# IOT/CLOUD BASED HEALTH MONITORING SYSTEM (TEMP., PULSE RATE, $SpO_2$)

*A Project report submitted in partial fulfilment of the requirements for the degree of B. Tech in Electrical Engineering*

*By*


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# PREFACE

This report comprises the summary of work we namely, Arkadeep Nandi, Sandipan Basu, Abhisek Kumar and Prajoy Dutta have achieved during our final year project. The task we have chosen to carry out during this year is IOT/CLOUD BASED HEALTH MONITORING SYSTEM (TEMP., PULSE RATE, $SpO_2$). The effort is conducted under the supervision of Prof. (Dr.) ASHOKE MONDAL, Department of Electrical Engineering, RCC Institute of Information Technology.

This is a microcontroller-based health monitoring system which specifically measures Body Temperature, Heart Rate with Oxygen Saturation ($SpO_2$) of a patient and upload those real time data to cloud, so that anyone can monitor a patient from remote distance.

# ACKNOWLEDGEMENT

It is my great fortune that I have got the opportunity to carry out the project work under the supervision of Prof. (Dr.) Ashoke Mondal in the department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT) Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India. I express my sincere thanks and deepest sense of gratitude to my guide for his constant support, unparalleled guidance and limitless encouragement.

I wish to convey my gratitude to Prof. (Dr.) Debasish Mondal, HOD, Department of Electrical Engineering, RCCIIT and to the authority of RCCIIT for providing al kind of infrastructural facility towards the research work.

I would also like to convey my gratitude to all the faculty members and the staffs of the Department of Electrical Engineering, RCCIIT for their wholehearted cooperation to make this work turn into reality.

Thanks to fellow members of our group for working as a team.

**Arkadeep Nandi**

**Sandipan Basu**

**Abhisek Kumar**

**Prajoy Dutta**

**Name and Signature of the Student**

**Place: Kolkata**
**Date: 06/07/2021**

*Department of Electrical Engineering*

**RCC INSTITUTE OF INFORMATION TECHNOLOGY**

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# CERTIFICATE

## To whom it may concern

This is to certify that the project work entitled **IOT/CLOUD BASED HEALTH MONITORING SYSTEM (TEMP., PULSE RATE, SpO2)** is the bona fide work carried out by **ARKADEEP NANDI (11701617071), SANDIPAN BASU(11701617040), ABHISEK KUMAR (11701618009), PRAJOY DUTTA (*11701618006*)** a student of B. Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year **2020-21**, in partial fulfilment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not been submitted previously for the award of any other degree, diploma or fellowship.

Type text here

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Signature of the Guide

Name: Dr. Ashoke Mondal

Designation Professotr & HOD , Dept. of ECE

Signature of the HOD

Name:

Designation

Signature of the External Examiner

Name:

Designation:

# ABSTRACT

This is a microcontroller-based health monitoring system which specifically measures Body Temperature, Heart Rate with Oxygen Saturation ($SpO_2$) of a patient

Among the applications that Internet of Things (IoT) facilitated to the world, Healthcare applications are most important. In general, IoT has been widely used to interconnect the advanced medical resources and to offer smart and effective healthcare services to the people. The information collected, can be analyzed, aggregated and mined to do the early prediction of diseases which helps the treatment and also it helps to make the health care economical, at the same time, with improved outcomes.

In this corona virus pandemic situation health monitoring of a patient becomes very risky and difficult to achieve. So, this system helps to monitor a patient remotely and offer real-time insights on the vitals of the patient for a better diagnosis.

Application of IoT technology would reduce number of personals required as multiple patients health monitoring could be done in one screen.

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# INTRODUCTION

The world population is increasing tremendously. The cities accommodating more population face astounding pressure of urban living. Even though the medical resources and facilities in cities are expanded daily, still the suffice level is not attained. The massive pressure towards the management of healthcare in cities has triggered the advancement in technologies to come out with the proper solutions to the booming problems. Health is always a major concern in every growth the human race is advancing in terms of technology. Like the recent corona virus attack that has ruined the economy of our country to an extent is an example how health care has become of major importance.

Doctors and healthcare workers who are responding to a global health crisis—trying to protect individuals, families and communities in adverse situations with stretched resources, shortage of personal protective equipment (PPE) and other equipment's—have found themselves as unexpected targets in the fight against COVID-19. There have been several reported incidences of such violence against them during this pandemic time in India. Although the exact numbers of such cases cannot be determined, there are a few glaring examples: on 8 April 2020, two trainee doctors in New Delhi were allegedly assaulted by a neighbour, who accused them of spreading the disease. On19 April 2020, the burial of a neurosurgeon who had died after contracting COVID-19 in Chennai was disrupted by a mob who attacked the undertakers. The citizen's opposition was due to a misconception that the contagion may spread in the neighbourhood if the surgeon was buried there. A group of public health workers in Indore, a city in central India, who were trying to 'contact-trace' a person, were descended upon by a group of 100 people pelting stones and drove them away.

Increasingly, reports pour in of doctors being spat on, hurled abuses at and driven away.

In such areas where the epidemic is spread, it is always a better idea to monitor these patients using remote health monitoring technology. So, Internet of Things (IoT) based health monitoring system is the current solution for it.

Pulse oximeters may be used in a variety of situations that call for monitoring oxygenation and pulse rates. Pulse oximeters increase patient safety by alerting the hospital staff to the onset of hypoxia during or following surgery.

Oximeters confirm adequate oxygenation during mechanical ventilation.

So, we developed a prototype model of pulse oximeter with temperature sensor. The pulse oximeter has revolutionized modern medicine with its ability to continuously and transcutaneous monitor the functional oxygen saturation of hemoglobin in arterial blood (**$SpO_2$**) in a continuous, accurate, and non-invasive fashion. Pulse oximetry is so widely prevalent in medical care that it is often regarded as a fifth vital sign.

The reason pulse oximeter probes interrogate the finger, nose, ear lobe and forehead are that the skin in these areas have a much higher vascular density than, for example, the skin of the chest wall. 4 Reusable clip probes (finger, nasal, ear) and single-patient adhesive probes (finger, forehead) are the two main types of pulse oximeter probes. Advantages of the reusable clip probes are the rapidity in which they can be employed, the ease in which different body sites can sampled in the event of low amplitude waves, and cost-effectiveness in outpatient settings where multiple patients can be measured sequentially with one probe because only a single reading of SpO2 is required.

Pulse oximeters may be used in a variety of situations that call for monitoring oxygenation and pulse rates. Pulse oximeters increase patient safety by alerting the hospital staff to the onset of hypoxia during or following surgery. Oximeters confirm adequate oxygenation during mechanical ventilation.

