DAYANANDA SAGAR UNIVERSITY

KUDLU GATE, BANGALORE – 560068

Bachelor of Technology
in
COMPUTER SCIENCE AND TECHNOLOGY

Project Phase-I Report

(20CT4704)

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CERTIFICATE

This is to certify that the work titled **"IOT enhanced tomato plant cultivation with machine learning"** is carried out by **Abhas Agnihotri(ENG20CT0001) , Deepak B G (ENG20CT0009),M Nikhil Guptha (ENG20CT0015), Shashikala M S(ENG20CT0025),** Bonafide students of Bachelor of Technology in Computer Science and Technology at the School of Engineering, Dayananda Sagar University, Bangalore in partial fulfillment for the award of degree in Bachelor of Technology in Computer Science and Technology, during the year **2023-2024**.

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DECLARATION

We, Deepak B G(ENG20CT0009), M Nikhil Guptha(ENG20CT0015), Shashikala M S (ENG20CT0025), Abhas Agnihotri(ENG20CT0001), students of the seventh semester B.Tech in Computer Science and Technology, at School of Engineering, Dayananda Sagar University, hereby declare that the project phase-I project titled "IOT enhanced tomato plant cultivation with machine learning" has been carried out by us and submitted in partial fulfillment for the award of degree in Bachelor of Technology in Computer Science and Technology during the academic year 2023-2024.

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ABSTRACT

The project introduces an IoT and Machine Learning (ML) enhanced system designed to enhance tomato cultivation, addressing the challenges of modern agriculture by optimizing resource usage while meeting the rising global food demand. The system's core components include soil moisture and nutrient sensors, continuously monitoring and maintaining optimal soil conditions. Soil moisture sensors triggers irrigation when the soil becomes dry, ensuring proper hydration, while nutrient sensors regulate Nitrogen (N), Phosphorus (P), and Potassium (K) levels for robust plant growth. Innovatively, the project integrates ML through a camera module capturing real-time plant images. A sophisticated ML model identifies potential pest threats like insects and diseases, autonomously activating a pesticide spray system for immediate mitigation. Remote monitoring via an IoT interface empowers users to access real-time data and configure settings. This IoT and ML-driven tomato cultivation system offers resource-efficient, proactive, and sustainable agriculture, elevating crop yields and reducing environmental impact

Keywords: Soil Moisture, NodeMCU, AB054, Relay Module, Blynk,

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CHAPTER 1

INTRODUCTION

Modern agriculture faces the dual challenge of meeting the escalating global demand for food while concurrently minimizing environmental impact and optimizing resource usage. In response to this challenge, our research presents an innovative solution that integrates Internet of Things (IoT) and Machine Learning (ML) technologies to revolutionize tomato cultivation. Traditional farming methods are often resource-intensive and susceptible to inefficiencies in water and nutrient management, leading to suboptimal yields and increased environmental footprints. Our project aims to address these limitations by introducing a smart, automated system that leverages IoT for real-time monitoring and ML for intelligent decision-making in tomato farming.

The core objectives of our research include:

1. Automated Irrigation: Utilizing soil moisture sensors and an IoT-connected system to automate the irrigation process, ensuring tomatoes receive optimal water levels based on real-time soil conditions.
2. Precision Nutrient Management: Implementing nutrient sensors to assess Nitrogen (N), Phosphorus (P), and Potassium (K) levels in the soil, and dynamically adjusting nutrient dispensing to foster robust plant growth.
3. Proactive Pest Detection and Control: Integrating small camera modules and a ML model capable of identifying potential pest threats. The system autonomously triggers pest control measures, mitigating the risk of infestations.
4. IoT Interface for Remote Monitoring: Developing a user-friendly interface that enables remote monitoring of the cultivation environment, configuration of system settings, and receipt of timely alerts.

