15EC401M-MULTIDISCIPLINARY DESIGN REPORT

on

PATIENT HEALTH MONITORING SYSTEM

by

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Certified to be the bonafide record of work done by **MITRANSH CHOUBISA, AYUSH SHARMA** and **AKSHITA RANJAN** of **ECE B.Tech** Degree course in **15EC401M Multidisciplinary Design** in **SRM Institute of Science and Technology**, Kattankulathur during the Academic year **2020-2021 (ODD Semester)**

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Table of Contents

List of Figures

List of Tables

Introduction

In situations like Covid-19, we need a system to monitor patient's health while following social distancing. Doctors and health workers are most prone to getting affected by such virus in these situations. In a normal situation also, there is a requirement of system which allow doctors to keep a track of patients while they are away. An IoT based health monitoring system is the best solution for such an epidemic. A nonstop checking and control instrument to screen the patient condition and store the patient information's in server utilizing Wi-Fi Module based remote correspondence. Authorized personal can access these data stored (including patient), for examining it in future as well. Using any IoT platform and based on these values received, the diseases are diagnosed by the doctors from a distance. Remote Patient Monitoring arrangement empowers observation of patients outside of customary clinical settings (e.g. at home), which expands access to human services offices at bring down expenses.

A Remote health monitoring system is an extension of a hospital medical system where a patient's vital body state can be monitored remotely. Traditionally the detection systems were only found in hospitals and were characterized by huge and complex circuitry which required high power consumption. Continuous advances in the semiconductor technology industry have led to sensors and microcontrollers that are smaller in size, faster in operation, low in power consumption and affordable in cost. COVID-19 demands social distancing from anyone and everyone. Medical health workers would be able to monitor the patient's health without any physical contact. Remote patient monitoring uses digital technologies to collect medical and other forms of health data from individuals in one location and electronically transmit that information securely to health care providers in a different location for assessment and recommendations.

Literature survey

1. Pervasive patient health monitoring.

This article presents a pervasive patient health monitoring (PPHM) system infrastructure. PPHM is based on integrated cloud computing and Internet of Things technologies. In order to demonstrate the suitability of the proposed PPHM infrastructure, a case study for real-time monitoring of a patient suffering from congestive heart failure using ECG is presented. Experimental evaluation of the proposed PPHM infrastructure shows that PPHM is a flexible, scalable, and energy-efficient remote patient health monitoring system.

The article makes the following contributions:

• A flexible, energy-efficient, and scalable remote patient health status monitoring framework

• A health data clustering and classification mechanism to enable good patient care

• A case study where the capabilities of the PPHM framework are exploited for patients with heart disease

• Performance analysis of the PPHM framework to show its effectiveness

2. The use of GSM/GPRS as an IoT element.

An IoT based patient monitoring system using LPC2148 microcontroller is designed. In this work LM35 temperature sensor and heartbeat sensor is used to read the temperature and heart rate of patient and microcontroller picks up the data and send it through GSM commands. The data is also sent to the LCD for display so patient or healthcare can know his health status. During extreme conditions to alert the doctor message is sent to doctor's cell phone through GSM modem connected and at the same time the buzzer turns on to alert caretaker. The doctors can view the sent data by logging to html webpage using unique logging ID and page refreshing option is given so continuously data reception is achieved. Hence continuous patient monitoring system is achieved.

The security issue has been addressed by transmitting the data through password protected with GPRS and the users/doctor can access the data by logging to the html webpage. At the time of extremity situation alert message is sent to the doctor through GSM/GPRS module connected to the controller. Hence quick provisional medication can be easily done by this system. This system is efficient with low power consumption capability, easy setup, high performance and time to time response.

3. Wi-Fi Module based remote correspondence

Healthcare is given the extreme importance now a- days by each country with the advent of the novel corona virus. So in this aspect, an IoT based health monitoring system is the best solution for such an epidemic. Internet of Things (IoT) is the new revolution of internet which is the growing research area especially in the health care. With the increase in use of wearable sensors and the smart phones, these remote health care monitoring has evolved in such a pace. IoT monitoring of health helps in preventing the spread of disease as well as to get a proper diagnosis of the state of health, even if the doctor is at far distance. In this paper, a portable physiological checking framework is displayed, which can constantly screen the patient's heartbeat, temperature and other basic parameters of the room. We proposed a nonstop checking and control instrument to screen the patient condition and store the patient information's in server utilizing Wi-Fi Module based remote correspondence. A remote health monitoring system using IoT is proposed where the authorized personal can access these data stored using any IoT platform and based on these values received, the diseases are diagnosed by the doctors from a distance.