A temperature sensor is a device that is designed to measure the degree of hotness or coolness in an object. The working of a temperature meter depends upon the voltage across the diode. The
temperature change is directly proportional to the diode’s resistance. The cooler the temperature, lesser will be the resistance, and vice-versa.

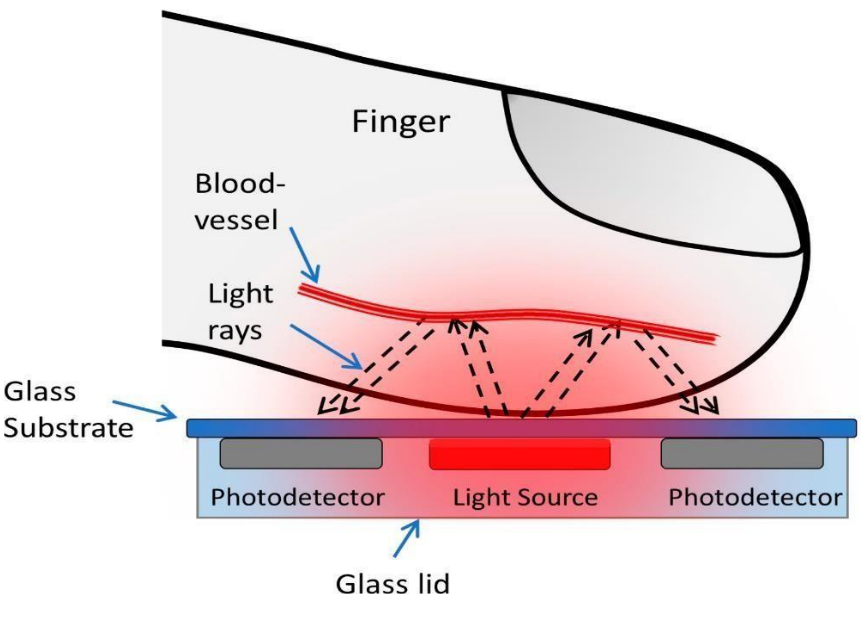
# THEORY

- ## WORKING PRINCIPLE:

### i. Working of Pulse Oximeter Sensor:

In this project MAX30100 sensor is used as pulse oximeter. The MAX30100 is an integrated pulse oximetry and heartrate monitor sensor solution. It combines two LEDs, one emitting a red light, another emitting infrared light. For pulse rate, only the infrared light is needed. Both the red light and infrared light is used to measure oxygen levels in the blood. It gives digital output signal to the microcontroller.

When the heart pumps blood, there is an increase in oxygenated blood as a result of having more blood.
As the heart relaxes, the volume of oxygenated blood also decreases. By knowing the time between the increase and decrease of oxygenated blood, the pulse rate is determined. It turns out, oxygenated blood absorbs more infrared light and passes more red light while deoxygenated blood absorbs red light and passes more infrared light.
This is the main function of the MAX30100: it reads the absorption levels for both light sources and stored them in a buffer that can be read via I2C.



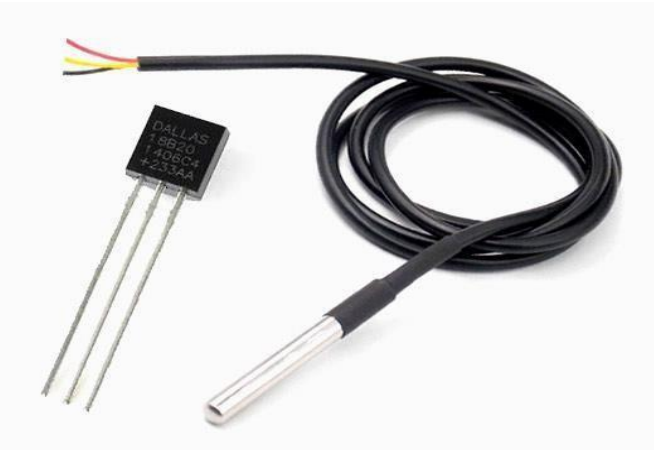
## ii. Working of Temperature Sensor:

In this project DS18B20 is used as temperature sensor.

The DS18B20 is one type of temperature sensor and it supplies 9-bit to 12-bit readings of temperature. These values show the temperature of a particular device. The communication of this sensor can be done through a one-wire bus protocol which uses one data line to communicate with an inner microprocessor.

The working principle of this DS18B20 temperature sensor is like a temperature sensor. The resolution of this sensor ranges from 9-bits to 12-bits. But the default resolution which is used to power-up is 12-bit. This sensor gets power within a low-power inactive condition. The temperature measurement, as well as the conversion of A-to-D, can be done with a convert-T command. The resulting temperature information can be stored within the 2-byte register in the sensor, and after that, this sensor returns to its inactive state.

If the sensor is power-driven by an exterior power supply, then the master can provide read time slots next to the Convert T command. The sensor will react by supplying 0 though the temperature change is in the improvement and reacts by supplying 1 though the temperature change is done.

