Integrated System for Monitoring Pulse Rate Using Pulse sensor

Joyonta Das Joy[1], Md. Raisul Islam Rifat [2], Fatema Tuz Zohora [3] and Md. Kamrul Hasan[4]
[1,2,3,4]Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology Chattogram-4347, Bangladesh.
[1]u1902082@student.cuet.ac.bd, [2]u1902081@student.cuet.ac.bd, [3]u1902079@student.cuet.ac.bd
[4]mkh21@cuet.ac.bd

Abstract-- This work involves the design and demonstration of a heart rate pulse sensor in real time. The goal of this project - "Monitoring pulse rate using sensor" is to construct an integrated system that monitors the pulse rate through finger via IR and provide the pulse rate in beat per minute (BPM). In this system we used a pulse sensor which, when a finger is placed on it, calculates the heartbeat of the person.

Index Terms - Heart beat; BPM; Pulse sensor; integrated system; Arduino Uno, LCD Display.

I. Introduction

This covid-19 pandemic has caused many problems to everyone and especially the most affected ones are the patients. Patients whose heart rate needs to be monitored regularly by the concerned doctors are affected by this Covid-19 outbreak. Due to the implementation of lockdown all over the world the situation got worse for the patients. This is where our idea flourished to help that section of patients whose heart rate needs to be monitored regularly. As we all know one of the fatal problems which cause the death of humans is respiratory problems. On the off chance that checking our well-being consistently, at that point we can identify various sicknesses by recognizing them well in advance. Many individuals have lost their lives to coronary diseases. In this way we are providing a solution to monitor the heartbeat of a patient remotely. We have researched and studied many research papers related to our problem statement. After reviewing many papers, finally we have chosen one paper, as our base paper and started working on the idea. In our project, "Integrated system for monitoring heart rate using pulse sensor", we have used reliable components such as Arduino Uno, which is the brains of the system, heart pulse sensor, which detects the heart rate of the body.

II. Literature Review

Different researchers used different methods and technologies to carry out the process of heart rate monitoring. Some of the important research works are reviewed in this paper.

[1] This paper includes working on a wirelessly display of Heart beat and temperature based on a microcontroller ATmega328 (Arduino Uno). Most monitoring systems that are used in today's world works in offline mode but their system has been designed in such a way that a patient can be monitored remotely in real time. This system consists of sensors which measures heartbeat and body temperature of a patient which is controlled by the microcontroller. Both the parameters are displayed in LCD monitor. The transmitted data is wireless and is send through microcontroller. Heartbeat is counted through pulse sensor in Beats per Minute while the temperature sensor measures the temperature and both the data are sent to the microcontroller for transmission to receiving end. Finally, the data are displayed at the receiving end. This system could be made available at a reasonable cost with great effect and accuracy.

[2] Sleep observance is used to observe the sleep timings in a whole day of human's life span. In this paper, respiratory and cardiac problems can be noted. Especially, during the night time there is an emergency purpose, the watch monitor is found to measure the patients' health. This is also known as sleep monitoring using the wearable watch type.

[3] In this paper, they have used a pressure mask with ECG device for the better application. The signal can be measured using the oximeter which is used to find the amount of oxygen flow in the blood. The viscous observation is the fluid resistance flow in the blood. The viscous observation is the fluid resistance flow in the blood. The pressure therapy

helps to cures any type of disorder in the human body.
[4] In this project, smart chair monitoring is used with the advanced feature telemonitoring with additional system being implemented. This can be urged to use because of the emergency health problems. The patients can be monitored by keeping them in smart chair very comfortably for the aged people. This can also be connected by using GSM, Bluetooth, Wi-fi and other network connections

III. Methodology

When a heartbeat occurs, blood is pumped through the human body and gets squeezed into the capillary tissues. Consequently, the volume of these capillary tissues increases. But in between the two consecutive heartbeats, this volume inside capillary tissues decreases. This change in volume between the heartbeats affects the amount of light that will transmit through these tissues. This can be measured with the help of a microcontroller. In Heartbeat/Pulse/BPM Rate Monitor using Arduino and pulse sensor, the pulse sensor module has a light that helps in measuring the pulse rate. When we place the finger on the pulse sensor, the light reflected will change based on the volume of blood inside the capillary blood vessels. This variation in light transmission and reflection can be obtained as a pulse from the output of the pulse sensor. This pulse can be then conditioned to measure heartbeat and then programmed accordingly to read as heartbeat count using Arduino.

