IoT Based Smart Irrigation System

September 23, 2021

Department of Electrical Engineering

Mureed Qasim Shah	2018-UET-NML-Elect-37
Muhammad Imran	2018-UET-NML-Elect-17

(Supervisor)
Mr. Muhammad Usama
Department of Electrical Engineering

(Co-Supervisor)
Dr. Majid Ali
Department of Electrical Engineering

Namal Institute, Mianwali Affiliated with
University of Engineering and Technology, Lahore

Table of Contents

Contents

List of Figures

1. Abstract

The agriculture of farming has started past 12000 many years straight back, Neolithic age gave the beginning of civilization, Farming and later becoming continued as traditional farming techniques. Agriculture has always been the backbone of Pakistan's economy. Pakistan is the fifth largest producer of sugarcane in the world, the seventh-largest producer of wheat, and the tenth-largest producer of rice. About 70 % of the populace in Pakistan is related to agriculture directly or indirectly. Its share towards GDP is mostly about 25 percent which can be more than the share of any other sector. Various problems related to agriculture are constantly hampering the development of the nation. Agriculture in Pakistan uses 93 % of the water that's available while significantly 60 % of that water is wasted for the application and transport into the field. The reason that is significant application losings could be the lack of knowledge about irrigation scheduling and proper irrigation system. A possible option for these irritating dilemmas is to decide on an advanced agriculture system that consists of contemporary styles. So we can make farming smart using IoT. IoT is the fastest-growing technology in every domain of society, especially in agriculture. The leading characteristic of this project is that it will reduce the wastage of water during irrigation alongside many more advantages. the sensor used in the system collects the data from the soil and sends it to the IoT web server where it can be further examined. We will design an android mobile application that will provide essay access to information to the farmer.

2. Project Problem

"To design a system that will reduce water wastage during irrigation as well as increase productivity of the crops."

3. Project Introduction:

IoT is a system consisting of computing devices that can sense the data as well as convert data over the web without any human involvement. The project group shall recommend an IOT based Irrigation and Weather Reporting System. This method will consist of two parts which can be crucial. The first part is linked to the irrigation monitoring and managing system plus the second is the weather reporting system. The project group can manage and monitor the way to obtain water coming from a place. The suggested system permits the people to directly look at the climate status online without the need for a weather forecasting company in this project. It will help to know about the current temperature, humidity, moisture, and rain by using a temperature sensor and humidity sensor respectively. The system will transfer the data to the microcontroller or process this data and the microcontroller will send this information to the web host over a WIFI Module.

In this project, sensors keep checking the values of humidity, temperature, soil moisture, and rain status and update the data on the website. A user can see the details of the sensor and according to the need of crops or plants he can supply the water just by a click on motor status. Farmers should work on the other parts of the field so that they will not care about the irrigation systems. The crops get damaged if the farmer does not supply the exact amount of water to crops or plants. So by using this system, farmers don't have to worry about the crops plants getting damaged as a result of drought waterlogging. So in this way, we will be able to save the wastage of water using proper irrigation systems.

4. Literature Review

Many people in the world worked on the smart irrigation system. They recommended many ways to reduce the wastage of water during irrigation and increase the productivity of the crops. Some of the work you can find is given below in the references. One of the major drawbacks that we have found in their project is that they only use one soil moisture sensor to run the motor pump. Some of them also used rain sensors. So it's nearly impossible to irrigate the field using one soil moisture sensor. So here in our project, we have used four soil moisture sensors to control the motor pump and to start the irrigation. In case of excess amount of water, we also proposed a water drainage system. Our project will store the excess amount of rainwater and

will use it for irrigation when needed. We also can change the soil moisture sensor limit according to temperature and humidity values.

5. Working

The working of this project is divided into 3 parts. The first one is related to the software simulation of the project. The second one is related to the coding of the Project. The third one is related to the hardware design of the Project.

6. Simulation Part

First of all, we have designed a circuit diagram of our project in Proteus software. The circuit diagram is given below.

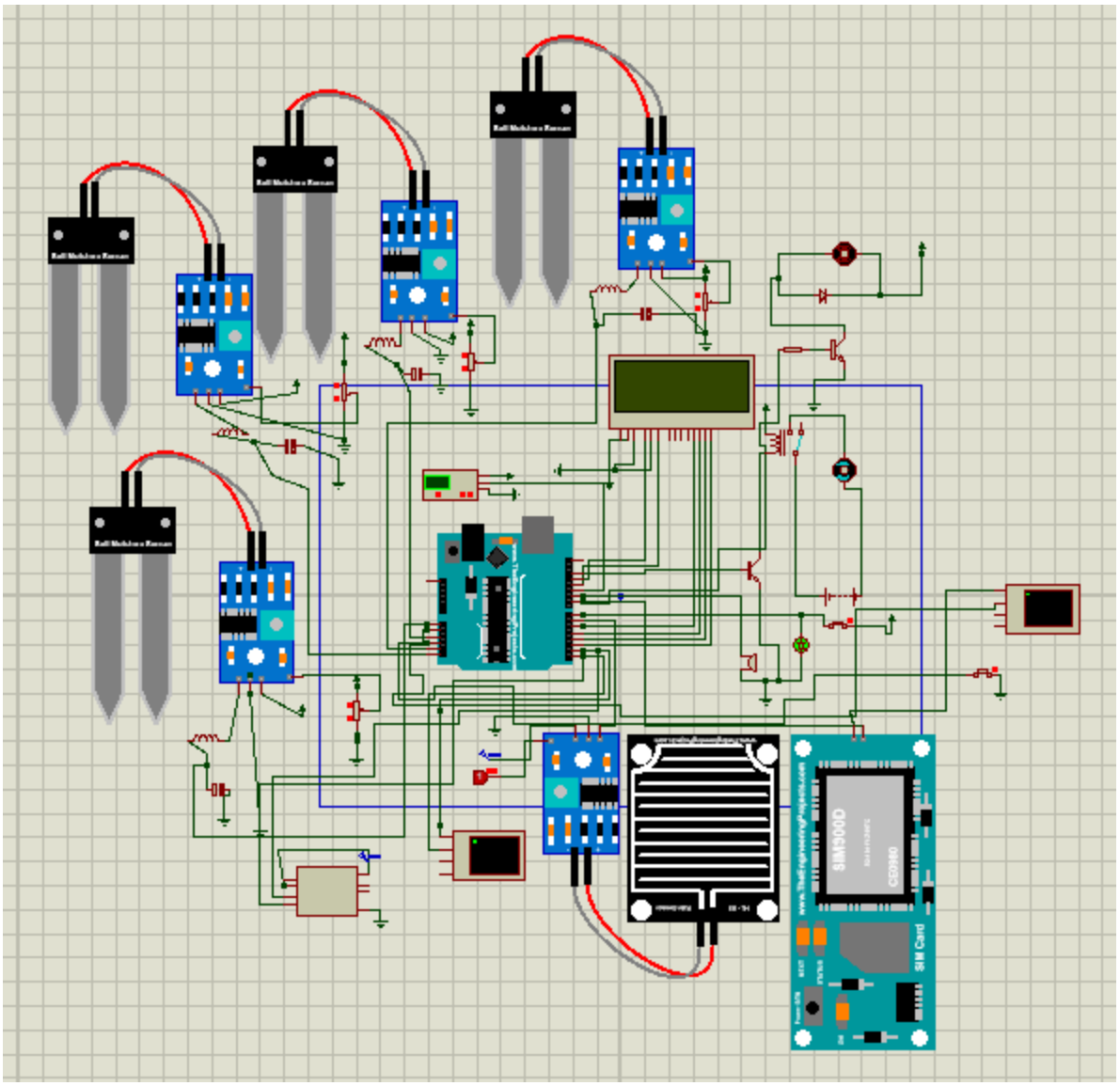

Figure 1:Complete Simulation Diagram

Fig 1:

This is The simulation circuit diagram that we have designed in Proteus.

