CHAPTER – 1

INTRODUCTION

Technology brings a remarkable advancement in every field of life, whether its industry or agriculture. Our lives are essentially dependent on agricultural development. Researchers are working to integrate modern technologies in agriculture to develop new practices for the enhancement of healthy agriculture and production. Internet of things is a domain of computer science that provides mechanisms and techniques to interconnect a wide range of digital devices to automate the real-life systems. In big cities, peoples facing problems in their homegrown gardens regarding the maintenance and availability of proper gardeners.

The moisture sensor provides analog output, read through the NodeMCU's analog pin (A0).When soil moisture drops below a threshold (e.g., 50%), the motor pump turns on to irrigate. The pump continues until moisture reaches another threshold (e.g., 55%), then turns off.

In our country most of the population depends upon the agriculture to live their daily lives. Agriculture is a major source of food production to the growing demand of the human population. In agriculture, irrigation is an essential process that influences crop production by supplying water to the needed land. Farmers have to visit their land to check how much amount of water is required for their field. This method takes a lot of time and effort particularly when a farmer needs to irrigate multiple agriculture fields distributed in different geographical areas. Traditionally farmers will present in their fields to do irrigation process. But nowadays farmers need to manage their agricultural activity along with other occupations. Automation in irrigation system makes farmer work much easier. Sensor-based automated plant watering system provides a promising solution to farmers where the presence of farmer in the field is not compulsory.

In this modern technological era poor farmers of India cannot get enough assistance from others to help them with technology and make their work easier. This equipment helps the farmer to monitor their fields from any place through IOT. This system can be utilized to improve the condition of the green house.

CHAPTER – 2

LITERATURE SURVEY

Based on the literature survey of moisture sensor-based watering systems using mobile technology, here are some general requirements you might consider:

1. Moisture Sensing Accuracy: The system should utilize moisture sensors capable of accurately measuring soil moisture levels. Requirements may include sensor precision, calibration methods, and sensor placement considerations.

2. Mobile Application Interface: Develop a user-friendly mobile application that allows users to monitor soil moisture levels, set watering schedules, receive alerts, and adjust settings remotely. The app should support both Android and iOS platforms.

3. Data Communication: Ensure reliable communication between the moisture sensors and the mobile application. This may involve Bluetooth, Wi-Fi, Zigbee, LoRa, or other wireless communication protocols depending on the application environment (e.g., range, power consumption).

4. Automation and Control: Implement automation logic within the mobile application to autonomously control watering based on real-time soil moisture readings. Include features for manual override and adjustment of watering schedules.

5. Power Management: Design energy-efficient solutions for both the moisture sensors and the mobile application to maximize battery life. Consider solar-powered options or low-power consumption strategies for extended operation.

6. Security and Privacy: Ensure robust security measures to protect user data and prevent unauthorized access to the system, especially when transmitting data over networks.

7. Maintenance and Support: Provide mechanisms for monitoring system health, diagnosing issues remotely, and offering timely customer support. Include features for software updates and sensor maintenance.

8. Cost Considerations: Balance system capabilities with cost-effectiveness, considering the affordability of sensors, mobile app development, and ongoing operational costs.

CHAPTER – 3

REQUIREMENTS

The design and development of this mini-project requires hardware and software tools as listed below.

Hardware requirements:

- Nodemcu ESP8266
- Soil Moisture Sensor
- L293D Motor driver module
- LCD Screen
- I2C Module
- Jumper Wires
- Motor pump

Software Requirement:

- Arduino IDE.

Nodemcu ESP8266

ESP8266 is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

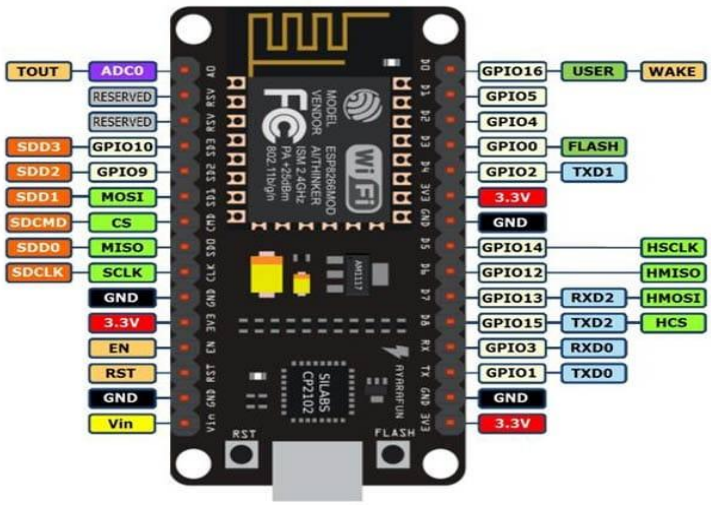

Fig. 3.1. Nodemcu ESP8266

ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 toGPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.

