Infectious Patient Monitoring and Caring Using Internet of Things (IoT)

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

Of

Bachelor of Science

in

Electrical and Electronic Engineering

Submitted By

Roll No: 1515032

Registration No: 1166

Session: 2015-2016

Department of Electrical and Electronic Engineering

Islamic University

Kushtia -7003, Bangladesh

Dedicated

to

My Parents

CERTIFICATE

This is to certify that this project "**Infectious Patient Monitoring and Caring Using Internet of Things**" is an original work done by Md Forhad Hossain under my supervision and submitted to Islamic University in partial fulfillment for the requirement of the degree of Bachelor of Science in Electrical and Electrical Engineering.

October, 2021

Islamic University, Kushtia
Bangladesh

9-10-2021

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DECLARATION BY THE CANDIDATE

I hereby declare that the project report entitled "**Infectious Patient Monitoring and Caring using Internet of Things**" submitted by me to Islamic University, Kushtia for partial fulfillment of the requirement for the award of the degree of BSc in **Electrical and Electronic Engineering** department is a good record of bonfide project work carried out by me under the guidance of Prof. Dr. Md. Humayun Kabir. I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or full, for the award of any other degree in this institute or any other institute or university.

October, 2021

Islamic University, Kushtia
Bangladesh

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Abstract

Healthcare monitoring system in hospitals and many other health centers has experienced significant growth, and portable healthcare monitoring systems with emerging technologies are becoming of great concern to many countries worldwide nowadays. The advent of Internet of Things (IoT) technologies facilitates the progress of healthcare from face-to-face consulting to telemedicine. This paper proposes a smart healthcare system in IoT environment that can monitor a patient's basic health signs as well as the room condition where the patients are now in real-time. In this system, five sensors are used to capture the data from hospital environment named heart beat sensor, body temperature sensor, room temperature sensor, Oxygen Saturation (SpO2) sensor. The error percentage of the developed scheme is within a certain limit (<9%) for each case. The condition of the patients is conveyed via a portal to medical staff, where they can process and analyze the current situation of the patients. The developed prototype is well suited for healthcare monitoring that is proved by the effectiveness of the system.

Keywords: Healthcare monitoring system, Internet of things, Sensors, ESP8622, MAX30100/MAX30102

Contents

Chapter 1

Introduction

Health is characterized as a full state of physical, mental, and social well-being and not merely a lack of illness. Health is a fundamental element of people's need for a better life. Unfortunately, the global health problem has created a dilemma because of certain factors, such as poor health services, the presence of large gaps between rural and urban areas, physicians, and nurses unavailability during the hardest time.[i]

IoT is making any objects internally connected in the recent decade and it has been considered as the next technological revolution. Smart health monitoring mechanism[ii], smart parking[iii], smart city[iv], smart climate[v], industrial sites[vi], and agriculture fields[vii] are some of the application of IoT. The most tremendous use of IoT is in healthcare management which provides health and environment condition tracking facilities. IoT is nothing but linking computers to the internet utilizing sensors and networks [[viii],[ix]]. These connected components can be used on devices for health monitoring. The used sensors then forward the information to distant locations like M2M, which are machinery for computers, machines for people, handheld devices, or smartphones [x]. It is a simple, energy-efficient, much smarter, scalable, and interoperable way of tracking and optimizing care to any health problem. Nowadays, modern systems are providing a flexible interface [xi], assistant devices [xii], and mental health management [xiii] to lead a smart life for the human being.

Heart rate and body temperature are the two most significant indicators for human health. Heart rate is the per-minute amount of heartbeats, commonly known as the pulse rate. To measure the pulse rate, an increase in the blood flow volume can be used by calculating the pulses. Normal heart rate ranges between 60 and 100 beats per minute for healthy people. The typical restful heart for adult males is roughly 70 bpm and for adult females 75 bpm[xiv]. Female with 12 years of age and above, typically have higher rates of heart in contrast with males. The temperature of human body is simply the heat of body and the sum of heat radiated by the body is scientifically determined. The average person's body temperature relies on different factors such as ambient temperature, the person's gender, and his eating habits. In healthy adults, it is likely to range between 97.8 °F (36.5 °C) and 99 °F (37.2 °C). Different factors such as flu, low-temperature hypothermia, or any other illness may lead to a change in body temperature. In almost all illnesses, fever is a typical indicator [xv]. Various methods exist to invasively and noninvasively assess the heart rate and body temperature. For the consumer, noninvasive approaches over a while have proven accurate and convenient [xvi]. It is suggested that a healthcare should provide good room conditions to facilitate the patients[xvii]. Some measures like room humidity, level of all gases like CO, and CO2 can determine the quality of room environment. The toxic gases and certain levels of humidity are very harmful to patients. For optimum comfort, the room humidity should be between 30 and 65%. Some studies [[xviii], [xix]] are done only for a smart home, not for dedicated healthcare.