7. Component Used in Simulation Part

Given below are the components that we used in our Project which are

1. Soil moisture sensor
2. Temperature and humidity sensor

3. Rain sensor
4. GSM module
5. Motor pump
6. LCD
7. Arduino Uno
8. WIFI Module

7. Components Working Explanation

In this section, we will explain how every component is working in the simulation of this project. How do we integrate these sensors and how to get the output from this sensor.

7.1 Soil Moisture Sensor

Soil moisture sensor working is very simple. Resistance present in the soil is inversely proportional to the soil moisture. The fork-shaped probe acts just like a potentiometer whose resistance changes according to the water content present in the soil. An excess amount of water present in the soil means better conductivity. So the resistance will be low. If there is less water present in the soil means poor conductivity. So the resistance will be high.
Sensor output values will be according to the resistance. So by measuring these values we can measure the moisture level. It only has 4 pins to connect as shown below:

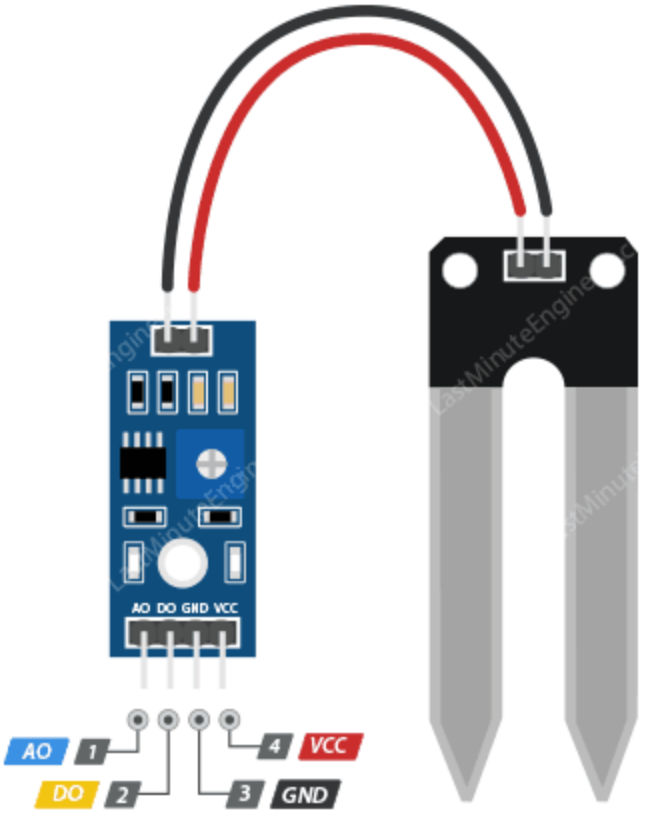

Figure 2:Rain Sensor

As we know the module provides an analog and digital output. We will measure the soil moisture by reading the analog output. So in this Project, we have used 4 Soil Moisture sensors. We interface these sensors with Arduino Uno as shown above in the circuit diagram figure. We are constantly measuring the percentage of

moisture present in the soil. These four sensors are connected to the Arduino pins A0, A1, A2, and A5. These four pins are acting as output. By using the analogRead command we are reading the values of moisture present in the soil. As shown below

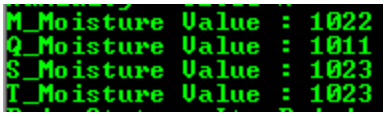

Figure 3:Moisture Sensor Values

So given above are the four values of 4 soil moisture sensors. So in this way we are reading the values of the sensor.

7.1.1 Technical specification of soil moisture sensor

Given below are the technical specification of the Soil Moisture Sensor.

Technical Specification:

Type	Specifications
Measuring range	Moisture: 0 ~ 99.9 % Temperature: 0 ~ 60 C
Accuracy	Moisture: + - 3% Temperature: + 0.5 C
Sensor type	Frequency Domain Reflectometry
Operating range	0 – 60C
Power supply	DC: 9 - 15 V
Current	25mA
Size	Probe Length 12cm 38mm

7.1.2 Motor pump control using a soil moisture sensor

In this section, we will explain how we are controlling the motor pump using the values of our soil moisture sensors and rain Sensor. Soil moisture that we used in this project measured the values from 0 to 1023.

7.1.3 Condition 1: (Soil Moisture Values > 700 && No Raining)

As we are continuously reading the values of all four soil moisture sensors. When all four sensor values are greater than 700 it means that our soil is dry and the motor Pump will be ON only if there is no rain.

Figure 4: Moisture>700 & No Raining

As shown in the above picture we can see the rain status which shows "No Raining in Your Area". All four sensor values are > 700 and there is no rain, so there is a need for irrigation so the motor pump is ON.

7.1.4 Condition 2: (Soil Moisture Values between 300 & 700 & No Raining)

As we are continuously reading the values of all four soil moisture sensors. When all four sensor values are

less than 700 and greater than 300 it means that our soil is moist so the motor pump will be on and irrigation will start only if there is no rain.

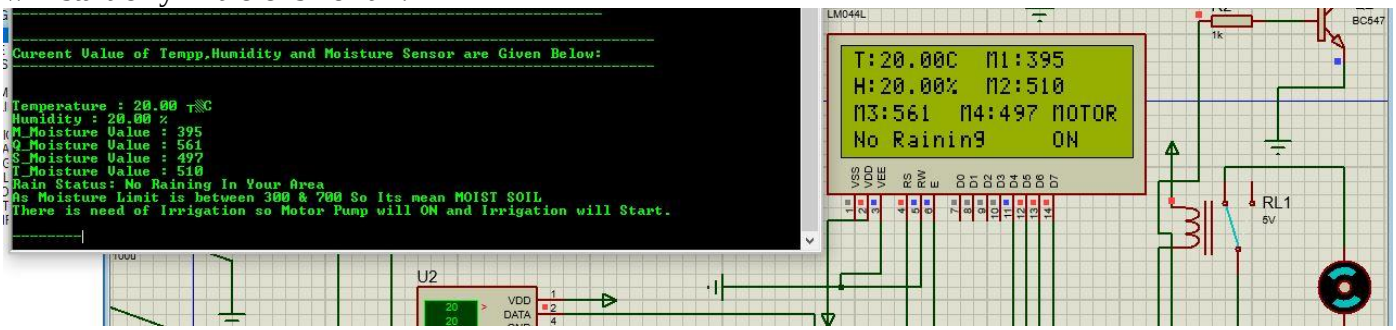

Figure 5:Moisture>300&& Moisture<700 && No Raining

As shown above, our motor is on and irrigation will start in case of moist soil.

7.1.5 Condition 3: (Soil Moisture Values < 300 & No Raining)

As we are continuously reading the values of all four soil moisture sensors. When all four sensor values are less than 300 it means that our soil is completely wet so the motor pump will remain OFF.

