Automated Plant Irrigation System

ABSTRACT—
This project focuses on developing an automated plant irrigation system using Arduino Uno, aimed at enhancing the efficiency of plant maintenance. The project employs a soil moisture sensor, a water pump, and an Arduino Uno microcontroller to detect the moisture level of the soil and water the plant when necessary. The system is designed to activate the water pump automatically when the moisture level falls below a predefined threshold. The project utilizes a straightforward yet effective approach to automate the plant watering process, which is cost-effective and sustainable. The system's potential to reduce water consumption and improve agricultural practices makes it a suitable solution for plant irrigation. The project's success highlights the importance of integrating technology with agriculture, paving the way for further advancements in sustainable agriculture practices.
Keywords-: Arduino Uno, Water pump, soil moisture sensor, Automated water plant irrigation system, Efficiency, Plant maintenance, Microcontroller, Moisture level.

3.INTRODUCTION

Automated plant irrigation systems have gained a lot of attention in recent years due to their potential to conserve water and improve plant growth. With the advancement of technology, these systems have become more sophisticated and efficient. The system involves monitoring the soil moisture level and providing water automatically when needed, eliminating the need for manual intervention.

In a study conducted by Mohamad et al. (2019), an automated irrigation system was developed using a microcontroller and soil moisture sensor. The system was able to maintain the soil moisture level within a specified range, resulting in improved plant growth and water conservation. Another study by Shinde et al. (2021) proposed a similar system using Internet of Things (IoT) technology, which allowed remote monitoring and control of the irrigation system through a mobile application.
These studies demonstrate the potential of automated plant irrigation systems to improve agricultural practices and conserve water resources. As such, this project aims to design and implement a cost-effective automated plant irrigation system using Arduino microcontroller and soil moisture sensor. By developing such a system, we hope to contribute to the ongoing efforts towards sustainable agriculture practices.

3.1 Background of study and Motivation:

Automated plant irrigation systems are becoming increasingly popular among farmers and gardeners. These systems are designed to automatically monitor and water plants, taking into account factors such as weather, soil moisture levels, and plant type. This has the potential to improve crop yields, reduce water waste, and reduce the amount of labor required for manual watering.
In recent years, there has been significant research into the development of automated plant irrigation systems. A study by Goyal and Gupta (2018) proposed a smart irrigation system that uses sensors to detect soil moisture levels and weather conditions, allowing for more efficient water usage. The system was tested on tomato plants and showed a 75% reduction in water usage while maintaining plant growth and yield. Another study by Hu et al. (2021) focused on using machine learning algorithms to optimize irrigation scheduling for potted plants. The system used a combination of sensors and machine learning models to predict the optimal time and amount of water needed for each plant. The results showed that the system was able to reduce water usage by up to 70% while maintaining plant health.

The aim of this project is to design and develop an automated plant irrigation system that utilizes sensors and machine learning algorithms to optimize water usage and improve plant growth. The system will consist of soil moisture sensors, weather sensors, and a microcontroller to collect and process data. Machine learning algorithms will be used to predict the optimal amount and time of watering for each plant. The system will be tested on a variety of plants, including vegetables and ornamental plants. The results will be compared to traditional manual watering methods to determine the efficiency and effectiveness of the system.

3.2 Project objective:

The objective of an automated plant irrigation system is to provide a consistent and efficient means of watering plants in a variety of settings, such as homes, farms, and gardens. The system must be designed to measure the moisture content of the soil and adjust watering cycles based on real-time data in order to prevent over- or under-watering. Additionally, the system should be equipped with a means of alerting users if there are any issues, such as low water pressure or mechanical failures. The primary goal of the automated plant irrigation system is to ensure that plants receive the proper amount of water needed for healthy growth and maximum yield without wasting water or requiring constant human intervention. Overall, the system should provide users with a convenient and reliable solution for watering their plants while promoting environmental sustainability and reducing water usage.

3.3 A brief outline of the report:

In this report, we will discuss the design and development of an automated plant irrigation system. The system is intended to provide an efficient solution to the problem of plant watering, especially for people who have busy schedules or are away from home for extended periods. The system will incorporate a variety of sensors and technologies to ensure accurate and precise watering while also conserving water resources.

Watering plants manually can be a time-consuming and labor-intensive task, and it can be difficult to ensure that plants receive the correct amount of water. Automated plant irrigation systems have become increasingly popular in recent years as a way to address these challenges. These systems typically use sensors to monitor the soil moisture levels and water the plants when necessary. Some systems may also incorporate weather data and other factors to optimize watering schedules and conserve water.

The automated plant irrigation system will consist of several key components, including sensors, a microcontroller, a water pump, and tubing. The sensors will be used to measure the moisture content of the soil as well as other environmental factors such as temperature and humidity. The microcontroller will act as the brain of the system, processing sensor data and controlling the water pump and other components. The water pump will be responsible for delivering water to the plants through the tubing.

The automated plant irrigation system will be designed to operate on a set schedule or based on sensor data. The system will monitor the soil moisture levels and water the plants as needed to ensure that they receive the correct amount of water. The system may also incorporate other factors, such as weather data, to optimize watering schedules and conserve water. The user will be able to set up the system and customize its settings, such as the watering schedule and the types of plants being watered.

