ULK POLYTECHNIC INSTITUTE

POBOX 2280 KIGALI

Website: //www.ulkpolytechnic.ac.rw

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION: ELECTRICAL TECHNOLOGY

DESIGN AND IMPLEMENTATION OF AN AUTOMATIC PLANT MOISTURE

Research project submitted in partial fulfillment of the requirement for the award of an Advanced Diploma in Electrical Technology of ULK Polytechnic Institute

Submitted By: NSHIMIYIMANA Placide

Roll number: 202150023

Supervisor: Eng. KARANGWA Augustin

Kigali, September 2024

DECLARATION A

I, NSHIMIYIMANA Placide declare that this final year project titled **“Design and implementation of an automatic plant moisture monitoring and driver system”** is presented in partial fulfillmentof the requirements for award of Advanced Diploma. It is entirely our own work and has not been submitted to any other higher education institution, or college as a whole or in part. Where use has been made of the work of other people, it has been fully acknowledged and fully referenced.

Student Name: NSHIMIYIMANA Placide

Roll number: 202150023

Signature………………………………

Date………. /………. /…………….

DECLARATION B

I confirm 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 as the UPI supervisor.

Supervisor Name: Eng. KARANGWA Augustin

Sign: ____________________________

Date: _________________

DEDICATION

I dedicate this work to:

Almighty GOD,

My family members, my brothers and sisters,

My classmates and friends,

My supervisor for the support he gave me,

All the teaching staff that have helped me during the studies,

AKNOWLEDGEMENT

I would like to express my gratitude to the almighty God for blessing me with strength and courage to complete this project. From the beginning until the end of this project, I have so many people who stand by me; gives guidance for every obstacle that stand in my way. Therefore, we would like to express my deepest appreciation to those involved in this project.

I would like to express my gratitude and to my project supervisor Eng. **KARANGWA Augustin** who had showered me with ideas and guidance through the whole time the last second. I will never forget all your sacrifices and only God could ever repay that you have done for me.

Finally, yet importantly, I cannot forget to thank ULK Polytechnic Institute administration

ABSTRACT

An original way to automate plant disease control and irrigation is the Automatic Plant Moisture Monitoring System. This system monitors and controls the moisture content of the soil using an LCD display, relays, moisture sensors, and an Arduino microcontroller. A water pump is activated to irrigate the plants automatically when the water content falls below a certain threshold, which is monitored by moisture sensors placed in the soil. There is less chance of overwatering or under-watering because to this real-time response that makes sure the plants get the right amount of water. By streamlining irrigation management, the technology relieves users of the requirement for ongoing manual monitoring. The system has a second pump that is especially made to guard against fungal infections in addition to irrigation. The purpose of this pump is to spray the plants with an antifungal solution on a periodical basis. This characteristic keeps the plants healthy and disease-free by preventing fungal infections, which are common in humid areas. Without continual human intervention, the monthly spraying helps to maintain a preventive approach to plant health. Users can track the moisture content of the soil in real time by viewing the data from the moisture sensors on an LCD screen. Users may remain informed about plant conditions and system operation thanks to this easy-to-read display. This technology offers farmers and gardeners an effective, user-friendly way to prevent fungal diseases and automate irrigation. It is a useful tool for contemporary agricultural methods because it conserves time, water, and fosters stronger plants.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVEATION

ADC: Analog Digital Converter

CPU: Central Processing Unit

DAC: Digital Analog Converter

HOD: Head of Department

TTL: Transistor Transistor Logic

USB: Universal Serial Bus

DC: Direct Current

PWM: Pulse Width Modulation

CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

One of the most important things in guaranteeing plant health and increasing agricultural production is maintaining ideal soil moisture. Reduced productivity, subpar crop production, and even plant death can result from over- or under watering. Irrigation and soil moisture monitoring have historically been done by hand, which is frequently labor intensive, ineffective, and prone to human error [1]. Improper watering practices can also result in significant water waste in areas where water conservation is essential. The Automatic Plant Moisture Monitoring System was created as a solution to these problems. With the integration of contemporary moisture-sensing technology and automated control mechanisms, this system enables autonomous watering based on soil moisture levels and real-time monitoring.

This technique is particularly useful in regions where preserving agricultural output and environmental health depends on sustainable water use. Because human operations are inefficient, conventional irrigation systems have the potential to squander large amounts of water [2]. This issue is handled by the Automatic Plant Moisture Monitoring System, which continuously measures the water content of the soil using moisture sensors. Based on predetermined moisture levels, an Arduino microcontroller receives data from these sensors and decides when to turn on the irrigation pump. A relay in the system initiates a water pump to irrigate the plants when it senses that the soil moisture level has dropped below a predetermined level. According to Brown and Blackwell [3], this automation reduces the need for human intervention and guarantees that plants receive enough water at the appropriate moment.

This system has a second pump that is intended to stop fungal infections in addition to managing irrigation. In humid conditions, fungus infections are frequent and can seriously harm plants. In order to lessen this, the system periodically roughly twice a week activates the second pump, which sprays antifungal solutions over the plants to offer a layer of protection [4]. The system's dual purpose guarantees adequate hydration and disease prevention, which promotes healthier plants and higher harvests. The system also has an LCD display that lets users see the soil moisture levels in real time. This makes it simple to track system performance and change settings as needed. This technology allows for time and water savings, as well as the promotion of healthier plants by automating the avoidance of fungal diseases and irrigation. Its incorporation of dependable elements like Arduino, moisture sensors, and relays renders it a proficient resolution for contemporary farming methodologies. All things considered, the Automatic Plant Moisture Monitoring System offers an affordable and easy-to-use answer to the persistent problems associated with effective water management and plant maintenance.

