ADRUINO BASED HEART RATE MONITORING DEVICE

Project report submitted in partial fulfillment of the requirements for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

Rishabh Singh (131011)
Simran Rana (131059)

Under the supervision of

Prof. Sunil V. Bhooshan

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

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DECLARATION

We hereby declare that the work reported in the B-Tech thesis entitled **"HEART RATE SENSOR ANDROID APPLICATION"** submitted at **Jaypee University of Information Technology, Waknaghat, India,** is an authentic record of our work carried out under the supervision of **Prof. Sunil V. Bhooshan**. We have not submitted this work elsewhere for any other degree or diploma.

Rishabh Singh - 131011

Simran Rana - 131059

Department of Electronics and Communication Engineering

Jaypee University of Information Technology, Waknaghat , India

Date- May 2, 2017

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled "**ADRUINO BASED HERT BEAT MONITORING DEVICE**", submitted by **Rishabh Singh (131011) and Simran Rana (131059)** at **Jaypee University of Information Technology, Waknaghat , India,** is a bonafide record of their original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

Prof. SV Bhooshan

HOD ECE Department

May 2,2017

ACKNOWLEDGEMENT

Before Commencing, this report, We would like to express our gratitude and appreciation to our respected guide **—Prof. SV Bhooshan** who encouraged us to work on real-time health related issue of heart rate monitoring an Adruino based Project which further enhanced our skills and knowledge .

Thank You

List of Abbreviations

1. AC	Analog Current
2. AFH	Adaptive frequency-hopping
3. AREF	Analog Reference
4. ASCII	American Standard Code for Information Interchange
5. AVR	Alf and Vegard's RISCprocessor
6. BPM	Beats per minute
7. BT	Bluetooth
8. CMOS	Complementary metal–oxide–semiconductor
9. CPU	Central processing unit
10. CSR	Cambridge Silicon Radio
11. DC	Direct Current
12. DFU	Device Firmware Upgrade
13. EDR	Event data recorder
14. EN	Enable
15. FTDI	Future Technology Devices International
16. I/O	Input Output
17. IBI	Inter-beat interval
18. ICSP	In-Circuit Serial Programming
19. IDE	Integrated development environment
20. IOREF	Input output Reference
21. LED	Light emitting Diode
22. LNA	Low Noise Amplifier
23. MISO	Multiple input Single output
24. MOSI	Multiple output Single input
25. PA	Power Amplifier
26. PCM	Pulse code Modulation
27. PIO	Programmable input output
28. PWM	Pulse Width Modulation
29. r3	Revision 3
30. RX	Reception
31. RXD	Receive Data

32. SCK	Serial Clock
33. SCL	Serial Clock
34. SDA	Serial Data
35. SPI	Serial Peripheral Interface
36. SPP	Serial Port Protocol
37. TTL	Transistor Transistor Logic
38. TX	Transmission Data
39. TXD	Transmit Data
40. UART	Universal asynchronous receiver/transmitter
41. USB	Universal Serial Bus

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ABSTRACT

This project aims to make use of the pulse sensor with Arduino Uno r3 and Bluetooth HC-06 module. We will place our finger on the pulse sensor connected to Arduino Uno and the heart rate will be measured by it and then it sends the data to the phone and via bluetooth device. A display of the heart rate will be obtained by measuring the time between signal peaks and then calculating the frequency of the peaks in units of beats per minute. We can obtain the pulse rate the using the processing software graphically, where the graph is drawn by measuring the time interval between the two consecutive beats and measured in BPM. Our implementation of the heart monitor involves hardware: Arduino Uno, Bluetooth Module, Pulse rate sensor. Software: IDE, Processing2.

CHAPTER 1

INTRODUCTION

The heart beat monitor is measuring device ,which is used to measure the individuals heart rate in real-time and store the results for future use according to World health organisation the heart rate of infants is around 110-120 bpm for a healthy adult is between 70-100 bpm and in case of older children is about 90 bpm.

However, heart rate peak to higher value after exercise or when we are frightened, if the heart rate is lower than the threshold it is case of bradycardia and in case higher the threshold it is termed as tachycardia . Although, the method used in the project is simple, It is not that much correct, can show error due the physical condition.

Now days, the some of the electrical method are used, which are very efficient, like Electro-Cardiogram, some wristband can also measure the heart rate very accurately but they are costly. Hence this device can be used to measure the heart rate in a cheaper manner.

1.1 Overview of the project:

The project demonstrates a method to measure the heart rate by observing the fluctuations in blood volume in a finger artery while the heart is pumping the blood.