The automated plant irrigation system offers several benefits and advantages over manual watering methods. First and foremost, it saves time and labor by automating the watering process. It also ensures that plants receive the correct amount of water, which can improve plant health and growth. Additionally, the system may help conserve water by using sensors to optimize watering schedules and reduce waste.

While the automated plant irrigation system offers many benefits, there are also some challenges and limitations to consider. One potential limitation is the cost of the system, which may be prohibitive for some users. Additionally, the system may require regular maintenance to ensure that it functions properly. There may also be limitations to the types of plants that can be watered with the system, as certain plants may require specialized watering methods.

The development of an automated plant irrigation system offers a promising solution to the challenges of manual plant watering. By incorporating sensors and other technologies, the system can provide accurate and precise watering while also conserving water resources. While there are some limitations and challenges to consider, the benefits of the system make it a worthwhile investment for many users.

4. LITERATURE RIVEW:

Automated plant irrigation systems have gained significant attention in recent years due to their potential to improve the efficiency and effectiveness of irrigation practices. These systems use sensors to monitor soil moisture levels and weather conditions, and automatically adjust the irrigation schedule and amount of water delivered to the plants. This literature review aims to provide an overview of the existing research on automated plant irrigation systems, including their benefits, limitations, and future directions for development. The review will also highlight the different types of sensors and control algorithms used in these systems, as well as their impact on plant growth, water usage, and sustainability. Overall, the review will demonstrate the importance of automated plant irrigation systems in the context of modern agriculture and the potential for their widespread adoption.

One study by (Ranga and sathish,2019) presented their own automated plant irrigation system using a microcontroller. Their system also incorporated soil moisture sensors, which triggered the microcontroller to turn on the water supply when the soil moisture fell below a certain threshold. the study found that the automated irrigation system was able to maintain optimal soil moisture levels, leading to improved plant growth and yield. Additionally, the system was able to save significant amounts of water compared to manual watering methods. Overall, the use of microcontrollers in automated plant irrigation systems has shown promising results in terms of improving crop yield and reducing water waste. As such, further research in this area is warranted to refine and optimize these systems for widespread use in agriculture [1]

The paper "Automatic plant watering system" by Mayuree et al. (2019) presents a solution to the problem of watering plants automatically using a microcontroller-based system. The authors state that the traditional method of manually watering plants is time-consuming and laborious. Furthermore, if plants are not watered on time, it can result in damage to the plants or even the death of the plants. Thus, an automatic plant watering system can solve this problem by ensuring timely watering of plants.
The paper presents a literature review on related works in the field of automatic plant watering systems. The authors highlight the significance of such systems and the need for their development. They also provide a brief overview of the existing automatic plant watering systems, including their advantages and disadvantages.
The authors highlight that existing automatic plant watering systems are either too complicated or too expensive, which limits their practical use. Therefore, they propose a simple and cost-effective solution for automatic plant watering. The authors also discuss the components of the proposed system, including a microcontroller, soil moisture sensor, water pump, and power supply. They explain the working of the system, where the moisture sensor detects the moisture level in the soil, and if the moisture level is below a certain threshold, the microcontroller activates the water pump to water the plants. In conclusion, the authors provide evidence that their proposed system is efficient and reliable, which could significantly reduce the time and effort required for plant watering. They suggest that their system can be useful in households, small gardens, and large-scale plantations. Overall, the literature review presented in this paper demonstrates the need for an automatic plant watering system and the potential of the proposed system in addressing this issue [2]

And The another article "Automatic Plant Watering System using Arduino and Moisture Sensor" by Islam et al. (2020) describes the development of an automatic plant watering system using an Arduino microcontroller and a moisture sensor. The purpose of the system is to eliminate the need for manual watering of plants, providing a cost-effective solution for ensuring optimal plant growth. The article begins by introducing the concept of automated plant watering systems and their importance in agriculture and gardening. The authors provide a brief overview of existing solutions for plant watering, such as drip irrigation and sprinkler systems, and highlight their limitations. They then propose the use of an Arduino microcontroller and a moisture sensor as a means of automating the plant watering process. The article goes on to provide a detailed description of the hardware and software components of the system. The authors explain how the moisture sensor works, and how it is used to determine the moisture level of the soil. They also describe the role of the Arduino microcontroller in controlling the watering process and the mechanisms used to deliver water to the plants. The article then presents the results of a series of experiments conducted to test the performance of the system. The authors report that the system is able to accurately detect the moisture level of the soil and adjust the watering frequency accordingly. They also demonstrate the effectiveness of the system in promoting plant growth, with plants in the test group growing faster and healthier than those in the control group. Finally, the article concludes by discussing the potential applications of the system in various fields, such as agriculture, horticulture, and home gardening. The authors suggest that the system has the potential to revolutionize the way we care for plants, providing an efficient and cost-effective solution for plant watering. Overall, the article provides a comprehensive overview of the design, development, and testing of an automatic plant watering system using an Arduino microcontroller and a moisture sensor. The study demonstrates the effectiveness of the system in promoting plant growth and highlights its potential for various applications [3]

The article "Automatic Plant Watering System Using Arduino and Moisture Sensor" by Sethumadhavan et al.(2021) discusses the design and implementation of an automatic plant watering system that utilizes an Arduino microcontroller and a moisture sensor to monitor and control the soil moisture level in plants. The paper provides a literature review that outlines the background information on plant watering systems, the various types of sensors used in these systems, and the role of microcontrollers in automating plant watering.