1.1 Statement of the problem

Maintaining optimal soil moisture is crucial for plant health, yet traditional manual methods are inefficient and give errors. This often leads to over- or under-watering, resulting in issues such as root rot, stunted growth, and reduced crop yields. Efficient irrigation management is particularly challenging in large-scale or resource-constrained environments, where manual monitoring is impractical and inconsistent. There is also a need for periodic antifungal treatments to protect plants from these diseases, which is challenging to manage manually.

1.2. Objectives of the study

1.2.1. Main objective

The main objective of this research project is to entitled design **and implementation of an automatic plant moisture monitoring system.**

1.2.2. Specific objectives

i. To Accurately measure soil moisture levels using sensors for irrigation.
ii. Automate irrigation with sensors and a relay-controlled water pump.
iii. Periodically spray antifungal solutions to prevent leaf diseases.

1.3 Research Questions

1) What are the most effective sensor technologies for accurate soil moisture measurement?
2) How can the moisture sensing system be integrated with irrigation controls for optimal performance?
3) How can the antifungal spraying system be automated to ensure consistent application and reduce manual labor?

1.4 Scope and limitation of the Study

1.4.1Scope

In order to prevent leaf diseases, the main objective of this study is to create and implement an Automatic Plant Moisture Monitoring System that monitors soil moisture levels, controls irrigation, and sporadically sprays antifungal treatments. By combining soil moisture sensors with irrigation controls and antifungal treatment methods, the system seeks to provide the best possible plant health and hydration. The research entails the selection of suitable sensor technologies, the development of automated systems for spraying antifungals and irrigation, and system validation in a range of environmental settings.

1.4.2 Limitations

The study is limited to the application of the system in specific types of plants and soil conditions, which may not encompass all plant species or soil types. The effectiveness of the moisture sensors and antifungal spraying mechanism may be influenced by environmental factors and sensor calibration issues. Additionally, the study does not address the long-term reliability and maintenance needs of the system. Testing might be constrained by practical challenges in replicating diverse real-world environmental conditions and varying plant health scenarios.

1.5 Organization of the study

This work is mainly composed by three chapters whereby:

Chapter 1: general introduction which explain all the project

Chapter 2: is the literature review this chapter is deal with the information about all components we used in our project.

Chapter 3: Research methodology which is deals with the methods and steps will be used to design and implementation of an automatic plant moisture monitoring system

Chapter 4: System, design analysis and implementation which is deals with system design and implementation of an automatic plant moisture monitoring system.

Chapter 5: is the conclusion and recommendation to my project

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides a detailed review of the research and hardware requirements that supported the development of our project, “design and implementation of an automatic plant moisture monitoring system.” Throughout our work, we explored various related projects to gain insight into alcohol detection technologies and vehicle safety systems. These references helped us acquire essential skills and knowledge on how to implement effective detection mechanisms. This chapter also outlines the hardware requirements used by others who developed similar systems. By examining previous research and applications, we identified key strategies and technologies to improve driver safety through alcohol detection, providing an in-depth understanding of the tools and techniques we utilized in our project.

2.2 Hardware requirements

2.2.1 Introduction

This part consists of the discussion about the basics of electronic elements and electrical devices that are joined together in order to achieve the desired result during the design and implementation of an automatic plant moisture monitoring system. Although there are several electronic and electrical elements and devices, this chapter will focus on those which are included with irrigation technology as the purpose of project. The concept contains both summaries and explanations of complete or current state of knowledge on text, theories related this topic and study made earlier which are similar the descriptions of work done before that found in books upon this subject. The entire system adopted the Arduino Uno Microcontroller Board (based on ATMEGA 328). The core functions modules are Arduino Uno, moisture Sensor, pump, relay and LCD.

2.2.2 Microcontroller

2.2.2.1 Introduction

Arduino is an open source microcontroller, which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, Employees and professionals to create devices that interact with their environment using sensors and actuators.

Based on simple microcontroller boards, it is an open source - computing platform that is used for constructing and programming electronic devices. It is also capable of receiving and sending information over the internet with the help of various Arduino shields, which are discussed in this paper. Arduino uses a hardware known as the Arduino development board and software for developing the code known as the Arduino IDE (Integrated Development Environment).

Built in microcontrollers can be programmed easily using the C or C++ language in the Arduino

Figure 1: Arduino Uno (Gianluca Martino)

2.2.2.2 Arduino pins

The Arduino Uno is a microcontroller board based on the ATmega328. It is a programmable micro controller for prototyping electromechanical devices. You can connect Digital and Analog electronic signals:

It has 14 digital Input / output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic Resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features theAtmega16U2 (Atmega8U2up to version R2) programmed as a USB to-serial converter. The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduino of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

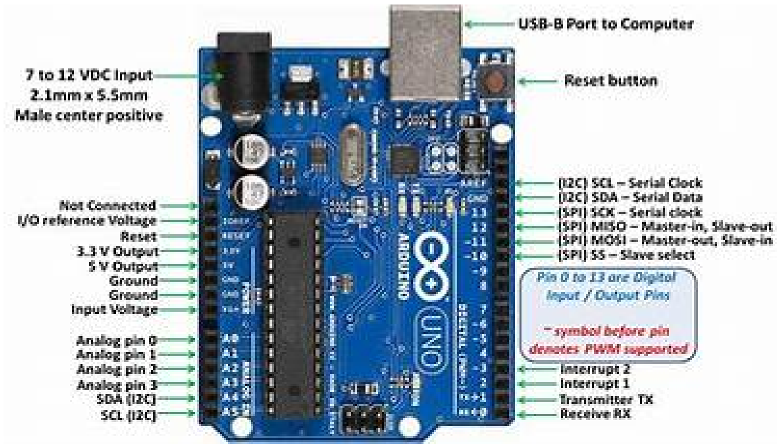

Figure 2: Arduino uno pins

2.2.2.3 Main Pin functions

- LED: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- VIN: The input voltage to the Arduino/Genuine board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuine board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

2.2.2.4 Special pin Functions

Each of the 14 digital pins and 6 Analog pins on the Uno can be used as an input or output, using pinMode (), digital Write (), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference () function.

