Department of Electrical and Computer Engineering

North South University

Senior Design Project

Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring System

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Summer, 2017

To

Dr. Shazzad Hosain

Chairman,

Department of Electrical and Computer Engineering

North South University, Dhaka

Subject: **Submission of Capstone Project on Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring System.**

Dear Sir,

With due respect, we would like to submit our Capstone Project Report on Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring Systems a part of our BSc program. It's a smart system to monitor a person's current health conditions and his positional details with Arduino based device which shows output on a mobile android application. This project was very much valuable to us as it helped us gain experience from practical field and apply in real life. We tried to the maximum competence to meet all the dimensions required from this report.

We will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be our immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

.....

Nishnat Nur Shilata

ECE Department

North South University, Bangladesh

.....

Md. Tanvir Hossain

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APPROVAL

Nishnat Nur Shilata (ID#122 0441 045), Md. Tanvir Hossain (ID#122 0458 045), Md. Kazi Ismail (#131 1001 045) from Electrical and Computer Engineering Department of North South University, have worked on the Senior Design Project titled on Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring System under the supervision of Dr. Mohammad Monirujjaman Khan partial fulfillment of the requirement for the degree of Bachelors of Science in Engineering and has been accepted as satisfactory.

Supervisor's Signature

…….

Dr. Mohammad Monirujjaman Khan

Assistant Professor, ECE Department, NSU

Department of Electrical Engineering & Computer Science

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Chairman's Signature

…….

Dr. Shazzad Hosain

Associate Professor

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Dhaka, Bangladesh.

DECLARATION

This is to certify that this Project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

Students' names & Signatures

1. Nishnat Nur Shilata_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

2. Md. Tanvir Hossain _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

3. Md. Kazi Ismail_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

ACKNOWLEDGEMENT

By kindness of the Almighty we have successfully completed our senior design project entitled **Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring System**

Our deep gratitude goes first to my faculty advisor **Dr. Mohammad Monirujjaman Khan**, who expertly guided us in our senior design project throughout the whole EEE499A and EEE499B. His guidance helped us in all type of research, writings and completing the project.

Our sincere thanks also goes to North South University, Dhaka, Bangladesh for giving us such a platform where we can have an industrial level experience as a part of our academics.

We would also like to thank my friends Sanim Iffat, Ahmad Rauf for helping us in this project.

Last but not the least, we would like to thank our family as their inspiration and guidance kept us focused and motivated.

Abstract

Statistics show that hypertensive heart diseases, body temperature, lack of oxygen level are risk factors for high death rate. So if vital parameters of the body such as body temperature, heart beat pattern and blood oxygen level can be monitored in real time, and it will increase the chance to avoid the fatal events.This is especially necessary for people who are in constant danger of adverse health effects such as patients, elderly people and soldiers. Therefore, when everything is being made “smart”, our health and well-being should be a part of it.

The goal of this project is to build a straight forward and reasonable, yet productive heath care system. The goal of this project is to build such a device that will collect data from human body and analyze by arduino and send this data through the bluetooth to an android mobile phone and show the output by android mobile application. This device stores the previous data and also compares with present data so that a patient can easily make a decision about his/her health condition.

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Chapter 1

Overview

1.1 Introduction

Technology is developed by people to improve the quality of human lives. In this modern age, all are using technological advances in many different ways. That's why portable & user-friendly healthcare system is necessary for battement of people to provide an effective system model that will monitor a person's vital readings in order to provide efficient medical services and decisions in time.

1.2 Project Description

Firstly, statistics show that hypertensive heart diseases, body temperature, lack of oxygen level are risk factors for high death rate. So if vital parameters of the body such as body temperature, heart beat pattern and blood oxygen level can be monitored in real time, fatal events can be avoided. This is especially necessary for people who are in constant danger of adverse health effects such as patients, elderly people and soldiers.

Secondly, in today's world, mobile application monitoring systems have evolved to respond for particular needs in every sector, which is an essential pillar in the concept of "Internet of Things". We propose a smart system to monitor a person's current health conditions and his positional details with Arduino based device which will show output on a mobile android application.
Therefore, preventive measures must be applied which provide a real-time health monitoring system, to save a person's life at acceptable time.

1.3 Purpose of the Project

Mobile computing platforms are going to dominate theInformation communication technology (ICT) sector in thisage of rapid technological innovations. Mobile computing devices especially smart phones are smart communication and computing device. Global ICT trends indicate that the future is definitely mobile as worldwide cellular subscriptions have reached 5.9 billion mark taking global penetration levels to 87% with 78% cellular density in the developing countries according to ITU`s current statistics. Mhealth (mobile health) has become a key technology in the domain of healthcare. Health and medical application downloads will reach very high in upcoming years. The advantages of Mhealth are unsurpassed when it comes to providing low cost healthcare delivery to unnerved or under-served population.

1.4 Project Goal

Smart mobile phones are already being used for increasing the effectiveness of public health programs and treating diseases. The trend is compounded by the growing number of peripheral devices such as wearable biometric sensors. IBGStar glucometer and spirometer for measuring blood glucose and volume of air respectively are the success stories of Smartphone Medical applications integrated with sensors. It has been reported thatcardiac monitoring devices demand is increasing in third world countries.

So, the objective of this project is

- To provide an effective system model that will monitor a person’s vital readings in order to provide efficient medical services and decisions in time.

- By using sensors, the data will be captured and compared with a predefined threshold, which can later be processed and sent to desired location.
- The project demonstrates the possibility of building a complete end-to-end health monitoring system by using wide range of available sensors for more vital human health parameters to connect patient with doctors in cases of emergency.

1.5 Organization of the Report

Chapter 1, Shows the overview of our project. It introduces the basic concept with specific details and goals of the project.
Chapter 2 shows the similar existence system that are being sold in market for higher prices.
Chapter 3 shows the system design, system description of hardware and software.
In chapter 4, we have shown the technical design of our overall system.
Chapter 5, describe design implementation, list of necessary hardware, principle of operation of external and internal parts.
Chapter 6 shows the cost of implementation, and how we could keep a minimum costing for the system.
Chapter 7, we have discussed the result and analysis of our system, and shows how our device is unique then other device available in the market.
Chapter 8, discussion about the various comparisons of standards with our system, such as IEEE standard, US standard and the European standard.
Chapter 9, discussion about the impact of our design on environment, politics, economic aspect, and health issue that we could face.
Chapter 10, summarizes about our entire project as a conclusion part of this report.

Chapter 11, discussion about how we can add more features to our system to make it worth enough to use commercially and sell for a better health monitoring system.

1.5 Summary

In this chapter, we discussed the importance and the goals of our project. As the proposed application based health monitoring system plays a vital role in public health and this system deals with health aspects, it needs more work on the accuracy of the data to provide highest standard value. This project is designed as user friendly, especially for women & disables & portable to anywhere .e.g. remote/disaster areas.

Chapter 2

Existing Systems

2.1 Introduction

Taking care of health is necessary to live.Heartdisease is the leading cause of death in the world over the past 10 years. Treatment and prevention of heart diseaseare important issues for modern medicine. ECG monitoring in daily life is a necessary way for curing heart disease with the widespread popularity of smart phones and its portability, smart phoneplays a role in monitoring heart nowadays Many researchers have done some studies on the application of smart phone inECG monitoring, such as an ECG monitor system based on android smart phone. But this are not in a satisfaction level, every devices has lots of limitations and lacks and monitoring devices offer the paramount feature of instant warning about the heart condition of the patient. Mostly this available products are high costly and low demandable.

