A PROJECT REPORT ON

IoT BASED SMART IRRIGATION FOR RURAL AGRICULTURE

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CERTIFICATE

This is to certify that the internship of B. TECH 2nd Year, entitled “IoT Based Smart Irrigation For Rural Agriculture” have been carried by

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Abstract

In India crop production and its standard has declined due to inefficient agricultural practices. Widely accepted definition of irrigation is watering the crops to maximize the crop production. Due to many obstacles like water scarcity, inefficient irrigation practices and manual irrigation the amount of water to be supplied may get higher or lower than the requirement. The best effective way to overcome water management is Precision irrigation. It is the process of delivering high accuracy irrigation to permanent crops. To deliver high precision irrigation through automatic irrigation using wireless sensor networks. Precision irrigation in DSS (Decision Support System) plays a major role. In most of the developing countries permanent crop irrigation is the major sector in which water consumption is more. Sensors play a major role in precision irrigation. They sense, monitor, and collect the signals from permanent crops. The system uploads various data like the soil moisture and temperature on server and automatically switches on and off the dc water pump module based upon the data collected by the sensors. In the existing system in case of any natural calamity like rigorous rainfall the system doesn't mention any prediction module. This paper proposes a solution for flood detection using water level sensor and a rain sensor to detect unpredicted rainfall management. It will support for improvement of economically weaker sections, small and marginal farmers.

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INTRODUCTION

Agriculture is the backbone of many developing countries, where about two-third of the world's population depends on agriculture for its economic sustainability. Water resource plays a predominant role in agriculture. India has more than 17% of the world's population but has only 4% of world's renewable water resource with 2.6% of world land area. In India water scarce resource in arid and semi-arid region therefore it has a huge impact on food production. As per the International water management Institute, agriculture accounts for about 70% of global water with drawl. The agriculture industry is drastically changing and there is a need to develop automated systems tom monitor and control the growing plants. To overcome these struggles an effective method should come in practice. One such method of water management is irrigation management. Irrigation is a method of watering the crops to maximize the crop production. Most of the irrigation system do not use the water in the most efficient way. One among that is manual irrigation. In manual irrigation the amount of water supplied may be slightly higher or lower than the exact requirement of crops and the user must check the field at regular interval of time to maintain proper functioning and safety. Hence manual monitoring has a limitation that the user must check the field continuously which is difficult. To overcome this situation, the best practice for efficient water management is introduced which is Automatic irrigation. The amount of water required by the crop is found by measuring certain parameters like soil moisture, temperature, and other leaf based parameter like crop water stress index, pH,…both measuring and watering are controlled by the automatic irrigation system to provide an efficient crop production.

LITERATURE SURVEY

In this paper proposed an IoT based smart irrigation system which will provide an efficient crop production. This paper is concentrated on crop monitoring and information of temperature and soil moisture is collected as initial spatial data and analysed to reduce crop losses and to improve crop production. Rain and other natural phenomenon effects the crop production too. A Rain Alert System was designed in the previous report to inform the user regarding rainfall by uploading it on the server. The system is developed by using sensors and according to the decision from a server based on sensed data, the irrigation system is automated. By using wireless transmission, the data sensed is transferred on the web server database. The user can monitor and control the system remotely with the help of application which provides web interface to the user. The sensed data is then read and uploaded on the server, where the adequate amount of water and temperature content for the crop is present. The data sensed and the data uploaded on the server for the crop is then compared and the decision is made to switch on or off the DC water pump for irrigation. IOT Based Smart Irrigation develops various features like GPS based remote controlling and monitoring, moisture and temperature sensing and proper irrigation facilities.

Chapter 1

IRRIGATION AND FACTOR INFLUENCING

The amount of water required by a crop to grow varies for different type of crops and soil in which it is grown. The water required also depends on certain external factors like temperature. In this chapter we discuss the need of irrigation, the amount of water required and climatic factors influencing them.

1.1 IRRIGATION REQUIREMENT OF VARIOUS CROPS

For the design of water harvesting systems, it is necessary to assess the water requirement of various crops intended to be grown. In the absence of any measured climatic data it is often adequate to use estimates of water requirement of various crops.

