A

Project Report

on

# Substation Monitoring and Control through IOT

*Submitted in partial fulfillment of the requirement for the award of*

*the Degree of*

**BACHELOR OF TECHONOLOGY**

*in*

**ELECTRICAL AND ELECTRONICS ENGINEERING**

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**SCHOOL OF ELECTRICAL, ELECTRONICS AND COMMUNICATION ENGINEERING**

# DECLARATION

We declare that the work presented in this report titled "**Substation Monitoring and Control through IOT**", submitted to the Department of Electrical and Electronics Engineering, Galgotias University, Greater Noida, for the Bachelor of Technology in Electrical and Electronics Engineering is our original work. We have not plagiarized unless cited or the same report has not submitted anywhere for the award of any other degree. We understand that any violation of the above will be cause for disciplinary action by the university against us as per the University rule.

**Place:**

**Date:**

**Signature of theStudent**

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## School of Electrical, Electronics and Communication Engineering

# CERTIFICATE

This is to certify that the project titled **"Substation Monitoring and Control through IOT''** is the bonafide work carried out by Om Prakash & Shilpi, students, during the academic year 2019-20. We approve this project for submission in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Electrical and Electronics Engineering, Galgotias University.

Dr. PratimaWalde
Project Guide(s)

**The Project is Satisfactory / Unsatisfactory.**

Approved by

_____

Dean

# ACKNOWLEDGEMENT

We are grateful to The Department of Electrical and Electronics Engineering, for giving us the opportunity to carry out this project, which is an integral fragment of the curriculum in Bachelor of Technology program at the Galgotias University, Greater Noida. We would like to express our heartfelt gratitude and regards to our project guide, Dr. Pratima Walde, Assistant Professor, School of Electrical, Electronics and Communication Engineering, for his unflagging support and continuous encouragement throughout the project.

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# ABSTRACT

Power is generated at power plant and is used to be carried out by transmission line to the distribution substation. The substation steps down the voltage through the transformer and distributes it to the different area. We need to monitor the parameters of distribution line like current, voltage, power and temperature of the substation. So, we have made a system where we can monitor all these parameters on the LCD.

Then after suppose there is a fault in the distribution line say short circuit then we are making a system which can trip the particular distribution line in case of fault. After that alarm and indicator in the substation will become on alarm the people about the fault in the particular area where the fault has been occurred.

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# GLOSSARY

| | |
|---|---|
| IOT | Internet of Things |
| GSM | Global System for Mobile Communication |
| LCD | Liquid Crystal Display |
| LED | Light-emitting Diode |
| DC | Direct Current |
| P.F. | Power Frequency |
| Wi-Fi | Wireless Fidelity |

# 1. INTRODUCTION

We need to monitor the parameters for distribution of electricity properly with proper values of voltage, current, power, etc. So, our project intends to make a working prototype of monitoring system of distribution line.

Further, in case of fault like grid failure, open circuit, short circuit we need to alert the people in the substation and make an automatic system which take the action in case of fault. So, our project also intends to make a working prototype of control in case of fault.

Our innovation in this is to control the distribution lines from any part of the world without physically present at the substation. Our project intends to make this innovative feature of the distribution line.

## 1.1 Issues

In case of fault, there may be damage due to the fault so, we need system to cut off that distribution automatically and prevent that distribution line from further damage. So we need to set up a system for control for automation in case of fault.

We need to be physically present at the substation for monitor and control. If the substation is in difficult terrain area then it is very difficult to be present at substation and monitor the parameters of distribution line and control in case of fault.

## 1.2 Problems

One needs to be physically present at the substation to monitor. Although the relay automatically cut off the distribution line then also the person has to manually cut off that particular distribution line power manually from main switch present at the substation control panel for safety and then the concerned person repair the particular damage at particular area of fault. So it is necessary in the present system to physically be present at the substation to cut off power on it in case of fault and after restoration of fault respectively.

## 1.3 Objectives

- Our system intends to monitor the parameters of distribution line like current, voltage, power and temperature of the substation.
- Power system intends to automatically take the action in case of any undesired circumstances or fault. We have developed such an automatic system in which case of fault alarm the person present at substation and take action by cutting off the electricity in that particular area where fault has occurred. Our system also intends to display the status of distribution and in case of fault which type of fault has occurred.
- We have developed an innovative system for controlling and monitoring the distribution lines and substation from anywhere in the world without physically being present at the substation through IOT.

