Misan University

College of Engineering

Electrical Engineering Department

# MONITORING SICK USING ARDUINO

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# APPROVAL FOR SUBMISSION

I certify that this project report entitle **" MONITORING SICK USING ARDUINO"** was prepared by **(HAIDAR GASPE MEJBEL , AHMED AUDA ATEA , ZEINAB KARIM ALWAN)** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Electrical Engineering at University of Misan

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# Certificate of Examiners

We certify, as an examining committee, that we have read this project report entitled **" MONITORING SICK USING ARDUINO "** examined the students **(HAIDAR GASPE MEJBEL , AHMED AUDA ATEA , ZEINAB KARIM ALWAN)** in its contents and found the project meets the standard for degree of B.Sc. in Electrical Engineering.

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# List of symbols and abbreviations

| | |
|---|---|
| WHO | World Health Organization |
| CVD | Cardiovascular Disease |
| USB | Universal Serial Bus |
| DC | Direct Current |
| LED | Light Emitting Diode |
| ECG | Electrocardiogram |
| GND | Ground |
| GPS | Global Positioning System |
| MCU | Microcontroller Unit |
| PCB | Printed Circuit Board |
| IC | Integrated Circuit |
| SMS | Short Message Service |
| IDE | Integrated Development Environment |
| WWW | World Wide Web |
| GSM | Global system mobile |

# Abstract

There are many wireless technologies that have made it easier to connect In all its means, whether in the field of medicine or communications and in multiple magazines.

This work is focused on transferring the electrical signal of the heart from the patient and the temperature of the room to be presented to the doctor for diagnosis or treatment. The main purpose of this work is to reduce the time consumed and reduce the cost by reducing the resources used and providing free movement of the patient, and this work be useful for patients who need to monitor the house And medical services.

# الملخص

هناك العديد من التقنيات في مجال الاتصال اللاسلكي التي ساهمت بفعاليه في تسهيل عملية الاتصال بشتى وسائلها سواء في مجال الطب او مجال الاتصالات وفي مجلات متعدده .

ويركز هذا العمل على نقل الإشارة الكهربائية للقلب من المريض ودرجه حرارة الغرفة لعرضها على الطبيب بغرض التشخيص او العلاج والغرض الاساسي من هذا العمل هو تقليل الوقت المستهلك وتقليل التكلفة وذلك بتقليل الموارد المستخدمة وتوفير حرية الحركة للمريض ، وهذا العمل يكون مفيد للمرضى الذين يحتاجون لمراقبه منزليه وخدمات طبيه اقتصاديه.

# CHAPTER ONE

# Introduction

## 1.1 Introduction

Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve patient's health status. Telemedicine is a newest technology which combining telecommunication and information technology for medical purposes [1]. It gives a new way to deliver health care services when the distance between the doctor and patient is significantly away. Rural area will get the benefit from this application. Patient monitoring is one of the telemedicine, which always needs improvement to make it better. It is vital to care in operating and emergency rooms, intensive care and critical care units. It is also important for respiratory therapy, recovery rooms, out-patient care, radiology, ambulatory, home and sleep screening applications. The advantages of a patient monitoring system are it can reduce the risk of infection and other complication in order to make the patients comfortable. Furthermore, implement of patient monitoring in hospitals might reduce the costs in terms of installation and also maintenance of wiring

## 1.2 Problem Statement

According to WHO, 17 million people die from CVD Which makes up to 31% of the deaths worldwide. Hence a method to prevent or to help in reducing the losses of people's lives.

### 1.3 Literature review

Real Time Heart Attack and Heart Rate Monitoring Android Application at Computer Science & Engineering, Malnad College of Engineering ,Hassan. Abstract: Technological innovations in the field of disease prevention and maintenance of patient health have enabled the evolution of fields such as monitoring systems. This concept deals with the detection of heart attack and heart rate monitoring. It is an android application which continuously monitors the patient's heart beat rate and sends appropriate notifications to the registered users. This will help doctors to monitor the health of remotely located patients, thus enabling a smart health care system. This project can help save the lives of patients in nick time.