I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Table 3.1NodeMCU Development Board Pinout Configuration

Soil Moisture Sensor

The Soil Moisture Sensor is used to measure the water content (volumetric water content) of soil. This makes it ideal for performing experiments in courses such as soil science, agriculture science, environmental science, horticulture, botany, and biology. Use the soil Moisture sensor to:

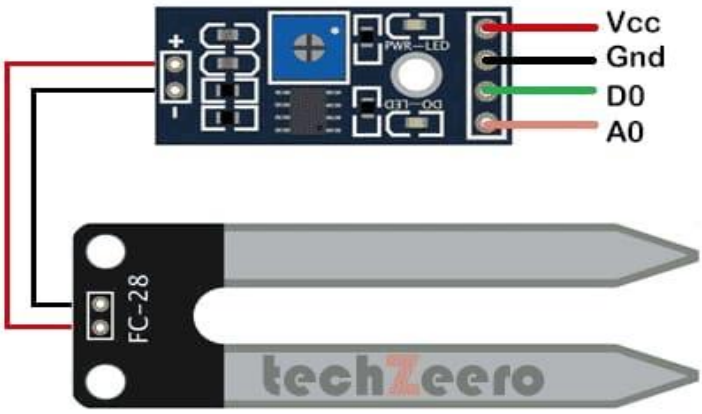

Fig.3.2. Soil Moisture Sensor

The sensor measures the loss of moisture over time due to evaporation and plant uptake. It can evaluate optimum soil moisture content for various species of plants.

It is used to monitor soil moisture content to control irrigation in greenhouses. They can enhance your bottle biology experiments.

Soil Moisture Sensor Pinout:

Pin Name	Description
VCC	The Vcc pin powers the module, typically with +5V
GND	Power Supply Ground
DO	Digital Out Pin for Digital Output.
AO	Analog Out Pin for Analog Output

Table 3.2.Moisture Sensor Pinout

Specifications:

The specifications of a soil moisture sensor play a crucial role in determining its effectiveness in monitoring the water content of the soil. These sensors typically operate within a specific voltage range, most commonly around 3.3V to 5V.

Moreover, the sensor's output signal is often digital, providing easy integration with different IoT devices for real-time data transmission and analysis. The measurement accuracy of these sensors can vary depending on the model, with some offering precise readings within a specific moisture range

L293D Motor driver module:

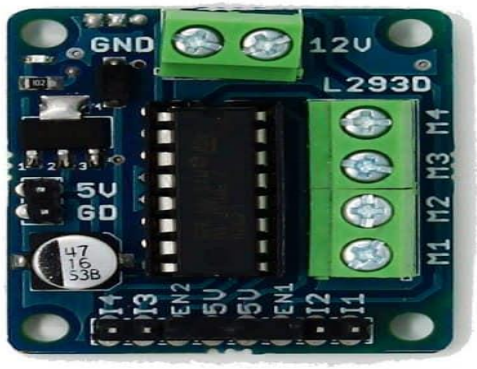

Fig.3.3. L293D Motor driver module

Description:

L293D is a basic motor driver integrated chip (IC) that enables us to drive a DC motor in either direction and also control the speed of the motor. The L293D is a 16 pin IC, with 8 pins on each side, allowing us to control the motor. It means that we can use a single L293D to run up to two DC motors. L293D consist of two H-bridge circuit. H-bridge is the simplest circuit for changing polarity across the load connected to it.

There are 2 OUTPUT pins, 2 INPUT pins, and 1 ENABLE pin for driving each motor. It is designed to drive inductive loads such as solenoids, relays, DC motors, and bipolar stepper motors, as well as other high-current/high-voltage loads.

