient
- One for doctor

One cannot install both application at a time on their mobile. Therefore doctor will install only doctor application and patients will install patient application respectively on their mobile. On the following section we will describe the details workflow of both doctor and patient application.

Interface of patient application:

The total workflow of a patient is given below by a flowchart.

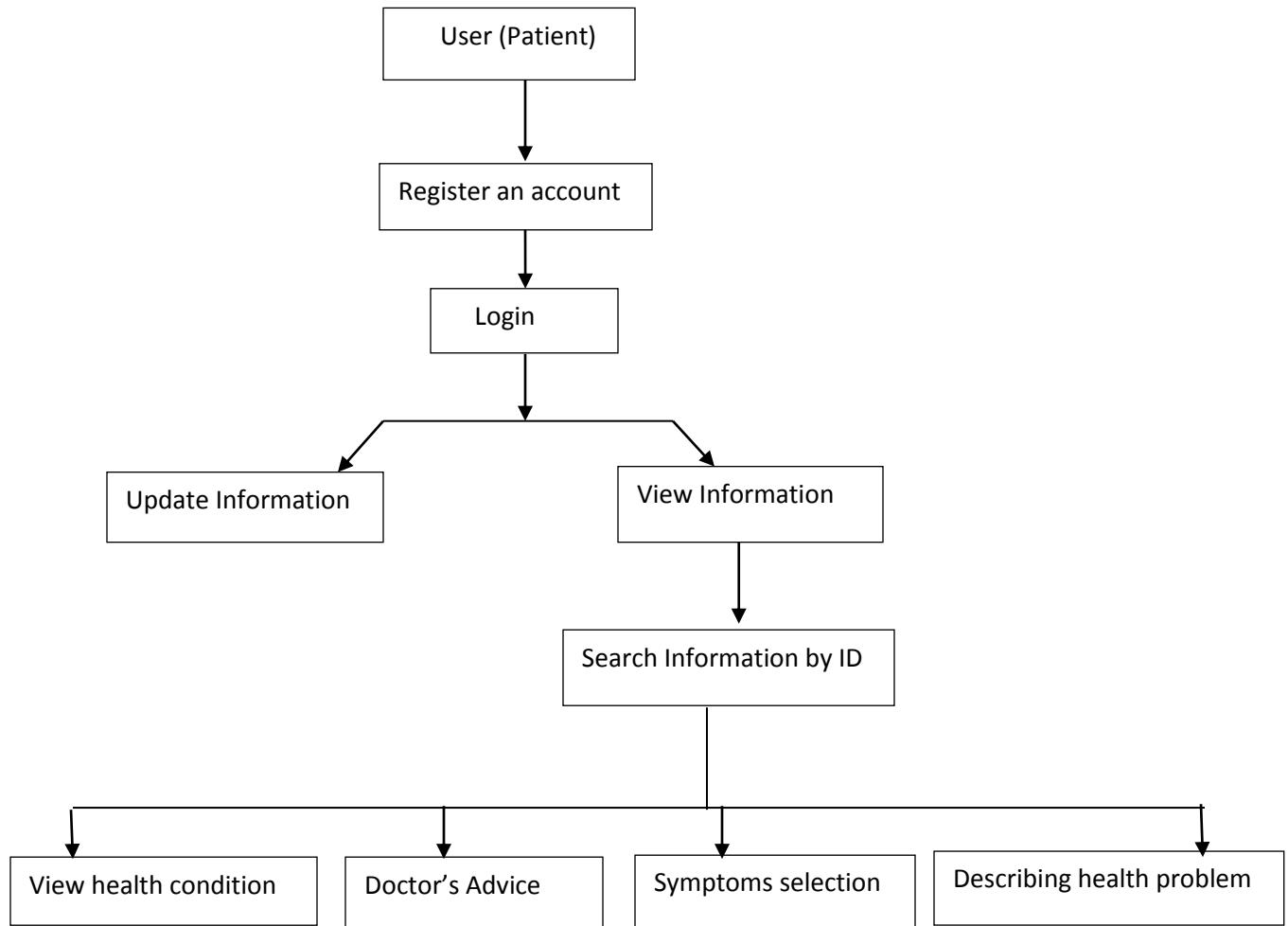


Figure 3.15: flowchart of patient application

Registration and Login account:

At the very fast a patient need to create an account if the patient has not created account before. For this, patient needs to register for an account. Patient needs to provide some basic necessary information such as username, password, first name, last name and email address. After the registration done successfully patient can enter into the account by login. Login requires only username and password.

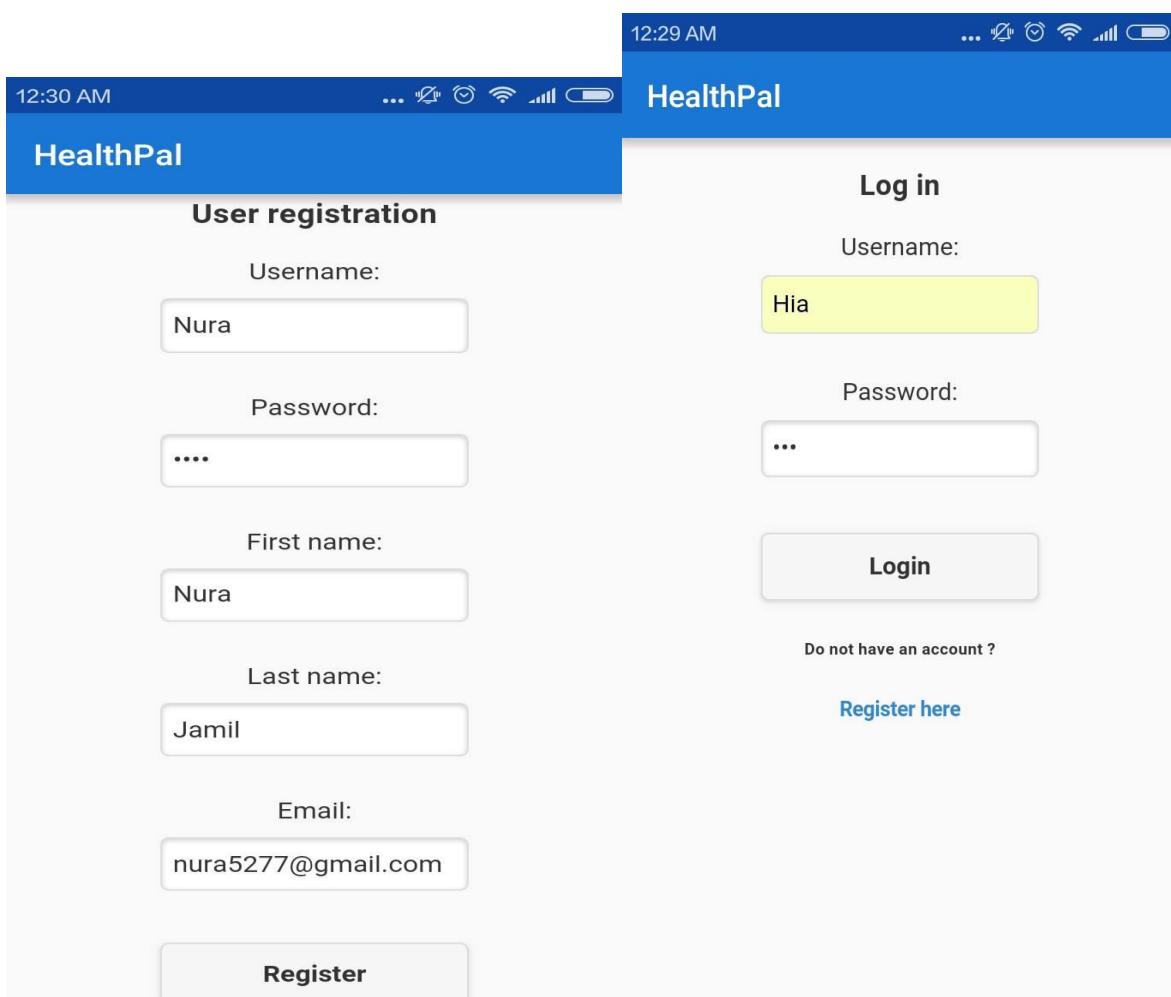


Figure 3.16: Patient registration and login interface

Update Information:

After login is done, there will be two options for patient. One option is to update information of patient by giving information about name, age, emergency email and Id which is actually the device id and of course the unique id for each patient.

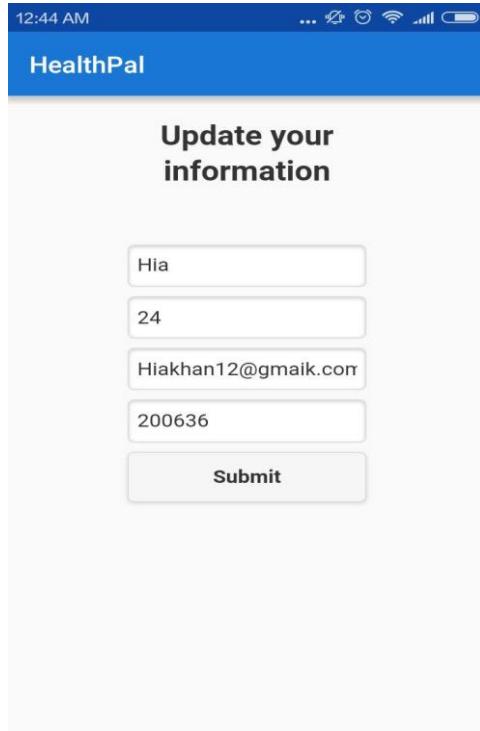


Figure 3.17: Patient Update Information

View Information:

Another option is to view information which is the entire information of patient's current health condition. This option will display the temperature and pulse rate. It also will display any advices from doctor. Moreover, patient can describe his/her health condition by either selecting given symptoms or by describing problems in a selected box which will directly reach to doctor's application.

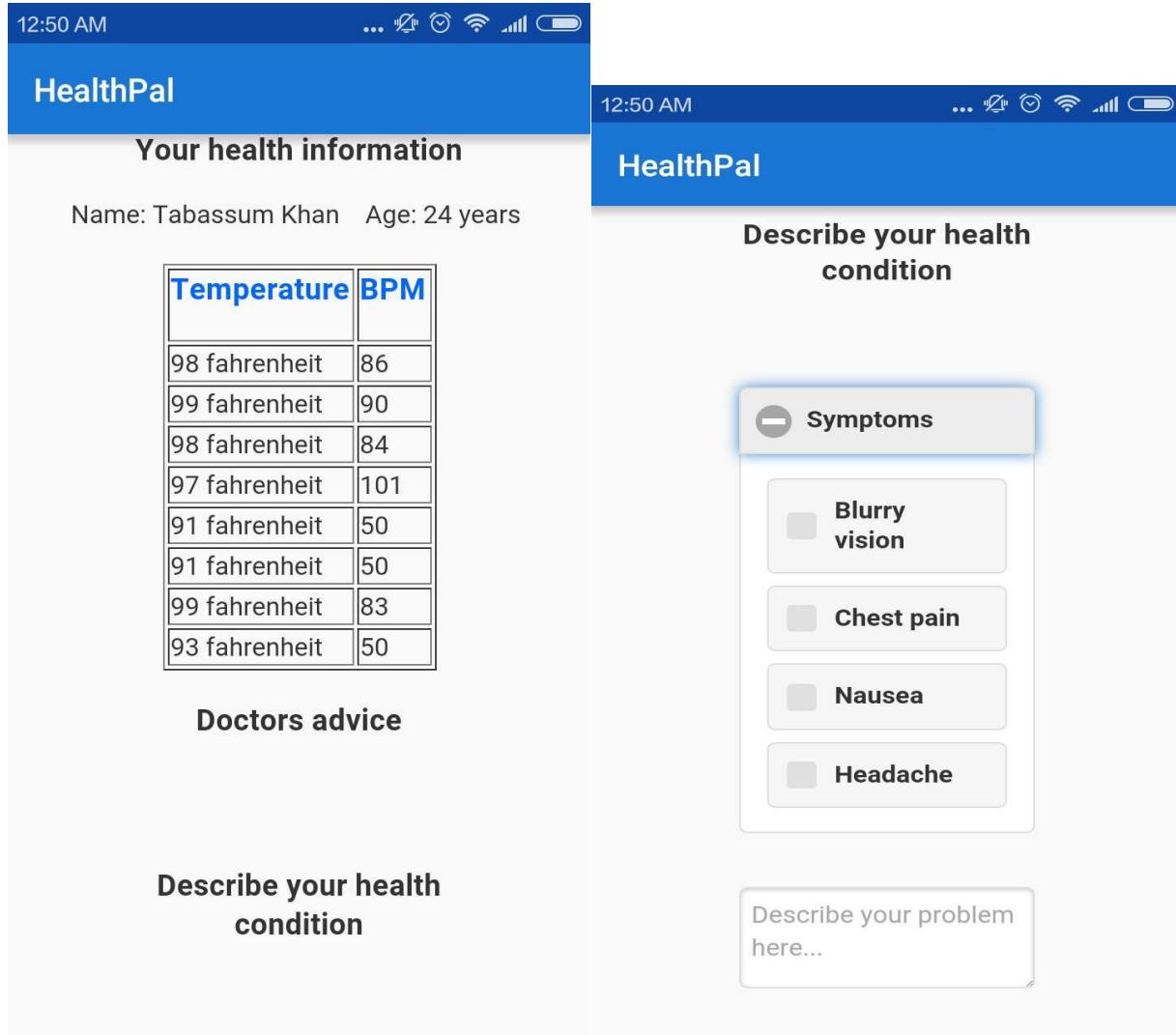


Figure 3.18: Patient's information view interface

This is how the patient application will work.

