SMART PHONE BASED E-HEALTH MONITORING SYSTEM

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ABSTRACT

To address the issue of increasing health care costs and overcrowded hospitals and care giving institutions, a great deal of research has been propelled into the use of mobile technology and sensor devices to realize better e-Health systems. Telemedicine provides medical information exchange at a distance, to support medical procedure, with the ultimate goal for improving community health care.

This project implements such a system, an electronic health (e-Health) monitoring system utilizing a Smart Phone, Ethernet module and a centralized Web Server. The system was developed using Java on the Android mobile platform and PHP, HTML / CSS3 and JavaScript for Web GUI. The basic components used are Ethernet Shield (based on Wiznet W5100 Ethernet chip), 3 lead ECG probes, Arduino Mega 2560, and OP-AMP AD624/620. Softwares used are Arduino IDE, Proteus, Android Studio and PHP Storm. The system was tested and found to satisfy its core requirements with a few recommendations regarding signal quality being affected due to noise produced from physically intense activities. Overall the system functioned well and provided a good warning system and was usable and beneficial.

CERTIFICATE OF CORRECTNESS AND APPROVAL

It is certified that the work contained in this thesis title "Smart Phone Based E-Health Monitoring System" carried out by Ali Raees, Rehan Shiraz and Rida Tariq under the supervision of Lt. Col. Dr. Muhammad Tayyab Ali in partial fulfillment of our degree of Bachelor of Telecommunication Engineering is correct and approved.

Approved By

_____

Lt. Col. Dr. Muhammad Tayyab Ali

Project Supervisor

Military College of Signals, NUST

DECLARATION

No portion of the work presented in this dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

DEDICATION

This thesis is dedicated to our respective parents who have been our constant source of inspiration. They have given us the drive and discipline to tackle any task with enthusiasm and determination. Without their love and support this project would not have been made possible.

ACKNOWLEDGEMENTS

There is no success without the will of ALLAH ALMIGHTY. We are grateful to ALLAH, for giving us guidance, strength and enabling us to accomplish this task. Without ALLAH's help we couldn't have achieved it. We are also grateful to our parents, family and well wishers for their admirable support and their critical reviews. We would thank our supervisor Lt. Col. Dr. Muhammad Tayyab Ali for his guidance and support throughout the project. Further we would like to thank our fellow students Raja Danyal and Imran Younas for helping us when we were critically stuck at one phase. Further we will also thank our juniors for their constant support and motivation.

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LIST OF ABBREVIATIONS

1.	**ECG**	>	Electrocardiogram
2.	**PHP**	>	PHP: Hypertext Processor
3.	**HTML**	>	Hypertext Mark Up Language
4.	**CSS**	>	Cascading Style Sheet
5.	**API**	>	Application Programming Interface
6.	**PC**	>	Personal Computer

CHAPTER 1

1. INTRODUCTION

1.1. OVERVIEW

Smart Phone Based E-Health Monitoring System is a cost efficient health monitoring system which detects and monitors various human body parameters comprising of the ECG, air flow and temperature using a smart phone and an e-Health sensor board. It will enable practitioners to evaluate, diagnose and treat patients remotely using the latest embedded and telecommunications technology. The e-Health sensor board comprises of all the circuitry required to collect the raw data from the sensors and pass the raw data for further purification and processing to the Microcontroller (Arduino Mega2560). The processed data is stored on a centralized server so that the data can be accessed from anywhere through internet.

1.2. PROBLEM STATEMENT

According to a World Health Organization (WHO) estimate, heart diseases, stroke and low respiratory diseases kill almost 10.5 million people around the globe each year, with around twenty million people at a risk of sudden death [1]. Some of these lives can often be saved if prompt emergency care is provided within the so-called golden hour.

Therefore, patients who are at risk require that their health to be monitored frequently whether they are indoors or outdoors so that emergency treatment can be given if problems arise. Telemedicine is widely considered to be part of the inevitable future of the modern practice of medicine. It is gaining more and more momentum as a new approach for patients' surveillance outside of hospitals (at home) to encourage public safety, facilitate early diagnosis, treatment, and for increased convenience.

1.3. APPROACH

1. Develop a prototype board having three different sensors; ECG, Airflow and Temperature sensor.
2. Use 3-lead ECG for ECG monitoring which can be either mounted on the chest or arms.
3. Use an airflow sensor attached to the nostrils to measure breathing rate.
4. Use temperature sensor for measuring temperature of different parts of body.
5. Raw data from the sensors to be processed by Arduino Mega2560 microcontroller board.
6. Processed data will be stored on a centralized server.
7. The data from the server can be viewed on the website in real time in form of graphs.
8. The doctor and patient will be notified using an android app on anomaly detection.

1.4. SCOPE

Earlier, the concept of telemedicine was alien to us and we could never imagine that such kind of thing would come into being. But, now with technological advancements this concept has gained momentum. The usage of various telecommunications systems by medical institutions and physicians for providing healthcare to their patients makes us wonder how technology can change our lives for better.

This project will aid caregivers in treating patients remotely and in collection and transfer of medical data transmission. Some common methods utilized include the internet, satellite and ordinary telephone lines. This project will benefit not only the specified fields but also fields like radiology, psychiatry, cardiology and oncology.

1.5. OBJECTIVES

The primary objective of this project is to alleviate primary health care problems. This project aims at developing a highly cost-effective health monitoring system which would cater the needs of people of remote areas. It will reduce paperwork and operational time. Accuracy, reliability and operational efficiency will be achieved.

1.6. ORGANIZATION

The first part of thesis is the abstract which describes the main details of our project **Smart Phone Based E-Health Monitoring System**, followed by the introduction section which specifies the problem statement, approach, scope and objectives. The literature review section state the various resources read online before the commencement of the project. They include learning about diseases and history of telemedicine. The design and development part illustrate the diagrams which describe the detailed design of the project, its components, interfaces and data necessary for the implementation phase. The analysis and evaluation part is the detail of the testing the actual results against expected results. The future work gives states the enhancements that can be applied to the application.

CHAPTER 2

2. BACKGROUND STUDY / LITERATURE REVIEW

Over the past few years, the explosive development, growth, and use of the Smart Phones and Internet has dramatically changed the way World communicates, plays, and does business. The number of households connected to the Internet has increased over 250% in the last 5 years, and electronic technologies are now deeply embedded in every aspect of our daily lives [2].

Access to the internet through smart phones and the use of embedded devices has given patients more control over their own care. On top of being more convenient for patients, these tools and products can reduce costs and provide physicians with patient information more quickly and efficiently. Smart phones, laptops, and tablets are being used in hospitals to allow doctors to sync to the facility's network and outside hospitals to enable patients to monitor vital signs and transmit this information to their physicians. With massive amounts of data needing to be stored, many facilities are looking to cloud storage solutions to store information without incurring excessive hardware costs.

2.1. BACKGROUND STUDY

For more than 30 years, clinicians, health services researchers, and others have been investigating the use of advanced telecommunications and computer technologies to improve health care. At the intersection of many of these efforts is telemedicine — a combination of mainstream and innovative information technologies. As defined here, telemedicine is the use of electronic information and communications technologies to provide and support health care when distance separates the participants. Telemedicine is the use of telecommunications technology to provide health care services to patients who are geographically separated from physician or other health care providers.

Organized telemedicine services have been provided at The University of Arizona College of Medicine since 1979 by the Arizona Poison and Drug Information Center which handles 70,000patient inquiries a year. The Arizona Health Sciences Center

Physician's Resource Service was organized in 1990 and currently provides physicians, statewide, with specialty consultations. Last year, this service provided 11,000 consultations. Tele pathology has been offered in Arizona, Mexico and China since 1993. Several other health care providers in Arizona have active telemedicine programs [3].

The new technological era has improved the living standards and brought a major change to living styles. The world has become a global village; transmission of information from one place to another is extremely easy. Access to mobile phones has increased incredibly in the last few years, but we cannot restrict the usage of mobile phones for just to a day to day conversation through messages and phone calls. Rather they can be extended to have other varied and useful usages. Telemedicine technology via mobile phone is one of them [4].

Conventional telemedicine systems using Public Switched Telephone Network (PSTN) landlines are already available to enable a doctor to monitor a patient remotely for home care or emergency applications. Also, the mobile phone has been recognized as a possible tool for telemedicine since it became commercially available [5].

Internet is being used for many commercial and government applications, and this use is continuously increasing. Our motivation to use smart phone is because of its easy access to internet. Not only does internet offers an alternative means of transmission in a communication system, but at times it can be the most efficient option. With the right technology, health organizations can significantly have a reduction in operational costs by using these services. By performing follow up visits remotely, medical practices can take better control of their schedules, waiting room and visits.