The authors begin by describing the importance of maintaining proper soil moisture levels in plants and the challenges associated with manual watering. They then provide an overview of the different types of automatic plant watering systems, including drip irrigation, sprinkler systems, and self-watering pots. The authors note that while these systems have proven effective in maintaining soil moisture levels, they can be expensive and difficult to install and maintain. The paper then focuses on the use of sensors in plant watering systems, specifically moisture sensors, which are commonly used to monitor soil moisture levels. The authors discuss the different types of moisture sensors available, including resistive, capacitive, and conductive sensors, and their advantages and disadvantages. They note that while resistive sensors are more commonly used, capacitive sensors are more accurate and less prone to corrosion. The authors then introduce the use of microcontrollers in plant watering systems, specifically the Arduino microcontroller, which is a popular open-source platform used in a variety of DIY projects. They discuss the advantages of using an Arduino, including its low cost, ease of programming, and flexibility. They note that the Arduino can be used to monitor sensor data, control water pumps and valves, and adjust watering schedules based on environmental factors. The paper then describes the design and implementation of the automatic plant watering system, including the hardware components used (Arduino UNO R3, moisture sensor, water pump, and solenoid valve) and the software program used to control the system. The authors also provide detailed instructions on how to assemble and test the system, as well as suggestions for future improvements. The paper provides a comprehensive overview of the use of sensors and microcontrollers in automatic plant watering systems, as well as a detailed description of the design and implementation of a specific system using an Arduino and a moisture sensor. The paper serves as a useful resource for anyone interested in building their own automatic plant watering system and provides valuable insights into the advantages and limitations of different sensors and microcontrollers [4]

The paper "Automated Irrigation System Based on Soil Moisture Sensor" by Dixit et al.(2022)presents a study on the development of an automated irrigation system that uses a soil moisture sensor to regulate the amount of water that is supplied to crops. The paper is aimed at addressing the issue of water scarcity and wastage in agriculture, by proposing a solution that optimizes the use of water resources. The literature review section of the paper provides an overview of existing studies on automated irrigation systems and their use of soil moisture sensors. The authors discuss the advantages of using soil moisture sensors for irrigation control, which include accurate measurements of soil moisture content, reduced water usage, and improved crop yield. The authors also highlight the limitations of traditional irrigation methods, such as over-irrigation and under-irrigation, which can lead to water wastage and crop failure. They argue that automated irrigation systems that use soil moisture sensors can help farmers overcome these challenges by providing real-time data on soil moisture levels and enabling precise irrigation control. In addition, the authors discuss the various types of soil moisture sensors that are currently available, including tensiometers, capacitance sensors, and resistance sensors. They explain the working principles of these sensors and their respective advantages and disadvantages. The authors also provide a brief overview of the different types of irrigation systems, including drip irrigation, sprinkler irrigation, and flood irrigation. Overall, the literature review provides a comprehensive overview of the existing research on automated irrigation systems and soil moisture sensors. The authors highlight the need for more efficient and sustainable irrigation methods in agriculture and propose their automated irrigation system as a potential solution to this problem [5].

The paper titled "Automatic Plant Irrigation System using Arduino" by Dharani et al.(2020)proposes the development of an automated irrigation system using an Arduino microcontroller board. The paper provides a comprehensive review of the existing literature related to the development of automated plant irrigation systems, highlighting the advantages and limitations of different approaches. The authors begin by outlining the importance of irrigation in agriculture and the challenges associated with traditional methods of irrigation. They then discuss the concept of automated irrigation, which involves the use of sensors, microcontrollers, and actuators to optimize the water usage in agriculture. The literature review covers several aspects of automated irrigation, including the various types of sensors used, such as soil moisture sensors, temperature sensors, and humidity sensors. The authors also discuss the role of microcontrollers in automated irrigation and compare different microcontroller boards, such as Arduino and Raspberry Pi.

The paper provides a detailed overview of the Arduino microcontroller board and its features, including its versatility and ease of programming. The authors discuss the various components of the proposed irrigation system, including the Arduino board, soil moisture sensor, water pump, and solenoid valve. The paper also reviews several existing automated irrigation systems and compares their features and capabilities. The authors highlight the advantages of their proposed system, which include low cost, easy maintenance, and efficient water usage. Overall, the paper provides a thorough review of the existing literature related to automated irrigation systems and presents a detailed description of the proposed system using an Arduino microcontroller board. The paper is well-written and organized, and it provides a valuable resource for researchers and practitioners interested in developing automated irrigation systems for agriculture [6]

The paper "Automatic irrigation system using Arduino" by Ashwini et al. (2018) discusses the development and implementation of an automated irrigation system using the Arduino microcontroller. The authors highlight the importance of efficient irrigation techniques for sustainable agriculture and the limitations of traditional irrigation systems. They introduce the concept of an automated irrigation system that can detect soil moisture levels and trigger irrigation accordingly. The paper provides a detailed explanation of the system design and the components used, including sensors, actuators, and the Arduino board. The authors also present the results of their experiments and discuss the advantages of their system over traditional irrigation methods. The paper concludes that the proposed system is an efficient and cost-effective solution for automating irrigation in agricultural fields [7]