There are several fatal diseases like heart disease, diabetes, breast cancer, liver disorder, etc. in medical sector but the main concern of our developed system is to monitor the fundamental signs of all types of patients and the patient's room environment. This paper proposes a customized healthcare system that monitors the pulse and body temperature of patients as well as room humidity, SpO2 of patient's room via sensors and transmits the data through Wi-Fi that enables the medical staffs to get data from the server. The developed system also provides a solution for the problem of maintaining a single database of patients in hospitals using a web server, apart from the personalization of critical health-related criteria. In this system, the gas sensor is used to identify an unexpected occurrence that contrasts the performance with the threshold and produces a PPM signal if the output value crosses the threshold.

Chapter 2

Project Description

2.1 Background of the Study

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. This has further seen development in the remote monitoring of vital life signs of patients especially the elderly. The remote health monitoring system can be applied in the following scenarios:

1. A patient is known to have a medical condition with unstable regulatory body system. This is in cases where a new drug is being introduced to a patient.

2. A patient is prone to heart attacks or may have suffered one before. The vitals may be monitored to predict and alert in advance any indication of the body status.

3. Critical body organ situation

4. The situation leading to the development of a risky life-threatening condition. This is for people at an advanced age and maybe having failing health conditions.

5. Athletes during training. To know which training regimes will produce better results.

In recent times, several systems have come up to address the issue of remote health monitoring. The systems have a wireless detection system that sends the sensor information wirelessly to a remote server. Some even adopted a service model that requires one to pay a subscription fee. In developing countries, this is a hindrance as some people cannot use them due to cost issue involved. There is also the issue of internet connectivity where some systems to operate, good quality internet for a real-time remote connection is required. Internet penetration is still a problem in developing countries. Many of the systems were introduced in the developed countries where the infrastructure is working perfectly. In most cases, the systems are adapted to work in developing countries. To reduce some of these problems there is need to approach the remote detection from a ground-up approach to suit the basic minimal conditions presently available in developing countries.

A simple patient monitoring system design can be approached by the number of parameters it can detect. In some instances, by detecting one parameter several readings can be calculated. For simplicity considerations parameter detection are:

i) Single parameter monitoring system: In this instance, a single parameter is monitored e.g. Electrocardiogram (ECG) reading. From the ECG or heartbeat detection, several readings can be got depending on the algorithm used. An ECG reading can give the heart rate and oxygen saturation.

ii) Multi-parameter monitoring system:

This has multiple parameters being monitored at the same time. An example of such a system can be found in High Dependency Units (HDU), Intensive Care Units (ICU), during the surgery at a hospital theatre or Post surgery recovery units in Hospitals. Several parameters that are monitored include the ECG, blood pressure, respiration rate. The Multiparameter monitoring system basically proof that a patient is alive or recovering. In developing countries, just after retiring from their daily career routine majority of the elderly age group, move to the rural areas. In developed countries, they may move to assisted living group homes. This is where a remote health monitoring system can come in handy.

2.2 Statement of the problem

Remote health monitoring can provide useful physiological information in the home. This monitoring is useful for elderly or chronically ill patients who would like to avoid a long hospital stay. Wireless sensors are used to collect and transmit signals of interest and a processor is programmed to receive and automatically analyze the sensor signals. In this project, you are to choose appropriate sensors according to what you would like to detect and design algorithms to realize your detection. Examples are the detection of a fall, monitoring cardiac signals. Using a single parameter monitoring system an approach to a remote health monitoring system was designed that extends healthcare from the traditional clinic or hospital setting to the patient's home. The system was to collect a heartbeat detection system data, fall detection system data, temperature data and few other parameters. The data from the single parameter monitoring systems was then availed for remote detection. During design the following characteristics of the future medical applications adhered:

a) Integration with current trends in medical practices and technology

b) Real-time, long-term, remote monitoring, miniature, wearable sensors and long battery life of a designed device.

c) Assistance to the elderly and chronic patients. The device should be easy to use with minimal buttons.

2.3 Purpose of the study

Design a Remote Patient Health Monitoring System (RPHMS) which has heartbeat detection system, a fall detection system, temperature detection system, a humidity detection system, body temperature detection system and SPO2 detection system. A doctor or health specialist can use the system to monitor remotely of all vital health parameters of the patient or person of interest. An attempt at designing a remote healthcare system made with locally available components.

i) The fall detector, temperature, humidity, body temperature, SPO2 modules comprise of an accelerometer, wireless transmitter and microcontroller. The data collected was transmitted wirelessly to a receiver module

ii) A simple cloud server where hosted with a database for all the vital data to be accessed remotely whenever required.