In addition, some pins have specialized functions:

- Serial: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM (Pulse Width Modulation) 3, 5, 6, 9, 10, and 11 Can provide 8-bit PWM output with the analog Write () function.
- SPI (Serial Peripheral Interface): 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- TWI (Two Wire Interface): A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.
- AREF (Analog Reference: Reference voltage for the analog inputs. (leonardo, 2018)

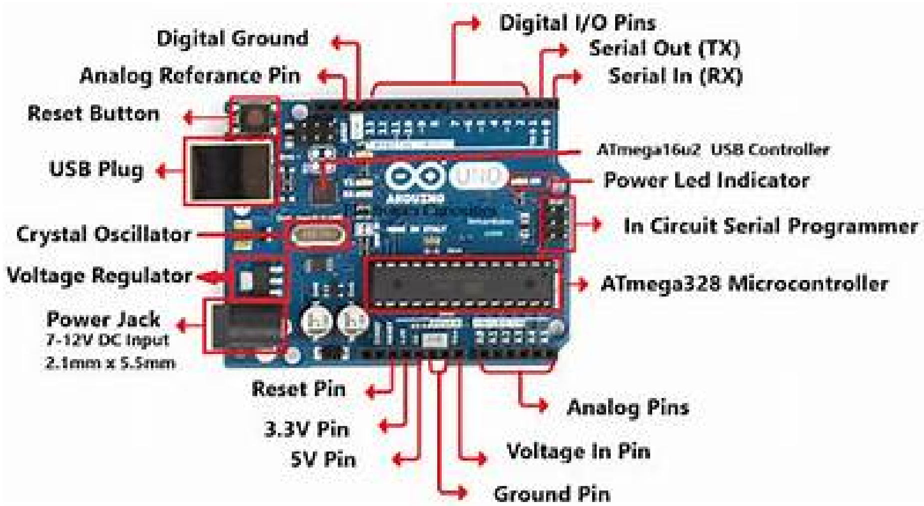

Figure 3: Special pin Functions of Arduino Uno

2.2.3 Soil moisture sensor

2.2.3.1 Introduction to soil moisture sensor

This is a soil moisture sensor, it is used for measuring the moisture in soil and similar materials.It is often used in automated irrigation systems.

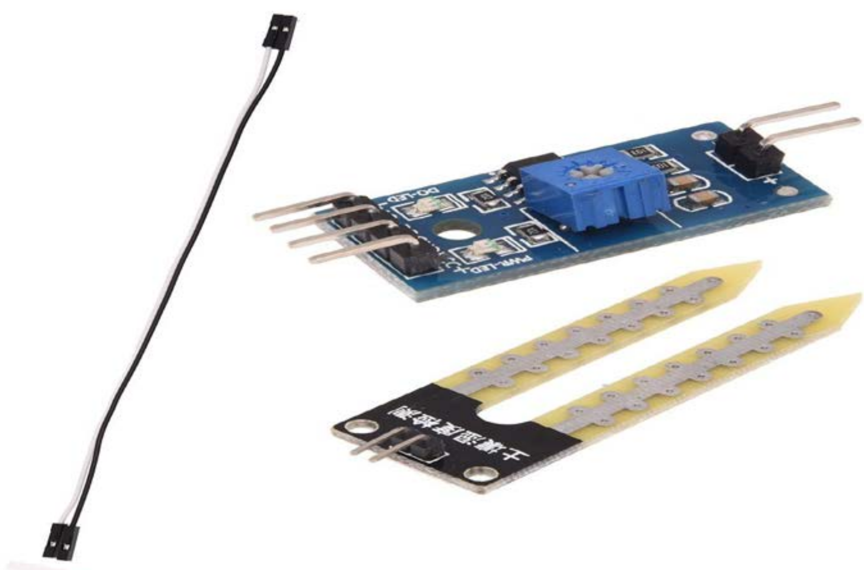

Figure 4: soil moisture sensor

Soil moisture module is most sensitive to the ambient humidity is generally used to detect the moisture content of the soil. The digital output D0 can be connected directly with the microcontrolle**r.**

2.2.3.2 Interface

VCC: 3.3V-5V

GND: GND

DO: digital output interface (0 and 1)

AO: analog output interface

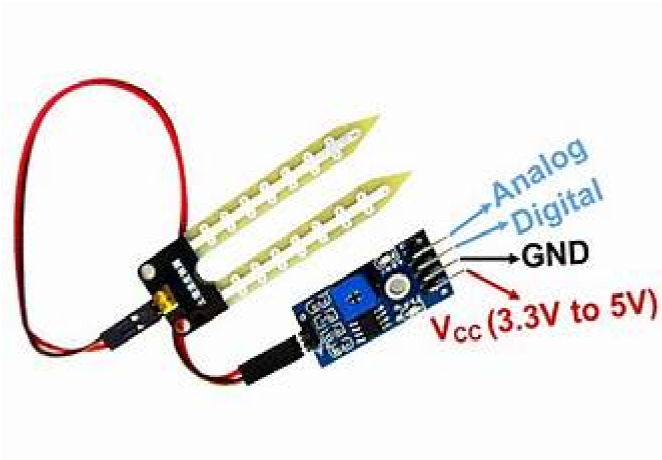

Figure 5: soil moisture sensor pins

2.2.5. DC Water pump

A water pump is a mechanical device designed to move water from one location to another by creating a pressure difference. It operates by drawing water into an inlet and expelling it through an outlet, utilizing mechanical force to facilitate the flow. Water pumps are crucial in various applications, including irrigation systems, water supply networks, and industrial processes. They come in different types, such as centrifugal pumps, which use a rotating impeller to move water; diaphragm pumps, which use a flexible diaphragm to create flow; and gear pumps, which use interlocking gears to move fluids. Water pumps can be powered by electricity, gasoline, or other energy sources, depending on the application and required flow rate.

