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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION OF ELECTRICAL TECHNOLOGY

FINAL YEAR PROJECT:

TITLE: DESIGN AND IMPLEMENTATION OF PLANT MOISTURE MONITORING SYSTEM.

Submitted in Partial Fulfillment of the Academic Requirements for the Award of an Advanced Diploma (A1) in Electrical Technology.

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Deepest appreciation to my supervisor Eng. Annuarita GATESI for her endless support, guidance, and consultation regarding this project throughout the academic year.

Lastly, thanks to all those who have contributed directly or indirectly to the success of this project.

DECLARATION

We**, ABESSOLO METOGO Mégane Francesca** with roll number **202150525** respectively, I hereby declare that I carried out the work presented in this report entitled "**DESIGN AND IMPLEMENTATION OF PLANT MOISTURE MONITORING SYSTEM"**, presented for the award of advanced diploma in Electrical Technology at **ULK POLYTECHNIC INSTITUTE** is my contribution to the best of my knowledge, no part of this report has been submitted here or elsewhere in a previous application for the award of an academic qualification.

ABESSOLO METOGO Mégane Francesca

Signature…………………….........................

Date…/…/2024

CERTIFICATION

I here certify that the work reported in this research project was carried out by the candidate under my supervision and it has been submitted with my approval.

Supervisor 's name: Eng. Annuarita GATESI

Signature:………………………

Date:………………………. …………..

ABSTRACT

This project presents a Plant Moisture Monitoring System that uses minimal human intervention to monitor plant humidity levels and provide watering as needed. Our topic's goals were to increase our understanding of plant moisture monitoring through the design and application of plant moisture monitoring systems. The initiative aimed to decrease water waste, boost plant growth, and automatically monitor the soil. The water pump was controlled by a relay module, an Arduino and a soil moisture sensor, and an LED to indicate when the soil was not humid. We tested two soil prototypes, one with the ideal humidity and the other with insufficient humidity, to fulfill our goals. When the first prototype had the ideal humidity (below 800), it didn't require a water pump for irrigation; however, when the humidity was insufficient, we did need a water pump, as shown by the signals from the LED diode (800 or higher). In conclusion, we discovered numerous uses for the project after planning and carrying it out, such as in parks, horticultural areas, and agricultural regions. Furthermore, this approach would be helpful and simple to utilize to solve the soil problem in any kind of climate.

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CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

To maintain ideal crop growth, increase production, and conserve water resources in agriculture, it is crucial to manage soil moisture and plant hydration status. Conventional irrigation management techniques frequently rely on empirical information and recurring evaluations, which might not be enough to satisfy the demands of contemporary agricultural operations in a changing environment. Plant moisture monitoring systems provide precise, up-to-date information on the moisture level of the soil, thereby offering a technological solution. They signify a substantial development in agricultural technology. Through the continual monitoring of soil and plant conditions, these technologies let farmers make well-informed decisions about when and how much irrigation to apply. This proactive strategy encourages effective water use while simultaneously enhancing agricultural productivity and health.

1.1 Background of study

The Plant Moisture Monitoring System is a system which typically consists of sensors embedded in the soil that detect the soil moisture. The plants have played a vital role in human life for a long time. As the percentage of population increase and the water is becoming rare in certain regions, Plant Moisture Monitoring System has become a priority in recent years. This system is intended to tell us if a plant's soil contains water and if not, the system put water in the soil. Before, people used traditional methods of monitoring soil moisture, such as manual inspection and visual observation which was often not sufficient. It was easy to make a mistake by putting excess water when the plant's soil already contains it which will kill the plant and waste water or the plant's soil contains it and do not water it which will also lead to the death of the plant.

1.2 Problem statement

In many regions, water scarcity and population growth pose significant challenges in the daily lives of the people who live there because they live mainly through agriculture. Manual or visual plant moisture monitoring systems rely on humans and are not sufficient to reduce water wastage or plant death caused by over or under dosing of water. To overcome these problems, we chose plant humidity monitoring systems as a project.

1.3. Research objective

Main objective

The main objective of this project is to design and implement a plant moisture monitoring system.

Specific objectives

The specific objectives of our research are:

i. To extend knowledge and skills in plants moisture monitoring system.
ii. To identify the factors involving in monitoring plants moisture.

1.4. Research questions

i. How advanced learning techniques be integrated into plant moisture monitoring system to predict irrigation needs more accurately and optimize water usage?
ii. What are the key factors involved in plant moisture monitoring?

1.5. Scope and Limitations

Plant moisture monitoring systems in agriculture are essential to address water management challenges in this area. With variable precipitation patterns, and an increasing need for efficient water use, due to the impacts of climate change such as prolonged drought periods and unpredictable weather events, there is a pressing demand for monitoring solutions innovative. It is to meet these demands that our project involves the development and implementation of technologies based on sensors capable of measuring soil moisture levels.

1.6 Project Significance

This system significantly contributes to sustainable agriculture, environmental stewardship and technological advancement. They play a pivotal role in enhancing food security, and fostering innovation in agricultural practices and technologies. So, being able to design and manufacture this plant moisture monitoring system is a solid step in emancipation of African people especially as Africa is still lagging and is still relying heavily on imports of crucial technologies.

1.7 Organization of the study

Based on recommendations provided by UPI Cabinet on Final Year Project Guidelines, our research is divided into five chapters as follows:

Chapter 1. General Introduction serves as opening section of our final year report. Its purpose is to provide an overview of the research study. This chapter is composed by these parts: Introduction, Background of study, Problem statement, Research objective, Research questions, Scope and Limitations, Project Significance, Organization of the study.

Chapter 2. the Literature Review, establish the scholarly context and theoretical foundations for the research. It demonstrates the researcher's familiarity with existing literature and synthetize the previous research.

Chapter 3. Research Methodology provides a clear and systematic description of the research. consisted by Introduction, Research design, Research population, Sample size, Sampling procedure, Research instrument, Choice of the research instrument, Validity and reliability of the instrument, Data gathering procedures, Data analysis and interpretation, Ethical considerations, Limitations of the study.

Chapter 4. System Design, Analysis and Implementation detailing how a system is conceptualized, developed and deployed.

Chapter 5. Conclusion and Recommendations, serves as the culmination of the research study, summarizing the findings, discussing their applications and offering guidance for future research based on the challenges met. References and indices are also provided at the end.

CHAPTER 2: LITTERATURE REVIEW

2.0 Introduction

A plant moisture monitoring system refers to a system that detects soil moisture and irrigates it if it is dry. It combines a soil moisture sensor, an Arduino microcontroller board, an LED, a relay, a water pump and a battery. This chapter aims to delve deeper into the design and implementation of this system, exploring current research and developments in sensor technologies and practical applications. It also seeks to provide a comprehensive overview of the benefits, challenges, methodologies and innovations in plant moisture monitoring. Understanding these advances is crucial to optimizing agricultural practices, conserving water resources, and adapting to changing environmental conditions.

2.1 Concepts, Opinions Ideas from Authors/Experts

Plant Moisture Monitoring System plays a crucial role in modern agriculture by providing real-time data on soil and plant moisture levels. These systems are essential for optimizing irrigation practices, improving water use efficiency, and mitigating the impacts of droughts and water stress on crop productivity and environmental sustainability. This part of the project explores concepts, opinions and ideas presented by authors and technological advances in plant moisture monitoring systems.