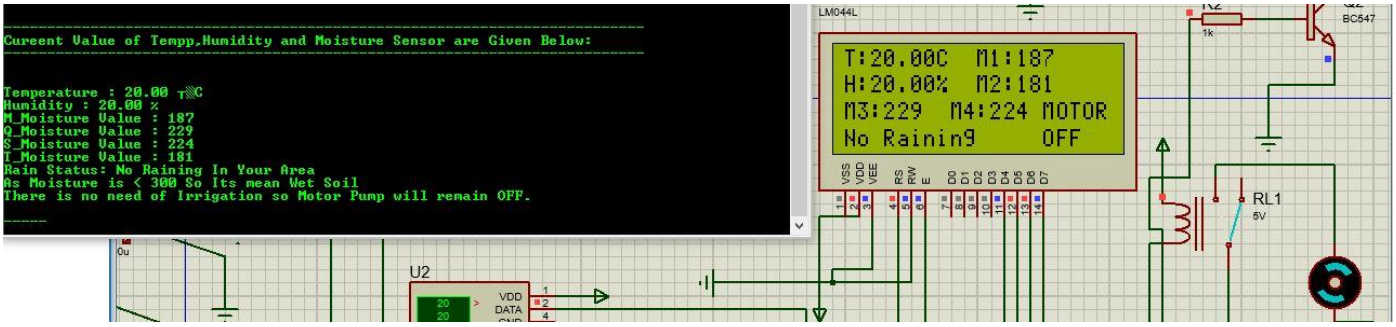

Figure 6: Moisture<300 & No Raining

7.1.6 Condition 4: (Anyone soil moisture sensor value > 700 & No Raining)

As we are continuously reading the values of all four soil moisture sensors. We have connected four soil moisture sensors and integrated them. Any one of the four sensors will give a moisture value greater than 700 then which means that one part of the soil is completely dry. so our motor pump will be on and irrigation will start. As shown in the below figure

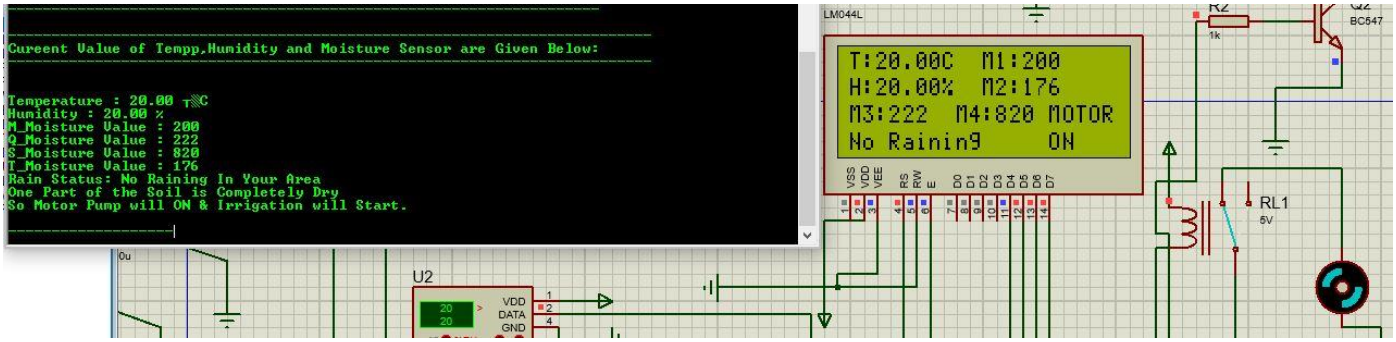

Figure 7: Anyone Moisture>700 & No Raining

7.1.7 Condition 5: (Anyone soil moisture sensor value > 700 & Raining)

As we are continuously reading the values of all four soil moisture sensors. We have connected four soil moisture sensors and integrated them. Any one of the four sensors will give a moisture value greater than 700 then which means that one part of the soil is completely dry. Its means that there is a need for irrigation but rain has started. So in this case our motor pump will remain off and irrigation will stop. As shown in the below figure

Figure 8:Anyone Moisture>700 & Raining

7.1.8 Condition 6: (Soil Moisture Values between 300 & 700 & Raining)

As we are continuously reading the values of all four soil moisture sensors. When all four sensor values are less than 700 and greater than 300 it means that our soil is moist so there is a need for irrigation but the rain has started so the motor pump will remain OFF and irrigation will stop.

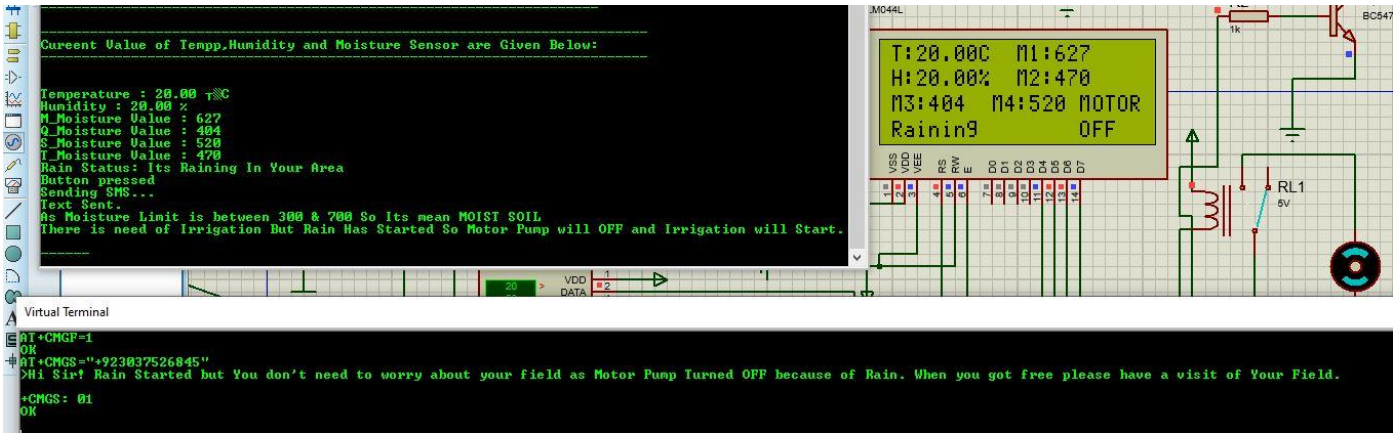

Figure 9:Moisture>300&& Moisture<700 && Raining

7.1.9 Condition 7: (Soil Moisture Values > 700 && Raining)

As we are continuously reading the values of all four soil moisture sensors. When all four sensor values are greater than 700 it means that our soil is dry and there is a need for irrigation but the rain has started so our motor Pump will remain OFF and irrigation will stop.

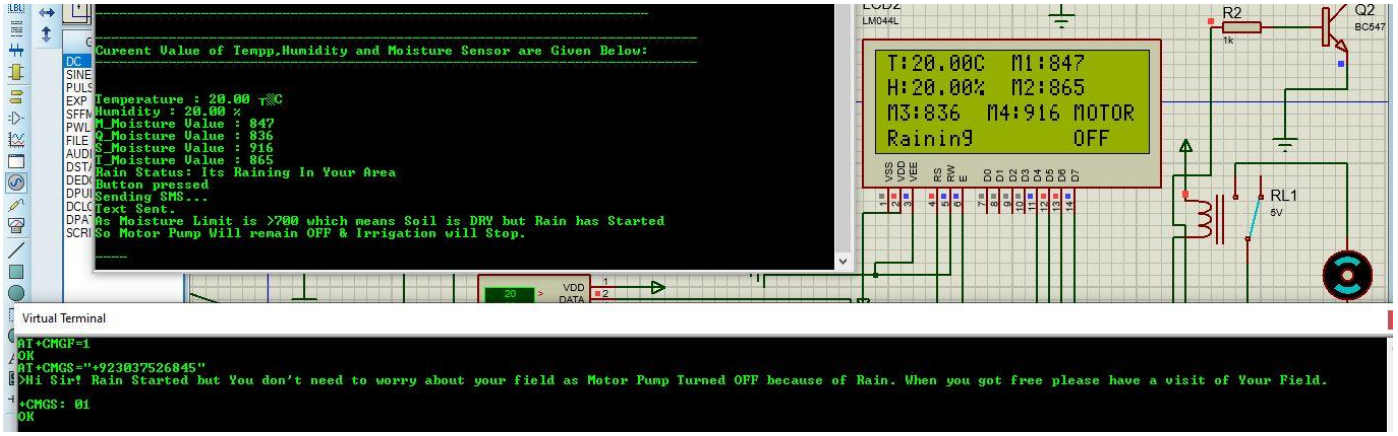

Figure 10:Moisture>700 && Raining

Here we have one more extension in this project. We have connected a GSM module for sending a message to farmers in case of rain.