To confirm the two way communication between the Android phone and the Arduino over Bluetooth we will use a basic Android Bluetooth app to send data from Bluetooth to phone connected to the Arduino Uno via a serial connection. Data will be read by the Arduino Uno and will turn an LED on, or off accordingly. After that a status message will be sent back, which will be displayed on the phone's screen.

The same approach can be used to interact with anything connected to your Arduino (like motors, sensors) or the different objects in your Smartphone (camera, etc).This projects aims to use the pulse sensor with Arduino Uno. We will place our finger on the pulse sensor connected to Arduino Uno and it will measure the heart rate in bpm.

Hardware Requirements:

1.2Microcontroller-Arduino Uno r3

The Arduino Uno is a microcontroller board comprising of 14 digital I/O pins (6 are for the purpose to measure PWM outputs), there is a 16 MHz crystal ceramic resonator, 6 analog inputs, a power jack, a USB connection, a reset button and an ICSP header.It is based on the ATmega328. It contains everything which is required to support the microcontroller; to get started we can simply connect it to a computer with aiUSBicable or power it with a AC-to-DC adapter or battery.

This board is different from other boards as it doesn't uses the FTDI(Future Technology Devices International) USB-to-serial driver chip and also uses the Atmega16U2 (Atmega8U2 up to version R2) programmed like USB-to-serial converter.

R2 of the the Uno board consists of a resistor which pulls the 8U2 HWB line to ground, which makes it better to put into DFU mode.

R3 of the board consists of the following special features:-

- **PINOUT**: additionally there are SDA and SCL pins which are close to the AREF pin. There are two other new pins placed which are close to the RESET pin,
- (IOREF) that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both boards that uses AVR, that operates with 5V and with the Arduino Due that operating at 3.3V.
- The second one is for future purposes and it is a not connected pin.
- It has stronger RESET circuit.
- Also the Atmega 8U2 replaced the 16U2.

NOTE: In Italian "Uno" means 1 and is pronounced for the upcoming release of Arduino 1.0.

1.3 Pulse Sensor

The Pulse Sensor is a sensor for Arduino. Actually it's simply a plug-play sensor. It uses a simple optical heart rate sensor employed with amplification and noise remover circuit. This makes it faster as well as easy to obtain reliable pulse readings. It is generally utilized by artists, athletes,students,game & mobile developers who want to incorporate live heart-rate data into their project.

Also,it is great for mobile applications since it consumes power with just 4mA current drawn at 5V.

1.4 Bluetooth Module

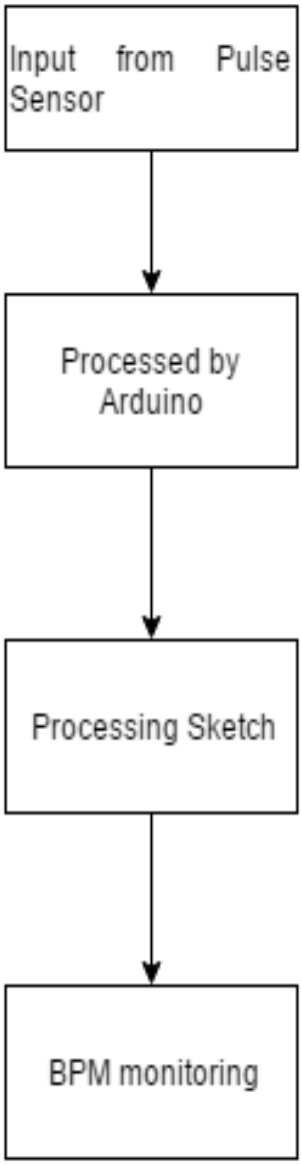
HC-06 module is a Bluetooth Serial Port Protocol (SPP) module. It was designed for transparent wireless serial connection setup.

Serial port Bluetooth module uses the CSR Bluecor 04-External single chip Bluetooth system with CMOS technology and with Adaptive Frequency Hopping Feature (AFH) . It is completely equipped Bluetooth V2.0+ Enhanced Data Rate (EDR) 3Mbps Modulation with complete 2.4 GHz frequency radio transceiver and baseband. It has the size small i.e 12.7mmx27mm.