2.2 Similar Existing Systems

There has already been research on these systems and efforts are going on for continuous development of these systems. Furthermore, commercial setups of health monitoring are already available which are being used by the health-care sector.

Few hospitals have implemented health monitoring systems to have a real-time health analysis of the patient and send it to the doctors concerned. But for this service patient has to rush to the hospital & has to go through a long process, which is costly & not time efficient.

Fig 2.1 :Clinical Digital Thermometer

[Brand: Generation guard,Source:Amazon.com]

Fig 2.2 Portable ECG Heart Monitor.

[Brand: My ECG,Source:Amazon.com]

Existing portable systems do not have integrated health and position monitoring which is a major drawback. Even if some smart systems exist but they are not mobile application based & doesn’t have data storage capacity. Moreover these systems are also very expensive and not available in developing countries like Bangladesh.

2.3 Summary

In this chapter, we discussed about the similar systems that are being invented before by researchers or that are already existing in the society and being sold in markets for higher prices. Devices have lots of limitations and lacks and monitoring devices could not offer the features of instant accurate graph about the heart condition of the patient. This makes products high costly but low demandable.

Chapter 3

System Design

3.1 Introduction

We proposed a smart system to monitor a person's current health conditions and his positional details with microcontroller based device which shows the output on a mobile android application. In this section we are going to describe implementation of this project which aims to develop a monitoring system based on a smartphone platform. It is a low cost monitoring system solution based on an Arduino.

3.2 System description

The whole system comprises of four designs

a. Electrocardiogram (ECG)

b. Body Temperature

c. Blood Oxygen Level

d. Mobile Android Application

The first 3 parts are Hardware (Electrocardiogram (ECG), Body Temperature, and Blood Oxygen Level) & the last one is Software (Mobile Android Application) part.

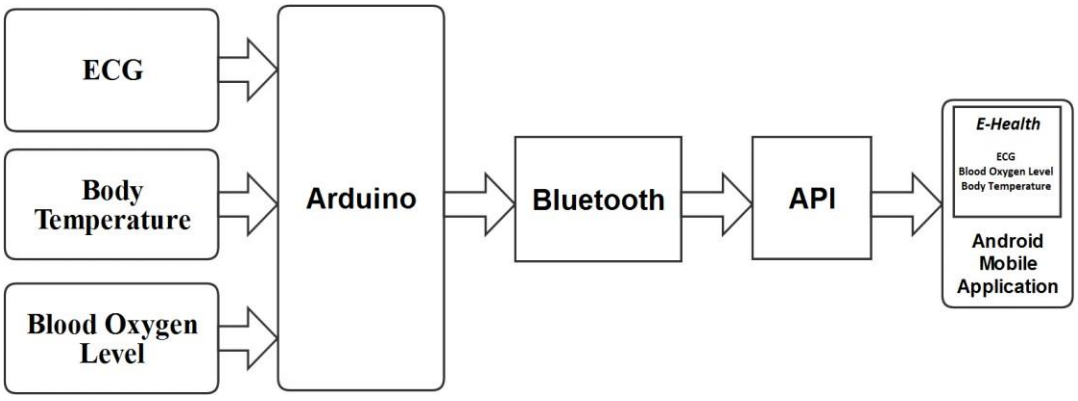

Fig 3.1: System Block DiagramOf Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring System

In this system, biosensors requires for Body temperature and ECG are integrated to Arduino to Mobile Application. In transceiver part the sensor collects data from the human body. Then the collected data comes to Arduino development board, where data processing occurs. Then the processed data transfers to the receiver part via Bluetooth. Bluetooth exchanges data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices. Then the application system of mobile converts the data into different features (e.g. graph, values and instructions) as the contents has been designed. In short, the system calculates the heartbeat rate in beat per minute (BMP), body temperature in degree Celsius(c) and Oxygen level in percentage (%), with the help of arduino and shows the visible output through the mobile android application.

3.2.1 Hardware

A. Electrocardiogram(ECG)

ECG is fundamentally all about the electrical conduction system of the heart. The signals generated by the senatorial node to cause contraction of the heart muscle, which are transmitted by the electrical conduction system of the heart. Then the generated signal travels through the right atrium to the atrioventricular node, this signal stimulates contraction first of the right and left atrium, and then the right and left ventricles. This process allows blood to be pumped throughout the whole body. The conduction system consists of specialized heart muscle cells, and is situated within the myocardium. There is a skeleton of fibrous tissue that surrounds the conduction system which can be seen on an ECG.

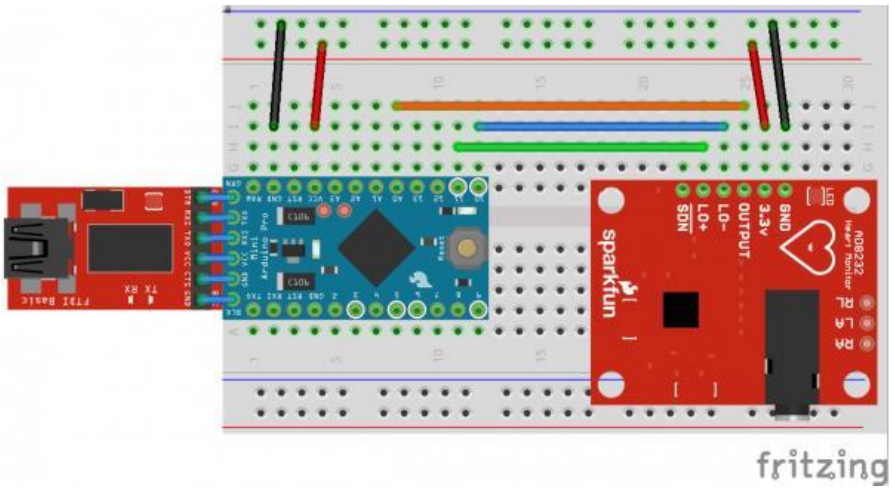

Fig 3.2: ECG Device Connection

B. Body Temperature

Human body temperature varies within a narrow range of values. Body temperature can be measured from different parts of the body, but this project proposed a design of measuring the human body temperature with GY-906 sensor as it is one of the most accurate types of body temperature measurement.

