PATIENT'S HEART BEAT AND TEMPERATURE MONITORING SYSTEM

BY

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17/A/BEE/0521/G/F

AN ENGINEERING PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, TECHNOLOGY, APPLIED DESIGN AND FINE ART KABALE UNIVERSITY (KAB) IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE BACHELOR DEGREE OF ENGINEERING IN ELECTRICAL ENGINEERING DEPARTMENT

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1.

PATIENT'S HEART BEAT AND TEMPERATURE MONITORING SYSTEM

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For The Degree of

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In

Electrical Engineering Department

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APPROVAL

This dissertation entitled "Patient's heart beat and temperature monitoring system" by MBABAZI **CALEB** meets the regulations governing the awarding of Bachelor of Electrical Engineering at Kabale University.

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ABSTRACT

Health related issues and parameters are of utmost importance to man, and it is essential to man's existence and influence and thus there is a need for an improved system that would be able to capture and monitor the changes in health parameters irrespective of time and location so as to provide for measures that will detect abnormalities and cater for emergencies. This work presents a system that is capable of providing real time remote monitoring of the heartbeat with the help of an alarm and SMS alert. This project aims at the design and implementation of a low cost but efficient and flexible heartbeat monitoring and alert system using GSM technology. It is designed in such a way that the heartbeat/pulse rate is sensed and measured by the sensors which sends the signals to the control unit for proper processing and determination of the heartbeat rate which is displayed on an LCD. It also triggered an alarm and send SMS to a mobile phone of medical expert or health personnel, if the threshold value of the heartbeat rate is exceeded. Thus this system proposed a continuous, real-time, remote monitoring of the heartbeat rate of a patient for diagnosis and early preventive treatment of cardiovascular ailments.

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LIST OF ABBREVIATION

CVD	Cardiovascular Disease
DB	Database
DC	Direct Current
ECG	Electrocardiogram
GND	Ground
GPS	Global Positioning System
GUI	Graphical User Interface
HR	Heart Rate
IBI	Inter-Beats Interval
IC IDE	Integrated Circuit
LED	Integrated Development Environment
MCU	Light Emitting Diode Microcontroller
OS	Unit
PCB	Operating System
PIO	Printed Circuit Board Programmable
PPG	Input/ Output Line
SMS	Photoplethysmogram
SPP	Short Message Service
UART	Serial Port Protocol
USB	Universal Asynchronous Receiver-Transmitter
WHO	Universal Serial Bus
	World Health Organization

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1.4 Significance of the project

This project is significant in the following ways

- Doctors can be able to monitor patients' health from their homes without going to the hospitals.
- It saves time as one doctor can monitor a number of patients within a shortest possible. time.
- It enables patients to know their health status.

1.5 Motivation

Cardiovascular disease is one of the main causes of death in many countries, it accounted for over 15 million deaths worldwide. In addition, several million people are disabled by cardiovascular disease. The delay between the first symptom of any cardiac ailment and the call for medical assistance **bas a** large variation among different patients and can have fatal consequences. One critical inference drawn from epidemiological data is that deployment of resources for early detection and treatment of heart disease has a higher potential of reducing fatality associated with cardiac disease than improved care after hospitalization. Hence new strategies are needed in order to reduce time before treatment. Monitoring of patients is one possible solution. This project can be used in hospitals (Calling Ambulance.) and also for patients who can be under continues monitoring while traveling from place to place (using heart rate band).

1.6 Project Outline

This project report is structured into five different chapters as follows;

Chapter l: In this chapter, a general background on the research is provided. Additionally, the project problem statement, aim and objectives, and project outline are described in this chapter.

Chapter 2: This chapter gives a background and literature review on the different components used in this project report

Chapter 3: This chapter provides a list of general materials and equipment used in designing and implementing the whole project.

9.

Chapter 4: This chapter provide the result and discussion of the designed system.

Chapter 5: Finally, this chapter summarizes the conclusion drawn from the project and provides some recommendations for future **work.**

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CHAPTER TWO

LITERATURE REVIEW

2.1. Overview

Vital signs derive its significance from the fact that they can be considered as an indication of the person's health. Any change in the measurements of these signs indicates an abnormality in the physical condition of the patient. A considerable number of medical conditions can be detected from variations in one or more of the vital sign. The specialized devices for measuring the vital signs are not portable and can't be found anywhere. Hence, in this thesis, the concept of using an arm band (potable heart rate monitor) and mobile phone as a diagnosing tool [1]. There are four vital signs which are standard in most medical settings:

11.Pulse rate.

12.Respiratory rate.

13.Blood pressure.

14.Body temperature.

2.2. **Heart**

The heart is the main organ within the human body, which responsible for pumping blood throughout the body. It is located in the middle of the thorax, slightly offset to the left and surrounded by the lungs. The heart is made up of two separate pumps: a right heart that pumps blood through the lungs, and a left heart that pumps blood through the peripheral organs. At the same time, each of these hearts is a pulsatile two chamber pump composed of an atrium and a ventricle. Each atrium is a pump helps in moving blood into the ventricle. Then the ventricles supply the main pumping force that propels the blood either through the pulmonary circulation by the right ventric1e or through the periphera1 circulation by the left ventric1e. That blood passes through the right ventric1e and is pumped to the lungs where it is oxygenated and goes back to the heart through the left atrium, and then the blood passes through the left ventricle and is pumped again to be distributed to the entire body through. The heart also consists of three major types of cardiac muscle: atrial muscle, ventricular muscle, and specialized excitatory and conductive

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muscle fibers. The atrial and ventricular types of differ from the specialized excitatory muscles in the method of contraction. The latter muscles exhibit either automatic rhythmical electrical discharge or conduction of the action potentials through the heart, providing an excitatory system that controls the rhythmical beating of the heart. The cardiac events that occur from the beginning of one heartbeat to the beginning of the next are called the cardiac cycle [2], [3], [4].

2.2.1 ***Heart Rate***

HR is the rate at which the heart beats and affected by the expansion of the arterial wall with every beat. The most prominent areas for the pulses are wrist (Radial artery), neck (Carotid artery), inside of the elbow (Brachial artery), behind the knee (Popliteal artery) and ankle joint (Posterior artery). The HR changes according to age and the physical and psycho1ogica1 impacts on the body. Higher pulse rate indicates the presence of abnormality in the body which can also be caused by other reasons such as anxiety, anger, excitement, emotion, and heart disorders. The pulse rate of an individual can help in determining various problems within the body, but it cannot be used lone to diagnose an abnormality [5]. The average heart rate is about 72 bpm for sedentary males and 80 bpm for sedentary females but these rates are often significantly different for trained athletes.

Table 1. The variation of People's age with their heart beat rate and the breathing rate

Age	Heart Rate **(BPM)**	Respiratory (Breathes/ min)
0-5 months	90-150	*25-40*
6-12 months	80- 140	20-30
1-3 years	80-130	20-30
3-5 years	80-120	20-30
6-10 years	70-110	15-30
11-14 years	60-105	12-20
14+ years	60-100	12-20

2.2.2 Effect of Temperature on Heart Function:

Variations in body temperature can cause a greatly variations in heart rate in a proportional relationship. Decreased temperature can cause the HR to fa]l as low as a few beats per minute when a person is near death when the body temperature ranges of 60° to 70F. These effects assure the fact that heat increases the permeability of the cardiac muscle membrane to ions that control heart rate, resulting in acceleration of the self-excitation process.