Norman Borlaug, [1], (2000), emphasized the importance of technological advancements in agriculture to increase food production and improve livelihoods, particularly in developing countries. While he is best known for his work in crop improvement and the Green Revolution, his advocacy for technology in agriculture underscores its transformative potential, including in moisture monitoring systems.

Kishore et al, [2], (2017), discussed the automatic plant monitoring system has recently attracted tremendous interest due to the potential application in emerging technology. More importantly, this technique is used to enhance the performance of existing techniques or to develop and design new techniques for the growth of plants.

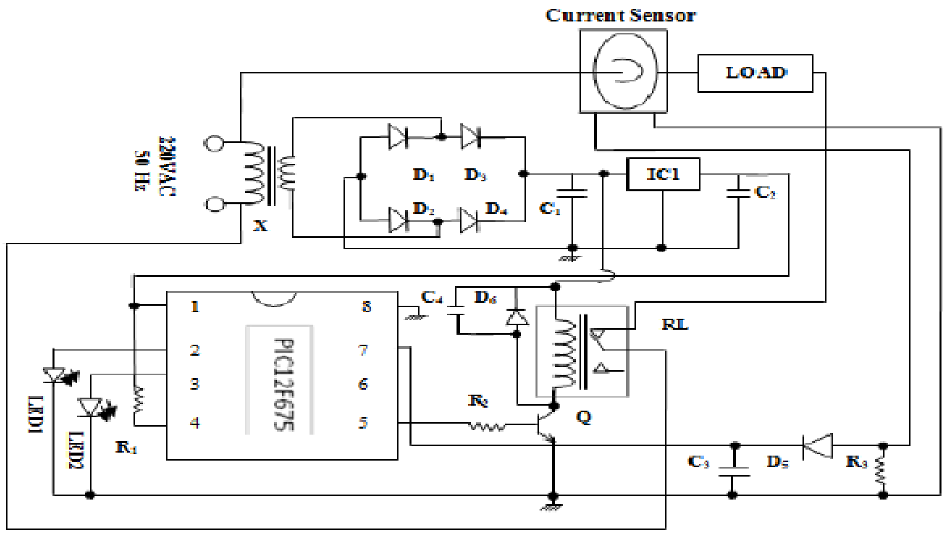

Figure 7 Completed Electric Schematic of Developed System

Caya et al, [3], (2018), proposed the integration of plant moisture monitoring systems that will assist the farmers to determine when is the right time to irrigate the soil so that they can avoid irrigation problems like waterlogging and to maximize the usage of the soil's moisture.

Kumar et al, [4], (2016), suggested that developing low-cost, high-efficiency sensors could make plant moisture monitoring systems more affordable and accessible for small-scale farmers. This idea involves creating more cost-effective materials and manufacturing processes to reduce the overall expense of sensor technology.

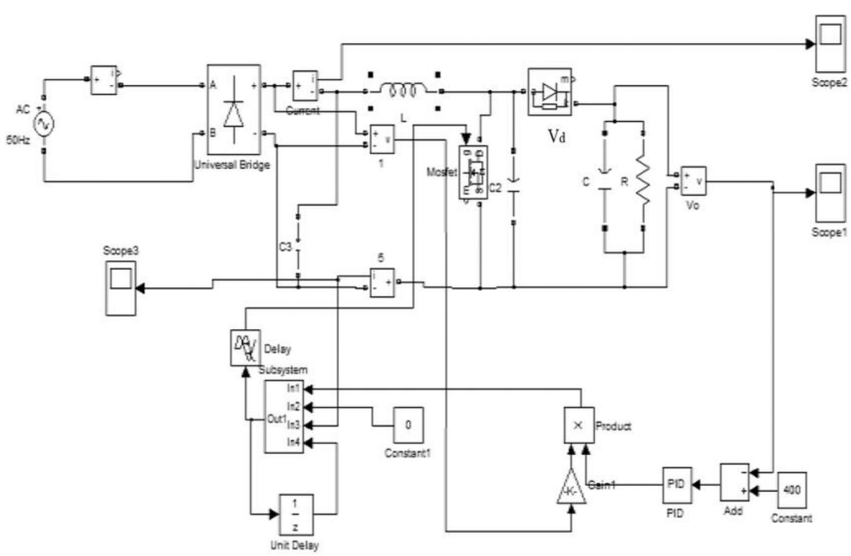

Figure 8 Contact Resistance Measurement

2.2 Theoretical perspectives

In the design and implementation of plant moisture monitoring systems, theoretical perspectives play a central role in guiding technological advances and operational practices. The principles of precision agriculture advocate the integration of advanced technologies such as these systems to accurately monitor soil moisture content while ensuring reliable measurements across various soil types and depths, thereby supporting irrigation decisions. based on data. Theories of environmental sustainability highlight the importance of moisture monitoring systems in promoting water conservation and sustainable agricultural practices, while economic theories guide assessments of return on investment and profitability, ensuring that investments in technology generate long-term benefits for farmers and stakeholders.

2.2.1 Resistive Soil moisture sensor

Soil moisture sensor is a device designed to measure the water content in soil. It provides information about how much water is present in the soil.

Working principle

A resistive soil moisture sensor measures soil moisture based on electrical resistance. It consists of two metal probes that are inserted into the soil. When a small electrical current is passed between the probes, the resistance encountered is inversely related to the soil's moisture content. Wet soil, which has better conductivity, results in lower resistance, while dry soil, with poorer conductivity, results in higher resistance. The sensor translates this resistance measurement into an output signal that indicates the soil's moisture level, which can be used for irrigation or other applications.

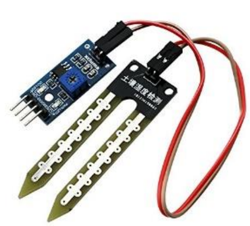

Figure 9 Resistive soil moisture sensor [5]

Advantages

The key advantages of soil moisture sensors are:

Prevents Overwatering: Overwatering, a common mistake, can lead to root rot and plant diseases. Sensors help target watering only when necessary, preventing detrimental effects and promoting healthy growth **[6].**

Optimizes Plant Growth: By providing the correct water amount, sensors ensure optimal conditions for plant health and growth. They can also assist in identifying areas prone to drying out or retaining excessive moisture.

Enhances Efficiency and Sustainability: By watering only when the soil demands it, sensors offer time and water conservation benefits, particularly valuable for busy individuals and those prioritizing eco-friendly practices.

Disadvantages

The main disadvantages of soil moisture sensor include:

Cost: Soil moisture sensors can be relatively expensive, especially for large-scale agricultural or landscaping applications where numerous sensors may be required.

Installation complexity: Properly installing soil moisture sensors to accurately measure soil moisture at the desired depth can be challenging, particularly in heavy or compacted soils.

Maintenance requirements: Soil moisture sensors may require regular calibration, cleaning, and replacement as they can become fouled or damaged over time, especially in harsh outdoor environments.

Power requirements: Many soil moisture sensors require a power source, which can increase installation and operating costs, especially in remote locations without easy access to electricity **[7].**

2.2.2 Arduino microcontroller

Arduino Microcontroller refers to a family of open-source hardware and software platforms designed for building digital devices and interactive objects. It consists of a single-board microcontroller that can be programmed to perform various tasks based on input from sensors and other electronic components.