7.2 GSM Module Working.

We also interface GSM Module with Arduino in this project. We will make 3 connections between the GSM module and Arduino. We will be sending an SMS to a particular number for the working demonstration whenever a switch is pressed. GSM Module figure is given below:

Figure 11: GSM Module

The switch is connected to digital pin A3 of Arduino as an input. When the switch is pressed, the Arduino will communicate with the GSM module using AT commands and send "MESSAGE" to the programmed mobile number. AT+CMGS is the main command that we are using to send SMS.

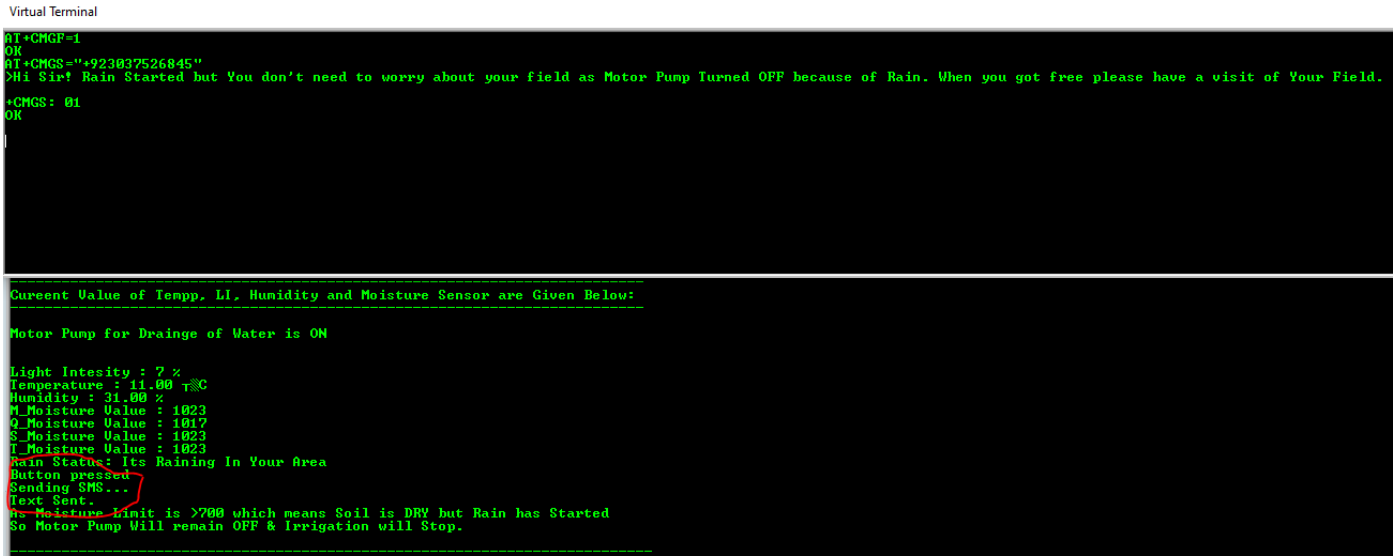

Figure 12: GSM Module Working

7.2.1 Purpose of using GSM Module

Let's assume a case that rain has started and there is no internet connection for the farmer then he will receive a message on his mobile phone how his field is doing and he could save himself from many troubles caused by rain. So in our project GSM module will send a message to the farmer with the text "Hi Sir! Rain Started but You don't need to worry about the field as Motor Pump Turned OFF because of Rain. When you got free please have a visit of Your Field". That's why we have used GSM Module in Our Project.

7.3 Temperature and Humidity Sensor

The DHT11 is a simple and low-cost sensor. It uses a humidity sensor and a thermistor to determine the temperature and relative humidity present in the air. It's very simple to use.

7.3.1 How the DHT11 measures humidity and temperature

It is used to measure water vapor by measuring the electrical resistance between two electrodes. The relative humidity is proportional to the change in resistance between two electrodes.
Greater relative humidity means there is a decrease in the resistance between the electrodes, while lower relative humidity increases the resistance between the electrodes.

There is a thermistor built into the unit of DHT11 which is used to measure the temperature.

DHT11 is shown below:

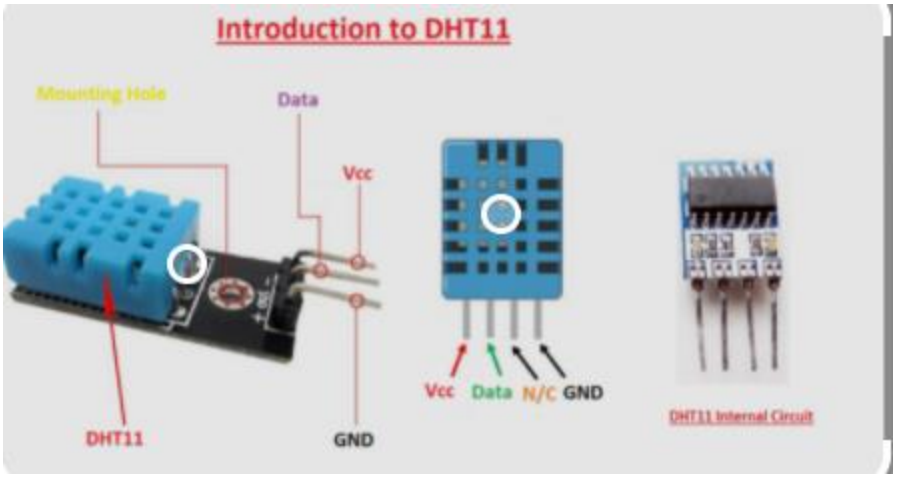

Figure 13: DHT11 Sensor

7.3.2 How it working in our Project:

In our project, we are measuring the values of temperature and humidity for two reasons. As we know Temperatures are high in summer and low in winter. Therefore, crops need less water in winter than in summer. So based on temperature and humidity sensor values in winter and summer, we can change the moisture limit of our project.

Another reason for using this is that we can observe the weather condition without going to a weather forecasting agency or without opening it in Google.

7.3.3 Technical Specification of DHT11 Sensor

Temperature Sensor:

Sensor Type	DHT11
Unique ID	-1
Driver Ver	1
Max Value	50°C
Min Value	0.0°C
Resolution	2°C

Humidity Sensor:

Sensor Type	DHT11
Unique ID	-1
Driver Ver	1
Max Value	80%
Min Value	20 %
Resolution	5 %

Given below is the value of temperature and humidity sensor measured by DHT11 Sensor

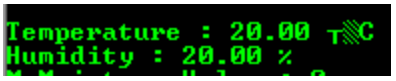

Figure 14: DHT11 Output

7.4 Rain Sensor

In our smart irrigation project, we also included a rain sensor for the detection of rain. It uses a rain detection plate to detect the effect of rain. The rain sensor is shown below

Figure 15: Rain Sensor

The rain sensor detects water that comes short-circuiting the tape of the printed circuits. It acts as a variable resistance that will change status. When the sensor is wet its means high resistance and when the sensor is dry it means low resistance.

