SMART HEALTHCARE MONITORING SYSTEM IN IoT

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ABSTRACT

Recently, the implementation of Raspberry Pi controlled monitor system performs well defined medical applications for diagnosis of DCM Healthcare. The development of IoT (Internet of Things) is an important application domain in medical field that draws huge interest from industry, research field and public sector. In medical applications, the temperature and humidity data are often major considerations. The main objective of this framework is to give immediate necessary services where cardiac patient can measure body temperature, heart rate in bpm and body position by themselves and promote hygienic environment. The framework is tested for a volunteer to check the body temperature, heart rate and observe the movement of body position and view the ECG graph using Serial Plotter Software on a local server.

Keywords: Arduino Uno, Bluetooth 4 BLE module, Raspberry Pi model B+, Electronic sensors, 16X2 LCD module, WI-FI/4G.

1. INTRODUCTION

Now, IoT is one of the buildings blocks that is considered to be use for developing smart system for Healthcare services. “Objects” connected to the internet are highlighted to cross 20 billion in the upcoming smart Technology. Over a billion “smart products” connected to the internet, recently IoT is about networking of physical objects and these physical objects are embedded to exchange data in between the IoT components and also sense surrounding environments in which they are operating. In environments like hospital and clean room, precise environment control is paramount in meeting your objectives of patient and product safety. The data such as temperature and humidity are collected and transmitted for data analysis. With the help of ECG and heart rate sensor, cardiac disease could be diagnosed with subject to body position. The uploaded data will be sent to the physicians / Care takers. It provides necessary services near the patient if any problems in breathing due to the harsh environments. The message notification will also be sent if any serious abnormalities.

2. LITERATURE REVIEW

The evaluation of monitoring vital parameters for healthcare services can be achieved by different researches with the advancements in IoT networking. These are functioning in medicinal domain and shown improvements in maintaining the health reward of a patient.

Tanveer Reza et.al. [1] focuses on android based pulse monitoring system which compromises heart monitor App for the mobile devices using android studio and web portal as doctor’s interface by the user using Bluetooth module HC-05. The developed system performs analysis of beats per minute of individual data on the website and predicted as a graph. The framework of the system consists of Arduino as a gateway which is interfaced with the pulse sensors.

Ravi Kishore Kodali et.al. [2] illustrates the experimental setup for the healthcare based IoT device, which monitors the temperature of a patient using network protocol of XBee S2 modules. The system has used its gateway as Intel Galileo generation 2 bound and interfaced with LM 35 temperature sensor.

Surya Deekshith Gupta et.al. [3] describes about the system design for Healthcare on IoT using Raspberry Pi. In this System, the combination of Raspberry Pi and GSM module are used to observe different ECG mechanisms which are monitored to know the type of cardiac illness by using python coding algorithms. The result of heart beat data is automatically updated in website database using MySQLdv module. Wi-Fi updates can also be accessed using USB 2.0 port which consists of an Ethernet port for network connection.

Punit Gupta et.al. [4] offers a service survey of the concept of medical care in order to provide medical data information by interfacing heart beat and temperature sensor through internet via Wi-Fi / Ethernet. The developed system has a 2nd generation Intel Galileo board and patient’s data is monitored on live graph using a Xampp based database server to analyse the health reports for tracking further.

Jusak Jusak et.al. [5] has examined a smart system for recording of all the sounds made by the heart during a cardiac cycle using phonocardiography (PCG). A framework was made similar to mobile module, working on the basis of Internet of Medical Things. The cardiac activity can be detected in the form of ECG or PCG signal using heart sound sensor. Doctors can access the patient’s data, anywhere through the web server media using cloud data centre. The performance of the system is examined in terms of sampling frequency band ratio and bandwidth utilization parameters.

Omar S.Alwan et.al. [6] has installed the system to monitor body temperature parameter cone through two transceivers. The system is based on wireless transmission consists of first devices as raspberry Pi-2 and Zigbee module while the second device consists of Arduino through Zigbee shield.

R.Kumar et.al. [7] describes a smart monitoring system using Raspberry Pi without environmental sensors and alert modification.

Emre Oner Tartan et.al. [9] demonstrates an android application for geo-location based health monitoring consultancy using alarm system. It includes real time remote monitoring of heart rate, geo-location tracking of a patient, decision making for different alarm situations in the smart phones and providing consultancy modules with the health experts to get advice. The prototype framework is equipped with Arduino Uno board and a wireless transmission of sensor data (GPS sensor and pulse sensor) to the smart phone via Bluetooth HC-05module through USB cable. The internet connection over cellular networks is based on 3G / 4G wireless technologies.

Kavita Jaiswal IIIT et.al. [16] Presents a system to measure only three biomedical parameters such as temp, ECG, BP using Raspberry Pi gateway and Docker container method.

3. COMPONENTS USED IN SYSTEM

3.1. Arduino Uno

It is an open source electronic platform, which is microcontroller-based as well as programmed with Arduino IDE. It comprises of following components: USB connector, Power port, Microcontroller, Analog input pins, Digital I/O pins, Reset switch, Crystal oscillator, USB interface chip, and TX - RX LEDs. The power source for this board can be provided by AC – DC adapter or batteries, even USB ports can be used. Through the USB port, program can be uploaded from Arduino IDE to the board. The board can be operated with a supply voltage of about 5 v through a power jack. The board can withstand a maximum of 20 volts. Voltage regulator comes into play at the time of high supply voltage in order to prevent it from burning.