2.2. LITERATURE REVIEW

There are many systems for remote monitoring and control design as commercial products or experimental research platforms. It is noticed that most of the research carried out belongs to the following categories:

1. Internet based Monitoring using Servers, GPRS modems etc. using different approaches.
2. Monitoring using Wireless Sensor Networks.
3. Wireless Monitoring using Bluetooth, WI-FI, ZigBee and RF.
4. Applications widely like Security Systems, Bio-medical applications, Agriculture, Environment, Reservoir, Bridge health monitoring, etc.

2.3. TELEMEDICINE

The prefix “tele” derives from the Greek meaning “far or at a distance or remote”. Hence the word telemedicine signifies as medicine delivered at a distance. A more accurate and informative definition of telemedicine is defined as the transfer of electronic medical data from one location to another (Telemedicine Research Centre, 1999).

Telemedicine is a branch of e-health that uses communication networks or information technologies (IT) for delivery of healthcare services and medical education from one geographical location to another. It is deployed to cope with issues like uneven distribution and shortage of infrastructural and human resources .In other ways, telemedicine may be as simple as two health professionals discussing a case related to health care over the telephone, or as complex as using satellite technology and video-conferencing equipment to conduct a real-time consultation between medical specialists in two different countries.

2.4. TELEMEDICINE CONCEPTS

Telemedicine is practiced on the basis of two concepts:

1. Real time (synchronous)
2. Store-and-forward (asynchronous)

Real Time Telemedicine (synchronous) is referred to as two way interactive television (IATV). It another meaning, it can be as simple as telephone calls or as complex as sophisticate virtual reality (VR) robotic surgery or tele-surgery. In it providers/patients at different locations interact with each other using communication technology in the form of audiovisual and wireless or microwave signals. Apart from video-conferencing, peripheral sensing devices can also be attached to the patient to aid in interactive examination. Besides that, it can also be used for long term monitoring for home care patients. In fact, due to the high cost constraints, quality and continuity of care issues, mal-distribution of physicians in different geographic regions and scarcity of the same, remote home care of chronically ill patients and of long term care patients, is the fastest emerging use of telemedicine. Specialties for which it is used most frequent are psychiatry, internal medicine, rehabilitation, cardiology, pediatrics, obstetrics and gynecology, neurology.

Store and Forward (asynchronous) technology involves acquiring medical data (images, bio-signals) and transmitting this data to a medical specialist for consultation, evaluation or other related purposes. It does not require simultaneous communication between both persons in real time. Tele-radiology and tele-dermatology is the fastest emerging branches that use such kind of services. Overall radiology, pathology and dermatology are most tending for utilizing this mechanism.

These basic telemedicine technologies as mentioned previously are utilized for providing various health care services that spawns numerous specialties and can be broadly categorized as tele-home, Home Health Care, telepsychiarty, tele-radiology, general telemedicine, tele-cardiology, telemedicine consulting (teleconsultation), tele-dermatology, emergency telemedicine, tele-pathology, tele-dentistry, tele-surgery, tele-diagnostic, tele-monitoring, tele-care and tele-education. Among these specialties, teleconsultation is one of the most significant applications as it uses

multimedia Telecommunication through networks for medical consultation. It can either use ordinary telephone, email, or video-conferencing equipment's. Real-time consultations use the video-conferencing technology and permit the interaction and communication between medical experts and clients.

2.5. CURRENT SITUATION OF TELEMEDICINE

Telemedicine is a growing field which has a high potential for improving accessibility to services, quality and continuity of care and significant savings in the overall cost of healthcare. However the use of telemedicine applications has not spread as extensively as other as other commonly used engineering techniques, such as medical imaging. Although telemedicine applications have proliferated in recent years, their diffusion has remained low in terms of the volume of consultations especially in Malaysia. This is not because telemedicine is less important but because supporting technologies have been traditionally costly, institutionalized and less pervasive and less capable in terms of data transfer speed and quality. They need to develop technically feasible, medically valid, reimbursable, and institutionally supported applications in order to justify the value of telemedicine and engender consistent and frequent use by medical experts or physicians. Fixed communication network has been used in different within telemedicine have been developed only in the last few years. One of the sole decisive factors that will cause a telemedicine system successful, in urban and rural areas, is the application of modern communication technology for information exchange between a homecare patient and the medical specialists providing care.

2.6. RELATED WORK

There are numerous tele-monitoring systems starting from basic pulse monitor to ECG monitor and sophisticated and expensive implanted sensors. Systems like the Holter device have been used to record ECG data, which is then only monitored offline making them unsuitable for real-time applications. Two related projects have been developed previously in MCS namely “Medical Wireless Sensor Network” and one other project. A lot of progress is still being made in this regard.

The following links contains some of the advances in telemedicine.

1. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=1411118&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D1411118
2. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=1019584&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D1019584
3. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6479932&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6479932

Some other projects being done in this field are

1. http://eprints.utar.edu.my/143/

There are many other projects as well.

CHAPTER 3

3. DESIGN AND DEVELOPMENT

A block diagram showing the data flow and the features of the project is shown below in ***Figure 1***.

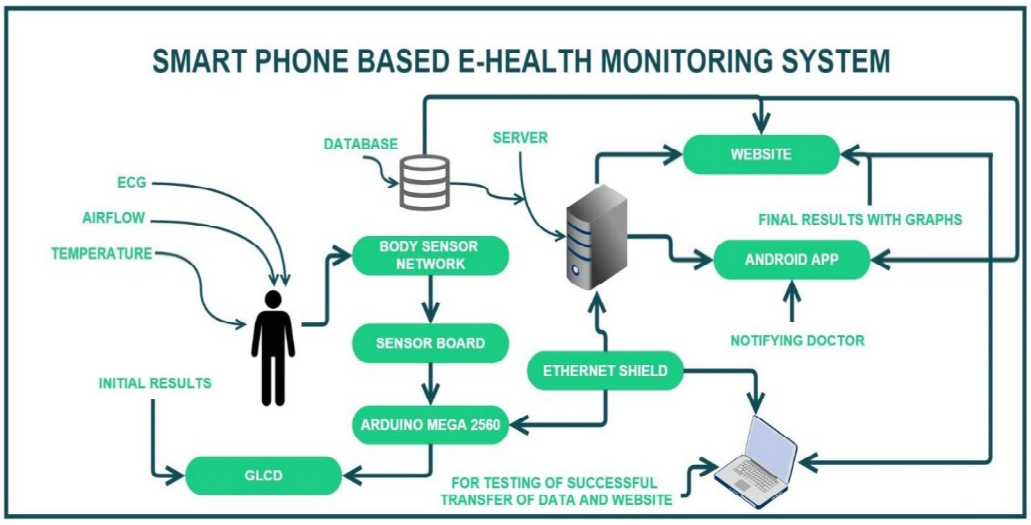

FIGURE 1: BLOCK DIAGRAM

Figure 1 show the block diagram of the project.

This section describes the design techniques that was implemented to complete this project. A system model is shown below that shows the structure and different steps of our project.

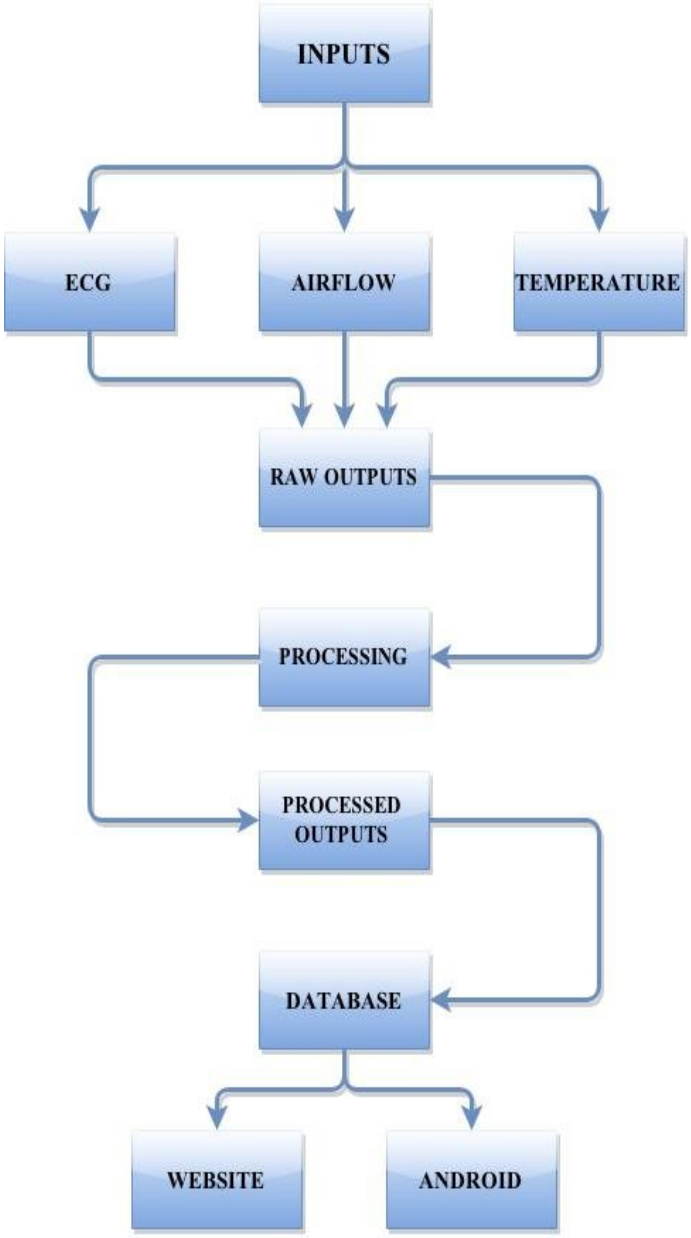

FIGURE 2: SYSTEM MODEL

Figure 2 shows the system model of our project.