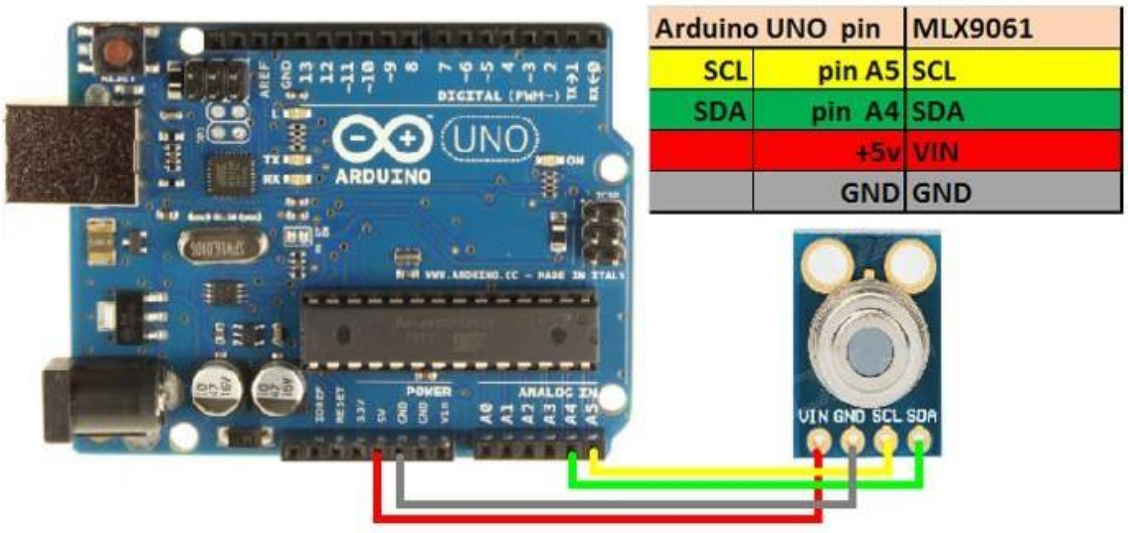

Fig 3.3: Body Temperature Device Connection

C. Blood Oxygen Level

Method for measuring blood oxygen saturation is shining an infrared LED through a body part such as finger and then comparing values. Measuring the light transmitted through tissue is called transmitted oximetry. Tran's missive pulse oximetry is mostly used in hospitals. Generally, most hospital patient monitoring systems have an integrated trans missive pulse oximeter.

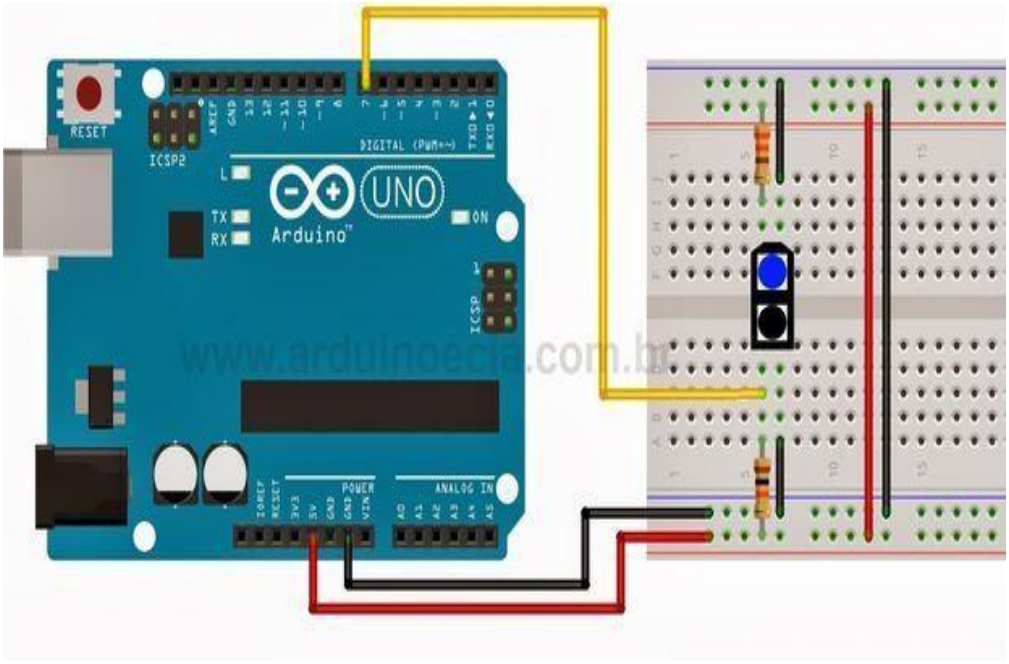

Fig 3.4: Blood Oxygen Level Device Connection

3.2.2 Software

The Android platform (Linux based) which is developed by using Android studio version 2.3.2 made for Android version 4.0 to upgraded versions. The aim of this project is to develop a prototype android application that works with the analog end unit discussed previously. The Java programming language, Eclipse and the android Software development Kit (SDK) are used as the development tools

3.3 Summary

The system mainly depends on a few factors, such as integration of all the sub systems into a single mobile android application. Gathering all the data from the different sensors in the system and processing the data through Arduino and forward it via Bluetooth to the sending side, are the biggest challenges. The project demonstrates the possibility of building a complete end-to-end health monitoring system by using wide range of available sensors for more vital human health parameters to connect patient with doctors in cases of emergency. At this project will deal with life and death the quality and accuracy of the hardware and implementation is very important.

Chapter 4

Technical Description

4.1 Introduction

In this chapter, we will discuss about the components used for technical functions of this project. The technical description of our project will be discussed in this section. As our project comes with four different types of features, we will discuss them one by one along with their roles in this project.

4.2 System Description

The entire system consists of several components which supports the project to be useful in all aspects. We were design three hardware based system and the components which were used in the whole system are described below for the better understanding of the project:

4.2.1 AD8232 ECG Measurement Sensor

The AD8232 ECG Measurement sensor is a neat little chip used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram. Electrocardiography is used to help diagnose various heart conditions. This single Lead Heart Rate Monitor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG and output as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op-amp to help obtain a clear signal from the PR and QT Intervals easily. The AD8232 is an integrated signal conditioning block for ECG and other bio potential measurement applications. It is designed to extract, amplify, and filter small bio potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement.

The AD8232 module breaks out nine connections from the IC that you can solder pins, wires, or other connectors to. SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use our own custom sensors. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heartbeat.

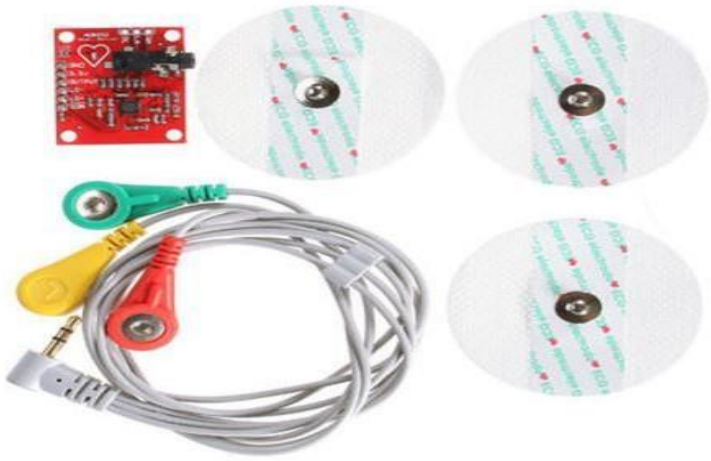

Fig 4.1: AD8232 ECG Measurement Sensor Module and Electrodes

4.2.2 MLX90614ESF Infrared Temperature Sensor

Melexi's MLX90614ESF-BAA is an infrared thermometer designed for non-contact temperature sensing. An internal 17-bit ADC and a powerful DSP contribute to the MLX90614's high accuracy and resolution. It has a huge number of applications including body temperature measurement and movement detection.

The MLX90614 provides two methods of output: PWM and SMBus (i.e. TWI, I^2C). The 10-bit PWM output provides a resolution of 0.14°C, while the TWI

interface has a resolution of 0.02°C. The MLX90614 is factory calibrated in wide temperature ranges: -40 to 85°C for the ambient temperature and -70 to 382.2°C for the object temperature. The measured value is the average temperature of all objects in the Field Of View of the sensor. The MLX90614 offers a standard accuracy of 0.5°C around room temperatures.