The Uno board has ATmega328P microcontroller which consists of 28 pins. ATmega328P has a flash memory of 32 KB, 2 KB RAM. It also has a non-volatile type of EEPROM memory of 1 KB. Arduino boards are pre-programmed, thereby making it user-friendly. In addition to this, it allows us to import new programs directly into the device without the support of external programmer.

The Analog input pins read voltage only. It is totally 6 pins in number, labelled as Analog 0, 1, 2, 3, 4, 5, input pins. The Digital pins can act as both input and output pins and are labelled from digital 0 to 13. It behaves as a source of power supply (5 V at 40 mA), when used as output pins. In case of input pins, they read signals.

When Reset switch is turned on, it sends pulse to the microcontroller's Reset pin to run the program. The Crystal oscillator has a frequency of 16MHz. The USB interface chip transforms USB level signals to Arduino board level signals. Whenever the Uno board acquires data, the TX (transmit) and RX (Receive) indicator flickers.

3.2. LM35 Body Temperature Sensor

The LM35 device is used to observe body temperature. The working of this sensor is based on its Analog output voltage which changes in accordance to the body temperature. The temperature readings are calibrated in Celsius (Centigrade). External circuitry for calibration is not needed. The sensitivity of LM35 is10 mV/°C i.e., for every 1 degree rise in temperature, the sensor measures 10mV. E.g. 270 mV means 27°C viewed on the LCD display in our system. It is a 3-terminal linear sensor which has a measuring range of -55 °C to 150°C. The accuracy of LM35 is comparatively high to that of Thermistor output.

3.3. DHT11 Humidity and Temperature Sensor

The DHT11 Humidity and Temperature sensor is popularly available in module of 4 pin package, in which three pins are only used. These pins are named as V_{CC}, Data pin and Ground pin. It uses digital pins to communicate with the microcontroller unit and also this module has inbuilt 5K pull up resistor with filtering capacitor. Hence it is easy to interface DHT11 with Arduino without having any additional components externally. The function of three pins is as follows;

- Pin 1 is Supply pin V_{CC}, whose supply voltage is from 3.5 V DC to 5.5 V DC.
- Pin 2 is Data pin that outputs the temperature and humidity values as Digital serial data.
- Pin 3 is Ground pin, which is commonly grounded in the circuit.

The main features are:

- The Temperature can be measured from 0 ◦ C to 50 ◦ C.
- The Humidity is from 20% to 90% with 5% accuracy.
- It has low power consumption.

- The current recorded is 0.3 mA

3.4. AD8232 ECG Sensor

Recently people have been affected by cardiac problems. As a result many individuals lose their lives and 20% of ischemic strokes are caused by cardiac disease. In this domain, serious attention must be taken for such coronary heart diseases. By examining or observing the ECG signal, the disease can be prevented at the initial stage. Hence, we developed a framework using AD8232 sensor and Arduino, with the help of Serial Plotter software to plot ECG graph. The AD8232 is a small chip used to analyse the pumping action of heart muscles. These electrical signals ultimately give rise to ECG or Electrocardiogram. The purpose of ECG is to analyse signals of the heart, irrespective of the person's body state. Thus, we can interface AD8232 heart rate sensor with Arduino IDE to observe the signal through a Serial Plotter. ECG can be interpreted by examining the various amplitudes of the waveform. This sensor is a single lead Analog heart rate sensor which is low cost ECG module attached to three electrodes. It gives voltage between left and right arm. The 8232 chip reduces the noise caused due to ECG signal and gives the output, since it acts as an op amp. It is normally tuned to a higher filter cut off from the basic intervals PR and QT of ECG wave. The cardiac movement can be charted using serial plotter and attain output as an Analog reading. It has three pins at the input side labelled as RA (Right arm), LA (Left arm) and RL (Right leg) which are internally connected to the jack. At the output side it has around six pins and out of these only five pins are used to deliver the output, they are labelled as GND pin, 3.3 V supply pin, O/P pin, LO – (leads-off detect -) and LO + (leads-off detect +).The LO- and LO+ are made connections with the Arduino Digital pins D11 & D10 respectively to detect the situations. The electrode pads with cable of three different colours; black for RA signal, blue for LA signal and red for RL signal are fixed to the human body to monitor heart rate.

3.5. ADXL335 Body Position Sensor

The objective for positioning of a patient is to prevent shoulder complications such as pain, body sore, respiratory problems and swelling of the Extremities. ADXL335 is a Breakout board for the 3 pivot accelerometer from Analog devices, which is based on the principle of piezoelectric effect. It is a small, thin, low power, complete 3-axis device and is a long proven line of Analog sensors. It is also available in a low profile with extremely low noise device. The ADXL335 is a triple pivot MEMS accelerometer with low power consumption of only 350 micro Amps. It has single supply operation in the range from 1.8V to 3.6VDC. Board comes completely assembled and achieves excellent temperature stability. It is tested with components which are installed externally. Bandwidth can be adjusted to suit the application with single capacitor for axis, with a range of 0.5 Hz to 1600 Hz for the X and Y axis, and a range 0f 0.5 Hz to 550 Hz for the Z axis. The user chooses the bandwidth of the accelerometer utilizing the C_X, C_Y, and C_Z capacitors at the X_{OUT}, Y_{OUT}, and Z_{OUT} pins. The ADXL335 is a 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead outline chip scale bundle (LFCSP_LQ).