Figure 6: DC water pump

2.2.6 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over segments and other multi segmented. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special &even custom characters(unlike in seven segments),animations and so on. A 16x2 LCD means it can display 16 characters per line and there are two such lines. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD

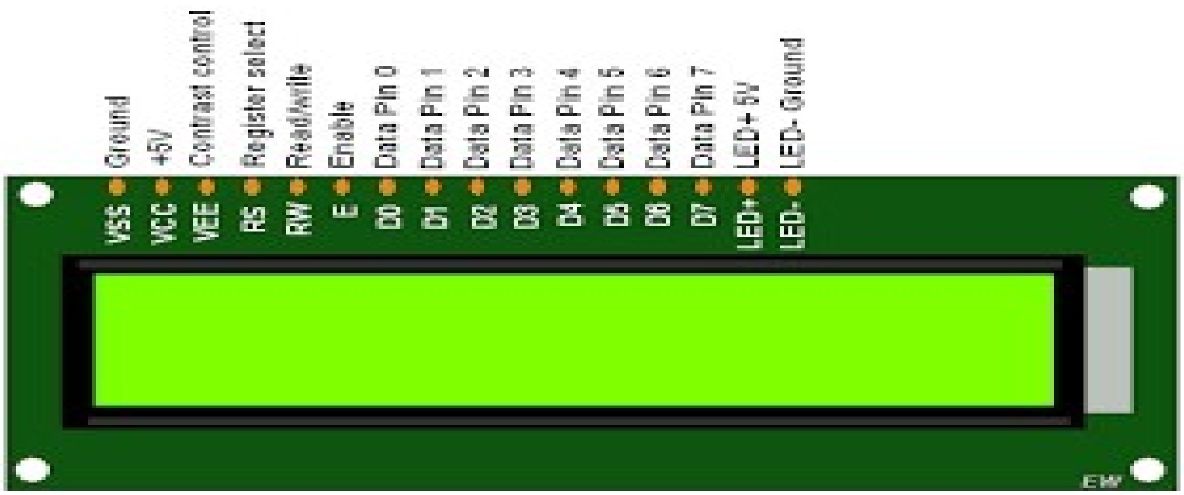

Figure 7: Liquid Crystall Display

an LCD (Liquid Crystal Display) serves as the primary interface for communicating critical information to the driver. The LCD can display real-time feedback on the driver's alcohol level, indicating whether it is safe to drive or if the vehicle is immobilized due to alcohol detection. It can also show alert messages, such as warnings to stop the vehicle, instructions to retry the breathalyzer test, or system status updates for example an Alcohol Detected or Engine Disable. The clear visual output provided by the LCD enhances user interaction, making the system more intuitive and informative for the drive.

2.2.7 Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations.

Figure 8: relay

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays are electrically operated switches that open and close the circuits by receiving electrical signals from outside sources

2.2.8 PCB (printed Circuit Board)

A printed circuit board (PCB; also printed wiring board or PWB) is a medium used to connect electronic components to one another in a controlled manner. It takes the form of a laminated sandwich structure of conductive and insulating layers: each of the conductive layers is designed with an artwork pattern of traces, planes and other features (similar to wires on a flat surface) etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate. Electrical components may be fixed to conductive pads on the outer layers in the shape designed to accept the component's terminals, generally by means of soldering, to both electrically connect and mechanically fasten them to it. Another manufacturing process adds plated-through holes that allow interconnections between layers.

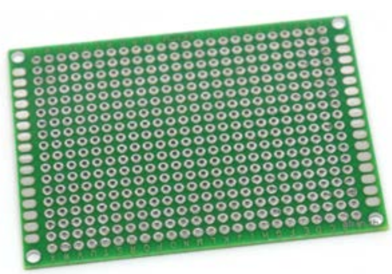

Figure 9: PCB (Printed Circuit Board)

2.3 Related works

a system that uses sensors to track soil moisture levels can automatically irrigate plants. The purpose of the system is to increase the efficiency of plant care by only turning on a water pump when the soil moisture content falls below a certain level. This method ensures that plants get enough moisture while also helping to conserve water. The hardware configuration, which includes the sensors and microcontroller, is covered in the paper along with the software algorithms that regulate the watering schedule in response to real-time soil moisture data [5].

a wireless sensor network-based irrigation system that uses the Internet of Things to track environmental parameters and soil moisture levels. The system makes use of sensors that are wired to a central microcontroller. This microcontroller sends data for real-time analysis to a cloud-based platform. This intelligent irrigation system optimizes water use and enhances crop health by modifying water distribution in response to soil moisture content and meteorological variables. The system architecture, including sensor integration, data transmission, and the user interface for remote control and monitoring, is described in full in the article [6].

Examine the creation of an Arduino-based smart plant monitoring system. This system combines a number of sensors to track temperature, light levels, and soil moisture content, giving detailed information on the health of plants. IoT protocols are used to transfer the data to a cloud platform so that it may be examined and displayed. The benefits of remote monitoring and automated responses to environmental changes for improved plant care are highlighted in the study, along with the usage of Arduino microcontrollers for sensor interface and data processing [7].