## 1.4 Contributions

We have developed the system by which we can control and monitor the distribution lines and area from any part of the world without being physically present at the substation. The authorized person can open the particular IOT application in the device like phone or laptop and can cut off or on the particular area power on the basis of demand.

# 2. LITERATURE SURVEY

## 2.1 Introduction

1. **Krupal Dhimar et al:** Their project aim was to control and monitor the electrical parameters voltage, current and frequency using through microcontroller and GSM. In this, they were controlling these parameters by the use of relay. The relay trips the whole current when the parameter exceeds their limit. The relay sends the message whenever it breaks the circuit.

2. **Ghous Buksh Narejo et al:** They enhanced this project by using GSM modem .They were making the whole system more intelligent and automated. This project helps in reducing labor cost and decreased time utility.

## 2.2 Failures

One needs to be physically present at the substation to monitor. Although the relay automatically cut off the distribution line then also the person has to manually cut off that particular distribution line power manually from main switch present at the substation control panel for safety and then the concerned person repair the particular damage at particular area of fault. So it is necessary in the present system to physically be present at the substation to cut off power on it in case of fault and after restoration of fault respectively.

## 2.3 Techniques

We have developed the system by which we can control and monitor the distribution lines and area from any part of the world without being physically present at the substation. The authorized person can open the particular IOT application in the device like phone or laptop and can cut off or on the particular area power on the basis of demand

# 3. COMPONENTS USED

## 3.1 Current Sensor

The current sensor senses the current through the wire and produces signal 0-1024 according to the current. The signal is processed by the Arduino calibrated and then sent to the LCD for the display. We are using current sensor ACS712.


Figure3.1 Current Sensor

## 3.2 Voltage Sensor

The voltage sensor senses the voltage through the wire and produces signal 0-1024 according to the voltage. The signal is processed by the Arduino, calibrated and then sent to the LCD for display. We are using voltage sensor of 25 volt.


Figure3.2 Voltage Sensor

## 3.3 Temperature Sensor

LM 35 is a temperature sensor used to measure the voltage between 0 to 150°C. For 1°C there is a voltage of 0.01 volt.

Voutput is given as:

Voutput = 0.01V/C * temperature.

V = Volt

C = Celsius

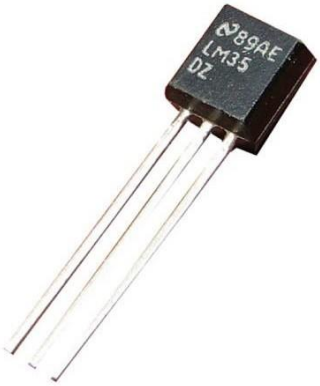


Figure3.3Temperature Sensor

## 3.4 Arduino

It is the microcontroller in which programming is feed on the basis of which the input signal is analyzed and sent to the output device.


Figure3.4Arduino

## 3.5 LCD Display

We are using 16*2 LCD display for displaying the parameters of the distribution line like current, power, voltage and temperature. We are using potentiometer in the LCD for contrast.

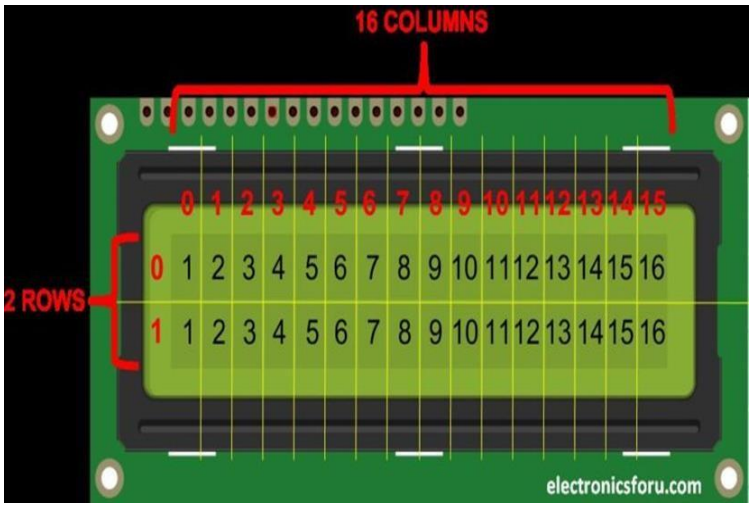

Figure3.5 LCD Display

## 3.6 Buzzer

In case of fault, the buzzer will sound and alarm to aware the people at substation.

