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Cloud Based Smart Health Care Monitoring and Alert System

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Abstract: Health is fundamental need and it is human right to get quality Health Care. Nowadays India is facing many health issues because of less resource. This review paper presents the idea of solving health issues using latest technology, Internet of Things. It presents the architectural review of smart health care system using Internet of Things which is aimed to provide Quality Health Care to everyone. Using this system architecture, patients' body parameters can be measure in real time. Sensors collects patients body parameters and transfers that data to Arduino Uno which further transfer that data to cloud with the help of WiFi module. This data is stored into Thingspeak database server which manages data and provides accessibility. User can view this data with the help of Android App. Which one can install in Smart phone, Tablet or PC. Cloud computing handles authentication, privacy, security, data management etc. If data is abnormal then patient gets notification also care takers will get mail. With the help of different decision making algorithms decisions can be made and according to it people have access to database. Patient can check their medical record Hence, this system provides Quality Health Care to everyone and error free and smooth communication to patients.

Keywords: Internet of Things (IoT),ArduinoUno, Arduino IDE,ESP8266,Thingspeak,Blood pressure sensor,Temperature sensor(DS18B20)

I. Introduction

Internet of Things where 'things'- sensors and devices transmit data directly to the Internet has become an enabling technology eco-system with several application areas Smart Home, Smart Farming, Smart City, Smart Grid, Industrial Internet, Connected Health, Smart Supply Chain. The application list is impressive, however, since the technologies involved are many- sensors, microcontrollers, wireless networking, cloud based services, mobile apps, web pages -practical implementation of an IoT application is complex. Present innovations in technology mainly focus on controlling and monitoring of different activities. These are increasingly emerging to reach the human needs. Most of this technology is focused on efficient monitoring and controlling different activities.

Better health is central to human happiness and well-being. It also makes an important contribution to economic progress, as healthy populations live longer, are more productive, and save more. India faces a high burden of disease because of lack of environmental sanitation and safe drinking water, malnutrition, poor living conditions, and limited access to preventive and curative health services. Many patients especially in rural areas, where there is no fundamental access to health care needs are on the brink of deteriorating their health due to undiagnosed and unmonitored prolonged fever, high blood pressure level, fluctuations in pulse rate by an expert doctor. There is a need for using the Internet of Things (IoT) devices such as smartphones, sensors etc., to trigger a significant improvement in health care in clinical settings and out of them. Technology plays the major role in healthcare not only for sensory devices but also in communication, recording, and a display device. It is very important to monitor various medical parameters and post operational days. Hence the latest trend in Healthcare communication method using IOT is adapted.

The concept of Internet of Things entails the use of electronic devices that capture or monitor data and are connected to the private or public cloud, enabling them to automatically trigger certain events . It enables everyday devices to communicate with each other and/or with humans, allows object to sense and control often is referred to as the Internet of Things (IoT). It includes many field like home automation, health care, smart environment. Internet of things (IoT) serves as a catalyst for the healthcare and plays prominent role in wide range of healthcare applications. Using smartphone one can access his or her medical data and can get the knowledge of their physical fitness. Also in this field different mobile app, notifications are used that gives alert

message when data is abnormal. IOT has given rise to smart health and focus is on improving the operating efficiency and achieving cost effective system while maintaining quality, provide health record, privacy to data. Thus, results in providing quality health care to users.

This Health Care System is a complete system that provides full way communication of user and health care provider. In this system temperature and Blood pressure sensor are used. They sense body temperature and Blood pressure rate respectively, according to their function and then with the help of microcontroller we can have the data, which can be processed further.

WIRELESS PORTABLE HEALTH MONITORING SYSTEMS have been given more attention in recent research efforts as they are not only used for patients but also recommended for old age people, sports persons, drivers' community and home makers. In developing countries like India, some road accidents may happen due to driver's poor health condition like heart stroke while driving, over stress due to continuous work, etc.