CHAPTER 2

LITERATURE SURVEY

1. IoT based Automatic Watering System for Indoor Plants,2019

Journal

JOURNAL OF INNOVATION IN ELECTRONICS AND COMMUNICATION ENGINEERING

Author

V J S T Anirudh

Algorithm Used

A] Soil Moisture Sensor

B] Liquid Crystal Display

Problem Statement

Many individuals struggle to remember watering their plants regularly, posing a challenge to maintaining plant health. This research proposes an IoT-based Automatic Watering System for Indoor Plants, leveraging sensor technology, microcontrollers, and electronics to create a smart switching system. The system detects soil moisture levels and irrigates the plant as needed, offering an automated solution to plant care. The objective is to demonstrate how one can easily create a cost-effective automatic plant watering system with readily available electronic components.

Tools Used

Arduino Uno, Soil Moisture Sensor, Power Supply, Liquid Crystal Display, Water Pump, Temperature Sensor, Arduino IDE Tool

Result and Discussion

i.Sensor Components:
The soil moisture sensor comprises two probes. Probes measure the volumetric content of water in the soil.

ii. Principle of Operation:

The sensor passes a current through the soil.

iii. Resistance Measurement:

Measures the resistance of the soil.

Wet soil conducts electricity well, resulting in lower resistance.

Dry soil conducts electricity poorly, leading to higher resistance.

iv. Moisture Levels:

Higher moisture levels are indicated by lower resistance.

Lower moisture levels are indicated by higher resistance.

v. Relation to Water Content:

More water in the soil results in better electrical conductivity and lower resistance.

Less water in the soil results in poor electrical conductivity and higher resistance.

Knowledge Acquired

The paper provides insights into building an IoT-enabled smart drip irrigation system for precision agriculture, emphasizing automation and control using a microcontroller. It also discusses calibration, sensor validation, and field testing. The system offers real-time monitoring and control through a Blynk IoT dashboard.

2. IoT-Enabled Smart Drip Irrigation System Using ESP3,2023

Journal/Conference

MDPI

Authors

Gilroy P. Pereira, Mohamed Z. Chaari, and Fawwad Daroge

Problem Statement and Solution

This paper introduces a Smart Drip Irrigation System to address the challenge of efficient water management in agriculture. The solution is an IoT-enabled system that automates irrigation based on soil moisture, temperature, and humidity, optimizing water usage for plant growth.

Tools Used

Microcontroller: ESP32

Moisture Sensor: DFRobot SEN0308

Temperature Sensor: DS18B20

Air Humidity Sensor: DHT22

Water Flow Sensor: FS300A G3/4 Inch

Solenoid Valve: Hunter PGV-100G (24VAC)

Relay: Used as an electrically controlled switch

Step-Down Voltage Regulator: To supply power to the ESP32

Acrylic Container: Custom-made for housing the system

Soil: All-purpose potting soil with specific characteristics

Various containers and enclosures: To protect components from dust and water

Blynk IoT Dashboard: Used for monitoring and controlling the system

Results and Discussion

Primary tests in the laboratory validated the functionality of various sensors, solenoid valve, and firmware. Comparison of sensor readings to weather forecasts demonstrated accurate measurements, particularly in air temperature and humidity. Outdoor testing of the solenoid valve confirmed the system's effectiveness in an outdoor environment. Field testing of the smart drip irrigation system showcased successful growth of spring onions, ensuring adequate water supply and automated irrigation based on sensor readings.

Knowledge Acquired

The paper provides insights into building an IoT-enabled smart drip irrigation system for precision agriculture, emphasizing automation and control using a microcontroller. It discusses calibration, sensor validation, and field testing, offering real-time monitoring and control through a Blynk IoT dashboard.

3. **A Literature Review on Automatic Watering of Plants,2022**

Journal/Conference

IJCRT

Author

Mani Bansal, Abhay Pandey, Mandvi Singh, Nivesh Sharma, Ms. Neha, Raj Kumar Goel

Problem Statement and Solution

In this literature review, we explore the challenges associated with manual plant watering and the benefits of implementing automatic plant watering systems. The problem lies in the time and effort required for regular plant care, especially in a world where people have increasingly busy lives. The solution obtained involves investigating various automatic plant watering systems and assessing their effectiveness, cost-efficiency, and impact on plant health.