The design techniques and circuit diagrams for each sensor will be described in details followed by a complete PCB Layout of the project.

3.1. ELECTROCARDIOGRAM (ECG)

Electrocardiogram (ECG) is the recording of the heart's electrical activity over time via skin electrodes. The deviations in the normal electrical patterns indicate various cardiac disorders and abnormalities.

To keep our project simple we used 3 lead ECG rather than using a 5 lead and 12 lead ECG, which are more accurate as compared to 3 lead ECG and are required in ICU for patients admitted due to heart attacks or any other disorders. While 3 lead ECG is used to monitor the heart activity on the go and are mostly used in transport monitors. Einthoven's triangle (***Figure 3***) is known as the "three lead" ECG, with measurements taken from three points on the body. If two leads are connected between two points on the body, it will form a vector between them, electrical voltage observed between the two electrodes is given by the dot product of the two vectors. Another lead connected at the body acting as ground to protect human body.

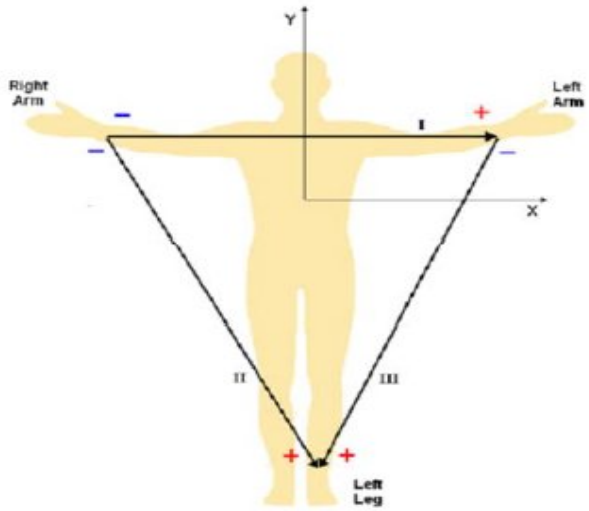

FIGURE 3: EINTHOVEN'S TRIANGLE

Figure 3 shows the 3 lead ECG known as Einthoven's triangle.

3.1.1. 3 LEAD ECG PROBES AND PLACEMENT

The term "lead" in electrocardiography causes much confusion because it is used to refer to two different things. In accordance with common parlance, the word lead may be used to refer to the electrical cable attaching the electrodes to the ECG recorder. As such, it may be acceptable to refer to the "left arm lead" as the electrode (and its cable) that should be attached at or near the left arm.

Alternatively, the word lead may refer to the tracing of the voltage between two of the electrodes and is what is actually produced by the ECG recorder. Each will have a specific name. For example "lead I" is the voltage between the right arm electrode and the left arm electrode, whereas "Lead II" is the voltage between the right arm and the left leg.

The placement of 3 lead ECG probes according to Einthoven's triangle is described below

TABLE 3.1.1- 1

Probe label (General)	Probe Placement
RA	On the right arm, avoid thick muscles
LA	On the left arm at the same location where RA is placed.
LL	On the left Leg , lateral calf muscle

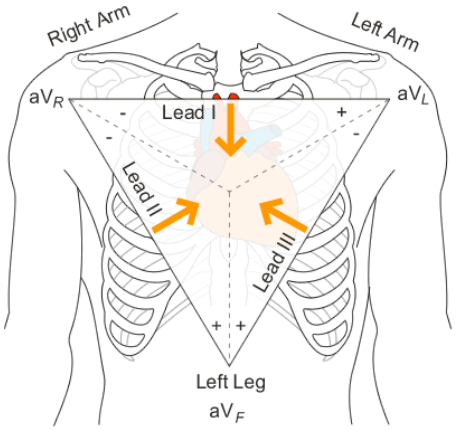

FIGURE 4: 3 LEAD ECG PROBES PLACEMENT

Figure 4 shows the placement of ECG probes.

3.1.2. ECG SYSTEM CONCEPT

The basic concept of the ECG system is:

- The Patient will have 3 ECG probes connected to his body.
  - Right arm
  - Left arm
  - Left leg
- The probes will collect data in analog form.
- The AD-624 ECG modulator will amplify the data collected by the probes and send it to the microcontroller. The Arduino microcontroller will make it digital and then take the required action as programmed by the program burn in controller.
- The ECG data will be stored on the server and will be display on a website in real time.

When anomaly is detected the doctor or consultant will receive a notification alert on smart phone.

3.1.3. ECG CIRCUIT DIAGRAM

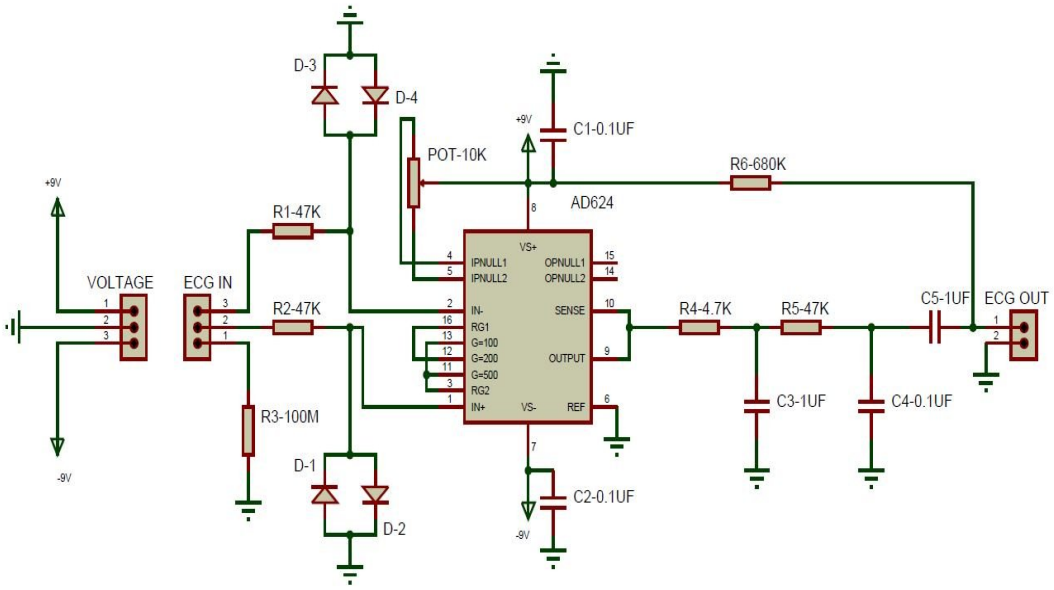

FIGURE 5: ECG CIRCUIT DIAGRAM

Figure 5 shows a functional circuit diagram for ECG sensor. The ECG leads are connected with ECG IN connector. Raw data from the ECG Probes is collected and passed on to the operational amplifier AD624 through the leads where the data is amplified. The amplified data is passed to the Arduino Microcontroller through ECG OUT where analog data is converted to digital form using some programming techniques and further sent for storage on the data base using Ethernet Shield.

3.2. AIRFLOW

Airflow sensing is used for patients having breathing or respiratory problems.

There are many causes of breathing problems. Some people have difficulty breathing when they get a cold. Others have trouble breathing because of occasional bouts of acute sinusitis. Sinusitis can make it difficult to breathe through your nose for a week or two until the inflammation subsides and the congested sinuses begin to drain.

Many breathing problems are chronic or long-term. These common breathing problems include chronic sinusitis, allergies, and asthma. These problems can cause a

host of symptoms such as nasal congestion, runny nose, itchy or watery eyes, chest congestion, cough, wheezing, labored breathing, and shallow breathing.

The nasal passage is a pathway for viruses and allergens to enter your lungs. So the nose and sinuses are often associated with many lung disorders. A sinus or nasal passage inflammation may trigger reflexes and cause asthma attacks.