Interface of doctor application:

The total workflow of a doctor application is given below:

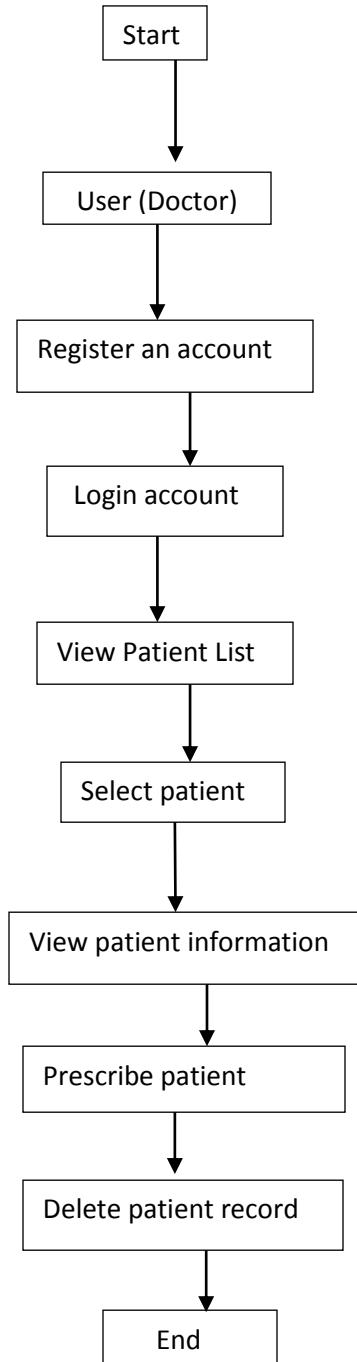


Figure 3.19: flowchart of doctor application

Registration and Login Account:

Just like patient application, doctor will also need to first create a new account on doctor application. After that doctor can login to his account. Again doctor needs to register his account by giving the basic information required to open the account and can login to account by using his username and password.

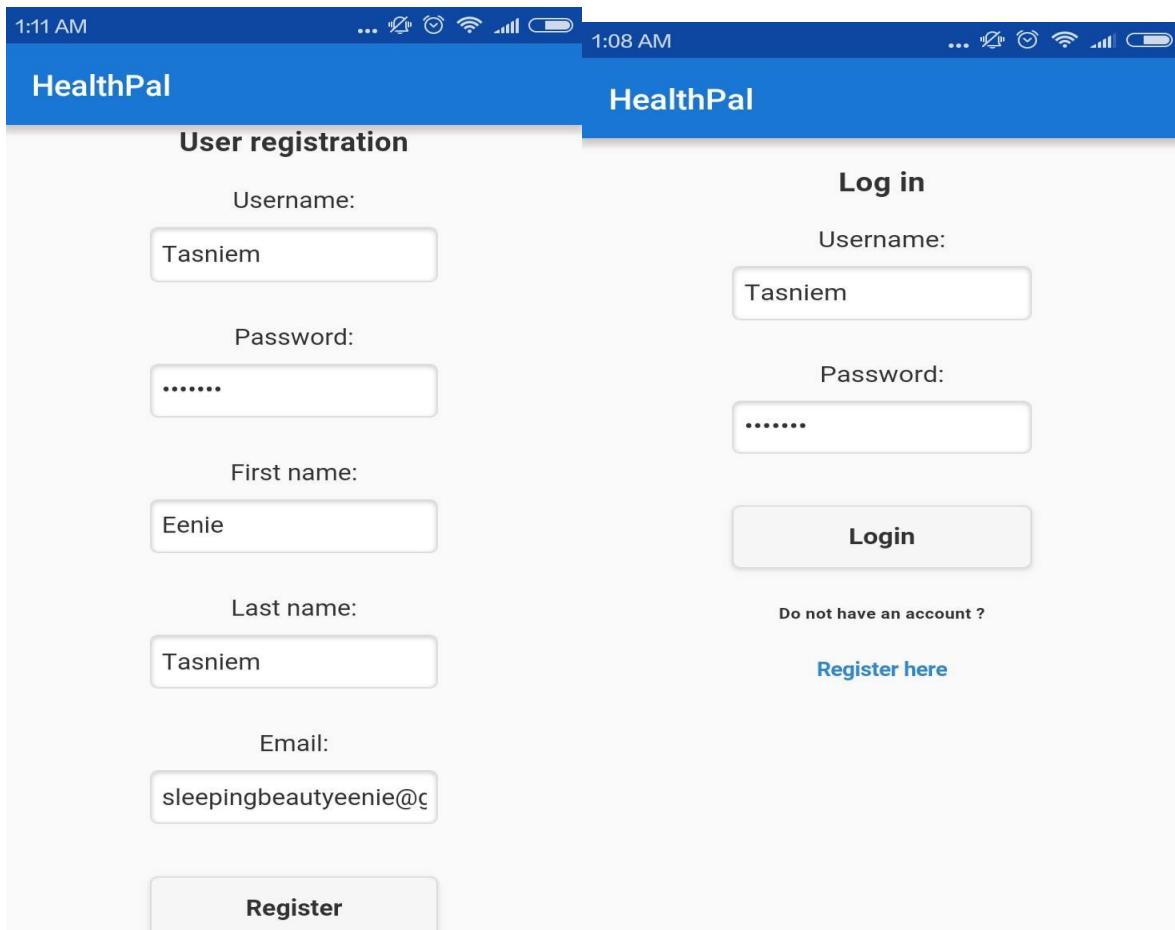


Figure 3.20: Doctor Registration and login interface

Selection of patient from patient list:

A doctor can have multiple patients under his treatment. Therefore a doctor will be able to see the patient list of all patients who will be treated by that particular doctor. Again doctor can select a single patient by clicking on the name of patient from patient list.

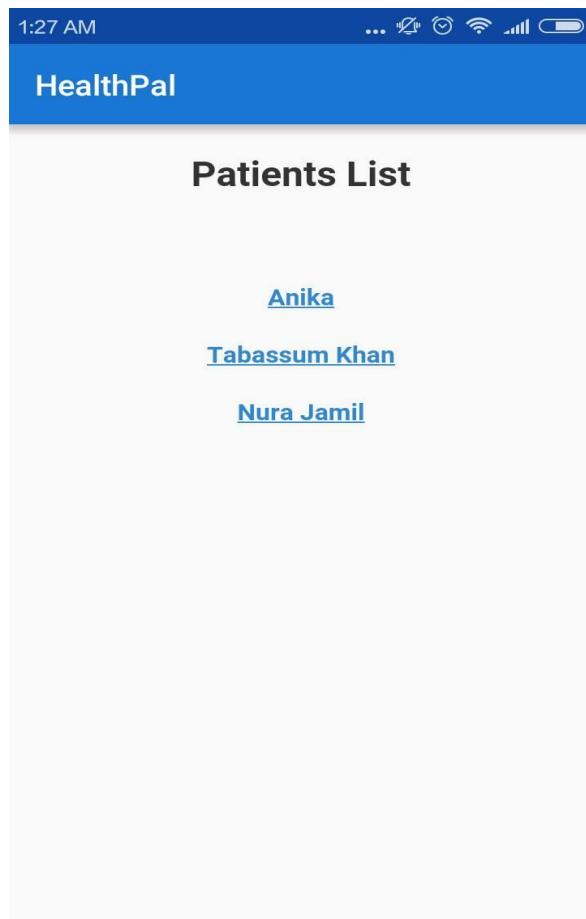


Figure 3.21 Patient list interface

After clicking on a particular patient, doctor will be able to see all the records of patients. He also will be able to see if any kind of symptoms or any type of message is sent to doctor. According

to symptoms doctor can prescribe doctor. There is an option named “delete patient data”. It means if doctor wants he can delete some previous record of a patient.

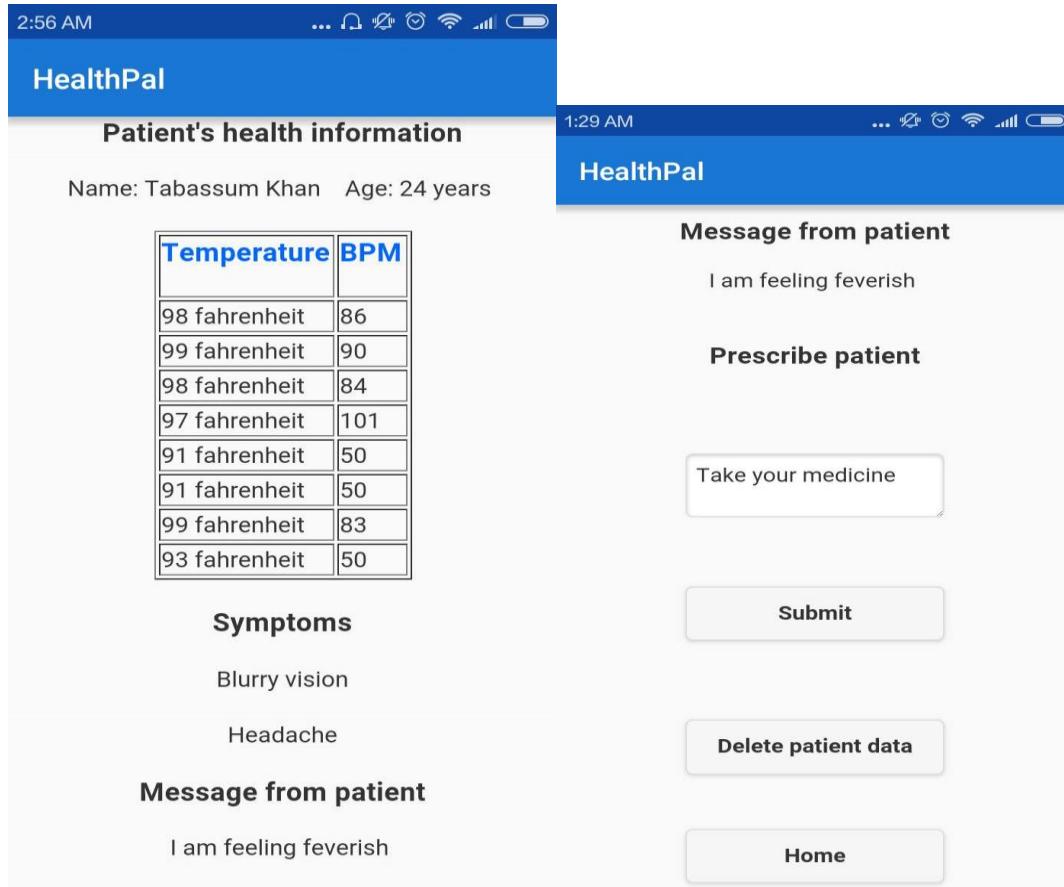


Figure 3.22 Doctor's application view

Email Notification:

We have another feature of our application. While registering, a patient needs to provide a email address. This email address can be patient's own email address or can be patient's relative's email address. We are assuming this email address is an emergency email address for a patient. Therefore whenever patient's data fluctuates from normal to high or low, as soon as the new record is found with abnormal signs an email with the alarming signs will be send to direct on the emergency email address

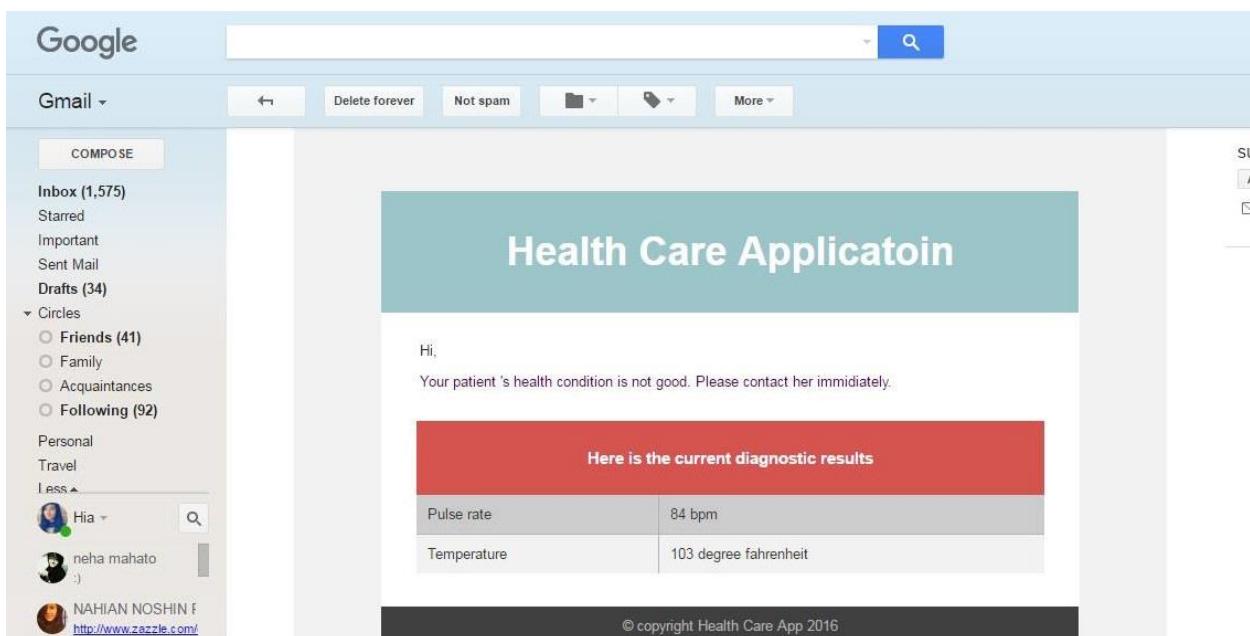


Figure 3.23 Email notification

This is the total workflow of our application. The application is surely got a user friendly interface. We have successfully implemented the initial model of application to communicate between patient and doctor,

DIGITAL BLOOD PRESSURE MACHINE:

Blood pressure machine which is also called Sphygmomanometer is a very important machine. It is used to measure blood pressure. Digital blood pressure machine uses oscillometric measurements and electronic calculations. They are easy to operate and give almost correct values. They measure systolic and diastolic pressure by using piezoelectric pressure sensor also including microprocessor.

We included blood pressure data addition to our system in the future work. But still we tried to work on it when we fulfilled our proposed work successfully. To measure blood pressure we need a blood pressure sensor which is known as piezoelectric sensor. This sensor is not so available in our country. The sensors which are available in our country do not give the expected output. These are the reason we decided to hack a digital blood pressure machine.

Extracting Data from Blood Pressure Machine: There are few steps of extracting the machine and getting the outputs to Arduino.

STEP 1.Soldering and joining wires:

We got a digital blood pressure machine The MCU is used for converting the analog voltage signal which is outputted by the demodulator into a digital voltage signal.[1]

We soldered two pins and joined with wires. One is for Systolic pressure and another one is for Diastolic pressure. We also connected a wire with the GND pin and another wire with a +5V. This is the basic hardware configuration to hack the blood pressure machine. We set up the connection with the MCU and the wires.



Figure 3.24: Digital Blood Pressure Machine after Soldering.

STEP 2. Connection set up with Arduino:

This is a very easy step. We connect the wires for Systolic and Diastolic pressure output to the Arduino Uno's analog input pin. We used analog Pin 4 and analog Pin 5 of the Arduino. Then we connected the other two wires- one with GND and another with 5V of the Arduino.

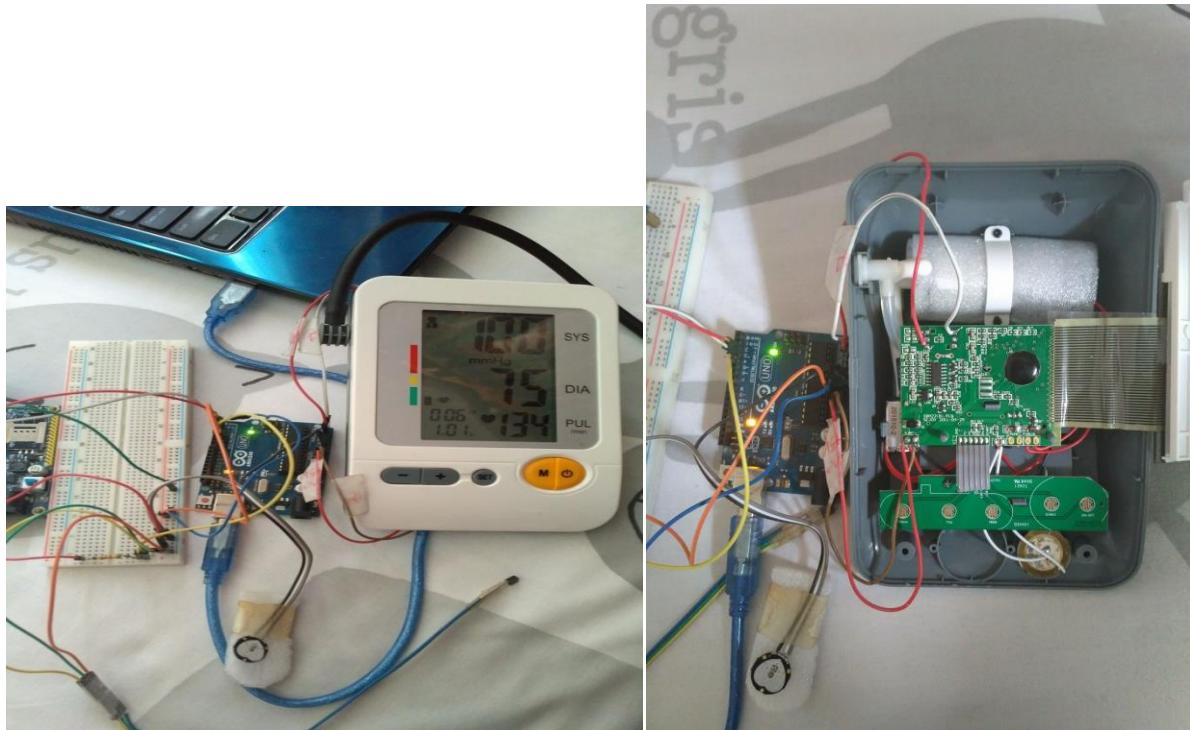


Figure 3.25: Connection with Arduino

STEP 3. Uploading code and Get the output:

In third step we upload the code and turn the serial monitor on. It takes time to get the output in the serial monitor. The delay is very high. It is not so accurate either.

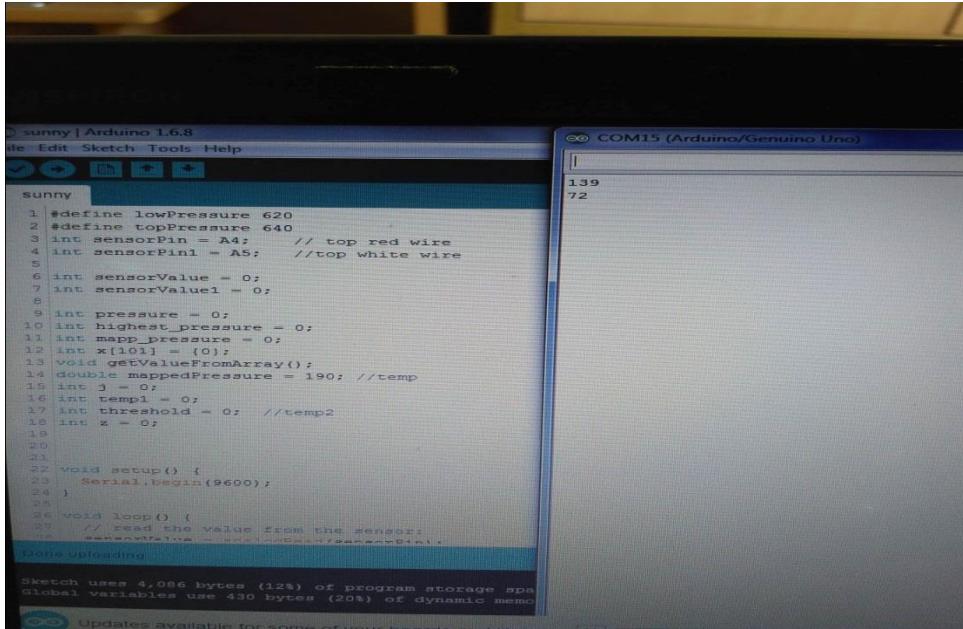


Figure 3.26: Result shown in the serial monitor.

In this figure there is a program that we used to get the output from the digital blood pressure machine. We had to define the threshold value and it defers when we are getting the power from a laptop. But if a battery is used then the threshold value gets fixed. Here in the serial monitor the output is 139/72 where 139 is the systolic pressure and 72 is the diastolic pressure.

CHAPTER FOUR

Result and Data Analysis

In this chapter we will be discussing about our result from our project. Previously we have discussed about the demo version of our system. How the device was built, how the data is sent to the database by GSM module and how the application “HealthPal” was developed.

4.1 Result Analysis:

To verify whether our device is giving a better output or not we compared the result with the result that we get from thermometer. As we are taking temperature and pulse rate we need to make sure that our device produces an almost accurate output.

Temperature Using Thermometer	Temperature Using Device
98F	99F
97F	98F
100F	101F
98F	99F

Table 4.1: Comparing output with expected output.(Temperature)

Pulse Rate (Manually)	Pulse Rate using Device
60bpm	65bpm
68bpm	74bpm
64bpm	70bpm
75bpm	81bpm

Table 4.2: Comparing output with expected output.(Pulse)

4.2 Result Display:

It takes around one minute to get data from sensors through microcontroller. After that we turn on the GSM module. Usually it takes 5 to 10 seconds to get the connection. Right after turning the GSM module on, it starts to blink. When it starts to blink slowly, means connection has been established. The output can be displayed where it shows whether database connection is okay and responding or not. It also shows the status. Finally we get a confirmation by getting a message of data receiving.

