Topic: SMART HEALTH MONITORING SYSTEM FOR PATIENTS USE

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TITLE: SMART HEALTH MONITORING SYSTEM FOR PATIENTS USE

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APPROVAL FORM

The undersigned certify that they have supervised the student MAZVIITAM.CHIKEYA dissertation entitled Smart health monitoring system for patients use submitted in Partial fulfillment of the requirements for the Bachelor of Science Honours Degree in Information Technology of Bindura University of Science Education.

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DEDICATION

I dedicate this dissertation to my parents, my best friend Kunle and all the loved ones who did well in their ability to get me in the path I have chosen and supported each one of my dreams in every way that was possible to them. I know they waited for a long time to see this achievement.

ACKNOWLEDGEMENTS

Above all, I want to thank the Lord Almighty for life. Special thank goes to all the students and lecturers at BUSE, especially Mr.MATOMBO the project supervisor, for the author wouldn’t have gone that far had it not been for their tutoring and guidance.

I am particularly indebted to BUSE for taking me and, giving me more than I expected, their patience and cooperation in my learning process has been extraordinary. I also extend my gratitude to all the Lecturers in the department of computer science.

Finally, my big thank goes to my parents and family members for helping me and supporting me to succeed in this event. There are other people that I was unable to mention by their names. So, I’m grateful for all your support and help.

Topic: SMART HEALTH MONITORING SYSTEM FOR PATIENTS USE

Abstract

Health is wealth. Wealth and happiness are earned by having a healthy mind and body. However, people nowadays do not have much free time to keep track of their health status. Thus, a health monitoring system that automatically tracks and alarm the users about their health status is needed. Rapid improvement of the internet and technology, such as the Internet of Things allows the health monitoring system to be improved. The internet of things allows communication between machines and programmed actions to be triggered automatically, which makes the system to be more efficient. The traditional health monitoring system requires regular visitation of patients to doctors to check their health status. However, with the implementation of the internet of things in the health monitoring system, the health monitoring processes can be automated and helps the patient to save their precious time. Besides, the cloud that revolutionized data changing aids in the efforts of making a better and more reliable health monitoring system. The health data can be stored and visualized in real-time. In this project, a Pulse Sensor is used as a gateway to collect the health data of the user, and an Arduino Uno is used as the central processing unit that processes all the received data. The broker receives health data from the gateway and process the data. The system is capable of displaying the pulse on the LCD Screen. Several experiments and tests, such as accuracy test and error analysis were conducted on the proposed system, and encouraging results were obtained.

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CHAPTER 1: INTRODUCTION

1.0 BACKGROUND OF STUDY

Today internet has become one among the vital components of our daily life. It is modified to methodologies how individuals live, work, play and learns. Internet serves as a tool for several purposes like education, finance, business, industries, recreation, social networking, shopping and etc. Future new mega trend of internet is IoT. Visualizing a world wherever several objects will sense, communicate and share data over a personal net protocol or public networks can be done through IoT. The interconnected objects collect the data at regular intervals, analyse and initiate needed action, providing associate intelligent networks for analysing, designing and decision making (Rashmi, 2011). This is the world of Internet of Things. IoT is mostly thought about as connecting object to the internet and victimization that affiliates for management of these objects or remote watching. But definition of IoT is creating a brilliant invisible network which may be detected, controlled and programmed (Filip, 2014). The products developed based on IoT include embedded technology that permits them to exchange information, with one another or the internet and it is assessed that 8-50 billion devices are connected by 2020. Since these devices come online, they provide better life style, create safer and more engaged communities and revolutionized healthcare. In low and middle economical gain countries, there is more and more growing range of individuals with persistent diseases because of totally different risk factors like nutrient imbalance and physical inactivity. According to WHO report, 4.9million individuals die from carcinoma from the consumption of snuff, overweight a pair of 2.6million, 4.4million for increased cholesterol and7.1million for high pressure (Rohokale, 2017). Chronic diseases are extremely variable in their symptom, evolution and treatment. Some, if not monitored and treated early, will end the patient’s life. For several years the standard measure of glucose level, pressure level and heart beat was calculated in specialized health centres. Due to the technological development, there is a great variety of running sensors giving important signs such as blood pressure cuff, gluco meter and pulse monitor together with electrocardiogram, which permits the patient to take their vital signs daily. The readings taken daily are sent to doctors and enable them to suggest the medicine and physical exercise routine that enable them to improve the quality of life and overcome such disease. Internet of Things applied to the care and watching of patients is more and more common within the health sector, seeking to boost the standard of life of individuals. The Arduino is programmable devices that can senses and interact with its environment. The combination of Internet of Thing with Arduino is the new approach of introducing IoT in healthcare monitoring system of patient. The entire concept of IoT stands on sensor, gateway and wireless network that modify ser to communicate and access the information. IoT offer more guarantee within the health awareness. As a saying goes "Health is wealth" it's exponentially crucial to form utilization of innovation for better well-being (Kim, 2015). Arduino Uno collects the information from the sensor and transfers it to the IoT website.

1.1 PROBLEM STATEMENT

In the absence of the doctors, the patient cannot consult the doctors due to which emergency situation may also be created. The personal health monitoring of each individual is considered very important because of the rise in health problems in today's world (Fowler, 2016). The increasing stressful lifestyle is taking a maximum toll on public health. With the ever increasing queues at hospitals and an increasing number of patients, the doctor fees have sky-rocketed which is affecting especially those patients who cannot afford the fee or who are not suffering from major ailments but get to know so only after paying a hefty fee to the doctor (Wang, 2018).

1.2 JUSTIFICATION

In traditional methods, the health of a human body is monitored using thermometer, oximeter, etc. A thermometer used to take the body temperature. When some activities are carried out, small changes in body temperature will be detected. Pulse oximeters are devices that measure oxygen level in human body (Rolls, 2015). The device may be attached to a finger, a wrist, a foot, or any other area where the device can read blood flow. A heart rate monitor (HRM) is a personal monitoring device that allows one to measure/display heart rate in real-time. Fit bit tracks every part of your day, including activity, exercise, food, weight and sleep, pulse rate and steps. Doctors play an important role in health checkup. The process requires a lot of time for registration, appointment and then checkup. Due to this lengthy process working people tend to ignore the checkups. Present-day systems use health monitoring devices which are connected to the patients at the hospital (Smith, 2020). The use of these machines detects the conditions of the patient and the data is collected and transferred to the connected monitoring systems. Doctors and staff need to visit the patient frequently to examine his/her condition. The smart health monitoring system can provide information required to monitor the health parameters of the patient.