The primary function of the system is to monitor patients' physiological parameters such as, pulse rate, ECG, SpO2, body temperature, etc., using sensors and transfer to a Smartphone using wireless(Bluetooth/Zigbee/WiFi/GSM) communication. Then, the proposed healthcare application in a Smartphone verifies the criticality.

This portable health monitoring system can comprise various types of small physiological sensors, which enable continuous monitoring of a variety of human vital signs and other physiological parameters such as

- Monitoring ECG signal.
- Airflow control of patient.
- Body temperature data.
- Galvanic skin response measurements.
- Body position detection.
- Pulse and oxygen functions.
- Multiple data visualization systems.
- SpO2(oxygen saturation in blood)

The main vital signs which are complex and critical in health are ECG and body temperature. These signs are to be continuously monitored for patients with aliments of heart and other diseases.

The main aim and objective of the research is to understand the problems associated with wireless health monitoring systems and design systems that are faster to deploy and provide accurate solutions.

II. Existing System Model

The problems found in most hospitals are that continuous monitoring of vital parameters is done for ICU patients, but the monitors are local to the room in which the patient is admitted. Physician has to frequently visit the patient and asses his/her condition by analyzing the measured parameter such as temperature, blood pressure, pulse oximeter, E.C.G. and heart rate.

III. Proposed Model

A low-power, wireless, wearable physiological monitoring system has been developed and implemented using commercial off-the-shelf components. The non-invasive system supports physiological monitoring of skin temperature, oxygen saturation (SpO2), heart rate,Blood pressure and ECG. The sensors are integrated into a wearable device that can be used to monitor the health and wellness of various patient populations. Data collected by the sensors are sent wirelessly to a personal computer or a mobile phone. Using proposed system we can monitor critical health parameters from anywhere on the earth with the availability of internet

IV. System Architecture

The implemented system consists of a AVR microcontroller (ATmega328) as a main processing unit for the entire system and all the sensor and devices can be connected with the microcontroller. The sensors can be operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and updates it to the cloud through Wi-Fi module connected to it.

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V. Blockdiagram

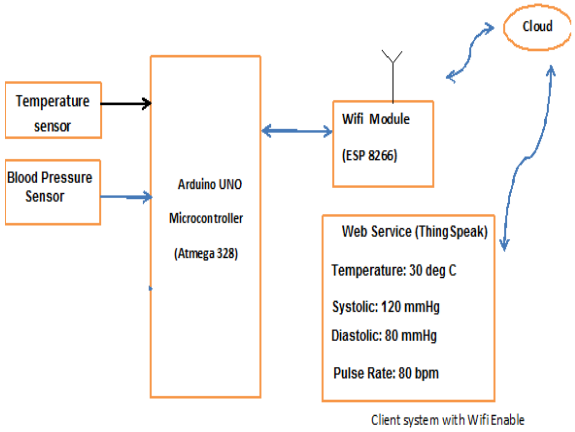

Figure 1 Block diagram of Cloud based Smart Health care monitoring and alert system

Arduino UNO:

Figure 2 Arduino Uno Board

Arduino is an open source tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple micro-controller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP). The boards can be assembled by hand or purchased pre-assembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro-controller; connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. All the modules in the circuit are connected to Arduino module. Sensors are connected to Arduino UNO board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated.

Thing Speak:

According to its developers, "**Thing Speak"** is an open source Internet of Things (IOT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Thing Speak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates"

Thing Speak has integrated support from the numerical computing software MATLAB from MathWorks Allowing Thing Speak users to analyze and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from Mathworks.