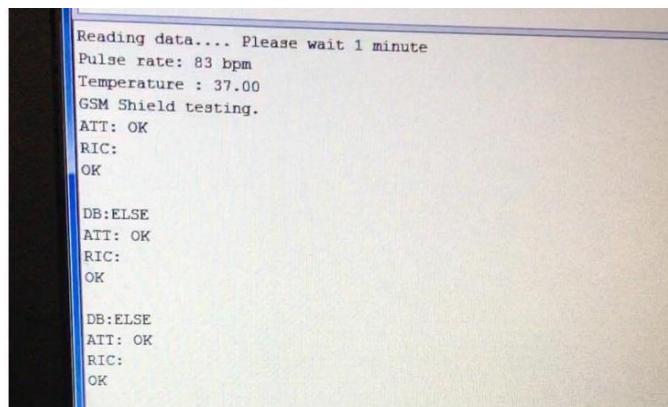


Figure 4.1: Result of temperature sensor and pulse sensor in arduino serial monitor

```

ATT: OK
RIC:
CONNECT OK

DB:OK TCP
ATT: >
RIC:
>
DB:>
ATT: SEND OK
RIC:
SEND OK

DB:SENT
HTTP/1.1 200 OK
Server: nginx
Date:
Number of data received:
50

Data received:
HTTP/1.1 200 OK
Server: nginx
Date

```

Figure 4.2: Data sent by the GSM modem is received with confirmation message

Application :

Our application is for android phones. It has user friendly interface and it is very simple to operate.

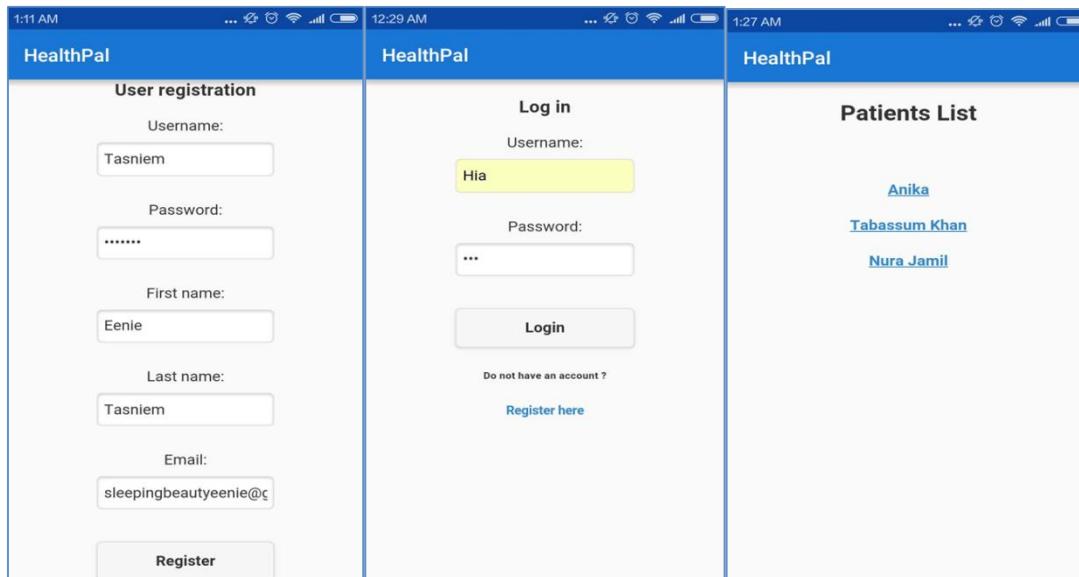


Figure 4.3: Different tabs of the application.

There are two type of application system. One is for doctor and another one is for patient. “HealthPal” for doctor is very simple application. Doc needs to log in and then he can see the patient list and then he select the patient. After that another tab opens where he can see the information and the data in a table. This is how he can monitor his patient.

In the application “HealthPal” for patient, the patient registers and then he/ she enters the device id. Then whenever he uses the device, the data is stored automatically in the database and are shown in the table which the doctor can see. Our current system sends data in the database in every 10 minutes. This is how we configured the device.

In our application we have an option of email that is sent to patient’s emergency email address. It is an auto generated email. Whenever a patient will have pulse rate less than 60 and temperature greater than 100 the email will be sent. For this we have run a query from owlseyard_gsm to select the email against of the device id to identify the patient and sent email.

Health Care Application

Hi,

Your patient's health condition is not good. Please contact her immediately.

Here is the current diagnostic results

Pulse rate	84 bpm
Temperature	103 degree fahrenheit

© copyright Health Care App 2016

Figure 4.4: Email Sent to Emergency Contact with Abnormal Reading

4.3 BP measurement issues:

After reaching our motive successfully we took an attempt to include the blood pressure machine to our system. We eventually succeed to read the data from it and got it saved in Arduino. But while analyzing the output shown in the serial monitor and comparing it with the expected output we found that the data were not that reliable. Our concern is also accuracy along with cost efficiency, we decided not to include it. Hence, we will work on it in the future.

Here are the outputs we get from the digital machine.

Systolic	Diastolic
135	96
118	73
120	82

Table 4.3: Output from Digital BP machine.

Here are the results we get in the serial monitor (after hacking).

Systolic	Diastolic
148	72
108	52
100	60

Table 4.4: Output shown in the Serial Monitor.

4.4 Cost Analysis:

There are different types of health equipment in the market but there is no such device as ours in Bangladesh. In developed countries there are few health monitoring devices which are very expensive. Our purpose is to make a device which is suitable for developing countries.

To build the device we used Arduino uno, Dallas temperature sensor, SEN11574 pulse sensor and GSM module SIM900A. Total cost will be around 3,000/- to 5,000/-.

For our device the cost was nearly 5,000/- .

Components	Price
Arduino Uno	650/-
GSM module SIM900A	1000/-
Dallas Temperature Sensor	70/-
Pulse Sensor SEN11574	1500/-
	3,220/-

Table 4.5: Initial Cost Calculation

This is not just a device. There is also an Android application which is for free. The patient can be monitored by doctor constantly.

Chapter Five

Conclusion

The system that was proposed was a prototype system model. Our main objective was to focus on health monitoring with wireless body area network. However we have successfully implemented the prototype and came up with an accurate result analysis. Basically wireless body area network is a vast area to expand. Implementing computer science on medical science has become a new era to develop. Introducing a health monitoring system with an application will really be helpful to people of developing country. One of the main motive of our project was to create a real time communication between doctor and patient in an easier way. Though our model has implemented and tested but to introduce it in real life a lot more improvements and also equipment are needed. Actual goal of our system will be fulfilled when we can use the health monitoring system and “healthpal” application in real life and people will be benefited

5.1 Challenges:

While building the entire system we had to face some challenges. In our system there are three phases:

- a. Hardware implementation
- b. Web server and database management
- c. Android application

The challenges that we faced are discussed below:

- a. **Hardware Implementation:** The process of getting all components together was a really challenging part. While taking the values through the sensor and get it saved in arduino, we faced some problems. At first we were using LM35 sensor to get the temperature. But it was not giving satisfactory result. So, later on we used dallas temperature sensor which gives nearly accurate output. For pulse sensor we used SEN 11574. This sensor is not so expensive and the output is reliable. But at first it was not functioning properly due to the connectivity. We also faced the most common hardware problem which is that the Arduino was not operating. Sometimes it showed the error that there was low capacity even though there was not.

After getting the outputs into an Arduino we had to proceed to the next step which was sending these data through the GSM module to our database. Handling the GSM Module was the hardest part since we never worked with a GSM module before. We used the model sim900A. Even when we connected it to the Arduino successfully it sometimes could not get connected to the database and for this reason even though the outputs were shown in the serial monitor but they were not sent to the database. It took a very long time to make it work properly. There was another difficulty which is data upload delay. We succeed to reduce it.

- b. **Web server and database management:** We have worked on small projects using localhost database. But we never worked with online hosting server. We faced difficulties to send data in the database.
- c. **Android application:** While developing the application “HealthPal” we faced few problems as well. . We were able to fix the bugs of our application. The application is a demo and we plan to use it for realistic application one day.

5.2 Future Work:

a. Advanced Medical Equipment Including :

Our system is just a platform for the developing countries. We have done it with an efficient cost. Other medical equipment such as Continuous Glucose Monitoring, Shield EKG-EMG (ELECTROCARDIOGRAPHY ELECTROMYOGRAPHY SHIELD) etc for better service.

b. Upgraded Version of the application:

We want to add some features to this application in the future such as making it dynamic so that the doctor can customize the time interval. Currently the data is sent according to the device is configured.

c. Include Blood Pressure Data:

We already have hacked the blood pressure machine. We want to add it to our device in future. Blood pressure values are really important to determine a person's health condition. So, we want to include it in the future.

d. Multiple Patients can use one device:

Our current device is for one particular patient only. But it can be used for multiple patients too. We hope to work on it.

e. Push Notification System for the application:

We have an automated emergency email sending system in our application. When the patient's data is abnormal, an emergency email will be sent to the emergency email address. We also plan to add a push notification system in the future.

f. Include GPS system:

We also will include GPS system to know the current location of the patient.

Our project is just a platform. This is our initiative to introduce this device to a developing country like ours. Though it may sound like an expensive project but it is very cost efficient as our concern was the developing country. It is just a demo but we look forward to carry on our research on this topic and implement it in real world.

REFERENCES:

- 1.Gyselinckx et al., "Human++: Autonomous Wireless Sensors for Body Area Networks," IEEE 2005 Custom Integrated Circuits Conference
- 2.A. Juric& A. Weaver, "Remote Medical Monitoring", IEEE Computer, PP96-99 April 2008
- 3.K. Bilstrmp, "A Preliminary Study of Wireless Body Area Network", Tech. Report, IDE0854, University of Halmstad, Sweden, PP1-36, Aug. 2008
- 4.E. Jovanov,A. Milenkovic, C. OttO, P. De Groen, B. Johnson, S. Warren , G. Taibi.(2005)A WBAN System for Ambulatory Monitoring of Physical Activity and Health Status: Applications and Challenges
5. Mohammad WajihAlam, Tanin Sultana and Mohammad Sami Alam;
A Heartbeat and Temperature Measuring System for Remote Health Monitoring using Wireless Body Area Network;Vol.8, No.1 (2016), pp.171-190
6. P.Verma, J.S. Bhatia," DESIGN AND DEVELOPMENT OF GPS-GSM BASED TRACKING SYSTEM WITH GOOGLE MAP BASED MONITORING", International Journal of Computer Science, Engineering and Applications (IJCSEA) Vol.3, No.3, June 2013
7. G. Gridling, B. Weiss, "Introduction to Microcontrollers", Version 1.4, Vienna University of Technology, Institute of Computer Engineering, Embedded Computing Systems Group February 26, 2007
8. A.G. Smith, "Introduction to Arduino: A piece of cake!", September 30, 2011
9. W. Durfee, "Arduino Microcontroller Guide", University of Minnesota, October-2011
10. J.G. Sempere, "An overview of the GSM system", Department of Electronic&Electrical Engineering, University of Strathclyde, Glasgow, Scotland,1999
11. Scourias, John. "Overview of the Global System for Mobile Communications". 1997, Link:
<http://www.shoshin.uwaterloo.ca/~jscouria/GSM/gsmreport.html>.
12. R.J. Robbins," Database Fundamentals", Johns Hopkins University,1994,1995

13. H.M. Thwe,H.M.Tun," Patient Health Monitoring Using Wireless Body Area Network", "INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH" VOLUME 4, ISSUE 06, JUNE 2015

14. S.S. Sarade, N.A. Jadhav, M. D. Bhambure, "PATIENT MONITORING AND ALERTING SYSTEM BY USING GSM", International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 03 | June-2015

15.P. Vignesh, E. Sathya.(2012)Bluetooth Based Patient Monitoring System

16.S. Sharma, A. L. Vyas and B. Thakker, D. Mulvaney and S. Datta, "Wireless Body Area Network for Health Monitoring", Biomedical Engineering and Informatics (BMEI), 2011 4th International Conference, Vol.4, October 15-17 2011, pp 2183-2186

17. S. Krishnamurthi, P.W. Hopkins and J. McCarthy "Implementation and Use of the PLT Scheme Web Server" December-2006

18. url :<https://www.mysql.com>

19.AkshaySugathan, GauravGautamRoy , G. J. Kirthyvijay , Jeffrey Thomson.(2013)Application of arduino based platform for wearable health monitoring system



Development of Application Based Health Monitoring System Using GSM Module

Supervised By
Dr. Amitabha Chakrabarty

Anika Tasniem (12101081)
Nura Jamil (12101007)
Tabassum Khan (12101012)