## 3.7 LED

It is used as indicator which will brighten in case of fault.

## 3.8 DC Motor

To display the fan in the household, we are using motor.


Figure3.6 DC Motor

\\\\

## 3.9 Jumper Wire

Obviously, wire will be used to connect the components.

Figure3.7 Jumper Wire

## 3.10 Breadboard

For easier connection of the components and Arduino, we are using breadboard to connect the components as breadboard does not require any soldering and also it is reusable.

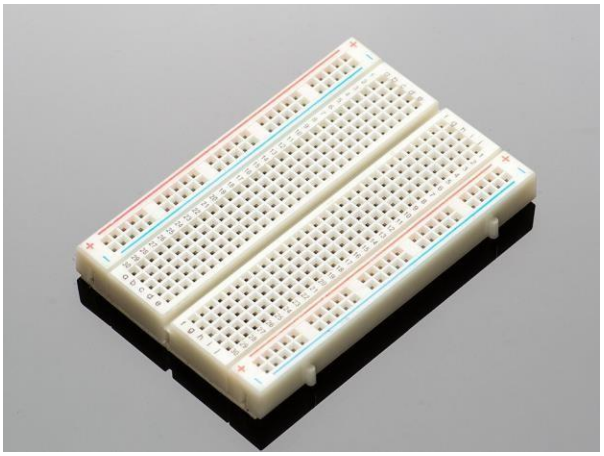

Figure3.8 Breadboard

## 3.11 Switch

The switch is used to manually cut OFF or ON the electricity of a particular area.

## 3.12 Node MCU ESP8366

Node MCU ESP8266 is a programmable IOT kit. It is having both the IOT feature and programming feature unlike ESP-01 ESP8266 which has only IOT feature.