Explain a method for detecting soil moisture in real time that is intended to automate irrigation procedures. Soil moisture sensors are used in the system to continuously monitor the moisture content and send the data to a central control unit. The technology initiates an irrigation mechanism to restore soil moisture when moisture levels drop below a predetermined threshold. The integration of automated irrigation and real-time monitoring is highlighted in this research, with an emphasis on the system's dependability and effectiveness in preserving the ideal soil conditions for plant growth [8].

Suggest an Internet of Things (IoT)-based greenhouse monitoring system that tracks environmental variables like temperature, humidity, and soil moisture using a variety of sensors. With the use of a cloud-based platform, the system provides real-time data collecting and analysis, giving exact control over greenhouse conditions. The deployment of sensors and communication modules, along with the creation of an intuitive user interface for remote monitoring and management, are all covered in this paper. The goal of this intelligent system is to enhance plant growth results and optimize greenhouse conditions [9].

CHAPTER 3. RESEARCH METHODOLOGY

3.1. Introduction

The methodology was a systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. While gathering information from different people of how they think my project will resolve, with the help of Class notes, internet, documentation, observation, lecturers' notes, etc. Which they have been mainly to accomplish our project.

3.2. Methodology

The methodology for designing and implementing the Automatic Plant Moisture Monitoring System involves several critical steps. Initially, we select and integrate key components, including the Arduino Uno for processing, soil moisture sensors for data collection, relays and water pumps for automated irrigation, and an LCD display for real-time monitoring. A secondary pump was included for periodic antifungal treatments to prevent leaf diseases. The system's circuitry is designed and assembled, followed by programming the Arduino to manage sensor data and control the pumps. Calibration ensures accurate moisture readings and effective irrigation. Testing involves evaluating the system with various soil types and moisture levels. The project relies on research from technical resources, collaboration with peers, and guidance from instructors and supervisors to refine and validate the system's performance.

3.3 Research design

In order to obtain satisfactory outcomes, we have used different methods and techniques for carrying out this research and data collection. This will be done by taking references and consultation with those having more experiences such as facilitators, classmates, different views done by researchers and internet.

3.4 Research Instrument

In order to collect data, I had used experiment, observation, documentary and internet was be used.

3.5 Research choice instrument

3.5.1 Documentary review

Documentation was a data collection instrument based on reading books and other documents related to the research subject in order to get the background of the situation to analyze and find out information of the studies on similar topic. Documents refer to any written material that may be used as source of information about the subject in order to achieve the objective of the study. I have used this tool in time of collecting data through reading various documents such as, internet, books, and other relevant materials related to this project.

3.5.2 Experimental method

In this research instrument, I had used Arduino programming language and plot as for simulating the design and implementation of an automatic plant moisture monitoring system. Therefore, as our project is based on Arduino microcontroller it is required to develop Arduino program that will help to achieve the research objectives as the researcher have been mentioned in first chapter.

3.5.3 Data gathering procedures

Producing of data in the study I had focused for various resources like library books, class handout, classmates; some websites on the internet, as well as reports done by other researchers. Also, in this section, different researchers have been consulted for their ideas from the field, as we have been used different ideas from other researchers in order to collect all information, after collection those data we have implemented automatic irrigation using moisture sensor.

3.6 Data analysis and interpretation

To get information on design and implementation of an automatic plant moisture monitoring system. I have used variety documents to examine our project, books of electrical and electronics and other documents from different websites. In order to get all the relevant data information to this project, some methods of data collection procedures or techniques have been used for the collection of data, interviewers were carried out. The main respondent to these interviews was coming from the electrical and electronic engineering department.

3.7 Ethical consideration

This research project was be conducted by following the guidelines of ULK I therefore to have this project being implemented it will require to follow and to analyses the advices from our supervisor, facilitators, instructors and those who are qualified in electrical and electronic engineering with more experiences.

CHAPTER 4: SYSTEM DESIGN, ANALYSIS AND IMPLEMENTATION

4.1 Introduction

In this chapter, we will research the details of designing and implementing the system. During this phase, we transitioned from addressing issues within the problem domain to representing solutions within the solution domain. This chapter provides a complete account of the construction of the new system, joining innovative concepts to achieve the expected results.

4.2 Calculation

4.2.1 Soil Moisture Sensor

Voltage: Typically operates at 5V

Current: Approximately 20 mA (0.02 A)

P sensor=V×I=5V×0.02A=0.1 W (100 mW)

4.2.2 Relay Module

Voltage: Typically operates at 5V

Current: Approximately 15 mA (0.015 A) when activated

4.2.3. Water Pump

Voltage: 5V

Current: Depends on the pump; assume 500 mA (0.5 A) for a small pump

P pump=V×I=5V×0.5A=2.5 W

P relay=V×I=5V×0.015A=0.075 W (75 mW)

4.2.4 Arduino Power Consumption

The power consumption of the Arduino depends on the model, but let’s assume you're using a typical Arduino Uno. The relevant specs are:

Operating Voltage: 5V

Current Draw: Approximately 50 mA (0.05 A) when idle.