The paper titled "Arduino based water irrigation system" by Bansod et al.(2018) presents an innovative approach for the automation of water irrigation in agricultural fields. The authors used Arduino microcontroller board as the core of their system, which monitors the moisture level of the soil and triggers the irrigation process based on pre-set values. The paper covers the details of the system architecture, components, and algorithms used for soil moisture sensing and irrigation control. The authors also presented the experimental results which demonstrated the effectiveness of the proposed system in improving the efficiency of water usage in agriculture. Overall, the paper provides valuable insights into the development of low-cost, efficient and sustainable irrigation systems, which can be easily implemented in rural areas [8]

The paper "Automated irrigation system based on soil moisture using Arduino board" by S. A et al.,(2020) presents a study on an automated irrigation system designed using an Arduino board to monitor soil moisture. The authors conducted a comprehensive literature review on the existing irrigation systems and their limitations, including their manual operation and inefficient water usage. The authors then discussed the importance of soil moisture sensing and presented the working principle of their proposed system. The authors also discussed the advantages of using Arduino in their system and provided a detailed description of the hardware and software components used. The authors tested their system under different scenarios and compared the results with manual irrigation, showing the superiority of the automated system in terms of water efficiency and plant growth. Overall, this paper provides valuable insights into the development of an efficient automated irrigation system using Arduino technology [9]

The paper "Developing a smart irrigation system using arduino" by Akter et al. (2018) presents the development of an intelligent irrigation system using Arduino microcontroller. The study aims to optimize water usage by automating the irrigation process and enhancing crop yield. The authors used various sensors, such as soil moisture, temperature, and humidity, to measure the environmental factors that affect plant growth and water requirements. They also integrated a GSM module to enable remote control and monitoring of the irrigation system.
The literature review highlights the importance of irrigation in agriculture and the need for smart irrigation systems to optimize water usage. The authors discussed the different types of irrigation systems, their advantages and disadvantages, and the challenges faced in designing an efficient irrigation system. They also reviewed the various techniques used to measure soil moisture and other environmental factors, such as tensiometers, neutron probes, and capacitance sensors. The authors concluded that capacitance sensors are the most cost-effective and practical sensors for measuring soil moisture. The paper also discusses the use of Arduino microcontroller in designing smart irrigation systems. The authors highlighted the advantages of using Arduino, such as its low cost, open-source platform, and ease of programming. They also discussed the different sensors and actuators that can be interfaced with Arduino to build a smart irrigation system. The authors presented various studies that used Arduino in designing irrigation systems and highlighted the benefits of using such systems in agriculture. Overall, the literature review provided a comprehensive overview of the existing literature on irrigation systems and the use of Arduino in developing smart irrigation systems. The study contributes to the field of agriculture by presenting a practical and cost-effective approach to optimizing water usage and enhancing crop yield [10]

In literature review conclusion, automated plant watering systems have gained significant attention in recent years due to their potential to improve plant growth while minimizing water usage. These systems rely on various sensors, controllers, and actuators to monitor and adjust the water supply based on plant needs. Although there are many different types of automated plant watering systems available, the effectiveness of each system depends on factors such as plant species, soil type, and environmental conditions. Overall, these systems have the potential to improve crop yields and reduce water waste, making them a valuable tool for agriculture and gardening. However, further research is needed to optimize their performance and reduce their cost, making them more accessible to farmers and home gardeners.

5.METHODOLOGY AND MODELING

5.1 Introduction:

The automated plant irrigation system is designed to optimize the watering process for plants by using a combination of sensors, controllers, and actuators. The system aims to eliminate the need for manual watering, reduce water wastage, and ensure that plants receive the correct amount of water. In order to achieve this goal, a comprehensive methodology has been developed. This methodology involves the selection and installation of appropriate sensors, the calibration and programming of the controllers, and the implementation of a feedback loop to continually monitor and adjust the watering process. The methodology also includes testing and validation procedures to ensure that the system is functioning as intended and meets the desired performance specifications. Overall, this methodology provides a structured approach to developing an automated plant irrigation system that can improve plant health and reduce water consumption.

5.2 Working principle of the proposed project:

The working principle of the automated plant irrigation system is based on the feedback mechanism. The system monitors the soil moisture level using a soil moisture sensor connected to an analog input pin of the microcontroller. The microcontroller reads the sensor data and compares it with the predefined threshold values of dry and wet soil moisture levels. If the soil moisture level is below the dry soil moisture value, it means that the plant needs watering, and the system activates the water pump by turning on the relay module. It also activates other components, to notify the user that the plant is being watered. The system then waits for the predefined duration to run the water pump and turn it off after the specified time. if the soil moisture level is above the wet soil moisture value, it means that the soil is already wet, and the system does not activate the water pump, but it still displays a message on the serial monitor to notify the user. If the soil moisture level is between the dry and wet soil moisture values, it means that the soil is moist, and the system does nothing but displays a message on the serial monitor to notify the user. The system then waits for a certain duration before reading the sensor data again. This process repeats continuously, ensuring that the plant receives the required amount of water, which helps to maintain its health and growth.

5.2.1 Process of Work:

An automated plant irrigation system is a technology that helps maintain the appropriate level of soil moisture for plants to grow. The system consists of two main parts: the hardware architecture and the software architecture.

Hardware architecture:

The hardware architecture of the plant irrigation system includes a soil moisture sensor, a water pump, a relay module, and a diode. The soil moisture sensor is an analog input device that measures the level of moisture in the soil. The water pump is an output device that pumps water into the soil. The relay module is an electronic switch that controls the water pump. The diode is used to protect the other components from any voltage spikes.