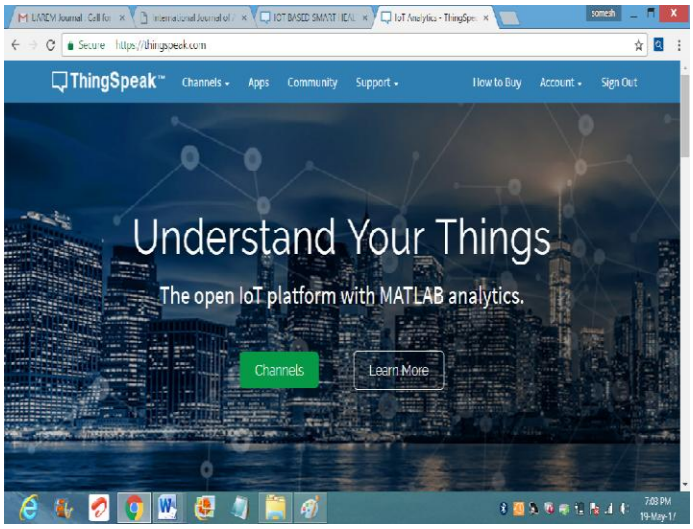

Figure 3 Thingspeak platform

ESP8266 Wi-Fi Module

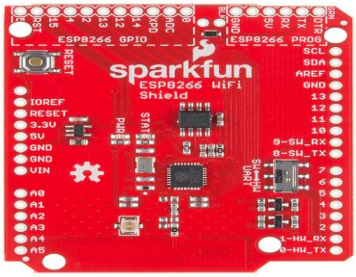

Figure 4 sparkfun ESP8266-WiFi Shield

The SparkFun ESP8266 WiFi Shield is an Arduino compatible shield for the ESP8266 WiFi SoC – a leading platform for Internet of Things (IoT) or WiFi-related projects. There are a variety of designs based around the ESP8266, including tiny, modular boards and more accessible development boards like our very own SparkFun ESP8266 Thing.

Here we used ESP8266 Wi-Fi module which is having TCP/IP protocol stack integrated on chip. So that it can provide any microcontroller to get connected with Wi-Fi network. ESP8266 is a preprogrammed SOC and any microcontroller have to communicate with it through UART interface. It works with a supply voltage of 3.3v. The module is configured with AT commands and the microcontroller should be programmed to send the AT commands in a required sequence to configure the module in client mode. The module can be used in both client and server modes.

SUNROM Blood Pressure Sensor:

Blood pressure is the pressure of the blood in the arteries as it is pumped around the body by the heart. When your heart beats, it contracts and pushes blood through the arteries to the rest of your body. This force creates pressure on the arteries. Blood pressure is recorded as two numbers— the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). The unit which measures this is called Sphygmomanometer.

Monitoring blood pressure at home is important for many people, especially if you have high blood pressure. Blood pressure does not stay the same all the time. It changes to meet your body's needs. It is affected by various factors including body position, breathing or emotional state, exercise and sleep. It is best to measure blood pressure when you are relaxed and sitting or lying down.

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Figure 5 SUNROM Blood pressure sensor Module

Blood Pressure & Pulse reading are shown on display with serial out for external projects of embedded circuit processing and display. Shows Systolic, Diastolic and Pulse Readings.
High blood pressure (hypertension) can lead to serious problems like heart attack, stroke or kidney disease. High blood pressure usually does not have any symptoms, so you need to have your blood pressure checked regularly.

Classification of blood pressure for adults (18 years and older)

	Systolic (mm Hg)	Diastolic (mm Hg)
Hypotension	< 90	< 60
Desired	90–119	60–79
Prehypertension	120–139	80–89
Stage 1 Hypertension	140–159	90–99
Stage 2 Hypertension	160–179	100–109
Hypertensive Crisis	= 180	= 110

Specification

- Working Voltage: +5V, 200mA regulated
- Output Format :Serial Data at 9600 baud rate(8 bits data, No parity, 1 stop bits). Outputs three parameters in ASCII.
- Sensing unit wire length is 2 meters.