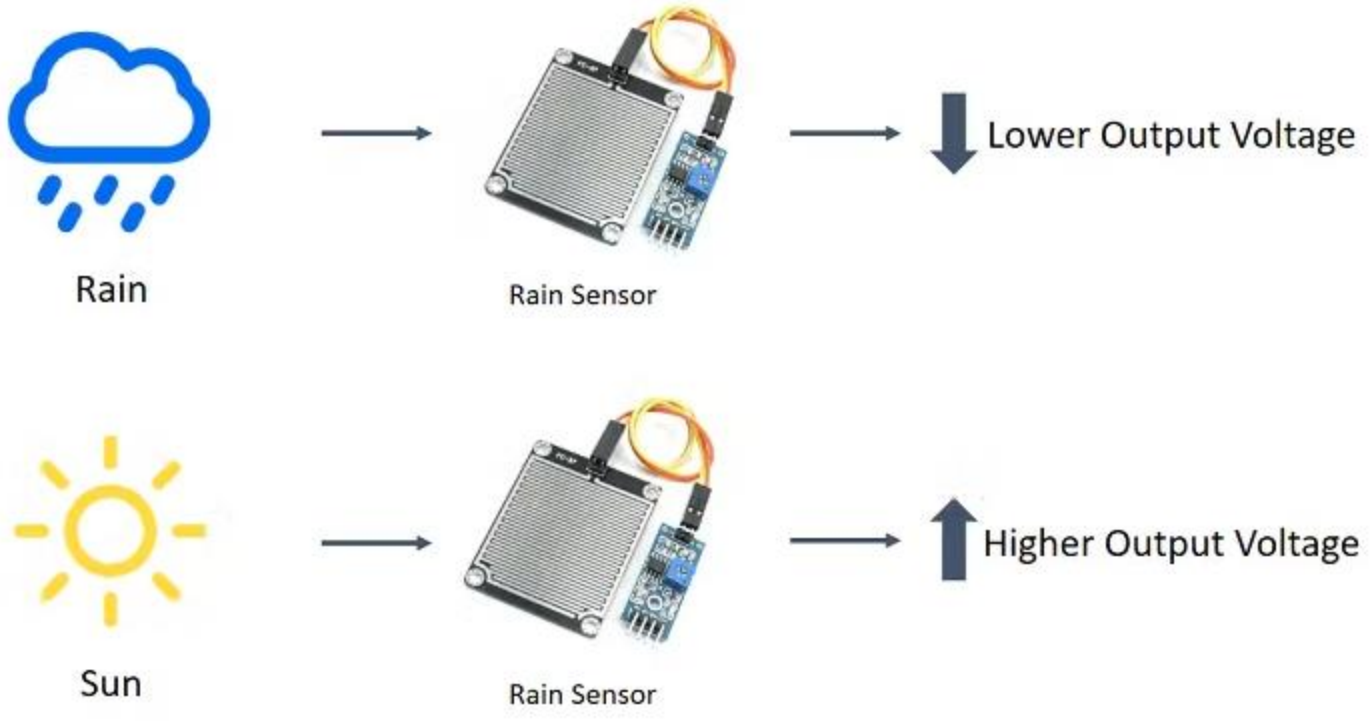

Figure 16:Rain Sensor Working

The comparator has 2 outputs connected to the rain sensor.

7.4.1 Technical specification

- Voltage: 3, 3v to 5v
- Sensor dimension: 3.9 * 5.4 cm
- Sensitivity potentiometer
- 2 control LEDs

7.4.2 Adjust the sensitivity

There is a potentiometer present on the comparator of the rain sensor. By changing the sensitivity of the potentiometer, detection can be realized on the drop of rain or in a glass of water.

7.4.3 How it working in our project

We have successfully connected the rain sensor with our Arduino Uno. When it starts to rain and the drops fall on the plate then its digital output value will be high and we will receive the message that rain has started.

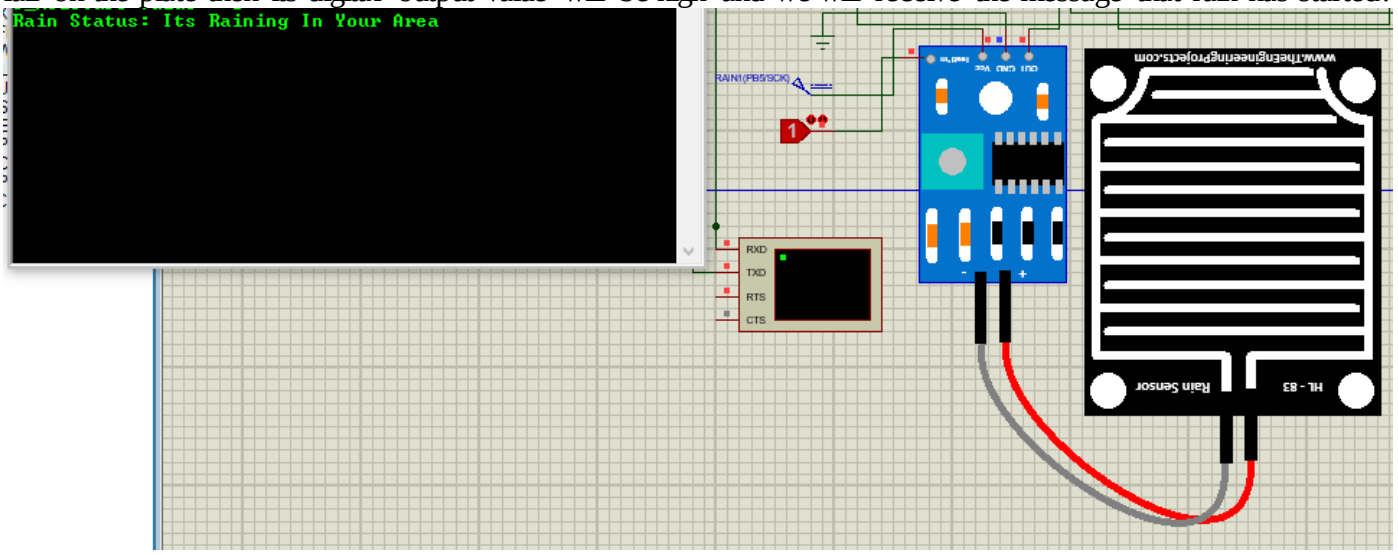

Figure 17: Rain Start Condition

As shown above when the logic state is 1 which means that rain has started then our serial monitor will print the value that "Rain Status: Rain has started in your Area".

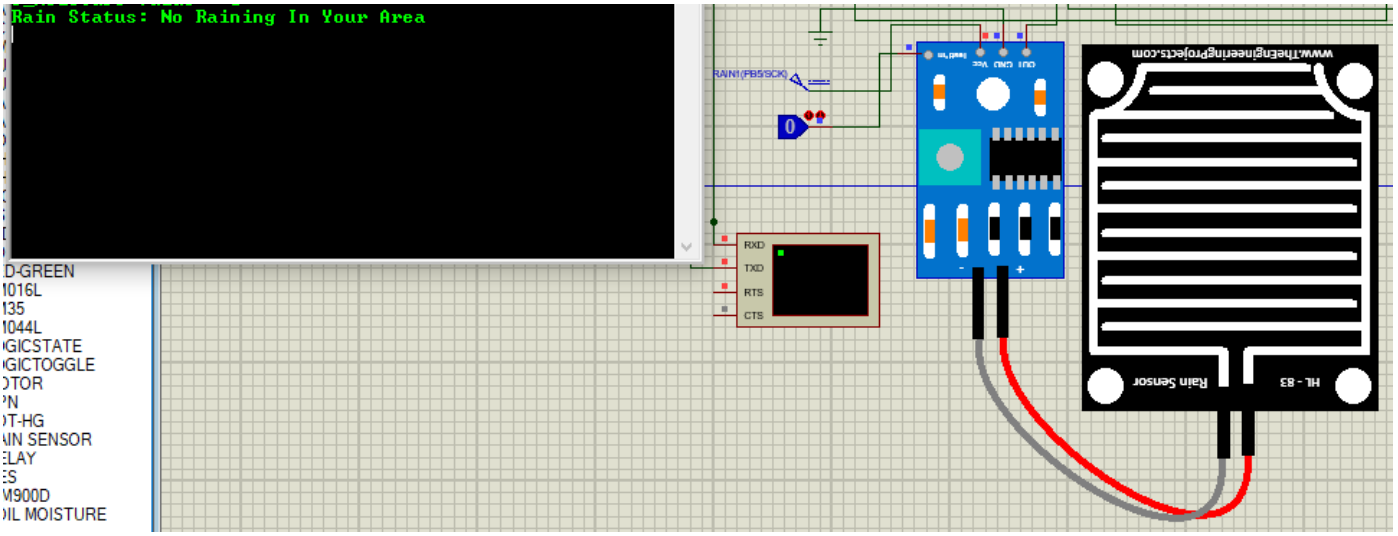

Figure 18: No Raining Condition

As shown above, when the logic state is 0 it means that there is no rain in our area. Our serial monitor will print the message that "Rain Status: No Raining has started in your Area".
We also explained above how can we control our motor pump based on the rain sensor output.