Power for the Arduino:

P arduino=V×I=5V×0.05A=0.25W(250mW)

4.3 Block Diagram

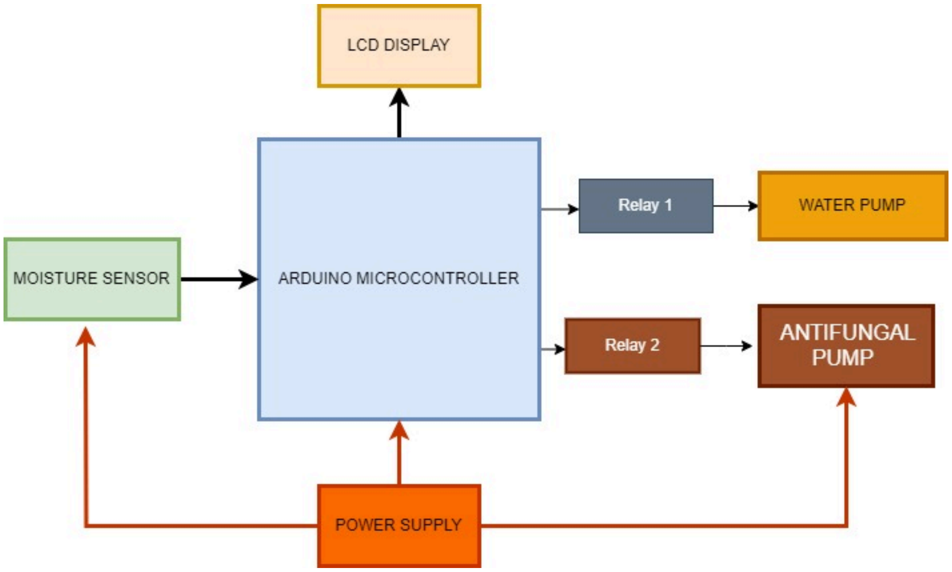

Figure 10: Block Diagram

The automatic plant moisture monitoring system utilizes an Arduino microcontroller to automate plant care by monitoring soil moisture levels and controlling water and antifungal treatment. A moisture sensor measures the soil's moisture content and sends the data to the Arduino, which processes it to determine if irrigation is needed. If the soil is dry, the Arduino activates Relay 1 to turn on the water pump, providing hydration. Similarly, Relay 2 controls the antifungal pump to deliver antifungal agents when required. An LCD display shows real-time information, such as moisture levels and system status. Powered by a central power supply, this system ensures efficient plant care, reducing the need for manual intervention and helping maintain optimal plant health.

4.4 Flowchart

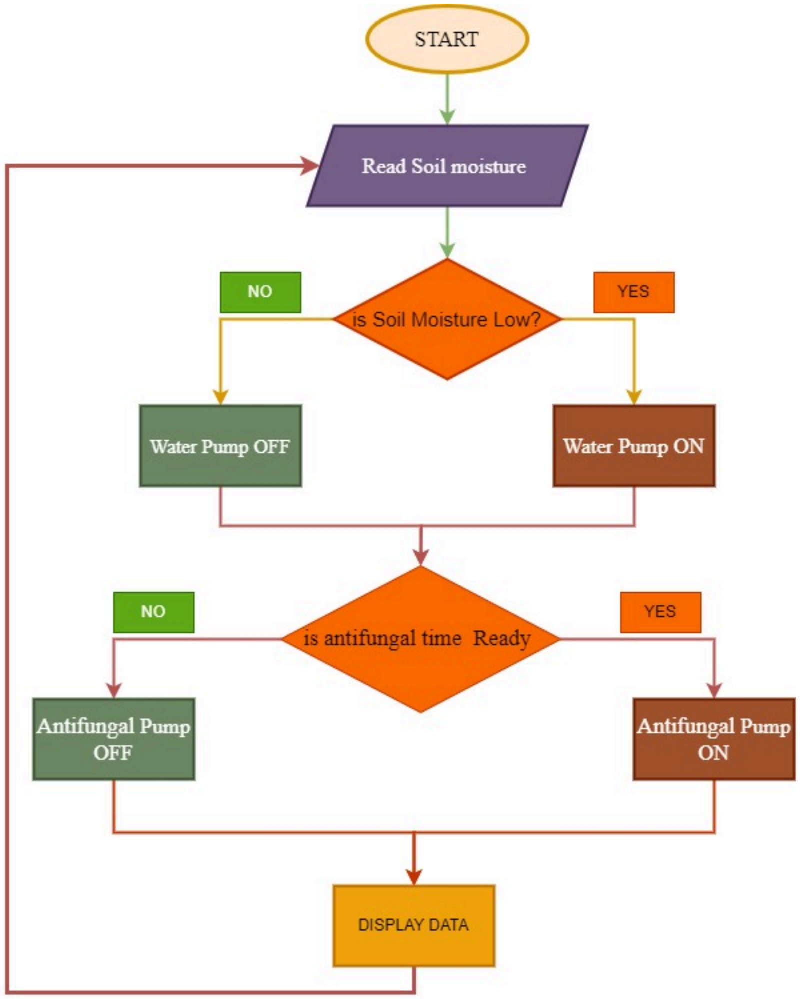

Figure 11: flowchart

The procedure of an automatic plant moisture monitoring system is shown in the flowchart, which begins with the sensor determining the soil moisture content. The system calculates whether the soil moisture content is low based on these facts. If this is the case, the water pump is turned ON to irrigate the plants; if not, it stays OFF. The system determines whether antifungal treatment is necessary after any period. The antifungal pump turns ON if antifungal treatment time is ready, if not it remains OFF. On an LCD display, the system then shows the current state and data, including soil moisture levels and pump operations. With the least amount of manual labor, this procedure guarantees that the plants receive water and antifungal treatment automatically, resulting in the best possible plant care.