Sensor Pinouts:

- TX-OUT = Transmit output. Output serial data of 3V logic level, Usually connected to RXD pin of microcontrollers/RS232/USB-UART.
- +5V = Regulated 5V supply input.
- GND = Board Common Ground

DS18B20-Temperature sensor

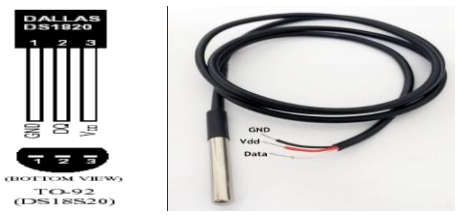

Figure 6 Temperature sensor Module

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus.

VI. Implementation

In this implementation model we used Arduino Uno board ,Sensors and ESP8266 Wi-Fi module as an Embedded device for sensing and storing the data in to cloud. Arduino Uno board consist of 6 analog input pins (A0-A5), 14digital output pins (0-13), inbuilt ADC. Wi-Fi module connects the Embedded device to internet.

The Health parameters such as blood pressure, pulse rate and body temperature are measured from the blood pressure and temperature sensors respectively. The data available from the sensors is transferred to the microcontroller board(Arduino Uno) by interfacing it with the sensors. This data from the microcontroller is further transferred to the ESP8266 Wi-Fi module, this WiFi module transfer the data to the cloud (Thing speak server)through internet.

The web service application that we use here is Thing Speak, which is an open source Internet of Things(IoT) application that enables us to collect and store sensor data in the cloud. The sensor data is stored in the form of graphical format representing x and y coordinates. Whenever the data stored in web service(ThingSpeak) surpasses a certain threshold value then a tweet alert is sent using the react app to warn the patients about their deteriorating health.

Here we are connected the blood pressure sensor to the UART pins(0 and 1) of the ATmega328,Temperature sensor is connected to the pin 4 of Arduino Uno and Esp8266 WiFi module serial pins(Tx&Rx) to the software serial pins(8 &9)of Arduino Uno.

Figure 7 Real time Implementation of the project**.**

Flowchart:

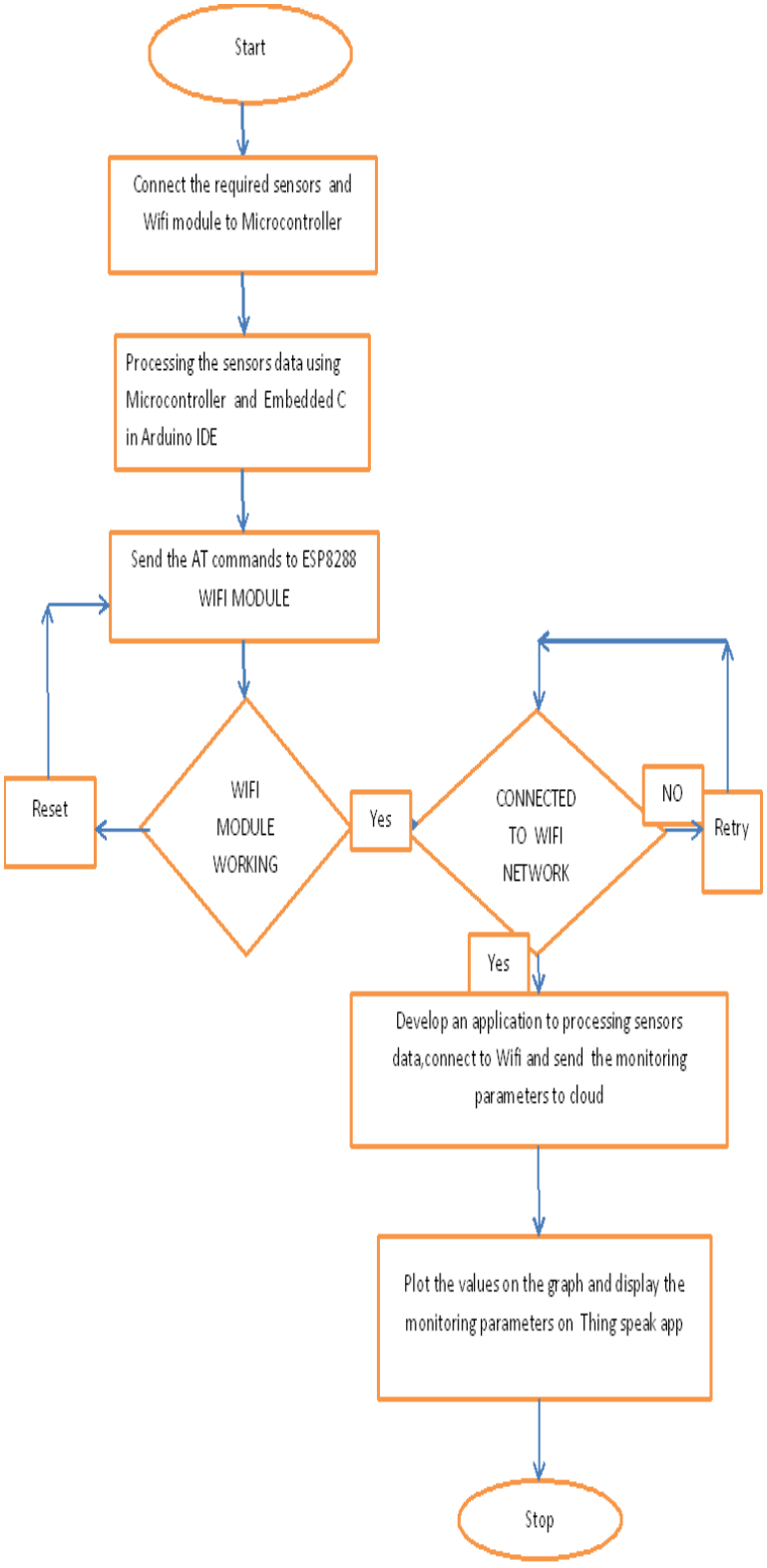

Figure 8 Flowchart for Implementation of the project**.**

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VII. Implementation Results

1. Create an account on Thing speak platform.
2. Connect Arduino Uno board to system through USB cable.
3. After connecting select board and COM port in Arduino IDE.

Figure 9: Arduino IDE Window for Board and COM port selection

4. Develop an Arduino Code for cloud based smart health care monitoring and alert system in Arduino IDE ,compile and upload the code in Arduino Uno board

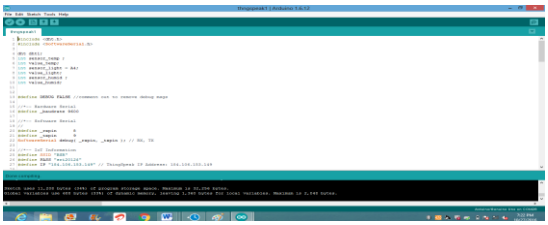

Figure 10: Arduino IDE Window for Compilation successful.

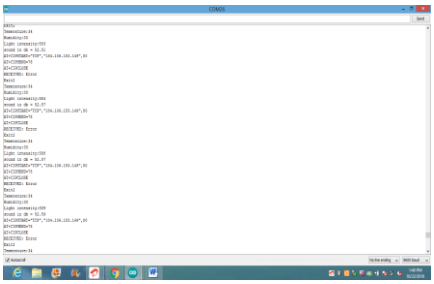

Figure 11 :Sensors Result and Wi-Fi status on Serial monitor.

5. **Data Acquisition:**

Data from the blood pressure sensor and temperature sensor are acquired through powering it with Arduino microcontroller. Data acquisition performed by multiple wearable sensors that measure physiological biomarkers such as Blood pressure sensor, Pulse rate sensor, temperature sensor. The sensors connect to the network though an intermediate data aggregator or concentrator, which is typically a smart phone located in the vicinity of the patient.