4. Intravenous monitoring system

This is based on the concept of refraction. When light rays are passed from rarer to denser medium then the ray deviates towards the normal of the plane of the common plane of the two mediums. Lasers are used to create these rays and Light Dependent Resistors (LDR) to detect these laser rays when it hits the LDR. The laser rays hit the LDR when the liquid level goes below the LDR and if the liquid is above the LDR then the ray will refract from the original path and miss the LDR. There will be a column of these Lasers to measure the liquid level at equal distance intervals throughout the bottle length.

This method does not contaminate the liquid inside the bottle as it is a non-contact approach. As these low power lasers and LDRs are cheap the overall cost decreases. And the device can be easily changed from one bottle to another.

System Design and Description

1. Hardware

I. Main system design

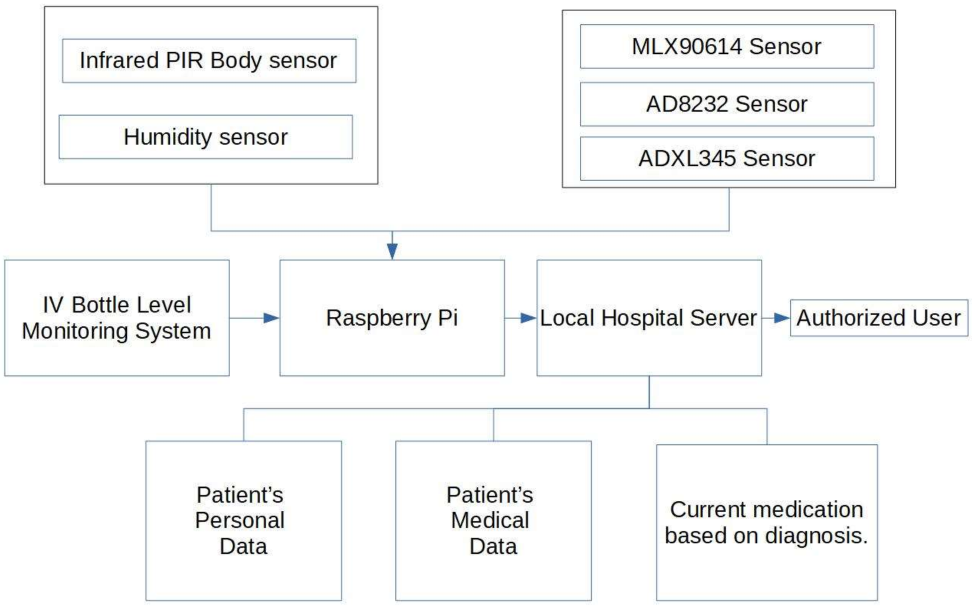

Fig. 1 System Integrated Design

a. There are two types of sensors to be used. The first ones are for patient's body data and the second ones are patient's room data. Although the room's sensor may be eliminated in ideal situations but for patients in state of coma and paralysis need them.

b. If we observe the patient's sensor, we can see the sensors used are perfectly selected for balancing each other. Now by understanding the patient's temperature and heart rate along with the body movement we can understand, what is the patient suffering from at the moment. This may take a lot of modeling but the result will be very beneficial.

c. There is a unique component in our project which is a novelty of our model. We are also monitoring the IV bottle level. We are using laser and detecting at which level the solution is in there.

d. Raspberry pi serves as the brain of the system. It is powerful enough to process everything easily.

e. There are three databases planed by us:
   i. Personal data: this includes patient's name, address and other details. primary key is patient_id.
   ii. Medical data: this includes past medication, current doctors and medical history. Primary key is diagnose_id and foreign key is patient_id.
   iii. Current medication: this includes the details of all the medication for patient. Primary key is diagnose_id.

f. Finally, the authorized user only can access the information.