4.5 Circuit Diagram

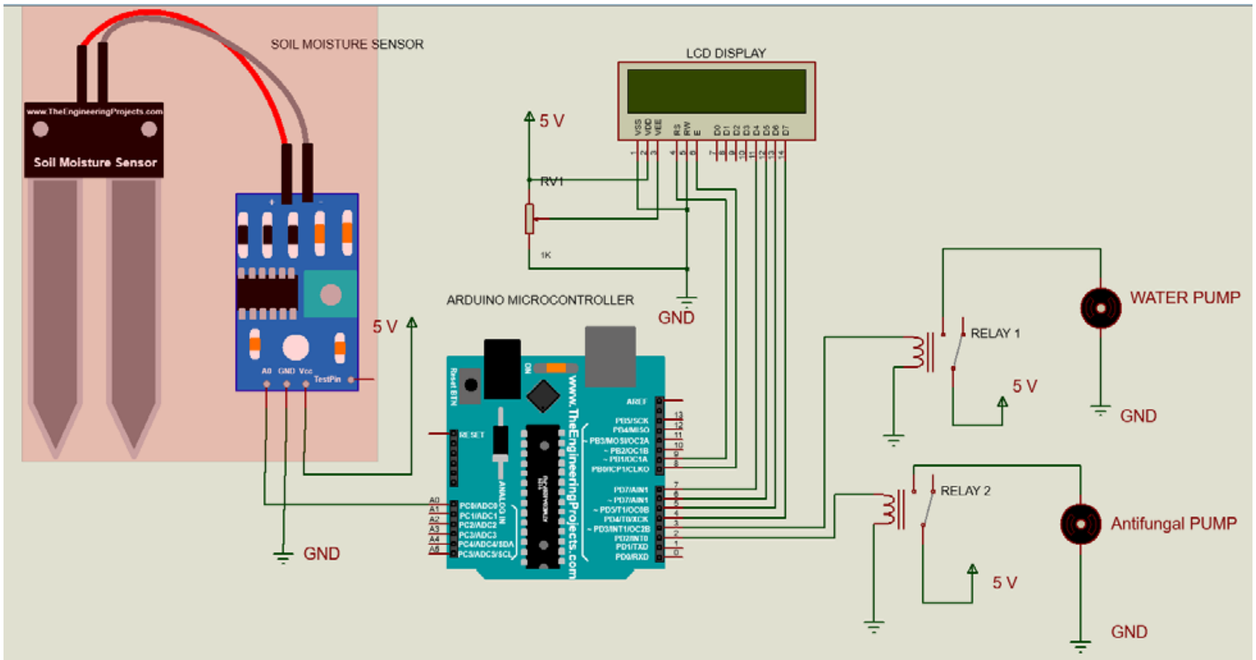

Figure 12: circuit diagram

4.5.1 working principle

The automatic plant moisture monitoring system connects various components to the Arduino microcontroller for efficient operation. The soil moisture sensor's VCC and GND are linked to the Arduino's 5V and GND, with its output connected to analog pin A0 to read soil moisture levels. The LCD display is wired using four data pins (D4-D7) connected to Arduino pins 2-5, with control pins RS and E connected to pins 12 and 11, and powered by the Arduino’s 5V and GND. Relay 1 and Relay 2, responsible for controlling the water and antifungal pumps, are powered via the 5V pin, with signal inputs connected to pins 8 and 9. This setup automates plant watering and antifungal treatment while displaying real-time data on the LCD screen.

4.6 components specifications

Table1: components specifications

No	name	specification
1.	Arduino uno	• Microcontroller: ATmega328 • Operating Voltage : 5V • Input Voltage (recommended): 7-12V • Input Voltage (limits): 6-20V • Digital I/O Pins : 14 (of which 6 provide PWM output) • Analog Input Pins: 6 • DC Current per I/O Pin: 40 mA • DC Current for 3.3V Pin: 50 mA • Flash Memory: 32 KB (ATmega328) of which 0.5 KB used by bootloader • SRAM : 2 KB (ATmega328) • EEPROM: 1 KB (ATmega328) • Clock Speed: 16 MHz
2	Soil moisture sensor	• VCC: 3.3V-5V • GND: GND • DO: digital output interface (0 and 1) • AO: analog output interfac
3	LCD display	• LCD display module with Yellow Backlight • SIZE : 16×2 (2 Rows and 16 Characters Per Row) • Can display 2-lines X 16-characters • Operate with 5V DC

		• Wide viewing angle and high contrast • Built-in industry standard HD44780 equivalent LCD controller • Commonly Used in: Student Project, Collage,copiers, fax machines, laser printers, industrial test equipment, networking equipment such as routers and storage devices • LCM type: Characters
4	Water pump	• Voltage : 2.5-6V • Maximum lift : 40-110cm / 15.75″-43.4″ • Flow rate : 80-120L/H • Outside diameter : 7.5mm / 0.3″ • Inside diameter : 5mm / 0.2″ • Diameter : Approx. 24mm / 0.95″ • Length : Approx. 45mm / 1.8″ • Height : Approx. 30mm / 1.2″
5	Relay	• 5V DC relay coil. It is equipped with high-current relay that work under AC250V 10A or DC30V 10A.

4.7. Cost estimations

Table2: cost estimations

S/N	Material/devices	quantity	Unity price	Total /price(FRW)
1	Arduino uno	1	15000	15,000frw
2	Soil moistue sensor	1	4,500	4,500 frw
4	pump	2	5,000	10,000 frw
5	Wires + cables	1 roll	5000	5000 frw
6	PCB	1	2000	2000 frw
7	Battery	1	10,000	10,000 frw
8	LCD	1	9,000	9,000 frw
9	Water pins	2m	2,000	4,000 frw
10	Buzzer	1	500	500 frw
11	Relay	2	2,000	1,000 frw
	Total			**70,500 frw**

4.8 Results and Discussions

Figure 13: prototype photo

This prototype is an automatic plant irrigation system, featuring an Arduino microcontroller, moisture sensor, water pump, and antifungal pump. The system automates plant watering based on soil moisture levels, activating when levels fall below a set threshold (40%). Additionally, the antifungal pump operates periodically to prevent disease. The LCD display shows real-time moisture readings and system status, making it an efficient, user-friendly solution for maintaining plant health.