2.4 Objective of the study

Here the main objective is to design a Remote Patient Health Monitoring System to diagnose the health condition of the patients. Giving care and health assistance to the bedridden patients at critical stages with advanced medical facilities have become one of the major problems in the modern hectic world. In hospitals where many patients whose physical conditions must be monitored frequently as a part of a diagnostic procedure, the need for a cost-effective and fast responding alert mechanism is inevitable. Proper implementation of such systems can provide timely warnings to the medical staffs and doctors and their service can be activated in case of medical emergencies. Present-day systems use sensors that are hardwired to a PC next to the bed.

The use of sensors detects the conditions of the patient and the data is collected and transferred using a microcontroller. Doctors and nurses need to visit the patient frequently to examine his/her current condition. In addition to this, use of multiple microcontroller based intelligent system provides high-level applicability in hospitals where many patients must be frequently monitored. For this, here we use the idea of network technology with wireless applicability, providing each patient a unique ID by which the doctor can easily identify the patient and his/her status of health parameters. Using the proposed system, data can be sent wirelessly to the Patient Monitoring System, allowing continuous monitoring of the patient. Contributing accuracy in measurements and providing security in proper alert mechanism give this system a higher level of customer satisfaction and low-cost implementation in hospitals. Thus, the patient can engage in his daily activities in a comfortable atmosphere where distractions of hardwired sensors are not present. Physiological monitoring hardware can be easily implemented using simple interfaces of the sensors with a Microcontroller and can effectively be used for healthcare monitoring. This will allow development of such low-cost devices based on natural human-computer interfaces. The system we proposed here is efficient in monitoring the different physical parameters of many number bedridden patients and then in alerting the concerned medical authorities if these parameters bounce above its predefined critical values. Thus, remote monitoring and control refer to a field of industrial automation that is entering a new era with the development of wireless sensing devices.

The Internet of Things (IoT) platform offers a promising technology to achieve the healthcare services, and can further improve the medical service systems. IoT wearable platforms can be used to collect the needed information of the user and its ambient environment and communicate such information wirelessly, where it is processed or stored for tracking the history of the user. Such a connectivity with external devices and services will allow for taking preventive measure (e.g., upon foreseeing an upcoming heart stroke) or provide immediate care (e.g., when a user falls and needs help).

2.5 Limitation of the study

The scope of the project was limited to SpO2, temperature, humidity detection and remote viewing of the collected data for a single patient. Here, the most important specification considered was that they should be safe to use and accurate. This is because the physiological information being detected determines the severity of a critical life-threatening situation.

Chapter 3

Proposed System

The main objective is to design a Patient Monitoring System with two-way communication i.e. not only the patient's data will be sent to the doctor through email on emergencies, but also the doctor can send required suggestions to the patient or guardians through SMS or Call or Emails. And Patient or guardian can able to track patient's location at any point in time through Google Maps which would enable to send medical services in case of an emergency for non-bed ridden patients.

IoT in the health monitoring system has given us a big advantage in the development of modern medical treatment [xx]. Due to advances in VLSI technology, the sensors have become smaller which has enabled the development of wearable solutions. Due to consistent internet connectivity, the devices are becoming more efficient and powerful. IoT based health monitoring devices monitor a patient 24/7. At any crucial moment, the devices generate necessary signals by analyzing statistical data [xxi]. As IoT based devices are constantly connected to the internet, the patients can be remotely monitored and necessary measures can be taken in case of an emergency. IoT based devices can thus provide both detection and emergency response services. There are significant differences between normal health monitoring systems and IoT based health monitoring systems. Incorporating IoT in health monitoring systems is a challenging task [xxii]. Some of the challenges are discussed below: Most of the IoT initiatives have not been successfully implemented yet. IoT generates a massive amount of data, which requires specialized big data and data warehouse systems for proper management. Security is a big issue for IoT systems. Hackers can easily obtain sensitive private data of users in case of buggy or outdated security protocols. Obsolete infrastructure can generate problems as they are not up to date with recent security protocols.