Concept

Wireless Body Area Network

Comprises of
sensor nodes

Have the ability to
transmit data

Wireless
communication
Possible

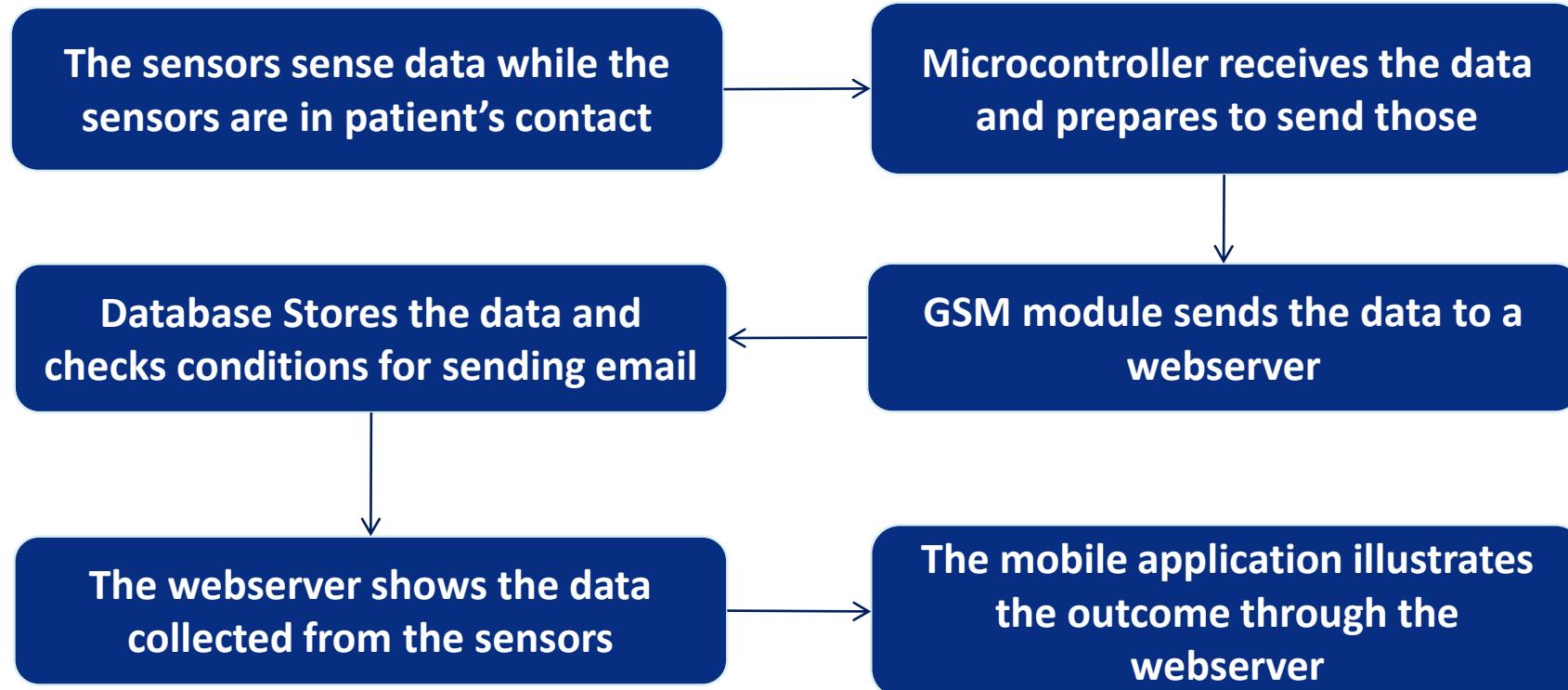
Sensors sense data

Widely supported by
Ubiquitous
Network system

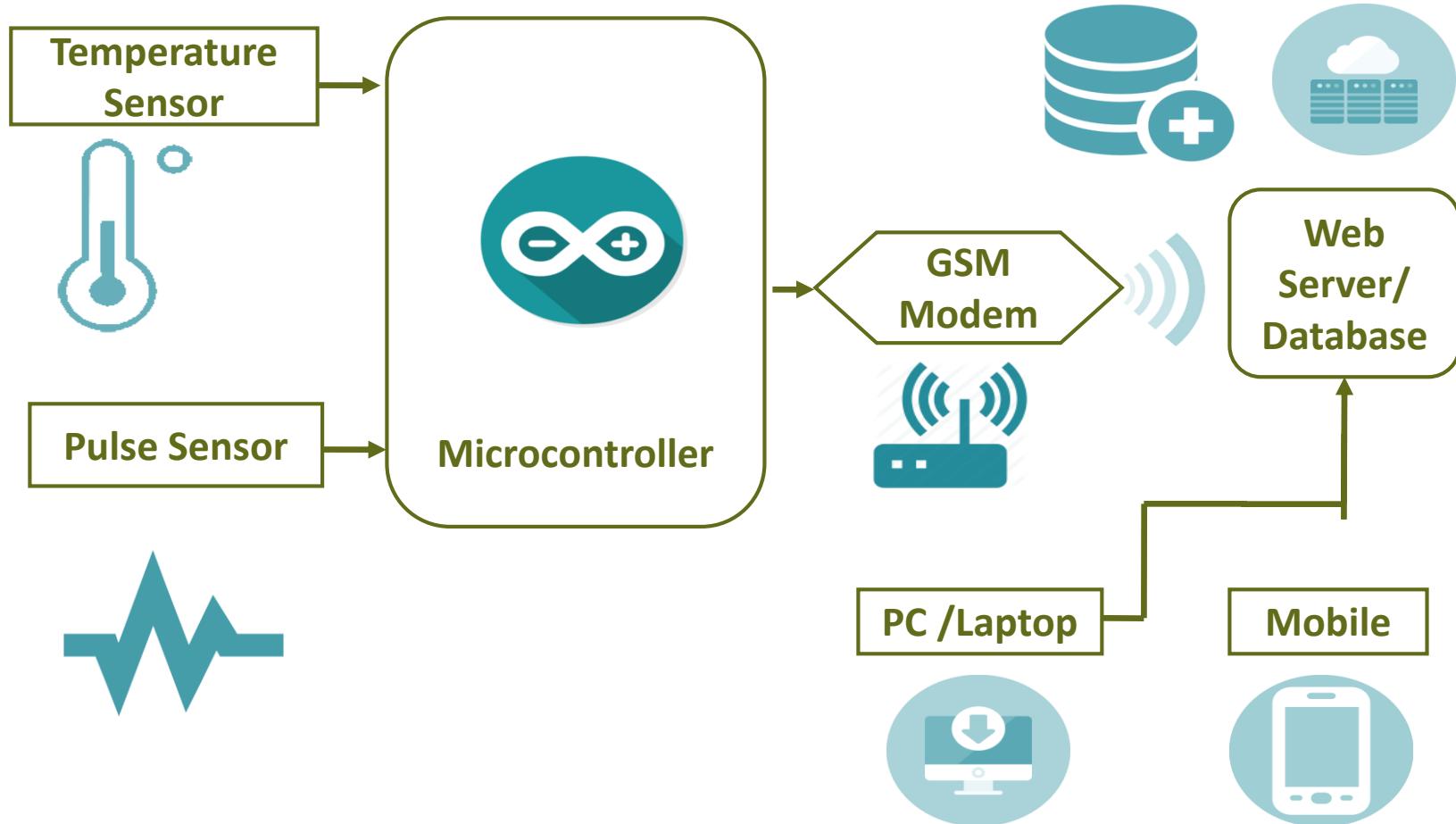
Overview

- ◆ Creating convenient communication among doctors and patients
- ◆ Monitoring multiple patients at a time
- ◆ Cost effective for developing countries
- ◆ Reduces the burden of travelling to doctor's chamber for patients who are old, paralyzed and handicapped
- ◆ Provides flexibility in health management
- ◆ Saves time of both doctor and patient
- ◆ Introducing mobile application version for the system

Work Flow



System Model



System Specification

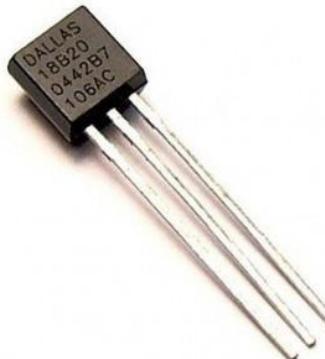
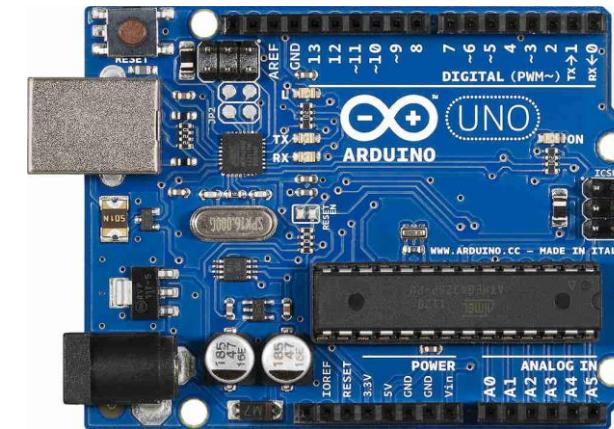
**Hardware
Implementation**

**Web Server
Implementaion**

**Mobile Application
Implmentation**

Hardware Overview Of The System:

- Microcontroller – Arduino Uno
- Sensors- Dallas Temperature sensor



Hardware Overview Of The System



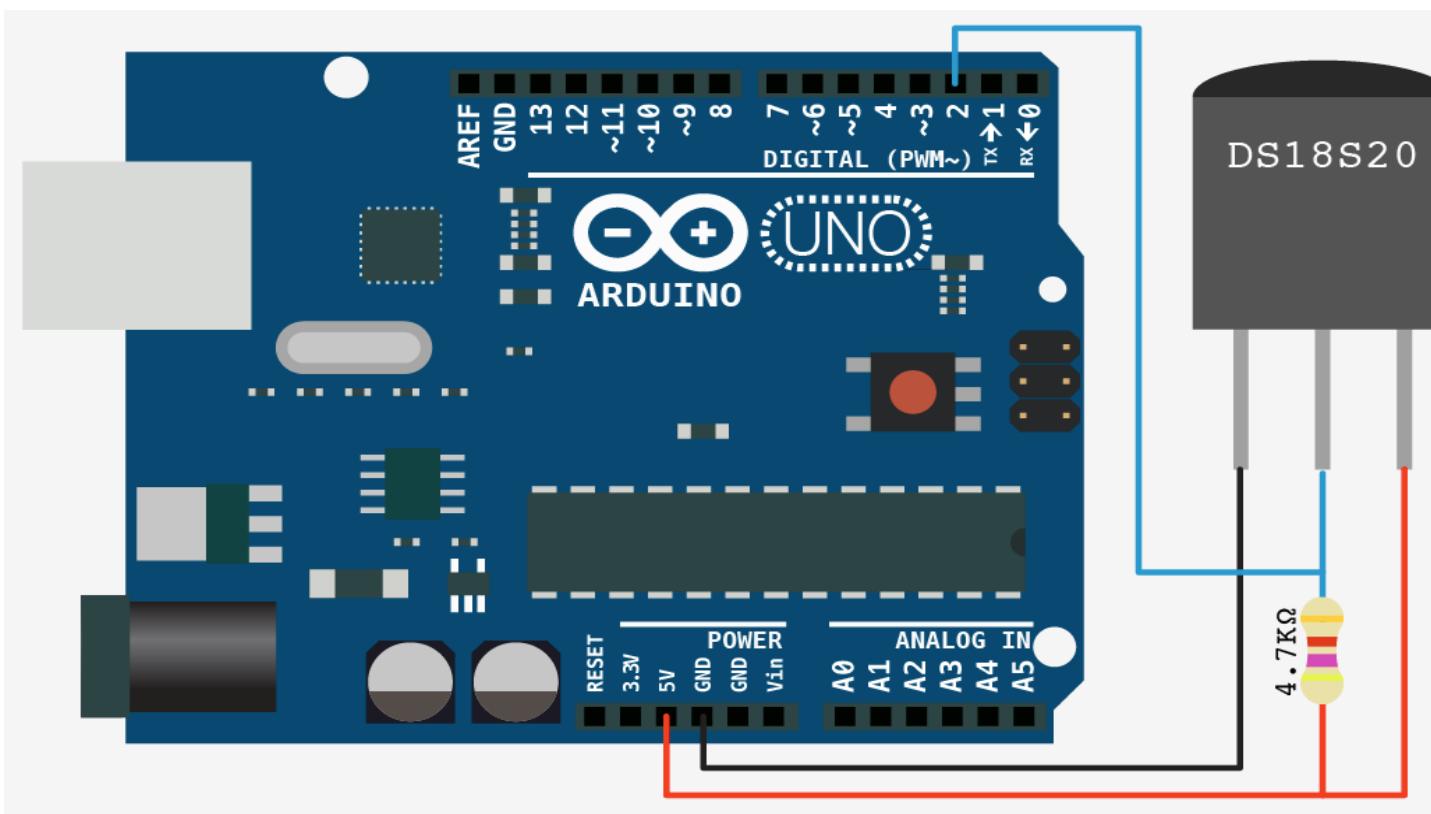
- GSM Module- SIM900A with GPRS enable



- Pulse sensor
- Laptop/pc

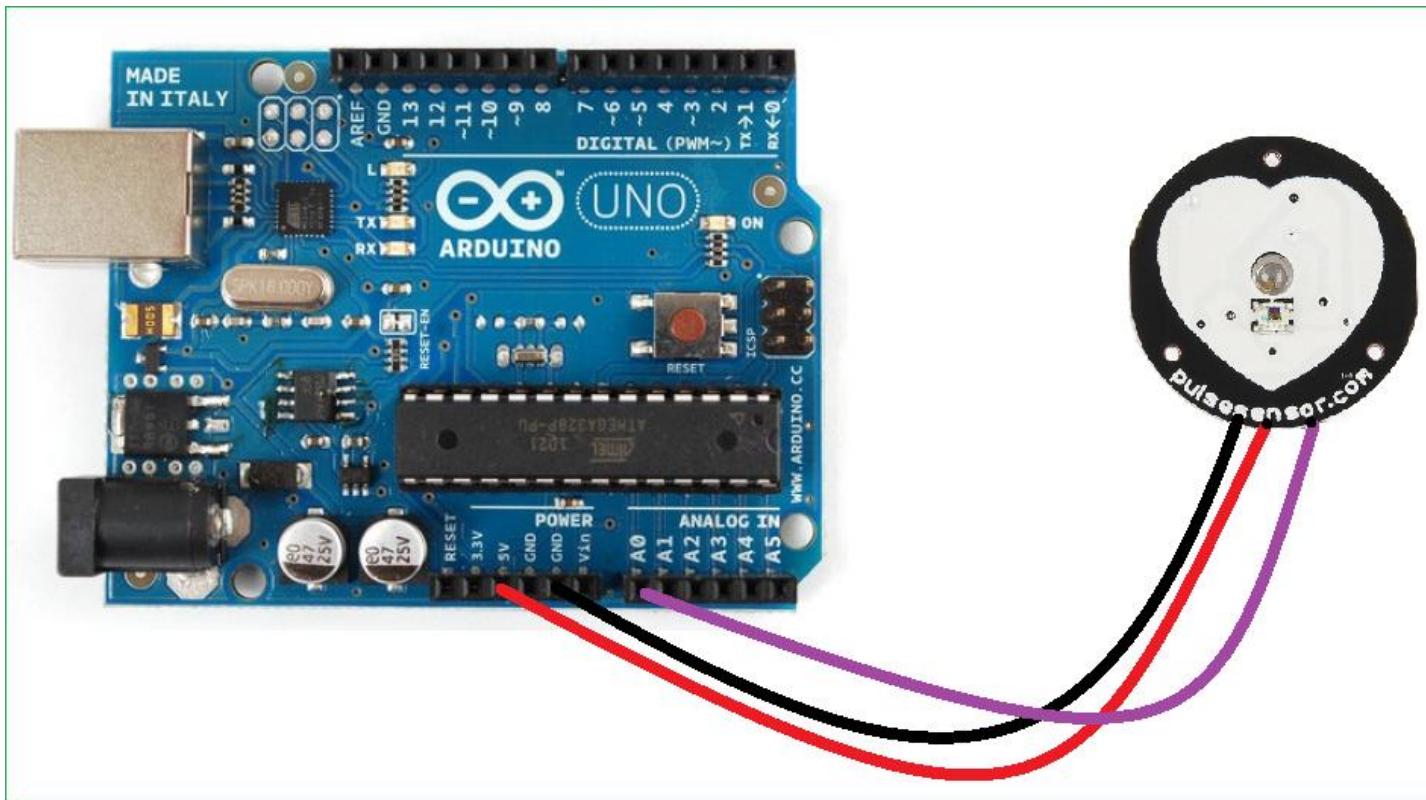
Connection Set-Up

- Arduino Uno configured with DS18B20



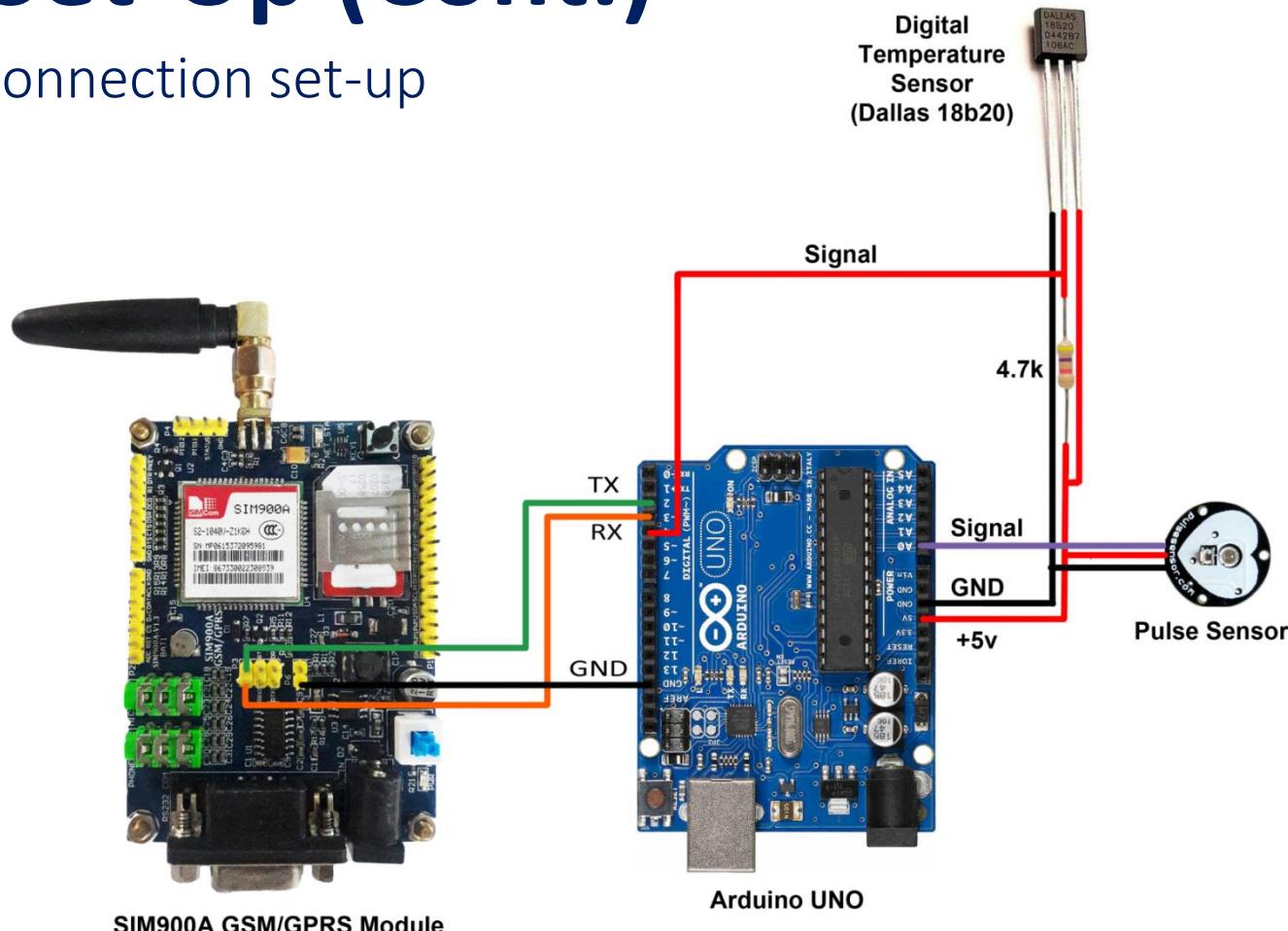
Connection Set-Up (Cont.)

- Arduino configured with Pulse Sensor

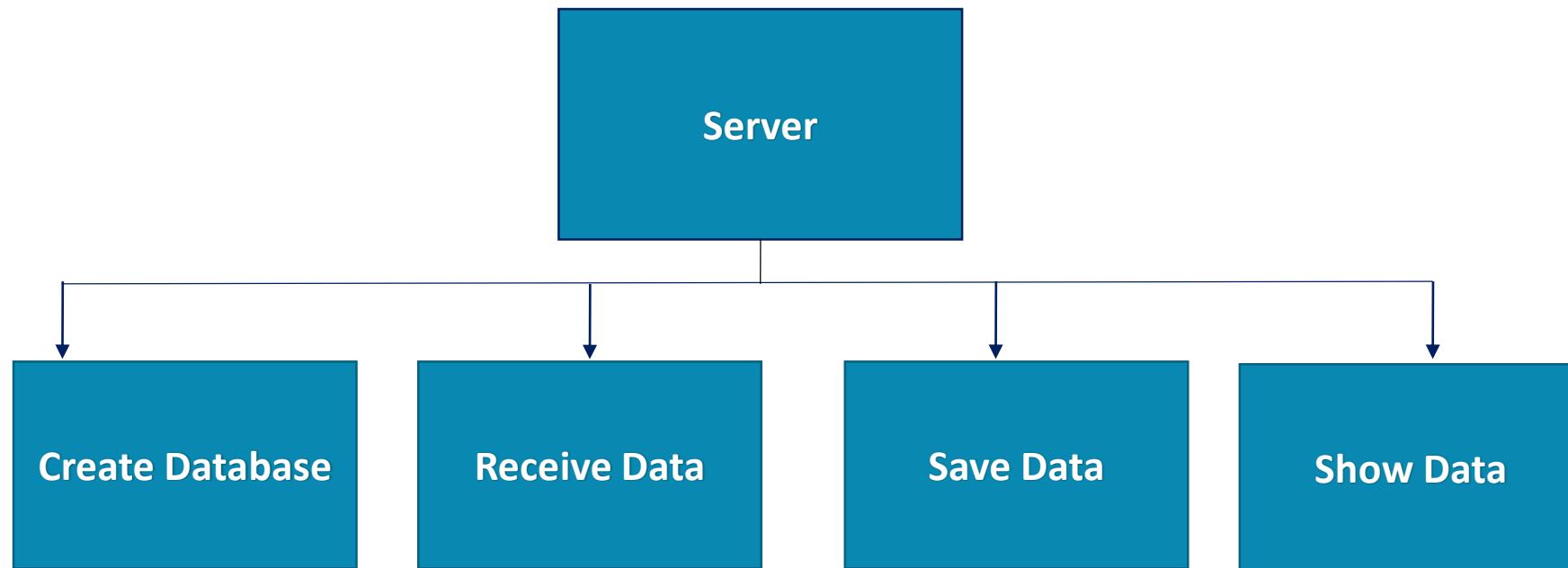


Connection Set-Up (Cont.)

