

AUTOMATIC PLANT WATERING SYSTEM USING SOIL MOISTURE SENSOR, WATER LEVEL SENSOR AND ARDUINO.

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in Biotechnology.

Interdisciplinary Project Report

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**DEPARTMENT OF BIOTECHNOLOGY
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **A Karen (41230012), Chethana D (41230015) and Varsha D (41230071)** who carried out the Interdisciplinary Project entitled **"AUTOMATIC PLANT WATERING SYSTEM USING SOIL MOISTURE SENSOR, WATER LEVEL SENSOR AND ARDUINO"** under our supervision from January 2024 to April 2024.

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DECLARATION

We, **A Karen (41230012)**, **Chethana D (41230015)** and **Varsha D (41230071)** hereby declare that the Project Report “**AUTOMATIC PLANT WATERING SYSTEM USING SOIL MOISTURE SENSOR, WATER LEVEL SENSOR AND ARDUINO**” done by us under the guidance of **Dr. R. Thyagarajan, M.Phil., PhD., Associate Professor** is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology in Biotechnology.

DATE: 06-05-2024

PLACE: CHENNAI

A handwritten signature in blue ink that reads "Karen" with a horizontal line underneath the name.

SIGNATURE OF THE CANDIDATE

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I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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ABSTRACT

In the realm of modern agriculture and urban gardening, the efficient management of water resources is paramount. This abstract introduces the design and implementation of an Automatic Plant Watering System aimed at optimizing water usage while ensuring the healthy growth of plants. The automatic plant watering system incorporates various sensors to monitor soil moisture levels, ambient temperature, and humidity, enabling it to assess the precise watering needs of plants. These sensors provide real-time data, which is processed by a microcontroller unit to determine when and how much water to dispense to the plants. Furthermore, the system integrates wireless communication capabilities, allowing users to remotely monitor and control watering schedules via a smartphone application or web interface. This feature enhances convenience and accessibility, especially for individuals with busy schedules or those away from home for extended periods. The design prioritizes energy efficiency and sustainability by employing low-power components and implementing water-saving algorithms. Additionally, the system incorporates fail-safe mechanisms to prevent over-watering and minimize the risk of plant damage. The automatic plant watering system represents a promising solution for automating plant care, promoting water conservation, and facilitating the cultivation of healthy vegetation in both agricultural and domestic settings.

Keywords: Microcontroller unit, water-saving algorithms, plant care automation, real-time data.

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LIST OF ABBREVIATIONS

ACRONYM	FULL FORM
LCD	Liquid-crystal display
LED	Light-emitting diode
GND	Ground
VCC	Voltage Common Collector
I2C	Inter-Integrated circuit
SCL	Serial clock
SDA	Serial Data

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CHAPTER 1

1. INTRODUCTION

1.1 Challenge of Traditional Plant Care

In today's fast-paced world, where time is a precious commodity, traditional plant care methods often fall short in meeting the demands of busy lifestyles. Manual watering routines are not only labor-intensive but also prone to inconsistency, leading to suboptimal plant health. However, with the advent of automated plant watering systems, powered by cutting-edge technologies such as soil moisture sensors, water level sensors, and Arduino microcontrollers, a new era of efficient and hassle-free plant care has emerged. Watering plants stands as a cornerstone cultural practice within daily greenhouse operations, representing a significant labor-intensive task. Implementing watering systems reduces the challenge of delivering water to plants promptly as required. Understanding the optimal timing and appropriate quantity of water to provide constitutes two vital aspects of the watering process. An automatic plant watering system is devised to simplify the tasks of farmers. This idea utilizes an Arduino board containing an ATmega328P Microcontroller. The system is programmed to detect the moisture level of the plants and provide water as needed. Many individuals appreciate the benefits of plants and the satisfaction of caring for them. However, for most people maintaining plant health and vitality can be challenging. To address this challenge, we have created a prototype that enhances a plant's self-sufficiency by automatically watering itself from a large water tank. The prototype provides updates on the current moisture levels of the plant and prompts the user to refill the water tank when necessary. The system's automation is intended to be supportive and helpful to the user.