Algorithm Used

This literature review does not directly involve the use of algorithms since it primarily focuses on summarizing and analyzing existing research. However, some of the automatic plant watering systems discussed in the review may employ algorithms for soil moisture measurement and water delivery.

Tools Used

Soil moisture sensors, Microcontrollers (e.g., Arduino), Water pumps, Solenoid valves, Cloud-based monitoring and control systems

Result and Discussion

The results section will summarize the key findings from the literature review. These findings may include the benefits of automatic watering, such as improved plant health and reduced water usage. It may also discuss the limitations and challenges associated with certain systems. The discussion section will provide insights into the implications of the results and highlight any gaps in the existing research.

Knowledge Acquired

The knowledge acquired from this literature review encompasses a comprehensive understanding of the state of the art in automatic plant watering systems. Readers will gain insights into the advantages and disadvantages of various approaches, the impact on plant growth, and the potential for widespread adoption of such systems.

4. **Automatic Plant Watering System, 2019**

Journal/Conference

2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN).

Authors

Manisha Mayuree, Manisha Mayuree, Prof. Bagubali A.

Problem Statement and Solution

Problem Statement

Many times, due to busy schedules, people forget to water their plants, which hinder their healthy growth. Also, it is very difficult for farmers to water their fields manually and to provide accurate amount of water for healthy growth of plants. Management of water also becomes a huge task due to water scarcity, since manual irrigation leads to wastage of water. Also, to avoid empty tank user should be notified to switch ON the motor to fill the tank.

Solution

Create a ARDUINO in such that it irrigates the plants based on the feedback of moisture content provided by the soil moisture sensor. When moisture content is lower than a prescribed limit, water pump starts irrigating. And When moisture content reaches the maximum limit, the water pump automatically switches off.

Algorithm Used

The automatic plant watering system prototype, designed for both small gardens and large crop fields, comprises essential components such as an Arduino UNO microcontroller, soil moisture sensor, water level sensor, water pump, and GSM module. Programmed using ARDUINO IDE, the system monitors soil moisture levels. When moisture falls below a set threshold, the water pump activates, facilitating irrigation through a sprinkler or drip system. Once the desired soil moisture is reached, the pump shuts off. The system enhances user engagement by sending notifications for low water levels, prompting refills, and preventing tank overflow. These alerts serve as practical reminders and provide crucial information on temperature and moisture levels for efficient plant care.

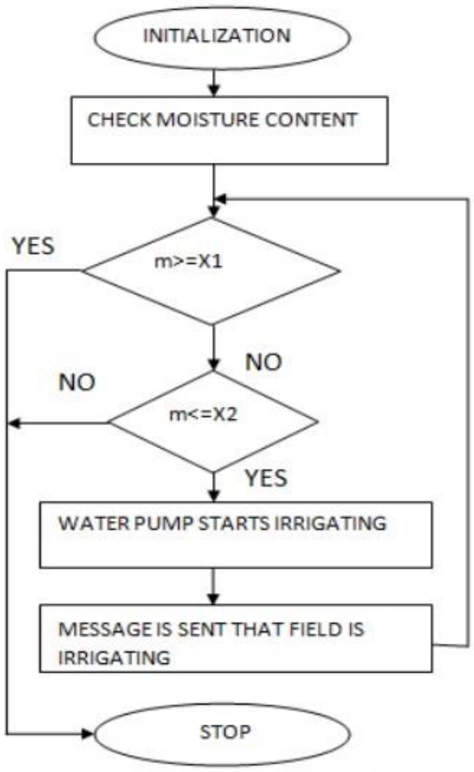

Fig 2.1: Methodology flowchart

Tools Used

i. ARDUINO UNO
ii. SOIL MOISTURE SENSOR
iii. WATER LEVEL SENSOR
iv. GSM MODULE
v. MOTOR SHIELD

Result And Discussion

This is a low budget project which the farmers of the country can easily afford and can be further improved using technology. This project solves the problem of manual watering and saves a lot of time user. It also focuses on conserving water with increased accuracy in water distribution to the crops and energy. This project includes monitoring soil moisture and supplying water uniformly to the plants using sprinkler or drip system. It also keeps the track of water level.