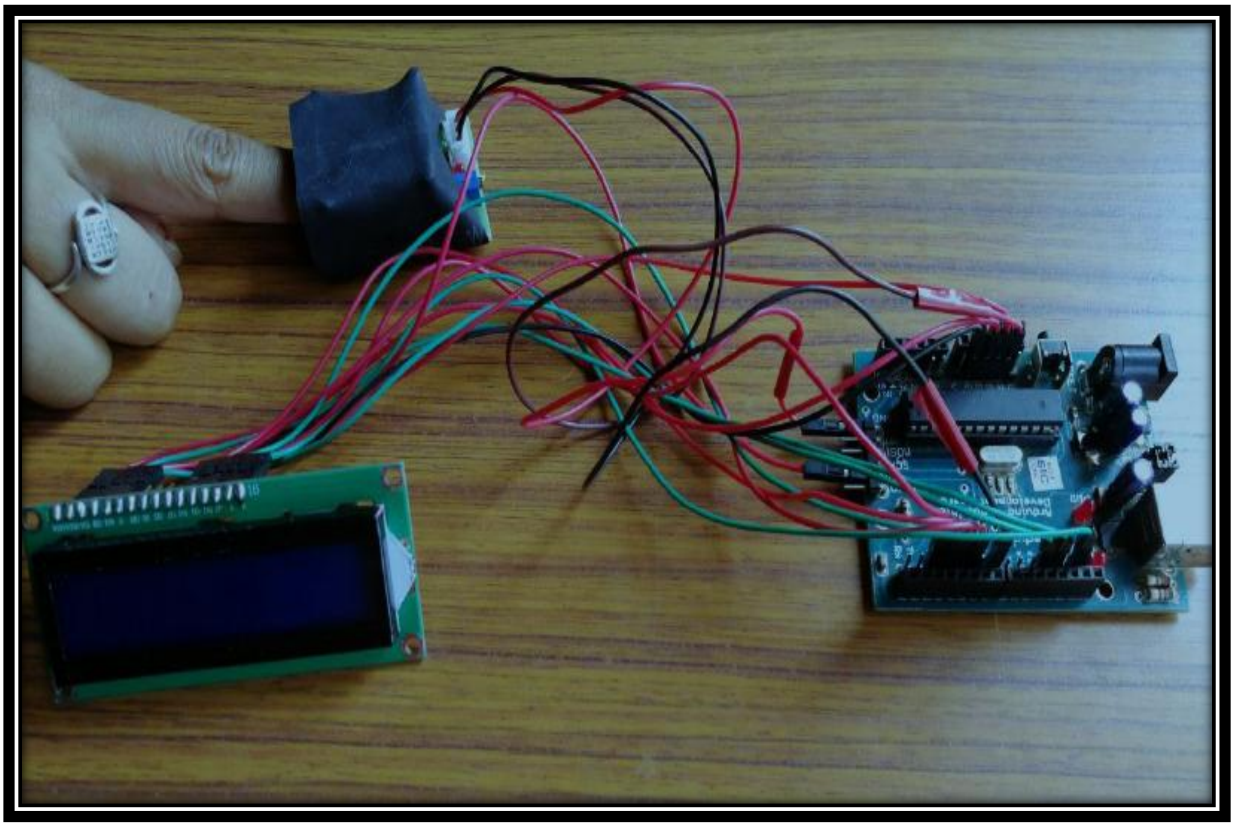


Figure (1)Real Time Heart Attack and Heart Rate Monitoring Android Application

Health Monitoring Wearables at New Jersey Governor's School of Engineering and Technology 2016.

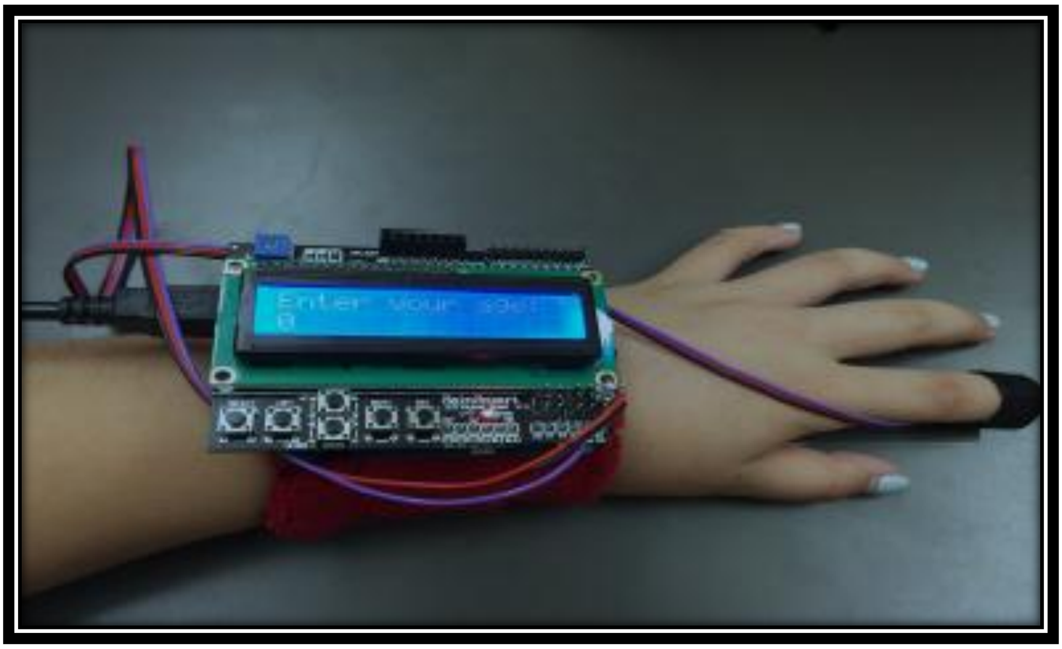


Figure (2) Health Monitoring Wearables

**1.4 Objectives**

The goal of this project is design low-cost device which measures the heart rate of the subject by clipping sensors on one of the fingers and then displaying the result on a android application interface.Miniaturized heart rates monitor system based on a microcontroller. It offers the advantage of portability over tape-based recording systems. The thesis explains how a single-chip microcontroller can be used to analyze heart beat rate signals in realtime. the Hardware and software design are oriented towards a single-chip microcontroller-based system, hence minimizing the size.

## 1.5 Motivation

Cardiovascular disease is one of the main causes of death in the many countries, it accounted for over 17 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 has 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). Since the system is continuously monitoring the patient and in case of any abnormal in the heart beat rate of the patient the system will immediately send message to the concerned doctors and relatives about the condition of the patient and abnormal details.

# CHAPTER TWO

# Theoretical Framework

## 2.1 Introduction

Early developments of the integrated circuit go back to 1949, when German engineer Werner Jacobi (Siemens AG)[2] filed a patent for an integrated-circuit-like semiconductor amplifying device[3] showing five transistors on a common substrate in a 3-stage amplifier arrangement. Jacobi disclosed small and cheap hearing aids as typical industrial applications of his patent. An immediate commercial use of his patent has not been reported. The idea of the integrated circuit was conceived by Geoffrey Dummer (1909–2002), a radar scientist working for the Royal Radar Establishment of the British Ministry of Defence. Dummer presented the idea to the public at the Symposium on Progress in Quality Electronic Components in Washington, D.C. on 7 May 1952.[4] He gave many symposia publicly to propagate his ideas and unsuccessfully attempted to build such a circuit in 1956.[5] A precursor idea to the IC was to create small ceramic squares (wafers), each containing a single miniaturized component. Components could then be integrated and wired into a bidimensional or tridimensional compact grid.[6] This idea, which seemed very promising in 1957, was proposed to the US Army by Jack Kilby and led to the short-lived Micromodule Program (similar to 1951's Project Tinkertoy).[[7] In this chapter we talk about the Arduino and the senses.