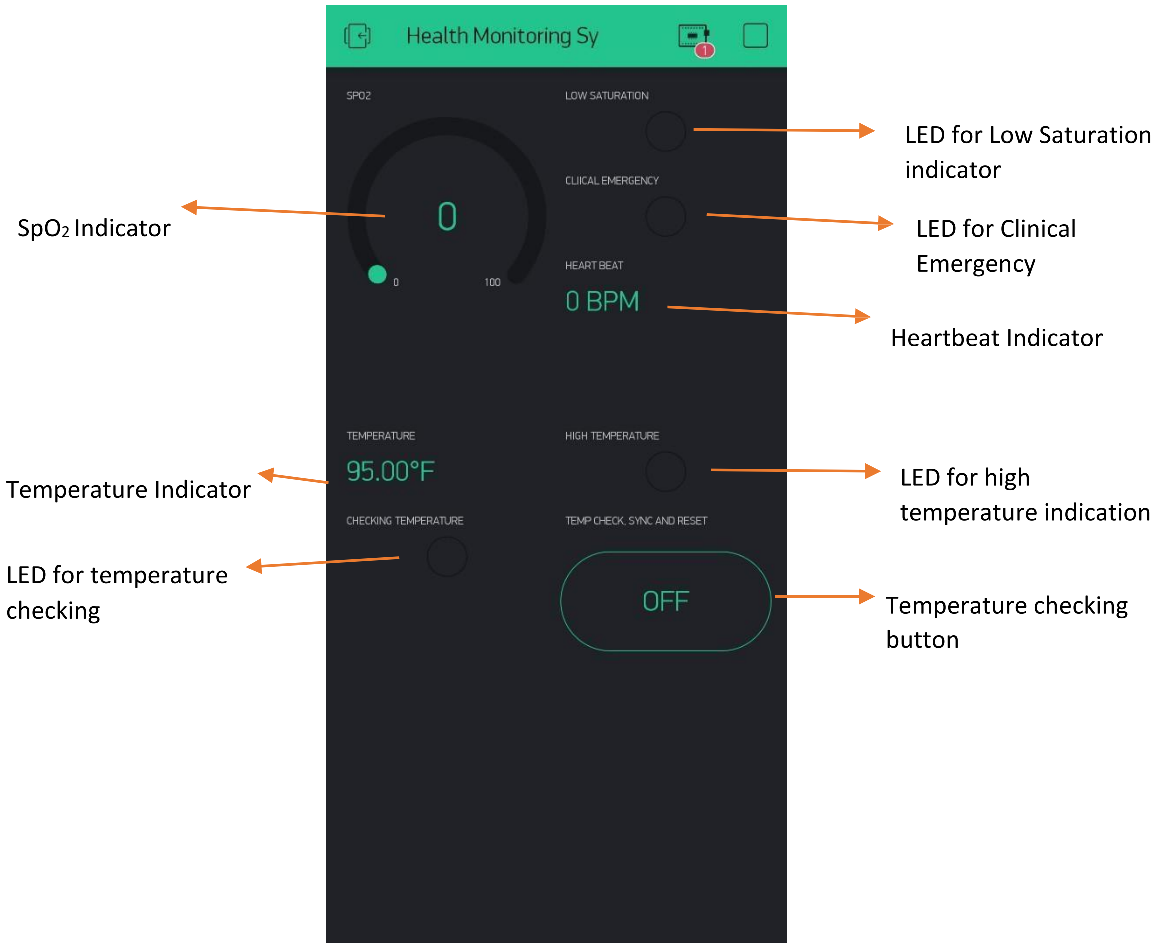


## iii. Working of Blynk App:

Blynk is a free IoT platform. This is an app available in Google play store. For using this app, needs to have an active Wi-Fi connection and the system must have a nodeMCU. To make it work, the nodeMCU code has to have a header named “BlynkSimpleEsp8266.h” and an authenticationcode passed during the time of logging in the app.

The Blynk App shows the data whatever is uploaded in the Blynk App Server on the registered login ID.

In this project, we made this widget as below.



## iv. Working principle of the system:

NodeMCU is the head of the system. MAX30100 and the OLED display are connected with nodeMCU by I2C protocol.

I2C (Inter-Integrated Circuit) is a serial bus interface connection protocol. It is also called as TWI (two-wire interface) since it uses only two wires for communication. Those two wires are SDA (serial data) and SCL (serial clock).

I2C is an acknowledgment-based communication protocol i.e. transmitter checks for an acknowledgment from the receiver after transmitting data to know whether data is received by the receiver successfully.

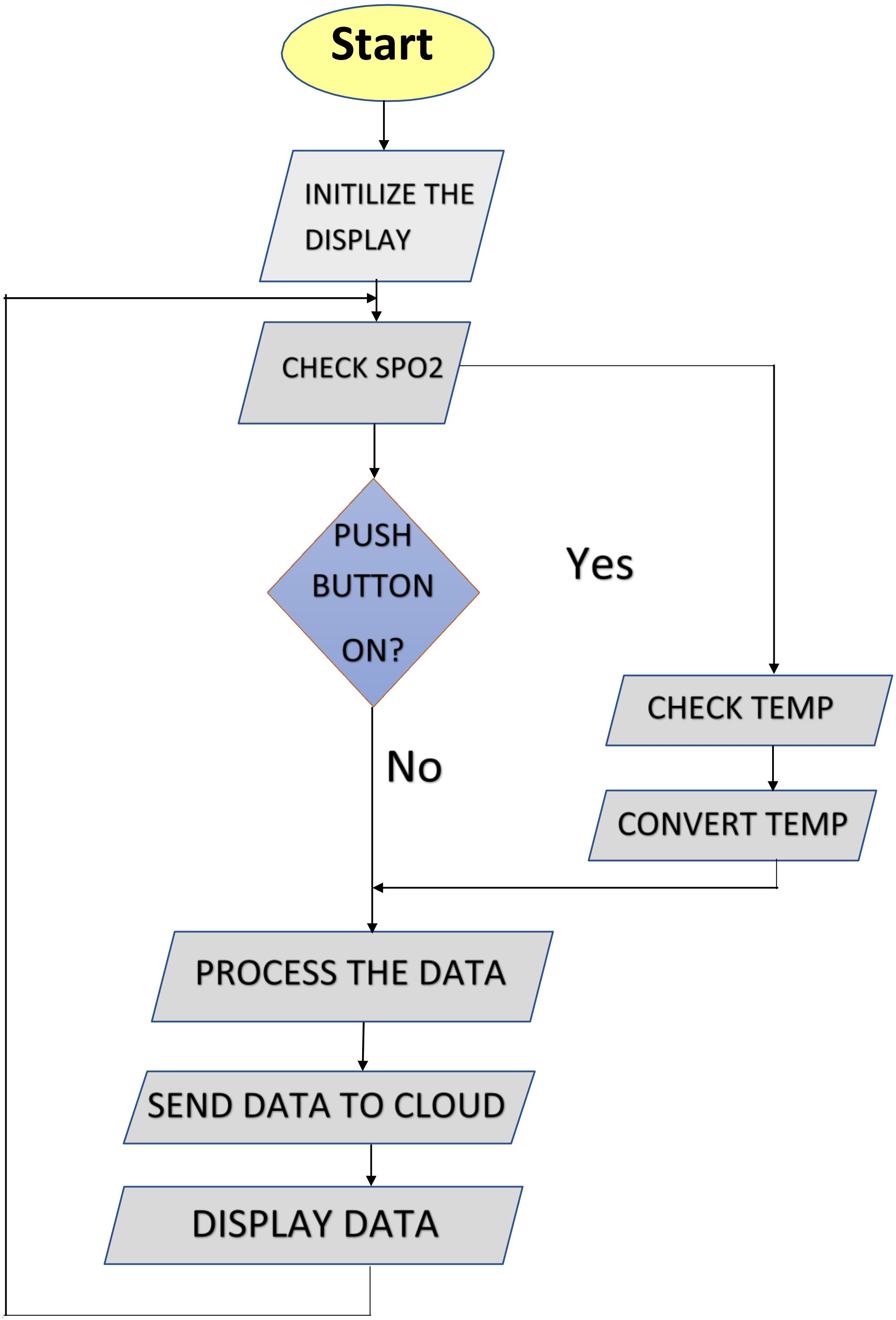
I2Cworks in two modes namely,

1. Master mode
2. Slave mode

SDA (serial data) wire is used for data exchange between master and slave devices. SCL (serial clock) is used for the synchronous clock in between master and slave devices.