Knowledge Acquired

- How can solar panels use to conserve energy.
- How feedback can be used to irrigates the plants.
- Based on the measuring of the soil moisture content can saves Farmer time.
- Avoid wastage of water in field.

CHAPTER 3

PROJECT REQUIREMENT SPECIFICATION

3.1 HARDWARE:

1. Soil Moisture Sensor:
   - AB054 soil moisture sensor for accurate soil moisture readings.

2. Microcontroller:
   - NodeMCU board for interfacing with the AB054 sensor and connecting to the internet.
3. Battery:
   - A 9 volts HW battery is used for power supply.

4. Water Pump:
   - A water pump suitable for the irrigation when the moisture is low.

5. Relay Module:
   - Relay module for controlling the activation and deactivation of the water pump.
   - Connected to the microcontroller to manage pump operation.
6. Tubing and Water Reservoir:
   - Tubing for connecting the water pump to the soil.

3.2 SOFTWARE:

1. Arduino Integrated Development Environment (IDE):
    - Utilize the Arduino IDE for coding the NodeMCU.
    - Install any specific libraries required for the AB054 sensor and NodeMCU.
2. Arduino Library for AB054 Sensor:
    - Check if there's a specific library for the AB054 sensor and install it.
    - Adapt the soil moisture detection code to work seamlessly with the AB054 sensor.
3. NodeMCU Programming:
    - Write code in Lua or use the Arduino IDE with the NodeMCU board support to control the irrigation system based on soil moisture readings.
4. Integration with Moisture Reading:
    - Modify the soil moisture detection code to incorporate the control logic for water dispensing.

CHAPTER 4

PROBLEM DEFINITION

Modern agriculture confronts a formidable challenge—satisfying the burgeoning global demand for food while concurrently endeavoring to streamline resource usage and mitigate environmental impact. Traditional farming practices, marked by imprecise water and nutrient management, fall short, yielding suboptimal crop outputs and an undue environmental footprint. This research project aspires to introduce an innovative remedy, harnessing the potential of Internet of Things (IoT) and Machine Learning (ML) technologies to elevate tomato cultivation.

The project targets critical agricultural quandaries, beginning with the inefficiencies inherent in conventional irrigation. The proposed solution involves an automated system that ensures optimal water supply by closely monitoring real-time soil moisture levels. Addressing nutrient management disparities, the project envisions a dynamic dispensing system for Nitrogen (N), Phosphorus (P), and Potassium (K) based on the plant's nutritional demands. To counter pest threats, the integration of ML algorithms and camera modules aims to proactively identify and control infestations.

Moreover, the project addresses the current limitations in monitoring and control mechanisms by establishing an IoT interface. This interface facilitates remote oversight, enabling farmers to make timely, informed decisions in response to evolving environmental conditions. The overarching goal is to contribute to the transformation of agriculture into a sustainable and resource-efficient industry. The project's outcome anticipates improved crop yields and quality, proactive pest control measures, real-time monitoring capabilities, and a significant stride towards sustainable agricultural practices. Through these initiatives, the research project aspires to redefine tomato cultivation, setting the stage for a data-driven, efficient, and sustainable approach to precision agriculture.

CHAPTER 5

SYSTEM ARCHITECTURE

The soil moisture sensor system architecture is designed to create a robust and efficient framework for monitoring and managing soil moisture levels in a cultivation environment. At its core, the architecture revolves around real-time data acquisition from soil moisture sensors strategically embedded in the cultivation area. These sensors act as the sensory nodes, continuously measuring the moisture content in the soil. The data collected is then transmitted to a central processing unit, which serves as the brain of the system. This unit, often an IoT-enabled microcontroller like NodeMCU, interprets the incoming data, making informed decisions about the irrigation needs of the plants.