APPROXIMATE WATER REQUIREMENT OF VARIOUS CROPS:

CROPS	WATER REQUIREMENT (mm)
Rice	900-2500
Wheat	450-650
Sorghum	450-650
Maize	500-800
Sugarcane	1500-2500
Groundnut	500-700
Cotton	700-1300
Soybean	450-700
Tobacco	400-600
Tomato	600-800
Potato	500-700
Onion	350-550
Chillies	500
Sunflower	350-500
Castor	500
Bean	300-500
Cabbage	380-500
Pea	350-500
Banana	1200-2200
Citrus	900-1200
Pineapple	700-1000
Gingelly	350-400
Ragi	450-500
Grape	500-1200

Table 1.1: Water Requirement for Various Crops

1.2 INFLUENCE OF CLIMATE ON WATER REQUIREMENT

A certain crop grows in a sunny & hot climate needs more water per day than the same crop grown in a cloudy & cooler climate. There are however apart from sunshine & temperature, other climatic factors which influence the crop water need. These factors are humidity & wind speed. When it is dry the crop needs are higher than when it is humid. In windy climates, the crops will use more water than calm climates. Thus, the crop grown in different climatic zones will have different water needs. It is therefore useful to take a certain standard crop or reference crop and determine how much water these crops need per day in various climatic regions. In the following table grass has be chosen as a standard crop.

EFFECT OF MAJOR CLIMATIC FACTORS ON CROP WATER NEEDS:

Climatic factor	Crop waters need	
	High	**Low**
Sunshine	Sunny (no clouds)	Cloudy (no sun)
Temperature	Hot	Cool
Humidity	Low (dry)	High(humid)
Wind Speed	Windy	Little Wind

Table 1.2: Climatic Factors Effecting Water Requirement

AVERAGE DAILY WATER NEED OF STANDARD GRASS DURING IRRIGATION SEASON (mm):

Climatic Zones	Mean Daily Temperature		
	Low (<15^0 C)	**Medium (15^0C– 25^0 C)**	**High(>25^0C)**
Desert/Arid	4-6	7-8	9-10
Semi-Arid	4-5	6-7	8-9

Table 1.3: Water need in mm in different Climatic Zones

Chapter 2

CIRCUIT DESCRIPTION

The circuit for IoT Based Smart Irrigation comprises of various components. The components used are NodeMCU ESP8266, Soil Hygrometer FC28, 5V DC Relay, Temperature Humidity Sensor DHT11, DC Water pump.