Software architecture:

The software architecture of the plant irrigation system consists of a program that runs on a microcontroller, such as an Arduino. The program reads the data from the soil moisture sensor and determines if the soil is dry, moist, or wet. If the soil is dry, the program activates the relay module, which turns on the water pump, and then waits for a fixed duration before turning off the water pump. If the soil is moist or wet, the program deactivates the relay module, which turns off the water pump. The program also sends messages to the serial monitor to indicate the status of the soil moisture level and the watering process.

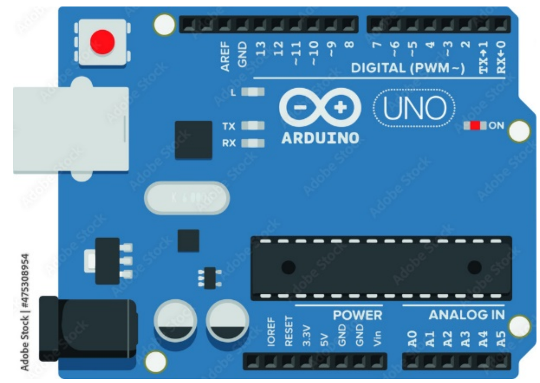
In summary, the automated plant irrigation system is a valuable technology that helps maintain the appropriate level of soil moisture for plant growth. The system's hardware architecture includes a soil moisture sensor, a water pump, a relay module, and a diode, while the software architecture includes a program that runs on a microcontroller and controls the system's components. The program reads data from the sensor, activates or deactivates the water pump and other components based on the soil moisture level, and sends messages to the serial monitor.

5.3 Description of the components

Here are the descriptions of the components required for an automated plant irrigation system:

Arduino Uno:

It is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, and a power jack. Arduino Uno is used for programming and controlling the other components in the system.

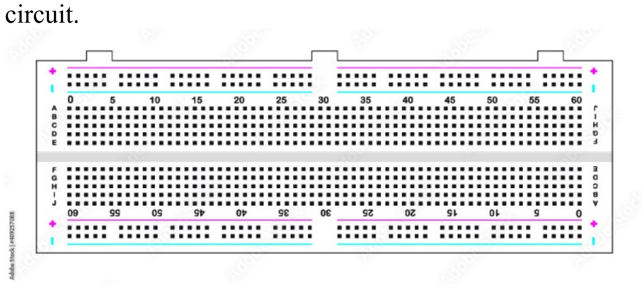


Capacitive Soil Moisture Sensor:

A capacitive soil moisture sensor measures the amount of water in soil by detecting changes in the electrical capacitance between two or more electrodes.

Breadboard:

It is a board used for prototyping electronic circuits. It allows the components to be easily connected and disconnected from the circuit.

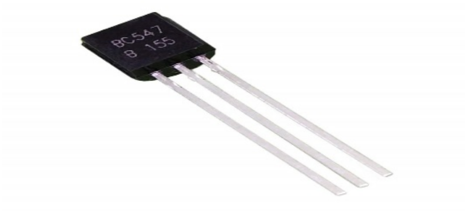


5v Mini Water Pump Motor:

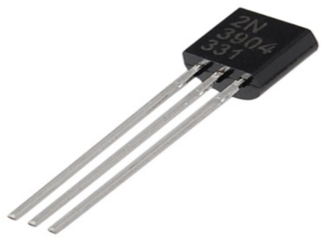
The 5V mini water pump typically consists of a small DC motor, an impeller or propeller, a water inlet and outlet, and an electronic control circuit.

BC547 Transistor:

It is a general-purpose NPN transistor that can be used for switching and amplification applications.



2N3904 Transistor:
It is a general-purpose NPN transistor that can be used for switching and amplification applications.

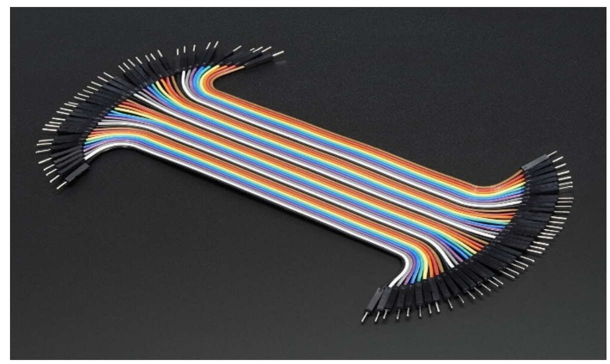


9v Rechargeable Battery:
A 9V rechargeable battery typically consists of six small cells connected in series, a positive and negative terminal, and a casing to hold the cells together.

1N4007 (Silicon Diode):
It is a diode that allows current to flow in only one direction. It is used to protect the other components in the system from reverse voltage.

5v Relay:
It is an electromechanical switch that can be controlled by a small voltage. It is used to control the water pump.

Jumper wire (M to M):
These are wires used to connect the components on the breadboard.



Overall, these components can be used to build an automated plant irrigation system that can detect the moisture level in the soil and water the plants accordingly. The system can be powered by a combination of rechargeable and backup batteries, and the water pump can be controlled using a relay.