- Total Hardware connection set-up



Web Server Implementation System



Database Creation

- ❖ MySQL Database System
- ❖ PHP
- ❖ Table Creation



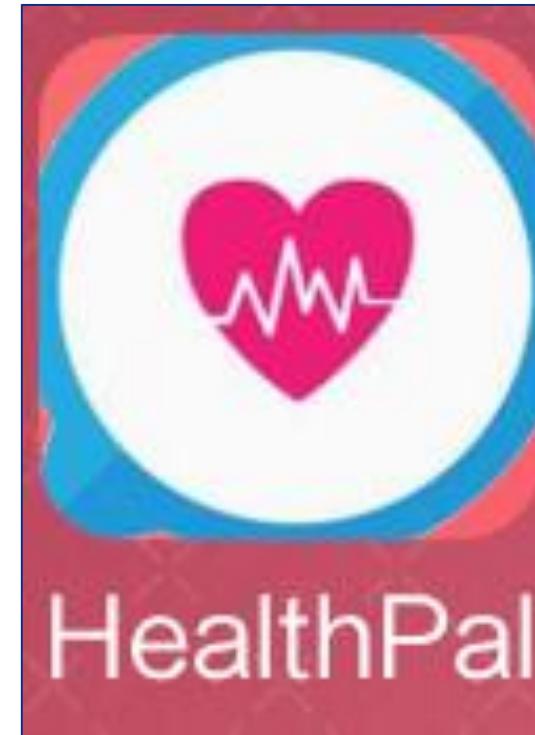
Technical specification

- Android Software Development Kit
- JDK JRE 8.0
- Min SDK version 15



Features of “HEALHPAL” - For patient application

- ❖ Registration and login
- ❖ View own Information
- ❖ Selection of Symptoms
- ❖ Message to Doctor



Interface of “HEALTHPAL” - For patient application

HealthPal

User registration

Username:
Nura

Password:
....

First name:
Nura

Last name:
Jamil

Email:
nura5277@gmail.com

Register

HealthPal

Log in

Username:
Hia

Password:
...

Login

Do not have an account ?
[Register here](#)

Interface of “HEALTHPAL” - For patient application (Cont.)

The image displays two side-by-side screenshots of the HealthPal mobile application interface.

Screenshot 1: Your health information

This screen shows the user's personal details and a history of temperature and BPM measurements.

User Details:
Name: Tabassum Khan Age: 24 years

Temperature & BPM History:

Temperature	BPM
98 fahrenheit	86
99 fahrenheit	90
98 fahrenheit	84
97 fahrenheit	101
91 fahrenheit	50
91 fahrenheit	50
99 fahrenheit	83
93 fahrenheit	50

Doctors advice

Describe your health condition

Screenshot 2: Describe your health condition

This screen allows the user to describe their current symptoms and provides a text input field for additional notes.

Symptoms:

- Blurry vision
- Chest pain
- Nausea
- Headache

Text Input Field:
Describe your problem here...

Features of “HEALTHPAL” - For Doctor application

- ❖ Registration and login
- ❖ View Patient List
- ❖ View Patient’s information
- ❖ Prescribe medicine
- ❖ Message from Patient



Interface of “HEALTHPAL” - For Doctor application

HealthPal

Patients List

[Anika](#)
[Tabassum Khan](#)
[Nura Jamil](#)

HealthPal

Patient's health information

Name: Tabassum Khan Age: 24 years

Temperature	BPM
98 fahrenheit	86
99 fahrenheit	90
98 fahrenheit	84
97 fahrenheit	101
91 fahrenheit	50
91 fahrenheit	50
99 fahrenheit	83
93 fahrenheit	50