2.1 FLOW CHART

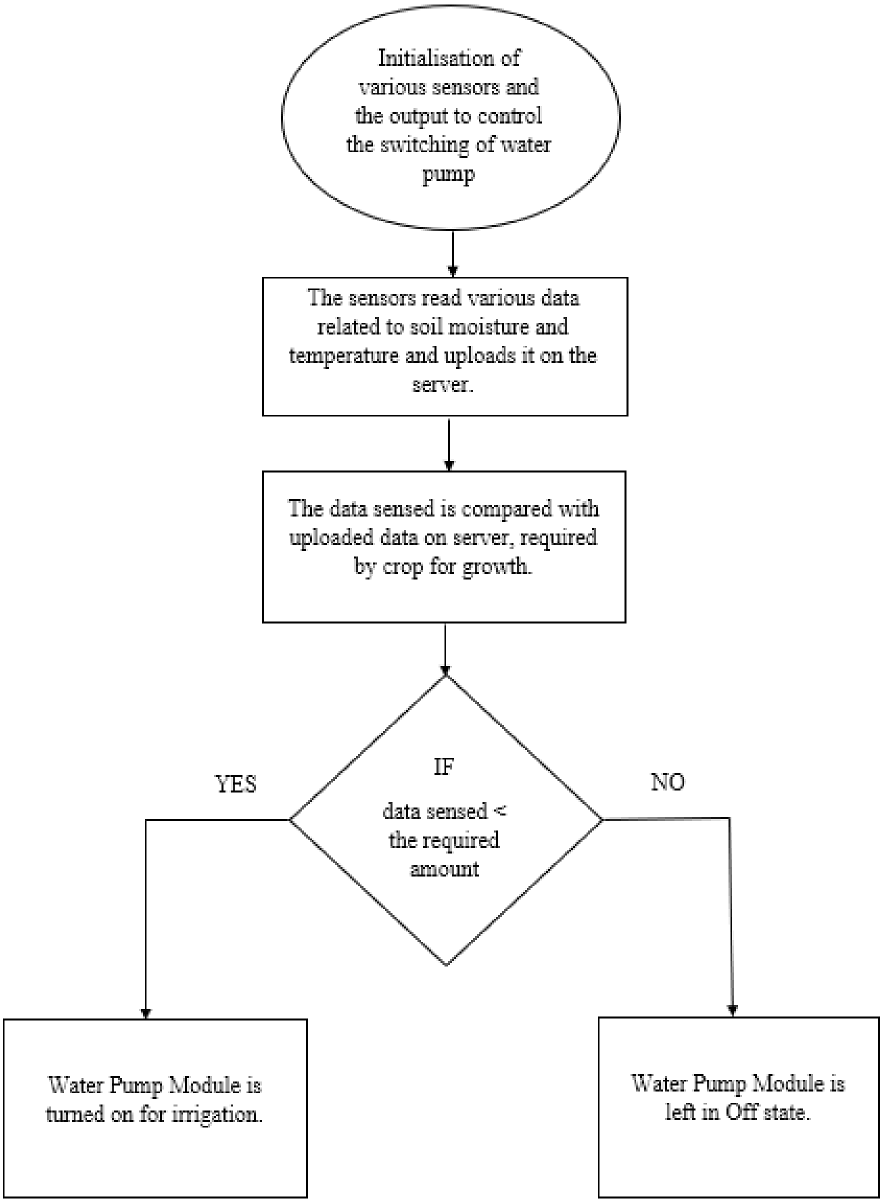

Figure 2.1: Flowchart

The whole working concept of the system is depicted in the flowchart. The circuit uploads the data sensed by the sensors which are Soil Hygrometer FC28 and Temperature Humidity Sensor DHT11 on the server. The circuit makes decision for switching of DC Water Pump for irrigation, by comparing the sensed data collected by the sensors and the data uploaded on the server for the growth of crop. If the humidity and temperature of soil falls below the required amount, then the water pump is turned on for irrigation.

The code for NodeMCU to implement the same is given below:


```
#include <DHT.h>
#include <ESP8266WiFi.h>
String apiKey = "X5AQ3EGIKMBYW31H";     //  Enter your Write API key here
const char* server = "api.thingspeak.com";        //Enter you server here
const char *ssid =  "";     // Enter your WiFi Name
const char *pass =  ""; // Enter your WiFi Password
#define DHTPIN D3          // GPIO Pin where the dht11 is connected
DHT dht(DHTPIN, DHT11);
WiFiClient client;
const int moisturePin = A0;             // moisture sensor pin
const int motorPin = D0;
unsigned long interval = 10000;
unsigned long previousMillis = 0;
unsigned long interval1 = 1000;
unsigned long previousMillis1 = 0;
float moisturePercentage;              //moisture reading
float h;                  // humidity reading
float t;                  //temperature reading
void setup()
{
  Serial.begin(115200);
  delay(10);
  pinMode(motorPin, OUTPUT);
  digitalWrite(motorPin, LOW); // keep motor off initally
  dht.begin();
  Serial.println("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED)
  {
    delay(500);
    Serial.print(".");              // print ... till not connected
  }
  Serial.println("");
  Serial.println("WiFi connected");
```

Figure 2.2: NodeMCU ESP8266 Code

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```
}
void loop()
{
  unsigned long currentMillis = millis(); // grab current time
  h = dht.readHumidity();     // read humiduty
  t = dht.readTemperature();     // read temperature
  if (isnan(h) || isnan(t))
  {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  moisturePercentage = ( 100.00 - ( (analogRead(moisturePin) / 1023.00) * 100.00 ) );
  if ((unsigned long)(currentMillis - previousMillis1) >= interval1) {
    Serial.print("Soil Moisture is  = ");
    Serial.print(moisturePercentage);
    Serial.println("%");
    previousMillis1 = millis();
  }
if (moisturePercentage < 50) {
  digitalWrite(motorPin, HIGH);         // tun on motor
}
if (moisturePercentage > 50 && moisturePercentage < 55) {
  digitalWrite(motorPin, HIGH);        //turn on motor pump
}
if (moisturePercentage > 56) {
  digitalWrite(motorPin, LOW);          // turn off mottor
}
if ((unsigned long)(currentMillis - previousMillis) >= interval) {
  sendThingspeak();           //send data to thing speak
  previousMillis = millis();
  client.stop();
}
}
void sendThingspeak() {
  if (client.connect(server, 80))       //ip server for uploading all collected datas
```

Figure 2.3: NodeMCU ESP8266 Code

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```
  previousMillis = millis();
  client.stop();
}
}
void sendThingspeak() {
  if (client.connect(server, 80))       //ip server for uploading all collected datas
  {
    String postStr = apiKey;              // add api key in the postStr string
    postStr += "&field1=";
    postStr += String(moisturePercentage);    // add mositure readin
    postStr += "&field2=";
    postStr += String(t);                 // add tempr readin
    postStr += "&field3=";
    postStr += String(h);                  // add humidity readin
    postStr += "\r\n\r\n";
    client.print("POST /update HTTP/1.1\n");
    client.print("Host: api.thingspeak.com\n");
    client.print("Connection: close\n");
    client.print("X-THINGSPEAKAPIKEY: " + apiKey + "\n");
    client.print("Content-Type: application/x-www-form-urlencoded\n");
    client.print("Content-Length: ");
    client.print(postStr.length());           //send lenght of the string
    client.print("\n\n");
    client.print(postStr);                      // send complete string
    Serial.print("Moisture Percentage: ");
    Serial.print(moisturePercentage);
    Serial.print("%. Temperature: ");
    Serial.print(t);
    Serial.print(" C, Humidity: ");
    Serial.print(h);
    Serial.println("%. Sent to Thingspeak.");
  }
}
```