Working principle

An Arduino microcontroller operates as a versatile, programmable platform that executes instructions based on user-defined code. At its core, the Arduino processes inputs from various sensors and devices through its analog and digital input pins. It then executes the programmed logic, which can involve reading sensor data, performing calculations, and controlling outputs such as LEDs, motors, or relays.

Figure 10 Arduino Microcontroller [8]

Advantages

Here are some advantages of the Arduino Uno board.

It is simple and easy to use. It is easily programmable, which makes it beginner friendly.

Arduino Uno can be used to build many projects, including LED blinkers, Robots etc.

It consists of various pins, which makes it more compatible and can be used to connect different electronic components **[9]**

Arduino Uno boards are cheap in comparison to other microcontroller boards.

Arduino has a large community of active users, making support or any help that is needed for Arduino boards widely available.

Disadvantages

While the Arduino Uno board has many advantages, there are some significant disadvantages to look up to.

The ATmega328p processor has limited memory and low processing power, which makes it slower than other microcontroller chips**.**

Arduino Uno boards can process only one task at a time as it has a single-core processor.

Arduino Uno boards do not have various connectivity options.

2.2.3 Relay 5V module

Relay 5v module is an automatic switch that is commonly used in an automatic control circuit and to control a high-current using a low-current signal. The input voltage of the relay signal ranges from 0 to 5V.

Working Principle

A 5V relay module functions as an electrically controlled switch that allows a low-voltage control signal to switch a higher voltage load. It consists of an electromagnetic relay and associated circuitry. When a 5V control signal is applied to the relay's coil, it generates a magnetic field that pulls a switch mechanism, closing or opening the circuit connected to the relay's output terminals. This action enables the relay to control devices such as lights or motors with higher voltage and current than the control signal itself.

Figure 11 Relay 5v module [10]

Advantages

The advantages of the relay module include:

- A remote device can be controlled easily
- It is triggered with less current but it can also trigger high power machines
- Easily contacts can be changed
- At a time, several contacts can be controlled using a single signal
- Activating part can be isolated,
- It can switch AC or DC,
- At high temperatures, it works very well

Disadvantages

The disadvantages of the relay module include:

- When contacts of relay modules are used overtime then they may damage.
- Noise can be generated through the opening & closing of the contacts **[11]**
- Time taken for switching is High.

2.2.4 Water pump

Water pump is a device that moves water from one place to another. It works by using mechanical energy to create a pressure difference, which causes the water to flow. Water pumps can be used for a variety of purposes, including irrigation, water supply, and drainage.

Working Principle

A mini water pump operates by using a small electric motor to drive a mechanical impeller or diaphragm that moves water through the pump. When electrical current is applied to the motor, it rotates the impeller or diaphragm, creating a flow of water from the inlet to the outlet. This movement generates a pressure difference, causing water to be pushed out of the pump and drawing more water in.

Figure 12 Water pump [12]

Advantages

Water pumps have several advantages, including:

Provides water supply: Water pumps can be used to extract water from underground sources, wells, lakes, rivers, or reservoirs to provide water for homes, irrigation, and other purposes **[13]**.

Saves time and energy: Using a water pump is more efficient than manually extracting water using a bucket or other means. This saves time and energy, especially when pumping large volumes of water.

Increased water pressure: Water pumps can increase water pressure, making them useful in situations where water pressure is low or insufficient.

Easy to install: Most water pumps are easy to install and operate, requiring minimal maintenance.

Cost-effective: Water pumps can be a cost-effective solution for providing water in areas where a reliable water supply is not available.

Disadvantages

However, some disadvantages of water pumps include:

Cost: Water pumps can be expensive to purchase and install, depending on the type and capacity required.

Noise: Some types of water pumps can be noisy, which can be a problem in residential areas.

Maintenance: Regular maintenance is required to keep water pumps in good working order, which can be time-consuming and costly.
Energy consumption: Depending on the type and capacity of the water pump, it can consume a significant amount of electricity, leading to higher energy bills.

2.2.5 Battery

Battery is an electrochemical device that stores chemical energy and converts it into electrical energy through a chemical reaction. Batteries consist of one or more electrochemical cells, each composed of two electrodes (anode and cathode) separated by an electrolyte.

Working principle

A battery operates by converting chemical energy into electrical energy through electrochemical reactions. It consists of one or more electrochemical cells, each with two electrodes a positive cathode and a negative anode separated by an electrolyte. When the battery is connected to a circuit, a chemical reaction occurs between the electrodes and the electrolyte, releasing electrons from the anode and creating a flow of electrical current through the external circuit to the cathode. This flow of electrons provides electrical power to devices.

Figure 13 Battery [14]

Advantages

The key advantages of batteries (we use a secondary battery)
Reusability: Users can recharge and reuse secondary batteries multiple times, reducing the need for frequent battery replacements and saving money in the long run **[15]**
Environmental Friendliness: Secondary batteries help minimize environmental waste and pollution by reducing the number of disposable batteries that people throw away.
Cost Savings: Although secondary batteries may have a higher initial cost than primary batteries, users can achieve cost savings over time by recharging them multiple times.

Versatility: Secondary batteries are available in various chemistries and sizes, making them suitable for multiple applications, from small electronic devices to large vehicles**.**

Disadvantages

The main disadvantages of batteries

Limited Lifespan: Despite being rechargeable, secondary batteries have limited charge-discharge **cycles before they degrade and lose capacity.**

Charging Time: Secondary batteries typically require longer charging times compared to the quick and easy replacement of primary batteries, which can be inconvenient for users with immediate power needs.

Memory Effect: Some secondary batteries, such as nickel-cadmium batteries, are susceptible to memory effect, where the battery gradually loses capacity if not fully discharged before recharging.

Safety Concerns: Certain secondary battery chemistries, such as lithium-ion, can be prone to overheating and even catching fire or exploding if damaged or improperly handled, posing safety risks to users.

2.3 Related study

Gao, Liu, and Zhou [16], (2020), in their "Comparative Analysis of Soil Moisture Sensors for Precision Agriculture" conducted a comparative analysis of various soil moisture sensors, including resistive, capacitive, and dielectric types. Their study provided insights into the performance, accuracy, and cost-effectiveness of these sensors under different soil conditions, what is not enough. So, for future work the researches should focus on the long-term reliability of these sensors.

Wei Yichang, Wang Zhenying, Wang Tongchao, et al [17], (2013), in their "Design of real time soil moisture monitoring and precision irrigation systems" developed a real time soil moisture monitoring and precision irrigation systems for precision of agriculture. The system aimed to improve irrigation practices by delivering real-time feedback on soil moisture levels. For future work the researches should investigate the development of more energy-efficient data transmission methods to enhance the system's functionality and sustainability.

Zhang, Wang and Liu [18], (2021), in their "A Hybrid Soil Moisture Sensing System for Sustainable Agriculture" developed a hybrid soil moisture sensing system that combined capacitive and resistive sensor technologies to improve measurement accuracy. The system was designed to support sustainable agricultural practices by providing reliable soil moisture data. Future work should evaluate the long-term performance of the hybrid sensor system under various environmental conditions and explore the potential for integrating additional sensing capabilities for comprehensive soil monitoring.