Block Diagram:

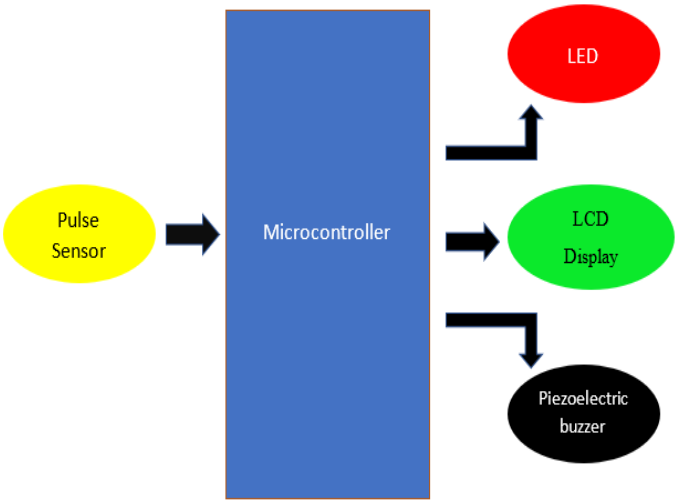

Figure 01: Block diagram of Integrated System for Monitoring Pulse rate using Pulse sensor

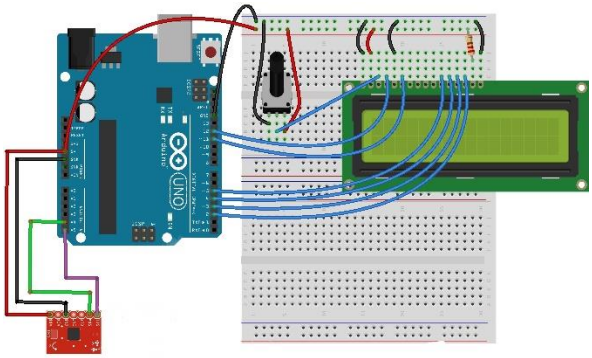

Figure 02: Circuit diagram of the following project

CODE:

```
#include <LiquidCrystal.h>
#include <Wire.h>
#include "MAX30105.h"
#include "heartRate.h"
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
MAX30105 particleSensor;
const byte RATE_SIZE = 4;
byte rates[RATE_SIZE];
byte rateSpot = 0;
long lastBeat = 0;
float beatsPerMinute;
int beatAvg;
void setup() {
  // put your setup code here, to run once:
Serial.begin(115200);
Serial.println("Initializing...");
if (!particleSensor.begin(Wire, I2C_SPEED_FAST))
  {
    Serial.println("MAX30105 was not found. Please check wiring/power. ");
    while (1);
  }
  Serial.println("Place your index finger on the sensor with steady pressure.");

particleSensor.setup();
particleSensor.setPulseAmplitudeRed(0x0A);
particleSensor.setPulseAmplitudeGreen(0);
lcd.begin(16, 2);
lcd.setCursor(3,0);
lcd.print("Heart Rate");
lcd.setCursor(5,1);
lcd.print("Monitor");
pinMode(13,OUTPUT);
delay(2000);
lcd.clear();
}
void loop() {
  // put your main code here, to run repeatedly:
long irValue = particleSensor.getIR();
if (irValue < 50000){
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Please put your");
  lcd.setCursor(0,1);
  lcd.print("finger");
  }
if (irValue > 50000){
  //lcd.clear();
  if (checkForBeat(irValue) == true)
  {
    long delta = millis() - lastBeat;
    lastBeat = millis();

    beatsPerMinute = 60 / (delta / 1000.0);

    if (beatsPerMinute < 255 && beatsPerMinute > 20)
    {
      rates[rateSpot++] = (byte)beatsPerMinute; //Store this reading in the array
      rateSpot %= RATE_SIZE; //Wrap variable

      //Take average of readings
      beatAvg = 0;
      for (byte x = 0 ; x < RATE_SIZE ; x++)
        beatAvg += rates[x];
      beatAvg /= RATE_SIZE;
    }
  lcd.setCursor(0,0);
  lcd.print("Heart Rate :    ");
  lcd.setCursor(0,1);
  lcd.print(beatAvg);
  lcd.print(" ");
  lcd.print("BPM  ");
  digitalWrite(13,HIGH);
  delay(10);
  digitalWrite(13,LOW);
  }
  }
}
```

IV. Software Simulation

The circuit was simulated in Proteus v8.11 before hardware implementation. In this software, all the components required were selected from the device library and we added Heart rate sensor library and Arduino library additionally. The program was compiled using Arduino IDE and the ".hex" file of the program was loaded into the Arduino Uno.