3.6. MAX 30105 Heart Rate Monitor Sensor

The integrated heart rate monitor sensor MAX 30105 with Arduino is operated in between 1.8V to 3.3V. It is an optical sensor which comprises of two LEDs in a single photo detector and processing an analog signal in low noise to detect heart rate signals. It carries 14 pins in which pin no.12 is for GND and pin no.11 for V_{DD} supply .There is no connection with pin nos. 1, 7, 8, and 14 designated as (SCL). Pin no.2 is clock input and pin no.3 is clock data which is designated as SDA. Pin no. 4 is used for the power ground of the LED driver designated as V_{GND}. The supply pins V_{DD} and V_{GND} of this sensor is connected to Arduino 3.3V and Arduino GND. The SCL and SDA of MAX 30100 to A_5 and A_4 pin of Arduino. Only four pins are interfaced with Arduino to function it. 16X2 LCD display is used to view the value of Beats per minute (BPM). By placing our finger on sensor after uploading source code/program, The BPM value will be displayed on the screen of LCD.

3.7. Bluetooth 4 BLE Module

The HM-10 Module establishes wireless communication, where short distance of less than 100mts is used. It is available in 34 pin module .Out of 34 pins, 4 pins are only used to establish a data communication through either RS232 or UART Interface. The standard power supply connected with the module is +3.3 V DC. It is very preferably used where power consumption is low. The V_{CC} pin is the input power of the module that connects the supply voltage. This module is very economical and easy to interface with Arduino through UART communication protocols using UART – T_X (Transmit) pin and UART –R_X (Receive) pin .The ground pin of both module and Arduino always connected to make the common ground with power (Voltage reference) .The latest module of HM-10 is designed to the CC2540 or CC2541 BLE System on a Chip (SoC) by using Texas Instruments and can withstand current up to 50milliamps. The maximum speed can be achieved up to 3Mbs speed. The data speed is very fast with 24Mbs rate. It uses the 2.5GHz frequency band for the short range of 100mts distance in an open space. It has no limitations in sending bytes with HM-10.

3.8. 16 X 2 Liquid Crystal Display

It has **2 Rows and 16 Characters**. It is cheap in cost, programmable based, low energy consumption and no restrictions to display characters. It has 16 pin configurations. Pin 1 is GND pin and pin 2 is supply pin V_{CC}. Pins 3-6 are control pins, whereas pins 7-14 are data pins. Pin 15 is connected to +5V and pin 16 is –ve pin which is connected to the GND. It is also referred as electronic display module and available in many usages for seven segments. It is operated between 4.7V to 5.3V and current capacity is 1mA without backlight. It carries alphanumeric characters and numbers. Both 4 bit and 8 bit mode make possible to display in function. It is a flat panel display used to view the output results.

3.9. Raspberry Pi

The gateway IoT platform has more updated features in my prototype model, when compared to the existing models. In this model, the type of processor is BROADCOM BCM2837BO, CORTEX A- 53. It carries 64 bit SoC with a clock frequency of 1.4GHz, Which was upgraded on the P13 Plus. The SD RAM memory is LPDDR2 type having 1GB capacity. The IoT platform connectivity is broadly upgraded with multiple protocols in comparison with existing models. It has supported 2.4GHz and 5 GHz IEEE 802.11B / G/N/AC wireless LAN , Bluetooth 4.2 module/ HM-10 Bluetooth Module followed by BLE Gigabit Ethernet over USB 2.0 whose throughput is maximum 300mbps (4 X USB 2.0 ports) .It is an extended 40 pin GPIO Header ,which is used to access a supply voltage of 5 Volt DC .The operating system loads and access the data storage with the support of Micro SD card . It can be powered with an input supply 5Volt / 2.5 A DC through Micro USB connector. The power over Ethernet is enabled in this upgraded model.

Video and Sound features: 1 X full size HDMI port, MIPI CSI Camera port and MIPI DSI Display port , 4 whole stereo output and composite video port.

Multimedia features: H.264, MPEG-4DECODE (1080p30); H.264 ENCODE, provides high definition recording of 1080p30 and OPENGL ES 1.1, 2.0 3 B graphics.

4.0 WI-FI/4G LTE Connectivity

4G is more secure when compare with public Wi-Fi spots. Whenever log into an unknown public Wi-Fi spot, there is a chance that device and information are forcible to attack. 4G networks offer better privacy, security and safety. 4G is fast and easy to use in comparison with 3G. With videoconferencing, a patient in a rural area with 4G coverage can receive a consultation from a world-renowned specialist in an urban location without ever leaving their neighbourhood or home. Furthermore, by receiving regular updates on a patient's vitals from telehealth devices, physicians can be immediately alerted to a potential medical problem that requires treatment.