Figure 2.4: NodeMCU ESP8266 Code

2.2 CIRCUIT DIAGRAM

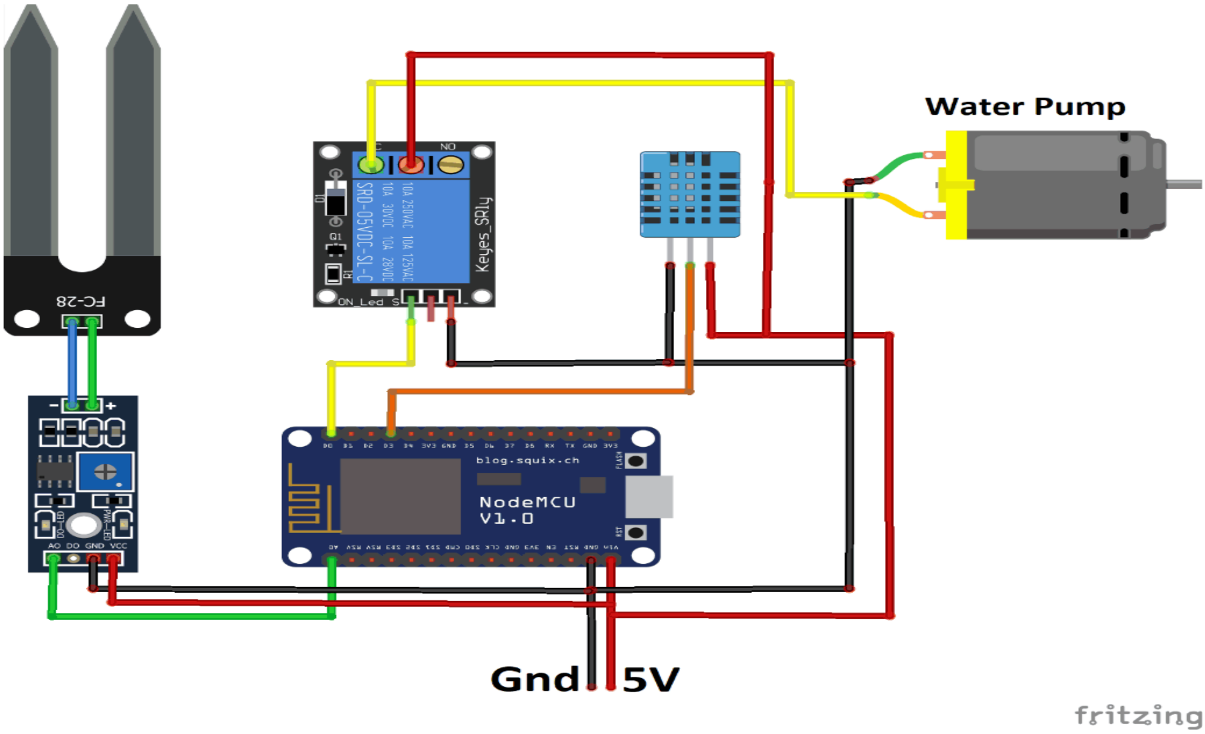

Figure 2.5: Circuit Diagram

The above circuit is a very simple circuit designed using NodeMCU ESP8266, 5V DC Relay, Soil Hygrometer FC28, Temperature and Humidity Sensor DHT11 and DC Water Pump. The sensors sense data and uploads it on the server where the user can see them through the mobile app which provides a web interface to the user. The system makes decision to switch on and off the water pump based on data sensed by the sensors and the data present in the server for the crop. Both the data are compared and if the sensed data is less than the required then the water pump is turned on to provide irrigation else the water pump is left in off state.