II. IV bottle SID

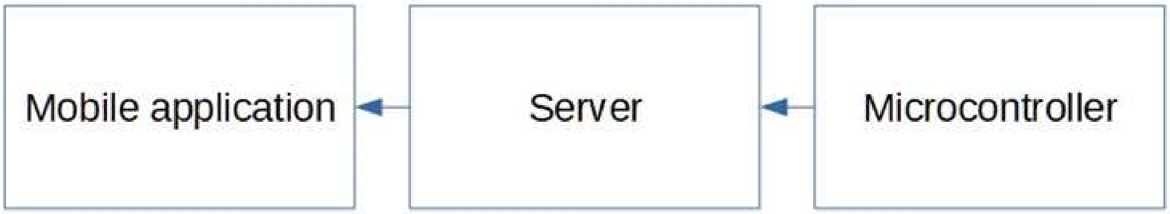

Fig. 2 System design for IV bottle

- The system will consist of the outer cover or shell structure of the bottle having two sides.
- One side will have a column of lasers fixed at a specific angle and the other side has a column of LDR's.
- The lasers are placed such that the rays coming out of the laser gets refracted by the liquid inside the bottle and hit the other side but not on the LDR.
- The LDRs are in series with resistor to act as a voltage divider.
- There will be five lasers, placed in a column with an angle of 30 to 45 degrees.

The LDR is one for each laser placed such that when the ray does not go through refraction then the ray will hit the LDR.

2. Software

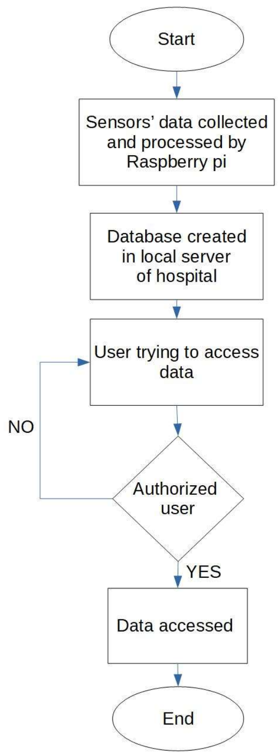

Fig. 3 Flowchart

Methodology adopted

1. Patient's health model

I. Health monitoring

The sensors are embedded on the patient body to sense the temperature and heartbeat of the patient. Two more sensors are place at home to sense the humidity and the temperature of the room where the patient is staying. These sensors are connected to a control unit, which calculates the values of all the four sensors. These calculated values are then transmitted through a IoT cloud to the base station. From the base station the values are then accessed by the doctor at any other location. Thus based on the temperature and heart beat values and the room sensor values, the doctor can decide the state of the patient and appropriate measures can be taken.

II. Sensors

The combined reading of sensors will help us to understand the situation of the patient even when we are away from the patients.

Let us understand with some test cases.

1. Cold: The body temperature will be more than a threshold value which will notify the doctors.
2. Heart attack: In this case the combined data of ECG and body movement, taken through ADXL can give the exact information.
3. Seizure: In case of seizure, just the data of body movement will change which can trigger the notification to medical authorities.

III. Cloud

The cloud relieves the IoT subsystem by performing heavy functions that require storing, processing, and analysing the collected patient health data from the IoT subsystem. Cloud storage offers benefits of scalability and accessibility on demand at any time from any place. The healthcare provider data centre hosts the cloud subsystem, which delivers storage resources and provides computational capability for analysing and processing of the collected data. The cloud also hosts the middleware system, virtual sensors, and application services that allow medical staff to analyse and visualize patients' data as well as to identify and raise alerts when events requiring urgent intervention are observed. The major components of the cloud subsystem are described below.

a. Patient's personal data
b. Patient's medical data
c. Medication

Hardware/Software requirements

1. **Hardware:**
1. Raspberry Pi
2. MLX90614
3. AD8232
4. ADXL345
5. ESP8266

2. **Software:**
1. Python IDLE
2. Fusion360
3. EagleCAD
4. Arduino IDE

Cost Modelling

Table 1 Component cost

S. No	Component Name	Cost (Rupees)
1	Raspberry pi	3000
2	MLX90614	900
3	AD82382	1500
4	ADXL345	100
5	Infrared PIR sensor	70
6	Humidity sensor	90

Table 2 Production cost

S. No	Section	Cost (Rupees)
1.	Designing (3D printing)	500
2.	PCB cost	1000

Realistic Constraints

1. The collection of data from patients and to convince any hospital to share their personal data for better modelling of system.
2. To create a system which can relay even in case of power-cut.
3. The cloud crashing in case local server is not hosted.
4. Cost will be another one such issue. To keep the system accessible by people might become a problem.
5. The model will need to be trained for the different ways in which body reacts in any disease so that it can alert the officials, this will be a long task and a major upgrade from the current system.

Deliverables

- CAD design for IV bottle Monitoring system.