## 2.2 Arduino

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community .There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50 Cross-platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows. Simple, clear programming environment - The Arduino

Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works. Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to Open source and extensible hardware - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.[8]

### 2.3 Sensors

In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics .Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micromachinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement.[9] for example into MARG sensors. Moreover, analog sensors such as potentiometers and

force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Some sensors can also affect what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors are usually designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages.[10] Technological progress allows more and more sensors to be manufactured on a microscopic scale as microsensors using MEMS technology. [11] In most cases, a microsensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches [12] .

# CHAPTER THREE

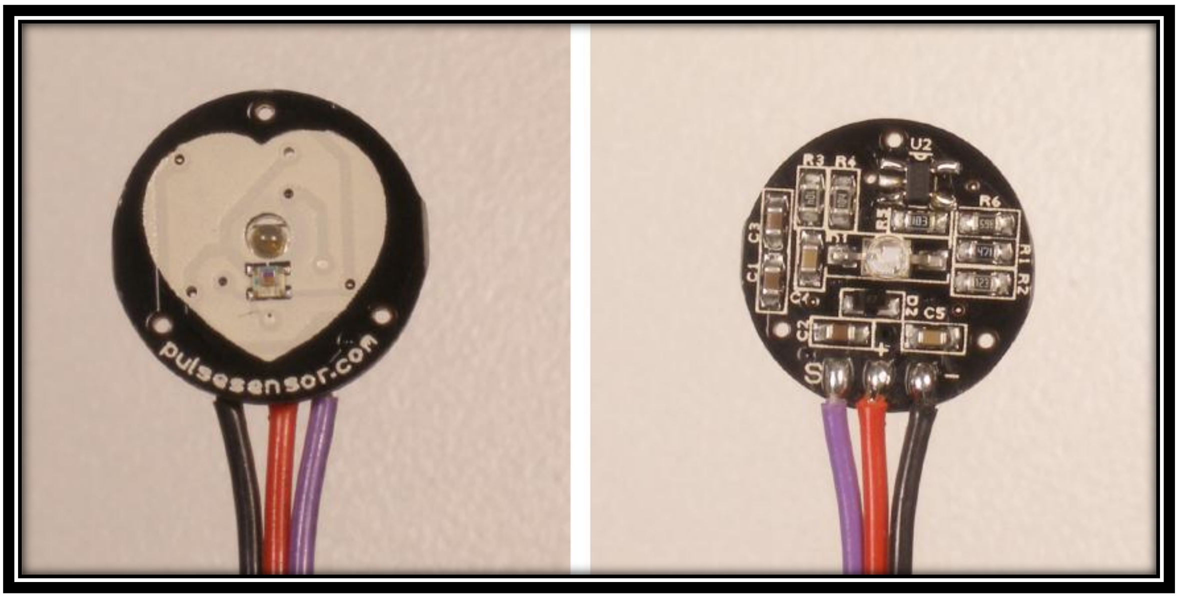
# Research Methodology

### 3.1 Component of project

1- Arduino Uno
2- Junction wires
3- SainSmart DHT11 Temperature And Relative Humidity Sensor Module For Arduino
4- Temperature Sensor DS18B20
5-Resistor 10k ohm
6-HC-06 Bluetooth Module
7-heart rate sensor
8- Breadboard

#### 3.1.1 Heart rate 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 heart rate 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.




Figure(3) heart rate sensor

The Pulse Sensor Kit includes:

1) 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 hotglued 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 finger tip.
4) Velcro strap to wrap the Pulse Sensor around your finger.
5) 3 Transparent Stickers. These are used on the front of the Pulse Sensor to protect it from oily fingers and sweaty earlobes.
5) 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 front of the sensor is the pretty side with the Heart logo. This is the side that makes contact with the skin. On the front you see a small round hole, which is where the LED shines through from the back, and

there is also a little square just under the LED. The square is an ambient light sensor, exactly like the one used in cellphones, tablets, and laptops, to adjust the screen brightness in different light conditions. The LED shines light into the fingertip or earlobe, or other capillary tissue, and sensor reads the light that bounces back. The back of the sensor is where the rest of the parts are mounted. We put them there so they would not get in the way of the of the sensor on the front. Even the LED we are using is a reverse mount LED. For more about the circuit functionality, check out the Hardware page.[needs link] The cable is a 24” flat color coded ribbon cable with 3 male header connectors. The Pulse Sensor can be connected to arduino, or plugged into a breadboard. Before we get it up and running, we need to protect the exposed circuitry so you can get a reliable heart beat signal.

Preparing the Pulse Sensor

Before you really start using the sensor you want to insulate the board from your (naturally) sweaty/oily fingers. 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. We will use a thin film of vinyl to seal the sensor side. Find the small page of four clear round stickers in your kit, and peel one off. Then center it on the Pulse Sensor. It should fit perfectly. When you are happy with the way it’s lined up, squeeze it onto the face all at once! The sticker (made of vinyl) will kind of stretch over the sensor and give it a nice close fit. If you get a wrinkle, don’t worry, just press it down really hard and it should stick. We gave you 4, so you can replace it if necessary. That takes care of the front side. The vinyl sticker offers very good protection for the underlying circuit,

and we rate it ‘water resistant’. meaning: it can stand to get splashed on, but don’t throw it in the pool! If this is your first time working with Pulse Sensor, you’re probably eager to get started, and not sure if you want to use the ear-clip or finger-strap (or other thing). 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 undesireable 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.