Kumar, Patel and Singh, [19], (2019) in their "Real-Time Soil Moisture Monitoring and Irrigation Management Using IoT Technologies" developed a real-time soil moisture monitoring system using Internet of Things (IoT) technologies to manage irrigation effectively. Their system aimed to enhance water use efficiency by providing real-time moisture data and automated irrigation control. For future work, the researches should explore improving the system’s scalability for large agricultural fields and investigate methods for enhancing data accuracy and security in IoT-based monitoring systems.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter describes the methods used to design and implement our project of plant moisture monitoring system.

3.1 Research Design

A research design provides a structured approach to evaluate the effectiveness, reliability and environmental impact of plant moisture monitoring system compared to the rudimentary methods of plant monitoring.
[20] The history of plant moisture monitoring systems traces a path from simple, manual methods to advanced, automated technologies. In the mid-20th century, early techniques such as electrical conductivity sensors and tensiometers were employed to gauge soil moisture. Electrical conductivity sensors estimated moisture indirectly by measuring the soil's ability to conduct electrical current, while tensiometers assessed soil water tension to infer moisture levels. These methods provided foundational insights but were limited by their indirect measurement approaches and the need for manual operation. A significant advancement came in the late 20th century with the introduction of capacitance sensors, which allowed for direct and continuous measurement of soil moisture by detecting changes in the soil's dielectric properties. This innovation marked a pivotal shift towards more accurate and reliable monitoring systems. The early 21st century saw further advancements with the integration of data logging and automation systems, enabling real-time data collection and remote monitoring. The integration of wireless communication and Internet of Things (IoT) technologies has since revolutionized soil moisture monitoring, facilitating sophisticated, automated irrigation systems that optimize water use based on precise soil moisture readings. These technological advancements have significantly improved agricultural practices by enhancing water use efficiency, increasing crop productivity, and reducing environmental impact.

3.2 Research population

The population studied was composed of two specific soil types: dry soil and moist soil. This selection of soil types was intended to illustrate contrasting moisture retention characteristics. Dry soil, known for its rapid drainage and low moisture retention, and moist soil, which provided a balance between moisture retention and drainage, offered a varied basis for evaluating the effectiveness of the plant moisture monitoring system.

3.3 Sample Size

The sample size for this study was determined to ensure robust and meaningful results. For each soil type, a sample of 2 soil samples was used. This figure was based on a power analysis that took into account the magnitude and variability of the expected effect, ensuring that the study had sufficient power to detect significant differences in humidity levels between the two types of soil.

3.3.1 Sampling Procedure

The sampling procedure utilized stratified random sampling to ensure that both soil types, dry and moist, were appropriately represented. Each soil type served as a distinct stratum, and within each stratum, 2 soil samples were randomly selected. This approach ensured that the sample accurately reflected the diversity within each soil type, minimized bias, and provided a robust basis for evaluating the performance of the plant moisture monitoring system across different soil conditions.

3.4 Research Instruments

3.4.1 Choice of the research instrument

The choice of research instrument for a plant moisture monitoring system depends on several factors, including the specific objectives of the study, the environmental conditions, and the technological capabilities available.

The choice of research instrument for a plant moisture monitoring system depends on several factors, including the specific objectives of the study, the environmental conditions, and the technological capabilities available. Instrument Selection: The primary research instrument is a soil moisture sensor system. This choice is based on the sensor’s ability to provide accurate, real-time measurements of soil moisture levels. The system features continuous data logging, which facilitate precise monitoring and analysis. Specifications for the sensor system include a wide measurement range, high accuracy, and low drift. This instrument was selected for its reliability in capturing detailed moisture data and its capability to handle the varying moisture levels in different soil types.

3.4.2 Validity and Reliability of the Instrument Validity

Validity and reliability were essential criteria for evaluating the effectiveness of instruments used in plant moisture monitoring systems. The validity and reliability of the plant moisture monitoring system were crucial to ensure accurate and consistent soil moisture measurements. Validity related to how well the system measured the specific parameter it was intended to assess, which was soil moisture. This involved ensuring that the sensor accurately captured moisture content in different soil types and conditions, and comparing these results with those of established methods such as the Touch and Feel method for assessing soil moisture by examining its texture and appearance. Dry soil was crumbly and dusty, while wet soil was soft and stuck. Although this method was less precise, it was useful for rapid and qualitative evaluations. Reliability, on the other hand, referred to the consistency of system measurements over time and under different conditions. This involved ensuring that the system provided stable readings for the same moisture levels at different times (test-retest reliability). To maintain both validity and reliability, it was essential to test the system's performance in different environments. Together, validity and reliability assessments provided assurance that data collected from plant moisture monitoring instruments were accurate, consistent, and reliable, thereby supporting effective water management decisions and sustainable agricultural practices.

3.5 Data Gathering procedures

Data gathering procedures for our plant moisture monitoring system involved systematic methods to ensure accurate and reliable data collection. Data was collected by deploying the soil moisture sensor of the Plant Moisture Monitoring System in samples from both soil types (dry and wet). This sensor was installed in the different soil pots one after the other, ensuring proper placement and consistent depth to obtain accurate moisture readings of the different soils. Measurements were recorded over a predetermined period to capture trends in humidity levels. After data collection, the data was compared for accuracy to ensure the reliability of the system.

3.6 Data Analysis and Interpretation

Data analysis involved statistical methods to evaluate the performance of the soil moisture monitoring system. Specifically, an analysis of variance was used to compare moisture levels between the two soil types: dry and wet. This helped determine if there were significant differences in moisture retention between the soil types. Additionally, regression analysis was employed to examine the relationship between soil moisture levels and any influencing factors, such as environmental conditions.

3.7 Ethical considerations

When testing our plant moisture monitoring system, ethical considerations focused on the responsible use of resources and impact on the environment. The study ensured that the soil and plants involved were treated ethically, with minimal disruption to their natural state. This included maintaining proper care throughout the study to avoid damage to plants and soil. The study also complied with environmental regulations by ensuring that any equipment used did not have a negative impact on the ecosystem. These measures helped ensure that the research was conducted with integrity and respect for the environment.

3.8 Limitations of the study

The study faced several limitations that could have affected the results and their interpretation. One potential limitation was the accuracy of the plant moisture sensor. Variation in sensor performance impacted the reliability of the moisture measurements. Another limitation was the variability in soil conditions, which might have affected moisture readings and introduced variability in the data. Additionally, the study's scope was limited to specific soil types and controlled environments, which may not have fully represented natural or diverse field conditions. Future research could have expanded the study to include different soil types and real-world conditions to enhance generalizability. Acknowledging these limitations helped contextualize the findings and guided the interpretation of the results within the constraints of the study.

CHAPTER 4: SYSTEM DESIGN, ANALYSIS AND IMPLEMENTATION

4.0 Introduction

In this section, we present the development and testing of the prototype for the design and implementation of plant moisture monitoring system, we provide a detailed description of components used in the prototype and the testing procedures employed to evaluate its performance.