7.5 Water Drainage System

we have proposed a water drainage system in case of heavy rainfall. We will dig a small pit next to our field. Excess rainwater will fall into it. so we will use that water to irrigate our crops by using a motor pump. so in this way, we are not only saving extra water from rain but we are also using it for irrigation purposes.

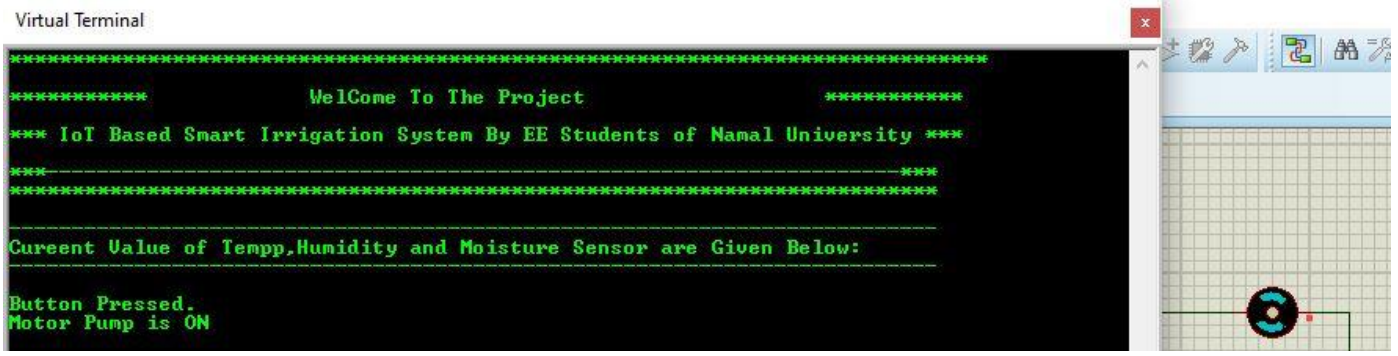

Figure 19: Water Drainage Condition

When the button is pressed motor pump will be on and we can use that water for irrigation purposes.

7.6 LCD

We also used a 20x4 LCD to display the values of

- Temperature
- Humidity
- Soil Moisture
- Rain Status
- Motor Status

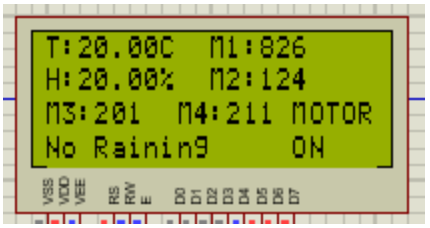

Figure 20: LCD Output

7.8 Arduino Uno

The main heart of the project is Arduino. Given below is the figure of Arduino that we used in our project.

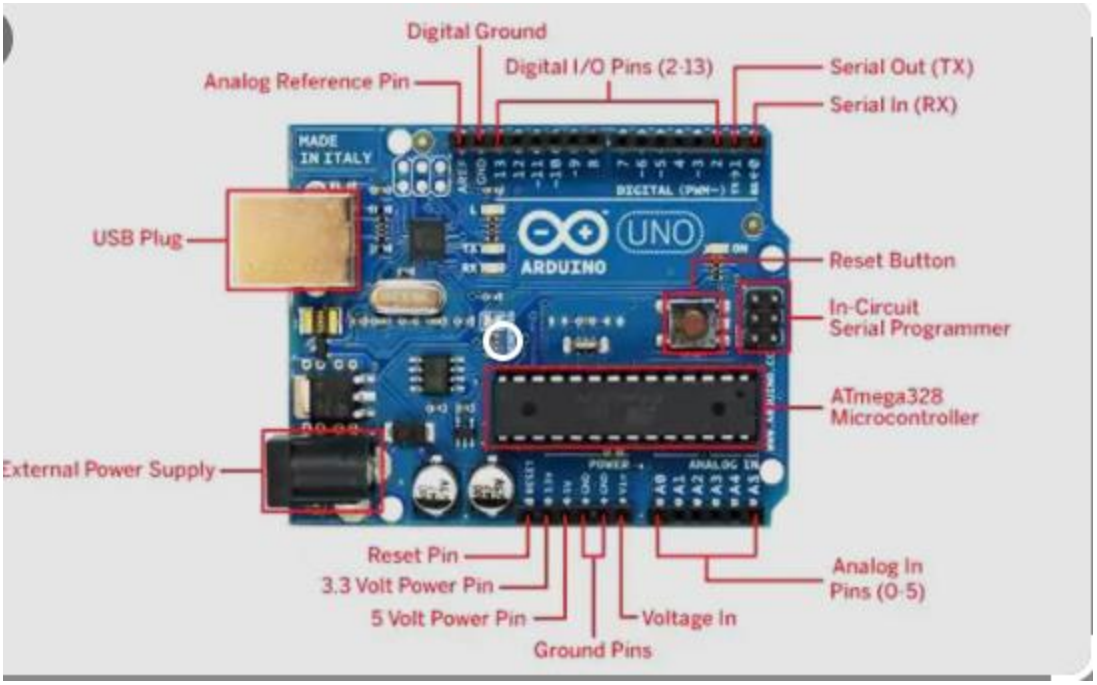

Figure 21: Arduino Uno

7.9 ESP8266 WIFI Module

So in our project, we have also interface an ESP8266 WIFI module to our Arduino for sending the data on the webserver. It is a low-cost wireless transceiver that can be used for end-point IoT developments. It uses UDP/TCP protocols to connect with the server.

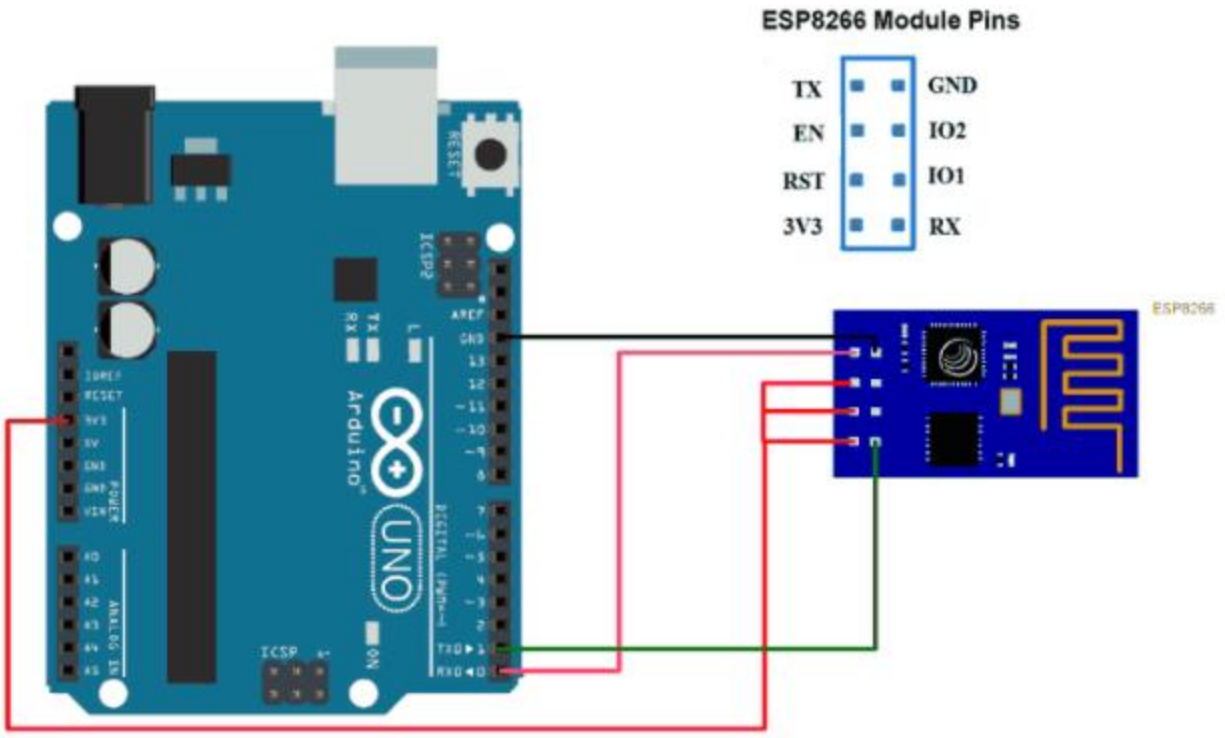

Figure 22: ESP8266 WIFI Module

So by using this WIFI module we are sending the values of Temperature, Humidity, Soil Moisture Sensor on the webserver. We are also showing the status of Rain and Motor status on the web dashboard.