Features:

- LM393 based design
- Easy to use with Microcontrollers or even with normal Digital/Analog IC

- Small, cheap and easily available
- Fixed bolt hole for easy installation
- Comparator output, clean signal, great waveform, and strong driving ability

L293D Pin Configuration:

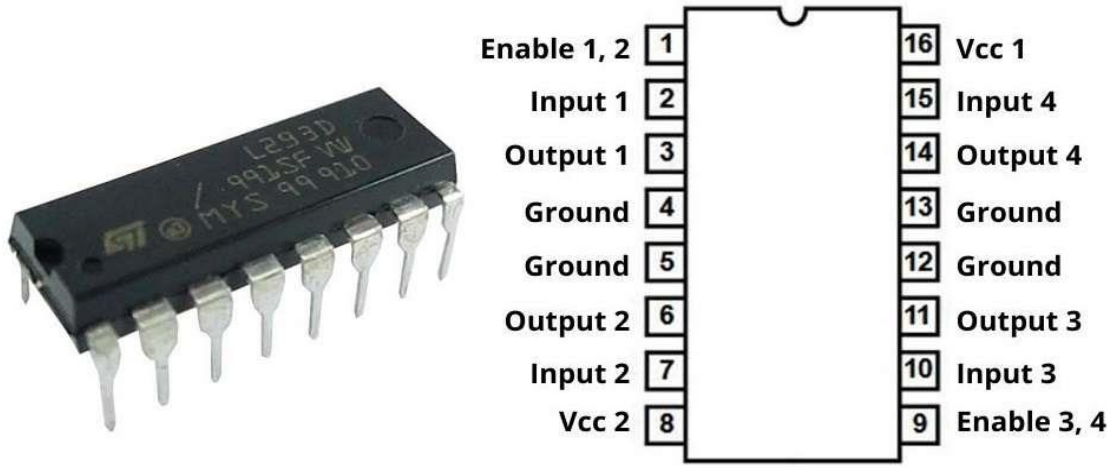

Fig: 3.4 L239D Motor driver IC

- Pin 1 (Enable1,2): When this pin is given High or Logic 1, the left part of the IC will work and when it is low, the left part doesn't work. So, this pin is the Master Control pin for the left part of the IC
- Pin 2 (Input 1): When this pin is High or Logic 1, output 1 becomes High. i.e. the current will flow through output 1
- Pin 3 (Output 1): This pin is connected to one of the terminals of motor 1
- Pin 4, Pin 5 (GND): These pins should be connected to the circuit's ground
- Pin 6 (Output 2): This pin is connected to one of the terminals of motor 1
- Pin 7 (Input 2): When this pin is given High or Logic 1, output 2 becomes high i.e. the current will flow through output 2
- Pin 8 (VCC2): This is the voltage required to run the motor. It can be greater than IC voltage VCC 1. If we are driving 12 V DC motors then make sure that this pin is supplied with 12 V
- Pin 9 (Enable 3,4): When this pin is given High or logic 1, the right part of the IC will work, and when it is low the right part doesn't work. So, this pin is the Master Control pin for the right part of the IC
- Pin 10 (Input 3): When this pin is given High or Logic 1, output 3 becomes high i.e. the current will flow through output 3
- Pin 11 (Output 3): This pin is connected to one of the terminals of motor 2

- Pin 12,13 (GND): These pins should be connected to the circuit's ground
- Pin 14 (Output 4): This pin is connected to one of the terminals of motor 2
- Pin 15 (Input 4): When this pin is given High or Logical 1, output 4 becomes High i.e. the current will flow through output 4
- Pin 16 (VCC1): This pin provides power to the IC. So, this pin should be supplied with a 5

LCD Screen:

Fig.3.5. LCD Screen

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations

The 16×2 LCD pinout is shown below:

Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.

Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.

Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.

Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).

Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).

Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.

Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.

Pin15 (+ve pin of the LED): This pin is connected to +5V

Pin 16 (-ve pin of the LED): This pin is connected to GND.

I2C Module:

Fig.3.6. I2C Module

The I2C LCD module is a form of liquid crystal display (LCD) screen that interacts using the Inter-Integrated Circuit (I2C) protocol. This protocol enables simple communication between microcontrollers and peripheral devices, with minimal wire required. The I2C LCD module is normally made up of a display screen, a tiny circuit board, and an I2C interface chip. It is often used in electronics projects, such as Arduino-based projects, to show information in an easy-to-read format without requiring a large number of input/output pins on the microcontroller.