### 3.1.2 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.[13]

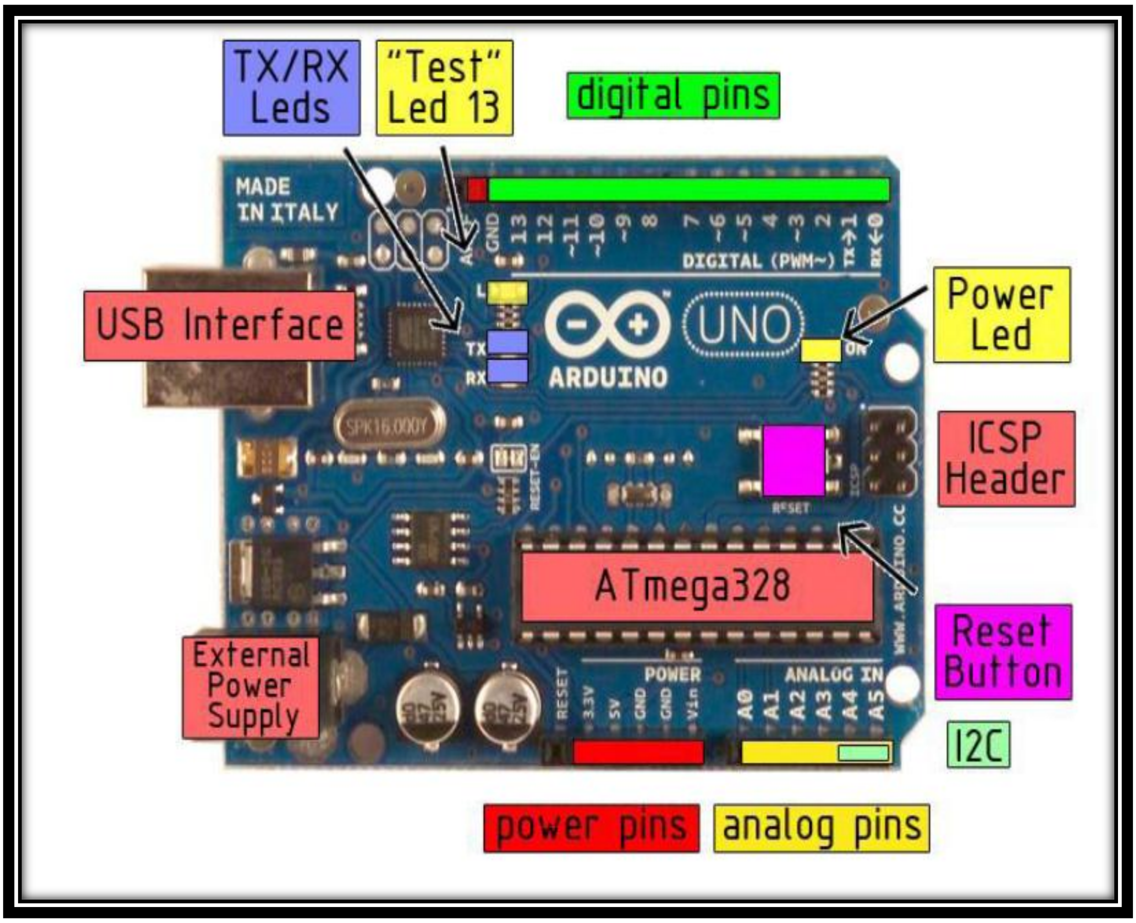



Figure (4) Arduino Uno

**1- Power**

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB)
power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply

of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board.

### 2- Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX) [14].

### 3- Summary

Microcontroller= ATmega328

Operating Voltage=5V

Input Voltage (recommended) =7-12V

Input Voltage (limits) = 6-20V

Digital I/O Pins = 14 (of which 6 provide PWM output)

Analog Input Pins= 6

DC Current per I/O Pin=40 mA

DC Current for 3.3V Pin= 50 Ma

Flash Memory = 32 KB (ATmega328) of which 0.5 KB used by boot loader SRAM 2 KB (ATmega328)

EEPROM=1 KB (ATmega328)

Clock Speed=16 MHz

### 3.1.3 HC-06 Bluetooth Module

Bluetooth modules are designed for wireless data transmission between small distances it Considered as wireless personal area network technology (WPAN) it works at ultra-high frequencies (UHF). Regarding to industrial, scientific and medical (ISM) radio bands witch governing industrial, scientific and medical frequencies, the Bluetooth range from 2.402 GHZ to 2.480. It considers as the cheapest method for data transmission, easiest and more flexible compared to other methods. It even can transmit files reach to 25 Mb/s. This technique depends on frequency hopping spread spectrum technique (FHSS) it use this technique to avoid interference with other devices and it a full duplex transmission which mean it can transmit and receive at same time.