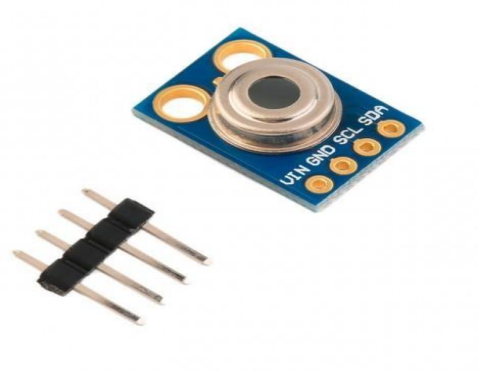

Fig 4.2: MLX90614ESF Infrared Temperature Sensor Module

4.2.3 TCRT5000 Infrared Sensor

It is an IR Emitter and an IR Phototransistor packaged together. The Ardiuno TCRT5000 is designed to sense the distance to an object using Infrared light waves. It can also identify the difference between white and black based on the contrast of an object and it is reflective properties.

Fig 4.3: TCRT5000 Infrared Sensor Module

4.2.4 HC-05 Bluetooth Module

The HC-05 is a Serial port Bluetooth module which having fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transreceiver and baseband. It uses CSR Blue core 04·External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

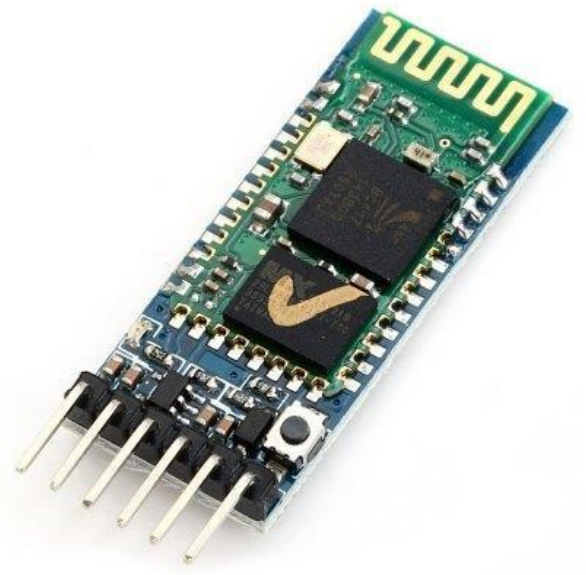

Fig 4.4:HC-05 Bluetooth Module

4.2.5 Vero board

Vero board is a brand of strip board, a pre-formed circuit board material of copper strips on an insulating bonded paper board which was originated and developed in the early 1960s by the Electronics Department of Vero Precision Engineering Ltd (VPE). We have replaced the internal part's initial setup with Vero board, which minimizes the wiring hassles. Vero board along with minimizing the long wires

also helps to avoid the wire connections being loose. The Vero board connects the buzzer and LED lights to motion sensors. The setup is shown in Fig. 4.6. For the better understanding of how the Vero board was set up.

4.2.6 Arduino UNO

This is a genuine new Arduino Uno R3. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Fig 4.5 : Arduino UNO board

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features: 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board.

In future, shields will be compatible both with the board that uses the AVR, which operate with 5V and with the Arduino due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes.

4.2.7 Arduino Nano

The Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino/Genuino UNO, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

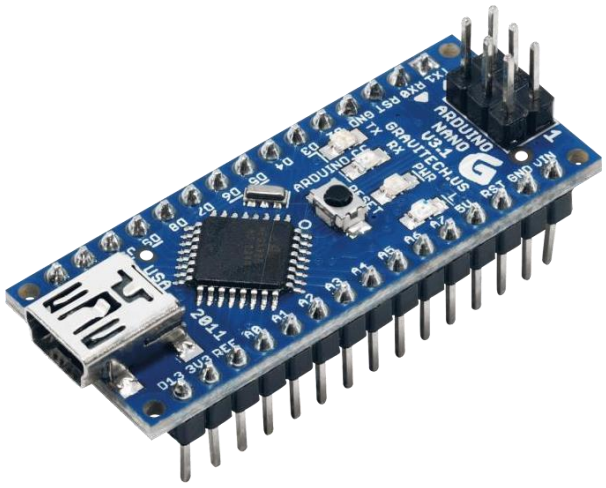

Fig 4.6: Arduino NANO board

4.3 Summary

In this chapter, we have discussed the components, their features and how they have played vital roles respectively to make the project a perfect one. We have discussed every single component and their reasons for using. We have discussed about ECG sensor, Infrared sensor, Bluetooth Module, Vero board, Arduino UNO & NANO etc. We have used reasonable components and that is the most interesting part of the project.

Chapter 5

Design Implementation

5.1 Introduction

In this chapter, we will discuss about the design of the technical functions of the project. Implementation is the action that must follow any preliminary thinking in order for something to actually happen. Our project features required perfect design implementation in order to run in harmony with other features. We have discussed the entire design implementation in this part.

5.2 List of necessary hardware components

- LCD display
- Resistors
- Bluetooth
- Wires
- Arduino UNO
- Arduino NANO
- Vero board
- Breadboard
- LED
- Cable
- Power bank
- Adapter etc.

5.3 Principle of operation

There are two parts in the whole system. First one is External Part and second one is internal part. Each part has some principles for working properly and they are described below:

5.3.1 External Part

This part is an Arduino Uno and Arduino NANO based which includes a fingerprint based Infrared sensor for Blood Oxygen Level, Three electrodes cable for ECG and also an infrared sensor for measuring Body Temperature. In this system, biosensors requires for Body temperature and ECG are integrated to Arduino to Mobile Application.

In Transceiver part the sensor collects data from the human body. Then the collected data comes to Arduino development board, where data processing occurs. Then the processed data transferred to the receiver part via Bluetooth. Bluetooth exchanges data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices.

In the External part of this system there are three sensors for measuring ECG, Body Temperature and Blood Oxygen level along with mobile application. The application has three different features.