CHAPTER 2

SYSTEM DESIGN

2.1 Flow Chart:



2.1 Arduino Uno

2.1.1 Technical Specifications

Microcontroller	**ATmega328P**
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Tabe:2.1 technical specifications

2.2.2 Pin Configuration

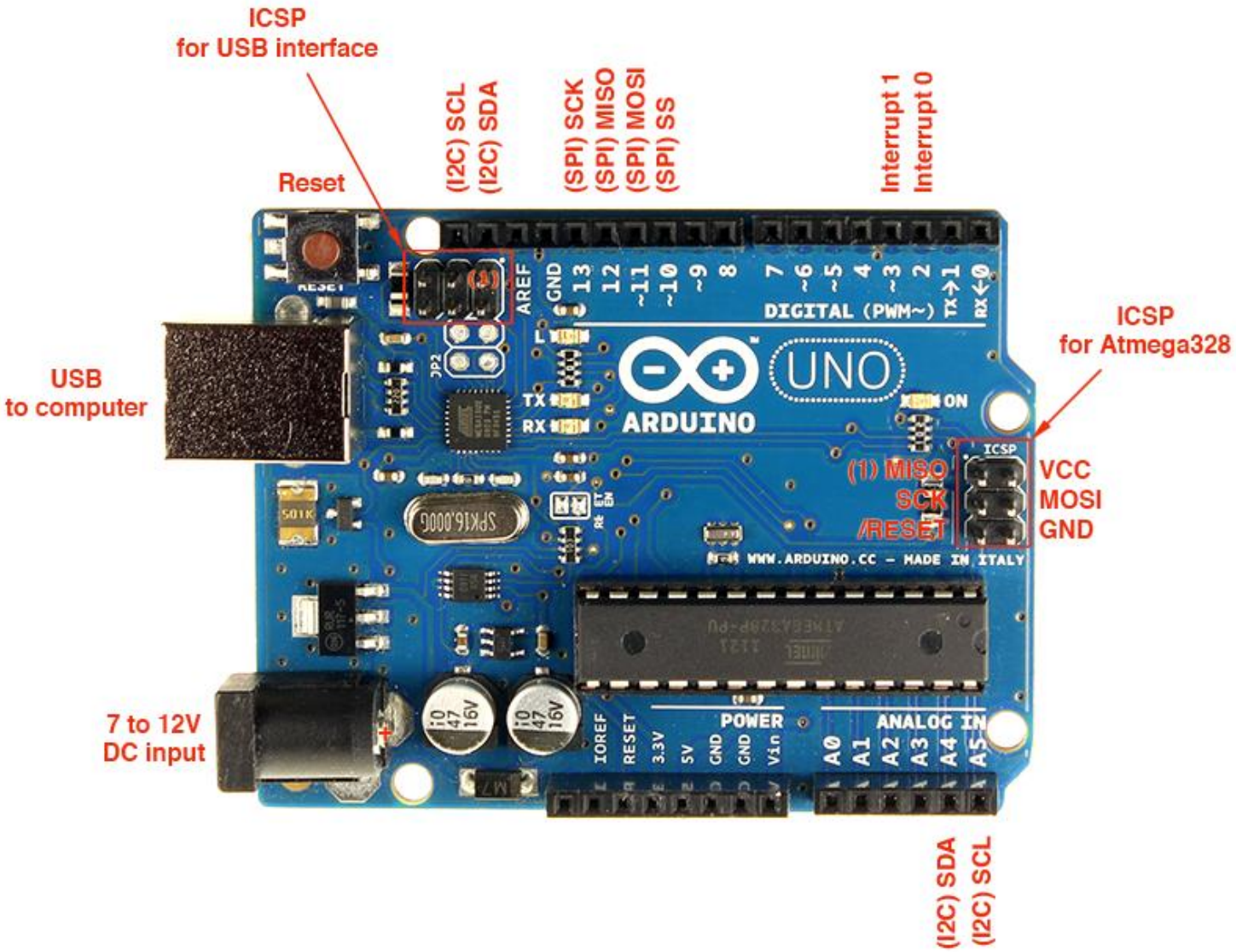


Figure 2.1: Arduino Uno r3

PIN Configurations:

1. Input and Output

The 14 pins (digital) in Arduino is utilized an input and output, digital Write(), pin Mode(),and digital Read() . Every pin can provide upto 40 mA and consists of internal pull-up resistors in between 20-50 kΩ. All of them operate at 5 volts (V).

2. Serial- The pin no. 0 and 1 are utilised for receiving and transmiting respectively the TTL serial data. They are connected to the pins of the ATmega8U2 USB-to-TTL Serial chip.

3. External Interrupts- Pin no 2 and 3. The pins are designed in order to trigger an interrupt for a low value, a falling or rising edge, and in case if there any sudden change in value.

4. PWM- Pin no. 3, 5, 6, 9, 10, 11,Gives 8-bit PWM output with the analogWrite() function.

5. SPI-(SS)-10, (MOSI)-11, (MISO)-12, (SCK)-13. These 4 pins are to support SPI communication from SPI library.

6. LED- Pin no. 13, is a built-in LED located at digital pin 13. If the pin is HIGH , the LED is off if the pin is LOW, LED is off.