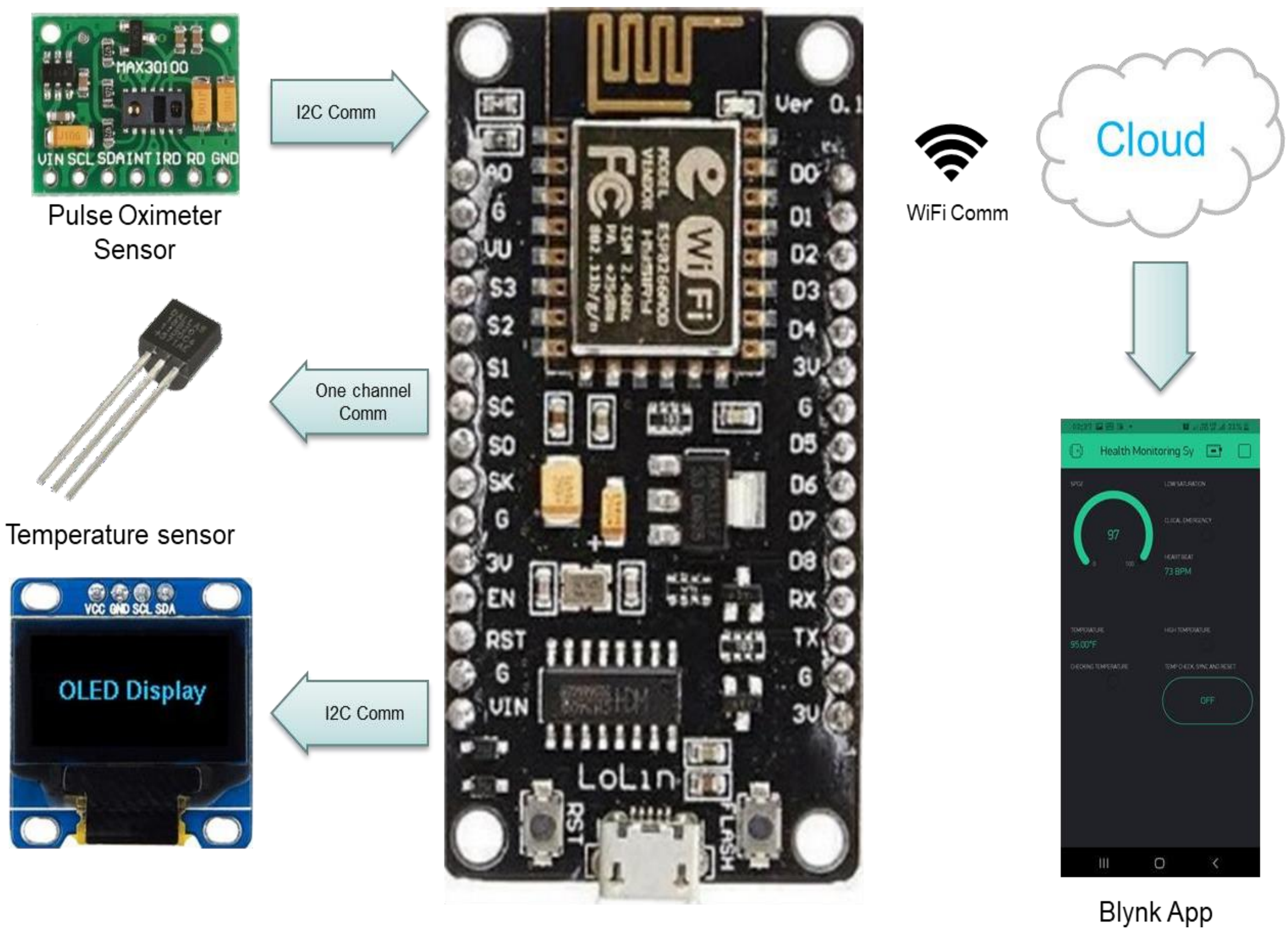
MAX30100 and OLED displays are connected in parallel manner with the NodeMCU. But the temp. sensor is single channel connection so it is connected with digital pin only. So, it is synced separately.