Here we listed about the I2C LCD Module Pinout and their function :

- VCC: Power supply voltage input (5V or 3.3V).
- GND: Ground connection.
- SDA: Serial Data Line for I2C Communication.
- SCL: Serial Clock Line for I2C Communication.
- Backlight Jumper: For controlling the LCD Module backlight.
- POT: For controlling the contrast of the LCD display

Jumper Wires:

Jumper Wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper Wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed.

A jumper Wire is a short insulated wire with bare (stripped of insulation) ends. You use jumper wires, such as the one shown in the following figure, to connect two points in a breadboard circuit.

Jumper Wires typically come in three versions:

1. Male-to-male

2. male-to-female

3. female-to-female

Fig .3.7. Male-Male Connector

Fig 3.8. Female-Female Connector

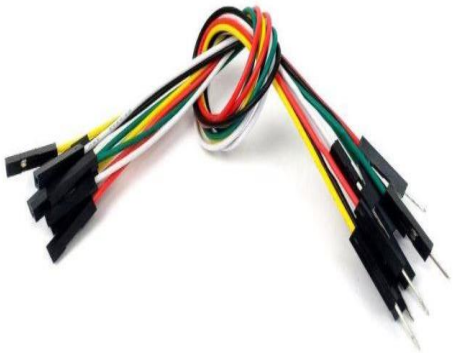

Fig .3.9. Male-Female Connector

Motor pump:

Fig .3.10.Motar Pump

This is a low-cost mini submersible type water pump that works on 3-6V DC. It is extremely simple and easy to use. Just immerse the pump in water, connect a suitable pipe to the outlet and power the motor with 3-6V to start pumping water. Great for building science projects, fire-extinguishers, firefighting robots, fountains, waterfalls, plant watering systems etc.

This motor is small, compact and light. It can be controlled from a micro controller/Arduino using our DC Motor Drivers or one of our Relay Boards. You may use our 5V SMPS Power Supply Adapter to run this pump. You may also use our 6V Solar Panel to run the pump with appropriate a 6V voltage regulator.

Features:

Operating DC Voltage: 2.5-6V

Maximum Water lift height: 40-110cm / 15.75"-43.4"

Flow rate: 80-120L/H

Outer Diameter of Water Outlet: 7.5mm / 0.3"

Inside Diameter of Water Outlet: 5mm / 0.2"

Pump Diameter: Approx. 24mm / 0.95"

Pump Length: Approx. 45mm / 1.8"

Pump Height: Approx. 30mm / 1.2"

Wire Length: ~13mm cm

Applications:

- Great for building science projects, fire-extinguishers, fire fighting robots, fountains, waterfalls, plant watering systems etc.
- Controlled fountain water flow
- Controlled Garden watering systems
- Hydroponic Systems
- Fresh water intake or exhaust systems for fish aquqriums

Programming On Arduino:

```
#include <ESP8266WiFi.h>
#include<LiquidCrystal_I2C.h>

// RemoteXY connection settings
#define REMOTEXY_WIFI_SSID "ESP8266"
#define REMOTEXY_WIFI_PASSWORD "123456789"
#define REMOTEXY_CLOUD_SERVER "cloud.remotexy.com"
#define REMOTEXY_CLOUD_PORT 6376
#define REMOTEXY_CLOUD_TOKEN "b1abd072922a22b7db61855c371cfc83"



#include <RemoteXY.h>
LiquidCrystal_I2C lcd(0X27, 16, 2);
// RemoteXY GUI configuration
#pragma pack(push, 1)
uint8_t RemoteXY_CONF[] =   // 78 bytes
{ 255, 1, 0, 4, 0, 71, 0, 17, 0, 0, 0, 31, 1, 106, 200, 1, 1, 2, 0, 71,
  22, 40, 60, 60, 56, 0, 2, 24, 135, 0, 0, 0, 0, 0, 0, 200, 66, 0, 0, 160,
  65, 0, 0, 32, 65, 0, 0, 0, 64, 24, 0, 2, 29, 114, 50, 26, 0, 2, 26, 31,
  31, 80, 117, 109, 112, 32, 79, 78, 0, 80, 117, 109, 112, 32, 79, 70, 70, 0
};

// this structure defines all the variables and events of your control interface
struct {

  // input variables
  uint8_t switch_01; // =1 if switch ON and =0 if OFF

  // output variables
  float instrument_01; // from 0 to 100

  // other variable
```

```
  uint8_t connect_flag;  // =1 if wire connected, else =0

} RemoteXY;
#pragma pack(pop)

//////////////////////////////////////////
//          END RemoteXY include          //
//////////////////////////////////////////


int pump = D0, Moisture = A0;
void setup()
{
  RemoteXY_Init ();
  Serial.begin(9600);
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Welcome");
  pinMode(pump , OUTPUT);
  digitalWrite(pump , LOW);
  delay(1000);
}

void loop()
{
  RemoteXY_Handler ();
  int val = analogRead(Moisture);
  int MoistureLevel = (1023 - val) / 10.23;
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Moisture:");
  lcd.print(MoistureLevel);
  lcd.print("%");
```

```
  Serial.print("Moisture:");
  Serial.print(MoistureLevel);
  Serial.println("%");
RemoteXY.instrument_01 = MoistureLevel;
if (RemoteXY.switch_01 == 1)
  {
    lcd.setCursor(0, 1);
    lcd.print("Pump ON");
    digitalWrite(pump , HIGH);
  }
  else
  {
    lcd.setCursor(0, 1);
    lcd.print("Pump OFF");
    digitalWrite(pump, LOW);
  }
delay(250);
}
```