2.2.3 Heart Rate Measurements Methods:

There are several methods to measure the heart rate, the most used methods:

- **Radial:**

It is taking the Pulse on the Wrist. By holding the palm of the right hand facing upwards, placing the tips of the middle three fingers from the left hand on the wrist joint and count the number of beats for six seconds. If we multiplied this number by ten it gives the BPM.

- Carotid:

It is taking the pulse on the Throat. By placing two fingers (first and second) lightly on the side of the throat just below the angle of the jaw. A pulse would be felt from the jugular vein. Count the number of beats for six seconds. Multiplying this number by ten will give the BPM.

- **Heart Rate Monitors:**

Many heart monitoring devices ensure a more accurate measure of heart rate than manual methods. In most physical training situations, they are the preferred method. These devices advantages:

1. Far more accurate than finger tests.
2. Give continuous and real-time readings that can be viewed via digital display.
3. When the heart rate is measured a simple formula can be used to work out whether the individual is training at the right intensity: 220 - Age = Maximum Heart Rate.
4. Small and lightweight to carry. Some can be programmed to sound an alarm or warning when set heart rate ranges are breached [5]

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2.3. Electrocardiograph:

E1ectrica1 current flows from the heart and a small fraction of it makes it way to the body surface as the cardiac impulse go through the heart. Electrocardiograph or ECG for short detects and records these electrical signals that are responsible for pumping blood by the heart all around the body. A normal electrocardiogram is shown in Figure 1.

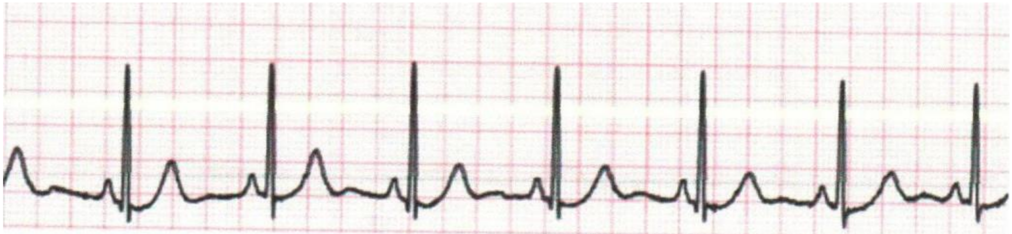

Figure 1: A graph describing Normal Electrocardiograph

ECG is an indication of the patient's heart health by recording the electrical activity to be read by specialized doctors which able to extract vital signs from it. Hence, HR can be calculated from ECG [6].

2.4 Photoplethysmograph:

The PPG is a low-cost and portable technique that for measuring blood volume changes by collecting the variations in reflected or transmitted light. The blood pressure, blood oxygen saturation, HR, cardiac output recently and information of the cardiovascular system can be supplied with this technique.
PPG experiences developments continuously, some researchers have used digital cameras and others a smart phone to detect HR by PPG technique. However, overcoming the motion artifact is a huge challenge for PPG as it is sensitive it. Adaptive noise cancellation (ANC), which uses accelerometers as a noise reference, is proposed in order to help in reducing the affection of motion artifact [6].

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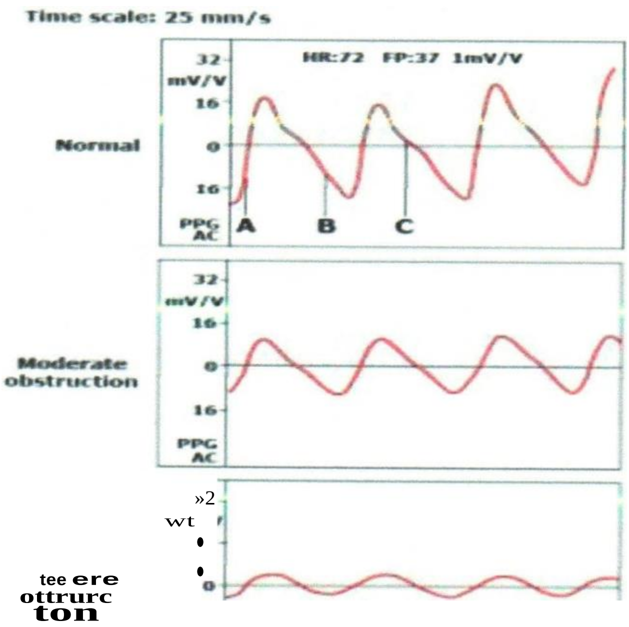

Figure 2: A graph describing Photoplethysmograph of different Conditions

2.5 Heart Attack

Cardiovascular diseases (CVDs) are disorders of the heart and blood vessels which they include:

1. Coronary heart disease which is a disease of the blood vessels supplying the heart muscle;
2. Cerebrovascular disease which is a disease of the blood vessels supplying the brain;
3. Peripheral arterial disease which is a disease of blood vessels supplying the arms and legs;
4. Rheumatic heart disease which is a damage to the heart muscle and heart valves from rheumatic fever, caused by streptococcal bacteria;
5. Congenital heart disease which is malformations of heart structure existing at birth;
6. Deep vein thrombosis and pulmonary embolism which is blood clots in the leg veins, which can dislodge and move to the heart and lungs.

Heart attacks and strokes are usually acute events and are mainly caused by a blockage that prevents blood from flowing to the heart or brain. The most common reason for this is a build-up of fatty deposits on the inner walls of the blood vessels that supply the heart or brain. Strokes can also be caused by bleeding from a blood vessel in the brain or from blood clots. The cause of heart attacks and strokes are usually the presence of a combination of risk factors, such as tobacco use, unhealthy diet and obesity, physical inactivity and harmful use of alcohol, hypertension, diabetes and hyperlipidemias. The most important behavioral risk factors of heart disease are unhealthy diet, physical inactivity, tobacco use and harmful use of alcohol. These risks affect raised blood pressure, raised blood glucose, raised blood lipids, and overweight and obesity.

2.5.1 Symptoms of Heart Attacks

Often, there are no symptoms of the underlying disease of the blood vessels. A heart attack or stroke may be the first warning of underlying disease. Symptoms of a heart attack include:

1. Pain or discomfort in the center of the chest;
2. Pain or discomfort in the arms, the left shoulder, elbows, jaw, or back.

In addition, the person may experience difficulty in breathing or shortness of breath; feeling sick or vomiting; feeling light-headed or faint; breaking into a cold sweat; and becoming pale. Women are more likely to have shortness of breath, nausea, vomiting, and back or jaw pain.

The most common symptom of a stroke is sudden weakness of the face, arm, or leg, most often on one side of the body.

Rheumatic heart disease is caused by damage to the heart valves and heart muscle from the inflammation and scarring caused by rheumatic fever. Rheumatic fever is caused by an abnormal response of the body to infection with streptococcal bacteria, which usually begins as a sore throat or tonsillitis in children. Rheumatic fever mostly affects children in developing countries, especially where poverty is widespread. Globally, about 2% of deaths from cardiovascular diseases is related to rheumatic heart disease.

At least three quarters of the world's deaths from CVDs occur in low-and middle-income countries. That is due to people in these countries often does not have the benefit of integrated primary health care programs for early detection and treatment compared with high-income countries.