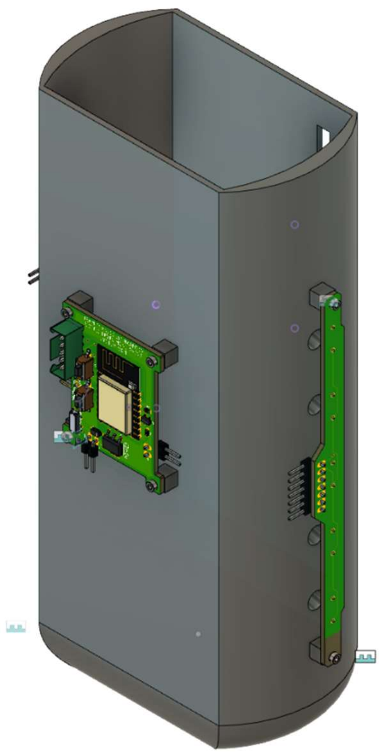

Fig. 5 IV bottle system (Front)

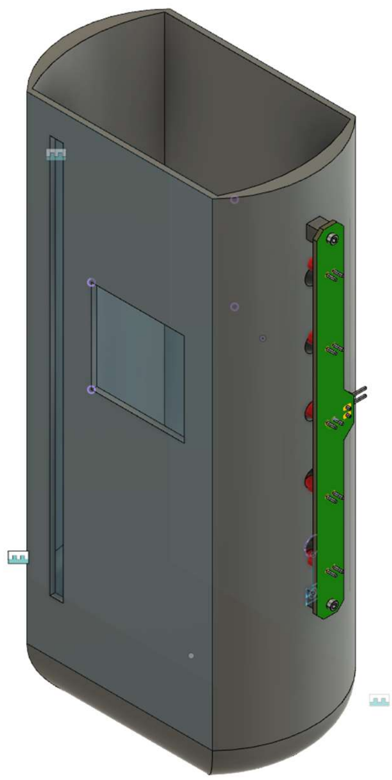

Fig. 4 IV bottle system (Back)