CHAPTER – 4

IMPLEMENTATION

ESP8266 module allows to use RemoteXY with microcontroller device for Wi-Fi. Implemented support for all Arduino boards. The source code of GUI can be download for the Arduino IDE and PLProg.

RemoteXY allows to configure module for operate in one of two modes: access point and client. Client allows to connect the module to an existing Wi-Fi access point.

Access point mode of ESP8266 configures the module as an access point and allows to connect Arduino directly to this point. The access point is available to connect to it from smartphone or tablet within a radius of availability of the radio signal. It does not require any other network infrastructure. This connection mode can be used in the faraway place where there is no computer networks and the Internet. To configure this mode in the configuration properties of editor need to select the type of connection "Wi-Fi access point."

Client mode of ESP8266 configures the module for automatically connect to an existing Wi-Fi access point, such as a home router or enterprise access point. At the same time connected to the Arduino module ESP8266 must be located in the physical availability of the radio signal of access point. Connecting to the device from smartphone or tablet will be not directly, but through the Ethernet network, an IP address provided by the DHCP server to ESP8266 module. It allows to connect to the Arduino device from anywhere in the local network as well as from the Internet. Connect from the Internet is possible with the correct configuration of the router, such as the use of the virtual server. To configure this mode in the configuration properties of editor need to select the connection type "Ethernet" and select ESP8266 module.

The module is connected to the microcontroller board via serial interface. You can choose to use software serial or hardware serial. Module connection option is selected in the module interface settings of editor. The module is controlled
via AT commands.

Steps to Connect NodeMCU to Remotxy

1. Set Up the Remotxy Account

1. **Download the Remotxy App:**
    - Install the Remotxy app from the Google Play Store or the Apple App Store on your smartphone.
2. **Create an Account:**
    - Open the app and create a new account or log in if you already have one.
3. **Create a New Project:**
    - In the app, create a new project. You will use this project to configure the user interface and communication settings.
4. **Add Widgets:**
    - Add widgets to your project that you want to control or monitor. For example, you can add buttons, sliders, or display widgets.
5. **Obtain API Key:**
    - After setting up your project and adding the necessary widgets, you will get an API key that is required for connecting your NodeMCU to Remotxy.

2. Prepare Your NodeMCU

1. **Install the Arduino IDE:**
    - Ensure you have the Arduino IDE installed on your computer. You can download it from the Arduino website.
2. **Install the Required Libraries:**
    - Install the `Remotxy` library. You can do this through the Library Manager in the Arduino IDE (`Sketch` -> `Include Library` -> `Manage Libraries...`). Search for `Remotxy` and install it.
3. **Connect the NodeMCU:**
    - Connect your NodeMCU to your computer using a USB cable.