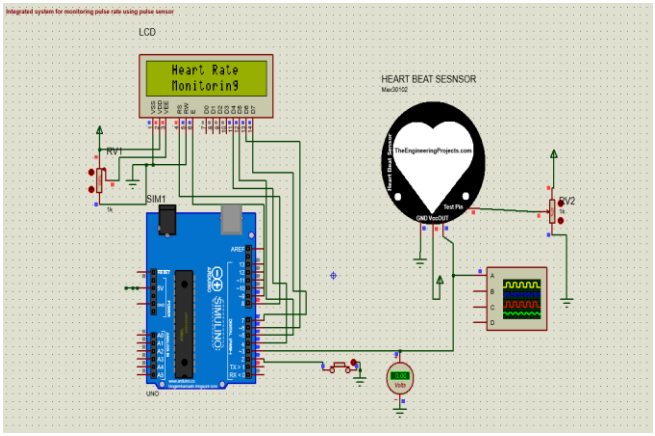

Figure 03: Circuit Configuration in Proteus Design Suite.

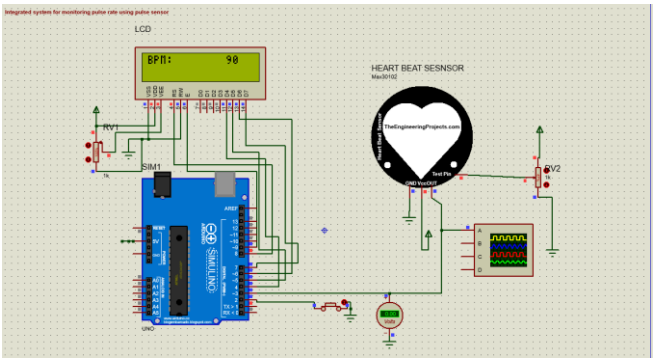

Figure 04: Simulation result in LCD Display.

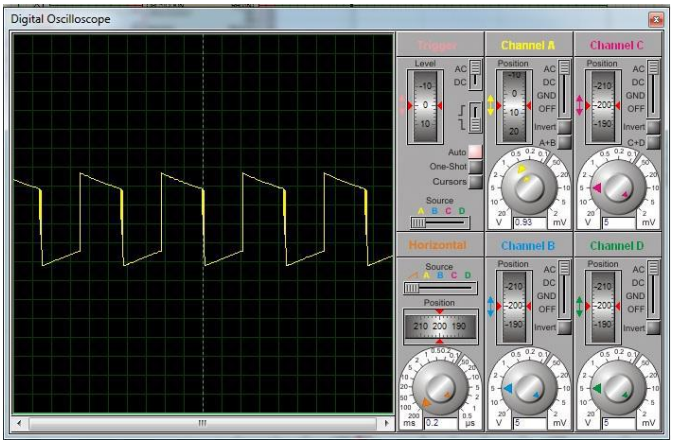

Figure 05: Equivalent Output in Digital Oscilloscope.

V. Hardware Requirement

The components which we used are:

1. Arduino UNO
2. 5V Passive Buzzer.
3. LCD (16x2 Alphanumeric Display).
4. LED.
5. Pulse sensor (Max30102)
6. 9V Battery.
7. 10k potentiometer.
8. PCB.

Arduino Uno: The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

Figure 08: - Arduino Uno

Passive piezo buzzer: Piezo buzzers are simple devices that can generate basic beeps and tones. They work by using a piezo crystal, a special material that changes shape when voltage is applied to it. It's lightweight with a simple construction, and it's typically a low-cost product.

Figure 09: - A passive piezo buzzer.