The architecture integrates a control algorithm that determines when to activate the water dispensing system based on predefined moisture thresholds. This ensures that the irrigation process is precisely triggered only when the soil moisture falls below the optimal level. The system's intelligence is further enhanced by the potential integration of machine learning algorithms, enabling it to adapt and optimize irrigation patterns over time. The IoT aspect of the architecture facilitates remote monitoring and control, allowing farmers to access real-time soil moisture data and make informed decisions through user-friendly interfaces. By offering a seamless integration of sensors, data processing, and control mechanisms, the soil moisture sensor system architecture optimizes water usage, fostering a more sustainable and efficient approach to agricultural irrigation.

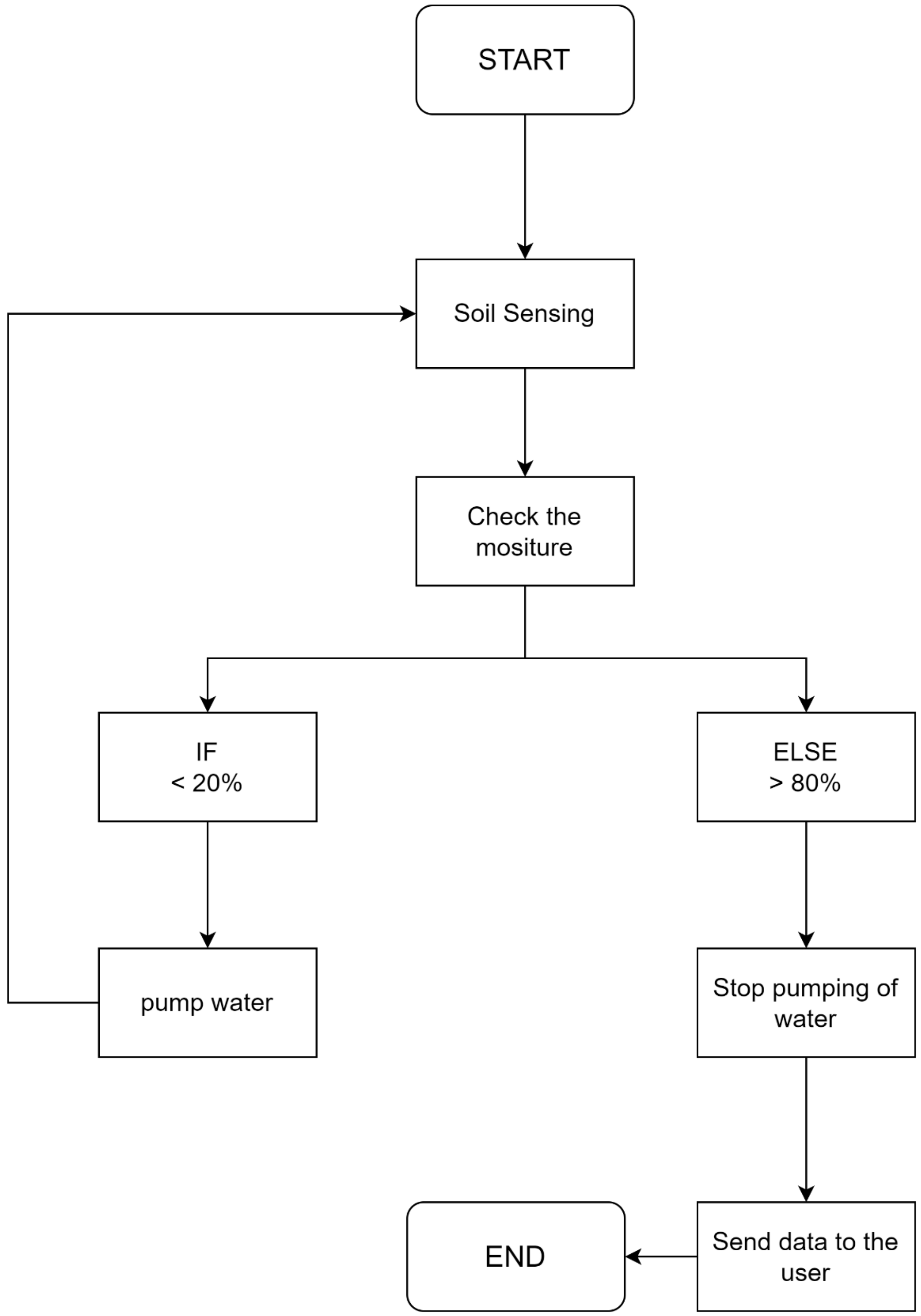

FIG 5.1 Flowchart about the working of soil moisture monitoring and automated irrigation