## FLOW CHART

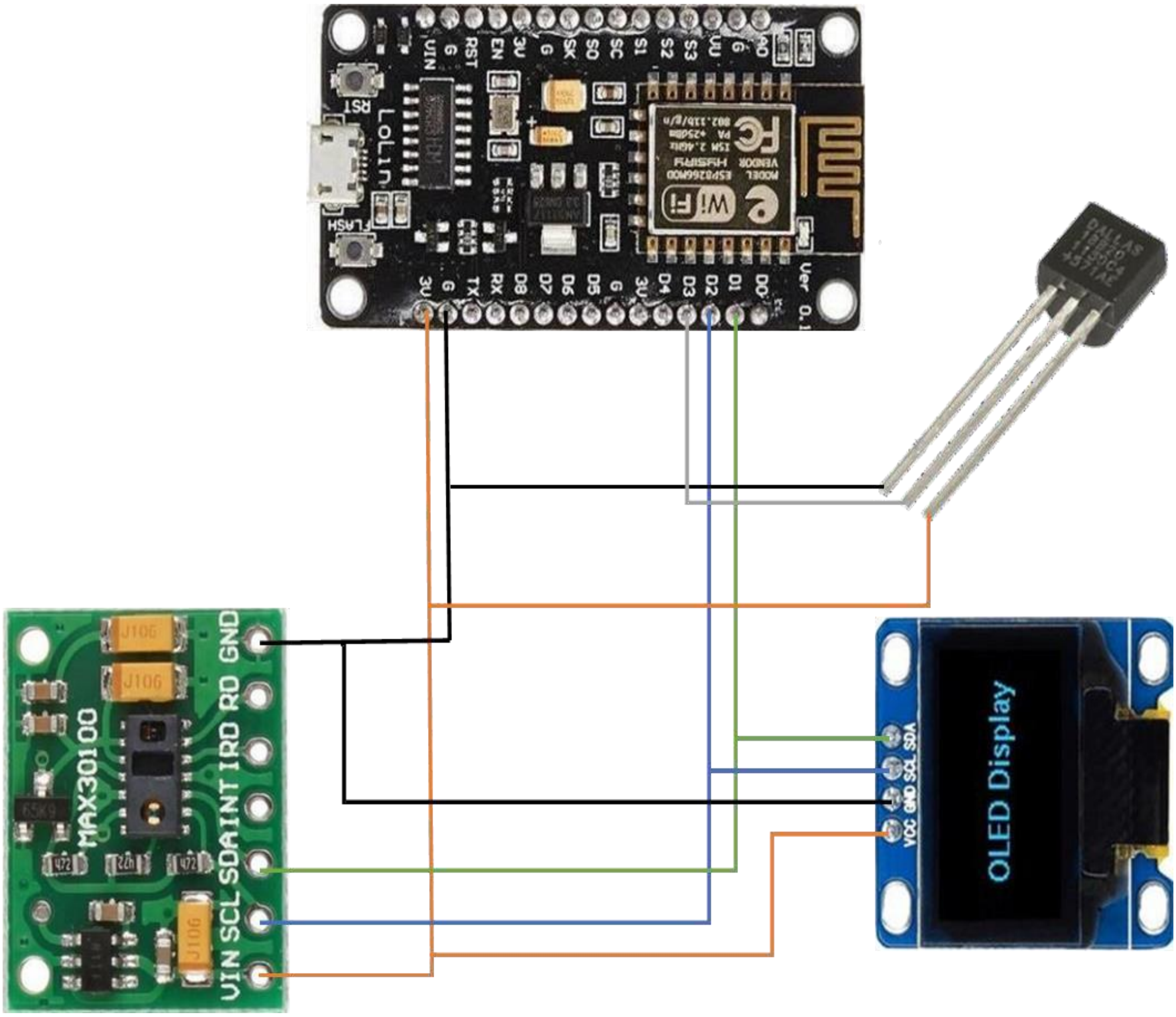


Start
INITILIZE THE DISPLAY
CHECK SPO2
PUSH BUTTON ON?
Yes
No
CHECK TEMP
CONVERT TEMP
PROCESS THE DATA
SEND DATA TO CLOUD
DISPLAY DATA

# BLOCK DIAGRAM



# CIRCUIT DIAGRAM



# COMPONENTS LIST

| Sl. No. | Item |
|---|---|
| 1. | NodeMCU |
| 2. | MAX30100 |
| 3. | DS18B20 |
| 4. | OLED Display 0.96” |
| 5. | PG-7 Gland |
| 6. | Power Supply |

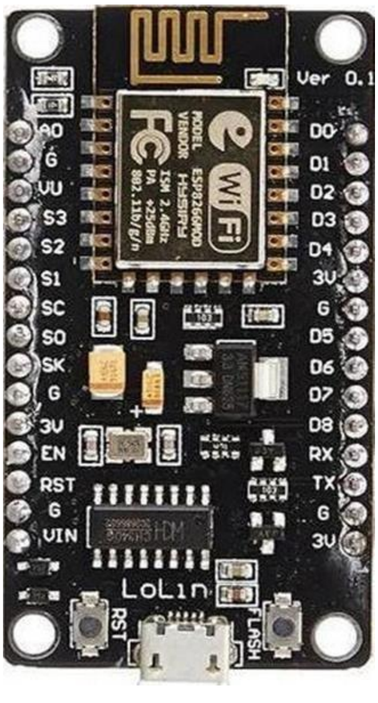
# COMPONENTS DESCRIPTION

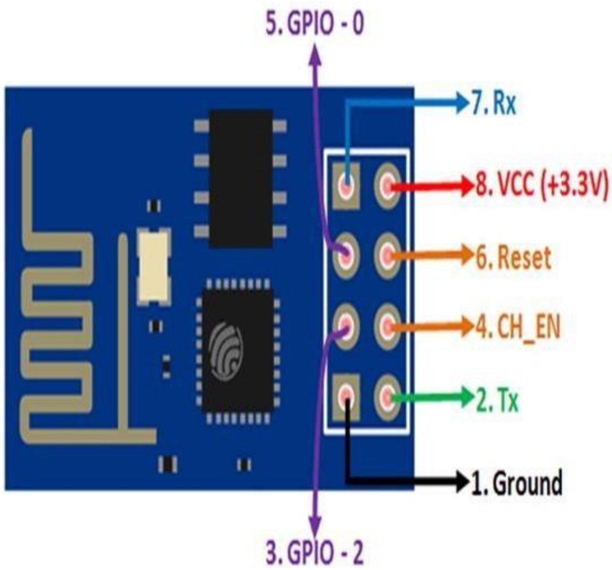
## i) NodeMCU:

It includes firmware that runs on the ESP8266 Wi- Fi system on a chip (SoC) from Espressif Systems and hardware which is based on the ESP-12 module.

NodeMCU is a Wi-Fi-enabled microcontroller. It has a micro- USB connector so it could be connected to any computer using data cable. The only thing that you must remember that it is a 3.3V logic level device. It means you will get a 3.3V digital high signal and giving more than 3.3V signal is not safe for the controller, however, the input voltage can vary from 5 to 12V.
NodeMCU contains 9 Digital pins, 1 Analog pins, 1 Reset pins, 1 Power pins.

- Low cost, compact, powerful Wi-Fi module
- Power supply: +3.3 V
- Current consumption: 100mA
- I/O Voltage: 3.6 V (max)
- I/O source current: 12mA
- 512 kB flash memory





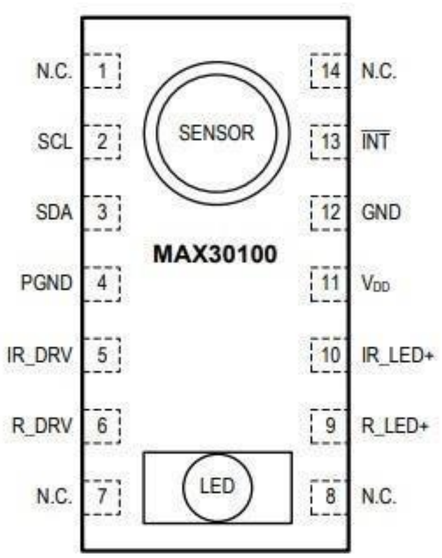
## ii) MAX30100:

MAX30100 is an integrated pulse oximeter and heart-rate monitor sensor solution. Combined with two LEDs, a photodetector, optimized optics, and low-noise analog signal processing. Operates from 1.8V and 3.3V power supplies. It is fully configurable

through software registers and the digital output data is stored in a 16-deep FIFO within the device. It has an I2C digital interface to communicate with a host microcontroller.

**Features:**

- Consumes very low power (operates from 1.8V and 3.3V)
- Ultra-Low Shutdown Current (0.7µA, typ)
- Fast Data Output Capability




## iii) DS18B20:

The DS18B20 is one type of temperature sensor and it supplies 9-bit to 12-bit readings of temperature. These values show the temperature of a particular device. The communication of this sensor can be done through a one- wire bus protocol which uses one data line to communicate with an inner microprocessor.