5. Algorithm of Proposed Model:

Input: Environmental data and patient data.
Output: Visualize the current status of patient data and environmental conditions.
Step 1: Begin.
Step 2: When slave circuit is switched on. The wireless sensors capture the environmental data of patient room and patient's vital data.
Step 3: Transform the sensed data to the open source microcontroller via wireless network.
Step 4: Monitor both the data continuously on the display screen of LCD in regular intervals.
Step 5: Analysis of observed data at the slave circuit.
Step 6: Enable self-care service according to the output data observed.
Step 7: Analysis of observed data at the Master Circuit.
    Step 7.1: If data value reaches the abnormal
        Then Patient_Status = Unstable. Go To Step 8
    Step 7.2: Else Patient_Status = Stable.
    Step 7.3: Return Step 4.
Step 8: Transform data to the processor of master circuit for processing and transmit to the cloud database for analysis.
Step 9: Create alert notification to client 1 (patient).
    Step 9.1: Deliver the required emergency services.
Step 10: End

6. METHODOLOGY

The proposed system will be carried out in two circuit parts which consists of slave and master circuit. The implementation of experimental setup is shown below.

6.1. Slave Circuit:-

The different wearable electronic wireless sensors are interfaced with Arduino, shown in Fig.1.

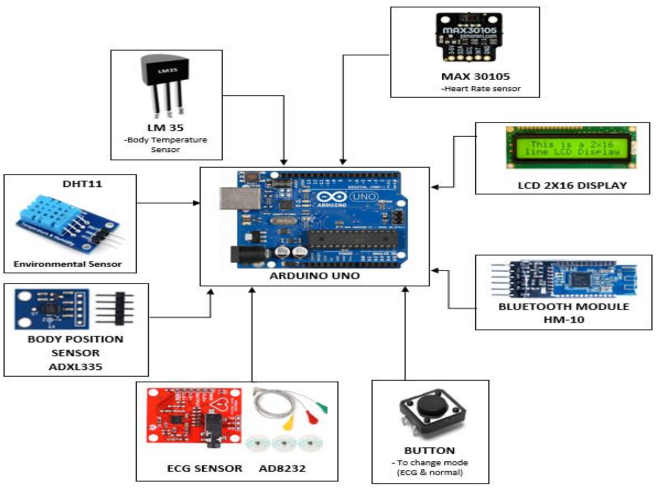


Figure.1.Architecture of Slave Circuit

The various physiological data such as body temperature, humidity, room temperature, body position and ECG are monitored using sensors and processed data for analysis and store the data on regular intervals. The LCD display is used to view the above specified data to ensure the status of self-healthcare and comfort of Room Parameters at the patient. Slave circuit is operated in two different modes namely, Normal mode and ECG mode. In ECG mode, the cardiac movement of the heart is plotted as a graph using **Serial Plotter** software if electrodes are properly fitted into our body without the intervention of parameters. A single lead ECG sensor is used to visualize the changes in amplitude of QRS wave and QT interval variability. It provides the information of cardiac thickness and cardiac volumes as well as heart rhythm. The ECG data is transmitted wirelessly for further analysis and store the output result as an Analog reading, whereas in normal mode of operation, the other physiological data such as body Temperature, Room Parameters, heart rate are viewed on the LCD display without the intervention of ECG. The data of Room Parameters and body Posture are also transmitted wirelessly to the master circuit via HM-10 BLE module for further analysis and store the output result on the webpage of local server.

6.1.1. Programming code for Arduino

```
#include <Wire.h>
#include "MAX30105.h"
#include <LiquidCrystal.h>

#include "heartRate.h"
#include "dht.h"
#define dht_apin 6
dht DHT;
MAX30105 particleSensor;
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

const byte RATE_SIZE = 4; //Increase this for more averaging. 4 is good.
byte rates[RATE_SIZE]; //Array of heart rates
byte rateSpot = 0;
long lastBeat = 0; //Time at which the last beat occurred

float beatsPerMinute;
int beatAvg;

void setup()
{
  Serial.begin(9600);

  lcd.begin(16, 2);
  Serial.println("Initializing...");

  // Initialize sensor
  if (!particleSensor.begin(Wire, I2C_SPEED_FAST)) //Use default I2C port, 400kHz speed
  {
    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(); //Configure sensor with default settings
  particleSensor.setPulseAmplitudeRed(0x0A); //Turn Red LED to low to indicate sensor is running
  particleSensor.setPulseAmplitudeGreen(0); //Turn off Green LED
}
```

```
void loop()
{
  DHT.read11(dht_apin);
  long irValue = particleSensor.getIR();

  if (checkForBeat(irValue) == true)
  {
    //We sensed a beat!
    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;
    }
  }

  Serial.print("BPM=");Serial.print(beatsPerMinute);
  Serial.print("Current humidity = ");Serial.print(DHT.humidity);Serial.print("%  ");
  Serial.print("temperature = ");Serial.print(DHT.temperature); Serial.println("C  ");

  if (irValue < 50000)
    Serial.print(" No finger?");

  Serial.println();

  lcd.setCursor(0,0);
  lcd.print("BPM: ");
  lcd.print(beatAvg);
  delay(1000);
  lcd.clear();
  lcd.setCursor(0,1);
  lcd.print("HUMI:");
  lcd.print(DHT.humidity);
  delay(1000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("TEMP:");
  lcd.print(DHT.temperature);
  delay(1000);
  lcd.clear();
}
```

6.2. Master Circuit:-

The Raspberry Pi model B+ processor acts as a gateway platform in Master Circuit that received these physiological parameters from the Slave circuit via HM-10 BLE module. The parameters such as humidity, Temperature and body posture are then fed to the processor for further analysis and store the data in local server using **LAMP** which is configured with static IP address of the authority to ensure security. The master circuit module will send the information on regular intervals to the VNC server/ Personal server via Wi-Fi / 4G module. These data are viewed on the monitor / screen of the desktop using VNC viewer software through online application. The retrieved data will be displayed using DHCP network server on the webpage of physician so that the patient's life can be saved immediately and advised if requires any treatment plan remotely.