9. Web Dashboard Design

As mentioned in our proposal design of the web dashboard was after the midterm but we have started working on it. We explained above that we are sending the values of temperature, humidity, and soil moisture sensor on a web server by using the esp8wifiiffi module. So we have designed a web dashboard for displaying the values of

- Temperature
- Humidity
- Soil Moisture Sensor
- Rain Status

we have used the ThingSpeak platform to display the data of our sensors. So here we have created a private channel for the farmer. As shown in the below figure

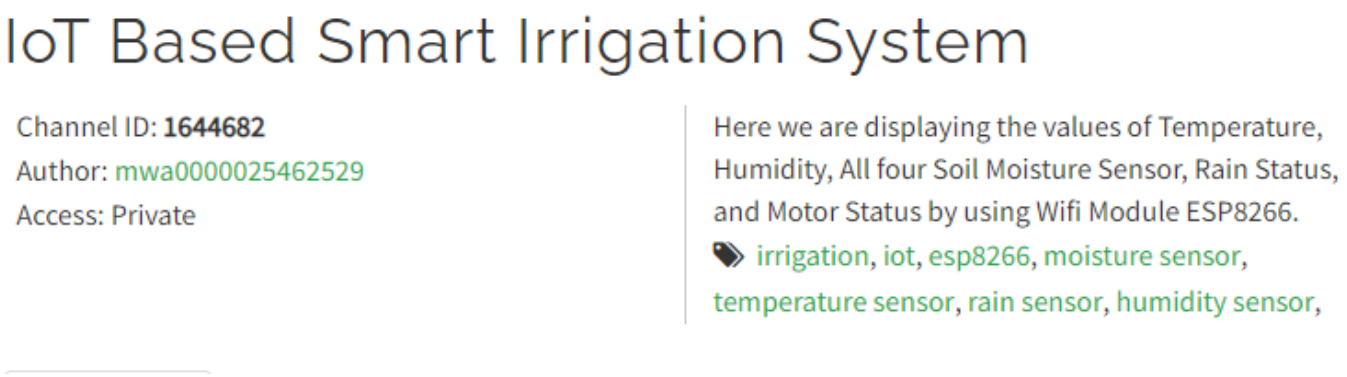

Figure 23: Web Design

So here we have also created 8 fields for

- Temperature Values
- Humidity Values
- M_Moisture Sensor Values
- Q_Moisture Sensor Values
- S_Moisture Sensor Values
- T_Moisture Sensor Values
- Rain Status
- Motor Status