1.3 AIM

This project aims to design and construct a Smart health monitoring system for patients that is inexpensive. Also to develop new innovations for the use of basic nursing as well as personal care.

1.4 OBJECTIVES

1. To design and implement a Smart health monitoring system for patients.
2. To design a Smart health monitoring system for patients that will be able to take the important body parameters pulse rate.
3. To assess the effectiveness and efficiency of the proposed system in mitigating the challenges faced by patients.

1.5 RESEARCH QUESTIONS

- How will the health monitoring system be working?
- How effective is the monitoring using sensors?
- How will the researcher demonstrate in real-time monitoring of the patients health?

1.6 DEFINATION OF TERMS

IOT – Internet of things.

Patient - a person receiving or registered to receive medical treatment.

Health - the state of being free from illness or injury.

1.7 SCOPE OF WORK

This work focuses on the design and implementation of an IOT based health monitoring system for patients. The scope of the project includes the following;

- Analysis of the existing systems
- Review of past works on proposed topic
- Design of the proposed system
- Construction and Implementation of the proposed system.

1.8 STRUCTURE OF DISSERTATION

The project is divided into five chapters. In Chapter I, an introduction which includes background study, problem statement, objectives and scope is presented.

Chapter II gives a literature review of past related works that have been conducted. Brief introduction of the proposed work and details of relevant theory are also presented in the Chapter II. Chapter III talks about the design and building of an IOT based health monitoring system for patients, circuit design and the system circuit diagram with its description. In Chapter IV, results are presented. Finally, the conclusion and recommendation of this project is done in Chapter V which includes the recommendations and directions for future research.

CHAPTER 2: LITERATURE REVIEW

2.0 INTRODUCTION

Topic: SMART HEALTH MONITORING SYSTEM FOR PATIENTS USE

Internet of Things (IoT)-enabled devices have created remote monitoring in the healthcare sector potential. It has reduced the costs and improved the health treatment of patients. IOT helps in collecting the information from various sensors and analyzing the data in real time. Connecting these devices to the patient's body will allow easy monitoring by the staff and can save live in any emergencies. Users can access the data resulting in better analysis of the patient. Different papers used different applications and methods in IoT healthcare system.

2.2 THEORETICAL FRAMEWORK

A theoretical framework is a foundational review of existing theories that serves as a roadmap for developing the arguments you will use in your own work. The researcher decided to use theories that are used in developing by researchers to explain health monitoring, draw connections, and make predictions. In this theoretical framework, i explained the existing theories that support this research, showing that this dissertation topic is relevant and grounded in established ideas.

2.3 LITERATURE REVIEW

2.3.1 Wireless Health Monitoring System for Patients

The project was to observe patients without having to be physically present at their bedside, be it in the hospital or in their home. A patient's body temperature, heart rate and electrocardiography (ECG) are transferred wirelessly through Bluetooth technology. The temperature sensor chosen was LM35 IC. The ECG had three electrodes that can monitor heart from three different angles. The heart rate monitoring was a follow up to the system for obtaining the electrocardiograph. After obtaining the electrocardiograph, the Arduino Uno was programmed to obtain the heart beat rate of that particular reading. The purpose of the Arduino was to show the result in the local PC and the Bluetooth is to transfer the same data wirelessly to the server PC or smart phone. Xoscillo software helped to observe the wave shape of the ECG. The project was to overcome the difficulty that is encountered by experts in monitoring multiple patients at a time (Ahmed, 2015).

2.3.2 Smart health monitoring system of patient through IoT

The general design of IoT applications can be partitioned into three layers: the detecting layer, the transport layer and the application layer. In the Detecting layer, to measure the body temperature DS18B20 body water resist body temperature sensor is used. To measure the heart beat rate of the patient, pulse sensor amped are used. To recognize the Electrocardiogram, AD8232 Heart-Rate observing sensor are used. The Bio data from the sensors is checked in Arduino using the serial monitor. In the Transport layer the information is sent to the cloud by utilizing the Arduino with the assistance of an Ethernet shield or Wi-Fi Module ESP8266. Here the system utilizes an open cloud server i.e. “Thingspeak" to make it accessible in cloud. Through ThingsSpeak an API key is generated. This API key is utilized while programming in Arduino with the end goal that the information is put in the server through the API key and at the application layer the information can be recovered by the utilization of an API key. The information of the patient including the location and the health parameters can be viewed in a graphical format with the help of Thingspeak (Aswar, 2019).

2.3.3 Internet of things (IoT) based smart health care system

For monitoring health parameters like temperature, pulse rate and blood pressure respectively, three sensors are connected to the Arduino Fio transmitter board. The xbee module is connected to the board. The sensed values are wirelessly transmitted to the arduino receiver which is connected to the patient side computer and the values are read in labVIEW which is connected to the Internet. A URL is generated by labVIEW which can be accessed from any computer .In this paper, tele-monitoring application is presented which allows the doctor to view the patient’s vital parameters remotely and dynamically in a Web page in real time and doesn’t need to have any special requirement on the PC; through an Internet access. For the patient side, a home based LabVIEW application which is embedded in home PC is required (Vikas, 2016).

2.3.4 Patient Health Monitoring System Based on Internet of Things

In this paper, a circuit was developed which can sense the temperature and heart-beat of the human body, and if it exceeds a certain set limit, then an alarm would be raised over IOT Gecko platform on the Internet. LM35 sensor was used to read temperature values whereas heartbeat sensor module gave heart rate of patient which was sent to microcontroller unit which thereby use to send this data to LCD for display as well as to ESP8266 WiFi protocol to display the measured readings over IOT Gecko Internet Platform. During an emergency, an alarm would be raised over the internet platform notifying the doctor about critical status of patient over internet. The doctors were able to monitor the health-related data of patient using the unique IP & login id over the IOT gecko platform over which the instantaneous health related data of the patient used to be updated (Gupta, 2017).

2.3.5 IOT Based Health care monitoring system

Author presented “An IOT Based Health care monitoring system”. Constant observation is required in hospitals where the patients are under medical care for a longer period of time (Mali, 2017). Although the patient is not in a critical situation, the doctors still need confirmation on their health parameters. Now a day, the expenses for hospitalization are high and expensive. So the health policies in various countries have shifted its focus from providing reactive, acute care to provide care outside the hospital. Hence author designs and build the sensing data that conditions the International Journal of Research in Advent Technology (IJRAT) Special Issue E-ISSN: 2321-9637 Available online at www.ijrat.org National Conference on “Role of Information Technology in Social Innovations” 26th & 27th February 2019 96 system to display accurate body parameters of the patients. The aim of this paper is to supervise the heart rate, blood pressure, temperature and ECG continuously through respective sensors. The recorded data is sent to the device and if the value exceeds, the alert message will be sent to the doctor.