4.1 Drawings and Simulation

4.1.1 Block diagram

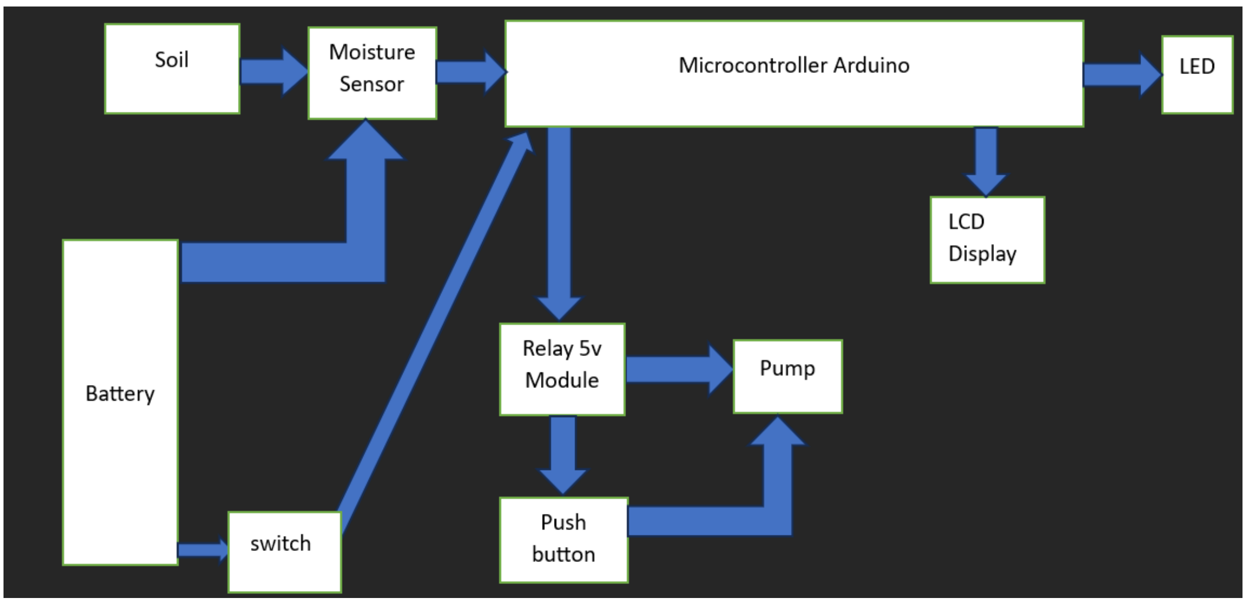

Figure 14 Block diagram

This block diagram illustrates the connections among the components of our plant moisture monitoring system.

As indicated, a battery provides the necessary electricity, and a switch allows us to turn the system on and off. The soil moisture sensor detects the moisture level of the soil and sends an analog signal to the Arduino, which converts it to a digital signal. This digital signal is then used to control several components:

LED: The LED remains off when the soil has adequate moisture and turns on when the soil is dry.

LCD Display: The LCD shows the soil status (dry or wet), the current humidity level, and the project designer's name.

Relay: The relay controls the pump based on the Arduino's signal. It turns the pump on when the soil is dry and off when the soil is wet.

Additionally, a push button is connected to the pump, allowing for manual activation if the system was defected.

4.1.2 Circuit diagram

The following circuit diagram depicts a thorough detail on how we have connected all components for implementation.

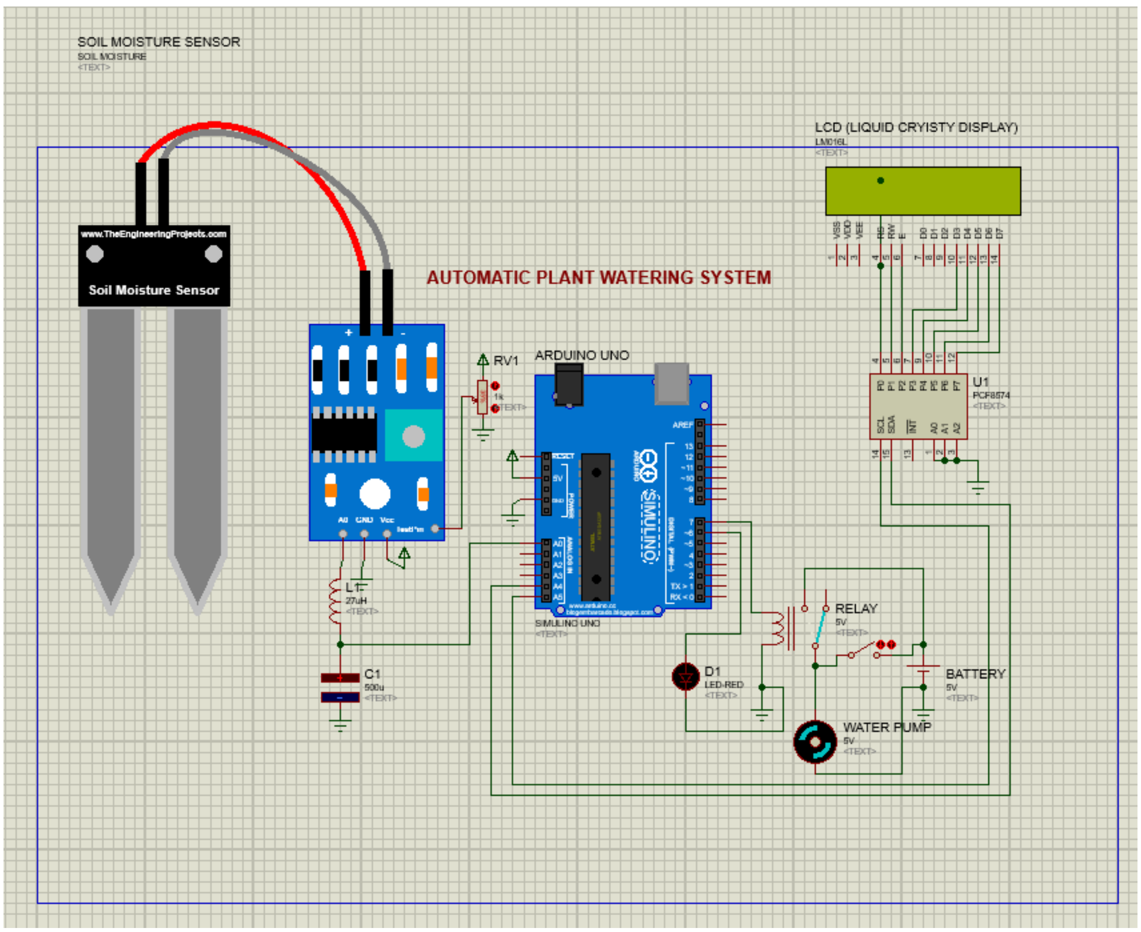

Figure 15 Circuit Diagram

4.1.3 Simulation

4.1.3.1. Program

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x20,20,4);
int LiquidCrystal_I2C(13,12,11,10,8);// pins of lcd_I2C
int soilMoisturePin = A0;// pin of sensor soil moisture it connected to A0
int ledPin = 6;
int Relay = 7;
void setup() {
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0,0);
  lcd.print("Made in Megane");
pinMode(ledPin, OUTPUT);
pinMode(Relay, OUTPUT);
}
void loop() {
  int sensorValue = analogRead(soilMoisturePin);
Serial.print("Moisture: ");
Serial.println(sensorValue);
if (sensorValue>800) {
    digitalWrite(ledPin, HIGH);
    digitalWrite(Relay, HIGH);
    lcd.setCursor(0, 1);
    lcd.print("Dry : ");
    lcd.print(sensorValue);
  }  else {
    digitalWrite(ledPin, LOW);
    digitalWrite(Relay, LOW);
```