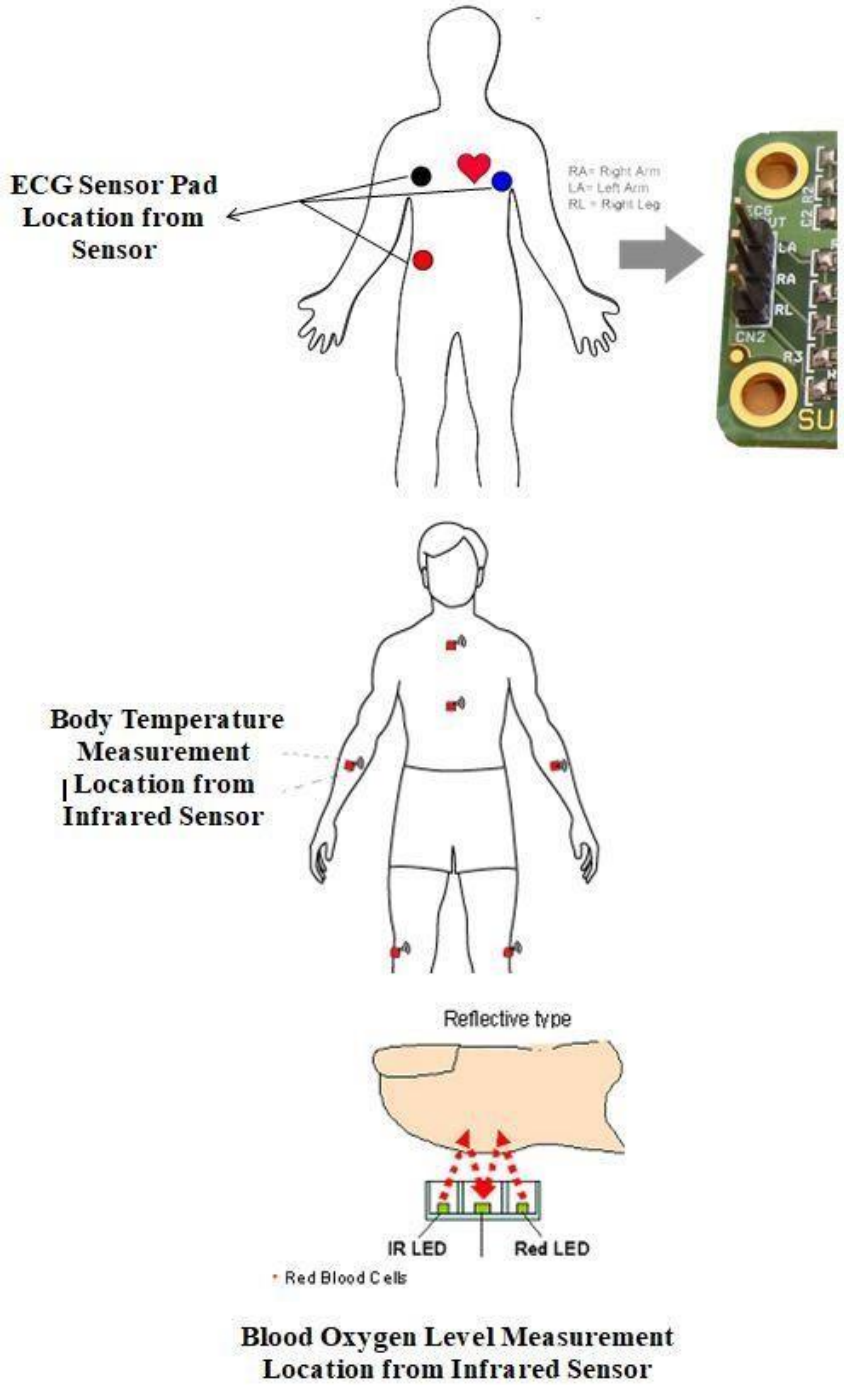

Fig 5.1: External Part of the System (Measuring part from the sensors)

5.3.2 Internal Part

The second part of the system is the hardware implementation with Arduino UNO and Arduino NANO. There is a Bluetooth connection individually in every device. The Bluetooth device is connected with Arduino. Than the sensors connected through the Arduino.

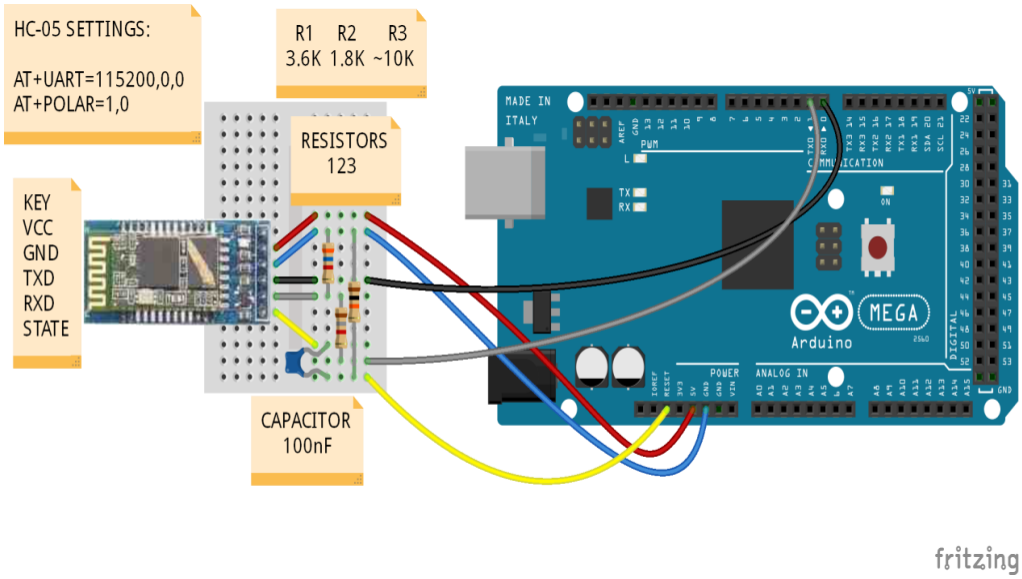

Fig 5.2: Bluetooth Connection with Arduino

In short, the system calculates the heartbeat rate in beat per minute (BMP) ,body temperature in degree Celsius(c) and oxygen level in percentage (%), with the help of Arduino and shows the visible output through the mobile android application. The design of internal part is shown in Fig.5.3

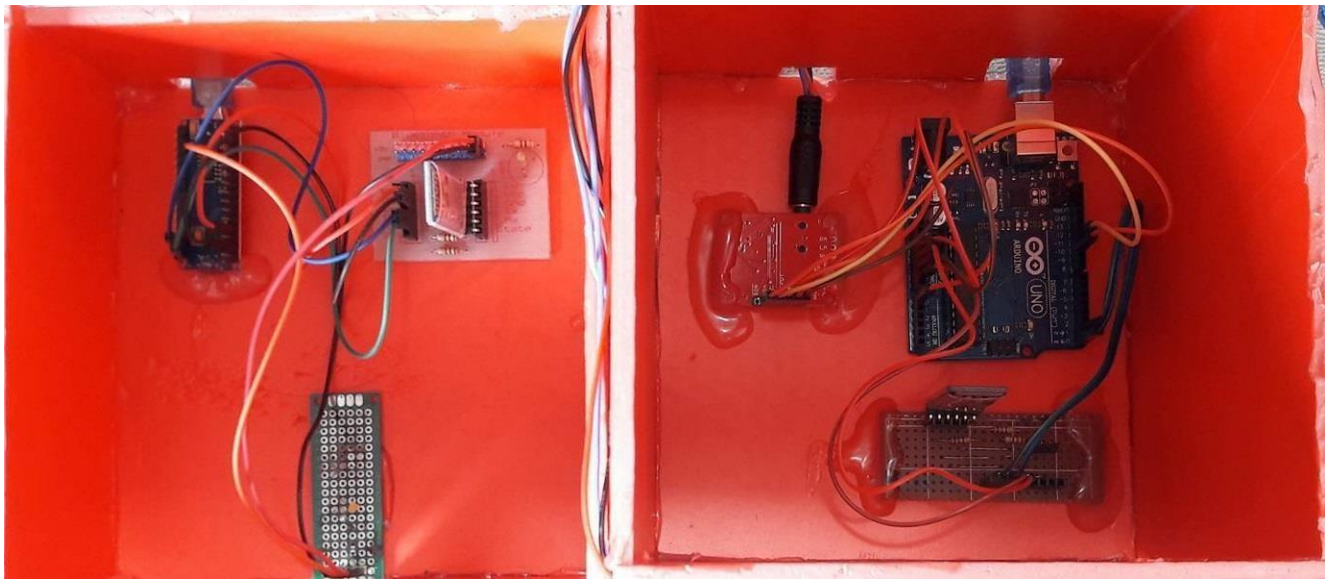

Fig. 5.3. Structure of internal circuit of ECG & Blood Oxygen Level

5.4 Summary

In this chapter, we have discussed the design of our project and how we achieved it with proper implementation. We faced some ups and downs for a getting a best result, because the sensors are not used in commercial purpose. Those sensors are only used in demo project like us. For that reason we are struggled for the best output. Although this process helped us to achieve not more than we expected but it will help us to make something what we can do some unique observation in future. We have used both Arduino Uno and Nano to make the whole project handier. The whole project can work individually or can be attached together. We have merged whole the systems for the betterment of the project.