2.3.6 IOT Based Smart Health care system using Raspberry Pi

Author has presented “An IOT Based Smart Health care system using Raspberry Pi”. They have used an exclusive sensor to monitor a patient’s health parameters. Hence author has used platform Raspberry Pi for IoT. The Raspberry Pi is a platform which offers compact platform for a Linux server with a low cost (Patil, 2018). The combination of Raspberry Pi and IoT is a new changing technology in the healthcare system. Raspberry Pi collects various data from sensors and transfers to database. Cloud computing possess numerous advantages such as flexibility, highly automated, low cost etc. The Cloud's features enable customers to build and deploy their applications on virtual servers. Here the author has concentrated over the idea of separating wireless sensor network and cloud computing. Once sensors are connected to patients’ bodies, they start to receive and transmit data to the database sensors like temperature (DS18B20), heartbeat, blood pressure, ECG (AD8232) services available in the cloud are responsible for receiving, storing, and distributing patient’s data.

2.3.7 Internet of Things as Key Enabler for Sustainable Healthcare Delivery

Author has presented “Internet of Things as Key Enabler for Sustainable Healthcare Delivery”. Here the author considers IOT as a global network infrastructure, linking physical and virtual objects. This architecture consists of existing and evolving internet and network developments. Exclusive object identification, sensor and connection capability are offered. Hence sensors will be characterized by a high degree of data capture. This paper aims to show how radio frequencies are identified and Internet of Things technologies allow patients to access healthcare services (Elena, 2017).

2.3.8 Simulation of Health care Monitoring System in Internet of Things by Using RFID

Author has presented “Simulation of Health care Monitoring System in Internet of Things by Using RFID”. Author has designed the effective healthcare monitoring system using the IoT. The health monitoring system plays a vital role with IOT; the RFID tag is used to initialize the bed system as a key. The sensors are used to observe the patient's condition frequently. The information report of patient is transmitted to the website through IOT system so that the doctor they can know about the condition of the patient. The movable bed mechanism is used to adjust the bed according to the patient's condition. The buzzer is to indicate the nearby persons that the patient is in critical situations. In this paper, there is a discussion over the security requirements of authentication. Particularly they have represented an ECC-based RFID authentication in terms of implementation and authentication. Even though most of these cannot satisfy the security requirements and implementation (Val an, 2018).

2.3.9 A Literature Survey in ECG Feature Extraction

Author has presented "A Literature Survey in ECG Feature Extraction". Patient's health has been observed in this paper. There is a well organized health monitoring system developed and designed by author. The system enables the doctors to monitor patient's health parameters (temp, heartbeat, ECG, position). The parameters of the patient are measured continuously (temp, heartbeat, ECG) and wirelessly transmitted using zigbee. It provides a solution for improving the performance and power management of the patient health monitoring system. The presented system is used to continuously observe and analyze the data in microcontroller. If a particular patient's health parameter falls below the particular range, SMS is sent to the doctor's mobile number using a standard GSM module. They have used Zigbee for wireless networking. The doctor can collect a record of a particular patient's data by accessing the database of the patient on their respective PC which is persistently updated through Zigbee.

2.3.10 IOT Based Patient Monitoring System

Author presented "IOT Based Patient Monitoring System". It is a mobile physiological monitoring system that is capable of continuously monitoring the patient's heart rate using ECG. Using replaceable electrodes ECG sensor can be attached to the patient's chest. Signals produced during muscle contraction is sensed by the system and recorded. The signals collected from the body are converted to an electrical signal. This paper shows the use of smart healthcare system. This new technology is capable of offering a large range of benefits to patients through early detection of abnormal conditions.

2.3.11 Health Monitoring Systems using IoT and Raspberry Pi

Author presented "Health Monitoring Systems using IoT and Raspberry Pi". IOT Raspberry Pi based health care monitoring system has been analyzed by author in this paper. Any unusualitiy in condition of patient health can be detected and informed to the related person of patient. The elemental component of ECG is Instrumentation Amplifier, which is responsible for taking the differences in the voltage. The exhibited system is efficient and easy to understand. It is a connection between patient and doctor.

2.3.12 Review on-IOT Based smart healthcare system

Author presented a "Review on-IOT Based smart healthcare system". Here architecture of Smart Health Care Monitoring and IOT is demonstrated by author. New technologies help in minimizing the better quality as well security concept. ECG signals are obtained by electrodes that are placed on the chest. Later wires are connected to ECG sensor (AD8232).The sensor is used in measuring the electrical activity of the heart. Problems and challenges that could be faced in future are presented by this system. Applications of IOT can be improved using new methodologies and technologies. Sensors like Blood pressure, Temperature, Heart rate, ECG are used in IOT along with Raspberry Pi kit and Wi-Fi module.

2.3.13 Heart rate Monitoring and Pulse Oximeter System

Author has presented "An Overview on Heart rate Monitoring and Pulse Oximeter System". In this paper a low-cost device is described that measures the heart rate of the patient by placing sensors on the fingers, later the result will be displayed on LCD. The designed system can be used by unprofessional people. The change in heart rate can be displayed by graph using graphical LCD. Over a period of time, maximum and minimum heart rate can be displayed using the designed system. Abnormalities are displayed on LCD indicated by buzzer. In order to send heart rate to PC output should be attached.

2.4 CHAPTER SUMMARY

The researcher has controlled to gather information that's relevant for this project. Some of the concepts from research journals, textbooks and unpublished material exhibit the depth and hole to be filled. The records collected are for use inside the chapters to follow to satisfy the set targets.

CHAPTER THREE: METHODOLOGY

3.0 INTRODUCTION

The health monitoring system for patients is designed in this chapter using a systemic approach. Because the system's overall architecture is complex, it's important to think of it as a collection of functional components. The following sections of this chapter go over the various components and the block diagram.

3.1 RESEARCH DESIGN

The author chose the experimental study design because it allows her to examine how systems and objects respond as he alters or adjusts variables.

3.2 REQUIREMENTS ANALYSIS

It is critical to document all of the required system's functional and non-functional specifications at this time. It is advisable to arrange all incoming data, assess it, consider all potential client limits, and create a ready-to-follow specification that matches the customer's requirements. The study also considered any constraints, such as time and financial constraints that could obstruct the design technique.