```
    lcd.setCursor(0, 1);
    lcd.print("Wet :  ");
    lcd.print(sensorValue);
  }
delay(100);
}
```

4.1.3.2. Flowchart

This section showed the flowchart that explain briefly the working principle of our project.

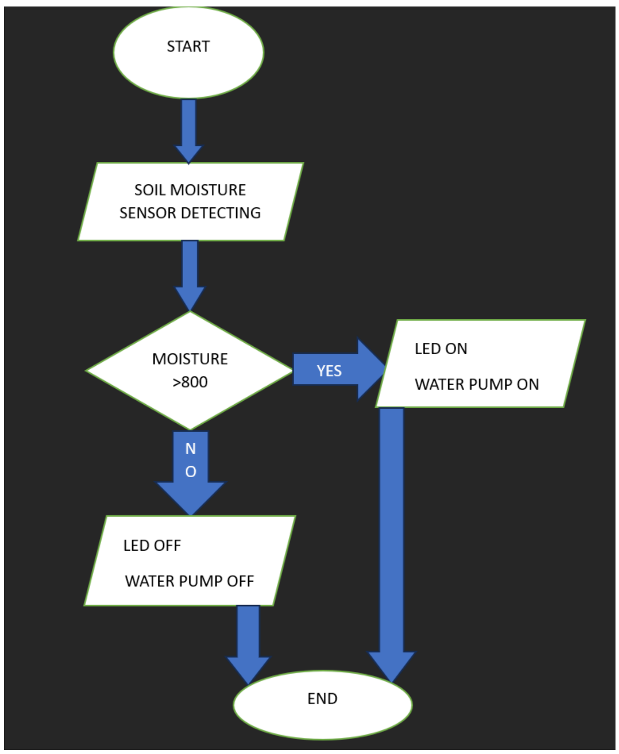

Figure 16 Flowchart

4.1.3.3. Simulation results

This section presents the simulation results of the project.

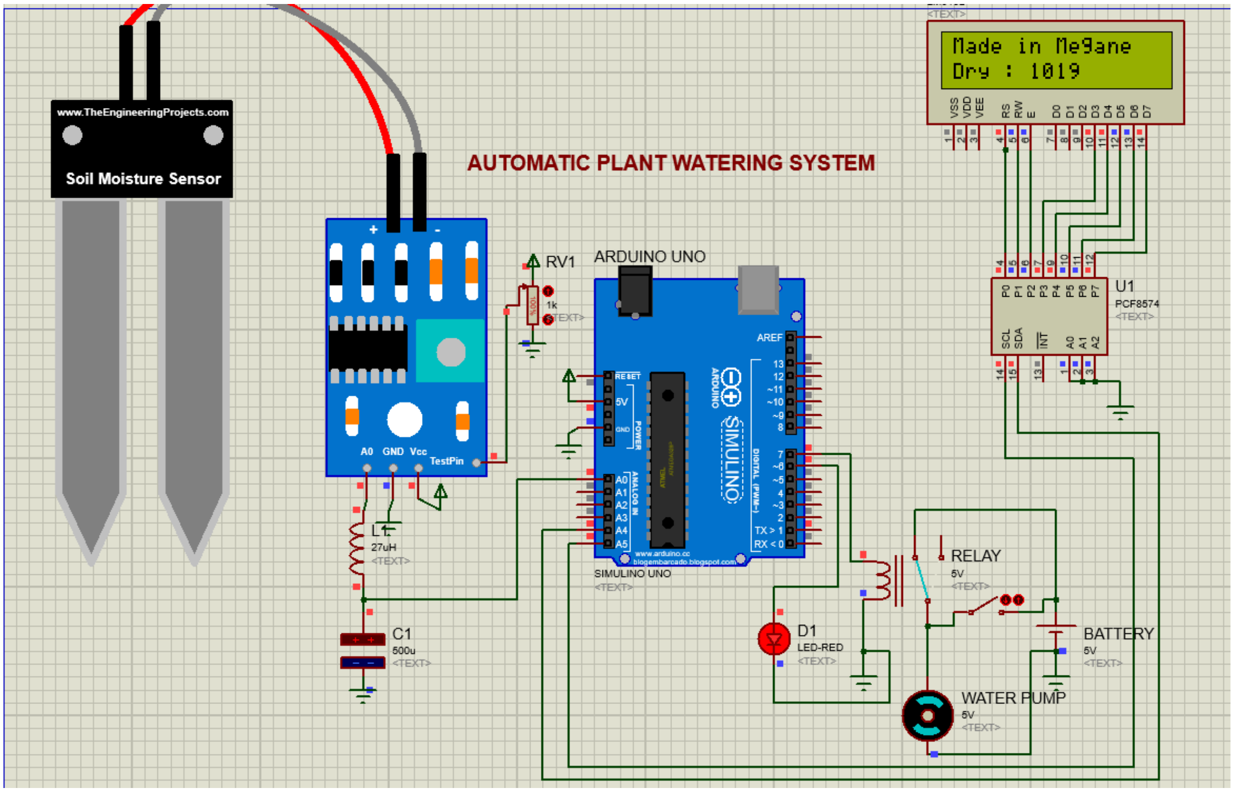

Figure 17 Simulation schema LED and Pump ON

The figure showed the simulation of our plant moisture monitoring system using Proteus software. We observed that when the moisture value of potentiometer (which represented soil) exceeded 800, indicating that the soil was dry, the pump remained active and the LED stayed on.

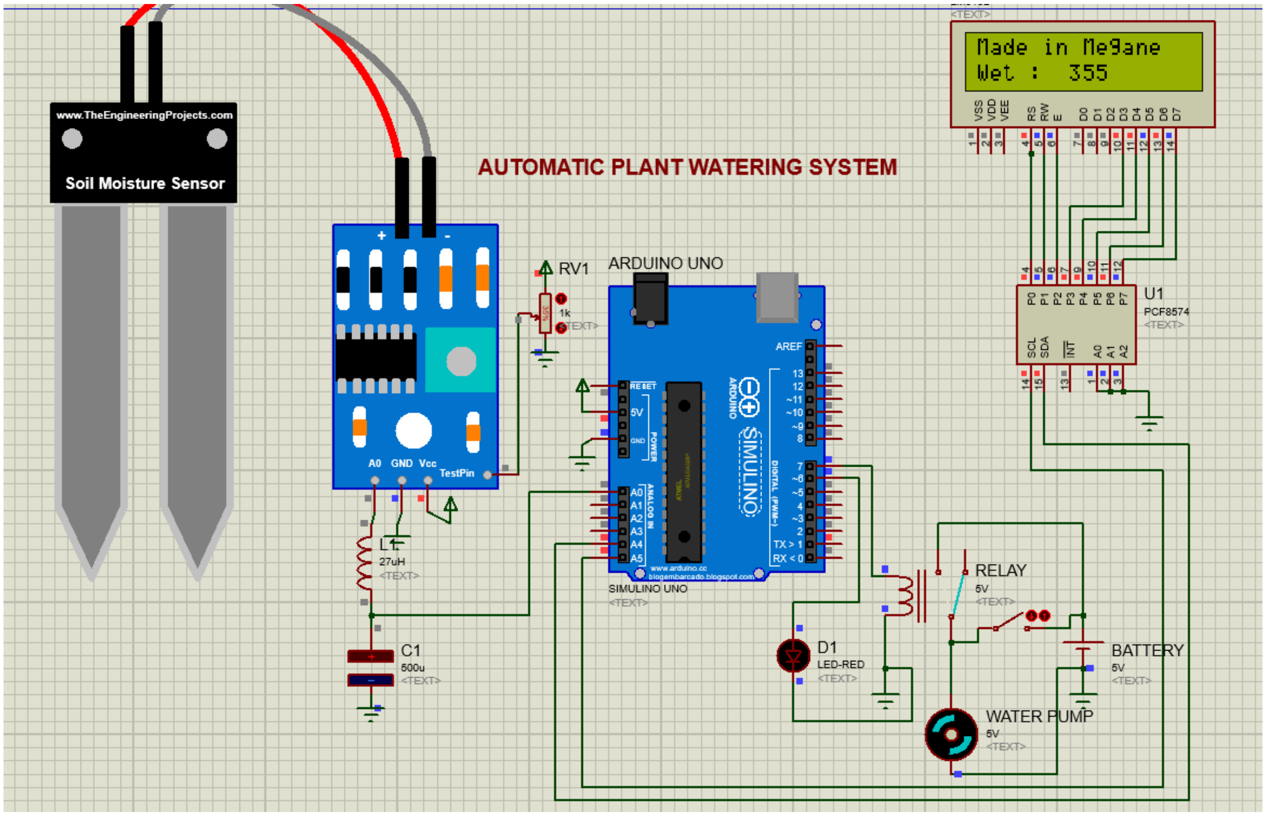

Figure 18 Simulation schema LED and Pump OFF

The figure showed the simulation of our plant moisture monitoring system using Proteus software. We observed that when the moisture value of potentiometer (which represented soil) was below 800, indicating that the soil was wet, the pump remained inactive and the LED stayed off.

4.2 Specifications

Types of components,

Soil moisture sensor

Operating Voltage: 3.3V to 5V DC

Operating Current: 15mA

Output Digital – 0V to 5V, Adjustable trigger level from preset

Output Analog – 0V to 5V based on infrared radiation from fire flame falling on the sensor

LEDs indicating output and power

PCB Size: 3.2cm x 1.4cm

LM393 based design

Microcontroller (Arduino UNO board)

Microcontroller: ATmega328P

Operating Voltage: 5V

Input Voltage (recommended): 7-12V

Input Voltage (limit): 6-20V

Digital I/O Pins: 14

PWM Digital I/O Pins: 6

Analog Input Pins: 6

DC Current per I/O Pin: 20mA

DC Current for 3.3V Pin: 50mA

Flash Memory: 32KB

Clock speed: 16 MHz ATmega328P

16x2 LCD Display

Display capacity: 16-character x 2 row

Display color: Blue backlit

Character size: 2.95 mm wide x 4.35 mm high

Character pixels: 5 W x 7 H

Voltage requirements: 5 VDC

Current requirements: 2 mA

White text on the blue background

Led

Color: Red

Diameter: 3mm

Voltage: 1.8-2.2V

Current: 5mA - 17.5mA

Relay 5V module

Supply voltage: 3.75V to 6V

Quiescent current: 2mA

Current when the relay is active: ~70mA

Relay maximum contact voltage – 250VAC or 30VDC

Relay maximum current – 10A

Mini water pump

Operating voltage: 2.5-6V DC

Working current: 130-220mA

Maximum delivery height: 40-110 cm

Delivery rate: 80-120 liters / h

Battery

Nominal Voltage: 6v

Rated Capacity (Ah Rating): 4.5Ah

4.3 Implementation