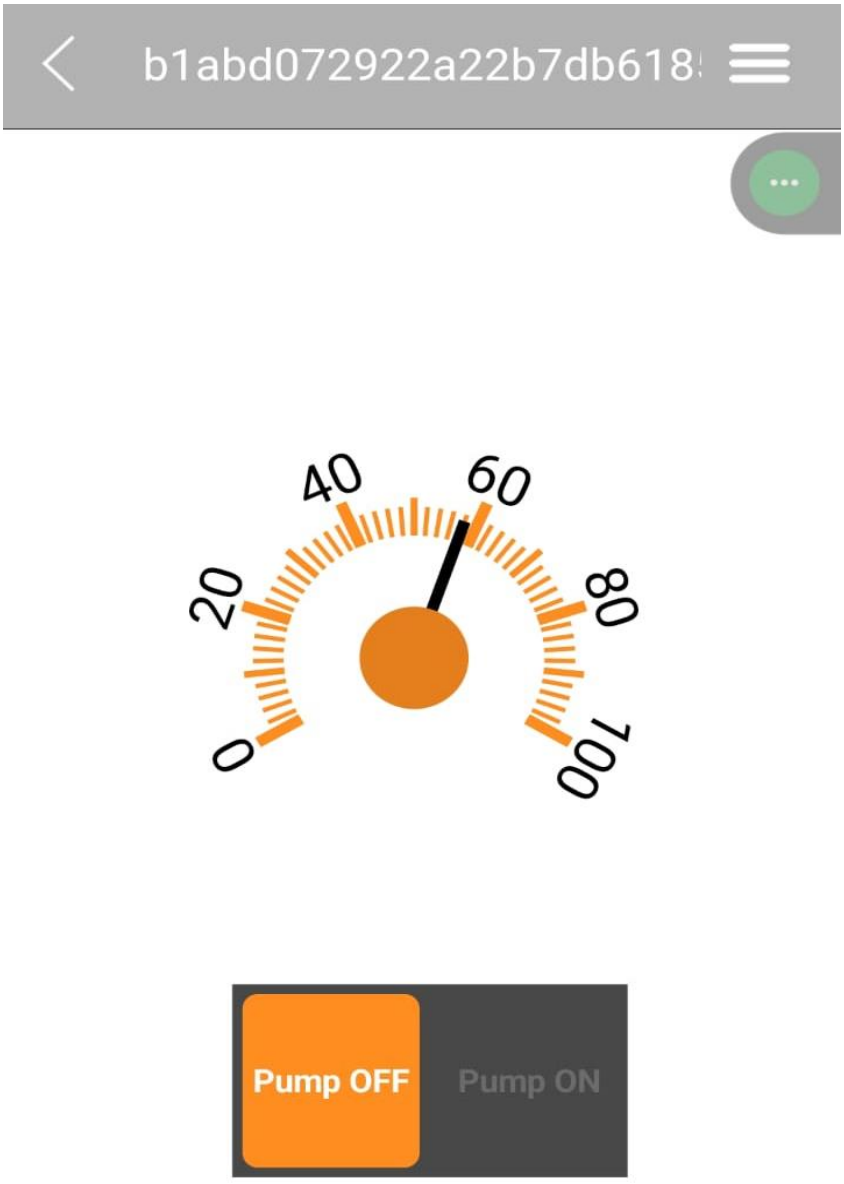

Fig.4.1 Remotexy app

Working of soil moisture sensor:

The working of the Soil Moisture Sensor is very simple. It works on the principle of voltage comparison. Moisture sensor module consists of four pins i.e. VCC, GND, DO, AO. Digital out pin is connected to the output pin of LM393 comparator IC while the analog pin is connected to Moisture sensor. The internal Circuit diagram of the Moisture sensor module is given below.

The following circuit will be helpful in understanding the working of a typical soil moisture sensor.

Working of soil moisture sensor, Block diagram of soil moisture sensor

As you can see, one input of the comparator is connected to a 10KΩ Potentiometer while the other input is connected to a voltage divider network formed by a 10KΩ Resistor and the Soil Moisture Probe.

Using a Moisture sensor module with a microcontroller is very easy. Connect the Analog/Digital Output pin of the module to the Analog/Digital pin of Microcontroller. Connect VCC and GND pins to 5V and GND pins of Microcontroller, after that insert the probes inside the soil. When there is more water presented in the soil, it will conduct more electricity that means resistance will be low and the moisture level will be high.