People in low- and middle-income countries who suffer from CVDs have less access to effective and equitable health care services which respond to their needs. As a result, many people are detected late in the course of the disease and die younger from CVDs.

At macro-economic level, CVDs place a heavy burden on the economies of low-and middle income countries.

To reduce the burden of CVD in low-income implemented even in low-resource settings have been identified by WHO for prevention and control of cardiovascular diseases. They include two types

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of interventions: population-wide and individual. According to WHO, population-wide interventions that can be implemented to reduce CVDs include:

1. **Comprehensive tobacco control policies**
2. **Taxation to reduce the intake of foods that are high in fat, sugar and salt**
3. Building walking and cycle paths to increase physical activity
4. Strategies to reduce harmful use of alcohol
5. Providing healthy school meals to children.

At the individual level, for prevention of first heart attacks and strokes, individual health-care interventions need to be targeted to those at high total cardiovascular risk or those with single risk factor levels above traditional thresholds, such as hypertension and hypercholesterolemia. The former approach is more cost-effective than the latter and has the potential to substantially reduce cardiovascular events. This approach is feasible in primary care in low-resource settings, including by non-physician health workers [7], [8].

2.6 Theory of major components used in the system

2.6.1 Arduino Microcontroller

Arduino is open Source electronic prototyping platform based on flexible easy to use hardware and software. It is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel A VR microcontroller, or a 32-bit Atmel ARM.

The software consists of a standard programming language compiler and a boot loader that executes on the microcontroJler.

2.6.1.1 Arduino Hardware

The Arduino board is a small-form microcontroJler circuit board. At the time ofthis writing, a number of Arduino boards exist.

- Arduino Uno
- Arduino Leonardo

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- Arduino Lily Pad
- Arduino Mega
- Arduino Nano
- Arduino Mini
- Arduino Mini Pro
- ArduinoBT

The figure below shows the Arduino Uno development board

Figure 3: Arduino Hardware

2.6.1.2 Arduino Software

Arduino microcontrollers are programmed using the Arduino IDE (Integrated Development Environment) Arduino programs, called "sketches", are written in a programming language similar to C and C++.

Every sketch must have a setup () function (executed just once) followed by a loop () function (potentially executed many times) as shown in the figure 5 below; add "comments" to code to make it easier to read. Many sensors and other hardware devices come with prewritten software line for sample code, libraries (of functions).

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Libraries are a collection of code that makes it easy for you to connect to a sensor, display, module, etc.For example, the built-in Liquid Crystal library makes it easy to talk to character LCD displays. There are hundreds of additional libraries available on the Internet for down

For this system, Arduino Nano will be used as the system microcontroller

2.6.2 Global System for Mobile communications ***(GSM)***

GSM (Global System for Mobile Communications), is a standard developed by the European Telecommunications Standards Institute.

It was created to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones and is now the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories [9]. GSM supports voice calls and data transfer speeds of up to 9. 6 kbps, together with the transmission of SMS (Short Message Service).

A GSM modem is a special type of modem that accepts a SIM card and operates over a subscription to a mobile operator just like as a mobile phone. GSM modem is a wireless modem which sends and receives data through radio waves. A GSM modem requires a SIM card from a wireless carrier in order to operate Just like as a GSM mobile phone. GSM modem support standard AT commands as well as extended set of AT commands.

With the standard AT commands and extended AT commands, you can do things like:

- Sending SMS message
- Reading, Writing and Deleting SMS massage
- Monitoring the signal strength
- Reading Writing and Searching phonebook entries
- Real time clock

GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz and 850MHz bands in the US. GSM services are also transmitted via 850MHz spectrum in Australia, Canada and many Latin American countries. The use of harmonized spectrum across most of the globe, combined with GSMs international roaming capability, allows travelers to access the same mobile services at home and abroad. GSM enables individuals to be reached via the same mobile number in up to

219 countries. Terrestrial GSM networks now cover more than 90% of the world's population. GSM satellite roaming has also extended service access to areas where terrestrial coverage is not available.

2.6.2.1 GSM Features

Quad Band GSM/GPRS: 850 / 900 / 1800 / 1900 MHz

Built in RS232 to TTL or vice versa Logic Converter (MAX232)

Configurable Baud Rate

SMA (Sub Miniature Version A) connector with GSM L Type Antenna

Built in SIM (Subscriber Identity Module) Card holder

Built in Network Status LED

Inbuilt Powerful TCP / IP (Transfer Control Protocol / Internet Protocol) stack for internet data transfer through GPRS (General Packet Radio Service)

Audio Interface Connectors (Audio in and Audio out)

Most Status and controlling pins are available

Normal Operation Temperature: -20 °C to +55 %C

Input Voltage: 5V to 12VDC

LDB9 connector (Serial Port) provided for easy interfacing.

2. 6.3 The Pulse sensor

Pulse Sensor is a well-designed plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heartrate data into their projects.

The sensor clips onto a fingertip or earlobe and plugs right into Arduino with some jumper cables. It also includes an open-source monitoring app that graphs your pulse in real time.

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Figure 4: The pulse sensor circuit •

The Pulse Sensor Kit includes

l) A 24-inch Color-Coded Cable, with (male) header connectors. You'll find this makes it easy to embed the sensor into your project, and connect to an Arduino. No soldering is required.

2) An Ear Clip, perfectly sized to the sensor. We searched many places to find just the right clip. It can be hot glued to the back of the sensor and easily worn on the earlobe.

3) 2 Velcro Dots. These are 'hook' side and are also perfectly sized to the sensor. You'll find these velcro dots very useful if you want to make a velcro (or fabric) strap to wrap around a fingertip.

2) 3 Transparent Stickers. These are used on the front of the Pulse Sensor to protect it from oily fingers and sweaty earlobes.

2) The Pulse Sensor has 3 holes around the outside edge which make it easy to sew it into almost anything. Let's get started with Pulse Sensor Anatomy

The Pulse Sensor is an exposed circuit board, and if you touch the solder points, you could short the board, or introduce unwanted signal noise.

The back of the Pulse Sensor has even more exposed contacts than the front, so you need to make sure that you don't let it touch anything conductive or wet. The easiest and quickest way to protect the back side from undesirable shorts or noise is to simply stick a velcro dot there for now.

The dot will keep your parts away from the Pulse Sensor parts enough for you to get a good feel for the sensor and decide how you want to mount it You'll find that the velcro dot comes off easily, and stores back on the little strip of plastic next to the other one. Notice that the electrical connections are still exposed! We only recommend this as a temporary setup so you can get started.

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CHAPTER THREE

METHODOLOGY

3.1. Overview

The project design is considered the most important stage in the development process of each projects, hence this step takes considerable time of the overall project lifecycle. In this chapter the high level design followed by the detailed design of the project is being the center of attention for detailed discussion. Both hardware and software designs are being discussed here intensively, describing their components, algorithms and their circuit diagrams. As well as specifying the detailed functions of the project's units and interfaces implemented between them.

3.2 Components used

1. Pulse sensor
2. Temperature sensor
3. Microcontroller (Arduino Nano)
4. Buzzer
5. GSMmodule
6. Liquid crystal display (LCD) (162)

3.2.1 Pulse sensor

It is an Open Source heart rate monitor which considered as a PPG device used to monitor the noninvasive heart rate. It measures the real-time heart beats and calculates BPM with the aid of algorithms implemented by Arduino.