Symptoms

Blurry vision
Headache

Message from patient

I am feeling feverish

HealthPal

Message from patient

I am feeling feverish

Prescribe patient

Take your medicine

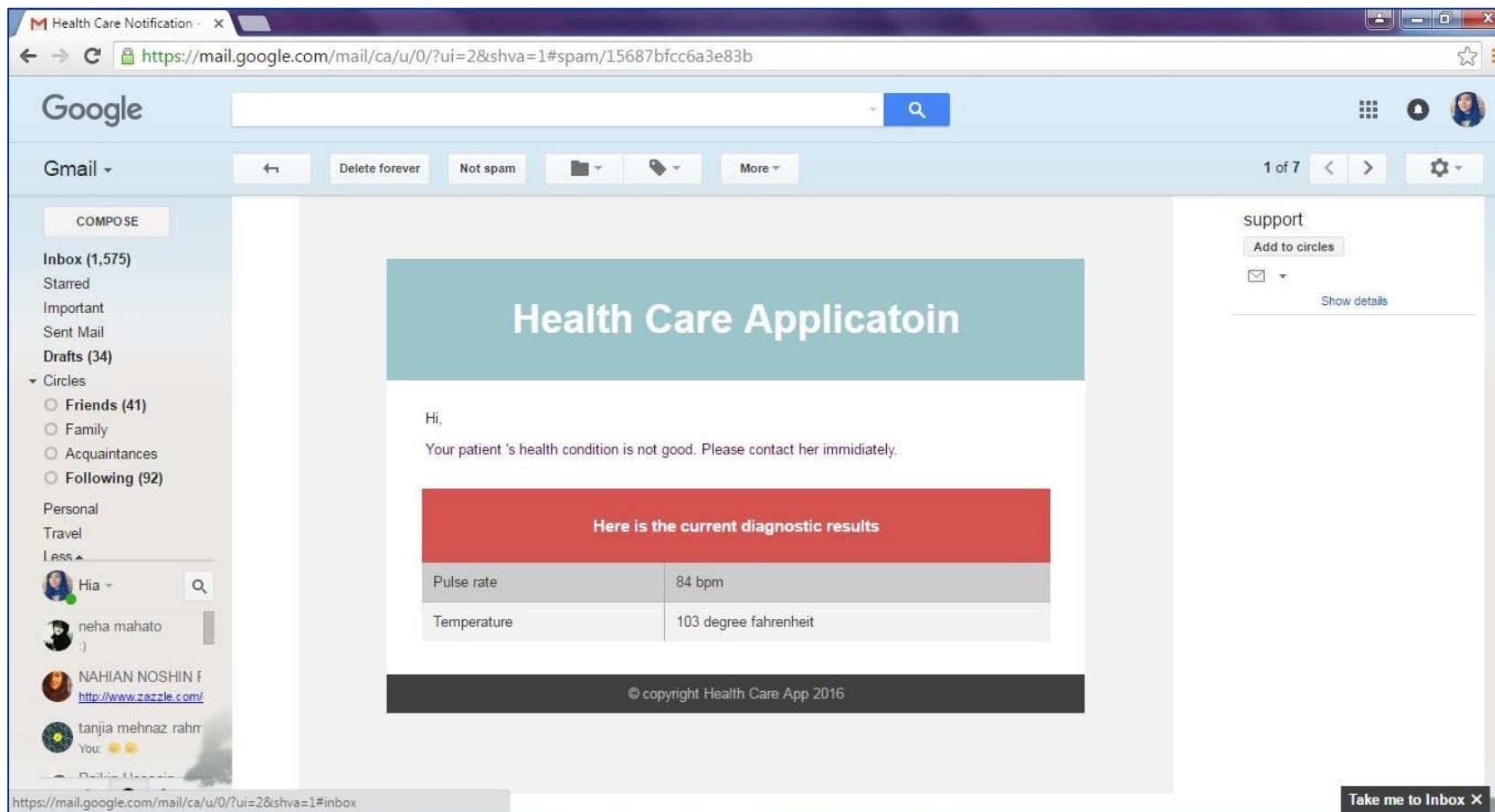
Submit

Delete patient data

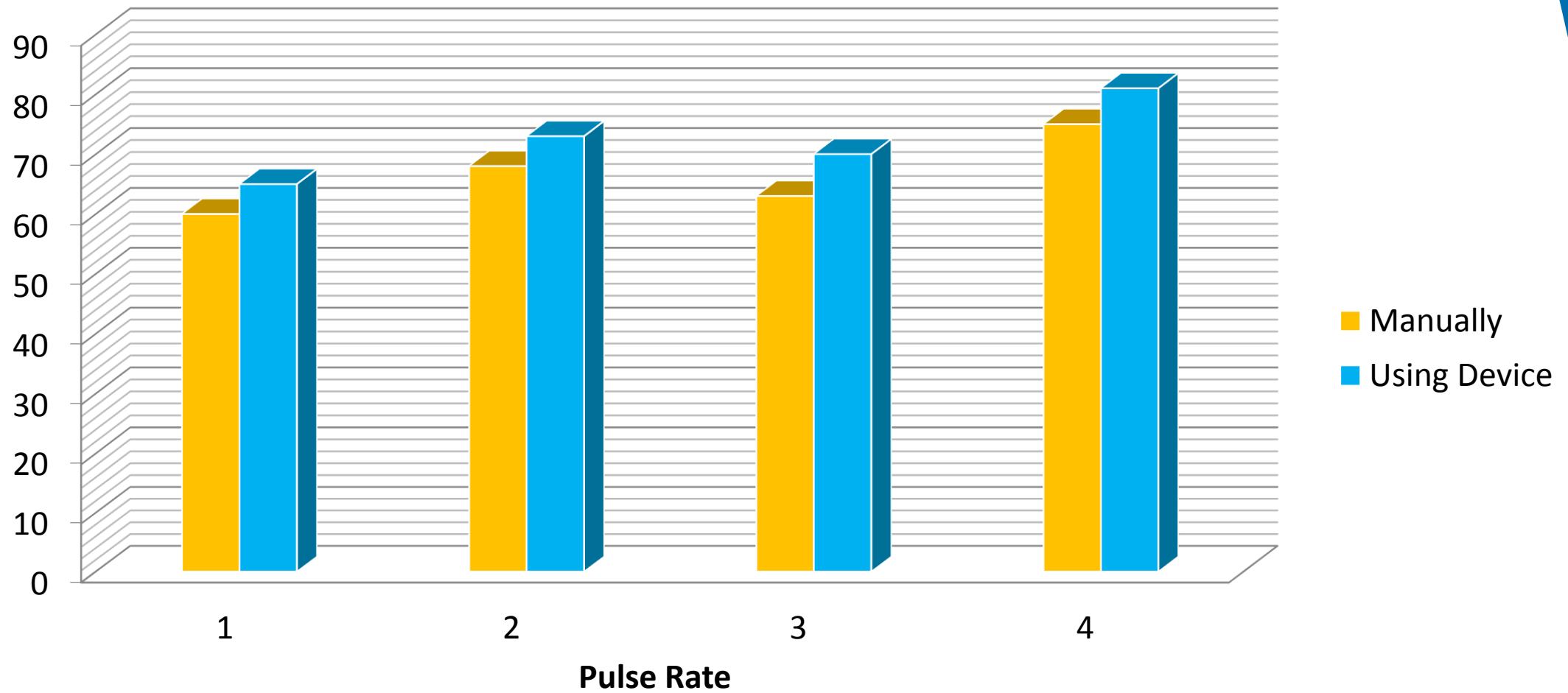
Home

Email Notification

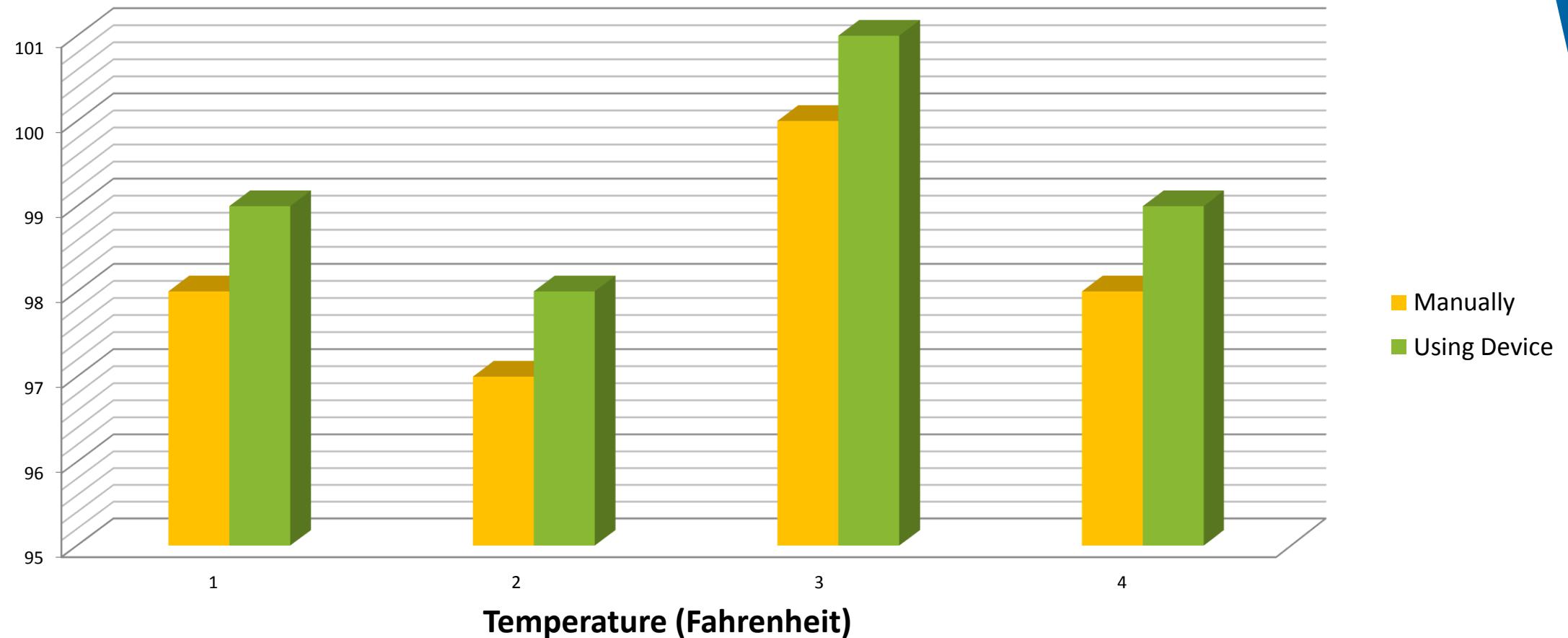
- Emergency mail sent to patient's emergency email address



Result Analysis



Result Analysis



Result Display

```
Reading data.... Please wait 1 minute
```

```
Pulse rate: 83 bpm
```

```
Temperature : 37.00
```

```
GSM Shield testing.
```

```
ATT: OK
```

```
RIC:
```

```
OK
```

```
DB:ELSE
```

```
ATT: OK
```

```
RIC:
```

```
OK
```

```
DB:ELSE
```

```
ATT: OK
```

```
RIC:
```

```
OK
```

Result (Android App)

HealthPal

User registration

Username:
Tasniem

Password:
.....

First name:
Eenie

Last name:
Tasniem

Email:
sleepingbeautyeenie@c

Register

HealthPal

Log in

Username:
Hia

Password:
...

Login

Do not have an account ?
[Register here](#)

- HealthPal**
- Patients List**
- [Anika](#)
- [Tabassum Khan](#)
- [Nura Jamil](#)

Email Notification System

Health Care Application

Hi,

Your patient's health condition is not good. Please contact her immediately.

Here is the current diagnostic results

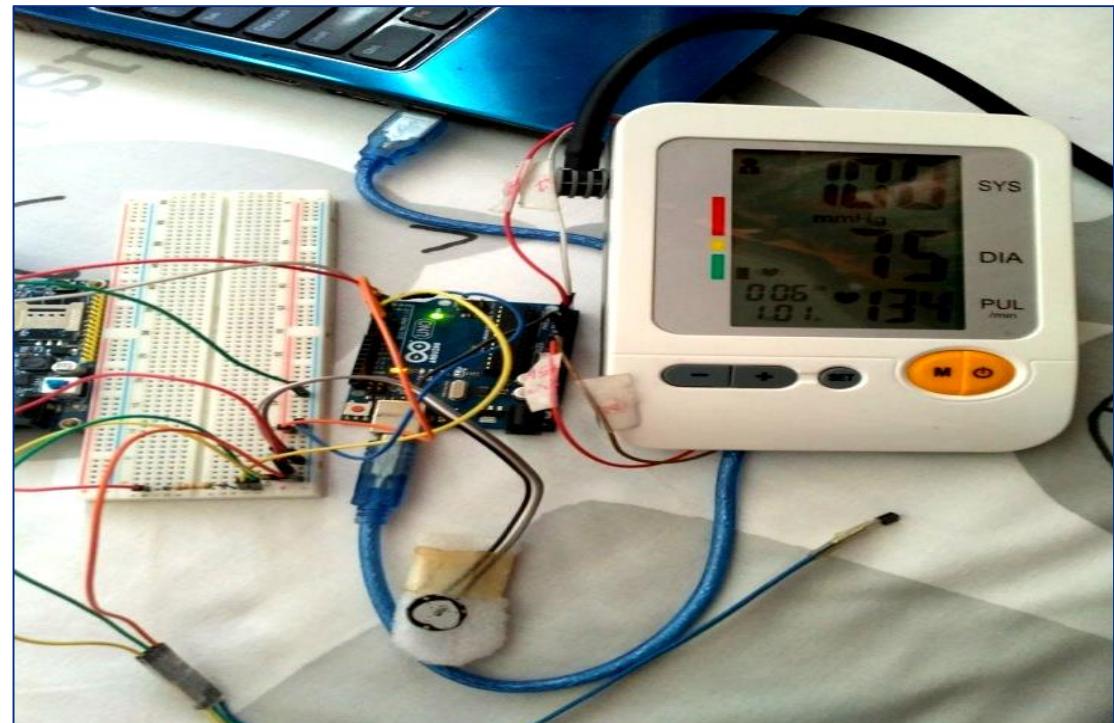
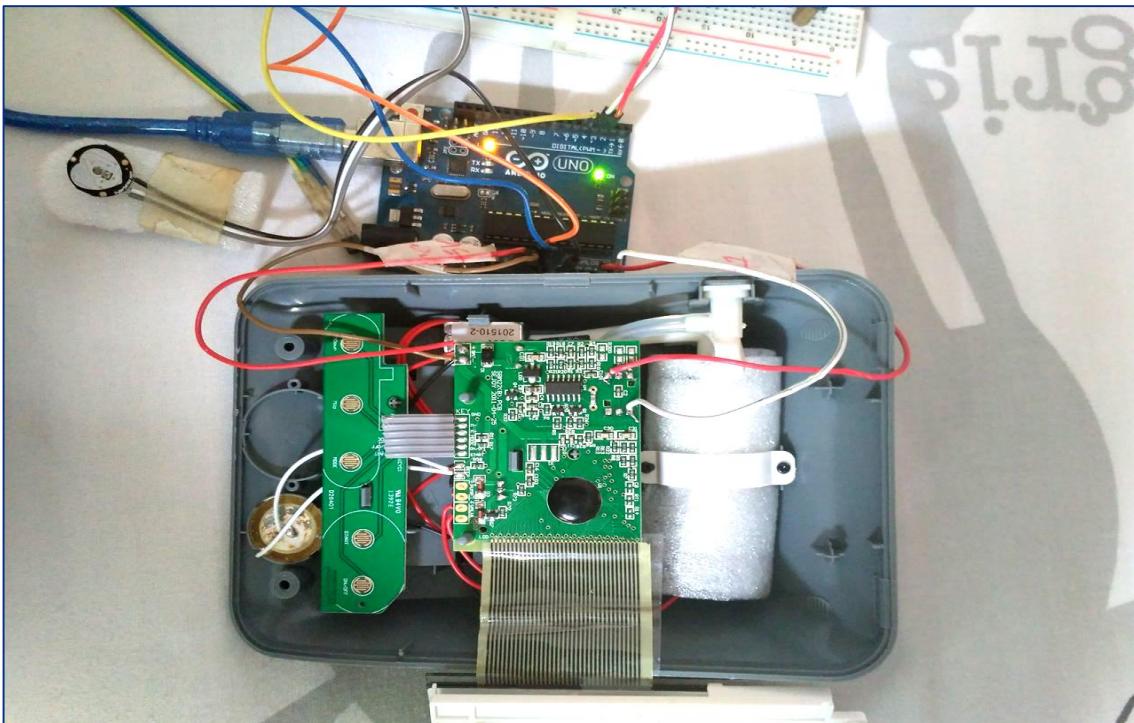
Pulse rate	84 bpm
Temperature	103 degree fahrenheit

Cost Analysis

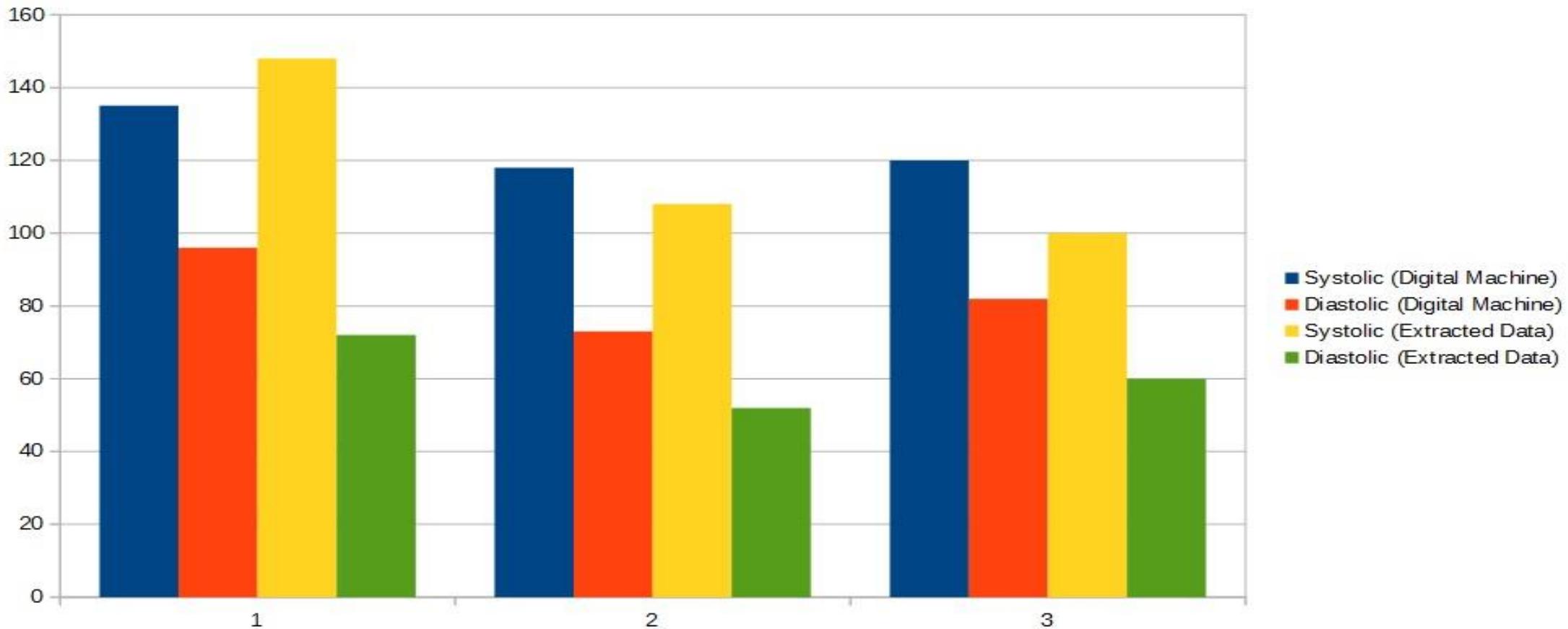
Components	Price
Arduino Uno	650/-
GSM module SIM900A	1000/-
Dallas Temperature Sensor	70/-
Pulse Sensor SEN11574	1500/-
Total Cost	3,220/-

Extract Data From BP Machine

- Soldering and joining wires
- Connection set up with Arduino
- Output



Data from BP Machine



Future Work

- Including advanced medical equipment
- Including push notification system in the application
- Customizing time interval
- One device for multiple patients
- Include GPS system

Limitations

- Time interval cannot be changed dynamically.
- Unavailability of sensors

Thank you, Everyone!