### Specification:

- The range of power supply is 3.0V – 5.5V
- Fahrenheit equal s to -67°F to +257°F
- The accuracy of this sensor is ±0.5°C
- The o/p resolution will range from 9-bit to 12-bit
- It changes the 12-bit temperature to digital word within 750 ms time
- The multiplexing can be enabled by Unique 64-bit address
- The temperature can be calculated from -55°C to +125°C.

### Pin Configuration:

- Pin1 (Ground): This pin is used to connect to the GND terminal of the circuit
- Pin2 ($V_{CC}$): This pin is used to give the power to the sensor which ranges from 3.3V or 5V
- Pin3 (Data): The data pin supplies the temperature value, which can communicate with the help of 1-wire method.

## iv) OLED Display:

0.96inch I2C/IIC 128x64 OLED Display Module 4 Pin - White Colour is a precise small, White OLED module which can be interfaced with any microcontroller using I2C/IIC protocol. It is having a resolution of 128x64.

OLED (Organic Light-Emitting Diode) is a self-light-emitting technology composed of a thin, multi-layered organic film placed between an anode and cathode. In contrast to LCD technology, OLED does not require a backlight. OLED possesses high application potential for virtually all types of displays and is regarded as the ultimate technology for the next generation of flat-panel displays.

**Specification**:

- **OLED Driver IC: SSD1306**
- **Resolution: 128 x 64**
- **Visual Angle: >160°**
- **Input Voltage: 3.3V ~ 6V**
- **Compatible I/O Level: 3.3V, 5V**
- **Mini Size: 2.7 x 2.8cm**
- **Only Need 2 I/O Port to Control**
- **Full Compatible with Arduino**
- **Working temperature: -30°C ~ 70°C**
- **Interface: I2C**

### v) PG-7 Gland:

Cable glands are used to pass cables through plates or the sides of waterproof boxes, without compromising the seal. They also provide strain relief.

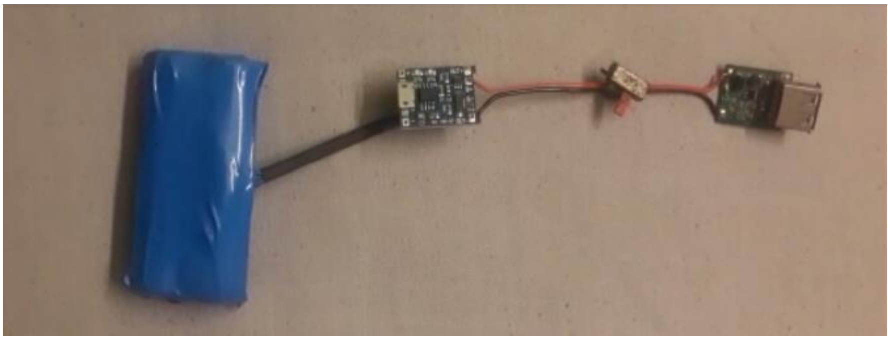
## Specification:

- **Threads:** **M12 x 1.25mm**
- **Waterproof Rating:** **IP67**
- **Cable Range Diameter:** **3mm to 6.5mm**
- **Material:** **Nylon**
- **Tap Hole Drill Bit:** **11mm (7/16")**
- **Colour:** **White**


**Pass Hole Drill Bit: 12mm (15/32)**

## vi) Power Supply:

- **2* 18650, 1200mAh, Li-Ion Cell**
- **1* TP4056 Battery Charging and Protection Module**
- **1* Power Switch**
- **1* 3.7 to 5V USB Charging Module**



**POWER SUPPLY UNIT**

NodeMCU has inbuilt AMS1117 so, we can give 3.7V power to the NodeMCU. NodeMCU runs on constant 3.3V. 3AAA Batteries also could supply the power to it. This is our cheapest and 2nd option to run the device.

If we remove IOT then it will consume far less power, then we will be able to run it on 2AAA Batteries. Though this is an untested possibility.

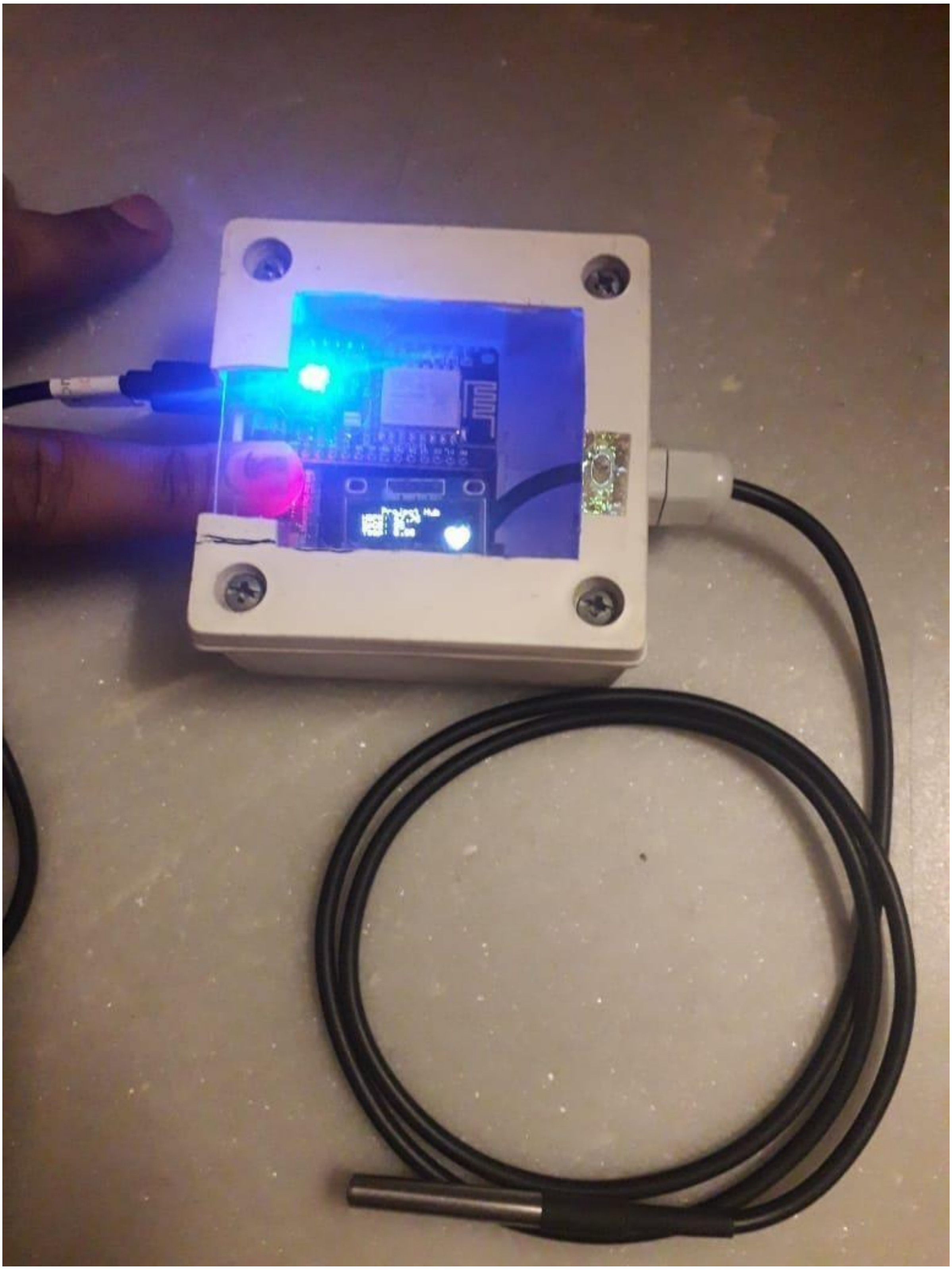
# SOFTWARE PROGRAM

```
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include "MAX30100_PulseOximeter.h"
#define REPORTING_PERIOD_MS 1000
#define REPORTING_PERIOD_MS1 10001
#define OLED_RESET D5
#define SCREEN_WIDTH 128 // OLED display width, in pixels
#define SCREEN_HEIGHT 64 // OLED display height, in pixels
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire,
OLED_RESET);
#define ONE_WIRE_BUS 2
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
PulseOximeter pox;
float TEMP, BPM, SpO2;
uint32_t tsLastReport = 0, tsLastReport1 = 0;
void setup()
{
if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) { // Address 0x3C for
128x64
//Serial.println(F("SSD1306 allocation failed"));
for (;;);
}

display.clearDisplay();
display.setTextSize(1);
display.setTextColor(WHITE);
display.println(F("RCCIIT"));
display.display();
pinMode(16, OUTPUT); //EXTRA
sensors.begin();
```

```
}
void loop()
{
jump:
if (!pox.begin()) {
display.println("Pox Failed");
display.display();
for (;;);
} else {
pox.setOnBeatDetectedCallback(onBeatDetected);//POSITION CHANGED
}
pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);
while (1)
{
pox.update();
BPM = pox.getHeartRate();
SpO2 = pox.getSpO2();
if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
display.clearDisplay();
display.setTextSize(1);
display.setTextColor(1);
display.setCursor(28, 0);
display.println(" ");
display.println("Heart BPM");
display.println(pox.getHeartRate());

display.println("SpO2");
display.println(pox.getSpO2());
display.println("Temp");
display.println(TEMP);
display.display();
tsLastReport = millis();
}
```