▶ PCB design of IV bottle Monitoring system

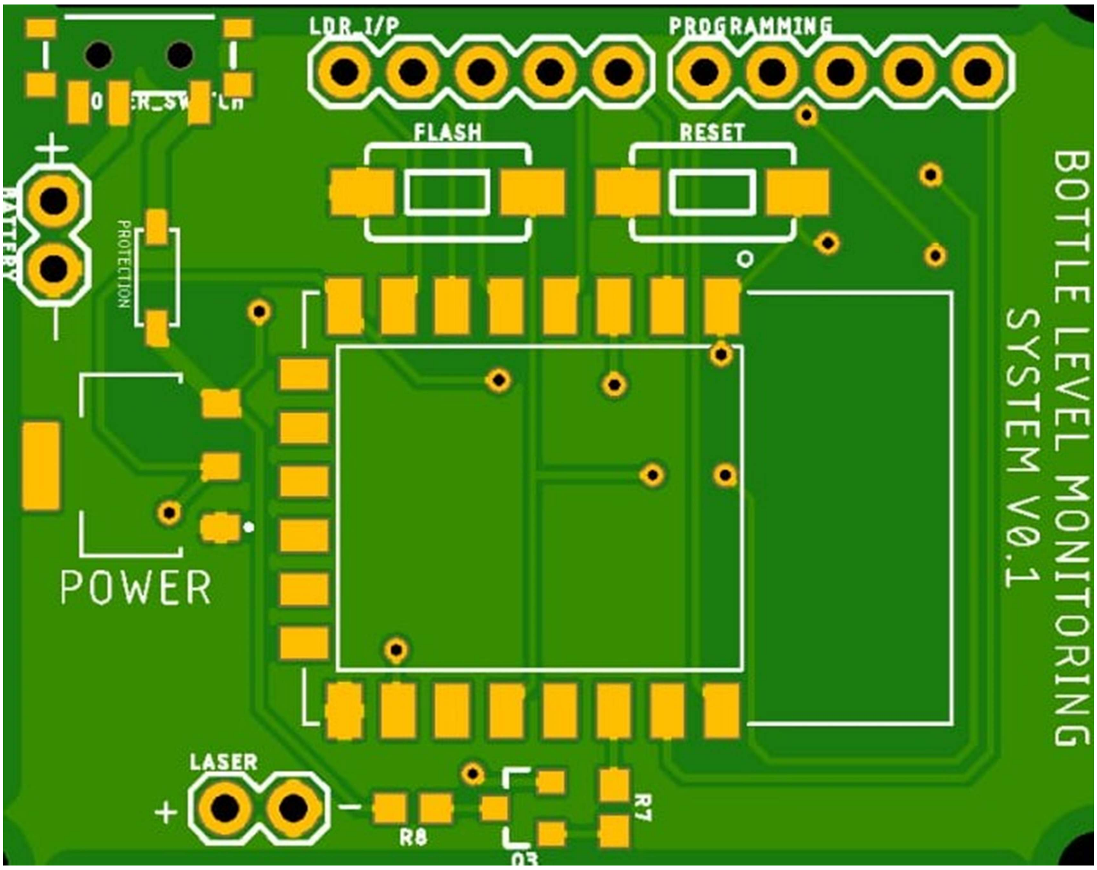

Fig. 6 IV bottle system PCB

▶ Design simulation of system model.