There are a number of techniques used to measure airflow but most of them are not accurate e.g. Flexible Stretch Sensor. The method we have implemented is to use temperature sensing on the nose. We have used DS18B20 module mounted by a nostril to measure temperatures. In this case breathing in will be the low temperature and breathing out will be the high temperature. By using 9 bit ADC we get 10 samples per second and it responds quickly to the changes [6].

3.2.1. AIRFLOW SYSTEM CONCEPT

The basic concept of the Airflow system is:

- The Patient will have an Airflow sensor near his / her nose for a minute as the breathing rate is measured per minute.
- The sensor will collect data in analog form.
- The data collected by the sensorwill be send to the microcontroller. The Arduino microcontroller will make it digital and then take the required action as programmed by the program burn in controller.
- The Airflow data will be stored on the server and will be display on a website in real time.

When anomaly is detected the doctor or consultant will receive a notification alert on smart phone.

3.2.2. AIRFLOW CIRCUIT DIAGRAM

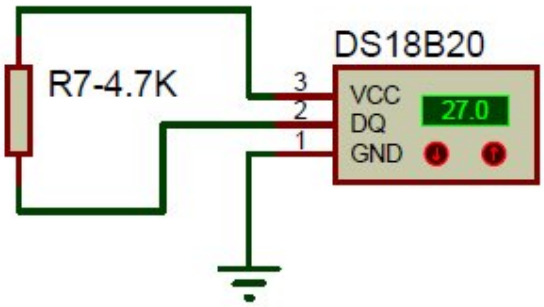

FIGURE 6: AIRFLOW CIRCUIT DIAGRAM

Figure 6 shows the circuit diagram for airflow sensor.The DS18B20 (Pin 2) is connected to the Arduino Microcontroller on pin 3 where analog data is converted to digital form using some programming techniques and further sent for storage on the data base using Ethernet Shield.

3.3. TEMPERATURE

Body temperature depends upon the place in the body at which the measurement is made, and the time of day and level of activity of the person. Different parts of the body have different temperatures. It is of great medical importance to measure body temperature. The reason is that a number of diseases are accompanied by characteristic changes in body temperature.

When using temperature sensor, we are actually measuring a voltage, and relating that to what the operating temperature of the sensor must be. If we can avoid errors in the voltage measurements, and represent the relationship between voltage and temperature more accurately, we can get better temperature readings.

A temperature sensor detects temperature or heat. A temperature sensor consists of two basic physical types

- **Contact Temperature Sensor Types** – These types of temperature sensor are required to be in physical contact with the object being sensed and use conduction to monitor changes in temperature. They can be used to detect solids, liquids or gases over a wide range of temperatures.

- **Non-contact Temperature Sensor Types** – These types of temperature sensor use convection and radiation to monitor changes in temperature. They can be used to detect liquids and gases that emit radiant energy as heat rises and cold settles to the bottom in convection currents or detect the radiant energy being transmitted from an object in the form of infra-red radiation (the sun).

We are using LM35 as a temperature sensor in the project.

3.3.1. TEMPERATURE SYSTEM CONCEPT

The basic concept of the Temperature system is:

- The Patient will have a temperature sensor connected to specific part of his body.
- The sensor will collect data in analog form.
- The data collected by the sensor will be send to the microcontroller. The Arduino microcontroller will make it digital and then take the required action as programmed by the program burn in controller.
- The Temperature data will be stored on the server and will be display on a website in real time.

When anomaly is detected the doctor or consultant will receive a notification alert on smart phone.

3.3.2. TEMPERATURE CIRCUIT DIAGRAM

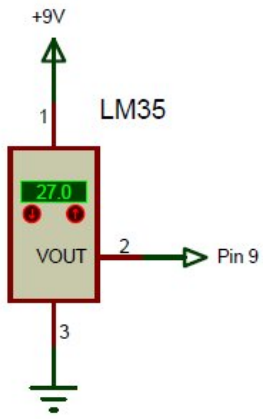

FIGURE 7: TEMPERATURE CIRCUIT DIAGRAM

Figure 7 shows the circuit diagram for temperature sensor. The LM35 (Pin 2) is connected to the Arduino Microcontroller on pin 9where analog data is converted to digital form using some programming techniques and further sent for storage on the data base using Ethernet Shield.

3.4. INVERTER CIRCUIT DIAGRAM

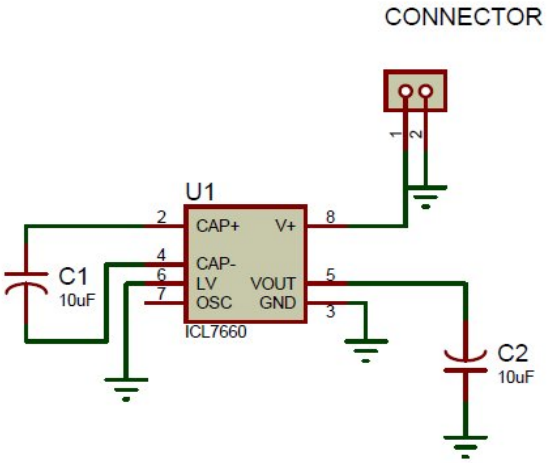

FIGURE 8: INVERTER CIRCUIT DIAGRAM

Figure 8 shows a voltage inverter circuit diagram using 7660 inverter IC. Positive voltage is given at pin 8 and we get the corresponding negative voltage as output on pin 5.

3.5. GLCD WITH ARDUINO CIRCUIT DIAGRAM (INITIAL TESTING)

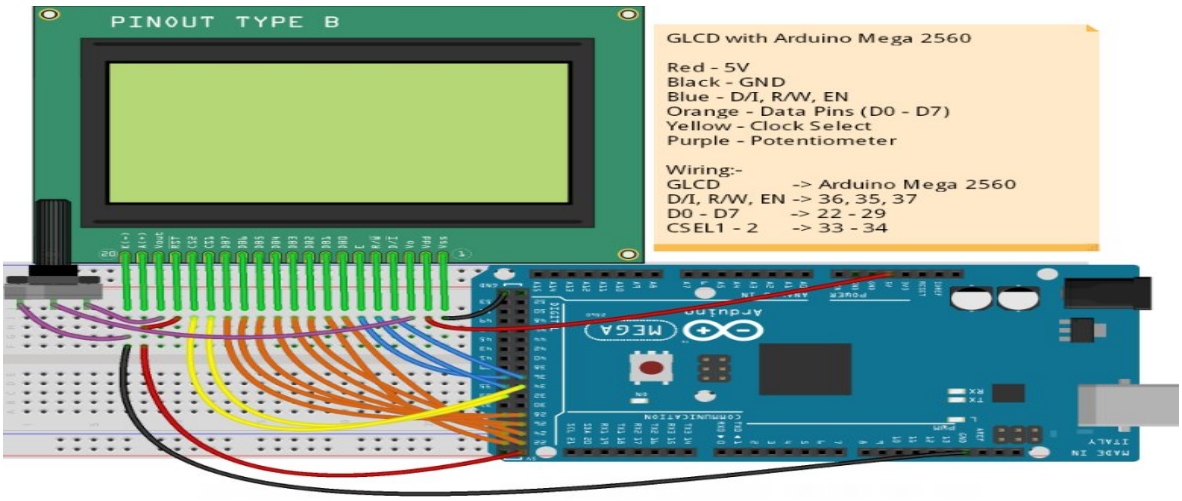

FIGURE 9: GLCD WITH ARDUINO CIRCUIT DIAGRAM

Figure 9 shows the circuit of GLCD with Arduino which was used initially for displaying sensor data.

3.6. SOFTWARE IMPLEMENTATION

The software part was implemented using the following languages and APIs

1. For the website PHP, HTML / CSS3, JavaScript and Bootstrap framework were used.
2. For real time simulation graphs HighCharts API is used.
3. For the Android App Java was used. For storing the data we choose a relational database MySQL.

3.7. SOFTWARES

The following softwares were used to complete this project

1. Arduino IDE.
2. PHP Storm.
3. Android Studio.
4. XAMPP Server.

3.8. COMPONENTS

The main components used in the project are

1. **Arduino Mega2560:** The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), 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**.**
2. **Arduino Ethernet Shield:** The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100ethernet chip (datasheet). The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. Use the Ethernet library to write sketches which connect to the internet using the shield. The Ethernet shield connects to an Arduino board using long wire-wrap headers which extend through the shield. This keeps the pin layout intact and allows another shield to be stacked on top.
3. **AD624 Amplifier:** The AD624 is a high precision, low noise, instrumentation amplifier designed primarily for use with low level transducers, including load cells, strain gauges and pressure transducers. An combination of low noise, high gain accuracy, low gain temperature coefficient and high linearity make the AD624 ideal for use in high resolution data acquisition systems.
4. **LM35:** The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ^{o}C).
5. **DS18B20:** The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points.
6. **7660 Inverter IC:** The ICL7660S and ICL7660A perform supply voltage conversions from positive to negative for an input range of 1.5V to 12V, resulting in complementary output voltages of -1.5V to -12V.