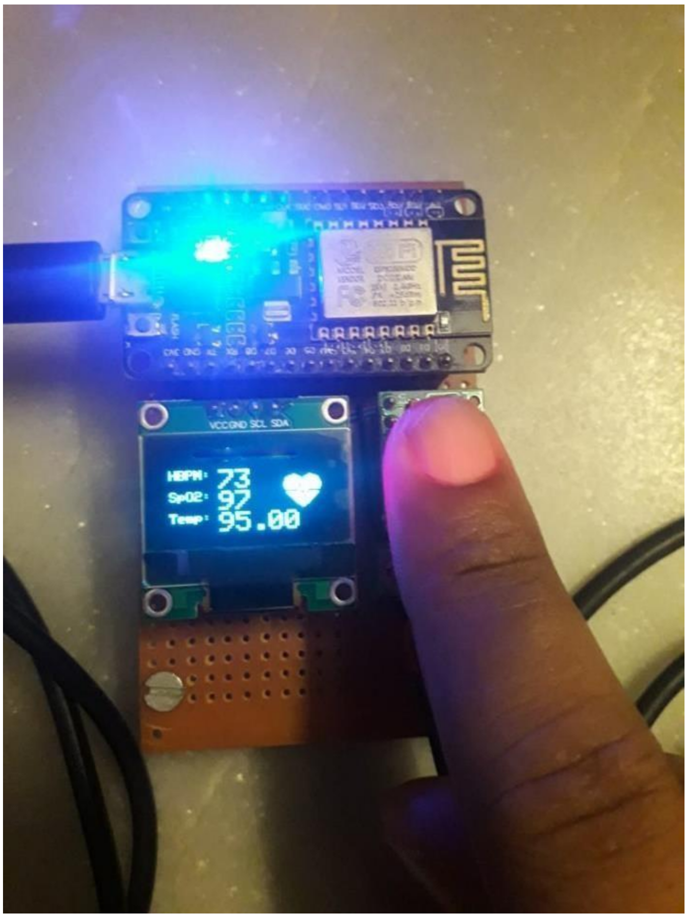
```
if (millis() - tsLastReport1 > REPORTING_PERIOD_MS1) {
sensors.requestTemperatures();
TEMP = sensors.getTempCByIndex(0);
tsLastReport1 = millis();
goto jump;
}
}
}
```