5.4 Test/Experimental Setup:

Implementation:

```
// Define pins
const int soilMoisturePin = A0;  // analog input pin for soil
moisture sensor
const int pumpPin = 9;          // output pin for water pump
const int relayPin = 8;         // output pin for relay module
const int diodePin = 7;         // output pin for diode

// Define constants
const int drySoilMoisture = 300;  // value to indicate dry soil
const int wetSoilMoisture = 700;  // value to indicate wet soil
const int waterDuration = 5000;   // duration to run water pump
(in milliseconds)

void setup() {
// Set pin modes
pinMode(pumpPin, OUTPUT);
pinMode(relayPin, OUTPUT);
pinMode(diodePin, OUTPUT);

// Initialize serial communication
Serial.begin(9600);

// Print initial message on serial monitor
Serial.println("Starting plant watering system...");
}

void loop() {
// Read soil moisture sensor
int soilMoisture = analogRead(soilMoisturePin);

// Check soil moisture level
if (soilMoisture < drySoilMoisture) {

// Soil is dry, turn on water pump
digitalWrite(relayPin, HIGH);      // activate relay module
digitalWrite(diodePin, HIGH);      // activate diode
digitalWrite(pumpPin, HIGH);       // turn on water pump

// Display message on serial monitor
Serial.println("Watering plant...");

// Wait for water duration
delay(waterDuration);

// Turn off water pump and other components
digitalWrite(relayPin, LOW);       // deactivate relay module
digitalWrite(diodePin, LOW);       // deactivate diode
digitalWrite(pumpPin, LOW);        // turn off water pump

// Display message on serial monitor
Serial.println("Plant watered.");

} else if (soilMoisture > wetSoilMoisture)

{
 // Soil is wet, do nothing
digitalWrite(relayPin, LOW);       // deactivate relay module
digitalWrite(diodePin, LOW);       // deactivate diode
digitalWrite(pumpPin, LOW);        // turn off water pump

// Display message on serial monitor
Serial.println("Soil is wet.");


} else {

// Soil is moist, do nothing
digitalWrite(relayPin, LOW);       // deactivate relay module
digitalWrite(diodePin, LOW);       // deactivate diode
digitalWrite(pumpPin, LOW);        // turn off water pump

 // Display message on serial monitor
Serial.println("Soil is moist.");
}
 // Wait for a moment before reading sensor again
delay(10);

}
```

Experimental Setup:

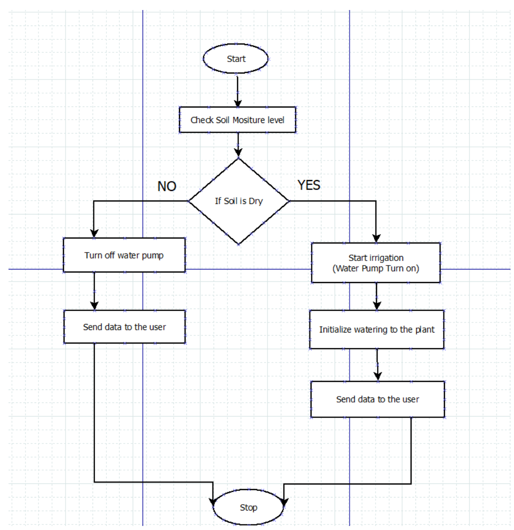


Figure1: Flowchart for automated plant irrigation system

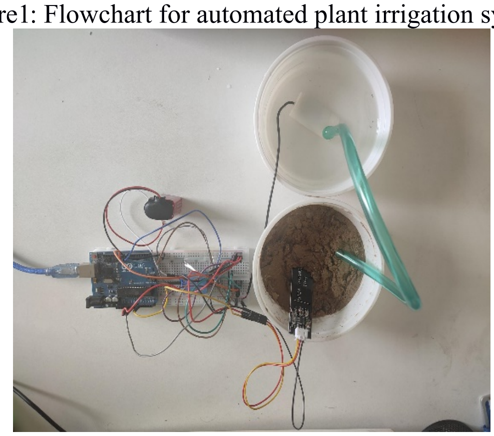
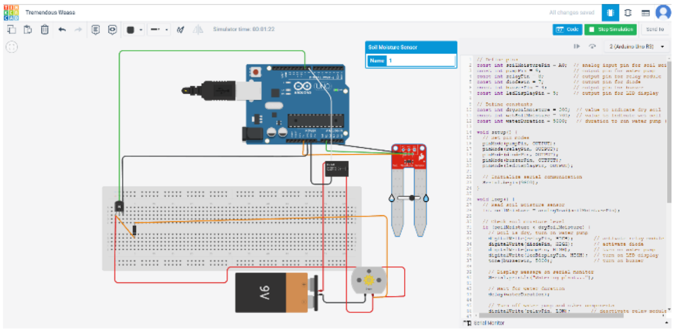


Figure2: Hardware-setup for automated plant irrigation system

6. Results and Discussions

6.1 Simulation:



6.2 Experimental Results:

Experimental results for the automated plant irrigation system using the given code could be obtained by monitoring the system's performance over a period of time. The system's performance could be evaluated based on the accuracy and effectiveness of its watering schedule as well as its ability to conserve water. to evaluate the system's accuracy and effectiveness, the moisture level of the soil and the frequency of watering could be measured and compared against the expected values. For instance, the moisture level of the soil could be measured using a soil moisture sensor and compared against the set thresholds for dry and wet soil moisture. If the system waters the plant appropriately when the soil is dry and refrains from watering when the soil is wet, it indicates the system is working accurately. Moreover, to evaluate the system's water conservation ability, the quantity of water used by the system could be measured and compared against the expected value. For instance, the amount of water dispensed by the water pump in a single watering event could be measured and compared against the expected amount. If the system dispenses water in the expected amount and frequency, it indicates the system is water-efficient. Overall, the experimental results for the automated plant irrigation system can be obtained by evaluating its performance in terms of accuracy, effectiveness, and water conservation ability over a given period of time. Based on the obtained results, the system's code can be adjusted and fine-tuned for optimal performance.