Chapter 6

Cost of Implementation

6.1 Introduction

Cost management is an important part within our project management processes. The components used and their prices and the techniques involved in making the system work are the key factors in making a project work. Initially after planning our system, we listed down the components which were needed initially and as time passed we added more components to it. Initially we also estimate a cost along with the components name but later on we could cut cost from our initial costing comparing with different shops where our components were available. We also got few components, which have some problems and errors. So, we have to keep some extra components for safety purposes.

6.2 Cost of Implementation

Here is our total cost, which used for the implementation of the project. We tried our best to reduce the cost as much as possible. We are successful to implement our planned system within a limited cost, which adds a great value to the system. Table 6.1 illustrates the name of the required components name, quantity, and the price.

The goal of this project is to build a straight forward and reasonable, yet productive heath care system.

	Equipment	Cost (Taka)
1	Single Lead Heart Rate Monitor - AD8232	1850.00
2	Vero Board Double Side (2x8 cm)	19*2 = 38.00
3	Arduino Uno	500*2=1000.00
4	Arduino Nano	350.00
5	GY-906 Infrared Temperature Sensor	1050.00
6	TCRT 5000 reflective optical sensor	18.00
7	Sensor Cable - Electrode Pads (3 connector)	650.00
8	HC-05 Bluetooth Module	300*3=900.00
9	1602 LCD	135.00
	Total	**5991.00**

Table 6.1: Total Costing Breakdown

6.3 Summary

In this chapter we have discussed what was our costing regarding initial plan and the final plan, how we could reduce the costing after research in the local markets to keep a minimum costing for the system.

Chapter 7

Result and analysis

7.1 Introduction

In this section, we will talk about the results we obtained, and its analysis. This shows how we obtained our results and what was our findings regarding the project. We will also discuss how we analyzed our project for the betterment of it.

7.2 Result and Analysis

In this project, the development of wireless electrocardiogram (ECG), body temperature, and blood oxygen level has been done. Three different modules were designed for measuring three different state of human body. These devices are very important for health aspects, so the output should be very accurate. Any kind of miscalculation can lead a bad impact on health &treatment. That's why in this project every output value has been taken very carefully. ECG is one of the vital parts of this complex project. An electrocardiogram (ECG) is a test that checks for problems with the electrical parts of human heart, so this device has to provide an exact output.

In this project the output of ECG device comparing to the commercial test, is pretty satisfactory. It also provides the value of signals Pmax, Pmin, Paverage(P-pick value). In body temperature measurement, this device gives output as expected. The normal human body temperature range is typically stated as 36.5–37.5 °C (97.7–99.5 °F). The Experimented result shows that this device provides accurate output.

In blood oxygen level Normal pulse oximeter readings usually range from 95 to 100% (saturation value). Values under 90 percent are considered low. This device shows result blood-oxygen saturation level 92-95 %, which is satisfactory.

Fig 7.1 : Comparison between Device output and real time output of ECG

In Figure 7.1 indicate that comparison between Device output and real time output of ECG. After completing the hardware part we designed an android mobile application. This part was very complex because we had to work with real time value.

All our devices show their output by android application which was connected to device via Bluetooth.

Fig 7.2: Device Prototype Development of Wireless Electrocardiogram (ECG), Body Temperature and Blood Oxygen Level Monitoring System

7.3 Summary

In this chapter, we have discussed the result and analysis of our system. The results obtained are discussed in this chapter and we sew that our method improved the entire system. We have also discussed how the internal part and the external part was working properly and gave perfect output better than we expected.This device can store previous data so that patient can compare their previous data and present data and make a proper decision. This function makes this device unique then other device available in the market.

Chapter 8

Compliance with standards

8.1 Introduction

In this chapter we will discuss the various comparisons of standards with our system, such as IEEE standard, US standard and the European standard. In general, compliance means conforming to a rule, such as a specification, policy, standard or law. Regulatory compliance describes the goal that organizations aspire to achieve in their efforts to ensure that they are aware of and take steps to comply with relevant laws, polices, and regulations.

8.2 Compliance with IEEE standards

The establishment of electrical and hardware particular architects guidelines companionship (IEEE-SA) is an association inside IEEE that develops worldwide principles for claiming industries, including: control systems, renewable energy, biomedical health care, data engineering. Furthermore robotics, telecommunication and also home automation, transportation, nanotechnology. Our project concerns about health hence we look at standards that relate to the IEEE standards concerned with health technology. Wireless health monitoring or smart health monitoring is a device which will monitor a person's health condition and store data for compare with future data. It Include an android mobile application to show the output and data storage. The IEEE standard IEEE 802.6 that is relevant to our project applies to Standards for information exchange between systems which was detecting through sensors and sending data to the android application via Bluetooth.

IEEE 1451 is a set of smart transducer interface standards developed by the Institute of Electrical and Electronics Engineers (IEEE) Instrumentation and Measurement Society's Sensor Technology Technical Committee describing a set

of open, common, network-independent communication interfaces for connecting transducers (sensors or actuators) to microprocessors, instrumentation systems, and control/field networks. This applies to all our sensor systems we have used in the project.

IEEE standard 802.15.4 intends to offer the fundamental lower network layers of a type of wireless personal area network (WPAN) which focuses on low-cost, low speed ubiquitous communication between devices.802.21 is an IEEE standard published in 2008. The standard supports algorithms enabling seamless hand over between networks of the same type as well as handover between different network types also called Media independent handover (MIH) or vertical handover. Our system manages to maintain the mentioned standards and meet with IEEE code.

8.3 Compliance with US standards

Recent technological advances in sensors, low-power integrated circuits, and wireless communications have enabled the design of low-cost, miniature, lightweight, and intelligent physiological sensor nodes. These nodes, capable of sensing, processing, and communicating one or more vital signs, can be seamlessly integrated into wireless personal or body networks (WPANs or WBANs) for health monitoring. These networks promise to revolutionize health care by allowing inexpensive, non-invasive, continuous, ambulatory health monitoring with almost real-time updates of medical records via the Internet. Though a number of ongoing research efforts are focusing on various technical, economic, and social issues, many technical hurdles still need to be resolved in order to have flexible, reliable, secure, and power-efficient WBANs suitable for medical applications. This paper

discusses implementation issues and describes the authors' prototype sensor network for health monitoring that utilizes off-the-shelf 802.15.4 compliant network nodes and custom-built motion and heart activity sensors. The paper presents system architecture and hardware and software organization, as well as the authors' solutions for time synchronization, power management, and on-chip signal processing.

According to the U.S. Bureau of the Census, the number of elderly over age 65 is expected to double from 35 million to nearly 70 million by 2025 when the youngest Baby Boomers retire. This trend is global, so the worldwide population over age 65 is expected to more than double from 357 million in 1990 to 761 million in 2025. These statistics underscore the need for more scalable and more affordable health care solutions.