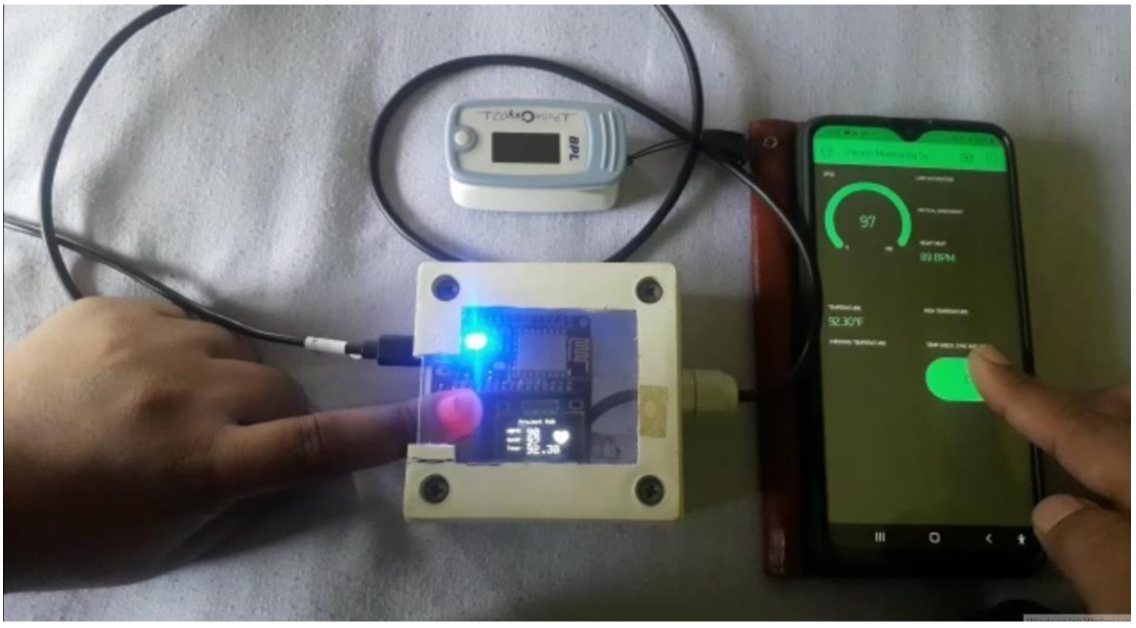
# HARDWARE MODEL

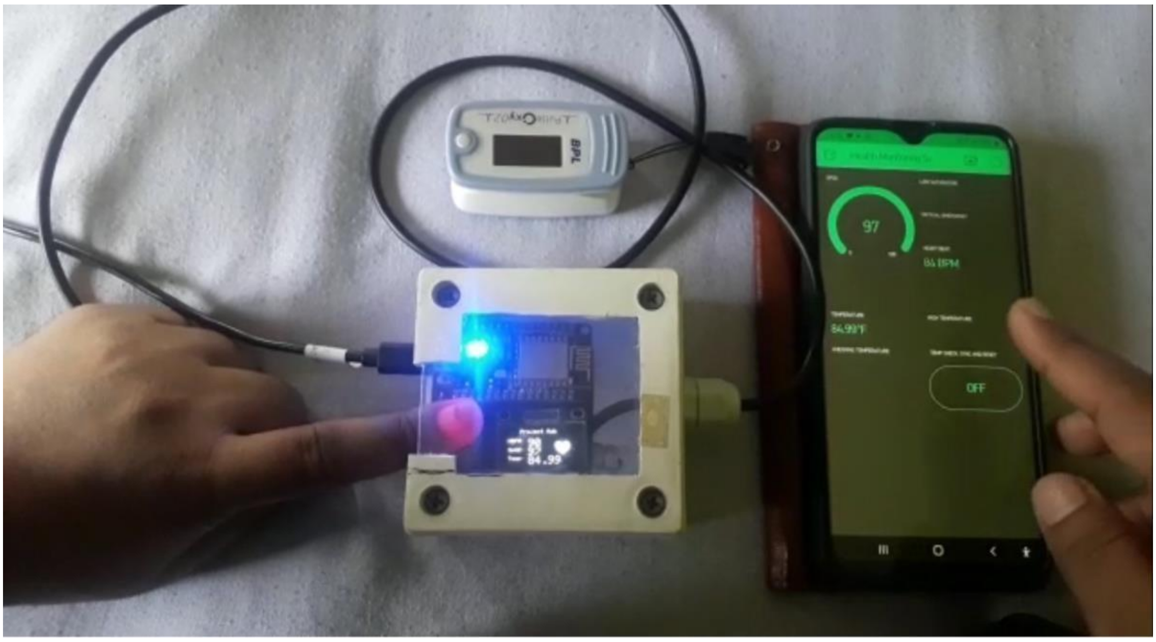


Size 76mm X 76mm X 51mm

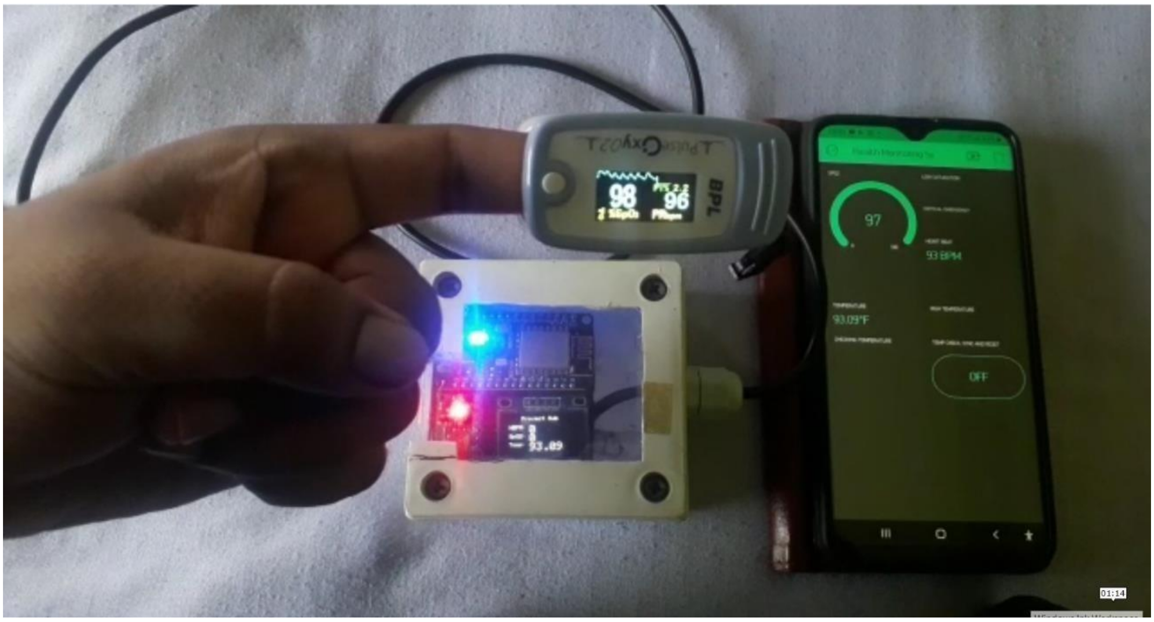
# OBSERVATION & RESULT






Real time value of the system




Calibration with commercially available oximeter

# DISCUSSION

The Internet of Things is considered now as one of the feasible solutions for any remote value tracking especially in the field of health monitoring. It facilitates that the individual prosperity parameter data is secured inside the cloud, stays in the hospital are reduced for conventional routine examinations and most important that the health can be monitored and disease diagnosed by any doctor at any distance. In this paper, an IoT based health monitoring system was developed. The system monitored body temperature, pulse rate and oxygen saturation using sensors, which are also displayed on a LCD. These sensor values are then sent to a medical server using wireless communication. These data are then received in an authorized personals smart phone with IoT platform. With the values received the doctor then diagnose the disease and the state of health of the patient without any close contact.

# CONCLUSION

This is a simpler prototype of an IOT based health monitoring system which will measure, display and store some basic health parameter data like body temperature, heart rate and oxygen saturation. 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 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. In our digital future, this can be used to monitor further more necessary parameters using more sophisticated sensors and powerful processors and by using more complex processing logics and machine learning algorithms, this can be a very important health monitoring device among the future population.

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