This section showed the real situation on what happened with our topic on ground. The following figures depict two scenarios where those scenarios were presented.

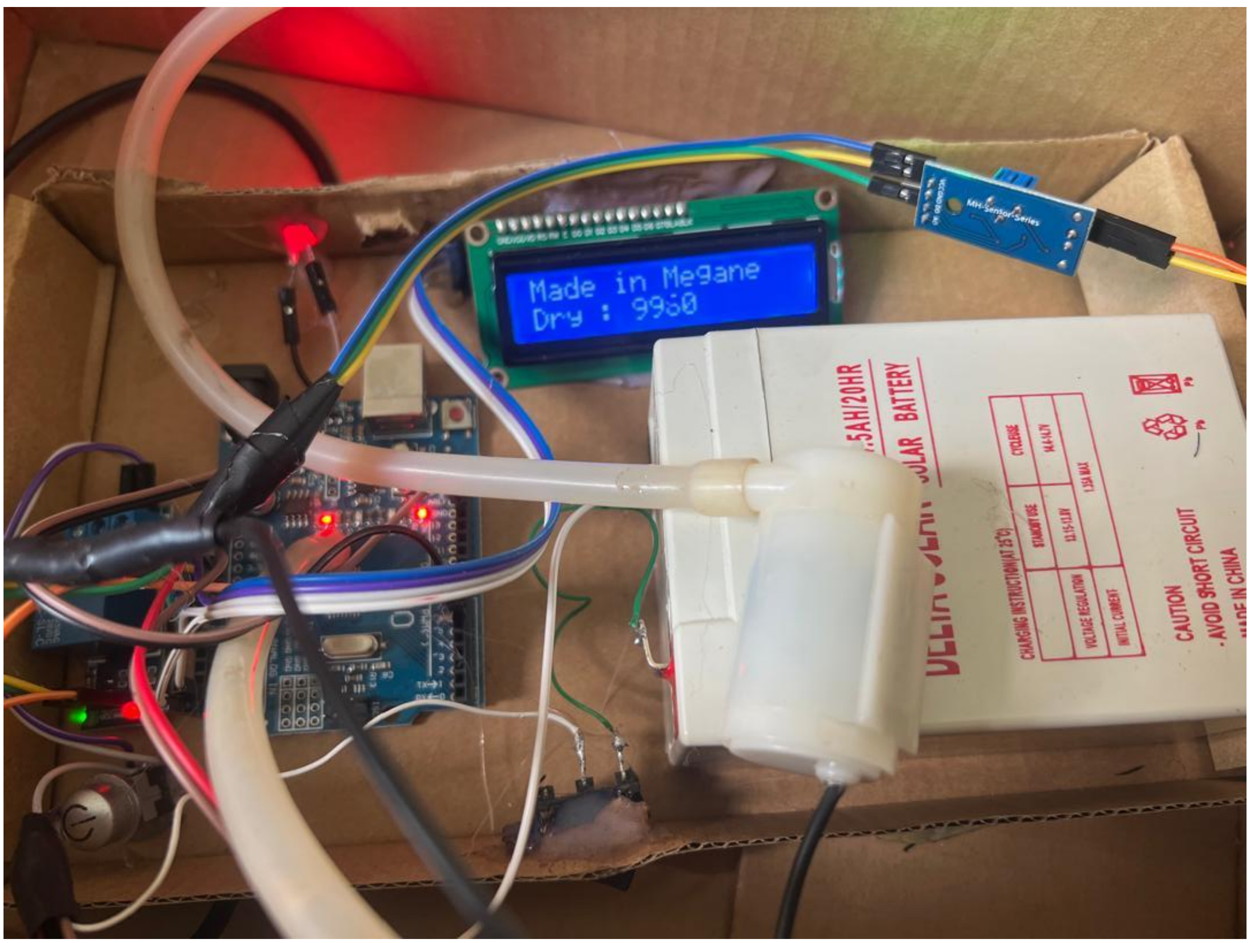

Figure 19 Scenario for a dry soil

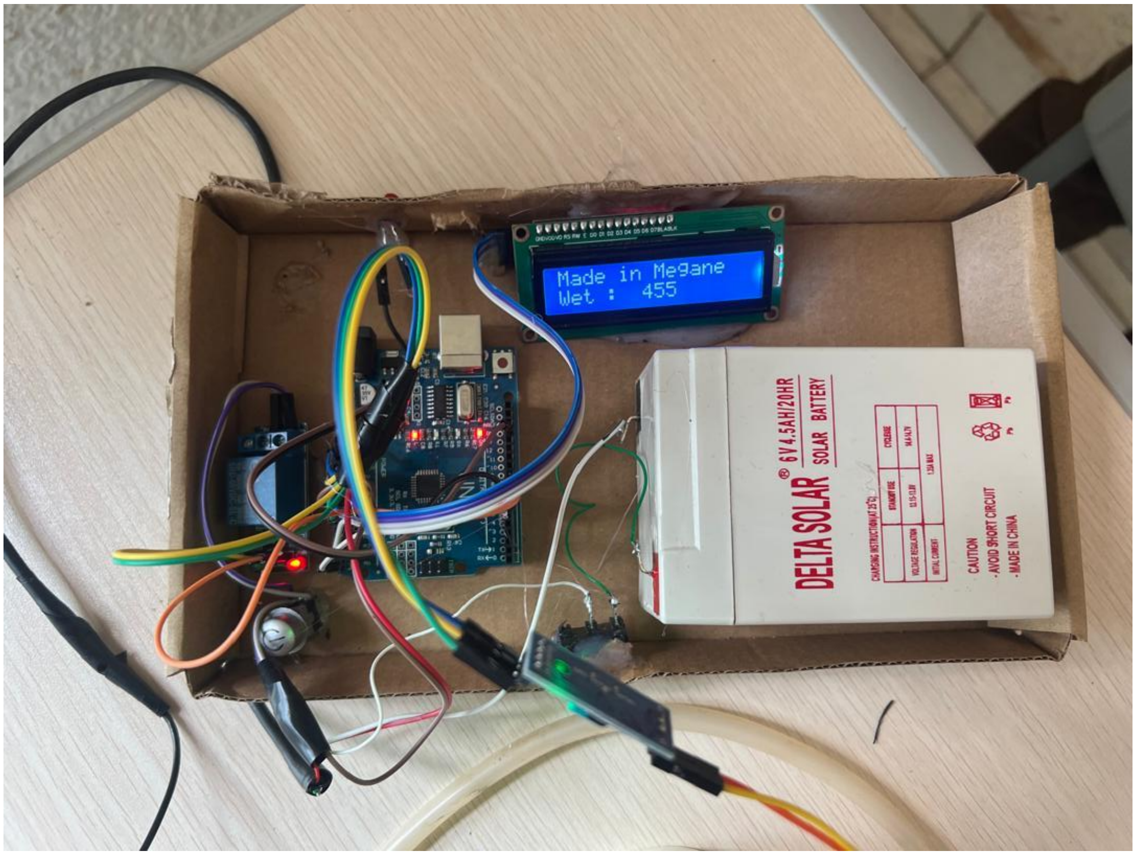

Figure 20 Scenario for a wet soil

Working principle

Soil Moisture Sensing:

The soil moisture sensor typically has two probes that are inserted into the soil. It measures the resistance between these probes.

When the soil is dry, the resistance is high. When the soil is wet, the resistance is low. The sensor converts this resistance into a voltage signal that is sent to the Arduino.

Arduino Processing:

The Arduino reads the analog voltage from the soil moisture sensor using one of its analog input pins.

The analog signal is converted to a digital value (using the ADC, Analog-to-Digital Converter) which can be used to determine the moisture level.

The Arduino can be programmed with a threshold value. When the moisture level falls below this threshold (indicating dry soil), the Arduino will activate the water pump to water the soil.

Water Pump Control:

The water pump is typically controlled via a relay module. The Arduino can send a signal to the relay to switch the pump on or off.

The relay isolates the low-voltage Arduino circuit from the high-voltage pump circuit, ensuring safe operation.

Connections

Soil Moisture Sensor:

VCC (Voltage Common Collector): Connect to Arduino 5V.

GND (Ground): Connect to Arduino GND.

Analog Output: Connect to one of the Arduino analog input pins (e.g., A0).

Relay Module:

VCC: Connect to Arduino 5V.

GND: Connect to Arduino GND.

IN (Input): Connect to one of the Arduino digital output pins (e.g., D7) that will control the relay.

COM (Common): Connect to one terminal of the water pump.

NO (Normally Open): Connect to the power supply positive terminal.

Water Pump: Connect the other terminal of the pump to the power supply ground.

Led:

IN: connected to D6

GND: connected to Arduino GND

Push Button(manually): It activated water pump when system was defected.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the concluding remarks and recommendations stemming from the development and evaluation of the plant moisture monitoring system. The findings and implications discussed herein aim to summarize the project's outcomes, suggest areas for improvement, and propose directions for future research.

5.1 Conclusion