Chapter 3

COMPONENT DESCRIPTION

3.1 NodeMCU ESP8266

NodeMCU is a low-cost open source IoT platform. It is an open source firmware for which open source prototyping board designs are available. Both the firmware and prototyping board designs are open source. The firmware uses the Lua scripting language. The firmware is based on Eula project, and built on the Espresso Non-OS SDK for ESP8266.The prototyping hardware typically used is a circuit board functioning as a dual-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows the easy prototyping on breadboards.

Nod MCU is connected to the same WIFI network as the Bolt IoT module is connected to, using a USB WIFI Module. Various sensors and Arduino used in controlling the irrigation and estimating the temperature, humidity and water content of soil is uploaded to the server also the weather forecast of the particular place is downloaded on the server so that user can estimate the amount of irrigation require by the crops.

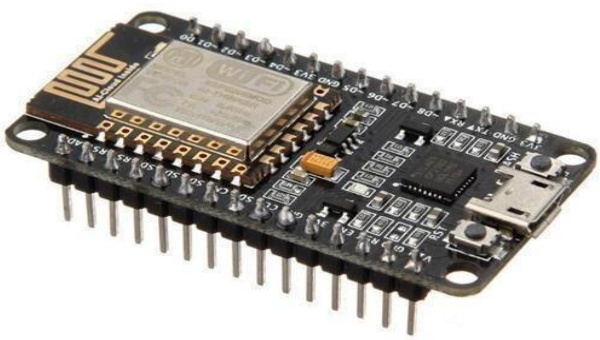

Figure 3.1: NodeMCU ESP8266

3.2 Soil Hygrometer FC28

This is a summary of the moisture sensor can be used to detect soil moisture, when soil water deficiency, the module outputs a high level, whereas output low level. Using this sensor to water the flowers make an automatic device, without people to manage your garden plants. Sensitivity can be adjusted (figure blue digital potentiometer adjusts)**.** Soil humidity module on the environment humidity the most sensitive, generally used to detect soil humidity. Module in soil moisture cannot reach the setting threshold, DO mouth output high level, when soil moisture more than setting threshold value, module D0 output low level**.** Small board PCB size: 3.2cm x 1.4cm. Comparator using LM393 chip, work stability. Plates made of Aluminium alloy.

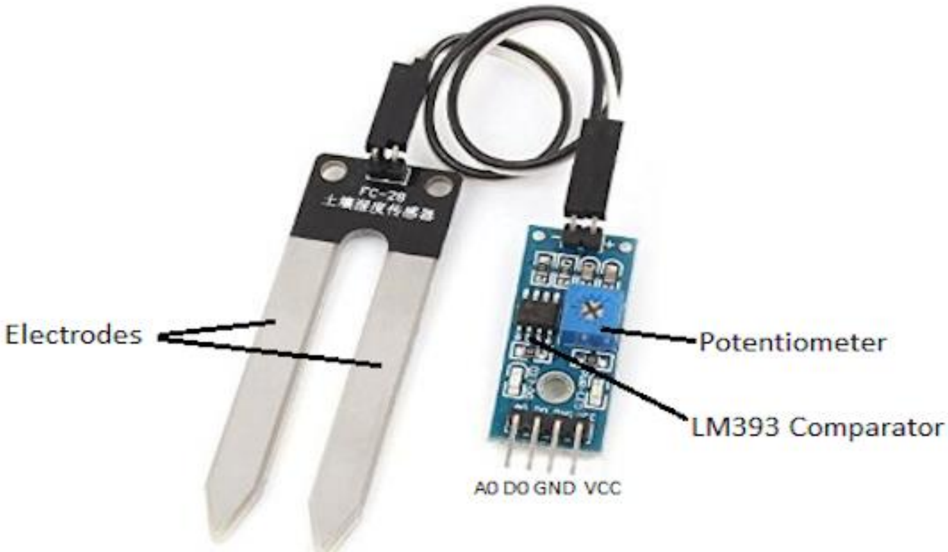

Figure 3.2: Soil Hygrometer FC28

Pin Description Table:

Pin	Configuration
Vcc	Input Power Supply
GND	Ground
Ao	Analog Output
Do	Digital Output

Table 3.1: FC28 Pin Configuration

Working Principle:

This sensor mainly utilizes capacitance to gauge the water content of the soil (dielectric permittivity). The working of this sensor can be done by inserting this sensor into the earth and the status of the water content in the soil can be reported in the form of a percent. This sensor makes it perfect to execute experiments within science courses like environmental science, agricultural science, biology, soil science, botany, and horticulture.