This sensor has two sides, the front one which has a heart shape is the side to be attached to the skin. The pins of the pulse sensors are three as shown in Figure 3.4 below.

If the frond side is facing you, then the most left pin is the GND while the middle one is the input voltage which will be connected to the +5v of the Arduino. The last one for outputting the electrical and will be wired with the analog bins of the Arduino.

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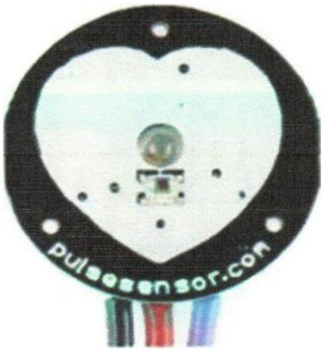

Figure 5: Pulse sensor

The Pulse sensor converts the physical PPG into electrical signals. The sensor outputs a raw signal of analog voltage fluctuations amplifies it and normalize the wave at V /2. With every beat of the heart, a pulse wave travel along all arteries to the tissues where the Pulse Sensor is attached. When this pulse wave goes under the sensor, the signal experiences a rapid upward rise in its value. It falls back down toward the normal point and before the next pulse sensor goes under the sensor, the signal stabilizes to the ambient noise.

Due to the repetitive characteristic of the pulse wave, the peak is chosen as a reference point because it's recognizable. By applying calculation algorithm on the time between each two successive peaks the heart rate is measured. Ideally we want to find the instantaneous moment of the heart beat for accurate measurements.

According to heart researchers, the instantaneous moment is when the signal gets *25%* or 50% of its amplitude. This pulse sensor first measures the IBI when the signal gets 50% of the amplitude, which from the BPM is derived from average of 10 IBI times. [9]

This is implemented by interfacing the pulse sensor with the Arduino board as shown in Figure

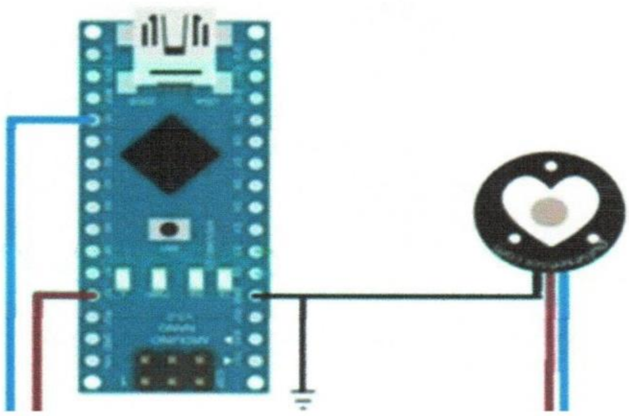

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Figure 6: Interface between Pulse sensor and MCU [l O]

3.2.2 Temperature sensor

This is considered as a solid state sensor. The precision integrated-circuit temperature sensor output a voltage linearly proportional to the centigrade temperature. With LM35, temperature is measured more accurately than using a thermistor.

For accurate readings, the sensor's package required to be in contact directly with the patient arm tissues along with the Pulse Sensor. It comes as a molded package or plastic package which is used in this project. It has many features, some of them are:

1. Guarantee accuracy at +25 C.
2. Wide range (-55 to + 150 C).
3. Suitable for use for remote applications.
4. **Operation voltage from 4 to 30 volts.**
5. Low self-heating and output's impedance.

As the pulse sensor, LM35 three has three pins except that the left pin is for the input voltage, while the middle one output the signal. Therefore, the pin on the right is the GND.

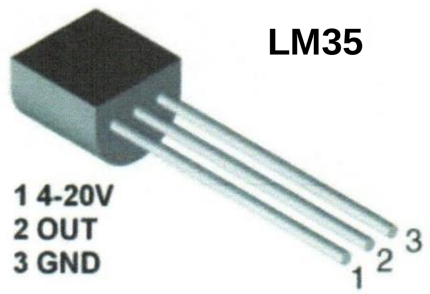

Figure 7: LM 35 Temperature Sensor [11]

To output the measured temperature, we use an Arduino. The interface between the LM35 and Nano Arduino is explained in the fo11owing Figure 3.3.

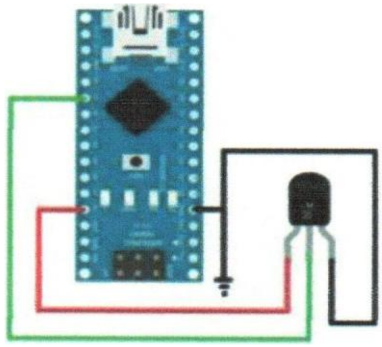

Figure 8: Interface between LM35 and MCU [12]

3.2.3 Microcontroller (Arduino Nano)

In this project, the microcontroller chosen is a Nano Arduino board which is based on ATMEGA328 controller.

Nano Arduino is a small and complete board with the same functionality of Adruino Duemilanove just in different package. The only difference is that Nano Arduino doesn't have a power jack instead it works with Mini-B USB. It fits perfectly for this project as it's easy to use as well as it provides mobility feature due to its suitable size for a wearable device.

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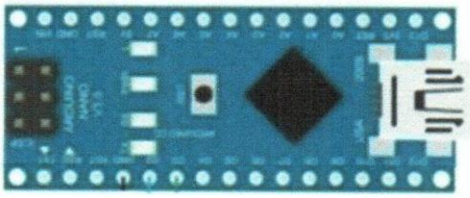

Figure 9: Nano Arduino **[13]**

3.2.4 Alarm Unit:

This unit is composed of a 5v DC buzzer which will peep if the heart rate increased or went below the specified threshold The values of the threshold are 150 for maximum HR and 30 for the minimum. Buzzer 5v DC: Buzzer is an audio signaling device that has many applications includes timers and alarm devices. Many types of buzzers are available mainly they are electromechanical, mechanical and electrical buzzers.

Figure 10: Buzzer

Buzzer important features are:

1. Operation power (3-6 DC)
2. No electrical noise
3. Low consumption of current.

3.2.4 ***GSM Module***

This is a GSM modem and it connects wirelessly to the GSM network. GSM Click is an addon board in micro BUST form factor which is a perfect solution for adding GSM/GPRS communication layer to your device. It is interfaced to the Arduino Microcontroller and whatever information that is received or transmitted by the Arduino passes through the GSM modem to or from the GSM network. The GSM modem features the Quetctel M95 FA

29.

GSM/GPRS module which supports GSM850MHz, GSM900MHz, DCS 1800MHz or PCS1900MHz quad band frequencies with 85.6kbps GPRS data transfer. The board contains an SMA antenna connector, quadruple audio/microphone jack and as well as the SIM card socket The GSM? click modem communicates with the target microcontroller via seven micro BUS lines (RX, TX, INT, PWM, CS, RST and AN). The board is powered by 5V or 3.3V power supply and 1/0 voltage levels. LEDs indicate the presence of power supply.