Adruino Uno input for analog data (6 pins) are labelled as A0 till A5, each of these pins provide 10 bits of resolution. They generally used to measure measure from 0 to 5 volts(V) by default, however it is very much possible to alter the upper limit of the analog input acceptance range (5 volts) using the AREF pin and analogReference() function. Also, some of those pins have specialized functionality.

7. TWI- A4 (SDA pin) and A5 (SCL pin). They avail TWI communication by the use of Wire library.

8. AREF- It provides the reference voltage for the analog inputs. It is used with analogReference().

9. Reset-Resets the microcontroller.

2.3 Pulse Sensor

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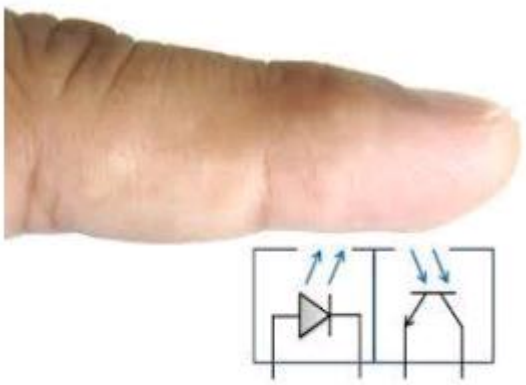


Fig2.1 working principle

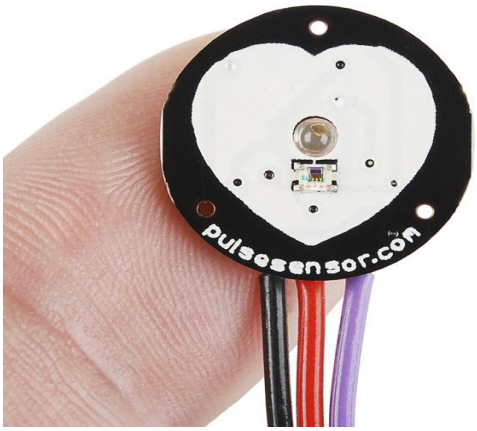


Figure 2.2:pulse sensor

Working principle:

The pulse sensor is based on principal of Photoplethysmography which is a simple and low-cost optical technique that can be used to detect blood volume changes in the microvascular bed of tissue.

2.3.1 Pulse Sensor Anatomy

The pulse sensor has a front having a symbol of heart.This is the portion which used to measure the heart rate after applying to to skin. The small hole on the front resides a LED that glows through from the back, and there is a little square photodiode . This LED throws the light onto either the finger and the body parts where the artery is visible where , thereafter the read by the pulse sensor the light that get reflected back. The cable consists of female head connector,which 24”color coded cable.

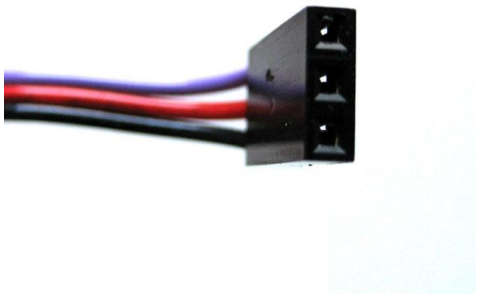


Fig2.3 female connector

RED cable = (3V - 5V)
BLACK cable = Ground
Orange cable = analog signal

The Pulse Sensor utilised in the following ways-
-It should be used by making connection to arduino with the help of jumpers.
-It should be inserted into a breadboard by using the with male connecters.

2.4 Bluetooth Module

Figure 2.5: Bluetooth Module HC-05

2.4.1 Specifications

Hardware characterstics

- sensitivity is -80dBm
- Radio Frequency transmit power +4dBm
- It should be operated under low power conditions i.e 1.8V
- Programmed input/output (PIO) is a method to send the data as well as info between a peripheral and the CPU, as same as a network adapter / Attachment storage device.
- UART interface with programmable baud rate.
- Employed with integrated antenna.
- Consists edge connector.

Software Features

- Baud rate-38400,
- Data bits-8,
- Stop bit-1,
- Parity-No parity,
- In case given a rising pulse in PIO0, device will remain disconnected.
- Status instruction port PIO1: low-disconnected, high-connected;
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.
- Automatically get connected to last device on power by default.
- Permits the paired devices to get connected as default.