Figure 14: soil, water and antifungal containers

This setup consists of three containers: one for the plant with a moisture sensor, one for irrigation water with a pump, and another for an antifungal solution with a second pump. The moisture sensor monitors the soil, triggering the water pump when moisture is low, while the antifungal pump operates periodically. This system automates plant care, ensuring optimal hydration and fungal prevention, providing an efficient solution for maintaining plant health.

Figure 15: all system

This image above shows an automatic irrigation system with a plant and moisture sensor, two containers for water and antifungal solution, and a microcontroller with an LCD. The moisture sensor monitors soil levels, triggering the water pump when moisture is low. The antifungal pump operates periodically to prevent plant diseases. The LCD displays real-time data, making this an efficient solution for automating plant care and health maintenance.

CHAPTER 5. CONCLUSION AND RECOMMANDATION

5.1. Conclusion

With its powerful solution for enhancing plant care through automated watering, the "design and implementation of an automatic plant moisture monitoring system" project represents a significant leap in agricultural technology. This research has shown how well sensors, microcontrollers, and wireless communication can be combined to monitor and control soil moisture levels in real time. The technology guarantees that plants receive enough water by automating the irrigation process, which promotes growth and saves resources. The project offered a great chance to hone technical abilities in data management, sensor integration, and system design, among other areas. Supervisors' advice and cooperative efforts made it possible to successfully execute a workable approach that might improve agricultural practices both domestically and abroad. In general, this project demonstrates the possibilities.

5.2. Recommendation

In order to optimize the advantages of the "Design and Implementation of an Automatic Plant Moisture Monitoring System," academic establishments such as ULK Polytechnic Institute are advised to give priority to hands-on training and incorporate practical projects into their curricula. It is imperative that outstanding student projects receive support, which includes supplying the tools and materials required to get around the high cost of parts like microcontrollers and sensors. Furthermore, the Rwandan government's enhanced financing for advanced research and final-year students will encourage creativity and real-world applications. Additionally, the Ministry of Education ought to support and encourage student initiatives so that they can move from theoretical ideas to products that are ready for the market. By putting these strategies into practice, we may improve the technical and engineering workforce's practical abilities, foster significant technological developments, and successfully handle pressing agricultural issues.

References

[1] Brown, T., & Blackwell, S, Automated Irrigation Systems and Precision Farming, 2017.

[2] Gates, D, Water Conservation in Agriculture, 2020.

[3] Jones, M, Smart Agriculture and IoT-Based Systems for Sustainable Farming, 2018.

[4] Miller, P., & Rose, L, Disease Prevention in Horticulture, 2019.

[5] D. Gupta, A. Kumar, and R. Patel, Design and Implementation of an Automated Plant Watering System, 2019.

[6] M. Kumar, P. Sharma, and S. Singh, Smart Irrigation System Using IoT and Wireless Sensor Network, 2020.

[7] S. Yadav, R. Kumar, and N. Singh, Development of an IoT-Based Smart Plant Monitoring System Using Arduino, 2021.

[8] Patel et al, Real-Time Monitoring of Soil Moisture for Automated Irrigation System, 2022.

[9] Lee et a, IoT-Based Smart Greenhouse Monitoring System, 2021.

APPENDIX

APPENDICE A: Project code

```
#include <LiquidCrystal.h>

const int rs = 7, en = 6, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

const int analogInPin = A0;  // Moisture sensor pin
const int waterpump = A4;    // Water pump pin
const int spraypump = A5;    // Spray pump pin

int sensorValue = 0;         // Variable to store the sensor value
int moisturePercentage = 0;  // Variable to store moisture percentage
const int moistureThresholdPercent = 40;  // Threshold for moisture level in percentage
unsigned long previousMillis = 0;   // Variable to store the last time the spray pump was
activated
const long sprayInterval = 10000;  // Spray interval set to 10 minutes (600,000 ms)

void setup() {
  Serial.begin(9600);
  lcd.begin(16, 2);         // Initialize the LCD with 16x2 display
  lcd.print("Irrigation Sys"); // Initial message on LCD
  delay(2000);              // Display for 2 seconds
  lcd.clear();
}

void loop() {
  lcd.clear();  // Clear the LCD at the beginning of each loop

  // Reading the moisture sensor value
  sensorValue = analogRead(analogInPin);

  // Convert sensor value to percentage (0 to 100)
  moisturePercentage = map(sensorValue, 0, 1023, 100, 0);

  Serial.print("Moisture sensor = ");
  Serial.println(sensorValue);
  Serial.print("Moisture (%) = ");
  Serial.println(moisturePercentage);

  // Display the moisture percentage on the LCD
  lcd.setCursor(0, 0);
  lcd.print("Moisture: ");
  lcd.print(moisturePercentage);
  lcd.print("%   ");  // Added spaces to clear out extra characters if any
```

```
  // Water pump control based on moisture percentage
  if (moisturePercentage < moistureThresholdPercent) {
    analogWrite(waterpump, 255);    // Turn on the water pump if moisture is below 40%
    lcd.setCursor(0, 1);
    lcd.print("Watering...    ");
  } else {
    analogWrite(waterpump, 0);      // Turn off the water pump if moisture is 40% or above
    lcd.setCursor(0, 1);
    lcd.print("Moisture OK    ");
  }

  // Control the spray pump to spray medicine every 10 minutes
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= sprayInterval) {
    previousMillis = currentMillis; // Update the last activation time
    analogWrite(spraypump, 255);    // Activate the spray pump
     lcd.setCursor(0, 1);
    lcd.print("spraypump................");
    delay(5000);                    // Run the spray pump for 5 seconds
    analogWrite(spraypump, 0);      // Turn off the spray pump
  }

  delay(1000);  // Delay for 1 second before the next reading
}
```