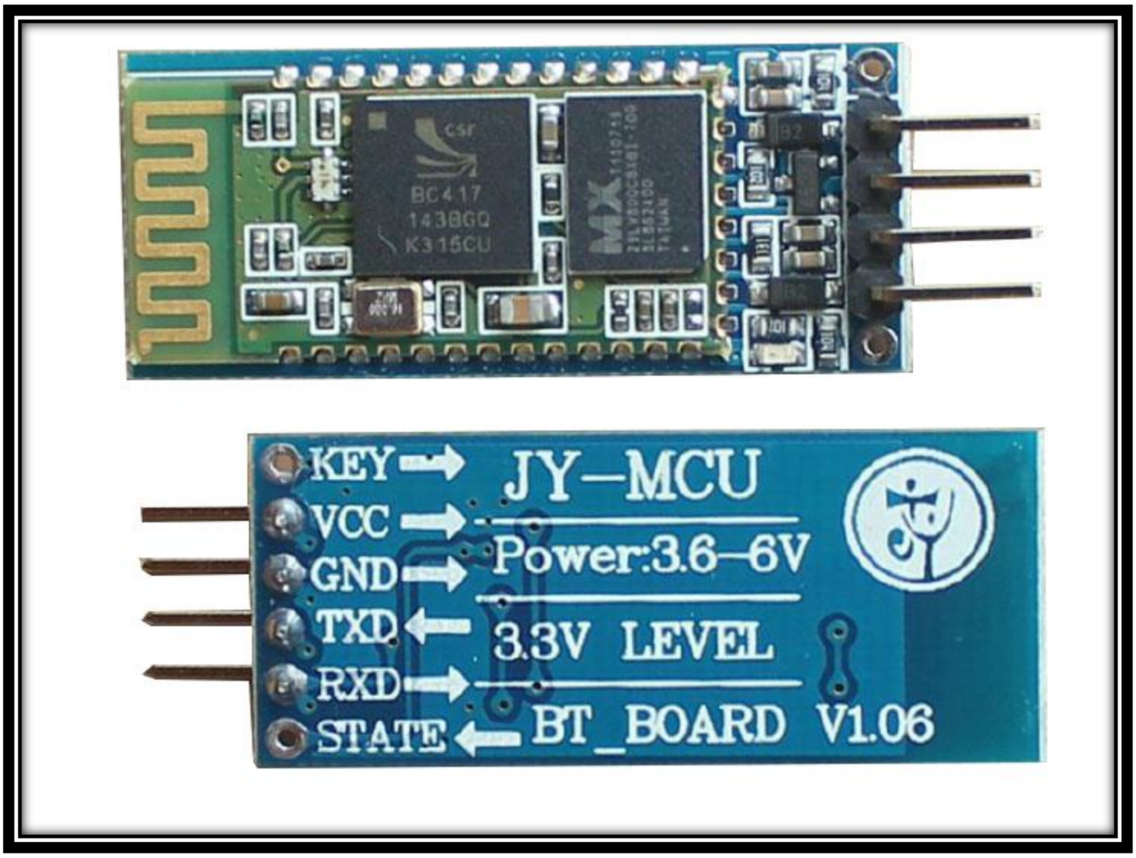



Figure (5) HC-06 Bluetooth Module

Bluetooth module HC06 Features

• Operating voltage: 5 v

• Slave: is a model for a communication protocol in which one device or process known as the master controls one or more other devices or processes known as slaves.

• Enable bin: it can be connected to 5V or left without connecting this allow the module to work but in case of connecting it to ground it doesn't work.

• Key pin: some modules doesn't contain this pin so a wire could be welded to it. This pin has two modes AT mode which allow the user to enter commands to it and connection mode which allow the connection between device

## How Bluetooth connection occurs :

1- The master device sends request to all surrounding Bluetooth modules, all slave modules reply with the 48-bit number which is unique for each Bluetooth device similar to MAC address.

2- when the master determines the slave wants to pair with it starts synchronization process as the master send message with the internal date, time, type of the device, services provided by him and operating frequency these process occurred in base band layer.

3- after that the link manager layer in which Link Management Protocol (LMP) responsible for authentication and authorization process, data Encryption and frequency hopping management.

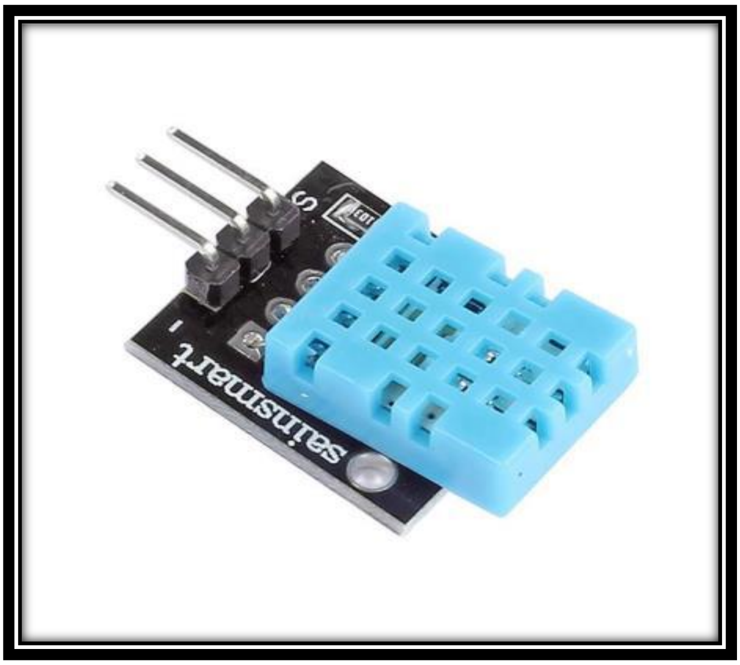
4- then in the next layer Logical Link Control and Adaptation Protocol (L2CAP) which responsible for data transmission management and data divide into packets.

5- using Service Discovery Protocol (SDP) the master Bluetooth module determines the service provided by the slave (profile) depending on this profile the master determines the type of data to send to this device.

6- finally the paring action occurs when the master device gives the pin number to allow the master to exchange data at any time.[15]

### 3.1.4 DHT11

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.