3.2.1 Functional requirements

- The system ought to be able to read and capture the heart rate
- The system should be able function on it’s on.

3.2.2 Non-functional requirements

- The system is supposed to be easy to use
- The system should be available all the time.
- The system should have a relatively small response and decision time

3.2.3 Hardware requirements

- Connecting wires
- Breadboard

- Pulse Sensor
- LCD screen
- Arduino Uno

3.2.4 Software requirements

- Windows 10 Operating system
- Arduino IDE

3.3 SYSTEM DEVELOPMENT

This system discusses the system's overall design and how it was created to deliver the desired goals. It lists all of the software tools and models that were used in the system's development.

3.2.1 System development tools

In software engineering, a methodology for software production or system design is a framework for organizing, planning, and regulating the procedures of building an information system. In this design the researcher used the waterfall model, Arduino ide, Arduino, Pulse sensor, LCD screen and breadboard.

3.2.2 Waterfall model

It is one of the classical and primitive models for developing a system, in this model there are six stages to develop the system. It begins with stage one and flows downwards like a waterfall meaning it does not allow going backward or receiving feedback, it also defines a stiff and linear development technique. The system has different objectives for each design stage where each stage is completed for the next stage to begin and there is no turning back.

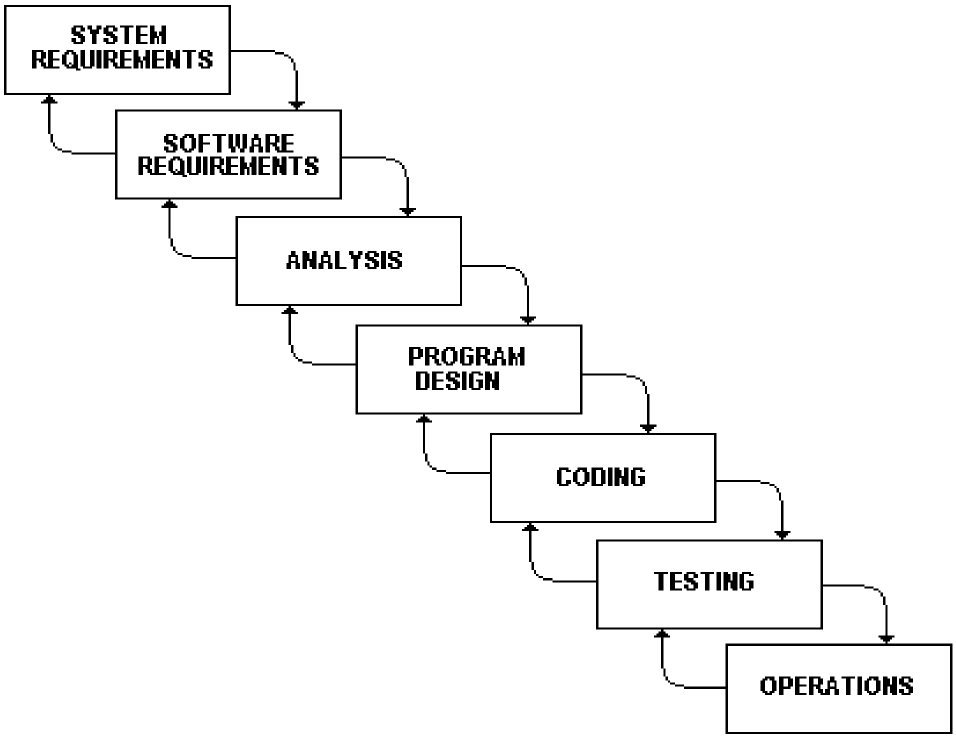


Figure 3.1 Waterfall Model

Apart from the methodology the system was also developed using the following tools:

- C is a high level programming language; the author used the C language as the Arduino IDE is based on the C programming language.

3.3 SUMMARY OF HOW THE SYSTEM WORKS

The health data can be stored and visualized in real-time. In this project, a Pulse Sensor is used as a gateway to collect the health data of the user, and an Arduino Uno is used as the central processing unit that processes all the received data. The broker receives health data from the gateway and process the data. The system is capable of displaying the pulse on the LCD Screen.

Several experiments and tests, such as accuracy test and error analysis were conducted on the proposed system, and encouraging results were obtained.

3.4 SYSTEM DESIGN

The requirements specification document is analyzed and this stage defines how the system components and data for the system satisfy specified requirements.

3.4.1 Proposed system flow chart

Flowcharts are an efficient way of bridging the communication divide between programmers and end users. They are flowcharts specialized in distilling a significant amount of data into comparatively few symbols and connectors.