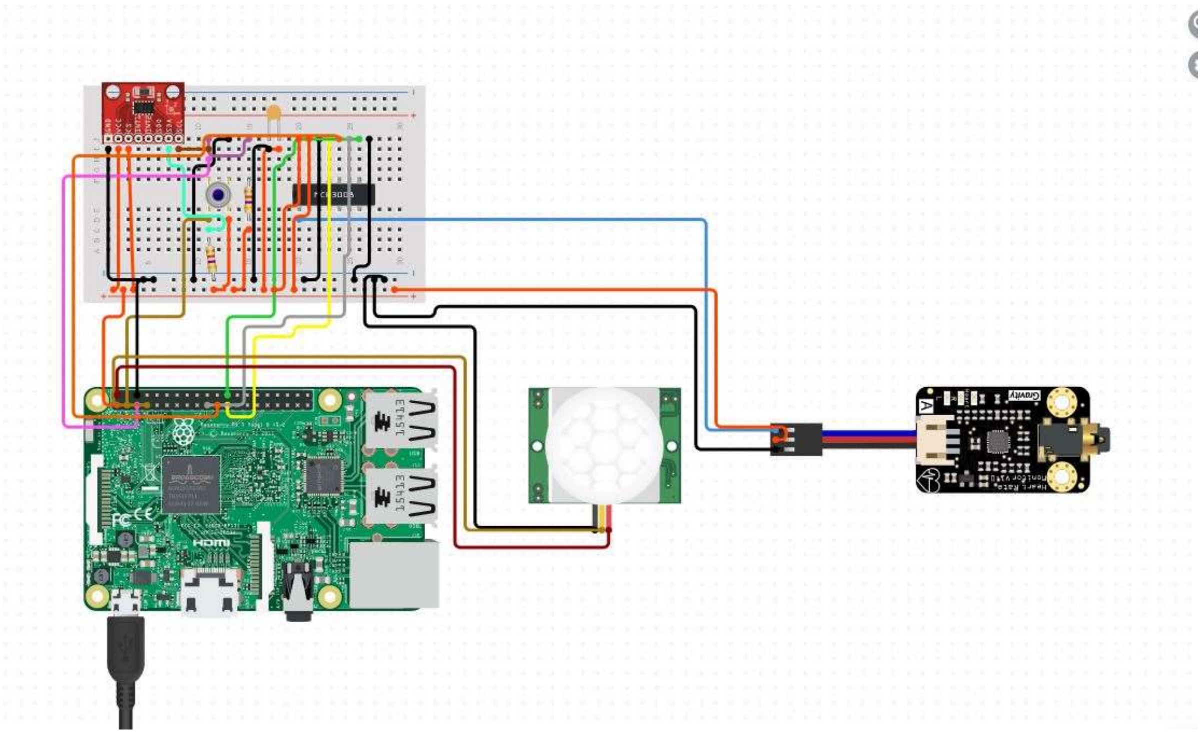

Fig. 7 Embedded design

- ▶ Code for IV bottle Monitoring system.

```
#include <WiFiServer.h>
#include <ESP8266WiFi.h>
#include <ESP8266WiFiMulti.h>

#include <ESP8266HTTPClient.h>
#include <ESP8266httpUpdate.h>

const char* ssid = "Note 4";
const char* password = "onetwothree";

int laser = 20;//define pins
int ldr_1 = 7;
int ldr_2 = 6;
int ldr_3 = 5;
int ldr_4 = 4;
int ldr_5 = 5;
WiFiServer server(80);

void setup() {
  Serial.begin(115200);
  delay(10);

  pinMode(laser,OUTPUT);
  pinMode(ldr_1,INPUT);
  pinMode(ldr_2,INPUT);
  pinMode(ldr_3,INPUT);
  pinMode(ldr_4,INPUT);
  pinMode(ldr_5,INPUT);

  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);

  WiFi.begin(ssid,password);
```

```
  while (WiFi.status() !=WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");;
  Serial.println("WiFi connected");

  //Start the server
  server.begin();
  Serial.println("Server started");

  //Print the IP address
  Serial.print ("Use this URL to connect: ");
  Serial.print("http://");
  Serial.print(WiFi.localIP());
  Serial.println("/");
}

void loop(){

  //Check if a client has connected
  WiFiClient client = server.available();
  if (!client){
    return;
  }
  //wait untill the client sends some data
  Serial.println("New client");
  while(!client.available()){
    delay(1);
  }

  String request = client.readStringUntil('\r');

  if (request.indexOf("/measure") != -1)
  {
```

```
    sendlevel();
  }
}

char level(){
  int L1 = 0, L2 = 0, L3 = 0, L4 = 0, L5 = 0;
  int L_decimal = 0;

  digitalWrite(laser,HIGH);
  delay(10);
  L1 = map(analogRead(ldr_1),0,220,0,1);  //map(analo
  L2 = map(analogRead(ldr_2),0,220,0,1);  //adc value
  L3 = map(analogRead(ldr_3),0,220,0,1);
  L4 = map(analogRead(ldr_4),0,220,0,1);
  L5 = map(analogRead(ldr_5),0,220,0,1);

  L_decimal = (L1*16)+(L2*8)+(L3*4)+(L4*2)+L5;

  if (L_decimal < 16)
  return 100;

   else if (L_decimal >= 16 && L_decimal <= 23)
   return 80;

   else if (L_decimal >= 24 && L_decimal <= 27)
   return 60;

   else if (L_decimal >= 28 && L_decimal <= 29)
   return 40;

   else if (L_decimal >= 30 && L_decimal < 31)
   return 20;

   else
   return 0;
```

```
void sendlevel(){

  WiFiClient client = server.available();
  if (!client){
    return;
  }

   while(!client.available()){
    delay(1);
  }
  String url = "/measured&LEVEL=" + level();

  Serial.print("Requesting URL: ");
  Serial.println(url);

  // This will send the request to the server
  client.print(url);
  delay(10);

}
```

▶ Code for system model.

```
import MySQLdb
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)

#define pins
define HEARTRATE_PIN_SIG 0
define PIR_PIN_SIG 4
define MCP3008_PIN_CS 8


########
GPIO.setup(0, GPIO.IN)
GPIO.setup(4, GPIO.IN)
GPIO.setup(8, GPIO.IN)

########
# Settings for database connection
hostname = '172.0.1.2'
username = 'patient'
password = 'patient'
database = 'INFO'

########
# Query to insert data into table
def insert_record( temp, ecg, bodymovement ):
	query = "INSERT INTO temps3 (temp, ecg, bodymovement) " \
		"VALUES (%s,%s,%s,%s)"
	args = (temp, ecg, bodymovement)

	try:
		conn = MySQLdb.connect( host=hostname, user=username, passwd=pas
		cursor = conn.cursor()
		cursor.execute(query, args)
		conn.commit()

	except Exception as error:
		print(error)

	finally:
		cursor.close()
		conn.close()
```

Conclusion

With the wide use of internet this work is focused to implement the internet technology to establish a system which would communicate through internet for better health. Internet of things is expected to rule the world in various fields but more benefit would be in the field of healthcare. The proposed IoT based patient health monitoring system is integration of embedded and IoT application, provides platform in cost efficient manner, solution for patient and doctor located at remote location. The key objective of developing patient monitoring system is to reduce health care cost by reducing emergency room, physician office visits, hospitalization and diagnostic testing procedures.

In the conventional hospital-centric healthcare system, patients are often tethered to several monitors. In this article, we develop an inexpensive but flexible and scalable remote health status monitoring system that integrates the capabilities of the IoT and cloud technologies for remote monitoring of a patient's health status. Through experimental analysis, we have shown that the proposed framework is scalable and energy-efficient with very high classification accuracy. We believe that the proposed work can address the healthcare spending challenges by substantially reducing inefficiency and waste as well as enabling patients to stay in their own homes and get the same or better care. We are currently implementing the proposed algorithm and testing it in a real-life environment. We are also extending the proposed work to include the privacy and security aspects.