3.1 Block Diagram

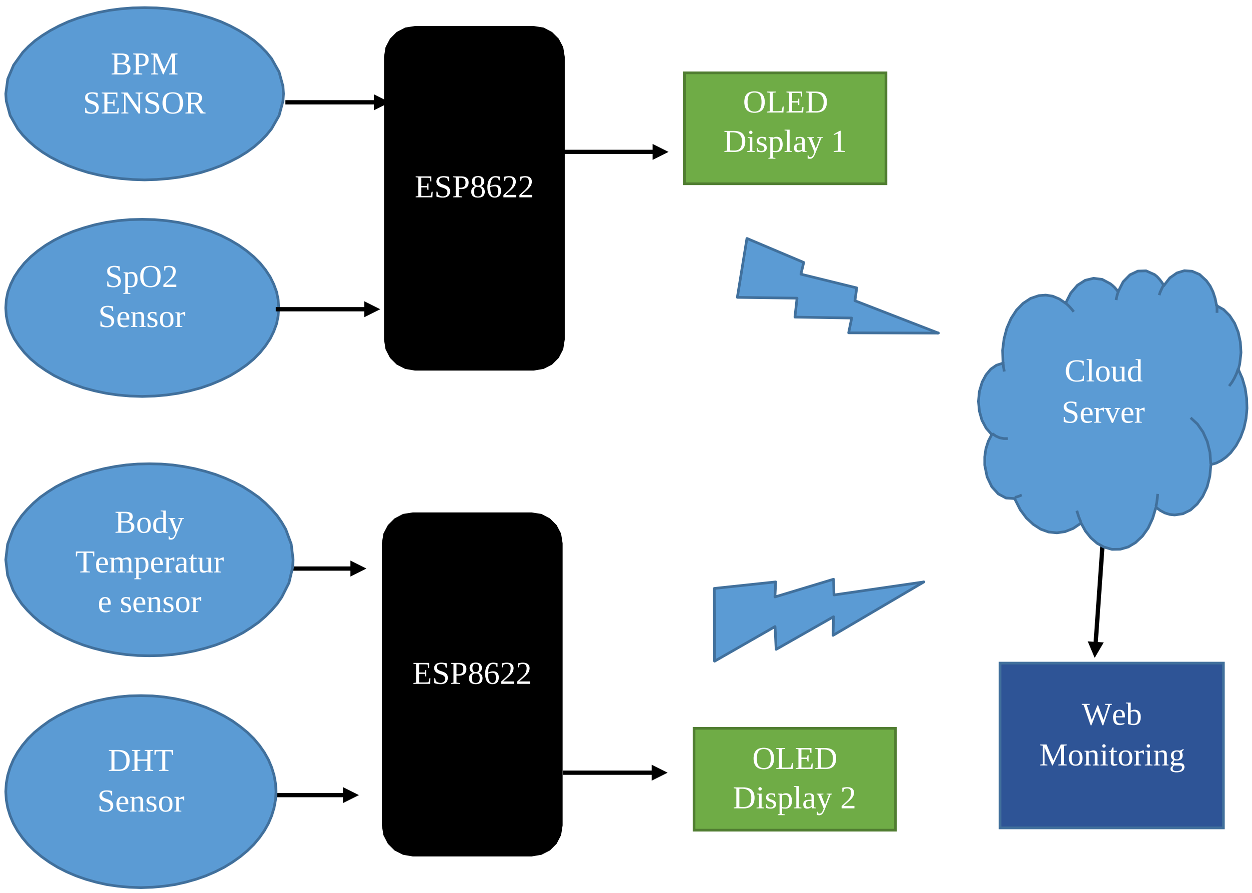


Figure 1: Block Diagram of Proposed System

Chapter 4

Sensors and Modules

1. ESP8622 Micro Controller
2. MAX30102 Pulse Oximeter Sensor
3. DS18B20 Digital Temperature Sensor
4. Temperature Sensor
5. Humidity Sensor
6. OLED Display

4.1 ESP8622 Microcontroller

NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

NodeMCU Development Board Pinout Configuration

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board. **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller.
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V.
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board.
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.

UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

Brief About NodeMCU ESP8266

The **NodeMCU ESP8266 development board** comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

NodeMCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

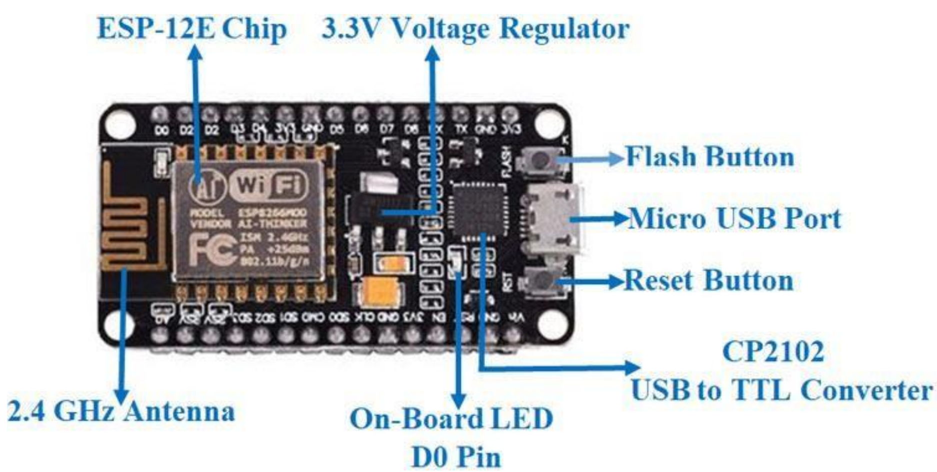


Figure 2: ESP8622 Micro Controller

Programming NodeMCU ESP8266 with Arduino IDE

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use.

Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself. You can check this Getting Started Tutorial for NodeMCU to prepare your Arduino IDE for NodeMCU.

Uploading your first program

Once Arduino IDE is installed on the computer, connect the board with the computer using the USB cable. Now open the Arduino IDE and choose the correct board by selecting **Tools>Boards>NodeMCU1.0** (ESP-12E Module), and choose the correct Port by selecting **Tools>Port**. To get it started with the NodeMCU board and blink the built-in LED, load the example code by selecting **Files>Examples>Basics>Blink**. Once the example code is loaded into your IDE, click on the ‘upload’ button given on the top bar. Once the upload is finished, you should see the built-in LED of the board blinking.

Applications

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities

4.2 MAX30102

The MAX30102 is integrated pulse oximetry and heart-rate monitor biosensor module based on PPG ((Photo Plethysmography). It is so small that you can just wear it on your finger or wrist for data collecting. Internally integrated 18bit ADC, the sensor supports I2C data output, which could be compatible with most controllers.

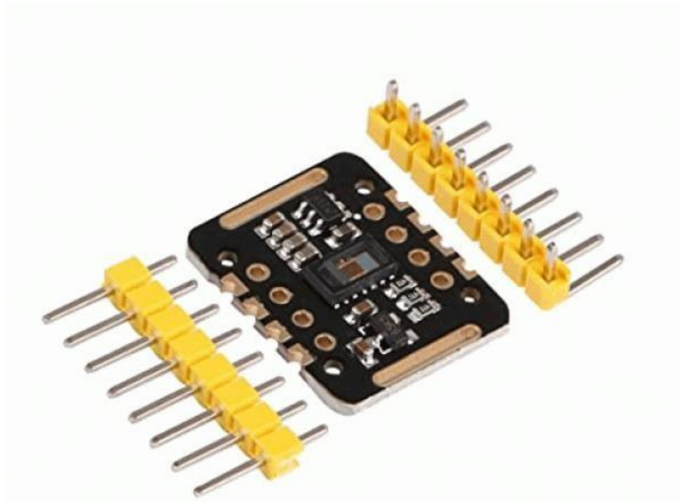


Figure 3: MAX30102 Pulse Oximeter

FEATURES

- Extremely low standby current
- High sampling rate
- High SNR

SPECIFICATION

- Power Supply: 3.3V~5V
- Working Current (LED off): <5mA
- RED/IR LED Driving Current: 0-50mA
- Communication: I2C
- I2C Address: 0x57
- Operating Temperature: -40℃\~85℃

- Dimension: 18*14mm/0.71*0.55”

APPLICATIONS

- Heart-rate Measurement
- SPO2 Detection

4.3 DHT11 Sensor

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.

DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

Working Principle of DHT11 Sensor

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz.i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

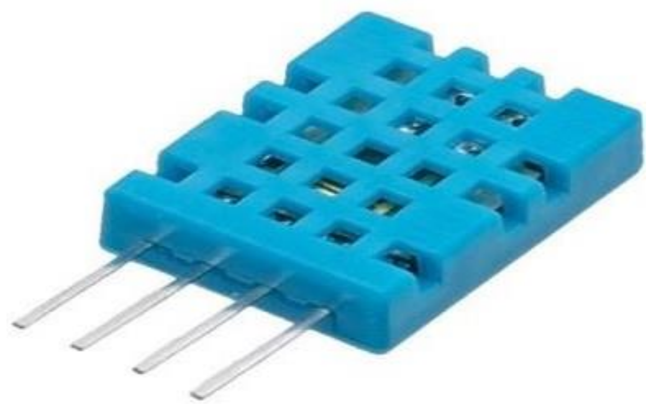


Figure 4: DHT11 Temperature and Humidity Sensor

DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller.

Applications

This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems. Weather stations also use these sensors to predict weather conditions. The humidity sensor is used as a preventive measure in homes where people are affected by humidity. Offices, cars, museums, greenhouses and industries use this sensor for measuring humidity values and as a safety measure.

It's compact size and sampling rate made this sensor popular among hobbyists.

4.4 DS18b20 digital temperature sensor

The DS18B20 is a 1-wire programmable Temperature sensor from maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. It can measure a wide range of temperature from -55°C to +125° with a decent accuracy of ±5°C.