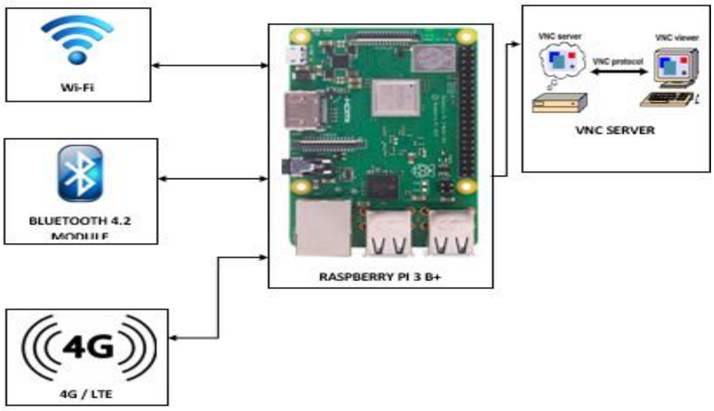


Figure.2. Architecture of Master circuit

6.2.1 Python Programming Code for Raspberry Pi

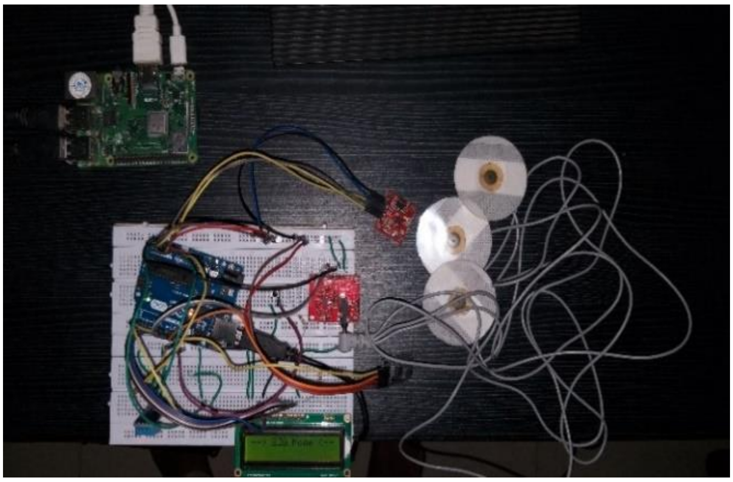
```
import paho.mqtt.publish as publish
import mysql.connector
from bluepy import btle
import time
from datetime import datetime
mydb = mysql.connector.connect(
  host="localhost",
  user="root",
  passwd="Admin@123",
  database="mysql"
)
class MyDelegate(btle.DefaultDelegate):
    def __init__(self,params):
        btle.DefaultDelegate.__init__(self)

    def handleNotification(self,cHandle,data):
#         print("handling notification...")
              print(data.decode("utf-8"))
              Temper = data.decode("utf-8")
              current_Date = datetime.now()
              temperature = Temper[0:7]
              humidity = Temper[7:13]
              mycursor = mydb.cursor()
              sql = """INSERT INTO health(date_time, temp, humi) VALUES (%s, %s, %s)"""
              val = (current_Date, temperature, humidity)
              mycursor.execute(sql, val)
              mydb.commit()
              time.sleep(0.5)
              publish.single("Gemicates/SIET/phd", Temper, hostname="test.mosquitto.org")
p = btle.Peripheral('00:13:AA:00:64:48')
p.setDelegate(MyDelegate(0))

while True:
    if p.waitForNotifications(1.0):
        continue
 #   print("waiting...")
```

7. RESULTS AND DISCUSSION:-

High temperatures or extreme humidity can negatively impact one's physical health, particularly those afflicted with cardiovascular disease. For those suffering with cardiovascular disease, these conditions can have catastrophic effects and in some cases can lead to the formation of deadly blood clots (called thrombosis).

The electrical activity of the heart rhythm is continuously monitored for a volunteer plotted in the front panel of **Serial Plotter** software using the ECG sensor AD-8232. This framework will be beneficial for a cardiac patient to ensure their heart functions whether found normal or not in single lead ECG graph. The changes in body posture such as on-bed to on-foot, right to left and left to right, causes changes on the amplitude of QRS waves in ECG graph. For instance, when posture changes from on-bed to on-foot, QT interval is reduced from its normal value that leads to tachycardia. It causes greater heart rate over 100 bpm. The fast heart beats reduced the effusion fraction ratio (EF rate) which leads to sudden cardiac arrest and death. The above study is used to observe various clinical causes and help for the diagnosis to categorize patients as cardiac and non-cardiac.