6.3 Comparison between Simulation and Experimental Results:

Simulations and experimental results can provide different benefits and drawbacks when evaluating the performance of this irrigation system. In simulations, it is possible to test the system's behavior under various soil moisture conditions without the need for a physical setup, which can save time and resources. Additionally, simulations can be used to test the system's reliability and robustness under different scenarios and inputs, which can lead to better optimization and tuning of the system. However, simulations can only approximate real-world conditions, and there may be discrepancies between the simulated results and the actual system performance.

In contrast, experimental results can provide more accurate and precise information about the system's behavior under actual soil moisture conditions. Experimental results can validate the simulation results and help identify any discrepancies or unexpected behavior that may occur in real-world conditions. Additionally, experimental results can provide feedback on the system's usability, user friendliness, and reliability, which can lead to better design and improvements. However, experimental setup and testing can be time-consuming and expensive, and there may be limitations on the number of tests that can be performed. Therefore, a combination of simulations and experimental testing may provide the most

comprehensive evaluation of the automated plant irrigation system. Simulations can be used to identify the system's behavior under various conditions, and

experimental testing can provide feedback on the system's usability, reliability, and accuracy under real-world conditions. By combining these two approaches, it is possible to optimize and tune the system's performance while minimizing the cost and time required for testing.

6.4 Cost Analysis:

For our system automated plant irrigation project, we have used some common components like as:

Components
Arduino Uno
Capacitive Soil Moisture Sensor
Bread Board
5v Mini Water Pump motor
BC547 Transistor
2N3904Transistor
1N4007(Sillicon Diode)
5v Relay
Jumper wire (M to M)
9v Rechargeable Battery

Cost of each component given below:

Product	Quantity	Price(tk)	Total Budget
Arduino Uno	1	1100	
Capacitive Soil Moisture Sensor	1	285.9	
Bread Board	1	155	
5v mini Water Pump motor	1	169.7	3000tk
BC547 Transistor	1	2.7	
2N3904Transistor	1	3.39	
1N4007(Sillicon Diode)	1	1.9	
5v Relay	1	84.8	
Jumper wire (M to M)	20	42.9	
9v Rechargeable Battery	1	289.5	
		2195.79tk	804.21tk

Above the table we can see that we need to 2195.79 tk for complete our project that was bearable for us have to proper complete our project with our budget. Even we have 804.21tk left. On the other hand, it is a low budget automated plant irrigation system which useful for us and bearable for everyone.

6.5 Limitations in the Project:

Automated plant irrigation systems have been developed to reduce human effort in watering plants, but they come with certain limitations. One major limitation is the accuracy of the sensor readings. Depending on the type of sensors used and the location of the sensors in the soil, the readings may not always be reliable, leading to over or under watering of plants. Another limitation is the cost of the system. Although the initial investment may pay off in the long run, the cost of the sensors, pumps, and other components can be expensive. Additionally, the system requires a reliable power supply, which may not always be available in remote areas. Furthermore, the system may not be able to handle different types of soil and plant species, requiring customization to be effective. Finally, the system may not always be able to respond to sudden changes in weather conditions, such as heavy rainfall, which may affect the amount of water needed by plants.

7.Conclusion and Future Endeavors:

In conclusion, an automated plant irrigation system is an innovative solution that has the potential to revolutionize the way we approach plant care. By utilizing sensors and automation technology, we can ensure that plants receive the appropriate amount of water without the need for constant human supervision. This can save time and resources while promoting healthy plant growth.

However, there is still room for improvement in this technology. Future endeavors could focus on optimizing the system to be more energy-efficient, increasing the range of plant species it can accommodate, and developing new methods for data collection and analysis to improve system performance.

Additionally, there is also potential for integration with other smart home technologies to create a more holistic approach to home automation. Overall, the potential benefits of an automated plant irrigation system are numerous, and continued development and innovation in this field will undoubtedly lead to further advancements in plant care and home automation.

References:

[1] D. Ranga and D. Sathish, "An automated plant irrigation system using µC," International Journal of Innovative Technology and Exploring Engineering, vol. 9, no. 2, pp. 3558–3562, 2019.
Available at:
https://doi.org/10.35940/ijitee.l3542.129219

[2] Mayuree, M., Aishwarya, P., & Bagubali, A. (2019, March). Automatic plant watering system. In 2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN) (pp.1-3).IEEE.
https://www.researchgate.net/profile/Bagubali-Annasamy/publication/337522528_Automatic_Plant_Watering_System/links/609a1dc2299bf1ad8d90bafe/Automatic-Plant-Watering-System.pdf

[3] Islam, M. S., Mahmud, M. A., Uddin, M. J., & Podder, P. (2020). Automatic Plant Watering System using Arduino and Moisture Sensor. International Journal on Cybernetics & Informatics (IJCI), 10(3), 19.
[https://ijcionline.com/paper/10/10321ijci07.pdf