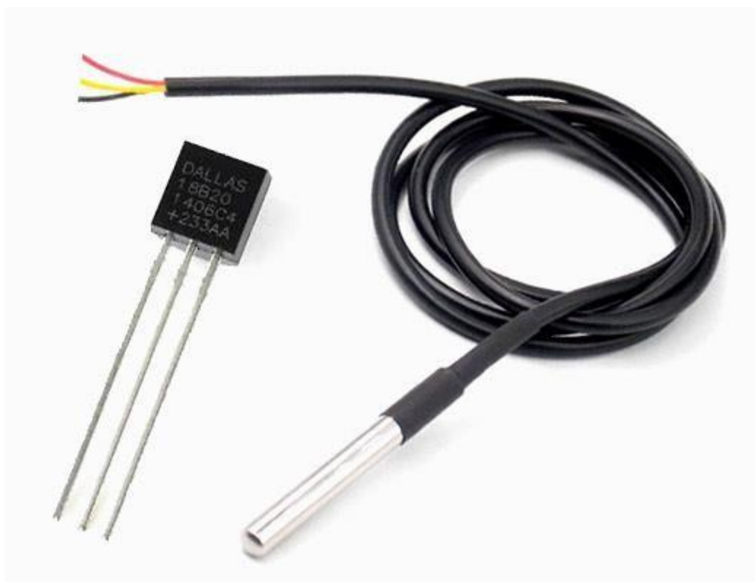


Figure 5: DS18B20 Sensor

DS18B20 Sensor Specifications

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C

- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit
- Programmable alarm options
- Available as To-92, SOP and even as a waterproof sensor

Pin Configuration

No:	**Pin Name**	**Description**
1	Ground	Connect to the ground of the circuit
2	Vcc	Powers the Sensor, can be 3.3V or 5V
3	Data	This pin gives output the temperature value which can be read using 1-wire method

Where to use DS18B20 Sensor

The **DS18B20** is a 1-wire programmable Temperature sensor from maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. The constriction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy. It can measure a wide range of temperature from **-55°C to +125°** with a decent accuracy of **±5°C**. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

How to use the DS18B20 Sensor?

The sensor works with the method of 1-Wire communication. It requires only the data pin connected to the microcontroller with a pull up resistor and the other two pins are used for power as shown below.

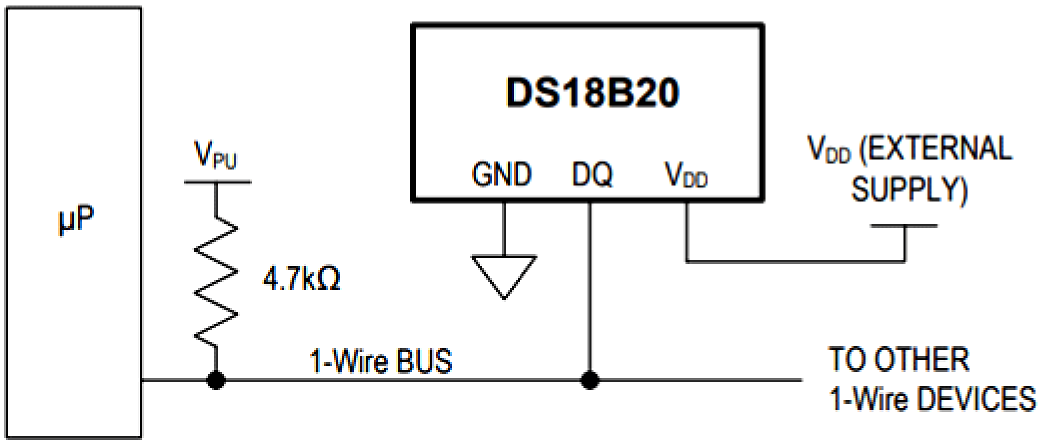


Figure 6: Connection of DS18B20

The pull-up resistor is used to keep the line in high state when the bus is not in use. The temperature value measured by the sensor will be stored in a 2-byte register inside the sensor. This data can be read by the using the 1- wire method by sending in a sequence of data. There are two types of commands that are to be sent to read the values, one is a ROM command and the other is function command. The address value of each ROM memory along with the sequence is given in the datasheet below. You have to read through it to understand how to communicate with the sensor.

If you are planning to **interface it with Arduino**, then you need not worry about all these. You can develop the readily available library and use the in-built functions to access the data.

Applications

- Measuring temperature at hard environments

- Liquid temperature measurement

Applications where temperature has to be measured at multiple points

4.5 OLED display 128x32

These displays are small, only about 1" diagonal, but very readable due to the high contrast of an OLED display. This display is made of 128x32 individual white OLED pixels, each one is turned on or off by the controller chip. Because the display makes its own light, no backlight is required. This reduces the power required to run the OLED and is why the display has such high contrast; we really like this miniature display for its crispness!

The driver chip SSD1306, communicates via I2C only. 3 pins are required to communicate with the chip in the OLED display, two of which are I2C data/clock pins.

The OLED and driver require a 3.3V power supply and 3.3V logic levels for communication. To make it easier for our customers to use, we've added a 3.3v regulator and level shifter on board! This makes it compatible with any 5V microcontroller, such as the Arduino.

The power requirements depend a little on how much of the display is lit but on average the display uses about 20mA from the 3.3V supply. Built into the OLED driver is a simple switch-cap charge pump that turns 3.3v-5v into a high voltage drive for the OLEDs, making it one of the easiest ways to get an OLED into your project!