Figure(6) DHT11

Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

Typical Application

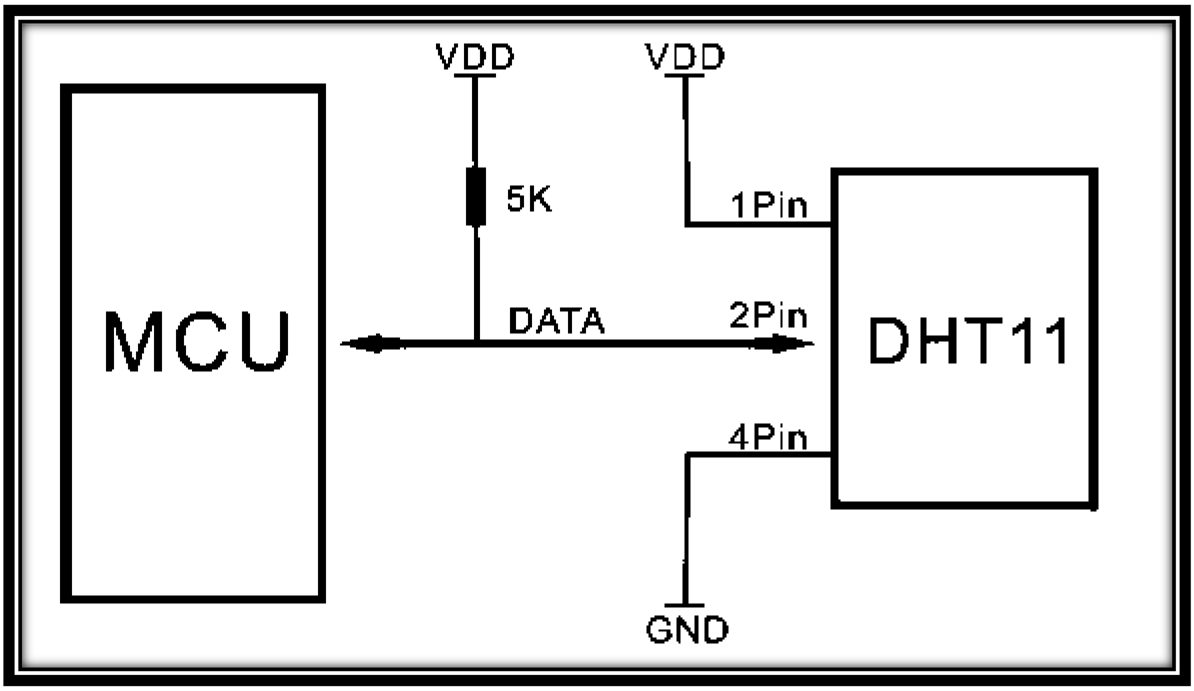



Figure (7) Typical Application

Note: 3Pin – Null; MCU = Micro-computer Unite or single chip Computer

When the connecting cable is shorter than 20 metres, a 5K pull-up resistor is recommended; when the connecting cable is longer than 20 metres, choose a appropriate pull-up resistor as needed.

Power and Pin

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.[16]

### 3.1.5 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. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central power directly from the data line ("parasite power) eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.[17]