Applications

GSM Click™ with its Telit GL865-QUAD IC is ideal for mobile devices. **Key features**

1. **Supports GSM/GPRS protocol stack 3GPP.**
2. Supports GSM/GPRS 850/900/1800/ 1900MHz Quad-band frequency.
3. On-board antenna connector as well as 3.5mm quadruple earphone/microphone jack

4.SIM card socket integrated at the bottom side of the board **Key Benefits**

The GSM click 2 modem was chosen for this project because the GSM mode of communication is a mature system which is now being used all over the world.

The other reasons for choosing the GSM click modem are listed below:

mikroBUSTM form factor enables easy integration and supported in all mikro Elektronika compilers. Ready-to-use examples save development time and Very compact design and affordable price.

Figure 11: GSM Module SIM 800A

30.

3.2.5 Liquid Crystal Display (LCD) (162)

It is an electronic display system. The liquid crystal display (LCD) has become the display device of choice for microcontrollers. An LCD features low power, full ASCII character displays of one to four lines, from 16 to 40 characters per line and low cost. A 16*2 LCD is a 16 column and 2- row LCD. It means it can display 16 characters per line and 2 such lines are available. The advantages of LCD's are that, they are economical, easily programmable, display a number of characters, compact, light and have low power consumption.

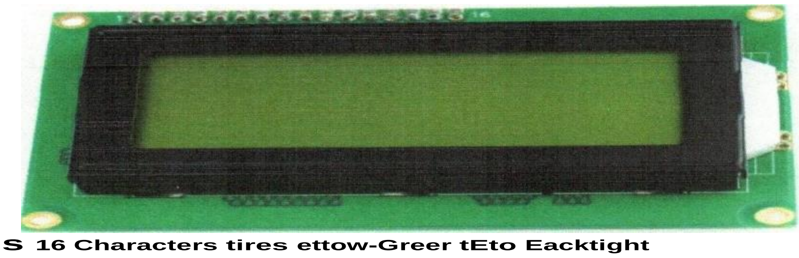

Figure 12: LCD

3.2.5.1 LCD pin connection

The figure below shows an LCD screen and its pinouts and the table that follows indicates how these pins are connected to the Arduino Nono

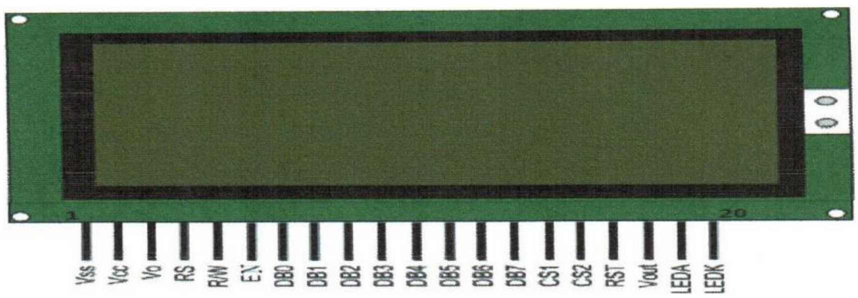

Figure 13: LCD pinouts

31.

Table 2: Arduino Nano pinout

Interface Pin Connections

Pein No.	Symbol	Level	Description
1	VSS	OV	Ground
2	VOD	5.0V	**Supply voltage** for logic
3	VO	_	Input voltage for LCD
4	RS	H/L	H : Oa1a signal, L: Instruction signal
5	R/W	H/L	H : Read mode, L : Write mode
6	E	H, H»»L	Chip enable signal
7	DBO	H/	Data bit 0
8	DB1	HIL	Data bit 1
9	082	H/	Data bit 2
10	3	H/L	Data bit 3
11	DB4	H/L	Data bit 4
12	DBS	H/L	Data bit 5
13	**086**	**H/L**	**Data bit 6**
14	**DB7**	**HIL**	**DOata bit 7**
15	**CS1**	**H**	**Chip select signal for KS0108(1)**
16	**CS2**	**H**	**Chip select signal for KS0108B(2)**
17	**RSTB**	**L**	**Reset signal**
18	**VOUT**	**-5v**	**Output voltage for LCD**
19	**SLA**	**4.2v**	**Sidelightanode**
20	**SU<**	**0V**	**Sidelight cathode**

8-Data pins carry 8-bit data or command from an external unit such as microcontroller. There are two registers in every LCD.

(i) Command Register (ii) Data Register Command Register

When we send commands to LCD these commands go to Command register and are processed there.' When RS=O Command Register is Selected.

Data Register

When we send Data to LCD it goes to data register and is processed there. When S=lData Register is selected.

EN (Enable Signal)

When you select the register (Command and Data) and set RW (read - write) now it is time to execute the instruction. The instruction can be the 8-bit data or 8-bit command present on Datalines of LCD. This requires an extra voltage push to execute the instruction and EN (enable) signal is used for this purpose. Usually EN=O and when we want to execute the instruction we make it high EN=l for some milliseconds. After this we again make it zero (low) EN= 0

3.3 Block diagram

Below is the block diagram of the system. It consists of 8 blocks which include Arduino Nano which controls the activities done by the system, a pulse sensor which measures the heartbeat, Temperature sensor that measures the temperature of the person, the GSM module which will send sms to the mobile phone, the LCD that displays the message taking place in the system and the Buzzer-that gives alarm. The system is interconnected as shown in the figure below.

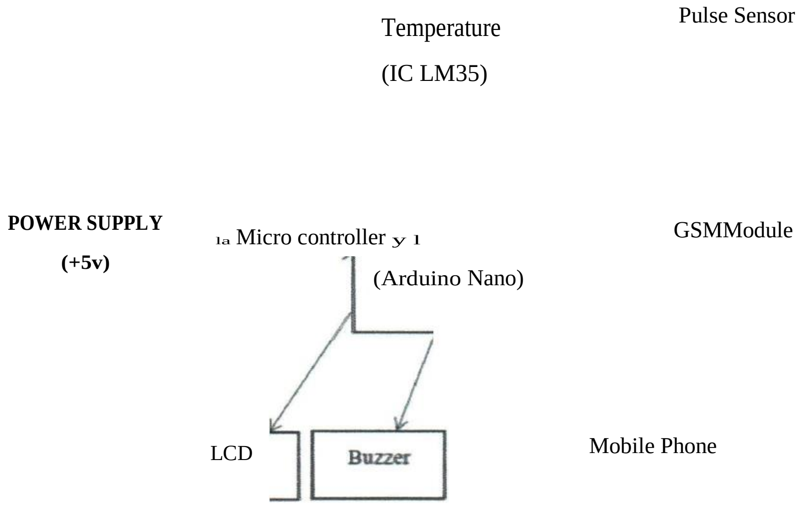

Figure 14: Block diagram of the system

3. 4 Power Supply

Always, the available power supply is 240 volts and my system needs less voltage than this and that's the need for designing the appropriate power supply