CHAPTER – 5

RESULTS

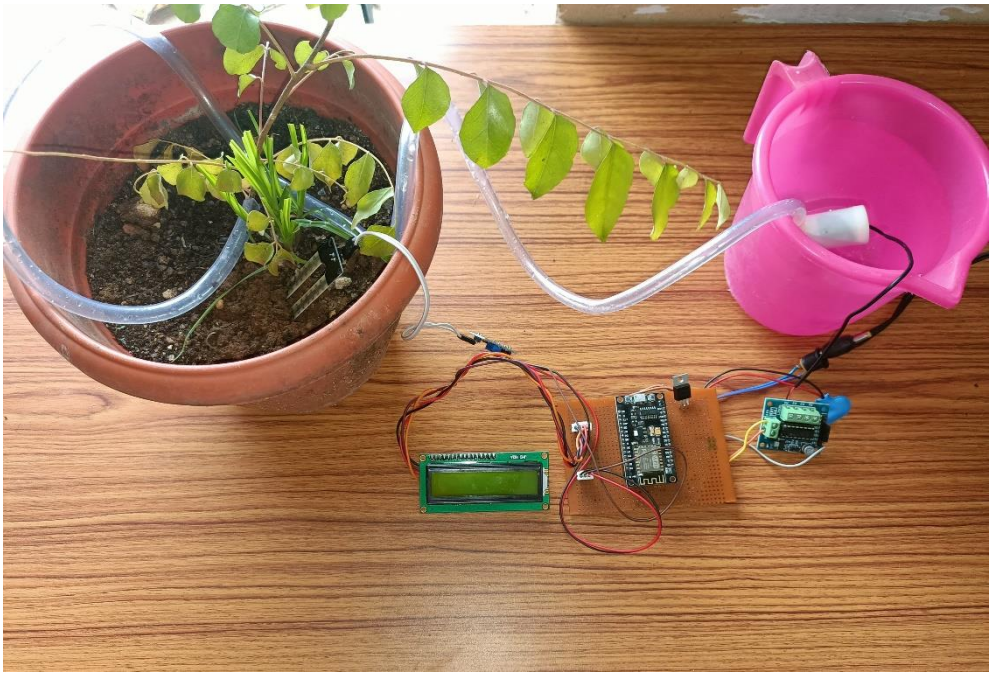

Fig.5.1 MINI PROJECT DEMO

Fig 5.1 is explaining the on-board connections made to perform

1) Collect all components
2) Connect NODE MCU board to PC
3) Write program in Arduino IDE development platform
4) Upload the program on to microcontroller at NODE MCU kit
5) Do connect Moisture sensor and L293D Module as per circuit designed
6) Observe results for test, record, rebuild and etc procedures to achieve accurate results