8.4 Compliance with European Standard

Patient data monitoring is a key issue for health and disease management. The use of wireless sensors within a body area network (BAN) makes this task seamless and easy. A BAN system is presented, which allows the connectivity of a wide range of heterogeneous body sensors to a portable hub device that is connectable to external networks (IEEE 802.11, GPRS). This BAN is based on the use of Zigbee/IEEE 802.15.4 standard technology and off-the-shelf modules. It is currently being used at the European level for the detection and the prediction of the human physiological state in relation to wakefulness, fatigue, and stress applications in which users carrying out daily activities are monitored in an unobtrusive and comfortable way.

We present a framework for a wireless health monitoring system using wireless networks such as ZigBee. Vital signals are collected and processed using a 3-tiered architecture. The first stage is the mobile device carried on the body that runs a number of wired and wireless probes. This device is also designed to perform some basic processing such as the heart rate and fatal failure detection. At the second stage, further processing is performed by a local server using the raw data transmitted by the mobile device continuously. The raw data is also stored at this server. The processed data as well as the analysis results are then transmitted to the service provider center for diagnostic reviews as well as storage. The main advantages of the proposed framework are

a) The ability to detect signals wirelessly within a body sensor network (BSN).
b) Low-power and reliable data transmission through Bluetooth module.
c) Secure transmission of medical data.
d) Efficient channel allocation for medical data transmission over wireless networks, and
e) Optimized analysis of data using an adaptive architecture that maximizes the utility of processing and computational capacity at each platform.

8.5 Summary

In this chapter, we examined the different standards of rules regulations for transportation, and how it compared to our own wireless health monitoring system. We have shown how our system follows all the standards, IEEE, USA standards and UK standards.

Chapter 9

Design Impact

9.1 Introduction

In this chapter we will discuss about the impact of our design on environment, politics, economic aspect and health issue that we could face. We will discuss the implications of our design on every aspect individually. We will discuss how it affects the economy and society and also the personal benefit. Our system does the followings: reduction in insurance premiums, opportunity cost of police presence, increase in tourist income and tourist employment, decrease in long-term health costs (due to the reduction in victim-hood and an increase in psychological well-being), reduction in the carbon cost of crime, Less people who feel forced to move to another home, reduction in costs of securing void areas. Major impacts are described below:

9.2 Economic impact

As our project is being made of health purpose and based on modern technology, so there is a huge opportunity of income from the project. We will make our project as product in market. As our product is user friendly and give proper output it will be popular in market. Our project is also cost effective so it will save a lot of money. We design our application such a way so any low level Android version mobile will allow to support our application.

9.3 Health and Safety Impact

Our system is designed in such a way that it has no negative impact on a person's health. It has a very positive impact on person's health. Our device will monitor a person's health condition and show the output at mobile, so everybody will be able to know their health condition and will be able to take proper action with no time.

The measurements which were followed while making the system makes it strong and unique than any other system available in the market.

9.4 Environmental impact

As our project is portable and user friendly, the user can use it in home, they doesn't need to rush to the hospital or diagnostic center for getting those features or contact with Doctor. So, it will reduce the pressure and traffic jam in the hospitals & diagnostic center's area.-our devices will consume less energy than the normal device that is used in hospitals.- As our Project is Mobile Application based & has data storage system, that's why paper, ink, printer is not necessary.
So our project will create a positive impact on environment, we can say that our project is eco-friendly.

9.5 Ethical Impact

Regarding issues based on ethics, this product does not hamper any sort of ethical or moral codes as it is clearly based on positive outcomes; it does not, in any form, affect one's perspective but rather help a person achieve better health monitoring system.

9.6 Manufacturability

In order to produce our system in larger scale thinking of marketing we can reduce cost per system if we get proper support from the government and buy components in bulk. Manufacturing the system can be a good deal for both the nation and for us.

9.7 Sustainability

In this country technology has gone so far and it's improving day by day. As technology improving so fast it is difficult for a project to become sustainable. Number of smart phone users are increasing day by day, people are becoming more dependent on their mobile phone, so is this situation our project has high chance to become sustainable.

9.8 Impact on real life

We hope our project will create a great impact on the aged peoples of the urban and city area. As study shows most of the aged (over 40) people are facing health problem because of unconsciousness and absence of proper guideline. As our project will be very user friendly and could be use in any instant of time for regular basis, it will make them aware and conscious about their health. They will also get some basic guidance information & instructions from our mobile application.

9.9 Impact on disabled person

It will be very helpful for Disable peoples. Disable people has to face a physical and mental challenge to move because of our poor transport service. This problem could be overcome by using our user-friendly device at home.

9.10 Impact on target group

We hope our project will create a great impact on the aged peoples of the urban and city area. As study shows most of the aged (over 40) people are facing health problem because of unconsciousness and absence of proper guideline. As our project will be very user friendly and could be used in any instant of time for regular basis, it will make them aware and conscious about their health. They will also get some basic guidance information & instructions from our mobile application.

9.11 Summary

In this chapter we have discussed the impacts health monitoring System will have on the economy, environment and also health. We discussed how this system does not do any pollution to the environment, provides health monitoring system on Android mobile application via Bluetooth. It will also store previous data to compare present data with previous one. Our project is such user friendly that anyone will be able to monitor his/her health condition by this.

Chapter10

Conclusion

Implementing the total setup and showing output in a mobile android application are the major milestone which affects the success of the total project. Thus, developing an application with three different features would be fundamental to the project's success.

This paper describes a wireless health monitoring system which consists of a portable multifunctional parameters detecting 3AHcare node and a mobile program for real-time data telemetry based on the smartphone with the Android operating system. The 3AHcare node is a health monitoring device with embedding Bluetooth module in it and capable of measuring a subject's ECG, blood pressure, blood oxygenation, respiration, temperature and motion – almost equivalent to the feature set of a hospital bedside patient monitor.

In the Android Application, we receive physiological parameters such as ECG via the socket connection between the Android device and the detecting module; we process the received data with special algorithms to get steady waves; we store data locally on micro SD flash; we display data by waveform and digit; we alarm by threshold algorithm and we realize remote data transmission via TCP/IP protocol. We have evaluated the performance of the monitoring system in capturing, recording, transmitting and displaying ambulatory data and found the system easy to use and with high precision.

Chapter 11

Future work

11.1 Introduction

In this chapter, we will discuss about how we can add more features to our system to make it worth enough to use commercially and sell for a better health monitoring system. Advancement in technology and emergence of smart health monitoring has led to the rise of integrated health monitoring systems, which can be connected to smartphones and enable the monitoring of health condition from remote locations.

11.2 Future Planning

We have planned how we can successfully do the industrial marketing of our project. The presence of a wireless health monitoring system provides many families with a peace of mind knowing that they know their health condition. Because of this, we feel that our idea of the system will be a boom as it is multi layered and comes with multiple features. In order to make the idea result in big we have thought to do the industrial marketing if we get enough support from the government.

We can ensure that our system will provide highly intuitive services for our customers or clients. Android mobile application (e_health) which is one of our features has the largest market value in world health monitoring system, the largest markets being Asia and America.

The features we are planning to add in future if properly nourished by our government and investors are:

- Add a GSM module so that we can send our data from one place to another place. Sending data will provide good support for rural people where doctors are absent.
- We will create a data base management system so patent can easily compare their past and present health condition.
- We will sum up our three different devices to one single device, so it will be easier to carry.
- As our device is directly related to public health we will make our device error less.