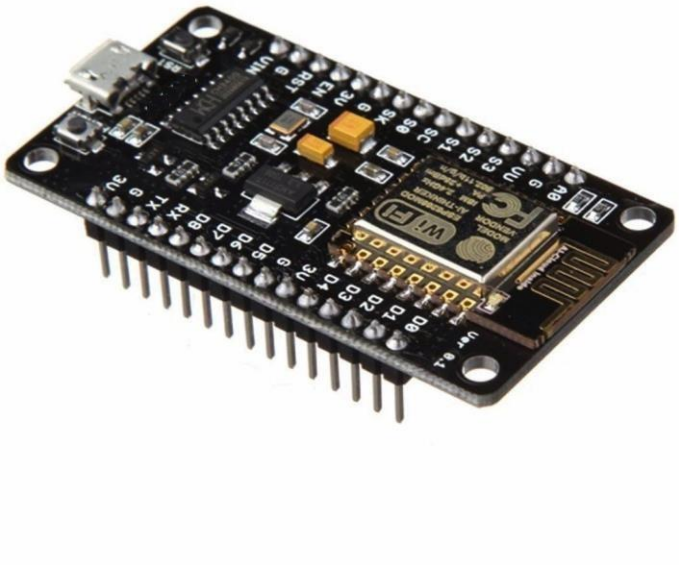

Figure3.9 Node MCU ESP8266

# 4. WORKING

## 4.1 Block Diagram

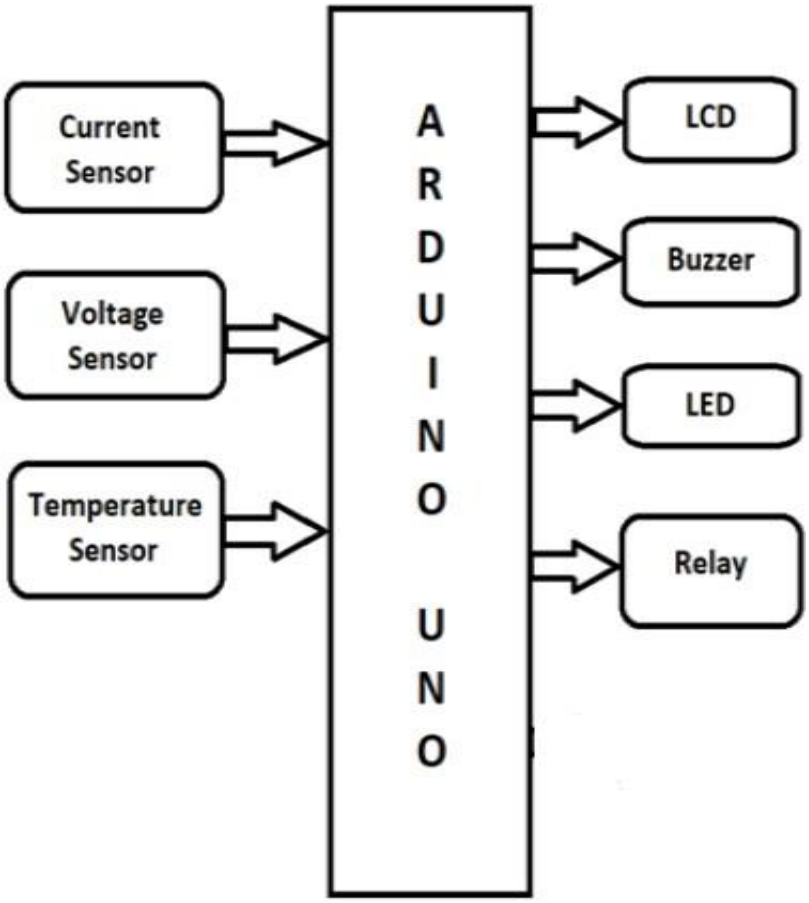


**Figure4.1.1 Block Diagram of Circuit**

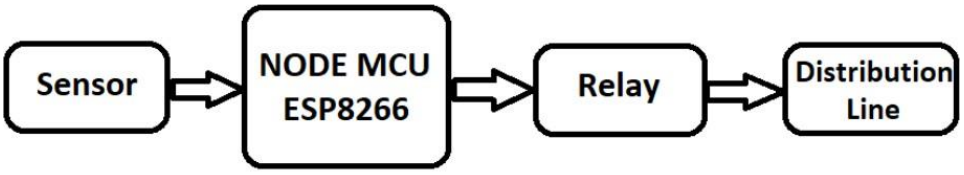



**Figure5.1.2.IOT Feature Block Diagram**

## 4.2 Monitoring

- We are using current sensor (ACS712) for measuring the current through the distribution line to a particular area.
- Voltage sensor is used for measuring the voltage.
- Power can be calculated with the help of current sensor value and voltage sensor value as power =current*voltage*P.F.
- Temperature will be measured through the temperature sensorLM35.
- Arduino will input these sensor values and convert them into analog form to digital form for the processing and then send it to the LCD.
- The value of the different parameters will be shown on the LCD 16*2screen.
- 16*2 LCD will be used to display these parameters which are current, voltage, power and temperature.

## 4.3 Arduino Programming Logic

- **For short circuit**

  If current is greater than the cut off value current, then relay of that particular area will be off.

- **For open circuit**

  If current is less than the minimum value current, then the relay of that particular area will be off.

- **For very high voltage**

  If voltage is greater than the cut off voltage, then the relay of that particular area will be off.

## 4.4 Control (In case of fault)

Suppose the certain distribution line of the certain area has been shot circuited, short circuit leads to increase in the value of current. When the current value exceeded the certain level then the following will happen-

- Arduino will give signal to the relay to cut off the particular area electricity where fault has been occurred.
- Buzzer and indicator of the panel will become ON to alarm the people in the substation.
- Although Arduino will automatically cut off the power supply of the particular area.

Then, also a cut OFF and ON which has been provided in the panel to manually cut OFF and ON the particular area distribution line.