3.9. PROJECT PCB LAYOUT

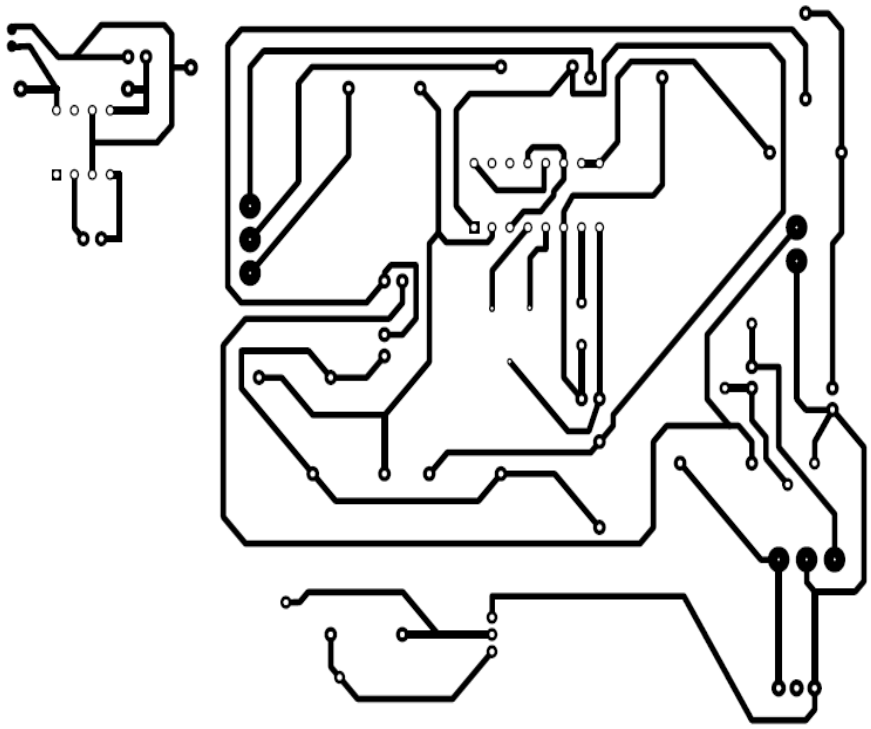

FIGURE 10: PROJECT PCB LAYOUT

Figure 10 shows the complete PCB layout of our project.

CHAPTER 4

4. ANALYSIS AND EVALUATION

The analysis will go through each phase of development step-wise and document what the output at each stage was. The results include real time graphs from the website. A dummy anomaly generated on smart phone.

4.1. SIMULATIONS, RESULTSAND GUI

FIGURE 11: ECG USING OSCILLOSCOPE

Figure 11 shows the result of ECG on oscilloscope.

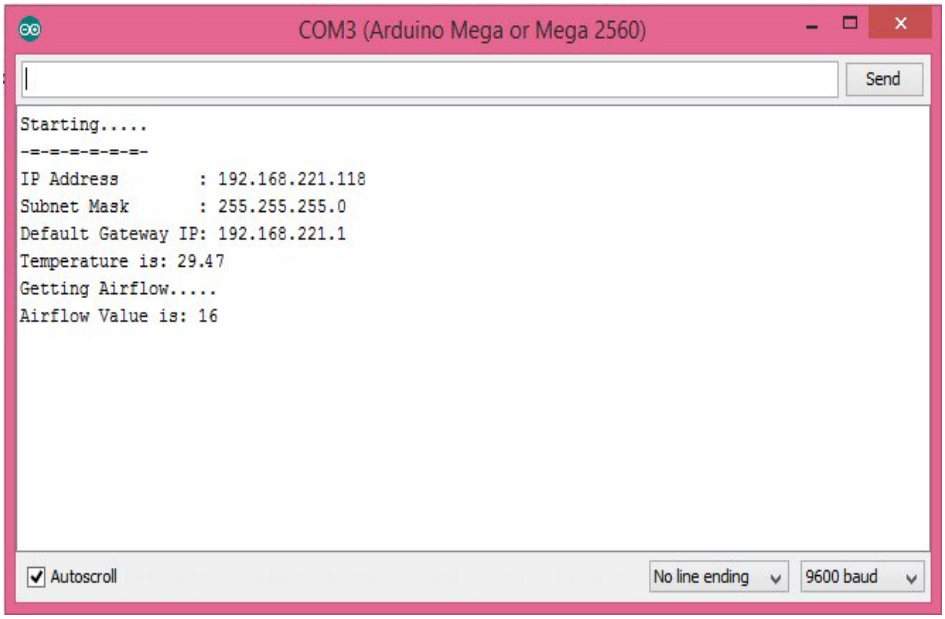

FIGURE 12: TEMPERATURE AND AIRFLOW RESULTS

Figure 12 shows the results of temperature and airflow sensor using serial monitor of Arduino IDE.

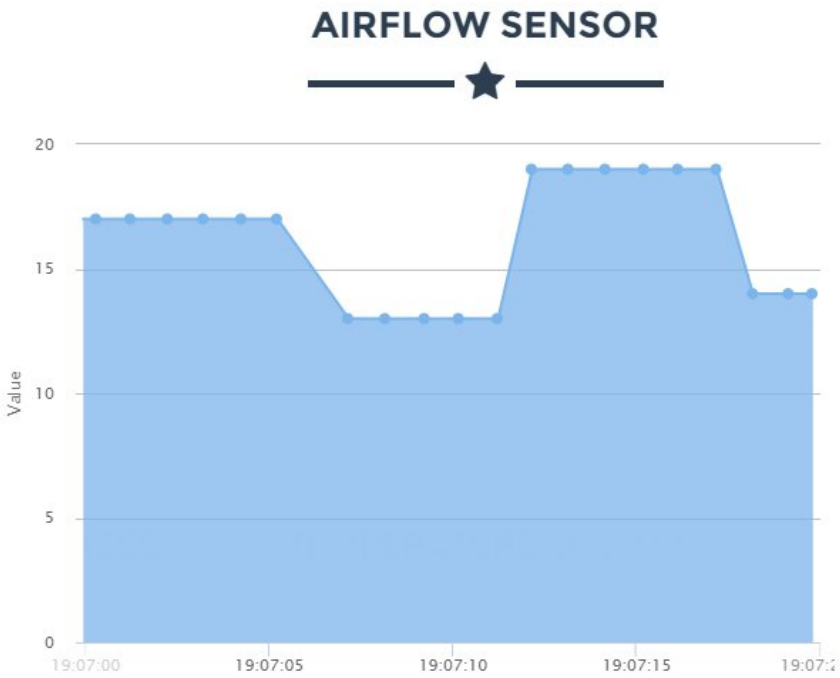

FIGURE 13: AIRFLOW SENSOR GRAPH ON WEBSITE

Figure 13 shows the real time graph of airflow sensor on website

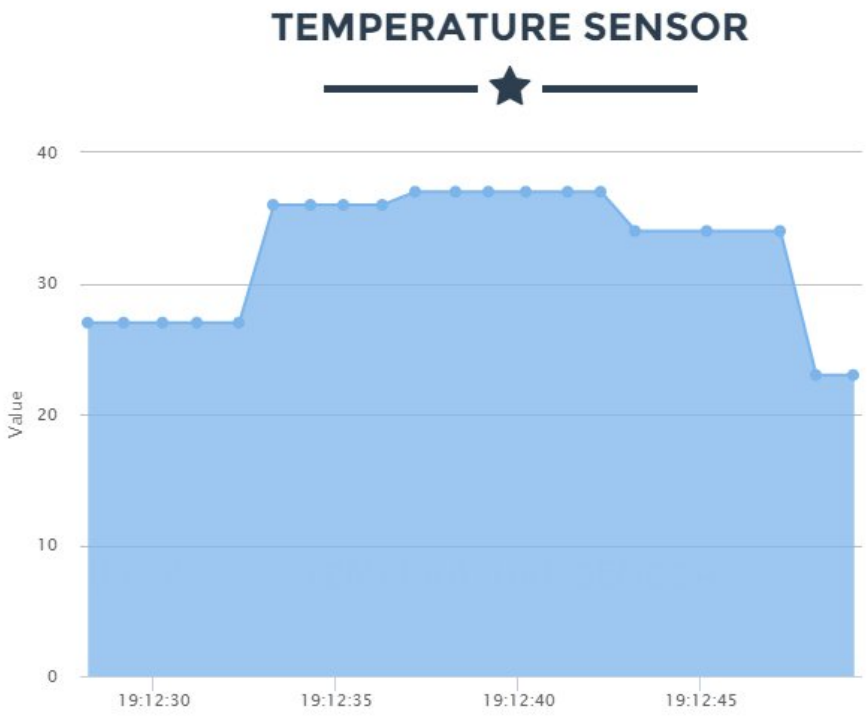

FIGURE 14: TEMPERATURE SENSOR GRAPH ON WEBSITE

Figure 14 shows the real time graph of temperature on website.