As shown in the below figures

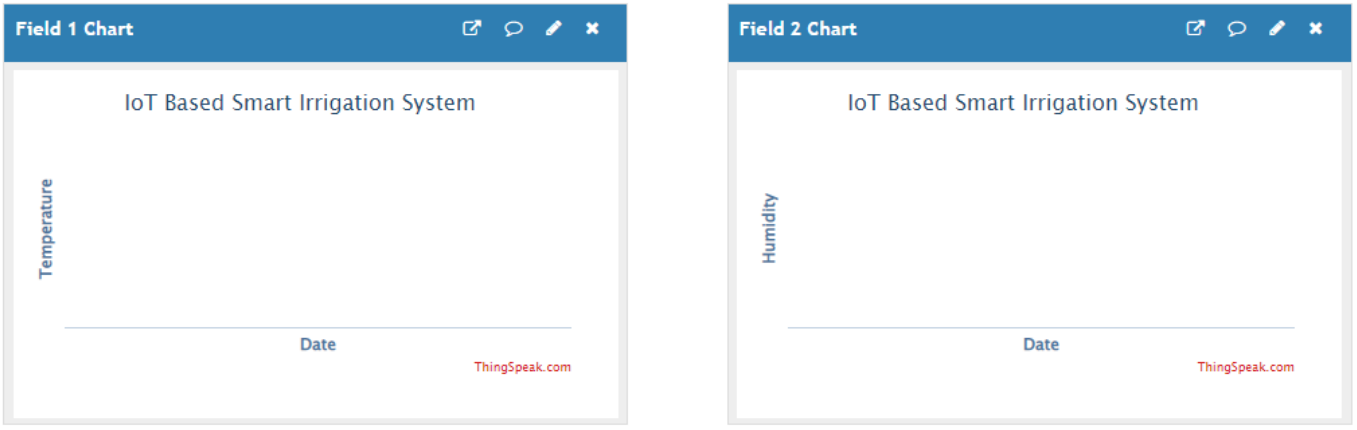

Figure 24: Temperature & Humidity Chart

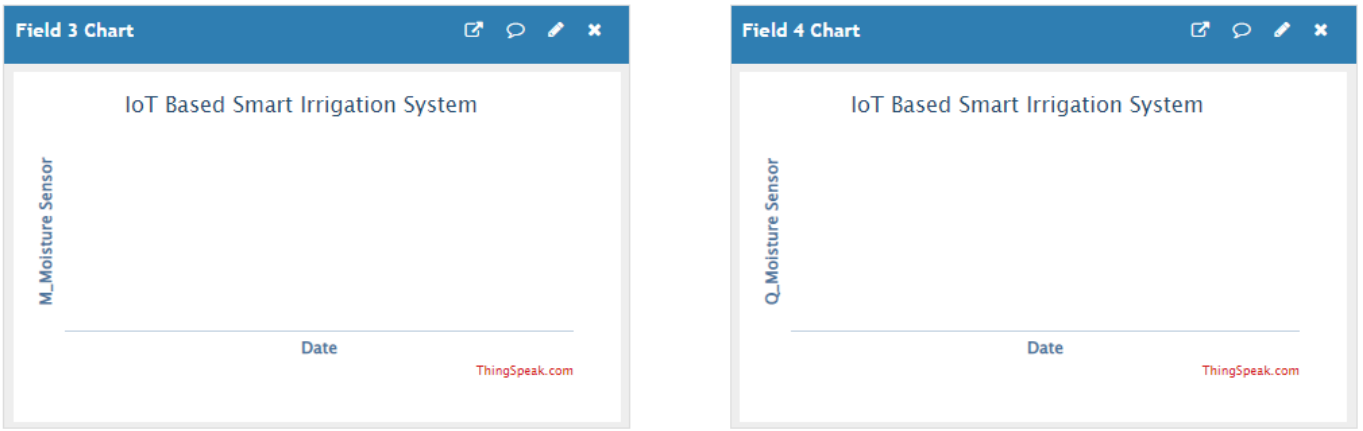

Figure 25: Soil Moisture Chart

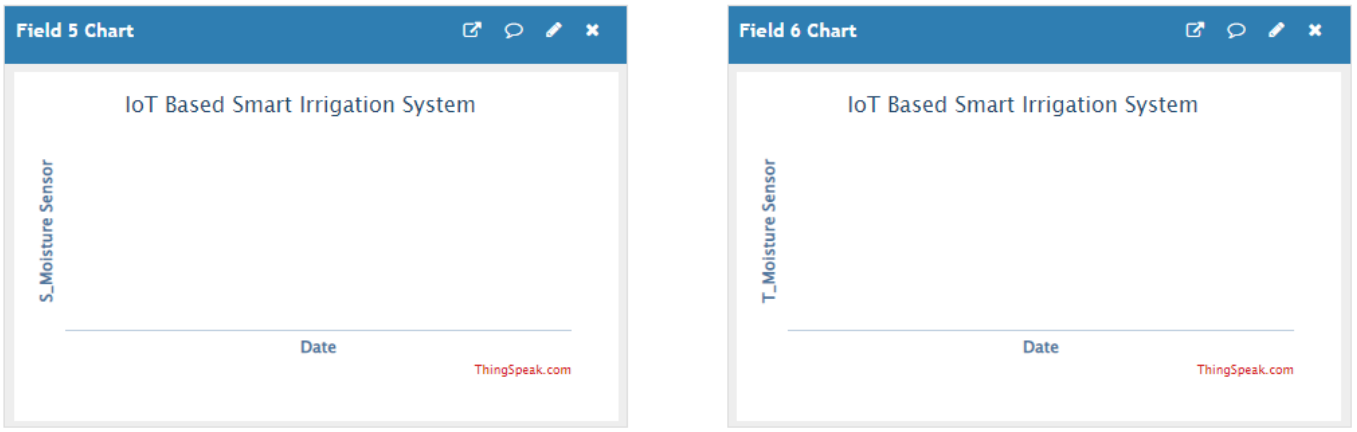

Figure 26: Soil Moisture Chart

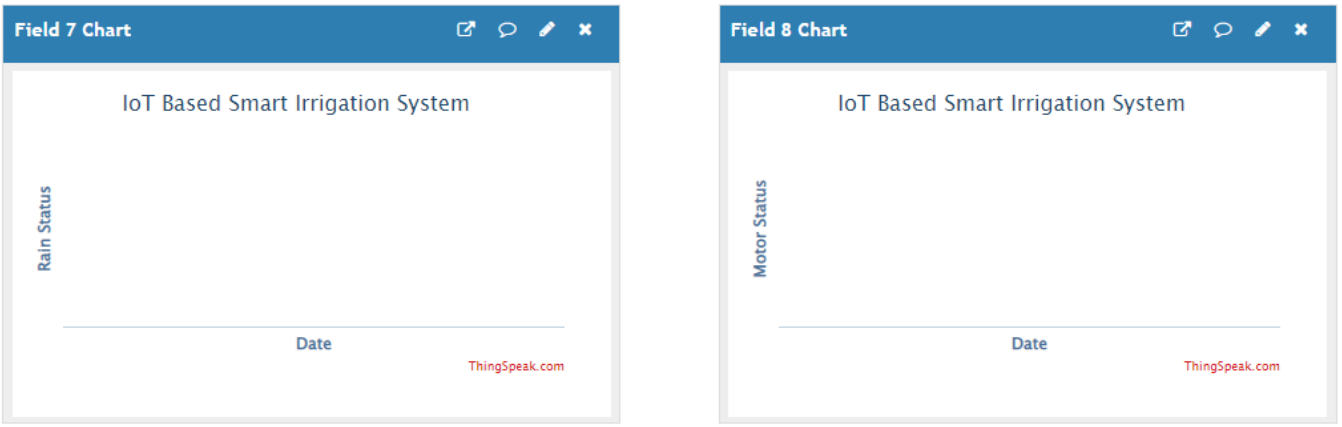

Figure 27: Rain & Motor Status

So we will use these field charts for displaying the data of sensors. After the midterm, we will address these two questions which are

1. How we will send data?
2. How can we display it on a field chart using ESP8266?

10. Coding Part

10.1 Humidity Sensor Code

```
// Get humidity event and print its value.
dht.humidity().getEvent(&event);
if (isnan(event.relative_humidity)) {
  Serial.println(F("Error reading humidity!"));
}
else {
  Serial.print(F("Humidity : "));
  Serial.print(event.relative_humidity);
  Serial.println(F(" %"));
}
```

Figure 28: Humidity Sensor Code

10.2 Temperature Sensor Code

```
// Get temperature event and print its value.
sensors_event_t event;
dht.temperature().getEvent(&event);
if (isnan(event.temperature)) {
  Serial.println(F("Error reading temperature!"));
}
else {
  Serial.println("\n");
  Serial.print(F("Temperature : "));
  Serial.print(event.temperature);
  Serial.println(F(" °C"));
}
```

Figure 29: Temperature Sensor Code

10.3 Soil Moisture Sensor Code

```
// Get Moisture event and print its value.
int rain_sensor = digitalRead(6); // Read the Pin 6
int Mois = analogRead(M_Sensor);
int Moist = analogRead(Q_Sensor);//
int Moistu = analogRead(S_Sensor);//
int Moisture = analogRead(T_Sensor);
```

Figure 30: Soil Moisture Sensor Code

10.4 Rain Sensor Code

```
if (rain_sensor == 1)
{
  lcd.setCursor(0, 3);
  lcd.print(F("Raining"));
  Serial.print("\n");
  Serial.println(F("Rain Status: Its Raining In Your Area "));
  Serial.print("\n");
  delay(500);
}
if (rain_sensor == 0)
{
  lcd.setCursor(0, 3);
  lcd.print(F("No Raining"));
  Serial.print("\n");
  Serial.println(F("Rain Status: No Raining In Your Area "));
  Serial.print("\n");
  delay(500);
}
```

Figure 31: Rain Sensor Code

10.5 GSM module code

```
//GSM
 if (button_State == LOW) {            //And if it's pressed
   Serial.println("Button pressed");   //Shows this message on the serial monitor
   delay(200);                         //Small delay to avoid detecting the button press many times

   SendSMS();                          //And this function is called

 }

 if (sim800l.available()){            //Displays on the serial monitor if there's a communication from the module
   Serial.write(sim800l.read());
 }
 //GSM
void SendSMS()
{
  Serial.println("Sending SMS...");              //Show this message on serial monitor
  sim800l.print("AT+CMGF=1\r");                 //Set the module to SMS mode
  delay(100);
  sim800l.print("AT+CMGS=\"+923037526845\"\r");  //Your phone number
  delay(500);
  sim800l.print("Hi Sir! Rain Started but You don't need to worry about your field as Motor Pump Turned OFF because of Rain. When you got free please have a visit of Your Field.");
  delay(500);
  sim800l.print((char)26);// (required according to the datasheet)
  delay(500);
  sim800l.println();
  Serial.println("Text Sent.");
  delay(500);

}
```

Figure 32: GSM Module Code

10.6 Motor Pump code

```
//Water Dranige
 if (digitalRead(W_led)==1)
 {
  digitalWrite(motor_pin,HIGH);
  Serial.println();
  Serial.println(F("Button Pressed."));
  Serial.println(F("Motor Pump is ON"));
 }
```

Figure 33: Drainage Motor Code

11. Way Forward:

After the midterm, we will work on the following remaining parts of the project which are

- Complete Hardware Design
- Integration of ESP8266 WIFI Module with ThingSpeak Dashboard
- Design of Mobile Application for Farmer
- Mobile App Integration with Project to observe the values of temperature, humidity, soil moisture, rain status, and water status.

12. References

- Gondchawar, N. and Kawitkar, R.S., 2016. IoT-based smart Agriculture. International
- Journal of advanced research in Computer and Communication Engineering, 5(6).
- Nayyar , Anand and Puri, Vikram,2016.Smart farming: IoT based smart sensors agriculture stick for live temperature and moisture monitoring using Arduino, cloud computing & solar technology
- IoT in agriculture: 5 technology use cases for smart farming
- https://www.geeksforgeeks.org/crop-monitoring-smart-farming-using-iot

- H. Kothiya, Rathinkumar. and L. Patel, Karan. and Prof. Jayswal., Hardik .S., 2018. Smart farming using IoT.