# 5. IOT MONITOR AND CONTROL

- We are developing such a system where we can monitor the parameters like current voltage power and temperature being anywhere in the world.
- We are using node MCU ESP8266 to control the relay and therefore electricity to distribution area through internet.
- We need to just have internet connection in our monitoring device and through IOT platform for IOT app, we can monitor the parameters of the transmission line being anywhere in the world.
- Node MCU ESP 8266 needs Wi-Fi connection so that it can send and receive data to server.
- Through IOT in our phone, we can give command to trip down any distribution area in case we require to do so.
- Therefore, we can monitor and control without being physically present at the substation and being at any port of the world.

# 6. RESULT & DISCUSSION

Thus the system enables us to monitor and control the distribution in case of any fault. It has the system for control for tripping down the relay of line in case of fault and to normalize the line again after clearing the fault and to normalize the temperature of transformer and substation by cooling fan. This project measures power substation and transformer and displays it on LCD display and will also send data to far distance placed wire lessly through GSM module (IOT).

Thus, it can be monitored at substation as well as from far distant place.

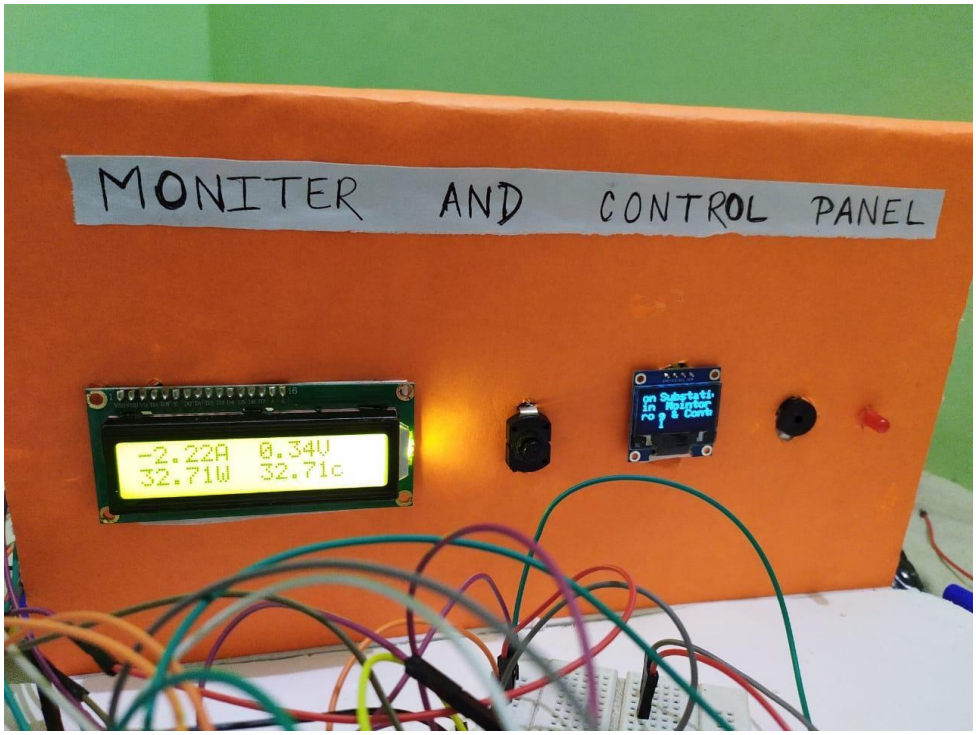


Figure6.1 Figure Showing Project Title on OLED Screen

## 6.1 ARDUINO CODING

```
constint tem=A0;
floattempc;
floatvout;
float power;
constintcurrentPin = A1;
int sensitivity = 66;
intadcValue= 0;
intoffsetVoltage = 2500;
doubleadcVoltage = 0;
doublecurrentValue = 0;
doubleundercur = 0.5;
doubleovercur = 10;
constintvoltageSensor = A2;
floatvOUT = 0.0;
floatvIN = 0.0;
float R1 = 30000.0;
float R2 = 7500.0;
int value = 0;
floatminvol=3.0;
#include<LiquidCrystal.h>
LiquidCrystalLCD(10,9,5,4,3,2);
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
```

```
#define SCREEN_WIDTH 128 // OLED display width, in pixels
#define SCREEN_HEIGHT 64 // OLED display height, in pixels
// Declaration for an SSD1306 display connected to I2C (SDA, SCL pins)
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);
void setup() {
  Serial.begin(115200);
  if(!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) { // Address 0x3C for 128x64
    Serial.println(F("SSD1306 allocation failed"));
    for(;;);
  }
  display.clearDisplay();
  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.setCursor(0, 0);
  // Display static text
  display.println("AyushGuptOmPrakashShilpiverSaurav Ch.");
  display.display();
  delay(4000);
  display.clearDisplay();
  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.setCursor(0, 0);