1.2 Modern Solution

An automatic plant watering system utilizing Arduino offers a modern solution to the challenge of maintaining plant health and vitality. By integrating sensors and actuators with an Arduino microcontroller, this system can monitor the moisture levels of plants and dispense water, accordingly, ensuring they receive the right amount of hydration. Additionally, the system can provide real-time updates on plant moisture levels and alert users when the water tank needs refilling. This innovative approach not only

simplifies the task of plant care but also promotes efficient water usage and contributes to the overall health of indoor and outdoor plants. At its core, the system depends on sensors like soil moisture sensors to consistently track the moisture levels in the plant's soil. These sensors offer immediate feedback on the soil's moisture content, allowing the system to precisely determine when watering is needed for the plant. When the soil moisture level decreases beyond a predetermined threshold, indicating the necessity for watering, the Arduino microcontroller initiates the water dispensing mechanism. This mechanism may vary in complexity, encompassing basic pumps or more sophisticated irrigation systems, tailored to meet the specific needs of the situation. In addition to watering the plant as needed, the system is equipped with features to enhance user interaction and convenience. This system includes an LCD display indicator to provide visual feedback on the plant's moisture status, the system incorporates a water level sensor to monitor the water tank level and alert the user when it's time to refill. The versatility of Arduino allows for customization and expansion of the system's capabilities to meet individual preferences and plant care requirements.

1.3 Key Features of an Automatic Plant Watering System

The soil moisture sensor is an essential component at the core of an automatic plant watering system. Its primary function is to measure the moisture content of the soil in which the plants are situated. By doing so, it provides vital real-time data on soil moisture levels, allowing the system to make informed decisions about when and how much water to deliver to the plants. The water reservoir is a fundamental component of an automatic plant watering system, serving as the storage unit for the water required to irrigate the plants. This reservoir can take the form of a tank or container, with its size varying based on the specific needs and scale of the watering system. The reservoir is connected to a water source, such as an irrigation system, to automatically replenish its supply as needed. Otherwise, users may manually fill the reservoir when necessary, ensuring that there is always an adequate amount of water available for plant irrigation. Whether connected to a water source or manually filled, the water reservoir plays a critical role in maintaining the hydration and health of the plants within the system. The water pump serves as a vital component within an automatic plant watering system, facilitating the transfer of water from the reservoir to the plants. Its primary function is activated in response to the readings provided by the soil moisture sensor. When the sensor detects that the soil moisture has fallen below a predefined

threshold, signaling the need for watering, the water pump is triggered into action. It then proceeds to deliver water to the plants, ensuring they receive the necessary hydration for optimal growth and health. Through this automated process, the water pump plays a crucial role in maintaining the overall well-being of the plants within the system.

1.4 Components of an Automatic Plant Watering System

The microcontroller, Arduino UNO acts as the central processing unit of the automated plant watering system. Its primary role is to receive and interpret data transmitted by the soil moisture sensor, which provides real-time information about the moisture levels in the soil. Based on this data, the microcontroller executes programmed instructions to control the operation of the water pump. Arduino microcontrollers are favored for their versatility and programmability, allowing users to customize watering schedules, moisture thresholds, and other parameters to suit the specific needs of their plants and environment. Power supply is an essential element of the automated plant watering system, providing the necessary energy to operate its various components, including the controller and water pump. Depending on the specific application and setup, the power supply can be sourced from mains electricity or battery power. battery power provides flexibility and portability, allowing the system to operate independently of mains electricity, which is particularly advantageous for outdoor or remote locations where access to power outlets may be limited. Programming logic allows users to tailor the system's operation according to specific requirements and conditions. By defining parameters such as moisture thresholds and watering schedules, users can ensure precise and efficient watering of the plants. Additionally, the system can adapt to changing environmental factors, such as temperature and humidity, by adjusting its parameters accordingly. User interfaces are integral components of certain automatic watering systems, providing users with convenient access to system functionalities and information. These interfaces come in various forms, such as display panels or web interfaces, allowing users to monitor the system status, adjust settings, and receive alerts remotely.

1.5 Advantages of Automatic Plant Watering Systems

An automatic plant watering system presents a convenient and efficient solution for ensuring optimal soil moisture levels and promoting healthy plant growth with minimal manual intervention. By integrating components such as soil moisture sensors, water pumps, and microcontrollers, these systems enable precise and responsive watering actions tailored to the specific needs of plants and environmental conditions. With customizable programming logic and user-friendly interfaces, users can effortlessly manage watering schedules and monitor system performance, ultimately promoting the flourishing of the plants while reducing the time and effort required for maintenance.