The specifications of the FC-28 soil moisture sensor are as follows:

- Input Voltage: 3.3–5V
- Output Voltage: 0–4.2V
- Input Current: 35mA
- Output Signal: both analog and digital

Analog output pin Ao is connected to ADC0 pin of ESP8266. Vcc and GND pin of FC28 is connected to 5V DC supply and ground respectively.

3.3 TEMPERATURE HUMIDITY SENSOR DHT11

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It’s simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

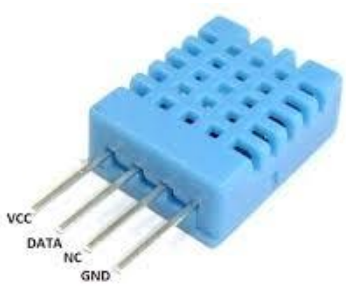

Figure 3.3: Temperature Humidity Sensor DHT11

Pin Configuration:

Pin	Configuration
Vcc	Input Power Supply
GND	Ground
DATA	Data Out
NC	Not Connected

Table 3.2: Temperature Moisture Sensor DHT11

Working Principle:

They consist of a humidity sensing component, an NTC temperature sensor (or thermistor) and an IC on the back side of the sensor. For measuring humidity, they use the humidity sensing component which has two electrodes with moisture holding substrate between them.

On the other hand, for measuring temperature these sensors use an NTC temperature sensor or a thermistor.

The technical details of DHT11 are as follows:

- 3.3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- 4 pins with 0.1" spacing

The Vcc pin and GND pin of DHT11 are connected to 5V DC supply and ground respectively. The DATA pin relates to GPIO0 or FLASH pin of ESP8266.

3.4 5V SINGLE CHANNEL RELAY MODULE

The Single Channel Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps, and AC load. It is designed to interface with microcontroller such as Arduino, PIC etc. The relays terminal (COM, NO and NC) is being brought out with screw terminal. It also comes with a LED to indicate the status of relay.

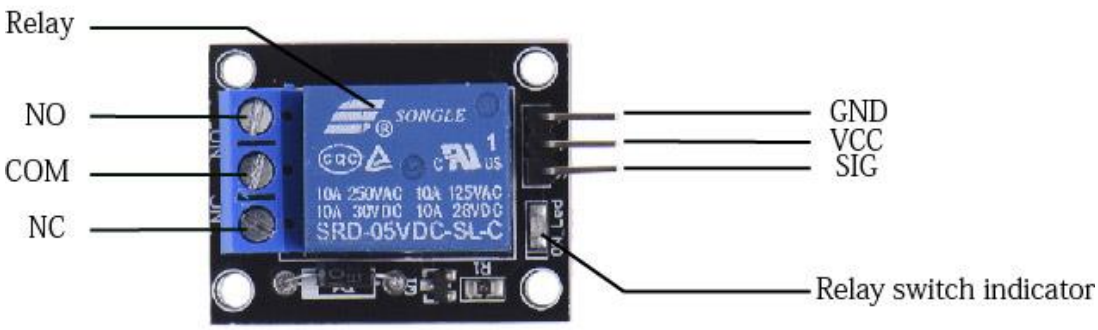

Figure 3.4: 5V Single Channel Relay Module

Pin Configuration:

Pin	Configuration
Vcc	Input Power Supply
GND	Ground
SIG	Input Signal
COM	Common Port
NO	Normally Open
NC	Normally Closed

Table 3.3: 5V Single Channel Relay Module Pin Configuration

Working Principle:

Based on input signal, the relay works. If load is connected to NC, then the load remains connected before trigger. If load is connected to NO pin the load remains open before trigger.