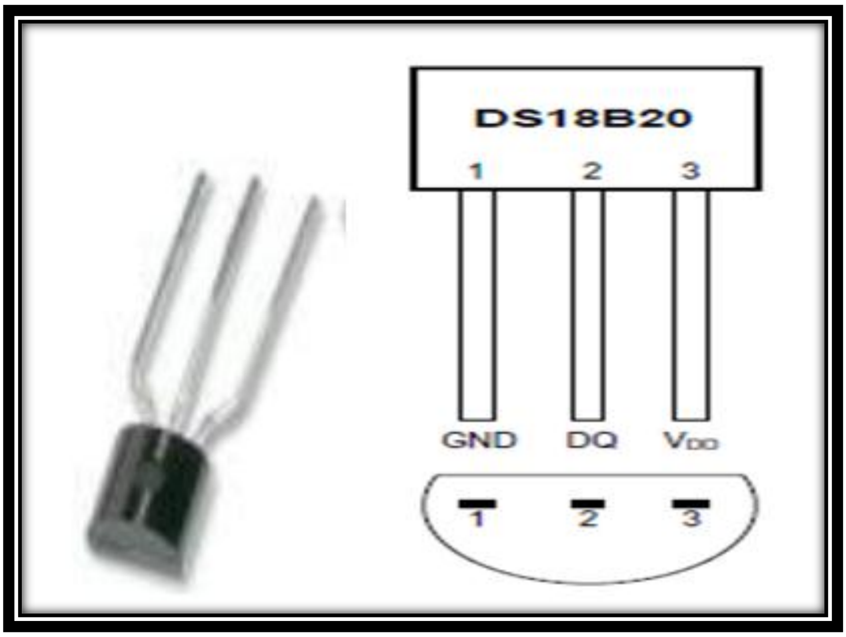



Figure (8)DS18B20

Applications

Thermostatic Controls

Industrial Systems

Consumer Products

Thermometers

Thermally Sensitive Systems

## 3.2 Circuit diagram

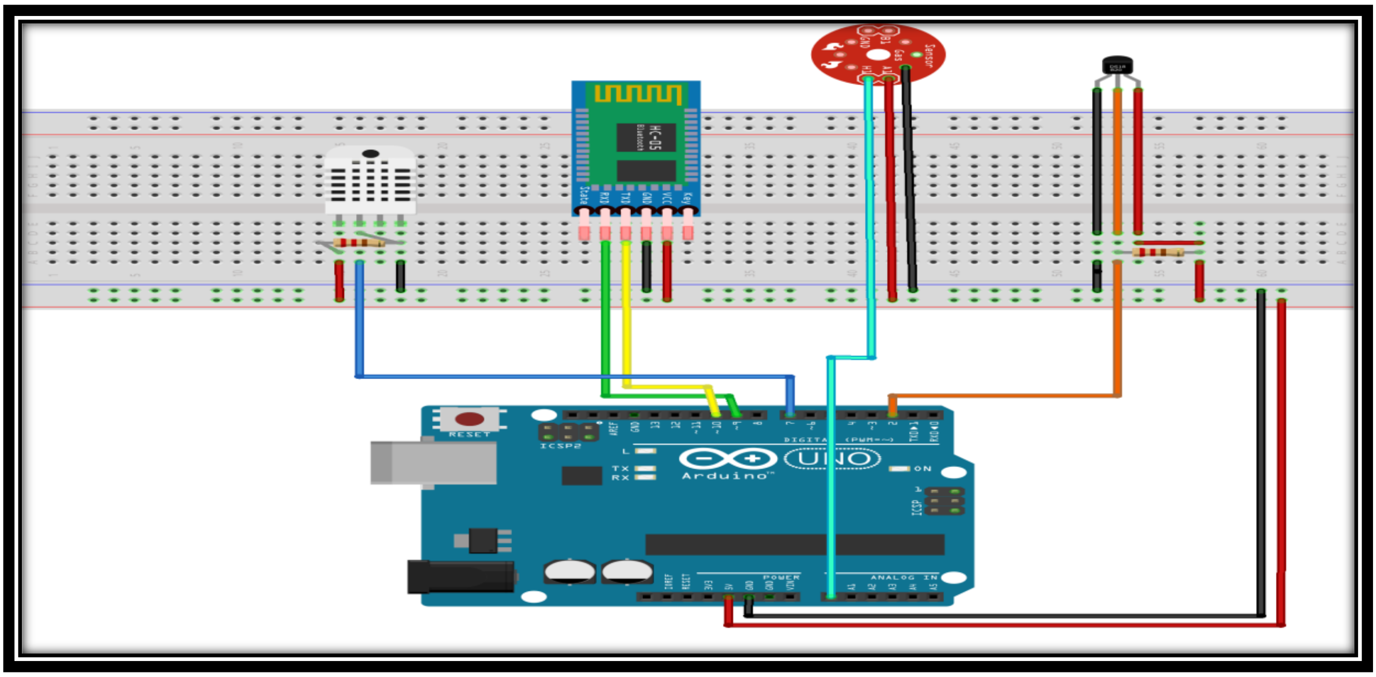


Figure (9) Circuit diagram

## 3.3Hardware Implementation

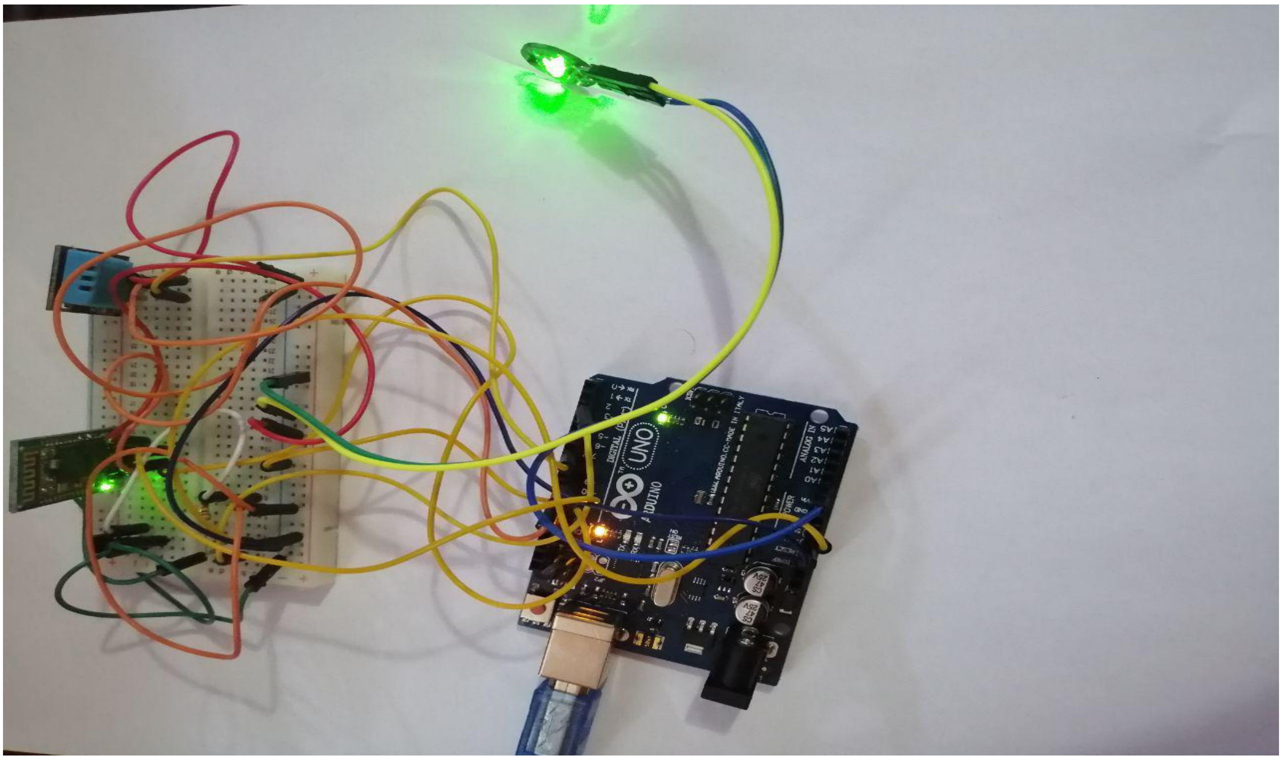


Figure (10) Hardware Implementation

# CHAPTER FOUR

# Results and Conclusions

## 4.1 Results

Once the circuit has been built as , codes have been uploaded into the Arduino then the project is ready for testing. When we carried out implementations and testing the following results were obtained

### 4.1.1 Heart Rate Results in Serial Plotter

The heart rate was obtained using two methods, the manual method and using the pulse sensor todetermine the accuracy of the project's circuit. The circuit is supplied by 5V power. For accurate reading as much as possible, the finger or the wrist needs to be placed close to sensor .