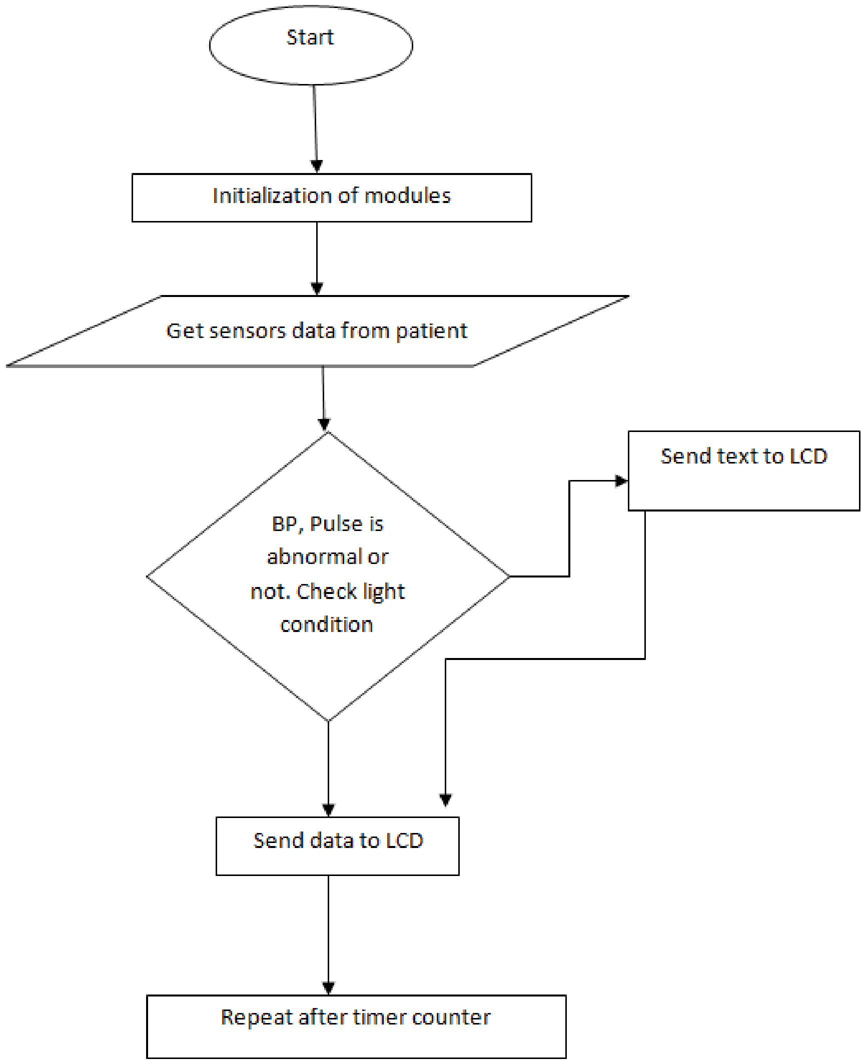


Figure 3.2 Flowchart of the system

3.5 BLOCK DIAGRAM AND DESCRIPTION

The application based controlled home automation consists of several individual components put together to perform its function. As shown in Fig 3-1, the system blocks are namely;

- Connecting wires
- Breadboard
- Pulse Sensor

- LCD screen
- Arduino Uno

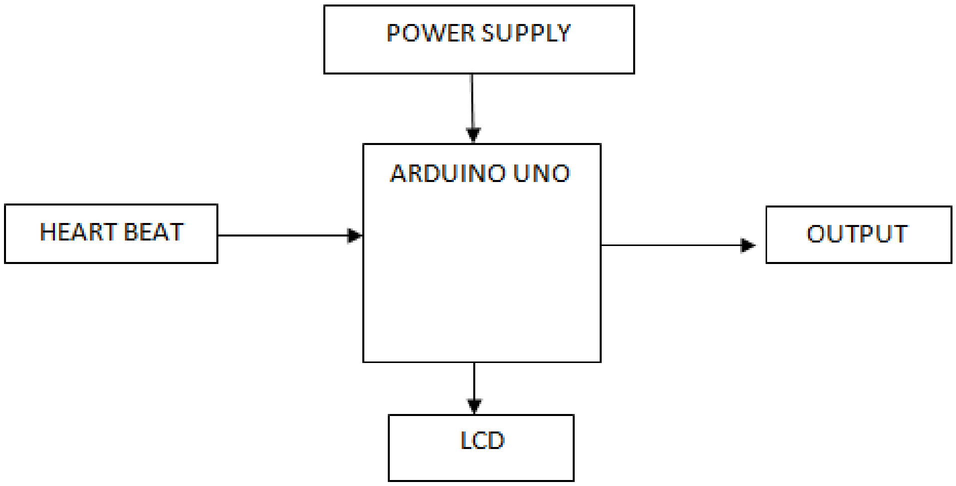


Figure 3.3: System block diagram

3.5.1 Heart beat sensor

Heart Beat Sensor: The heart beat sensor is a plug and play heart rate sensor for Arduino. It is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor. It sips power with just 4mA current draws at 5V.

Figure 3 Heart Beat Sensor

3.5.2 LCD screen

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizer's. Liquid crystals do not emit light directly, (Ulrich, 2020) instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden. For instance: preset words, digits, and seven-segment displays, as in a digital clock, are all good examples of devices with these displays

Figure 3.5 LCD Screen

3.5.3 Arduino Uno

According to (Barragán, 2016) the Arduino Uno is an open-source microcontroller board designed by Arduino.cc and based on the Microchip ATmega328P microprocessor. The board has digital and analog input/output (I/O) pins that can be used to connect to expansion boards (shields) and other circuits. The board features 14 digital I/O pins (six of which are capable of PWM output), 6 analog I/O pins, and is programmable through a type B USB cable using the Arduino IDE (Integrated Development Environment). It can be powered by a USB cable or an external 9-volt battery, with voltages ranging from 7 to 20 volts. It's similar to the Arduino Nano and Leonardo microcontrollers.

Figure 3.6 Arduino Uno

3.5.4 ***Connecting wires***

These wires typically come in three versions: male-to-male, male-to-female and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into.

Figure 3.7 connecting wires

3.5.5 *Breadboard*

A breadboard, or protoboard, is a construction base for prototyping of electronics. It is not necessary to solder the breadboard because it is reusable, David (2014). This makes it simple to use for making temporary prototypes and circuit design experiments. As a result, solderless breadboards are becoming increasingly popular among students and in technology education.

Figure 3.8 Breadboard

3.6 DATA COLLECTION METHODS

3.6.1 Data Collection Unit

For data collection, we are using the following sensors:

1) Heart Beat Sensor: The heart beat sensor is a plug and play heart rate sensor for Arduino. It is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor. It sips power with just 4mA current draws at 5V.

To train the model, the author employed a Pulse Sensor to gather positive and negative data. Positive samples contain when they is enough water in the tank, whereas negative samples do not contain water that must be found. The author ran numerous cycles and examined how the system responded to different conditions. Observation allowed the researcher to assess the system's accuracy as well as the solution's response time.