LCD (16x2 alphanumeric display):

A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

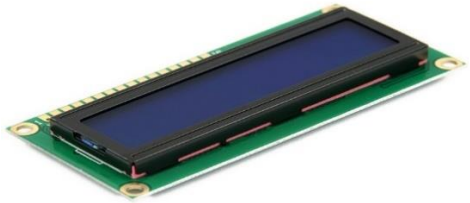

Figure 10: - 16x2 alphanumeric display.

Battery:

A 9V battery is the source of electric power in this project. It is connected to the Arduino power port by a DC barrel jack. All the electronic components used in this project receive power from this battery via the Arduino.

Figure 11: -9V battery.

Pulse sensor (Max30102):

The module features the MAX30102 – a modern (the successor to the MAX30100), integrated pulse oximeter and heart rate sensor IC, from Analog Devices. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry (SpO2) and heart rate (HR) signals Behind the window on one side, the MAX30102 has two LEDs – a RED and an IR LED. On the other side is a very sensitive photodetector. The idea is that you shine a single LED at a time, detecting the amount of light shining back at the detector, and, based on the signature, you can measure blood oxygen level and heart rate.

Figure 12: - pulse sensor (Max30102)

Potentiometer:

It is a 10K Ohm 3Pin 15mm Shaft Potentiometer. This is used for adjusting various parameters like voltage, current, etc. in an electronic circuit. Potentiometer are very useful in changing the electrical parameters of a system. It is a single turn 10k Potentiometer with a rotating knob. These potentiometers are also commonly called as a rotary potentiometer or just **POT** in short. These three-terminal devices can be used to vary the resistance between 0 to 10k ohms by simply rotating the knob. A potentiometer knob can also be used along with this POT for aesthetic purposes.

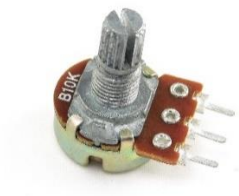

Figure 13: - 10k potentiometer

VI . Hardware Implementation

All the components have been assembled on a PCB board. It can be observed that, the circuitry is simple and occupies
little space. The complete unit can be easily put together into a small package to make it a handy device.

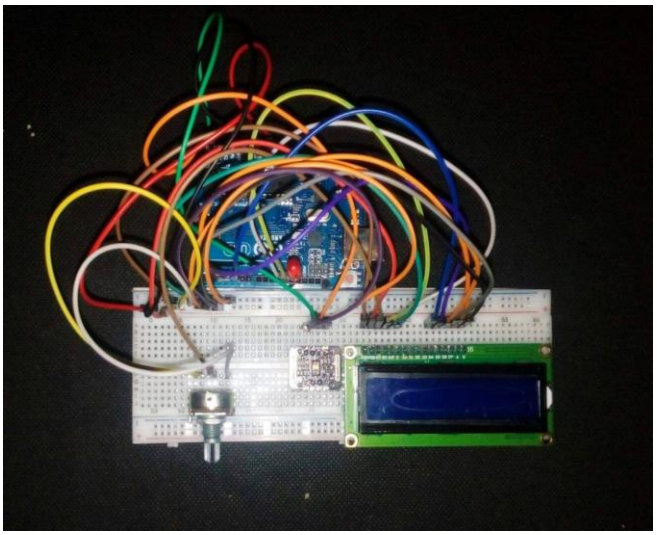

Figure 06: Breadboard Implementation of the project.