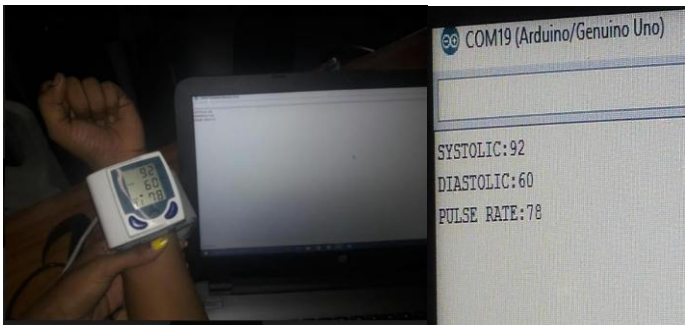

Figure 12 Blood pressure sensor values on Serial monitor and Sensor module display.

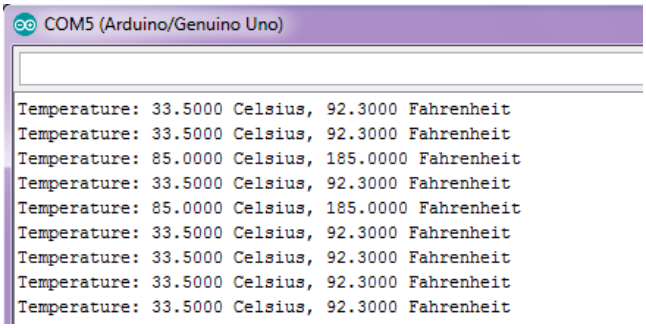

Figure 13 Display of temperature senor values on Serial monitor

6. Data Transmission

Data measured from the sensors is transferred to the IoT based Web service called ThingSpeak using the ESP8266 WiFi shield. Interfacing the ESP8266 WiFi shield with the arduino microcontroller can be done by connecting the Wi-Fi shield to nearest network using ssid and password and then after establishing the TCP connection using AT commands we can send the data acquired from the sensors to thingspeak web service.
Data sent from the sensors via ESP8266 WiFi shield is stored in the graphical format since thing speak web service works in collaboration with Math works whose major software product include Matlab.

Figure 14: Systolic , Diastolic, Pulse Rate and Temperature values on Thing speak platform

We obtain following Health parameters values
Systolic:92 mmHg
Dialostic:60 mmHg
Pulse Rate:78 bpm
Temprature:37 degrees Celsius

7. Data Monitoring and Alerting

We can analyse the data stored in the thing speak and then react on the data using the thing speak app called the "REACT APP". We can send a tweet to the twitter account whenever the data stored in the app surpasses a certain threshold value or falls below certain threshold value by configuring the react app with our requirements.