2.4.2 PINOUT Diagram:

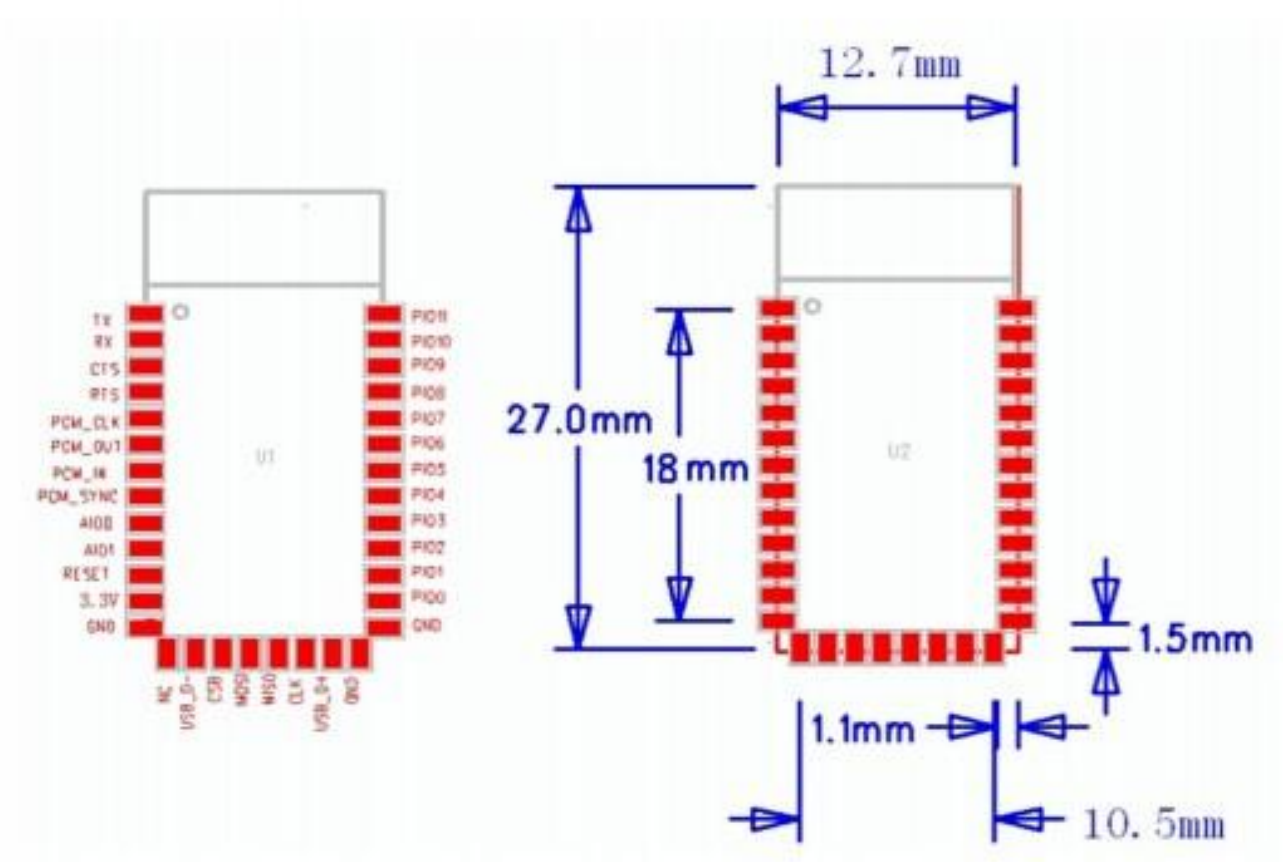


Figure 2.6: Bluetooth Module HC-06 Pinout diagram

2.4.3 Pin Description

The HC-06 Bluetooth Module has 6 pins. They are as follows:

1. ENABLE- In case if, the enable is at **LOW**, the Bluetooth module is not able to communicate and this indicates that Bluetooth module will remain turn off for the time being . And in the case if the enable is at **HIGH** /connected **to 3.3V**,the given Bluetooth module i.e the module is in on condition and is ready to communicate with the pared devices.

2. Vcc- Supply Voltage ranges between 3.3V- 5V.

3. GND- 0 volt (V),or ground

4. TXD & RXD- These two pins are used for transmission and reception after making the connection to the adruino in it is Rx And Tx pins .

5. STATE- The pin as is used for indicating status .when there is no connection made to blue tooth module the indicates a low. when there is no connection or pairing is done the LED glows without any interruption indicating the the low state. On the other hand, when the connection to other device is made module indicates a high state. If the state is high, the LED glows periodically, indicating the pairing.

6. BUTTON SWITCH: The button switch can be used for the purpose to connect the bluetooth module in AT mode.by using AT commands user will be able to alter the parameters of bluetooth module in case ,when the module is not connected to any other bluetooth device. But when the bluetooth module is connected with any other bluetooth device we aren't able to use AT commands.