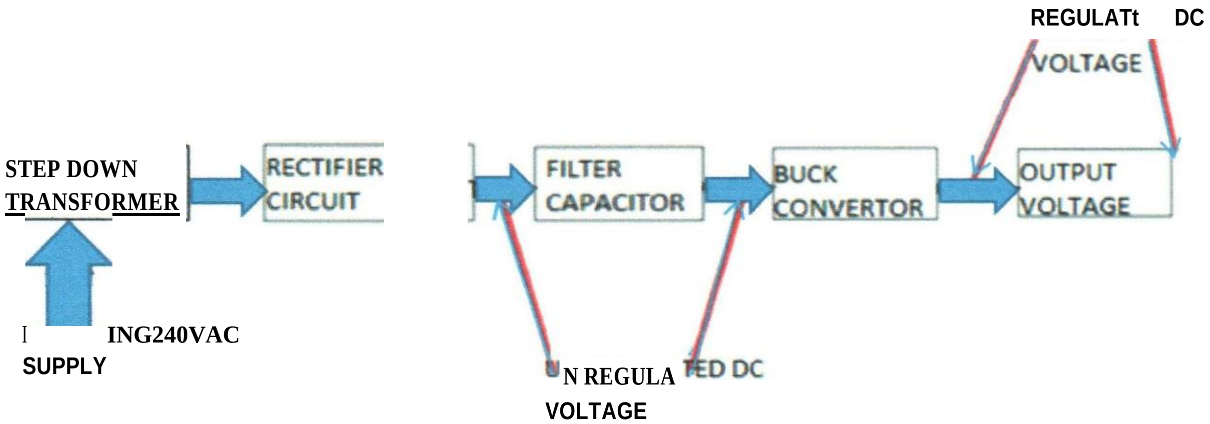

Figure 15: Block diagram of 5v power supply

It has the following Four main Blocks:-

1. The Transformer
2. The Rectifier Circuit
3. The Filter
4. The Buck Convertor

In brief, the transformer is used for stepping down the voltage from; the rectifier circuit is for changing the rectified Ac voltage to De; the filter is for filtering out the ripples since the rectified output is Pulsating De and the regulator is to give us the constant 5Vdc.

Steps to Design

1. Selection of the Regulator
IL The Selection of the transformer
m. Selection of the Diodes for the Bridge
1v. Selection of the filtering Capacitor.

3.4.1 Selection of the regulator

The selection of the Regulator depends on the output voltage. In this case, the output voltage being designed for is 5 V, therefore a selected regulator should be able to output *5* V. The linear Regulator that would be selected is LM7805 linear regulator IC.

On a Linear regulator, the first digit shows the minimum input voltage to the regulator while the last digit shows the output voltage. So on LM7805, the minimum voltage is 7 V AC and the output **voltage** is *5* **VDC.**

But because the linear regulators have heating problems and limited to one output, a buck convertor is chosen instead for this circuit.

Why a Buck Convertor not other Regulators?

- ✓ Buck convertor can provide variable output by varying the potentiometer; whereas linear voltage regulator is stuck at only one output

Again, linear voltage regulators heat up a lot and switch off after heating up, and switches on again; and this is solved once you use buck convertor

Selected Buck Convertor Specifications

- ✓ Conversion efficiency: 92%(highest)
- ✓ Switching frequency: 150KHz

- ✓ Output ripple: 30mA maximum)
- ✓ Load Regulation: ± 0.5%
- ✓Voltage Regulation: ± *0.5%*

Input voltage:220-35V

- ✓ Output voltage:1.25-26V(Adjustable)
- ✓Output current: Rated current is 2A, maximum 3A Module

Properties: Non-isolated step-down module (buck)

Operating Temperature: Industrial grade (-40 to +85) (output power lOW or less.

3.4.2 Selection of the Transformer.

The voltage from the supply in Uganda is generally 240 V AC and the AC voltage needed for rectification to get *5* V DC is in the range of7-12 V AC. So to get this a step down transformer is used

If **the <u>minimum</u>**input **voltage to the regulator** is **7 V, the transformer needed should be able to** step 240 V to atleast this value. But between the regulator and the secondary side of the transformer, there is a diode bridge rectifier too. The rectifier has a voltage drop across it i. e 1. 4 V. So this has to be compensated as well.

V secondary = 7+ 1. 4 = 8. 4 V peak value.

This means the transformer to be selected has to be having an output of atleast 9 V or Close to 9. So a 230/10 V is selected. The transformer selected is of the current rating of2 A Why 2 A current? Because the regulator has a current rating of 2 A, so it's not advisable to pass more current than this value as it would cost extra.

Voltage Transformer Specifications

- ✓ Type of the transformer: Step Down

In put voltage/Primary Voltage: 230 Ac Output

voltage/ Secondary Voltage: 10 V Ac

- ✓ Current rating: 2 A
- ✓ Frequency: 50Hz

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3.4.3 Selection of the diodes for the bridge rectifier.

Basically, there are two types of Rectifier circuits; half wave and full wave. However, the one that is selected is the fu11 wave rectifier because it is more power efficient than the first one.

When selecting the diodes for the circuit, keep in mind the output load current, and the maximum peak secondary voltage of the transformer i.e. 10Vin this case.

The selected diode must be having the current rating more than the load current (i.e. in this case 500mA).

The IN4001 diodes qualify to be used but choose IN4007 diodes because of the following.

- ✓ IN4007 diodes can withstand high voltages up to l 000 V unlike other diode; For instance IN4OOI with a peak repetitive voltage of 50 V, IN4148 with a Repetitive voltage of 100 V. So IN4007 is widely used as a general purpose diode even for high frequency circuits.
- ✓ 1N4007 diodes are used as rectifiers for]ow frequency having big capacitance at the junction, other diodes have less capacitance value therefore they have quick ON OFF time.

IN4007 Diode Specifications

- ✓ Average forward current is 1 A.
- ✓ Non repetitive Peak current is 30 A.
- ✓ Peak repetitive Reverse voltage is 1000 V.
- ✓ Power Dissipation 3 W.

3.4.4 Selection of a Filtering Capacitor

The output of the rectifier is pulsating DC. This pulsating DC is converted into pure DC using filter. The filter being used is a Capacitor Filter.

To calculate the value of capacitor the following formulae is used Q = Cx

V equation (1)

Q=CxIR

Q=lxRC

Q = Ix T equation (2) Substitute

equation (2) in equation (1) IxT=CxV

$C = (I \times T) / V$

Here output voltage is V =5DC; Output current is I=1.5 amps

Input voltage is AC 230V, 50 Hz.

So f= 50 Hz,

T = 1/2 f =1/2x3.14x50Hz =

3.184713376 x 10

Output current is I= 1.5 amps

C =(1.5x 3.184713376 x 10) / 5 C

= 9.554140128 x 10

C = 95541x 10

C= 955 uF

The value of capacitor is 955 uF. This value of capacitor is not available in market so the capacitor with a value nearer to it is selected which is l 000 uF.

According to the design calculations, a 1000F, *25* V Electrolytic capacitor is the one suitable for the system.

Fig 19:
Circuit

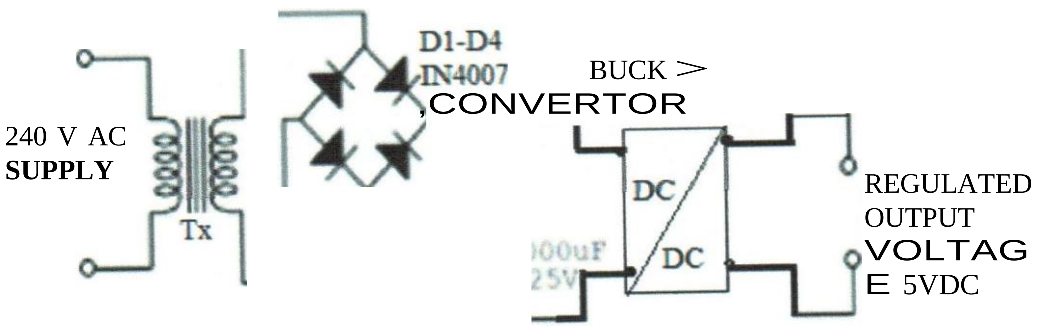

Figure 16: Circuit diagram of 5vdc supply

41.