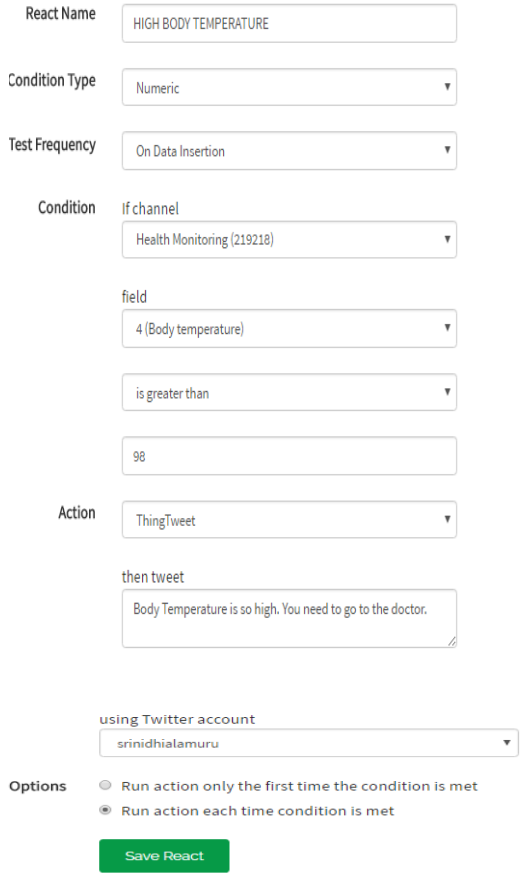

Figure 15 Sending Tweet alert when the body temperature exceeds 98 degrees

React works with ThingHTTP, ThingTweet, and MATLAB® Analysis apps to perform actions when channel data meets a certain condition.
For example, you can have a mobile app report your latitude and longitude to a Thing Speak™ channel. When your position is within a certain distance of your house, have ThingHTTP turn on your living room lights.
If you have sensor data or numeric data in the fields of a Thing Speak channel, use the numeric condion. Additionally, you can send a control command to another service or device that accepts HTTP requests using Thing HTTP.

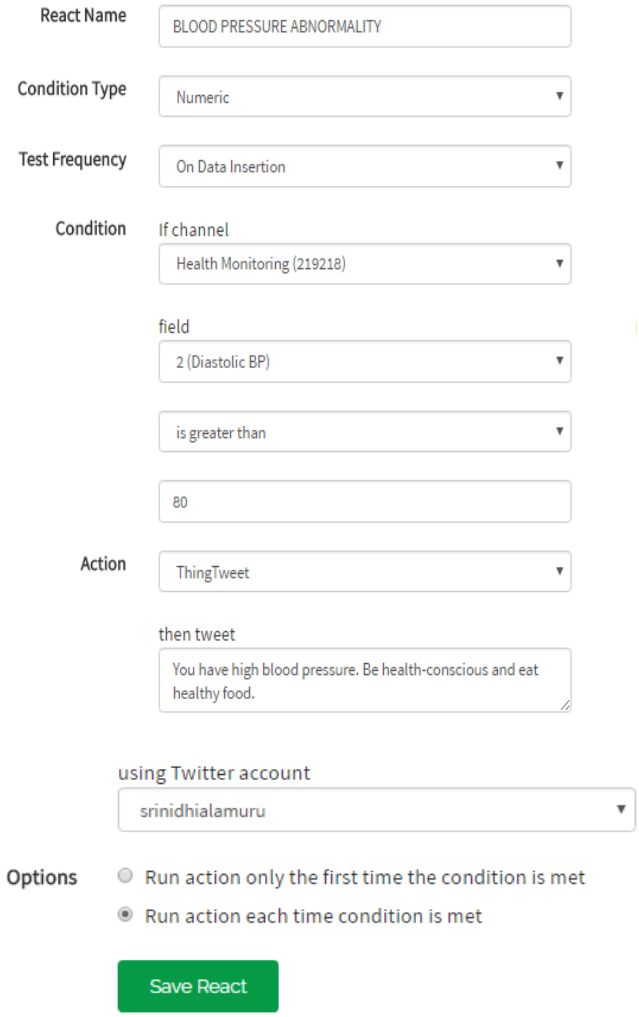

Figure 16 Sending tweet alert when the diastolic value exceeds 80 mmHG

Figure 17 The Tweet alert when abnormal values.

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8. Data Retrieval

Data stored in the Thing Speak web service can be retrieved from the android app on the mobile phone. We have designed the android app using the MIT app inventor by extracting the values stored in the fields.