Table 2.2:Pin Description of Bluetooth Module

NAME OF PIN	PIN No.	PAD Type	Description
GND	13,21,22	VSS	Ground Pot
3.3 VCC	12	3.3Volts	Integrated 3.3V(+) supply with an Over-chip linear regulator output range 3.15-3.3V
AIO0	9	Bi-directional	Programmable input/output line
AIO1	10	Bi-directional	Programmable input/output line
AIO0	23	Bi-directional RX EN	Programmable input/output line, control output in case of LNA
AIO1	24	Bi-directional TX EN	Programmable input/output line, control output in case of PA
PIO2	25	Bi-directional	Programmable input/output line
PIO3	26	Bi-directional	Programmable input/output line
PIO4	27	Bi-directional	Programmable input/output line
PIO5	28	Bi-directional	Programmable input/output line
PIO6	29	Bi-directional	Programmable input/output line
PIO7	30	Bi-directional	Programmable input/output line
PIO8	31	Bi-directional	Programmable input/output line

PIO9	32	Bi-directional	Programmable input/output line
PIO10	33	Bi-directional	Programmable input/output line
PIO11	34	Bi-directional	Programmable input/output line
RESET-B	11	CMOS input with weak internal pull-up	It should be low and greater than 5MS to cause a reset
UART-RTS	4	CMOS output, tri-stable with weak internal pull-up	UART requests for sending , an active low
UART-CTS	3	CMOS input with weak internal pull-down	UART clears to for sending ,an active low
UART-RX	2	CMOS input with weak internal pull-down	UART receive
UAR-TTX	1	CMOS output, tri-stable with weak internal pull-up	UART transmit
SPI-MOSI	17	CMOS input with weak internal pull-down	Serial peripheral interface data input
SPI-CSB	16	CMOS input with weak internal pull-up	Chip select for serial peripheral interface, active low
SPI-CLK	19	CMOS input with weak internal pull-down	Serial peripheral interface clock

SPI-MISO	18	CMOS input with weak internal pull-down	Serial peripheral interface data output
USB,-	15	Bi-directional	
USB,+	20	Bi-directional	
NC	14		
PCM-CLK	5	Bi-directional	Synchronous PCM data clock
PCM-OUT	6	CMOS output	Synchronous PCM data output
PCM-IN	7	CMOS input	Synchronous PCM data input
PCM-SYNC	8	Bi-directional	Synchronous PCM data strobe

2.4.4 Bluetooth module to arduino connection

hardware requirements

HC-06 Bluetooth Module

Arduino Uno r3

Arduino (Integrated development environment)

Hardware Connections

Since Vcc and Gnd of the module connected to Vcc and Gnd on the Arduino board. The pins Tx and Rx of the Bluetooth module is connected to Rx and Tx of the arduino uno respectively.

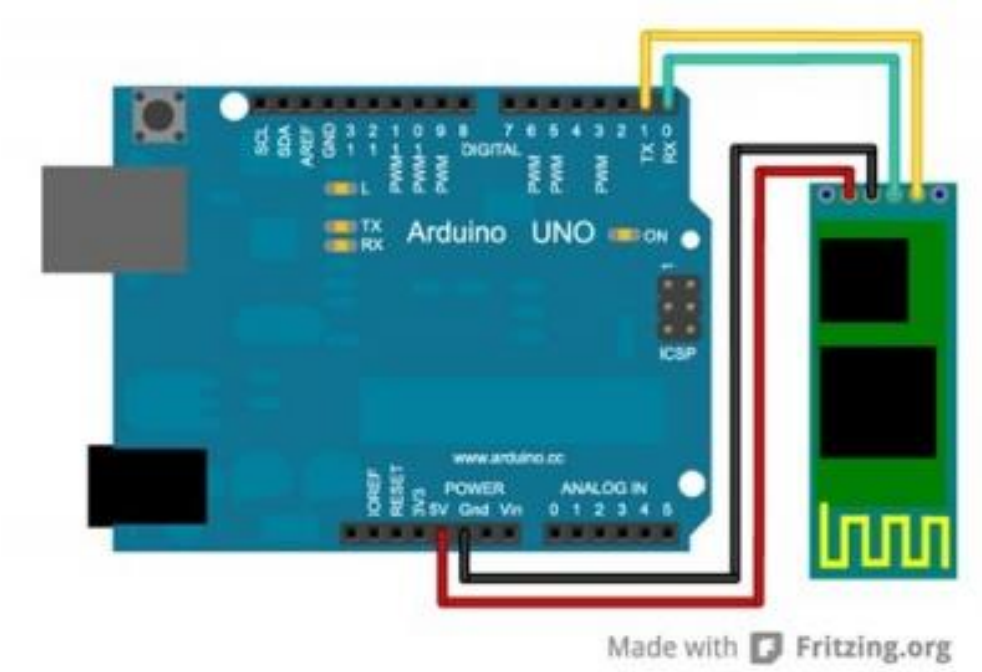


Figure2.7:Connecting Bluetooth Module to Arduino

2.5 Software Requirements

2.5.1 Arduino IDE

Adruino IDE (integrated development environment) , is a platform to write code the Arduino uno in different programming language which generate binary object code. It is genuine environment for the different controllers.