CHAPTER 6

IMPLEMENTATION

```
#define BLYNK_TEMPLATE_ID "TMPL3CrdJNIeY"
#define BLYNK_TEMPLATE_NAME "Irrigation"
#define BLYNK_AUTH_TOKEN "QHlqBHKbm2UDfai2NJFrNwMYGmuQFlBg"

#define BLYNK_FIRMWARE_VERSION        "0.1.0"
#define BLYNK_PRINT Serial
#define USE_NODE_MCU_BOARD
#include "BlynkEdgent.h"


#define soil A0
#define waterPump D3
WidgetLED pump(V1);

float soilLevel, soilR;


WidgetLCD vLcd(V2);

void sendSensor()
{
  readSoil();
  if(soilLevel>=80)
  {
    digitalWrite(waterPump, LOW);
    vLcd.print(0,0,"Water Pump OFF");
    pump.off();
  }

 if(soilLevel<20)
  {
    digitalWrite(waterPump, HIGH);
    vLcd.print(0,0, "Water Pump ON ");
    pump.on();
  }
}
```

```
void readSoil()
 {
  soilR=analogRead(soil);
  Serial.println(soilR);
  soilLevel=map(soilR, 0, 1024, 100,0); // ajust soil level here
  Serial.println(soilLevel);
  Blynk.virtualWrite(V0, soilLevel);
  delay(1000);
 }
 void setup()
 {
  Serial.begin(9600);
  pinMode(waterPump, OUTPUT);
  digitalWrite(waterPump, LOW);
  BlynkEdgent.begin();
  delay(2000);

 }

 void loop()
 {
  BlynkEdgent.run();

 sendSensor();
 }
```

Blynk Configuration:

The code sets up Blynk, an IoT platform, using the BlynkEdgent library. It includes essential details such as the template ID, device name, and authentication token.

Sensor and Actuator Setup:

The soil moisture sensor is connected to pin A0, and the water pump is connected to pin D7 on the NodeMCU board.

.

Sensor Reading:

The readSoil function reads the analog value from the soil moisture sensor, converts it to a percentage (soil moisture level), and sends the data to Blynk for visualization on the app.

Automatic Irrigation Control:

The sendSensor function checks the soil moisture level and controls the water pump accordingly. If the soil moisture is below 20%, it turns the pump on. If the moisture is above 80%, it turns the pump off.

Setup Function:

In the setup function, the serial communication is initiated, the water pump pin is configured as an output, and the BlynkEdgent initialization is performed.

Main Loop:

The loop function continuously runs, allowing BlynkEdgent to handle the Blynk-related tasks and periodically calls sendSensor to monitor and control the irrigation system.