11.3 Method of Production & Marketing

The entire method of production and marketing process on how we can implement the system in larger scale for marketing purpose is described below:

- **System Functionality**

Whatever one's specific health condition needs, whether it is price or features that are most important to one, our system layers are state of the art and offer all the latest technical advancements.

- **The output**

We have used the highest quality hospital standard detection devices, such as body temperature sensor, infrared light, red light, ECG pad etc. All detection devices and associated cabling can be monitored when we launch in the industry for selling purpose and earning revenue out of it. In future when we implement the GSM module, it will ensure to send data from one place to another. By capitalizing on

our distinctive capabilities, we continue responding to the increasingly diverse needs of health monitoring.

- **The Peace of Mind**

Our future work includes the feature that, data will be stored and monitored.The system will be able to tell us what is happening, weather patent are improving ornot. People will come to know there health condition instantly, it will make them tension free.

11.4 Current health situation in Bangladesh

“Health is a right, not privilege. It needs to be delivered with equity.” Well, no denying the fact that health is a basic requirement to improve the quality of life. National economic and social developments depend a lot on the state of health services. Access to health service is also guaranteed in our constitution and is accepted as a basic human right.

However, a large number of Bangladeshis, particularly in the rural areas have little access to healthcare facilities. It may seem that access to healthcare services for the insolvents, poor and the destitute countries to remain a day dream in one hand and on the other hand private sector healthcare service delivery with most modern and advanced facilities has developed remarkably for the affluent section of the society. Even then many of those wealthy people undertake medical tourism to neighboring countries with higher and better healthcare service such as India, Thailand, Malaysia and Singapore. Some good number of people often makes it to Australia, Japan, Europe or America.

The National Health Services Sector has been experiencing slide down even through budgetary allocation is on the rise even against resource constraints, resulting in exponential rise and multiplication of problems in the health sector. The state health services are being increasingly deteriorating due to increase in population and corruption and resulting in health services being transferred to private hands to a large extent.

The Government doctors are seen devoting more time to their private practices in private chambers and or private hospital. Some of them are allegedly accepting fees for their service at the government hospitals. Negligence, avoiding responsibilities, wrong treatment, higher costs, limited facilities (especially at the public hospitals, over prescribing and unnecessary lab tests (for getting handsome kick-backs from the private labs and diagnostic centres) have landed us in crisis at the health service delivery systems.

Bangladesh, a small country with a huge population.The situation of it's public health condition can be summarized

Population – 157.9 million

Rural population – 77%

Population density – (population/km2) 1,070/km2

People below poverty line – 60%

Population doubling rate – 25–30 years

Per capita GDP – Tk. 18,896

Health indicators Edit CDR – 5.2 /1000Annual Growth rate – 1.48%MMR – 1.94 /1000 live births (BMMS 2010) IMR – 43 /1000 live births Under 5 MR – 83 /1000 live births

Total Fertility Rate – 2.9CPR – 53.8%

Life expectancy at birth – 68 (m) and 69 (f) fully immunized children – 52%

TB (smear positive new) detection rate – 31.2%

So, we can see that people from rural area don’t get the proper opportunity to monitor their health. There are lake of equipment and doctor.
As our device is portable it can be moved to any place and we designed our android application such a way that any low configured android mobile can support and show the exact output.

11.5 Summary

In this chapter, we have discussed how we can make our system more efficient by implementing few more ideas in the future if we get the proper support and investments. Our system can add a great value to the society if properly nourished and implemented. We have also discussed how we can launch our project with proper support. Our wireless health monitoring system gives one the peace of mind and freedom that comes from the knowledge wherever you go and whatever they do, their health condition can be monitored. Designed to be technically advanced, simple to use and supported by unparalleled service, our health monitoring system is individually formulated to suit one’s unique needs.

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Appendices

Appendix A

Arduino UNO code

(For ECG and Body Temperature Part)

ECG (without delay)

```
intval;
void setup() {
  // initialize the serial communication:
Serial.begin(9600);
Serial.println("ECG with Arduino");
Serial.println("Developed by Ismail,Tanvir,Nishnat");
pinMode(10, INPUT); // Setup for leads off detection LO +
pinMode(11, INPUT); // Setup for leads off detection LO -
}
void loop() {
if((digitalRead(10) == 1)||(digitalRead(11) == 1)){
Serial.println('!');
  }
else
  {
    // send the value of analog input 0:
val = analogRead(A0);
Serial.println(val);
  }
```

ECG (With delay)

```
intval;
void setup() {
  // initialize the serial communication:
Serial.begin(9600);
```

```
Serial.println("ECG with Arduino");
Serial.println("Developed by Ismail,Tanvir,Nishnat");
pinMode(10, INPUT); // Setup for leads off detection LO +
pinMode(11, INPUT); // Setup for leads off detection LO -
}
void loop()
if((digitalRead(10) == 1)||(digitalRead(11) == 1)) {
Serial.println('!');
  }
else
  {// send the value of analog input 0:
val = analogRead(A0);
Serial.println(val);
  }
delay(15);
}
```

Body Temperature :

```
/*********************************************************
GY906(Body Temperature Sensor)
Arduino Uno
Vin with Arduino +5V
Gnd with ArduinoGnd
SCL with Arduino Pin A5
SDA with Arduino Pin A4
 *********************************************************/
```

```
#include <LiquidCrystal.h>
#include <Wire.h>
#include <Adafruit_MLX90614.h>

Adafruit_MLX90614 mlx = Adafruit_MLX90614();

LiquidCrystallcd(2,3,4,5,6,7);

void setup()
{
Serial.begin(9600);

Serial.println("Body Temperature Sensor with Arduino Uno");
Serial.println("Developed by Ismail,Nishnat,Tanvir");
Serial.println();
lcd.begin(16, 2);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("EEE 499 CAPSTONE");
lcd.setCursor(0, 1);
lcd.print("Body Temperature");

mlx.begin();
delay(3000);
}
void loop()
{
```

```
Serial.print("Human Body Temperature = ");
Serial.print(mlx.readObjectTempC()+2);
Serial.println("*C");
Serial.print("Human Body Temperature = ");
Serial.print(mlx.readObjectTempF()+4);
Serial.println("*F");
Serial.println();

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("BODY TEMPERATURE");
lcd.setCursor(0, 1);
lcd.print(mlx.readObjectTempC()+2);
lcd.setCursor(5, 1);
lcd.print((char)223);
lcd.print("C");

lcd.setCursor(9, 1);
lcd.print(mlx.readObjectTempF()+4);
lcd.setCursor(14, 1);
lcd.print((char)223);
lcd.print("F");
delay(2000);
```

Appendix B

Arduino NANO code

(For Blood Oxygen level)

```
floatsensorPin = A0;    // select the input pin for the potentiometer

floatsensorValue = 0; // variable to store the value coming from the sensor
float sensorValue1 = 0;
float sensorValue2 = 0;
void setup() {
Serial.begin(9600);
pinMode(sensorPin, INPUT);
Serial.println("Oxygen Saturation Meter");
Serial.println("Developed by
Ismail,Tanvir,Nishnat");
}
void loop() {
sensorValue = analogRead(sensorPin);
sensorValue1 = sensorValue/10;
sensorValue2 = 100-sensorValue1-5;
Serial.print("Oxygen Saturation level is: ");
Serial.print(sensorValue2);
Serial.println(" %");
delay(1000);
}
```