The Arduino (IDE) is the Arduino project which is a cross-platform means it can be used on different operating system, in which application written in the programming languages embedded and java .It provides functionalities like to edit the code, paste, cut copy, match the brace, emphasize the syntax. It also provides easier approach to compile and upload the instruction to Arduino.

Any program which is written in the IDE for Arduino is termed as a sketch. We can save all sketches on the development as .txt files using extension *.ino*. Arduino (IDE) earlier to 1.0 used to store the sketches using the extension *.pde*.

However, C and C++ are employed by the IDE with the help of rules of structuring the code. In order to change the executable code into a *.ino* file to hexadecimal encoding that is loaded into the Arduino board with the use of a loader program in the board's firmware.

2.5.2 Processing2

We have used Processing 2 Software for representing the heartbeat graphically

Processing is an open source computer programming language and IDE (integrated development environment) built for the visual design communities, new media art, electronic arts with the purpose to serve as the foundation for electronic sketchbooks and for teaching the fundamentals of programming in a visual context.

The aim of Processing is to allow non-programmers to learn computer programming aided by visual feedback. The Processing language is built on the Java language, but uses a simplified syntax and a GUI (graphics user interface).Processing 2 has a objective to try to learn the beginners the programming with visual feedback.

Processing consists of alternate to an IDE for doing the project is termed as a sketchbook.

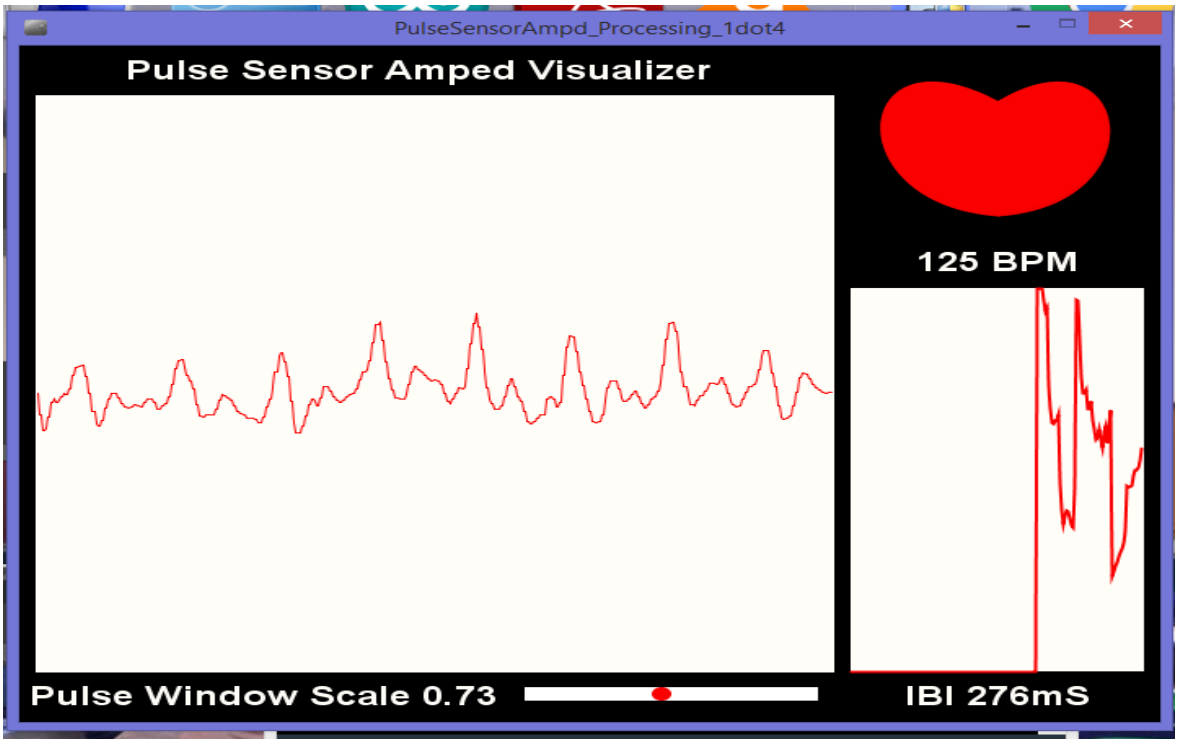
All Processing softwares is generally subclass of the Applet java class which is cause of most of the Processing language's features.