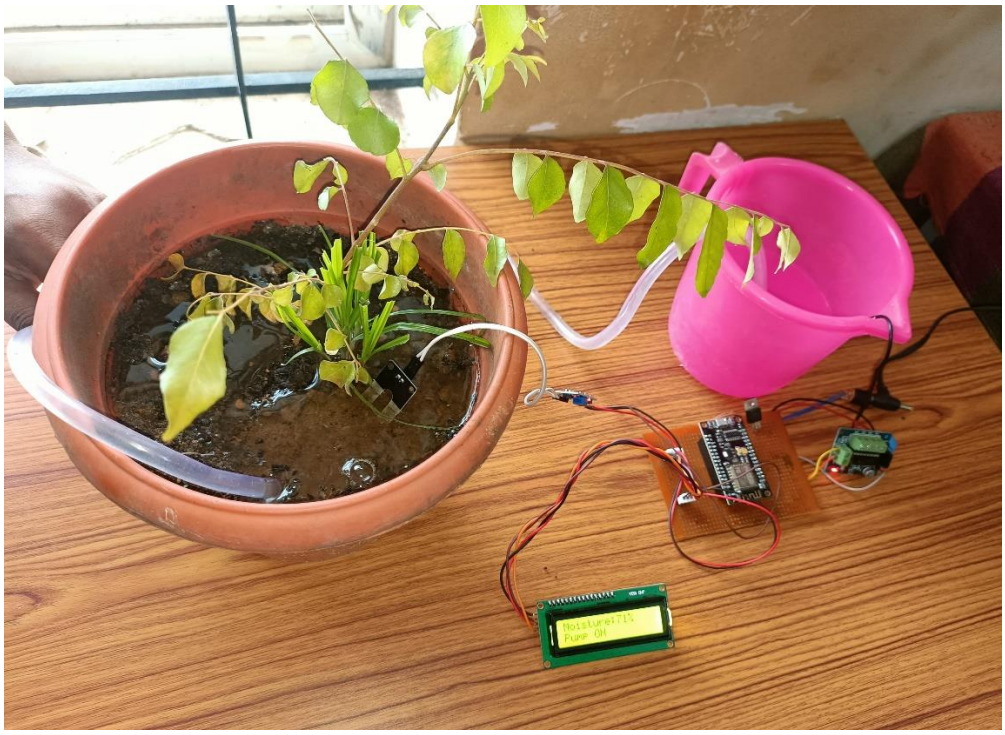

Fig.5.2 MINI PROJECT DEMO

- Here the results obtained by testing first sensor to identify the moisture level in the soil and it sends the readings to the remoteXY application
- Moisture level is shown in the LCD screen
- And also shows the whether motor is ON/OFF.

CHAPTER – 5

CONCLUSION AND FUTURE SCOPE

Conclusion:

The implementation of a moisture sensor-based watering system integrated with a Wi-Fi module represents a significant advancement in agricultural and horticultural irrigation technology. This system effectively addresses the challenges associated with traditional irrigation methods by automating the watering process based on real-time soil moisture data. Key findings from the system's deployment include:

1. **Enhanced Water Efficiency:** The system ensures that plants receive the right amount of water according to their needs, reducing water wastage and promoting sustainable water use.

2. **Reduced Manual Intervention:** By automating the watering process, the system decreases the need for manual monitoring and intervention, saving time and labor for farmers and gardeners.

3. **Real-Time Monitoring:** The integration of a Wi-Fi module allows for real-time monitoring and control of soil moisture levels from remote locations. This feature enhances the flexibility and convenience of managing irrigation.

4. **Data-Driven Insights:** The collection of soil moisture data over time provides valuable insights into irrigation practices, helping users make informed decisions and optimize watering schedules.

5. **Cost Savings:** Although initial setup costs may be higher, the long-term benefits include reduced water bills and lower operational costs, as the system minimizes overwatering and resource wastage.

Future Scope:

1. **Integration with Smart Home Systems:** Future enhancements could include integrating the moisture sensor-based watering system with broader smart home or smart agriculture platforms. This would allow for seamless automation and coordination with other environmental controls.

2. **Advanced Data Analytics:** Implementing advanced data analytics and machine learning algorithms could further refine watering schedules and predict water needs based on various factors such as weather conditions, plant growth stages, and soil types.

3. **Integration with Weather Forecasting:** Incorporating weather forecasting data into the system could enable dynamic adjustment of watering schedules based on predicted rainfall or temperature changes, further optimizing water use.

4. **Expansion to Other Sensors:** Integrating additional sensors, such as temperature, humidity, and light sensors, could provide a more comprehensive environmental monitoring system, allowing for even more precise control of irrigation.

5. **Energy Efficiency Improvements:** Future developments could focus on improving the energy efficiency of the system, including the use of solar power or other sustainable energy sources to power the sensors and Wi-Fi module.

6. **User Interface and Accessibility:** Enhancing the user interface with mobile apps or web-based dashboards could improve accessibility and user experience, making it easier for users to monitor and control their irrigation systems.

7. **Scalability for Larger Farms:** Adapting the system for scalability to accommodate larger agricultural operations could involve developing more robust hardware and software solutions that handle extensive networks of sensors and watering units.

REFERENCES

Research Papers and Journals

1. "Smart Irrigation System for Precision Agriculture Using IoT"
   By K. Shylaja and P. Thavavel
   International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2017.
   This paper discusses the integration of IoT with irrigation systems and can provide insights into similar implementations.

2. "IoT Based Smart Irrigation System"
   By S. S. K. B. Thangadurai and R. K. Sharma
   International Journal of Computer Applications, 2015.
   Provides an overview of IoT-based smart irrigation solutions and their effectiveness.

Online Resources

1. "ESP8266 NodeMCU Pinout Reference"
   https://www.electronicwings.com/nodemcu/nodemcu-pinout-and-features
   Provides detailed pin configuration and usage for the NodeMCU ESP8266, which is integral for designing sensor-based watering systems.

2. "Tutorial on Moisture Sensors with Arduino and ESP8266"
   https://www.instructables.com/Soil-Moisture-Sensor-With-ESP8266/
   A practical guide for setting up soil moisture sensors with ESP8266, offering hands-on examples and code snippets.