CHAPTER FOUR RESULTS AND DISCUSSION

4.1 Circuit Diagram of the system

After the selection of the components and block diagram construction, a circuit diagram was designed using Proteus software. It consists of an Arduino Nano which is the microcontroller that controls all the activities taking place in the system, a GSM module which for sending results in from of sms, LCD Screen that displays useful information during the process of operation, Temperature sensor for measuring body temperature and the Pulse sensor for measuring the real time heartbeat. The circuit diagram is shown in the Figure 18.

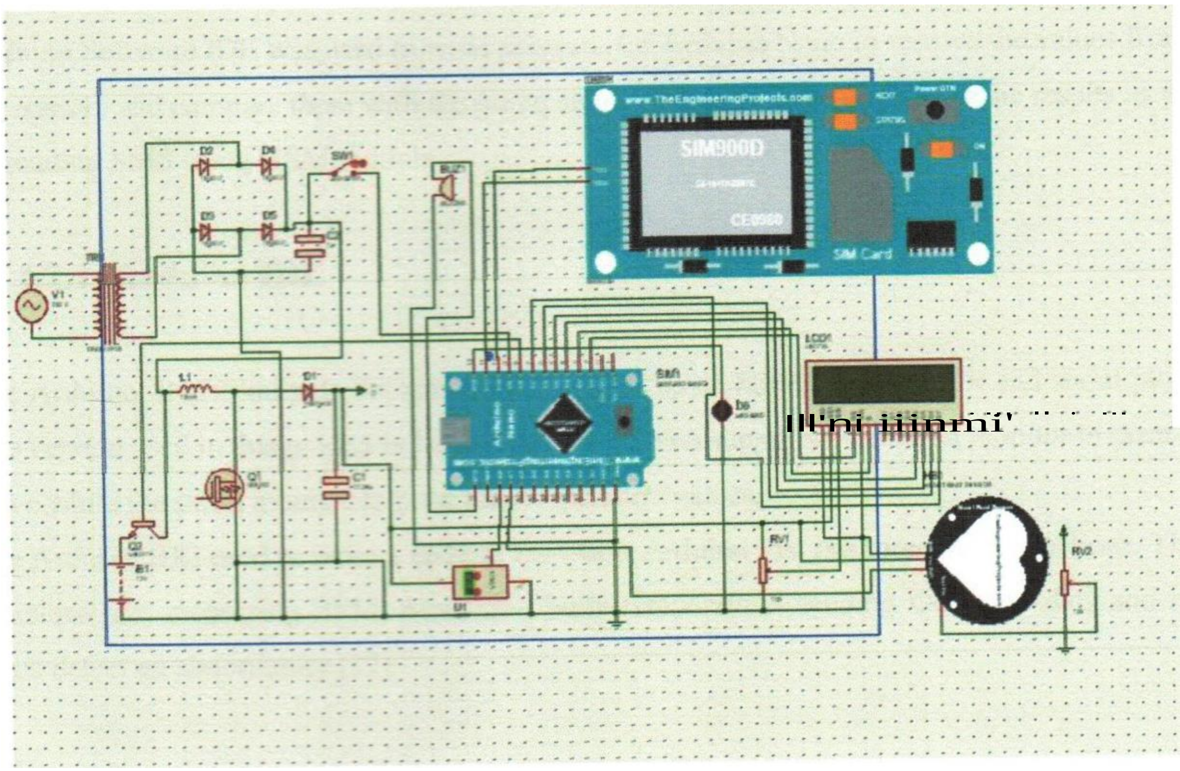

Figure 17: Circuit diagram of system

The overall project aim is taking continuous measurements of the patient vital signs in order to detect a heart attack before it occurs so it can be treated immediately. The pulse sensor converts

the blood pulse into electrical signals which will be next processed using the Arduino board according to the algorithm applied to it. Then output the measured data is displayed on LCD
At the same time, Arduino will keep monitoring the real-time HR hence the buzzer will peeps if **the heart rate exceeds a pre-defined maximum value or goes below a minimum to alert surrounding** people and doctor concerned via GSM.

4.2 Software Design

Several software tools were used throughout the entire development procedures of this project in order to program the Arduino board which is considered the core of this project.

Proteus design suite and Arduino IDE development environment were used for software implementation of the system. Proteus software was used for simulation of circuit before it was actually implemented in hardware. The Arduino Integrated Development Environment or Arduino Software IDE was used to write program for Arduino Nano to receive the values from the sensors and compare them with the preset standard values and then display the results as well as sending SMS using GSM module.

4.2.1 Arduino IDE

The Arduino. It also outputs the results for analysis using both serial monitor and serial plotter. The version used in this project is 1.8.3 Genuino) which supports both serial monitor to print HR wave while the serial monitor to print the temperature values.
The Arduino IDE used to write a code to the Nano Arduino that has three main functions. These functions are: measuring BPM, measuring body temperature, sending measured data and alert when detect an abnormality [12].

4.3 Hardware Implementation:

Is done to test the overall system functionalities, the hardware is implemented as it was discussed throughout this chapters with aid of figures including all components and using the software codes.
The final system's circuit is shown below in

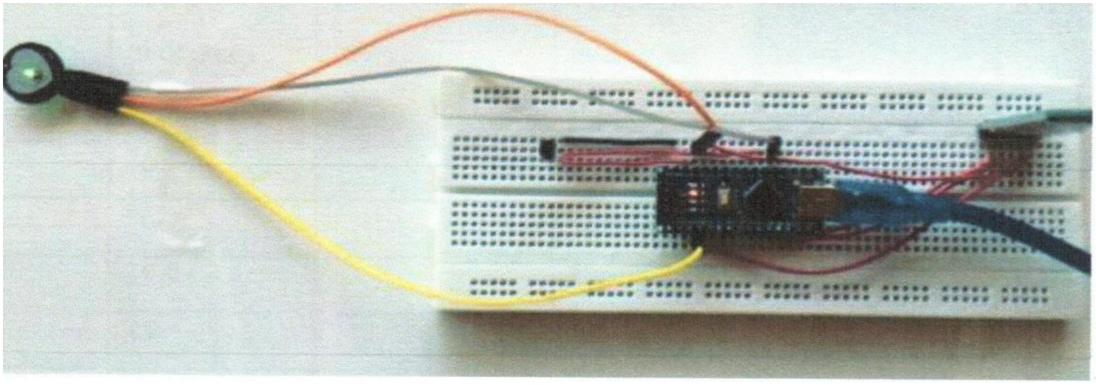

Figure 18: Implementation of the Overall System 4.4

Conclusion

In this chapter, the proposed system design was demonstrated in details for both the hardware and software units of the project This design was proposed in such a way to make it available and suitable for use by most people.