3.7 IMPLEMENTATION

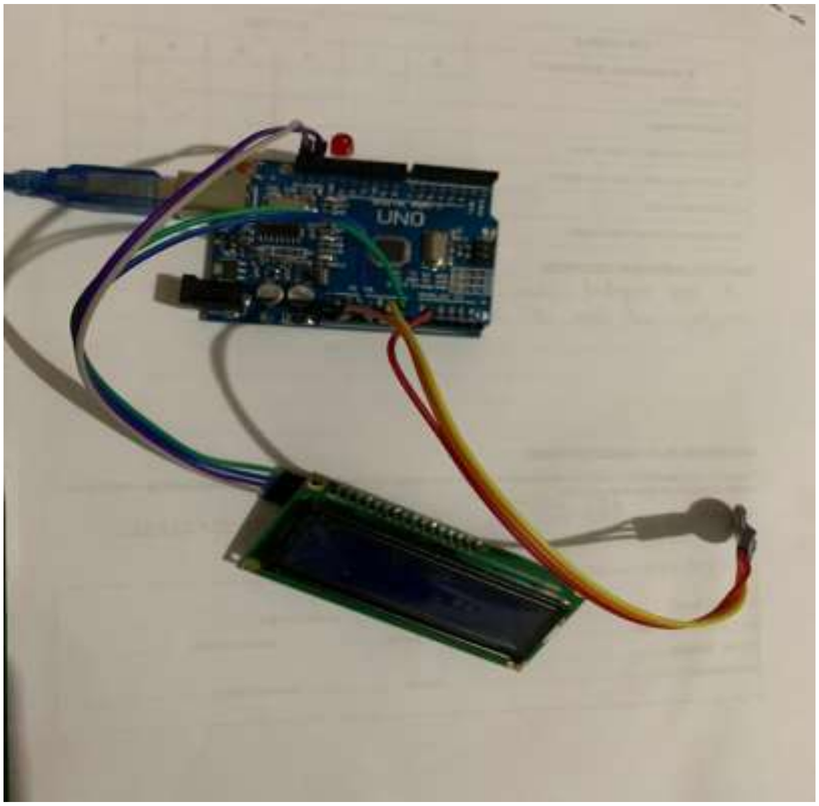


Figure 5 Picture of the system

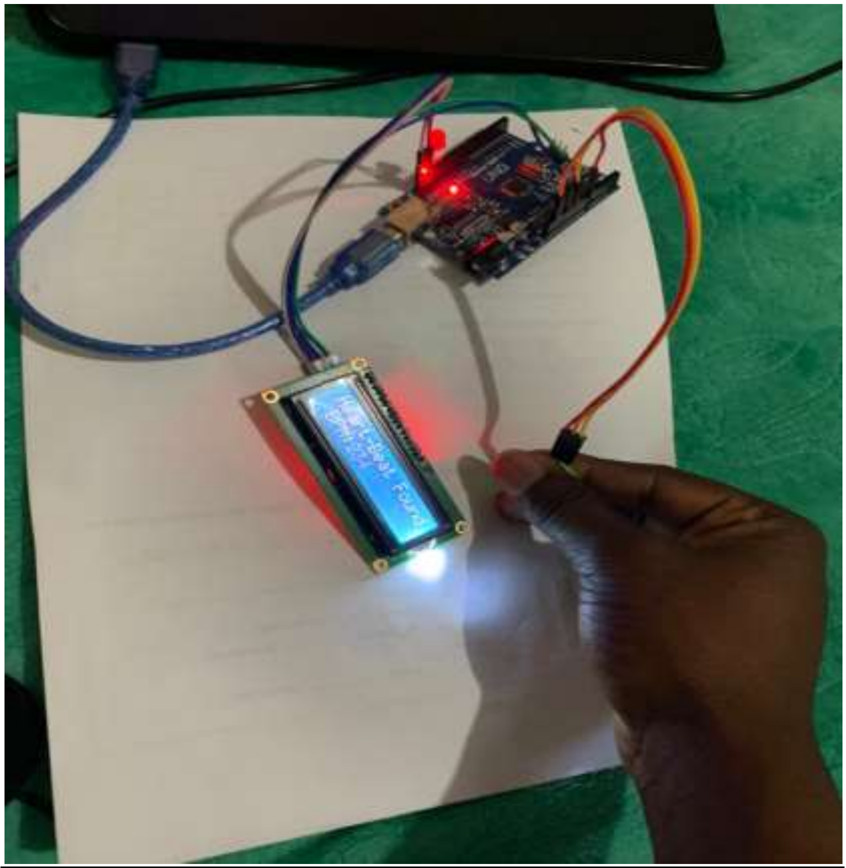


Figure 6 Picture of the system detecting the pulse

3.8 SUMMARY

This chapter focuses on the technique used in the development and design of the system. The system was built with a number of approaches and technologies, including the C programming language, Arduino and IR sensors, all of which contributed to the proposed solution. This chapter also looks at the system's operation and how data flows from start to finish. The findings of the generated solution were described and analyzed in the following chapter. The findings are also summarized in the next chapter.

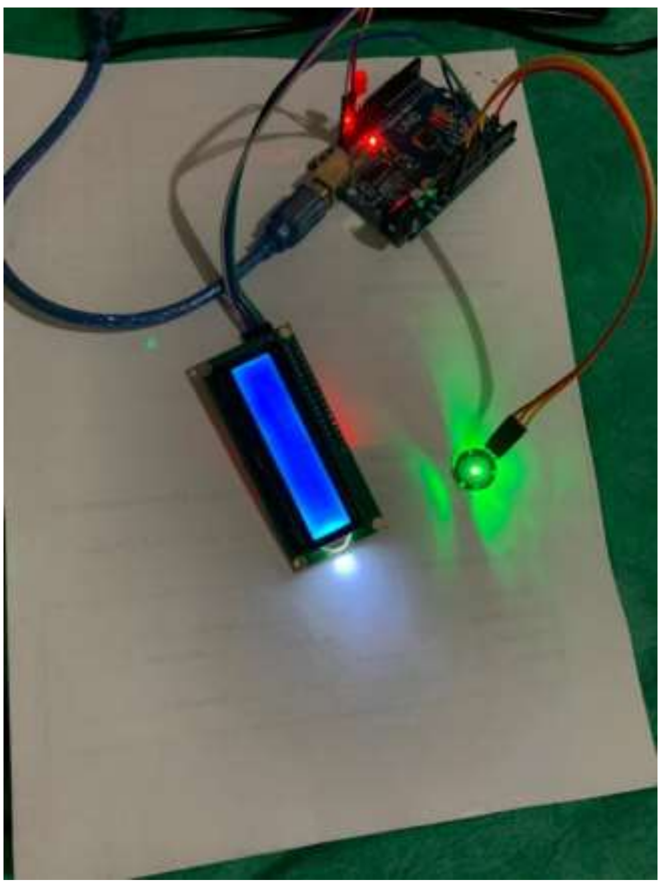
CHAPTER FOUR: RESULTS

4.1 INTRODUCTION

This chapter provides a full discussion of the system's testing. This chapter also goes into how the system was put to the test and calculates the response time.

4.2 PRESENTATION OF RESULTS

The supervisor, some students and some random people carried out the testing of the system, and some the tests and outcome are illustrated below.



Screenshot of the system turning on.

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Screenshot of the system checking the sensor checking the Heart rate

4.3 EVALUATION MEASURES AND RESULTS ANALYSIS

An evaluation metric measures the performance of a classifier. For the evaluation of results, metrics like precision and accuracy are calculated using different scenes to the system. The performance of the system is ranked according to its ability to check for heart rate and returning correct readings and displaying on the screen. The author thus tested the system its time response so as to ensure effectiveness of its functionality.