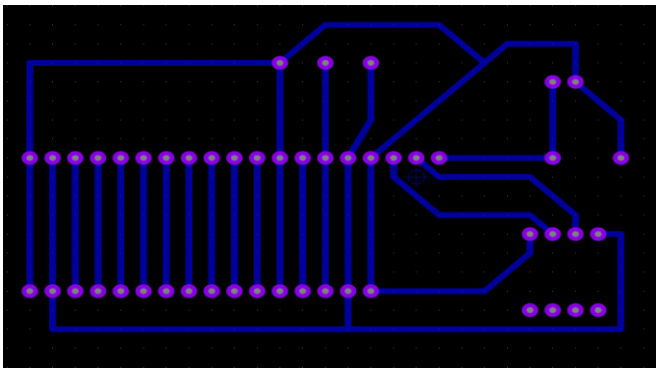

Figure: PCB Layout of the project

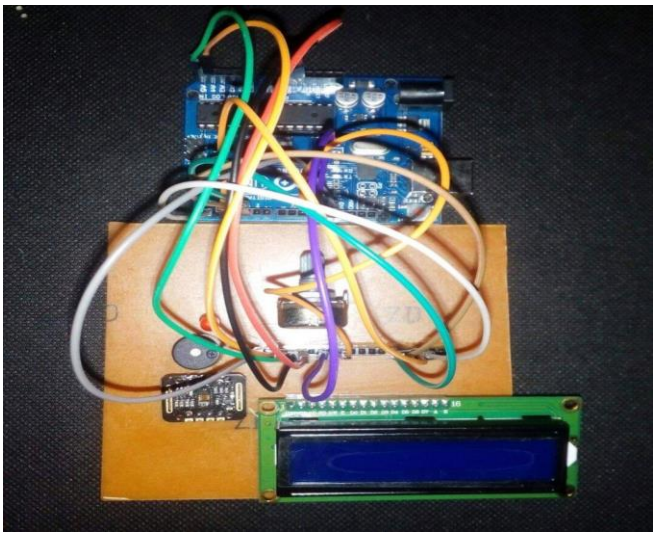

Figure 07: PCB Implementation of the project

VII. Result and Output

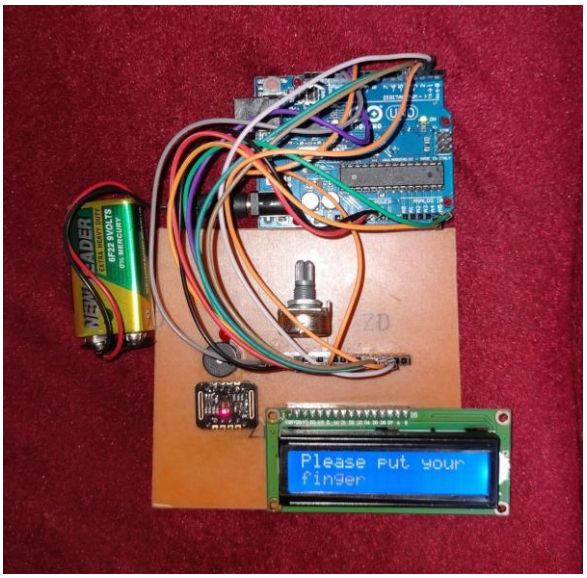

Figure: Project prototype of Integrated System for Monitoring Pulse rate using Pulse sensor

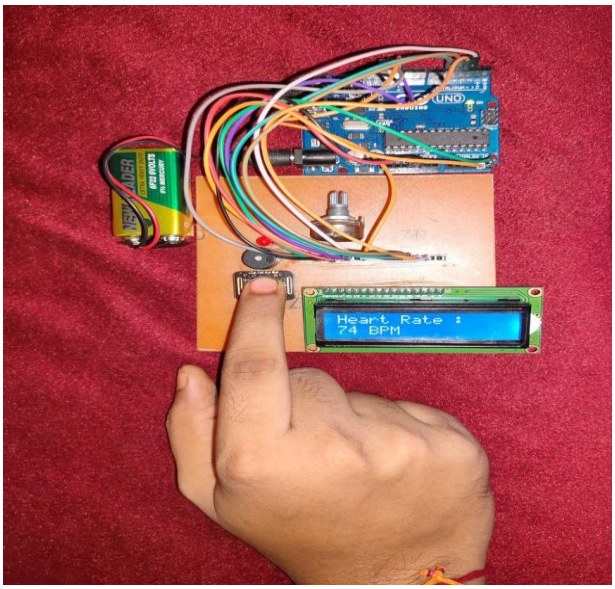

Figure: Output of the of the following project.

VIII. Cost Analysis

Component	Total cost (BDT)
Arduino Uno	1100
Max30102	650
LCD (16x2 Alphanumeric Display).	200
10k potentiometer.	30
PCB.	40
9V battery	30
5V Passive Buzzer	15
Battery Clip	30
Total	2095 BDT

IX. Application

- A simple project involving Arduino UNO, 16×2 LCD and Heartbeat Sensor Module is designed here which can calculate the heart rate of a person.
- This project can be used as an inexpensive alternative to Smart Watches and other expensive Heart Rate Monitors.
- Players, athletes can use this pulse sensor during their exercise.
- Before consulting to physician anyone can check their pulse by this.