CHAPTER 2

REVIEW OF LITERATURE

Mritunjay Ojha, *et al.* (2016), the authors studied the Microcontroller Based Automatic Plant Watering System, developed by Mritunjay Ojha, Sheetal Mohite, Shraddha Kathole, and Diksha Tarware, as a sophisticated solution for automating plant irrigation. Leveraging microcontroller technology, sensors, and a water delivery mechanism, the system autonomously monitors soil moisture levels and dispenses water as needed, ensuring optimal hydration for plants. Through the integration of intelligent control algorithms, the system provides precise and efficient watering tailored to the specific requirements of different plant species, promoting healthy growth and conserving water resources. Setting up a microcontroller-based automatic watering system requires some technical know-how in electronics and programming, which might be challenging for beginners. Components like microcontrollers, sensors, and actuators can be costly, potentially limiting accessibility for users with budget constraints. Plus, ensuring a stable power supply for continuous operation may be tricky, especially in areas with limited or unreliable electricity access. Regular maintenance is essential to keep the system running smoothly, including calibrating and cleaning sensors, which adds to the workload. Additionally, the accuracy of sensor readings is crucial for optimal watering decisions, any inaccuracies could affect plant health. Scaling up the system for larger areas or complex environments might require modifications and additional considerations. Despite these challenges, the microcontroller-based system offers convenience and efficiency, benefiting plant health and simplifying watering tasks for gardening enthusiasts. However, it's important to remember that the system may not address external factors like weather conditions or pests, requiring supplementary measures for comprehensive plant care.

Ipin Prasajo, *et al.* (2020), the Design of Automatic Watering System Based on Arduino, studied by Ipin Prasajo, Andino Maselena, Omar Tanane, and Nishith Shahu, offers a comprehensive solution for automating irrigation across various settings like home gardens, agricultural fields, and greenhouses. By leveraging Arduino microcontroller technology, the system incorporates sensors to monitor soil moisture levels and adjust watering accordingly, facilitating efficient water management and supporting robust plant growth. With customizable programming logic, the system

provides flexibility to meet the specific watering needs of different plant species, thereby optimizing resource usage and reducing the need for manual intervention. Implementing an Arduino-based automatic watering system involves some technical know-how in electronics, programming, and circuitry. Beginners may find the setup process a bit challenging and might need assistance or resources to navigate through it effectively. Getting all the necessary components for building such a system, like microcontrollers, sensors, actuators, and power sources, can be costly, which might be a concern for those with limited budgets. Also, keeping the system running smoothly requires a stable power supply, which could be an issue in areas with unreliable electricity access. Maintaining an Arduino-based watering system is essential for its optimal performance. Regular checks and occasional calibrations or replacements of components like sensors and actuators may be necessary over time. The accuracy of the sensors in measuring soil moisture levels is crucial for the system to make effective watering decisions. Inaccurate readings could affect plant health and the overall performance of the system. While the Arduino-based watering system is suitable for small to medium-scale applications, scaling it up for larger areas or more complex environments may pose some challenges. Additional adjustments and modifications might be needed to adapt the system for extensive garden areas or commercial agriculture operations. Additionally, external factors like weather conditions, pests, and diseases can still impact plant health, so the system may need to be supplemented with other measures for comprehensive plant care. Despite these challenges, the Design of Automatic Watering System Based on Arduino offers significant advantages in terms of efficiency, convenience, and plant health, making it a valuable tool for plant enthusiasts and professionals in the field of agriculture and plant cultivation.

Maria Beata Inka Astutiningtyas & Monika Margi Nugraheni (2020), the Automatic Plant Watering System for Small Gardens, as studied by the authors, provides an innovative solution for maintaining optimal soil moisture levels in small garden environments. Through the utilization of Arduino microcontrollers and sensors, the system monitors soil moisture levels and water reservoir status, facilitating precise and timely irrigation tailored to the plants' specific requirements. By incorporating automation, the system minimizes the need for manual intervention, offering time and effort savings for gardeners while enhancing plant health and resource efficiency. Designing and setting up an automatic watering system requires some technical know-how, including

programming skills and familiarity with electronics. This might make it challenging for beginners to use the technology. While the automated system reduces the need for manual watering, it still needs regular maintenance to ensure it works properly. This means things like sensors and pumps might need adjusting or replacing from time to time, which adds to the ongoing upkeep. The system relies on having a constant power supply to work, which could be tricky in places where access to electricity is limited or unreliable. How well the system works depends on how accurate and reliable the sensors are at measuring soil moisture and water levels. If the sensors aren't accurate, it could lead to problems like watering plants too much or too little. Other factors like extreme weather, pests, and diseases can still affect plant health even with the automated watering system in place. The system might not be able to deal with these issues, so gardeners might need to take extra steps to manage their gardens effectively. Despite these challenges, the Automatic Plant Watering System for Small Gardens brings many benefits, like making gardening more convenient and efficient. It can be a helpful tool for gardeners looking to take better care of their plants and optimize their gardening practices.