In conclusion, despite encountering challenges such as a faulty LCD display due to problematic Arduino code and the high cost of components, the plant humidity monitoring system developed in this project effectively met its research objectives. The primary goal was to design and implement a reliable system for monitoring plant humidity, which was successfully achieved through a methodical approach involving sensor and microcontroller technology. The system was tested using two types of soil: wet and dry. Observations showed that when the soil was dry, the LED indicator illuminated and the pump activated, providing water to the dry soil. Conversely, when the soil was wet, the LED turned off and the pump remained inactive, signaling that no additional watering was needed. So basically, this system efficiently communicated soil conditions by turning on the LED and activating the pump for dry soil, and by turning off the LED and deactivating the pump for wet soil.

5.2 Recommendations

Based on our experience in our research, and also based on findings and challenges met, we recommend to:

The Government of Rwanda:

To provide grants or funds for young researchers interested in agriculture sector so that they can stay focusing on how to improve this sector based on novel technology as most of Africa population depends on agriculture incomes.

ULK Polytechnic Institute

To facilitate students in their final year projects so that they can get enough equipment for design and implementation.

Also, based on time constraints, we recommend UPI Institute Administration, to provide enough time without other modules so that they can make more improvement on their projects.

5.3 Suggestions for further study

For young researchers who will be interested with our research, we suggest them to work on this project by using multi-sensor Integration so that they can make improvement on its automation.

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APPENDICES

Appendix A: Software used

Arduino

Proteus 8 professional

Appendix B: System Design Diagrams

Block Diagram: A high-level diagram showing the main components of the moisture monitoring system and their interactions.

Simulation Schematics: Detailed electrical schematics of sensor connections, microcontroller wiring, and power management.

Appendix C: Components Prices

COMPONENTS	PRICES
1: Soil moisture sensor	9000 rwf
2: Micro controller (Arduino board)	15000 rwf
3: 16x2LCD Display with I2C Interface	10000 rwf
4: Wires	7000 rwf
5: Relay 5v module	3000 rwf
6: Pipes	5000 rwf
7: Water pump dc motor	15000 rwf
8: Battery 5v	15000 rwf
TOTAL AMOUNT	79000 rwf

Appendix D: List of Abbreviations

ADC: Analog-to-Digital Converter

VCC: Voltage Common Collector

GND: Ground

IN: Input

COM: Common

NO: Normally Open