### 4.1.2 Body Temperature Results in Serial Monitor

Body temperature was obtained by interaction between the fingertip and the DS18B20 . First we measured the temperature using thermometer then we measured it again using DS18B20 to compare the results.

## 4.2 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 the help of Android Open Source platform is to immediately

alert Medical Emergency and the patient’s emergency contacts about the health condition of patient. We are 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 turn 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. Along with the Heart Rate Monitor, we developed an Android Application that allows both doctors and patients to interact with each other, records the data received from the heart monitor via Bluetooth as well as enable access to these records by the doctor.

### 4.3 Discussion

According to the specialized doctor, the heart rate ECG is not measurable, in other words the signal is noisy and has to be filtered first in order to be able to extract heart rate value from it. The ambient noise maybe generated from improper holding of pulse sensor or the component is defected. On the other hand, the temperature was much better which outputted data with accuracy of almost 97%. The Bluetooth were implemented correctly and performed their supposed functions successfully which is detection the HC-06 Bluetooth and pairing with it as well as receiving data from Arduino and determining the location of the patient repectively.

### 4.4 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.

### 4.5 Future Work

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

-Design robust system to improve measuring efficiency even in the presence of noise. In addition to propose a new method for efficient transmission of data between the MCU and the Android application.

-To ensure the accuracy of heart rate monitor device, more testing can be performed to larger number of people with different ages and weights.

-Replace the DS18B20 with specific temperature sensor of body measurement in order to make it more accurate and more functional to use.

-More vital signs parameters should have been added to increase the value of the project to the patients. These can include: Blood Pressure, Respiratory Rate and other parameters.

-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.

-The MCU should send a control signal along with the measured data when detect a heart attack and the buzzer is turned ON. The control signal should enable GPS, instruct the application to send an SMS containing the measured data and the patient's location to the medical emergency and emergency contacts of the patient in order to get an ambulance and notify his relatives.

-The device should be miniaturized into a PCB making its weight lighter in order to make the device commercial for public use.

-Portable battery unit for the device to provide required power by the sensors and MCU.

-Add gsm

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**APPENDIX**

Arduino program

```
#include <SoftwareSerial.h>
#include <cactus_io_AM2302.h>
#define AM2302_PIN 7
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS 2
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
AM2302 dht(AM2302_PIN);
SoftwareSerial Bluetooth(10, 9);
String Data;
int pulsePin = 0;
int blinkPin = 13;
volatile int BPM;
volatile int Signal;
volatile int IBI = 600;
volatile boolean Pulse = false;
volatile boolean QS = false;
volatile int rate[10];
volatile unsigned long sampleCounter = 0;
volatile unsigned long lastBeatTime = 0;
volatile int P = 512;
volatile int T = 512;
volatile int thresh = 512;
volatile int amp = 100;
```

```
volatile boolean firstBeat = true;
volatile boolean secondBeat = false;
void interruptSetup() {
TCCR2A = 0x02;
TCCR2B = 0x06;
OCR2A = 0X7C;
TIMSK2 = 0x02;
sei();
}
ISR(TIMER2_COMPA_vect) {
cli();
Signal = analogRead(pulsePin);
sampleCounter += 2;
int N = sampleCounter - lastBeatTime;
if (Signal < thresh && N > (IBI / 5) * 3) {
if (Signal < T) {
T = Signal;
}
}
if (Signal > thresh && Signal > P) {
P = Signal;
}
if (N > 250) {
if ( (Signal > thresh) && (Pulse == false) && (N > (IBI / 5) * 3) ) {
Pulse = true;
digitalWrite(blinkPin, HIGH);
IBI = sampleCounter - lastBeatTime;
lastBeatTime = sampleCounter;
```

```
if (secondBeat) {
secondBeat = false;
for (int i = 0; i <= 9; i++) {
rate[i] = IBI;
}
}
if (firstBeat) {
firstBeat = false;
secondBeat = true;
sei();
return;
}
word runningTotal = 0;
for (int i = 0; i <= 8; i++) {
rate[i] = rate[i + 1];
runningTotal += rate[i];
}
rate[9] = IBI;
runningTotal += rate[9];
runningTotal /= 10;
BPM = 60000 / runningTotal;
QS = true;
}
}
if (Signal < thresh && Pulse == true) {
digitalWrite(blinkPin, LOW);
Pulse = false;
amp = P - T;
```

```
thresh = amp / 2 + T;
P = thresh;
T = thresh;
}
if (N > 2500) {
thresh = 512;
P = 512;
T = 512;
lastBeatTime = sampleCounter;
firstBeat = true;
secondBeat = false;
}
sei();
}
void setup() {
Bluetooth.begin(9600);
Serial.begin(9600);
dht.begin();
sensors.begin();
interruptSetup();
}
void loop() {
sensors.requestTemperatures();
dht.readHumidity();
dht.readTemperature();
if (isnan(dht.humidity) || isnan(dht.temperature_C)) {
return;
}
```

```
if (QS == true) {
Serial.print(sensors.getTempCByIndex(0)); Serial.print(" ");
Serial.print(dht.temperature_C); Serial.print(" "); Serial.print(dht.humidity);
Serial.print(" "); Serial.println(BPM);
Bluetooth.print(sensors.getTempCByIndex(0)); Bluetooth.print(" ");
Bluetooth.print(dht.temperature_C); Bluetooth.print(" ");
Bluetooth.print(dht.humidity); Bluetooth.print(" "); Bluetooth.println(BPM);
QS = false;
}
delay(10000);
}
```