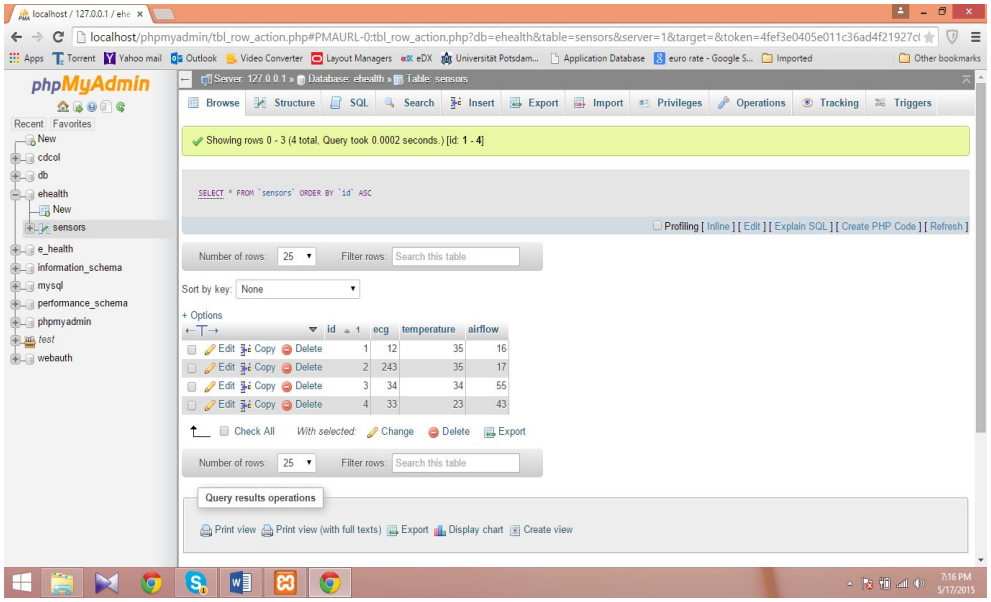

FIGURE 15: DATABASE

Figure 15 shows the database used to store the data from the sensors.

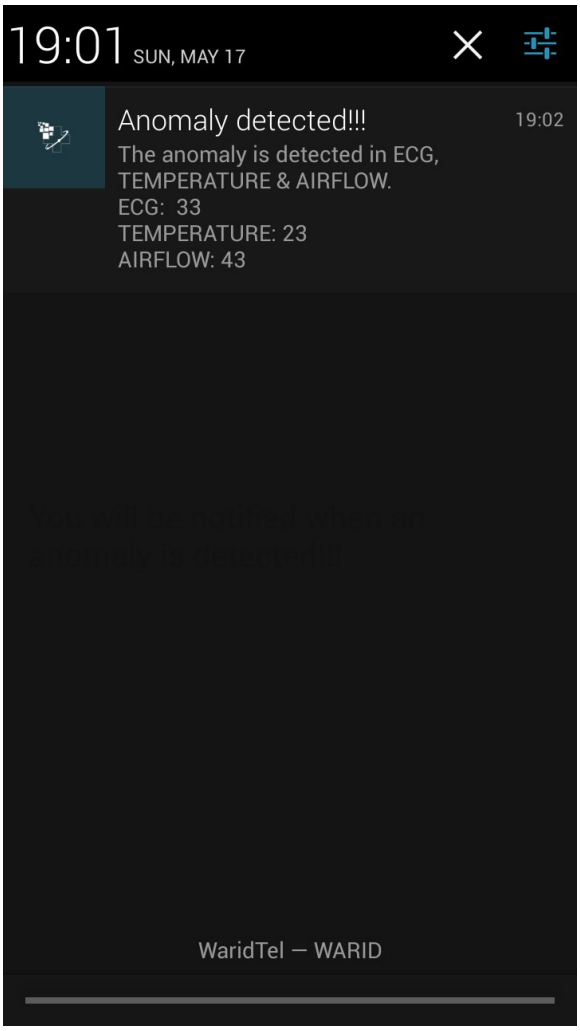

FIGURE 16: DUMMY ANOMALY

Figure 16 shows a dummy anomaly. As soon as the anomaly is detect the user or doctor is notified on the smart phone provided the E-Health app is installed.

CHAPTER 5

5. FUTURE WORK

5.1. INTRODUCTION

This chapter will focus on the ideas and suggestions given as input during the work done on the project. These ideas show how to expand the project into a more practical solution for real life control of inanimate objects, whether they are PC and laptops or control systems.

5.2. UNDERSTANDING THE AVENUES OF FUTURE DEVELOPMENT

Our device provides a link between the doctor and patients by monitoring various body parameters. Any future work will be along the lines of making the product much smarter and easier to use as well as expanding its functionality to measure other body parameters.

5.3. PACKAGING

The basic factor to be considered is miniaturization of components used in the design. Using breakout boards and miniature IC packages to replace the existing IC's can do it. A compact PCB manufacturing with these miniaturized components can allow for a smarter design that takes up less space on the back of the palm. Miniaturization will also reduce the weight the user has to carry.

Apart from that an attractive casing will not only beautify our project but can also attract people to use our project.

5.4. IMPROVED WIRELESS OPTIONS

The future work should focus on a robust wireless connectivity with lower interference factor rather than using a wired network..

5.5. USING BLUETOOTH AS WIRELESS MEDIUM

To eliminate the equipment connecting to the laptop/PC through a LAN cable, an alternative option is to use a Bluetooth module that communicates directly with the laptop's Bluetooth module. This is suitable for short-range applications where the user will be in 1-meter radius of his laptop. Also, this places a restriction on the use with PC's due to their lack of Bluetooth module. The plus point of this is however, it eliminates the cost of using a Ethernet shield.

5.7. CONCLUSION

This section has offered future work areas that were perceived to be practical and were offered as critical but constructive criticism during the project work. They are also the results of the problem areas the team members faced as well as ideas got during brainstorming on how to improve this product with future effort.

CHAPTER 6

6. CONCLUSION

6.1. OVERVIEW

This project is a cost efficient health monitoring system which will detect and monitor various human body parameters primarily comprising of the ECG, temperature and air flow. It is basically a body sensor network that will consist of different sensors for the measurement of the parameters mentioned above.

6.2. OBJECTIVES ACHIEVED

The major objectives achieved were:

1. To design a system that is low-cost intelligently embedded and is based on remote monitoring system using mobile phones or cellular devices.
2. To give an alternate way of health monitoring
3. A fast more convenient and easy go way.
4. To give flexibility to the user to use it anywhere.
5. To co-ordinate between the patient and medical consultant using a smart phone.
6. Effectively receive notifications on anomaly.
7. To eliminate the need of going to the hospital for ECG monitoring, or the need of any specialized person you can monitor it by yourself.
8. Minimize health risk and wastage of time and money.

6.3. LIMITATIONS

There are certain limitations related to the project:

- The user and receiver should reside in a location where there are internet facilities.
- Only those doctors having a smart phone with the E-Health app installed can get notification alert.
- The device can only be used with Smartphone and a PC.

6.4. APPLICATIONS

The project will have the following applications:

1. Beneficial venture for both consumers and as well as potential product manufactures (any companies that might be interested in picking our prototype and selling it commercially as their product).
2. Consumers will be rid of the hassles of going to hospitals.
3. Making technology healthy.
4. Health facilities of remote areas will be improved.

6.5. OPERATING ENVIRONMENT

The operating environment consists of three units, a PC, a smart phone device and a control unit. The smart phone device will be used to get alert notifications using Internet technology. The control unit consists of a microcontroller, an amplifying unit and USB port and conversion software.

6.6. INTENDED USERS AND USES

The system is aimed to facilitate all the average users or patients who want to monitor their health remotely, rather than paying a visit to the doctor in a hospital. It will further be less time consuming and easy in usage.

6.7. MAJOR CONSTRAINTS

During the course of our project completion we had to face various problems and obstacles. Not everything went according to the plan or sequence we desired. We had a limited amount of time for completing our project so we had to follow a strict plan and bear a lot of pressure. We started with the research phase and begin with gaining complete knowledge regarding all the hardware's and software's we intended to use in our project. The other phase of the project was developing a code, debugging, testing, documentation and implementing needed certain time of completion. In order to complete all this within the proposed time span we needed to be sharp in managing our time and finish the project and give our best shot.