  // Display static text
  display.println("SubstationMointoring& IOT     Control");
  display.display();
  delay(100);
```

```
 // Scroll in various directions, pausing in-between:
  display.startscrollright(0x00, 0x0F);
  delay(500);
  display.stopscroll();
  delay(250);
  display.startscrollleft(0x00, 0x0F);
  delay(500);
  display.stopscroll();
  delay(250);
  display.startscrolldiagright(0x00, 0x07);
  delay(500);
  display.startscrolldiagleft(0x00, 0x07);
  delay(500);
  display.stopscroll();
  delay(2000);
  pinMode(tem,INPUT);
pinMode(8,OUTPUT);
pinMode(12, OUTPUT);
LCD.begin(16,2);
LCD.setCursor(0,0);
 LCD.print("Current");
 LCD.setCursor(8,0);
 LCD.print("Voltage");
 LCD.setCursor(0,1);
 LCD.print("Power");
 LCD.setCursor(8,1);
```

```
 LCD.print("Temperat");
 delay(3000);

}

void loop() {
  vout=analogRead(tem);
  tempc=vout*0.48828125;
  adcValue = analogRead(currentPin);
  adcVoltage = (adcValue / 1024.0) * 5000;
  currentValue = ((adcVoltage - offsetVoltage) / sensitivity);
  value = analogRead(voltageSensor);
  vOUT = (value * 5.0) / 1024.0;
  vIN = vOUT / (R2/(R1+R2));
  power=currentValue*vIN;
  LCD.setCursor(0,0);
  LCD.print("        ");
  LCD.setCursor(0,0);
  LCD.print(currentValue);
  LCD.print("A");
  LCD.setCursor(8,0);
  LCD.print("        ");
  LCD.setCursor(8,0);
  LCD.print(vIN);
  LCD.print("V");
  LCD.setCursor(0,1);
```

```
LCD.print("       ");
LCD.setCursor(0,1);
LCD.print(power);
LCD.print("W");
LCD.setCursor(8,1);
LCD.print("       ");
LCD.setCursor(8,1);
LCD.print(tempc);
LCD.print("c");
if(vIN<minvol)
{
  digitalWrite(8,HIGH);
  display.clearDisplay();
display.setTextSize(3);
display.setTextColor(WHITE);
display.setCursor(0, 0);
// Display static text
display.println(" Grid  Failure");
display.display();
}
else {
 if(currentValue<undercur&&currentValue>-undercur)
{
  display.clearDisplay();
display.setTextSize(2);
display.setTextColor(WHITE);
```

```
  display.setCursor(0, 0);
  // Display static text
  display.println("  Open   Circuit   Fault");
  display.display();
  digitalWrite(8,HIGH);
  digitalWrite(12,LOW);
  }
  if (currentValue>=undercur || currentValue<=-undercur)
  {
  digitalWrite(8,LOW);
  display.clearDisplay();
  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.setCursor(0, 0);
  // Display static text
  display.println("Distribution  is   Normal");
  display.display();
  }
  delay (3000);
  digitalWrite(12,HIGH);
  }
}
```

**Now coding for IOT Module (NODE MCUESP8266):**

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266_SSL.h>
```

```
// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
charauth[] = "IjC7_YuInNpZD3uL6oERPQei-zd8HYJr";
// Your WiFi credentials.
// Set password to "" for open networks.