4.4 RESPONSE TIME

Response time refers to the time it takes the system to connect to the application and hardware components. It is used as a measure of system performance. To test for the system response time, the author used the average and the peak response times to determine the overall performance of the system. The average response time involves taking a series of time reading that is the time it takes the system to make connections and calculate their total and divide it by the total number of readings. The peak time is taking the highest valued reading which is also considered the worst case response time. The author took 10 readings and observed the time taken by the system to decide to make connections.

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Table 4.1 System response times

Test	**Reading Time in Seconds**
1	3.0
2	0.6
3	2.0
4	0.4
5	0.7
6	0.9
7	2.0
8	0.5
9	0.4
10	1.0

All the readings where rounded to the nearest one decimal place.

Average system response time = sum of all response time/ number of readings

= (3.0+0.6+2.0+0.4+0.7+0.9+2.0+0.5+0.4+1.0)/10

= 11.5/10 =1.15seconds (1dp)

4.4.1 Pulse sensor experiment

The heart rate is measured in beats per minute (BPM) in this project. BPM of the user is measured by using the pulse sensor. The pulse sensor can be clipped on the user's fingertips or earlobe.

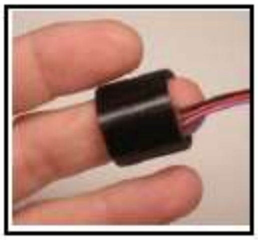

Fig.4.1: Pulse Sensor clipped on the fingertip

The pulse sensor was clipped on the fingertip of the test subject during the experiment, as shown in Fig.4.2. The resting BPM of the test subject was measured. The measuring process was repeated three times, and the average of the three data is calculated. Ten sets of readings were taken. The obtained results are as shown in Table 4.2.

Table 4.2: Resting heart rate measured using the pulse sensor

No.	Resting heart rate (Beats Per Minute)			Average
1	66	65	66	65.7
2	67	66	65	66.0
3	68	67	65	66.7
4	67	65	66	66.0
5	66	67	66	66.3
6	66	68	65	66.3
7	65	64	66	65.0
8	65	66	67	66.0
9	66	68	65	66.3
10	66	67	66	66.3
Total Average				66.1

The measuring process was repeated on the same subject for active heart measurement. BPM of the test subject after performing twenty push-ups was measured. Each set of readings was taken with ten minutes resting interval. The results obtained are as shown in Table 4.3.

Table 4.3 Active heart rate after twenty push-ups measured using the pulse sensor

No.	Active heart rate after 20 push-ups (Beats Per Minute)			Average
1	115	115	115	115.0
2	114	114	115	114.3
3	113	113	114	113.3
4	113	114	115	114.0
5	113	114	113	113.3
6	112	113	113	112.7
7	113	113	114	113.3
8	113	113	113	113.0
9	112	114	114	113.3
10	113	114	115	114.0
Total Average				113.6

The heart rate of the test subject shows a significant increase after performing twenty push-ups. The results obtained in Table 4.5 and Table 4.6 shows that the SEN-11574 heart rate sensor is capable of detecting the rise of the heart rate. Small fluctuations in the BPM obtained were caused by the pressure applied by the fingertip on the pulse sensor. The pulse sensor uses the LED light and photo sensor to detect the variation of the blood flow in the fingertip to measure the BPM. Pressure applied by the fingertip onto the pulse sensor will affect the blood flow and causes the fluctuation in the BPM measurement. The fluctuation obtained in Table 4.2 and Table 4.3 was around ±2 beats.

4.3.5 Accuracy of SEN-11574 Pulse Sensor

The accuracy of the pulse sensor was determined by comparison with the manual pulse rate measurement. The manual measurement was performed by pressing index and middle fingers on the opposite wrist, as shown in Fig.4.2. The BPM of the pulse sensor was compared to the BPM measured from the wrist.

Fig.4.2: BPM measured from the wrist

The BPM measurement process was repeated three times, and the average of the values was calculated. Ten sets of readings were taken. The experiment was done in both active and resting conditions. The obtained results are shown in Table 4.4 and Table 4.4.

Table 4.4: Resting heart rate measured from the wrist

No.	Resting heart rate (Beats Per Minute)			Average
1	67	66	64	65.7
2	66	65	66	65.7
3	66	66	65	65.7
4	65	65	64	64.7
5	64	66	65	65.0
6	64	66	65	65.0
7	65	66	65	65.3
8	66	67	65	66.0
9	64	66	65	65.0
10	66	67	66	66.3
Total Average				65.44

The measuring process was repeated on the same subject for active heart rate measurement. BPM of the test subject after performing twenty push-ups was measured. Each set of readings was taken with ten minutes resting interval. The results obtained are as shown in Table 4.5.

Table 4.5: Active heart rate after performing 20 push-ups measured from the wrist

No.	Active heart rate after 20 push-ups (Beats Per Minute)			Average
1	115	114	114	114.3
2	115	115	113	114.3
3	113	114	115	114.0
4	114	115	113	114.0
5	114	115	114	114.3
6	115	115	113	114.3
7	113	114	114	113.7
8	114	115	113	114.0
9	115	116	115	115.3
10	114	113	113	113.3
Total Average				114.2

A comparison between Table 4.2 and Table 4.4 is plotted in a graph as shown in Fig.4.3