APPENDIX A

Arduino Mega2560 code of the project.

```
// Ethernet Libraries
#include <SPI.h>
#include <Ethernet.h>
//////////////////////////////////////////////////////////////

// DS18B20 Libraries
#include <OneWire.h>
#include <DallasTemperature.h>
//////////////////////////////////////////////////////////////


// For Ethernet Shield
byte mac[] = { 0x54, 0x34, 0x41, 0x30, 0x30, 0x31 }; // Ethernet Shield MAC address - must be unique on your network
EthernetClient client;
char server[] = "192.168.221.112"; // IP Address of server to dump data to
int  interval = 100; // Wait between dumps
IPAddressip(192, 168, 221, 118); // IP Address of Ethernet Shield
//////////////////////////////////////////////////////////////

// For Temperature
float temperature;
int pin = 2;
int del = 0;
//////////////////////////////////////////////////////////////

// For Airflow
int airflow = 0, air1, air2, j;
intcurrTemp, prevTemp;
#define ONE_WIRE_BUS 3
```

```
OneWireoneWire(ONE_WIRE_BUS);
DallasTemperaturesensors(&oneWire);
DeviceAddressairflowMeter = { 0x10, 0x43, 0x21, 0xD9, 0x02, 0x08, 0x00, 0x49 };

////////////////////////////////////////////////////////////////

// For ECG
intecg;
intecgpin = 1;

////////////////////////////////////////////////////////////////

void setup() {

Serial.begin(9600);
////////////////////////////////////////////////////////////////

// For Ethernet Shield
Ethernet.begin(mac,ip);
Serial.println("Starting.....");
Serial.println("-=-=-=-=-=-=-");
Serial.print("IP Address        : ");
Serial.println(Ethernet.localIP());
Serial.print("Subnet Mask       : ");
Serial.println(Ethernet.subnetMask());
Serial.print("Default Gateway IP: ");
Serial.println(Ethernet.gatewayIP());
////////////////////////////////////////////////////////////////

// For Airflow
sensors.begin();
sensors.setResolution(airflowMeter, 9);
////////////////////////////////////////////////////////////////
```

```
}

// For Airflow
voidcalAirflow(DeviceAddressdeviceAddress)
{
   air1 = sensors.getTempC(deviceAddress);
if((air1 - 25) > air2) j++;
j++;
   air2 = air1;
}
//////////////////////////////////////////////////////////////////

void loop() {

// For Temperature
temperature = ( 4.88 * analogRead(pin) * 100.0) / 1024.0;
Serial.print("Temperature is: ");
Serial.print(temperature);
Serial.print("\n");
//////////////////////////////////////////////////////////////////

// For Airflow
sensors.requestTemperatures();
calAirflow(airflowMeter);
del = del + 100;
if(del == 60000){
airflow = af;
  }
if(del == 60000){
del = 0;
Serial.print("Airflow Value is: ");
Serial.print(af);
  }
//////////////////////////////////////////////////////////////////
```

```
// For ECG

ecg = analogRead(ecgpin)/36;

//////////////////////////////////////////////////////////////////

  // For Ethernet Shield connection with MYSQL
if (client.connect(server, 80)) {
Serial.println("Connected to Server.");
client.print( "GET /ehealth_arduino/add_data.php?");
client.print("temperature=");
client.print( temperature );
client.print("&&");
client.print("airflow=");
client.print( airflow );
client.print("&&");
client.print("ecg=");
client.print(ecg );
client.println( " HTTP/1.1");
client.print( "Host: " );
client.println(server);
client.println( "Connection: close" );
client.println();
client.println();
client.stop();
ecgi++;
  }
else {
  }
delay(50);
//////////////////////////////////////////////////////////////////
}
```

APPENDIX B

A portion of the code for Website GUI of the project.

```
<!DOCTYPE html>
<html lang="en">
<head>
<meta charset="utf-8">
<meta http-equiv="X-UA-Compatible" content="IE=edge">
<meta name="viewport" content="width=device-width, initial-scale=1">
<meta name="description" content="">
<meta name="author" content="">
<title>e-Health | We care</title>
<!-- Favicon -->
<link rel="shortcut icon" href="img/favicon.ico"/>
<!-- Bootstrap CSS -->
<link href="css/bootstrap.min.css" rel="stylesheet">
<!-- Custom CSS -->
<link href="css/main.css" rel="stylesheet">
<!-- Custom Fonts -->
<link href="font-awesome-4.1.0/css/font-awesome.min.css" rel="stylesheet" type="text/css">
<link href="http://fonts.googleapis.com/css?family=Montserrat:400,700" rel="stylesheet" type="text/css">
<link href="http://fonts.googleapis.com/css?family=Lato:400,700,400italic,700italic" rel="stylesheet" type="text/css">
<!-- HTML5 Shim and Respond.js IE8 support of HTML5 elements and media queries -->
<!--[if lt IE 9]>
<script src="https://oss.maxcdn.com/libs/html5shiv/3.7.0/html5shiv.js"></script>
```

```
<script src="https://oss.maxcdn.com/libs/respond.js/1.4.2/respond.min.js"></script>
<![endif]-->
<!-- Modernizer.js -->
<script src="js/modernizr-latest.js"></script>
<!-- jQuery Version 1.11.0 -->
<script src="js/jquery-1.11.0.js"></script>
<!-- Javascript for scroll to top Button -->
<script type="text/javascript">
$(document).ready(function(){
$(".scroll-top").hide();
$(window).scroll(function(){
if ($(this).scrollTop() > 100) {
$('.scroll-top').fadeIn();
} else {
$('.scroll-top').fadeOut();
}
});
});
</script>
<!-- Javascript for date and time -->
<script src="js/date.js"></script>
<!-- Javascript for charts -->
<script src="js/charts/ecg1.js"></script>
<script src="js/charts/ecg2.js"></script>
<script src="js/charts/temp1.js"></script>
<script src="js/charts/temp2.js"></script>
<script src="js/charts/af1.js"></script>
<script src="js/charts/af2.js"></script>
```

```
<script src="js/charts/highcharts.js"></script>
<script src="js/charts/modules/exporting.js"></script>
</head>
<body id="page-top" class="index">
<!-- Navigation -->
<nav class="navbarnavbar-inverse navbar-fixed-top">
<div class="container">
<!-- Brand and toggle get grouped for better mobile display -->
<div class="navbar-header page-scroll">
<button type="button" class="navbar-toggle" data-toggle="collapse" data-target="#navbar-1">
<span class="sr-only">Toggle navigation</span>
<span class="icon-bar"></span>
<span class="icon-bar"></span>
<span class="icon-bar"></span>
</button>
<a class="navbar-brand" href="#page-top">e-Health</a>
</div>
<!-- Collect the nav links, forms, and other content for toggling -->
<div class="collapse navbar-collapse" id="navbar-1">
<ul class="navnavbar-navnavbar-right">
<li class="page-scroll">
<a href="#page-top">Home</a>
</li>
<li class="page-scroll">
<a href="#recent_reading">Recent readings</a>
</li>
<li class="page-scroll">
```

```
<a href="#about">About Us</a>
</li>
<li class="page-scroll">
<a href="#contact">Contact Us</a>
</li>
</ul>
</div>
<!-- /.navbar-collapse -->
</div>
<!-- /.container-fluid -->
</nav>
<!-- Header -->
<header>
<div class="container">
<div class="row">
<div class="col-lg-12">
<img class="img-responsive" src="img/eHealth.png" alt="e-Health logo">
<div class="intro-text">
<span class="name">e-Health</span>
<hr class="star-light">
<span class="skills">Real time simulation - User friendly - Database management</span>
</div>
</div>
</div>
</div>
</header>
<!-- recent_reading Grid Section -->
<section id="recent_reading">
```

```
<div class="container">
<div class="row">
<div class="col-lg-12 text-center">
<h2>Recent readings</h2>
<hr class="star-primary">
</div>
</div>
<div class="row">
<div class="col-sm-4 recent_reading-item">
<a href="#recent_readingModal1" class="recent_reading-link" data-toggle="modal">
<div class="caption">
<div class="caption-content">
<i class="fa fa-search-plus fa-3x"></i>
</div>
</div>
<div id="ecg_outer" style="height: 190px"></div>
</a>
<br><p><h4 class="text-center lead">Electrocardiogram (ECG) Sensor</h4></p>
</div>
<div class="col-sm-4 recent_reading-item">
<a href="#recent_readingModal2" class="recent_reading-link" data-toggle="modal">
<div class="caption">
<div class="caption-content">
<i class="fa fa-search-plus fa-3x"></i>
</div>
</div>
<div id="temp_outer" style="height: 190px"></div>
```

```
</a>
<br><p><h4 class="text-center lead">Temperature Sensor</h4></p>
</div>
<div class="col-sm-4 recent_reading-item">
<a href="#recent_readingModal3" class="recent_reading-link" data-toggle="modal">
<div class="caption">
<div class="caption-content">
<i class="fa fa-search-plus fa-3x"></i>
</div>
</div>
<div id="af_outer" style="height: 190px"></div>
</a>
<br><p><h4 class="text-center lead">Airflow sensor</h4></p>
</div>
</div>
</div>
</section>
<!-- About Section -->
<section class="success" id="about">
<div class="container">
<div class="row">
<div class="col-lg-12 text-center">
<h2>About Us</h2>
<hr class="star-light">
</div>
</div>
<div class="row">
<div class="col-sm-4 recent_reading-item about-image">
```