Figure 7: Oled Display

TECHNICAL DETAILS

Dimensions:

- PCB: 20mm x 35mm (0.8" x 1.4")
- Display area: 7mm x 25mm
- Thickness: 4mm

Display details:

- Diagonal Screen Size：0.91"
- Number of Pixels：128 × 32
- Color Depth: Monochrome (White)
- Module Construction: COG

- Module Size (mm)：46.30× 11.50 × 1.45
- Panel Size (mm)：30.00 × 11.50 × 1.45
- Active Area (mm)：22.384 × 5.584
- Pixel Pitch (mm)：0.175 × 0.175
- Pixel Size (mm)：0.159 × 0.159
- Duty：1/32
- Brightness (cd/m2)：150 (Typ) @ 7.25V
- Interface：I2C

Chapter 5

Implementation

This project has been developed with nodeMCU ESP8622 microcontroller connected with sensors which are attached to the patient. All the sensors and location data sent from microcontroller to Thinger.io database into the cloud. A doctor or guardian can log in to web portal to monitor patient's data at any point in time. And at any point of time either a doctor or guardian can log into web portal with patient unique credentials and can track patient's location which would help medical services to send appropriate help in case of emergencies.

5.1 ESP8266 Micro Controller Unit:

Connecting Thinger.io with secret credential:

```
#define THINGER_SERIAL_DEBUG


#include <ThingerESP8266.h>

#define USERNAME "your_user_name"

#define DEVICE_ID "your_device_id"

#define DEVICE_CREDENTIAL "your_device_credential"


#define SSID "your_wifi_ssid"

#define SSID_PASSWORD "your_wifi_ssid_password"
```

ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);

Upload data using this line of code:

```
// digital pin control example (i.e. turning on/off a light, a relay, configuring a parameter, etc)
  thing["led"] << digitalPin(LED_BUILTIN);


  // resource output example (i.e. reading a sensor value)
  thing["millis"] >> outputValue(millis());
```

5.2 Implemented Device

I develop this device for better use for patient as like a smart band included fingertip pulse and heart beat sensor. Which are collect data and send to the cloud.