The effect of body posture on cardiac disease causes arterial pressure to fall. If arterial pressure falls appreciably upon standing, this is termed orthostatic hypotension. Patient may suffer dizziness because of the narrow blood flow to brain due to the drop in blood pressure. The effect of fever by means of viral infection is the most cause of acute myocarditis which can lead to DCM. It can be monitored by LM-35 body temperature sensor. The LM-35 temperature Sensor is used to observe the body temperature of the patient which has interfaced with the Arduino and output result is viewed on the LCD display. A single chip temperature and humidity sensor is used for respiratory therapy while controlling, monitoring and maintaining humidity. This is important for patient comfort and even more imperative for safety in medical facilities and other critical environments. There are also many other applications for smart monitoring where maintaining a specific temperature is vital for certain medical products in clinics and laboratories. The overall experimental setup is implemented for the proposed system shown in fig.3.and fig.4. Likewise, the data of room parameters such as temperature and humidity are also continuously monitored using DHT11 sensor. The results are viewed on the webpage of local server. The authorized ID web portal is shown in fig.4.



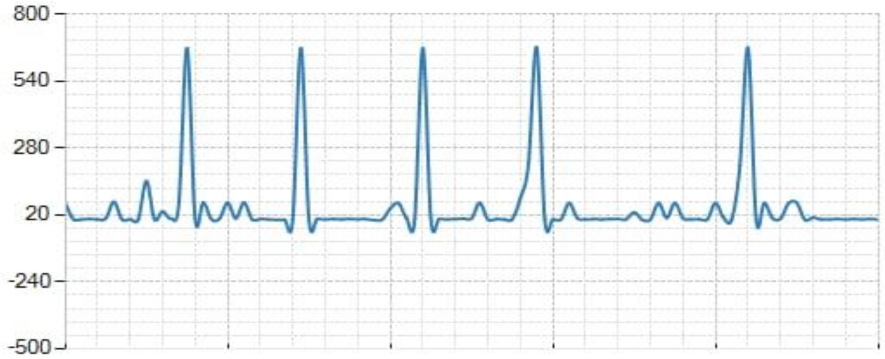


Figure.3. Experimental setup in ECG mode and result tested for a volunteer.

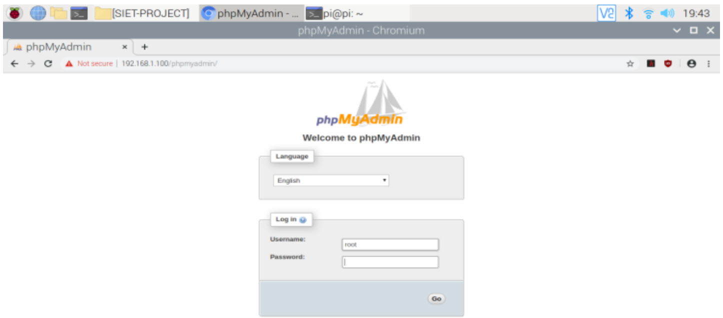
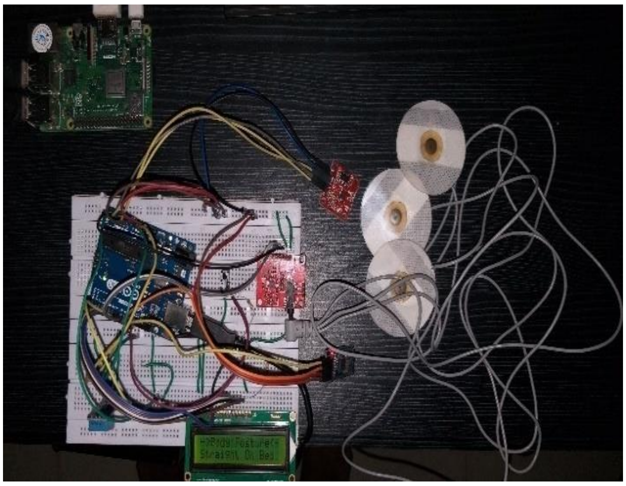
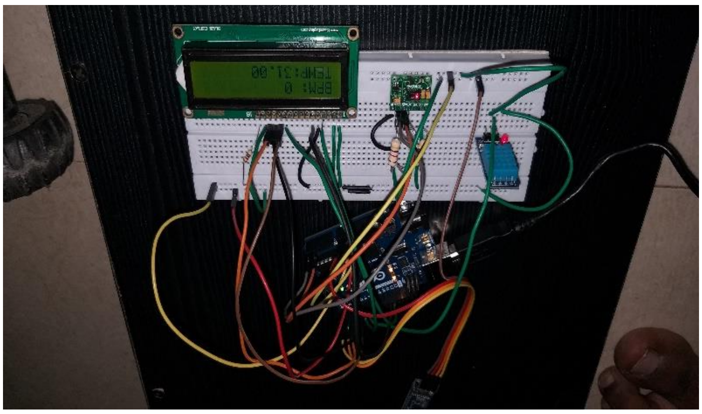


Figure.4.Experimental setup in normal mode and Authorized ID web portal.