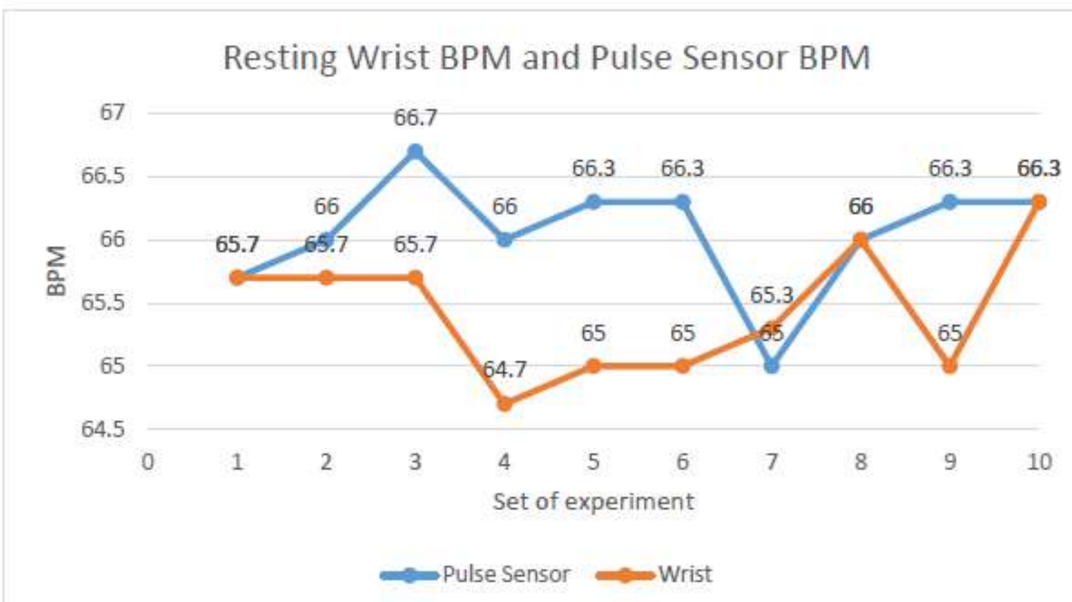

Fig.4.3: Comparison between resting wrist BPM and pulse sensor BPM

There were ±2 beats fluctuation in the measured pulse sensor and wrist BPM, as shown in Fig.4.28. Any movement of the test subject will affect the BPM and led to the fluctuations. The results of the experiment show that the SEN-11574 pulse sensor is capable of measuring the heart rate with high accuracy since the fluctuations obtained were small and insignificant.

A comparison between Table 4.6 and Table 4.8 is plotted in a graph, as shown in Fig.2.29.

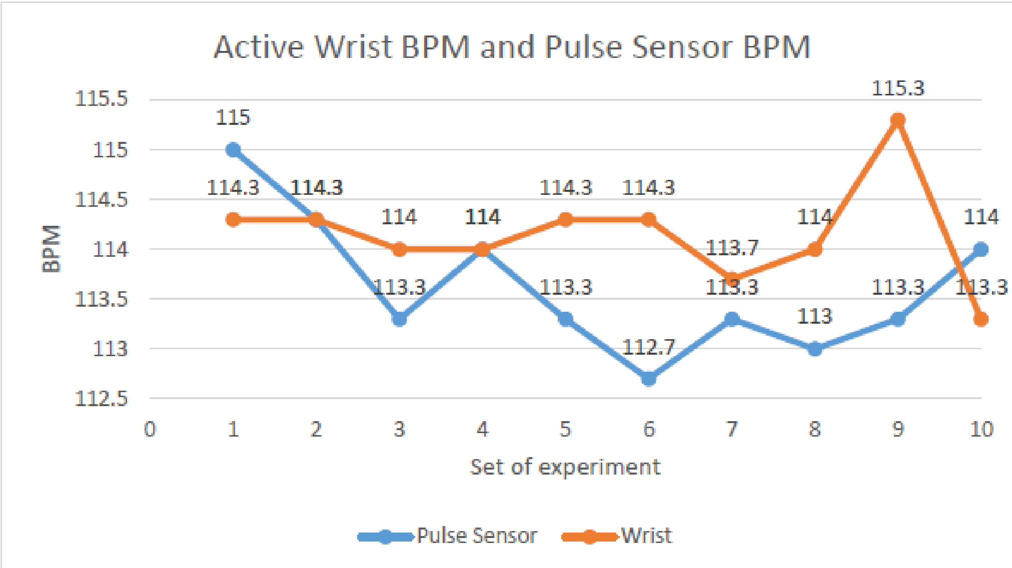

Fig.4.29: Comparison between active wrist BPM and pulse sensor BPM

4.6 OBJECTIVE FULFILLMENT

4.6.2 To design and implement an IOT based health monitoring system for patients.

On the first objective researcher designed and developed a health monitoring system with an Arduino Uno, pulse sensor, LCD screen and a battery. The LCD screen helped to display the pulse readings.

4.6.2 To design an IOT based health monitoring system for patients that will be able to take the important body parameters like pulse rate.

On my second objective the system was able to monitor patients taking pulse rate in real-time and giving the correct readings. Measuring the pulse rate in real-time, the new health monitoring system helps patients prevent future health complications.

4.6.3 To assess the effectiveness and efficiency of the proposed system in mitigating the challenges faced by patients.

Efficient health monitoring technologies help patients improve their livelihoods by allowing them to monitor their health at home without going to hospitals where they will be queues, and by enhancing the quality of their lives. On the last objective the researcher fulfilled it by making the system readily available.

4.7 CONCLUSION

The test results indicated the solution had a response time that is recommended on systems. The system has been designed and implemented successfully using Arduino UNO, Heart rate sensor, and LCD. The prototype of the system worked consistently with the specification. This model will help patients to understand more about their health in general and avoid future illnesses.

CHAPTER FIVE: RECOMMENDATIONS AND FUTURE WORK

Topic: SMART HEALTH MONITORING SYSTEM FOR PATIENTS USE

5.0 INTRODUCTION

The researcher's main focus was on presenting and interpreting data from earlier chapters. In this section, the researcher will assess if the research objectives were reached, as well as the challenges encountered during the research design and implementation.

5.1 AIMS AND OBJECTIVES REALIZATION

The research's main goal was to design and build an IOT based health monitoring system for patients. In addition, the system must be able to monitor the patients pulse rate in real time. The goal was accomplished successfully. The objective was successfully met. The system managed to measure the Beats per Minute (BPM) which is the pulse.

5.2 CHALLENGES FACED

During the testing rounds of the study, the researcher encountered difficulties. The aforementioned Arduino can make connections difficult at times. It may also take some time for the LCD Screen to display. Another issue arose during the connecting of the wires to the sensor.

5.3 RECOMMENDATIONS FOR FUTURE WORK

The proposed system consist of less hardware as compared to the previous model hence it is compact as compared to the previous system. It is more cost efficient, this claim is made on the fact that the proposed system does not need the heavy and expensive hardware for implementation. The LM35 temperature sensor should be used which is much reliable and accurate temperature sensors. Besides, other medical sensors such as ECG sensors and blood pressure sensors can be added into the system to improve the functionality of the system. The users will be able to track their health conditions better if the system is capable of tracking more other health data accurately.

5.4 CONCLUSION

In general health care platforms which connect with smart sensors attach with physical body for health monitoring for daily checkup. In this project we proposed about smart health monitoring system. Due to the importance of observing medical patient, continuous remote monitoring is important. Our project work is giving the chance to watch patient continuously by using the LCD to monitor their heart rate to reduce any future illnesses. This project also compared the early aged medical system between present time health monitoring. The present time represents the time reducing; reduce health care cost especially for rural area people.

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Topic: SMART HEALTH MONITORING SYSTEM FOR PATIENTS USE

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