CHAPTER 7

OUTPUT SCREENSHOTS

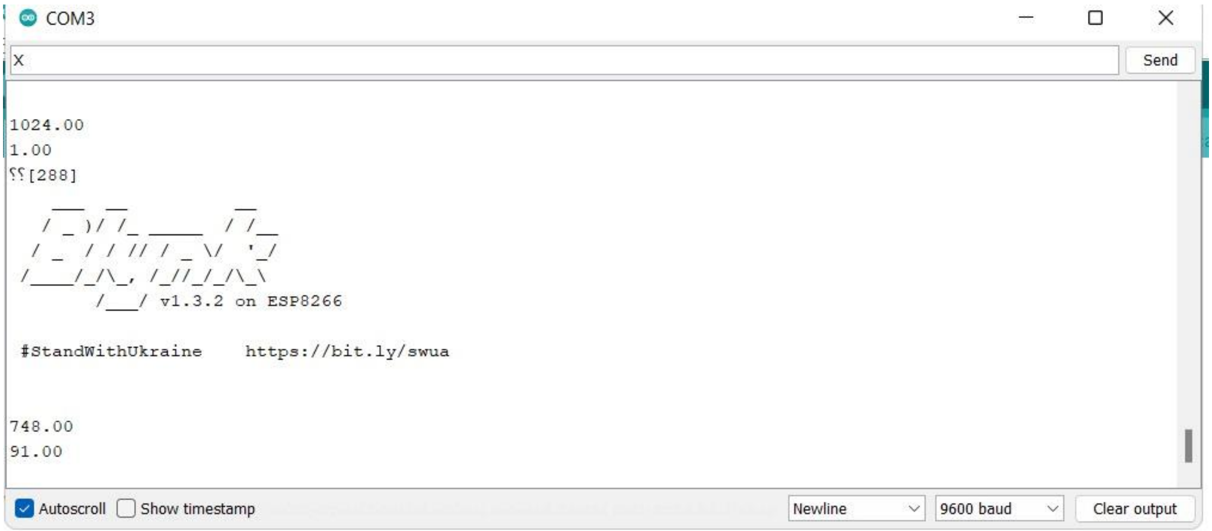

Fig 7.1: The sensor reads data from physical world and displays the value in serial monitor (91%)

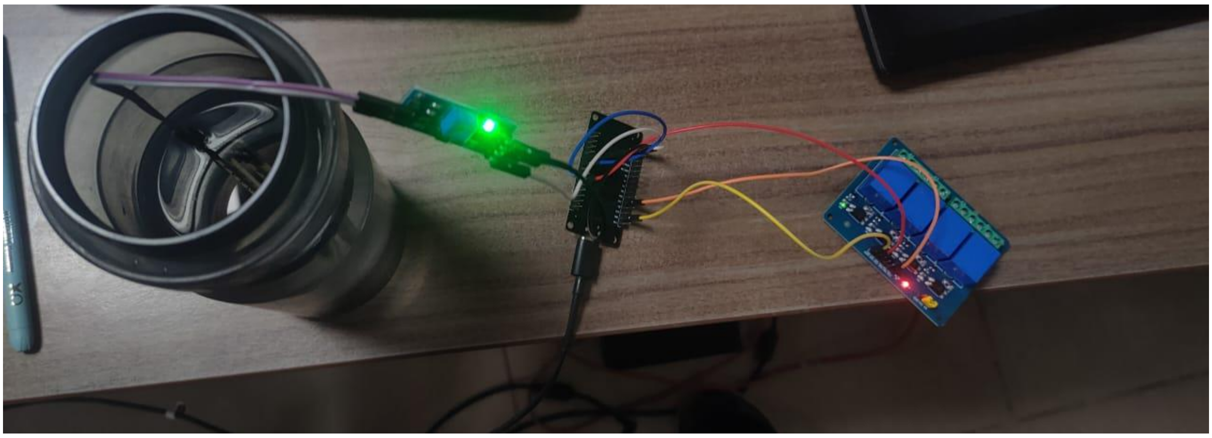

Fig 7.2: The setup of moisture sensor using AB054, NodeMCU and Relay Module.

CONCLUSION

In conclusion, the soil moisture monitoring and irrigation control system, implemented through the integration of a soil moisture sensor, NodeMCU board, and Blynk platform, represents a pivotal advancement in precision agriculture. By seamlessly translating real-time soil moisture data into actionable insights for automated irrigation, the system not only optimizes water usage but also offers a user-friendly interface through LCD and LED widgets. The inclusion of Blynk facilitates remote monitoring, empowering farmers with timely decision-making capabilities. This scalable and modular solution holds promise for revolutionizing traditional farming practices, aligning with the broader goals of resource-efficient and sustainable agriculture.

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[4] Manisha Mayuree, Manisha Mayuree, Prof. Bagubali A., “Automatic Plant Watering System”, International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN).,