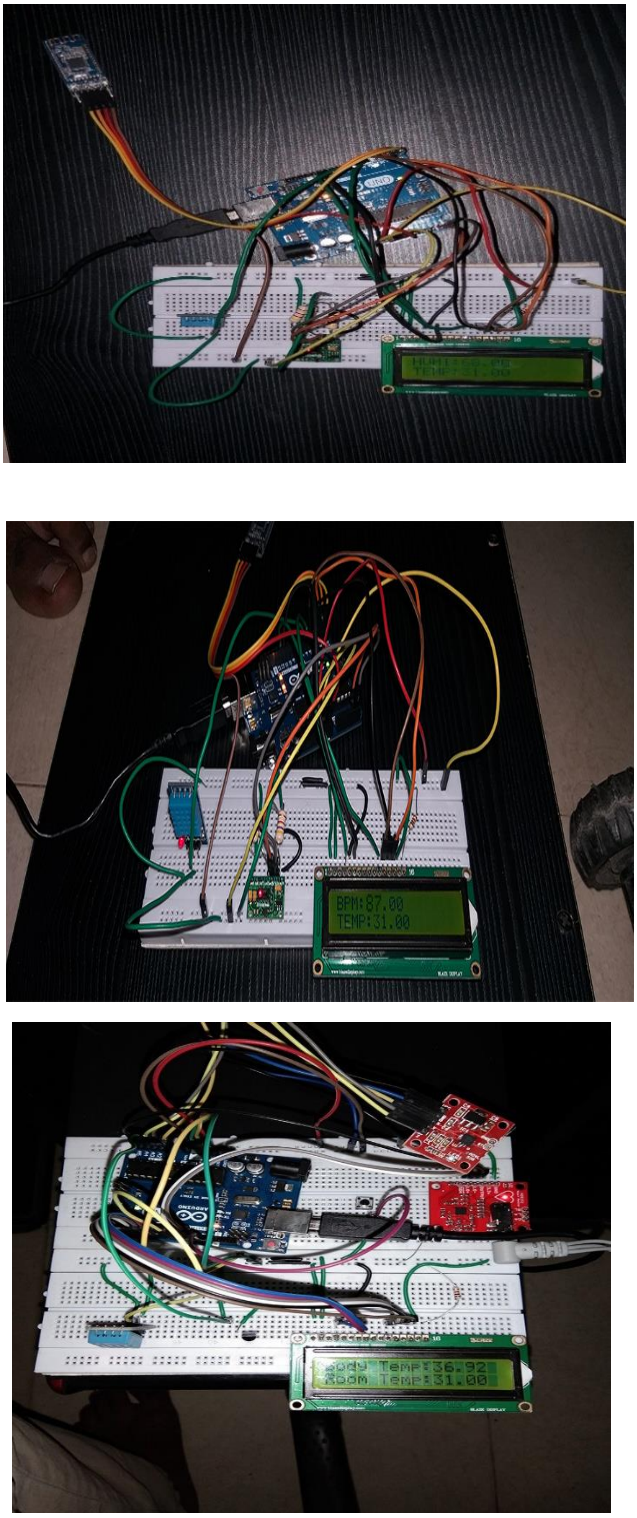
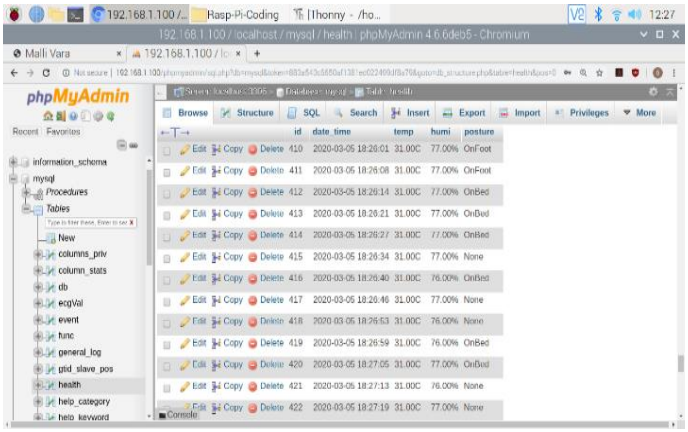


Figure.5. Snapshots of results using LM 35, BPM using MAX30105 and DHT11 Sensor in slave circuit.

The accelerometer sensor ADXL-335 is used to monitor movement of the patient. If movement of the patient body is changed, the sensor observe the positions and results are viewed such as on foot, on bed(right/left) on both LCD display and webpage of the server. The snapshots of above results are shown in fig.6.



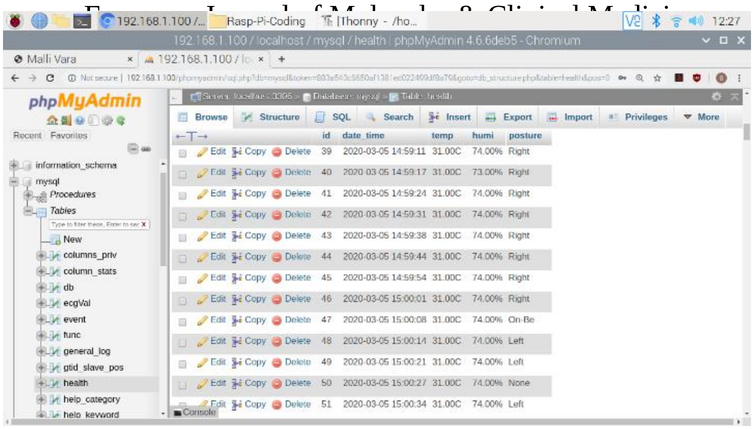


Figure.6. Snapshots of result on webpage using ADXL-335 and DHT11 sensor in master circuit.