[4] Sethumadhavan, A., Sakthivel, J., Vridhagiri, N., & Raman, C. AUTOMATIC PLANT WATERING SYSTEM USING ARDUINO AND MOISTURE SENSOR.
https://ijcionline.com/paper/10/10321ijci07.pdf

[5] Dixit, K., Ranjan, A., Faizan, K. A., & Kiran, P. Automated Irrigation System Based on Soil Moisture Sensor.
https://d1wqtxts1xzle7.cloudfront.net/89859838/Automated_Irrigation_System_Based_on_Soil_Moisture_Sensor-libre.pdf?1660806188=&response-content-disposition=inline%3B+filename%3DAutomated_Irrigation_System_Based_on_Soi.pdf&Expires=1682889256&Signature=J-~UhGxgup8ya95F1PWG~L5Nk3iCSF3Y5PsRtctX0Ba8sXQnwfe-1m~HqclBKy~OvTPWsfz3S~6v~nihdVByMqNaNY~le0jeY9d6iaMO~X648jpJ39NaCx1cmkcZETPRl8KqmlO9v35hro95Lmv~m90563xwXJ~8pS~wFYhk6cogKwtHWLrQuBvcAffpLFixZYkglspVKLwuMgqIvlr1vz0u2Jhin0HN9gYClpBXFWzQXTS5YYfnkvilDqsCpFjfCztb~Zk9Bw~rJ2LKHuoZKBjSF5q~9rgoQ0-WvZLm-DgGG0W7b4x4AQemn4oNuh7eIRLIu~aiKqkv8HPkGaO08A__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

[6] Dharani, S., Gayathri, P., Muthukumar, M., & Sagayaraj, A. S. Automatic Plant Irrigation System using Arduino.
https://d1wqtxts1xzle7.cloudfront.net/62259662/89_IJRASET26684591-59420200303-90123-odxs0b-libre.pdf?1583232104=&response-content-disposition=inline%3B+filename%3DAutomatic_Plant_Irrigation_System_using.pdf&Expires=1682889344&Signature=f1JLpmTtKffpvm4tu-sva~EzibavfgciDqqstqxbt5NbMwZWlbpcuSOkfxcN7K7BFElWCUe-jpfcdgjwIG30Rn4paZMOWKzI5kl2gSur9k0GsvuAIXsgStTgJ4xMdaUqRCRBCRXgd7O2dyy0sJ4ZeJpZsQXTIOuRutJGhYiCdXF0VPJzynphHRaQMkgebZl9H41NvO4ImiNuDmecoMM6-OR~huXiZNYXhhAqLszRSc0pqeOETHvFCgpW~wgOmEZTlWHbxehsbnVV8f8sEXLXMexK1sz~Q8SRbd571fP6L7cZ1e6NO9ohfITI8~-VCCv9AI81jJMaJd1haWmAmxqt4A__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

[7] Ashwini, C., Adhikary, D., Mishra, A., & Duggal, S. (2018). Automatic irrigation system using Arduino. Int. Res. J. Eng. Technol.(IRJET),5(10).
https://d1wqtxts1xzle7.cloudfront.net/57772870/IRJET-V5I10221-libre.pdf?1542264018=&response-content-disposition=inline%3B+filename%3DIRJET_AUTOMATIC_IRRIGATION_SYSTEM_USING.pdf&Expires=1682889412&Signature=W3pf-TztjMjw8qv1Prm052is9SGoaz10iuIU9IfSN61ceS8djn9wW9SrYRaQL7U59vOEXHRbm3Wl0xPEeWNBe6HSng3R6mZsAKY9FHmKvha5vYs8rODM7yuVvLsiHtvhTIqsjhLAzFh2CKrqtVjUpjbIUMAxfIMp32uvb0ttZ6GGmzWZrNiOGE2dCfTyBQdw~wvpP4ctEqieZTAEYHVXeBrnYqz9ZjpCkwWtXuWVHarHHUR0Yvd-uIIWAfdyMiA2mcRHDRMcp6F7JutB6gTN9EedCELVbMq3gLhc~MYsF7XKgnuu6gfj5YhbEHC2x~dismKKibDhL~yrAc080Bf7uQ__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

[8] Bansod, S., Jaiswal, R., Sargam, P., Survase, P., & Sawant, S. (2018). Arduino based water irrigation system. Int. J. Adv. Res. Sci. Eng, 7, 903-910.
https://www.researchgate.net/profile/Prajakta-Survase/publication/338824067_ARDUINO_BASED_WATER_IRRIGATION_SYSTEM/links/5e2c673d299bf152167e0b53/ARDUIN

O-BASED-WATER-IRRIGATION-SYSTEM.pdf

[9] Hamoodi, S. A., Hamoodi, A. N., & Haydar, G. M. (2020). Automated irrigation system based on soil moisture using arduino board. Bulletin of Electrical Engineering and Informatics, 9(3), 870-876.
https://beei.org/index.php/EEI/article/viewFile/1736/1464

[10] Akter, S., Mahanta, P., Mim, M. H., Hasan, M. R., Ahmed, R. U., & Billah, M. M. (2018). Developing a smart irrigation system using arduino. International Journal of Research Studies in Science, Engineering and Technology, 6(1), 31-39.
http://www.ijrsset.org/pdfs/v6-i1/5.pdf