X. Limitations

1. Failure in any hardware component might lead to inaccurate results (outputs).
2. Sometimes sensor can work inappropriately.
3. Indoor external light can influence to give false result to sensor.

XI. Future Work

The current paper presents a heart rate measuring device. Some features can be added in this project like measure oxygen saturation levels, and body temperature. To decide the patient's health status, the obtained measurements can also be monitored using an in-house mobile application with an integrated alarm system acquainted by both the physician and patient. This device can help the patients to check their health status and let the physicians provide suggested course of action.

XII . Conclusion

Biomedical engineering (BME) is the application of engineering principles and techniques to the medical field. It combines the design and problem-solving skills of engineering with medical and biological sciences to improve patient's health care and the quality of life of individuals. A medical device is intended for use in the diagnosis of a disease, or in the cure, treatment, or prevention of diseases. The Pulse Sensor is a well-designed low-powered heart-rate sensor for the Arduino. It can be used by students, artists, athletes, manufacturers, and game and mobile developers who want to incorporate live heart-rate data into their projects. And the best part is that this sensor plugs right into Arduino and easily clips onto a fingertip. It is also relatively small with holes, so it can be sewn into fabric.

XIII . Acknowledgement

We are grateful to our course teacher, **Md. Kamrul Hasan**, Lecturer, Department of EEE, Chittagong University of Engineering and Technology, for his continuous support and dictation for implementing the project successfully

References

[1] Heartbeat and Temperature Monitoring System for remote patients using Arduino Vikram Singh, R. Parihar, Akash Y Tangipahoa D Ganorkar (IJAERS), International Journal of Advanced Engineering and Science eissn- 2349-6495

[2] Philippe Renevey, Ricard Delgado-Gonzalo, Alia Lemkaddem", "Respiratory system and cardiac system can be evaluated at night using a wearable watch viewing system", IEEE 2018.

[3] Mark Gardner, Sharmil Randhawa, Gordon Malouf, and Karen J.Reynolds, "A changed Mask for Contin4uous viscous observation throughout Positive Airway Pressure Therapy", 2018.

[4] "Raja Lavanya, M.Nivetha, K. Revasree, K.Sandhiya" "Smart Chair-A Telemedicine Based Health Monitoring Systems using pulse sensor", IEEE , 2018.

[5] Kale N, Bhagwat D 2018 WEBCARE HEALTCHCARE MONITORING SYSTEM USING IOT *International Journal of Advance Research in Science and Engineering* Volume No.07, Issue No.(03), January 2018.

[6] Laulkar R, Daimiwal N 2015 Applications of Finger Photoplethysmography *International Journal of Engineering Research and Applications* Volume. 2, Issue 1, Jan-Feb 2015, pp.877-880.

[7] Wei M, Chang R, Wang C, Lin C, Chen H 2016 Design of a Flexible PPG Signal Processing Wireless Device *International Conference on Consumer Electronics-Taiwan,*

[8] Mohan P, Nagarajan V, Nisha A 2017 A Frame Work to Estimate Heart Rate and Arterial Oxygen Saturation (Spo2) *International Conference on Communication and Signal Processing* April 6-8, 2017

[9] M. H. Bhuyan, M. T. Hasan and H. Iskander, "Low-Cost Microcontroller Based ECG Machine," International Journal of Biomedical and Biological Engineering, vol. 14, no. 7, 2020, e-ISSN : 1307-6892, pp. 192-199.

[10] E. A. P. J. Prawiro, C.-I Yeh, N-K. Chou, M-W. Lee and Y-H. Lin, "Integrated Wearable System for Monitoring Heart Rate and Step during Physical Activity," Journal of Mobile Information Systems, Hindawi Publishing Corporation, Special Issue, Vol. 2016, Article ID 6850168, 10 pages, doi: http://dx.doi.org/10.1155/2016/6850168.

[11] J. Arora, Gagandeep, A. Singh, N. P. Singh, S. S. S. Rawat and G. Singh, "Heartbeat Rate Monitoring System by Pulse Technique Using HB Sensor," 2014 IEEE International Conference on ICICES, S. A. Engineering College, Chennai, Tamil Nadu, India.