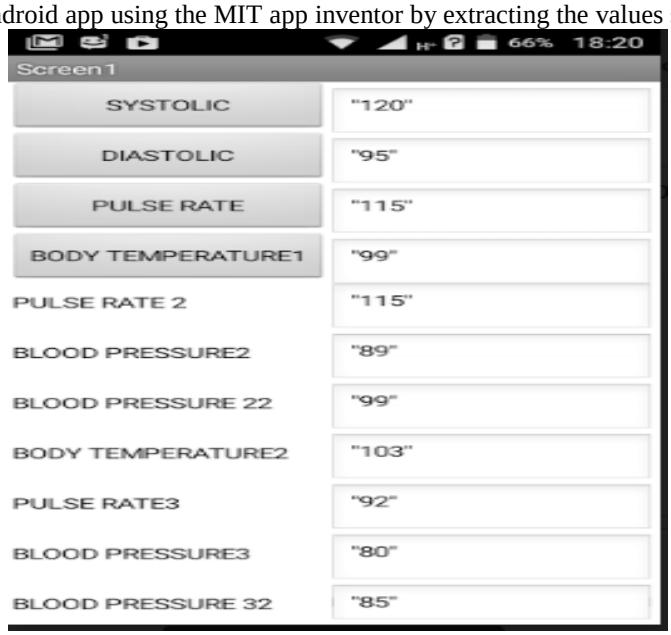

Figure 18 Health parameter values on android app

ThingView app is used to see the sensor data stored in the Thing Speak in graphical format.
ThingView enables you to visualize your ThingSpeak channels in an easy way, just enter the channel ID in thing view app.

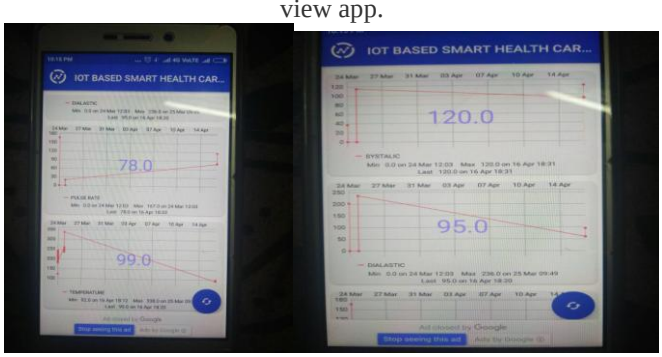

Fig.19.Temperature and Blood pressure values on Mobile (Thing view app)

VIII. Conclusion

This dissertation work describes research related to the design of an intelligent, self-adaptive and interactive portable system for health monitoring of people at risk. To provide a deeper insight into the current state-of-the art of Wireless Portable Health monitoring System, a comprehensive survey on corresponding research prototypes and commercial products was carried out. This helped us identify the shortcomings of the current technology, but also to define new capabilities that could be integrated in the system to improve their overall functionality and also the user's quality of life.

The developed prototype platform utilizes cheap off-the-shelf components and constitutes a novel paradigm of how multiple wireless-enabled biosensors can be utilized for electronic health monitoring applications. The developed interfaces on both the smart-phone and the remote workstation allow the user of this portable and the person supervising the patient to have a complete picture of the patient's health and to have instant access to real-time and past physiological data.

Hence, we were able to acquire data from the sensors which include sunroom blood pressure sensor and DS18B20 temperature sensor and then we were able to successfully send the data through ESP8266 Wi-Fi module establishing TCP connection and then after the connection establishment is successful then the data from sensors is transmitted to the cloud and then the value are retrieved from android app ThingView in graphical format. Whenever the values exceed a particular threshold value then a tweet alert is sent as a warning sign to the patient.

Hence, we were able to acquire data from the sensors which include sunroom blood pressure sensor and DS18B20 temperature sensor and then we were able to successfully send the data through ESP8266 wifi module establishing TCP connection and then after the connection establishment is successful then the data from sensors is transmitted to the cloud and then the value are retrieved from android app Thing View in graphical format. Whenever the values exceed a particular threshold value then a tweet alert is sent as a warning sign to the patient.

IX. Future work:

The developed system can be implemented with minimal development board with readily plug and play internet of things (IoT) and vital parameters can be monitored in a ubiquitous method.

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