<h4>Ali Raees</h4>Lead Designer

<imgsrc="img/about/ali.jpg" class="img-responsive img-circle" alt="Ali Raees">

<h4>Rida Tariq</h4>Graphic Designer

<imgsrc="img/about/rida.jpg" class="img-responsive img-circle" alt="Rida Tariq">

<h4>Rehan Shiraz</h4>Database Management

<imgsrc="img/about/rehan.jpg" class="img-responsive img-circle" alt="Rehan Shiraz">

</section>

<!-- Contact Section -->

<section id="contact">

<h2>Contact Us</h2>

<hr class="star-primary">

<!-- To configure the contact form email address, go to mail/contact_me.php and update the email address in the PHP file on line 19. -->

<!-- The form should work on most web servers, but if the form is not working you may need to configure your web server differently. -->

<form name="sentMessage" id="contactForm" novalidate>

<label>Name</label>

<input type="text" class="form-control" placeholder="Name" id="name" required data-validation-required-message="Please enter your name.">

<label>Email Address</label>

<input type="email" class="form-control" placeholder="Email Address" id="email" required data-validation-required-message="Please enter your email address.">

<label>Message</label>

<textarea rows="5" class="form-control" placeholder="Message" id="message" required data-validation-required-message="Please enter a message."></textarea>

<button type="submit" class="btnbtn-primary btn-lgbtn-block">Send</button>

</form>

```
</div>
</div>
</div>
</section>
<!-- Footer -->
<footer class="text-center">
<div class="footer-above">
<div class="container">
<div class="row">
<div class="footer-col col-sm-4">
<h3>Locate Us</h3>
<script src="https://maps.googleapis.com/maps/api/js?v=3.exp"></script>
<script src="js/location.js"></script>
<p id="map-canvas"></p>
</div>
<div class="footer-col col-sm-4">
<h3>Follow us</h3>
<ul class="list-inline text-center">
<li>
<a href="www.facebook.com" class="btn-social btn-outline"><i class="fa fa-fw fa-facebook"></i></a>
</li>
<li>
<a href="www.googleplus.com" class="btn-social btn-outline"><i class="fa fa-fw fa-google-plus"></i></a>
</li>
<li>
<a href="www.twitter.com" class="btn-social btn-outline"><i class="fa fa-fw fa-twitter"></i></a>
```

```
</li>
</ul>
</div>
<div class="footer-col col-sm-4">
<h3>About e-Health</h3>
<p>Made with <i class="fa fa-heart"></i> by :<br><br><span class="text-primary">Ali Raees | Rida Tariq | Rehan Shiraz</span></p>
</div>
</div>
</div>
</div>
<div class="footer-below">
<div class="container">
<div class="row">
<div class="col-lg-12">
<span class="text-success">Copyright &copy; E-Health 2014</span>
</div>
</div>
</div>
</div>
</footer>
<!-- Scroll to top button -->
<div class="scroll-top page-scroll">
<a class="btnbtn-success" href="#page-top">
<i class="fa fa-chevron-up"></i>
</a>
</div>
<!-- Recent reading Modals -->
<!-- For ECG sensor -->
```

<h3>ELECTRO CARDIOGRAM (ECG) SENSOR</h3>

<hr class="star-primary">

<ul class="list-inline item-details">

Date:

Time:

<button type="button" class="btnbtn-success btn-block" data-dismiss="modal"> CLOSE</button>

<!-- For Temperature sensor -->

<h3>TEMPERATURE SENSOR</h3>

<hr class="star-primary">

<ul class="list-inline item-details">

Date:

Time:

<button type="button" class="btnbtn-success btn-block" data-dismiss="modal"> CLOSE</button>

```
<!-- For Airflow sensor -->
<div class="recent_reading-modal modal fade" id="recent_readingModal3" tabindex="-1" role="dialog" aria-hidden="true">
<div class="modal-content">
<div class="close-modal" data-dismiss="modal">
<div class="lr">
<div class="rl">
</div>
</div>
</div>
<div class="container">
<div class="row">
<div class="col-lg-8 col-lg-offset-2">
<div class="modal-body">
<h3>AIRFLOW SENSOR</h3>
<hr class="star-primary">
<div id="af_inner"></div>
<p></p>
<ul class="list-inline item-details">
<li>Date: <strong><span class="cur_date"></span></a></strong></li>
<li>Time: <strong><span class="cur_time"></span></a></strong></li>
</ul>
<button type="button" class="btnbtn-success btn-block" data-dismiss="modal"><i class="fa fa-times"></i> CLOSE</button>
</div>
</div>
</div>
</div>
</div>
```

```
</div>

<!-- For about us modals -->

<!-- For Ali Raees -->
<div class="recent_reading-modal modal fade" id="recent_readingModal5" tabindex="-1" role="dialog" aria-hidden="true">
<div class="modal-content">
<div class="close-modal" data-dismiss="modal">
<div class="lr">
<div class="rl">
</div>
</div>
</div>
<div class="container">
<div class="row">
<div class="col-lg-8 col-lg-offset-2">
<div class="modal-body">
<h3>Ali Raees</h3>
<hr class="star-primary">
<h3>Lead Designer</h3>
<imgsrc="img/about/ali.jpg" class="img-responsive img-centered" alt="">
<p></p>
<ul class="list-inline item-details">
<li>Date: <strong><span class="cur_date"></span></a></strong></li>
<li>Time: <strong><span class="cur_time"></span></a></strong></li>
</ul>
<button type="button" class="btnbtn-success btn-block" data-dismiss="modal"><i class="fa fa-times"></i> CLOSE</button>
</div>
</div>
```

```
</div>
</div>
</div>
</div>
<!-- For Rida Tariq -->
<div class="recent_reading-modal modal fade" id="recent_readingModal6" tabindex="-1" role="dialog" aria-hidden="true">
<div class="modal-content">
<div class="close-modal" data-dismiss="modal">
<div class="lr">
<div class="rl">
</div>
</div>
</div>
<div class="container">
<div class="row">
<div class="col-lg-8 col-lg-offset-2">
<div class="modal-body">
<h3>Rida Tariq</h3>
<hr class="star-primary">
<h3>Graphic Designer</h3>
<imgsrc="img/about/rida.jpg" class="img-responsive img-centered" alt="">
<p></p>
<ul class="list-inline item-details">
<li>Date:<strong><span class="cur_date"></span></a></strong></li>
<li>Time:<strong><span class="cur_time"></span></a></strong></li>
</ul>
<button type="button" class="btnbtn-success btn-block" data-dismiss="modal"><i class="fa fa-times"></i> CLOSE</button>
```

```
</div>
</div>
</div>
</div>
</div>
</div>
<!-- For Rehan Shiraz -->
<div class="recent_reading-modal modal fade" id="recent_readingModal7" tabindex="-1" role="dialog" aria-hidden="true">
<div class="modal-content">
<div class="close-modal" data-dismiss="modal">
<div class="lr">
<div class="rl">
</div>
</div>
</div>
<div class="container">
<div class="row">
<div class="col-lg-8 col-lg-offset-2">
<div class="modal-body">
<h3>Rehan Shiraz</h3>
<hr class="star-primary">
<h3>Database Management</h3>
<imgsrc="img/about/rehan.jpg" class="img-responsive img-centered" alt="">
<p></p>
<ul class="list-inline item-details">
<li>Date: <strong><span class="cur_date"></span></a></strong></li>
<li>Time: <strong><span class="cur_time"></span></a></strong></li>
</ul>
```

```
<button type="button" class="btnbtn-success btn-block" data-dismiss="modal"><i class="fa fa-times"></i> CLOSE</button>
</div>
</div>
</div>
</div>
</div>
</div>
<!-- jQuery Version 1.11.0 -->
<script src="js/jquery-1.11.0.js"></script>
<!-- Bootstrap Core JavaScript -->
<script src="js/bootstrap.min.js"></script>
<!-- Plugin JavaScript -->
<script src="http://cdnjs.cloudflare.com/ajax/libs/jquery-easing/1.3/jquery.easing.min.js"></script>
<script src="js/classie.js"></script>
<script src="js/cbpAnimatedHeader.js"></script>
<!-- Contact Form JavaScript -->
<script src="js/jqBootstrapValidation.js"></script>
<script src="js/contact_me.js"></script>
<!-- Custom JavaScript -->
<script src="js/main.js"></script>
</body>
</html>
```

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