8. COMPARATIVE STUDY ON OBSERVED DATA

S.No.	Input Data	Normal Range	Observed Data
1.	Humidity	40 % – 70 %	67 % - Normal
2.	Room Temperature	20°C – 27 °C	31 °C - Moderate
3.	Body Temperature	36 °C – 37 °C	36.92 °C - Normal
4.	Heart Rate in beats per minute (bpm)	60 – 100 bpm	87.00 bpm - Normal

9. APPLICATIONS

- **Self-Care Services**
- **Emergency Ambulance Services**
- **Portable Wireless System for Home Healthcare Services**
- **Clinics**

10. CONCLUSION:-

The proposed system offers remote capabilities that support the patients who feel discomfort for the regular health check-up and long stay in the clinics which minimises the cost. It also facilitates to track the environmental progress to enable patient in the comfort at their home. The patient's data can be collected and accessed from any location remotely as well as efficiently using web app. The entire prototype framework can be converted as self-health care service for clinical monitoring such as body temperature, body posture, ECG, heart rate and environmental parameters at the patient. The above parameters can also be visualized on the display screen of LCD in the Slave circuit near the patient. Physicians can view the result on the webpage of personal server / mobile device. A GSM SIM800 module can also be incorporated to get alert messages as SMS in mobile device if data reaches abnormality value

In future work, the role of Nano Sensor modules under machine learning based decision model will be focussed via Advanced ZigBee connectivity to predict the accuracy in Datasets and efficiency of monitoring the physiological parameters. The security measure can also be promoted in thing speak loud. The system can be implemented with cloud server in future to clinics / hospitals for immediate treatment with necessary intensive care.

REFERENCES: - .

[1] Tanveer Reza, Sarah Binta Alam Shoilee, Sirajum Munira Akhand, Mohammad Monirujjanan Khan. “Development of Android Based Pulse Monitoring System”,IEEE , 2017

[2] Ravi Kishore Kodali, Govinda Swamy, Boppana Lakshmi.“An Implementation of IoT for Healthcare”, 2015 IEEE Recent Advances in Intelligent Computational Systems (RAICS), 2015

[3] M. Surya Deekshith Gupta, Vamsikrishna Patchava, Virginia Menezes. “Healthcare based on IoT Using Raspberry Pi”, 2015 International Conference on Green Computing and Internet of Things ((ICGCIoT), 2015

[4] Punit Gupta, Deepika Agarwal, Jasmeet Chhabra, Pulkit Kumar Dhir. “IoT based Smart HealthCare Kit”, 2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT), 2016

[5] Jusak Jusak, Heri Pratikno, Vergie Hadiana Putra. “Internet of Medical Things for Cardiac Monitoring: Paving the Way to 5G Mobile Networks”, 2016 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT), 2016

[6] Omar S. Alwan, K.Prahald Rao. “Dedicated Real – time monitoring system for health care using ZigBee”, IEEE, 2017

[7] R. Kumar, M. Pallikonda Rajasekaran. “An IoT Based patient monitoring system used raspberry pi”, IEEE, 2016

[8] Emre Oner Tartan, Cebrail Ciflikli. “An Android Application for Geolocation Based Health Monitoring, Consultancy and Alarm System”, 2018 IEEE 42nd Annual Computer Software and Applications Conference (COMPSAC), 2018

[9] Tatiana Huertas, Diego Mendez.“Biomedical IoT Device for Self – Monitoring Applications”, Springer, 2016

[10] Shreyaasha Choudhary. “Internet of Thing Based HealthCare Monitoring System”, IEEE, 2017

[11]K.Mohanraj,N.Balaji, R.Chithrakkannan.“IoT Based Patient Monitoring System using Raspberry Pi 3and LabVIEW”,Biotechnol, Elsevier, 2017

[12] SunilKumar Laxmanbhai Rohit, Bharat V.Tank.“IOT Based Health Monitoring System using Raspberry PI-Review”, 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), 2018

[13] Prabal Verma, Sandeep K.Sood. “Fog Assisted – IoT Enabled Patient Health Monitoring in Smart Homes”, IEEE, 2018.

[14] Anirvin Sharma, Tanupriya Choudhury, Praveen Kumar.“Health Monitoring & Management using IoT devices in a Cloud Based Framework”, 2018 International Conference on Advances in Computing and Communication Engineering (ICACCE), 2018

[15] Jorge Gomez, ByranOviedo,Emilio Zhuma,ANT. “Patient Monitoring System Based on Internet of Things”, ScienceDirect, Elsevier, 2016

[16] Kavita Jaiswal, Srichandan Sobhanayak,Ashok Kumar Turuk ,Sahoo L Bibhudatta, Bhabendu Kumar Mohanta,Debasish Jena. “ An IoT – Cloud Based Smart Healthcare Monitoring System Using Container Based Virtual Environment in Edge Device”, 2018 International Conference on Emerging Trends and Innovations In Engineering And Technological Research (ICETIETR),2018

[17] Vivek Pardeshi,Saurab Sagar ,Swapnil Murmurwar,Pankaj Hage . "Health Monitoring Systems using IoT and Raspberry Pi - A Review", 2017 International Conference on Innovative Mechanisms for Industry Applications (ICIMIA), 2017
[18] N. Shanmugasundaram, E.N. Ganesh & N. Kumar,(2018) "Estimation of power analysis in WLAN infrastructure", International Journal of Engineering and Technology (UAE) – Vol 7(2.21) ppno 198-200,
[19] N. Shanmugasundaram, K. Sushita, S. Pradeep Kumar and E.N. Ganesh "Genetic algorithm-based road network design for optimising the vehicle travel distance" Int. J. Vehicle Information and Communication System, Vol. 4, No. 4, 2019

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