Furthermore, there are many arm-bands today that people actually buy and use. Hence this project's :function can be simply added to one of these bands along with the main services it offers such as: Monitoring Fitness and calculate steps walked daily.

4.5 Discussion of Results

Once the circuit has been built as discussed above, codes have been uploaded into the Nano Arduino then the project is ready for testing, it was tested while comparing the results using other temperature monitoring tool that is mercury thermometer.

When the heart beat and temperatures are below and above threshold the buzzer is turned on and microcontroller sends signals to GSM and sends signals in form of an sms message to mobile phone thereby alerting the doctor, buzzer alerts people around for helps. Temperatures above 37 Degrees Celicius (0C) the buzzer will make an alarm, also heart beat below 30 beats per minute and above 140 beats per minute the buzzer will make an alarm.

Table 3: Table of results

Using mercury thermometer	Using heart beat and temperature monitoring system	Time

Persons	Temperature in degrees ce1cius[oc]	Heart beat inbeats preminute[bpm]	Temperature in degrees ce1cius[oc]	Heartbeat in beats perminute[bpm]	Minutes
1	36		34	78	2
2	36		33.6	62	2
3	*35.9*		32	69	2
4	35		30	73	2
5	36		30	68	2
6	36.7		34	73	2
7	37		32	*59*	2
8	35.9		33	64	2
9	36		34	57	2
10	36		33.5	80	2

4.6 **Discussion**

The ambient noise may be generated from improper holding of pulse sensor or the component is defect. Temperature sensor is affected by ambient temperature by holding it in the hands and cannot give accurate body temperature but for the mercury thermometer under arm pit gives exact temperatures. When the heart beat and temperatures are below and above thresh hold the buzzer is turned on and microcontroller sends signals to GSMand sends signals in form of a sms message to mobile phone thereby alerting the doctor, buzzer alerts people around for helps. Temperatures above 37 Degrees Celicius, the buzzer wilJ make an alarm, also heart beat below 30 beats per minute and above 140 beats per minute the buzzer will make an alarm.

CHAPTER FIVE CONCLUSION AND RECOMMENDATION

5.1. Conclusion

A pulse sensor which considered as an infrared sensor that has a response to variations in light intensity instead was used.

The key objective of developing this project with is to immediately alert Medical Emergency and the patient's emergency contacts about the health condition of patient. I am developing prototype of this application using the continuous monitoring of parameters to detect and predict the heart attack and generate an alarm. The buzzer will tum ON when body temperature and heart rate exceeds or goes below specified threshold level. This objective is met with measuring the heart rate and body temperature. It is helpful where continuous monitoring is required under critical condition. In addition, it is very usable device due to its portability which means the patients can *carry* it with him therefore no need to stay at hospitals because the Heart Rate Monitor is applicable almost everywhere.

5.2. Challenges and Limitations

Several challenges were faced throughout the entire life cycle of the project The first one was with the pulse sensor. It didn't detect accurate readings if it was placed with excessive or loose pressure on the body.

Although the pulse sensor amplifies and filters the ECG signal there will be a noise disturbance in the ECG signal. The wires attached to the patient's body play an important role in order to get a good ECG signal. This noise can be slightly reduced by grounded all the connection properly. Therefore, the ECG signal displayed will still have a noise.

Similar challenge was with the temperature outputs inaccurate measures because it takes a time to respond with the heat produced by the human body. However, LM35 is a suitable component to use in the project to reduce the cost in hardware implementation.

In order to have accurate data to some extent, a number of repeated measurements are required. Hence both challenges were overcome.

The next challenge was the fact that some of the purchased components were provided without datasheet, specifically the pulse sensor used for this project which made it difficult to fully understand the sensor specifications. Hence, it depended on the basic information supplied by the vendors on their website.

5.3. Accomplishments

On the other hand, this project succeeded in achieving many of its proposed goals. These accomplishments can be summarized as.

- Reading vital signs signals.
- Process these vital signs signals.
- HR measuring and monitoring system.
- Implementing alarm system
- Providing platform for communication between doctor and patient.
- Use of relatively low cost and low power hardware components.

5.4. Future Work:

Further improvements can be applied to this project to enhance its performance:

1. To ensure the accuracy of heart rate monitor device, more testing can be performed to larger number of people with different ages and weights.
2. Replace the LM35 with specific temperature sensor of body measurement in order to make it more accurate and more functional to use.
3. More vital signs parameters should be added to increase the value of the project to the patients. These can include: Blood Pressure, Respiratory Rate and other parameters.
4. Implement pulse and other parameters measurements using the mobile phone camera along with other built-in sensors in order to obtain these parameters on demand if the patient started experiencing some symptoms or abnormalities
5. Portable battery unit for the device to provide required power by the sensors and MCU.

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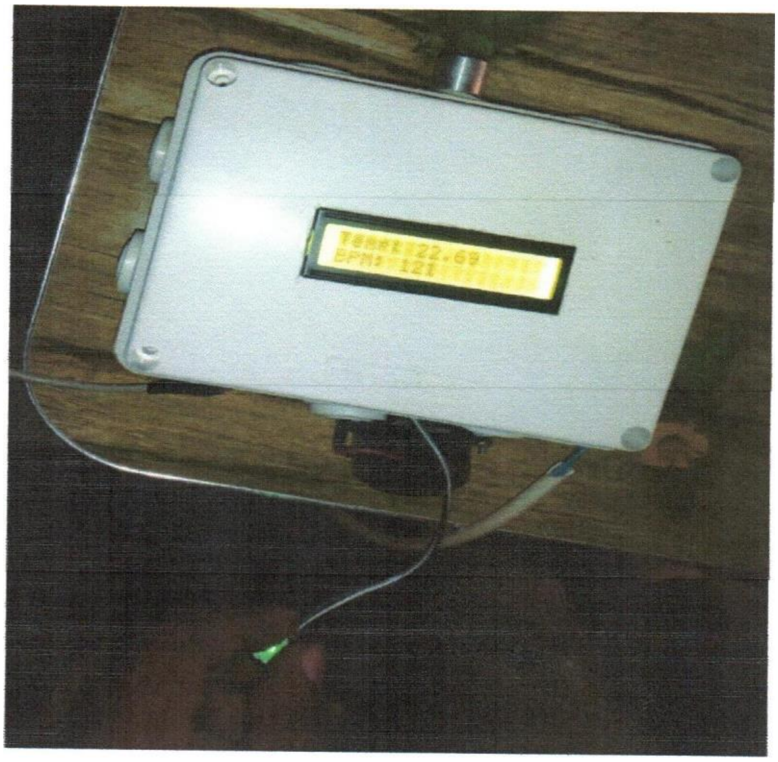
APPENDENCIES

A. Budget analysis

S/no	Item	Quantity	Amount
1	Temperature sensor	1	30000
2	Pulse sensor	1	30000
3	**Arduino**	**1**	50000
4	Buzzer	1	20000
5	Vero board	1	20000
6	Breadboard	1	20000
7	Diodes[IN4007]	4	2000
8	Transformer[9-12V]	1	30000
9	**GSM**	**l**	150000
10	Wires	l packets	5000
11	Solder	lroll	10000
12	LCD	1	50000
13	**Switch**	1	2000
14	Casing	1	10000
15	Top plug	1	10000
16	Connectors	5	5000
TOTAL			444000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