The other classes defined during coding in Processing2 can be called as inner classes util code is converted in pure Java the other classes within. This means that the use of static variables and methods in classes is forbid unless and until you explicitly tell Processing that you want to code in pure Java mode. Meaning thereby one can’t use variables which are static and methods in classes ,for doing so we have to get the processing acquainted that he/she willing to code pure java.

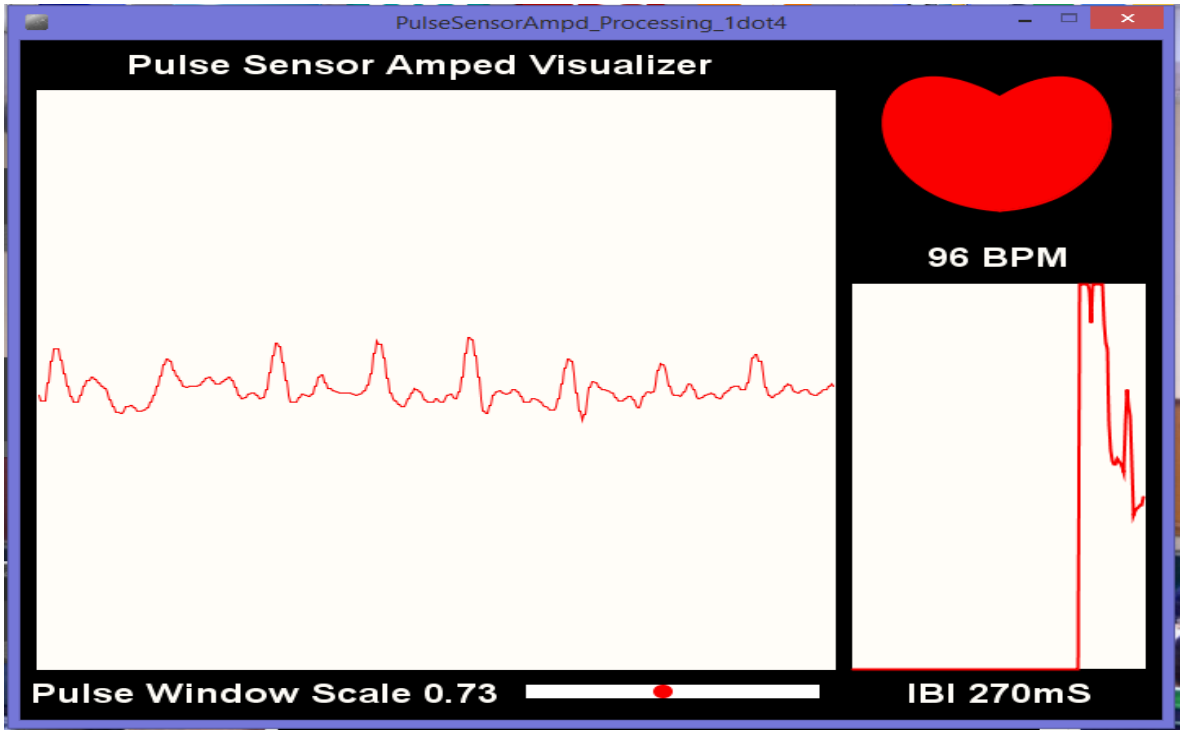
CHAPTER 3

PERFORMANCE ANALYSIS

We measured the BPM level of two persons which successfully determines the heart rate of the persons in Real Time. The results obtained are shown below.



This picture clearly shows the BPM level of first person.



This picture clearly shows the BPM level of second person**.**

CONCLUSION

We have utilized the amalgamation of problem solving skill of electronics engineering along with the medical-science in order to make the life better. India being the world's second most populated countries suffer severely from various cardiovascular problems, which resulted into large no of deaths in the country. Since the pulse rate can be measured and which can be used for pre-detection of multiple cardiac-arrests, therefore this project can contribute to national health. We can use simply our finger for heart rate measurement.

The device provides us the heart rate and hence the health of the patient can easily be taken care of. The device is cost effective and portable, it is not bulky as ECG and easy to use which avails decent flexibility in the system, which makes it comparable to various conventional heart rate measuring device.

FUTURE WORK

The Processing2 sketch that we have used, this version stores nothing, and displays the graph of the heart rate and time. There are lot opportunities for the improvement and make the project more human friendly.

- Alarm system can be implemented so that user will be able distinct the threshold.
- Android application can be made to make it more simple and flexible.

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