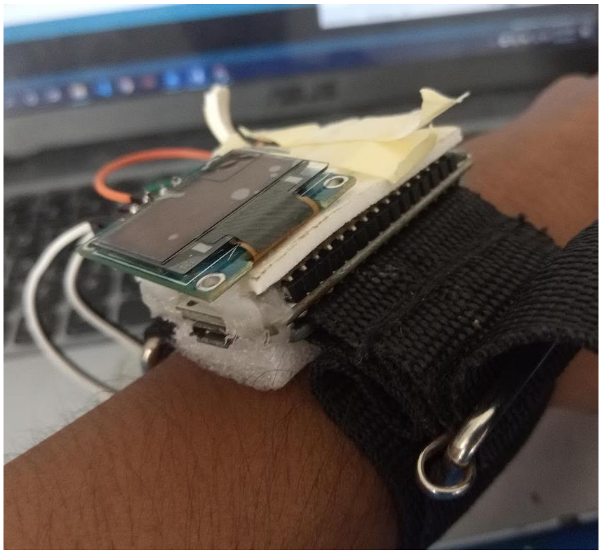


Figure 8: Implemented Device

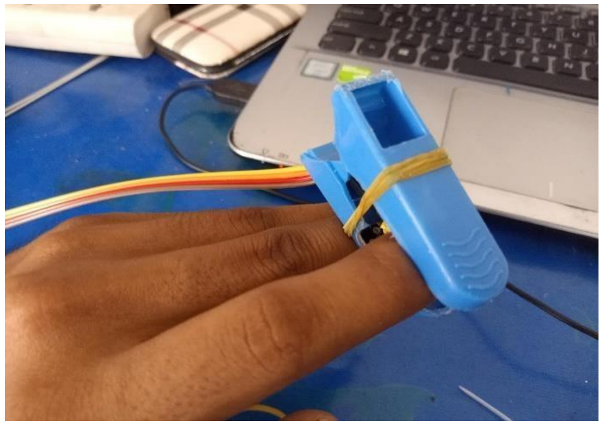


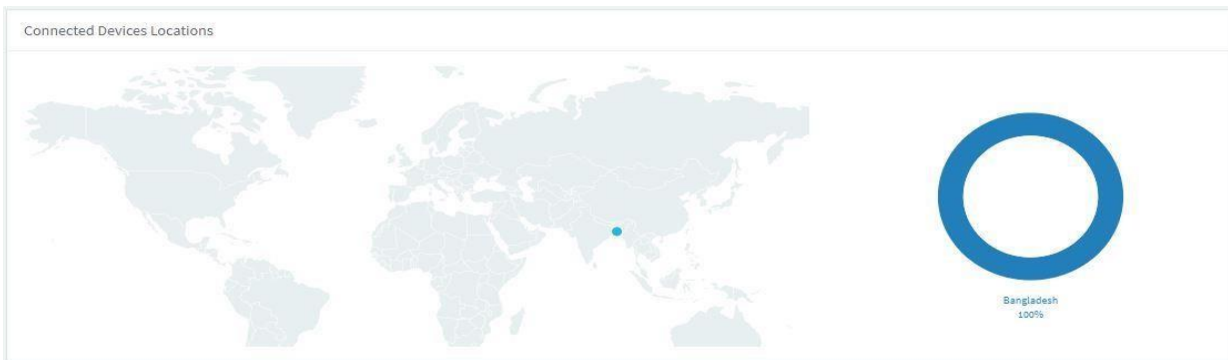
Figure 9: Fingertip bpm sensor

Chapter 6

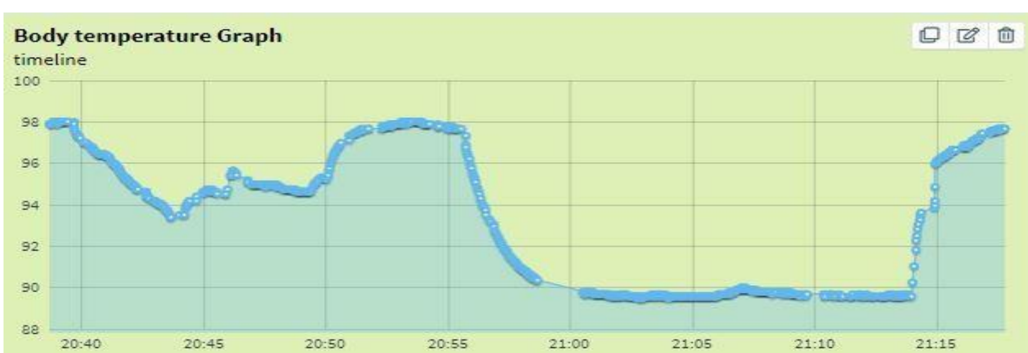
Monitoring Through Cloud

First of all, Log on to the thinger io IoT cloud platform. After successfully login this cloud we need to add device. In this case I added two nodeMCU ESP8622. Then we need to upload sketch from Arduino IDE using wifi and thinger io credential we can monitor patient physical status.

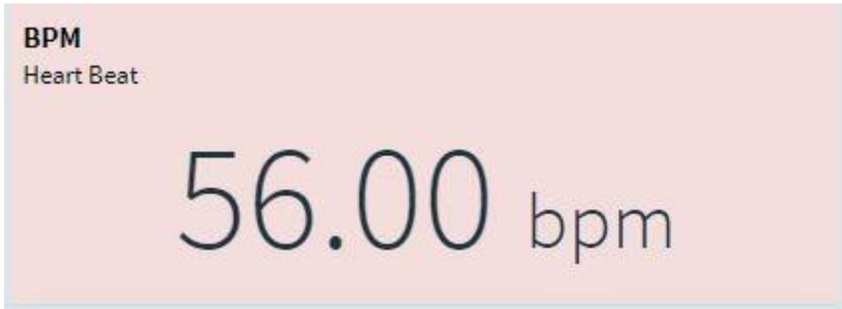
Monitoring patient Current Location



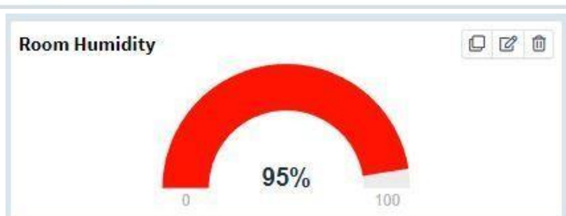
Patient Body temperature:



Patient BPM:



Patient's Oxygen Saturation:



Chapter 7

Conclusion

The system introduced smart healthcare to monitor the basic important signs of patients like heart rate, body temperature, and some measures of hospital room's condition such as room humidity, room temperature. The rate of success between the observed data and actual data is approximately greater than 95% for all cases of the developed healthcare system. Authentic medical staff can view and track the data in real-time even though the patients perform the tests outside of the hospital. The system can also benefit nurses and doctors in situations of epidemics or crises as raw medical data can be analyzed in a short time. The developed prototype is very simple to design and use. The system is very useful in the case of infectious disease like a novel coronavirus (COVID-19) treatment. The developed system will improve the current healthcare system that may protect lots of lives from death. Although the system looks somewhat bulky, it will be a tiny device by proper manufacturing in the near future. The video feature can be added for face to face consultation between the doctors and patients. Some more measures which are very significant to determine a patient's condition like the level of diabetes, respiration monitoring, etc. can be addressed as future work.

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