charssid[] = "Om";
char pass[] = "Om@prakash";
void
 setup()
{
  // Debug console
Serial.begin(115200);
Blynk.begin(auth, ssid, pass);
}
void loop()
{
Blynk.run();
}
```

## 6.2 Observed Reading

| Condition | Coding Comparative Value | Status Shown in Panel | Alarm and LED Indicator |
|---|---|---|---|
| For Normal Distribution | Vin>min. voltage=3 I=0.5 | Distribution is normal | OFF |
| For Grid Failure Fault | Vin<min. voltage=3 | Grid Failure | ON |
| For Open Circuit Fault | Vin<min. voltage =3 I<under current=0.5 | Open Circuit Fault | ON |

Table6.2.1.Observed Reading

## Normal Distribution Reading

Current = 3.85A

Voltage = 5.03V

Power = 19.35W

Temperature = 25.39C

Alarm and LED Indicator - OFF

Status shown on Panel- Distribution is Normal


Figure6.2.1. Figure Showing Distribution is Normal

## Grid Failure Reading

Current = 1.1A

Voltage = 1.17V

Power = 1.287W

Temperature = 43.4C

Alarm and LED Indictor – ON

Status shown on Panel – Grid Failure

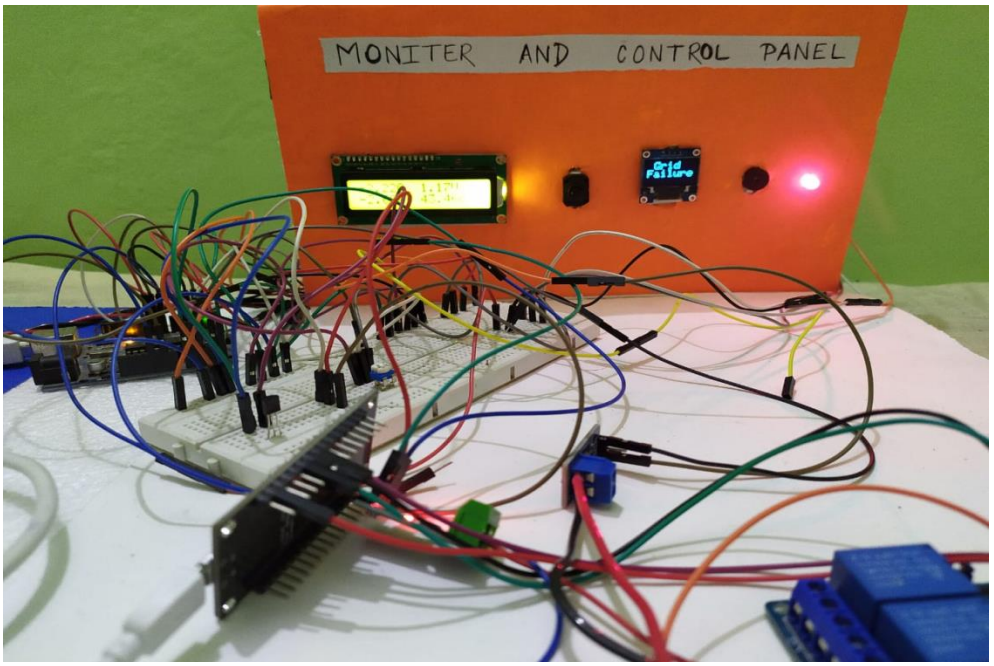


Figure6.2.2. Figure Showing Grid Failure

## Open Circuit Fault Reading

Current = 0.2A

Voltage = 4.93V

Power = 0.986W

Temperature = 24.89C

Alarm and LED Indicator – ON

Status shown on Panel – Open Circuit Fault

Figure6.2.3. Figure Showing IOT Controlling

# 7. CONCLUSIONS AND FUTURE RESEARCH WORKS

## 7.1 CONCLUSIONS

We made the prototype of substation monitoring and controlling. We can monitor and control the whole parameters by using IOT module. Our system contains fans, current sensor, voltage sensor, temperature sensor, buzzer, switch, LED indicator and LCD display etc. The Arduino is programmed in such a way that it gives proper and immediate information about any fault and immediately steps are taken to avoid any damage to system.

In remote areas, high terrain where it is very difficult for people to be physically present in that area the monitoring and control of the distribution lines in various areas can be done from far distance place through IOT.

We can also interchange the supply in case if a particular grid gets failed through IOT.

We can also cut off whole power supply in case of any emergency using IOT module.

## 7.2 FUTURE RESEARCH WORKS

Further cameras can be installed in the substation to visualize the parts and components of substation like transformer, bus bar, isolator, etc. and through IOT it could be visualized from the far distance place.

# 8. REFERENCES

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