The technical specifications are as follow:

- Digital output controllable
- Compatible with any 5V microcontroller such as Arduino.
- Rated through-current: 10A (NO) 5A (NC)
- Control signal: TTL level
- Max. switching voltage 250VAC/30VDC
- Max. switching current 10A
- Size: 43mm x 17mm x 17mm
- Input Supply: 5V

The Vcc and GND pin of the relay module is connected to 5V supply and ground respectively. The SIG pin is connected to GPIO16 or WAKE pin of ESP8266. The COM pin is connected to 5V DC supply and NC pin is with the positive terminal of the water pump.

3.5 DC WATER PUMP

A DC water pump JT80SL is required to supply the irrigation water to the field and crops. We can use any water pump 12V or 24V. For using 12V or 24V water pump connect the required voltage level wire to the COM terminal of the relay module. In this report we are using DC Water Pump JT80SL.

Figure 3.5: DC Water Pump JT80SL

Specifications of JT80SL:

Length	56 mm (include water inlet)
Diameter	24 mm
Weight	30 g
Height	33 mm (include water outlet)
Water inlet	outside diameter: 6.8 mm inner diameter: 4.5 mm
Water outlet	outside diameter: 7 mm inner diameter: 4.5 mm
Voltage range	DC 2.5-6V
Operating current	130-220 MA
Hydraulic head	40-110 cm
Flow	80-120 L/H
Power	0.4-1.5W

Table 3.4: Specifications of JT80SL DC Water Pump

The positive terminal of the water pump is connected with the NC terminal of the relay while the negative terminal of the water pump is connected with ground.

Chapter 4

SCHEME OF INTERNSHIP

The main objective of this system is to automate the irrigation system with the application of IoT. The IoT based system uses sensor like Soil Hygrometer FC28 and Temperature Humidity Sensor DHT11, Soil Hygrometer FC28 has an analog signal output which senses the humidity of soil and uploads the sensed data on the server. The system takes decision for the switching of motor by comparing the sensed data and the data present in the server i.e. the amount of humidity required for the growth of crop. If the data sensed is less than the required data, then the water pump is switched on else water pump is left in off state. The sensed data is uploaded on the server with the help of NodeMcu ESP8266 when connected to WIFI. The user is provided with a mobile application which provides a web interface to the server using which the user can see the sensed data uploaded on the server.

Chapter 5

EXPECTED OUTCOME

India has more than 17% of the world's population but has only 4% of world's renewable water resource with 2.6% of world land area. In India water scarce resource in arid and semi-arid region therefore it has a huge impact on food production. The IoT based smart irrigation focuses on automating the irrigation process for agriculture. Automation of this process will optimize crop treatment such as accurate planning and watering. It also focuses on conservation of water as it keeps tracks of both rainwater and required level of irrigation by crops. The system will result in increase in quality of production, improved livestock farming and with implementation of IoT makes the system remote monitoring as the decisions are taken in real time. With the application of technology in farming ad agriculture, the system helps the farmer and user for accurate farm and field evaluation.

Chapter 6

COST ESTIMATION

The cost estimation of the whole project is as follows:

PRODUCT	**COST (IN RS.)**
NodeMCU ESP8266	400
Soil Hygrometer FC28	132
Temperature Humidity Sensor DHT11	130
5V Single Channel Relay Module	175
DC Water Pump JT80SL	200
TOTAL COST	**1037**

Table 6.1: Cost Estimation

Cost Estimation source Flipkart.

CONCLUSION AND FUTURE SCOPE

• Conclusion

Therefore, the paper proposes a thought of consolidating the most recent innovation into the agrarian field to turn the customary techniques for water system to current strategies in the way making simple profitable and temperate trimming. Some degree of mechanization is presented empowering the idea of observing the field and the product conditions inside some long-separate extents utilizing cloud administrations. The points of interest like water sparing are stated utilizing the sensors that work continuously as they are modified. This idea of modernization of farming is straightforward, reasonable and operable. As relying upon these parameter esteems rancher can without much of a stretch choose with fungicides and pesticides are utilized for enhancing crop production.

• Future Scope

Our project can be improvised by using a sensor to note the soil pH value such that the usage of unnecessary fertilizers can be reduced. A water meter can be installed to estimate the amount of water used for irrigation and thus giving a cost estimation. Further it also reduces manual labour. Smart farming offers high-precision crop control, useful data collection, and automated farming techniques. The technology is here today to make the future of farming possible i.e. where you can predict and prevent crop from diseases, where you can view data on soil and crop condition in near real-time, and where your system and machine can make sure that your crops are fed and watered without your interventions.

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IMAGE SOURCES

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