Kritika Shah, *et al.* (2020), the proposed Automated Plant Watering System using IoT, developed by Kritika Shah, Saylee Pawar, Gourav Prajapati, Shivam Upadhyay, and Gayatri Hegde, offers an innovative solution for automating the irrigation process in various environments, including home gardens, agricultural fields, and green building settings. By integrating IoT (Internet of Things) technology with advanced hardware components, the system can monitor soil moisture levels and dispense water as needed, ensuring optimal hydration for plants. Through intelligent control algorithms and real-time data processing, the system provides flexibility to adapt to different plant species' watering requirements, promoting healthy growth and conserving water resources. Acquiring the necessary components for building an automated watering system using IoT technology can be expensive, which may deter users with limited budgets. Designing and assembling such a system requires technical expertise in electronics, programming, and network communication, making the setup process challenging for novice users. Dependence on electricity for continuous operation may pose challenges in remote locations with limited access to power. Additionally, the system relies on internet connectivity for remote monitoring and control, which could be disrupted by connectivity issues or network outages. Like any automated system,

regular maintenance is essential to ensure optimal performance. This includes calibrating sensors, cleaning components, and addressing network issues as they arise. Accurate sensor readings are crucial for effective watering decisions, and any inaccuracies could impact plant health. Security measures must be implemented to protect the system from unauthorized access and data breaches, especially when transmitting data over the internet. While suitable for small to medium-scale applications, scaling up the system for larger environments may require additional considerations and modifications. Despite these challenges, the proposed Automated Plant Watering System using IoT offers significant benefits in terms of efficiency, convenience, and plant health. It serves as a valuable tool for enthusiasts and professionals involved in plant cultivation and agriculture.

Mukkapati Ganesh Raghunadh, *et al.* (2021), the Automated Plant Watering System, devised by Mukkapati Ganesh Raghunadh, Kyung Tae Kim, Nelavelli Brahma Manas, and Ravuri Sri Kanth, introduces a pioneering approach to streamline the irrigation process across various environments, spanning from household gardens to agricultural fields and greenhouses. Employing cutting-edge technology like microcontrollers, sensors, and actuators, the system meticulously monitors soil moisture levels and administers water as per necessity, ensuring plants receive optimal hydration. Through the implementation of intelligent control algorithms and customizable programming, the system adapts seamlessly to the diverse watering requirements of different plant species, fostering robust growth while conserving precious water resources. Acquiring the necessary components for building an automated watering system, including microcontrollers, sensors, actuators, and power sources, can be expensive. Designing and assembling such a system requires a certain level of technical expertise in electronics, programming, and circuitry. Novice users may find the setup process challenging and may require guidance or resources to navigate through it effectively. Continuous operation of the system relies on a stable power supply. Dependence on electricity may pose challenges in off-grid or remote locations where access to power is limited or unreliable. Maintenance is essential to ensure optimal performance. Components like sensors, actuators, and electrical connections may need calibration, cleaning, or replacement over time, adding to the ongoing maintenance workload. The accuracy and reliability of sensors used to measure soil moisture levels are crucial for the system's effectiveness. Variability or

inaccuracies in sensor readings could lead to suboptimal watering decisions, potentially affecting plant health and overall system performance. Scaling up the automated watering system for larger or more complex environments may present challenges. Despite these drawbacks, the Automated Plant Watering System offers significant benefits in terms of efficiency, convenience, and plant health, making it a valuable tool for enthusiasts and professionals involved in plant cultivation and agriculture.

Md Mijanur Rahman, *et al.* (2022), the E-Irrigation Solutions for Forecasting Soil Moisture and Real-time Automation of Plant Watering, developed by the authors, represents an innovative approach to automating the irrigation process using electronic solutions. The system leverages real-time soil moisture data and weather forecasting to optimize plant watering, ensuring efficient water management and promoting healthy plant growth. By integrating electronic sensors, microcontrollers, and forecasting algorithms, the system offers a reliable and adaptable solution for agricultural and horticultural irrigation needs. The study conducted by Md Mijanur Rahman examines the challenges and benefits associated with implementing an e-irrigation system for forecasting soil moisture and real-time automation of plant watering. The research highlights the potential barriers to adoption, such as the initial investment required for acquiring components and the technical expertise needed for system design and assembly. The study emphasizes the importance of a stable power supply for continuous operation and the necessity of regular maintenance to ensure optimal performance. Furthermore, the research discusses the critical role of sensor accuracy and reliability in measuring soil moisture levels and making informed watering decisions. The study also addresses concerns regarding data security and privacy in transmitting and storing real-time sensor data and weather forecasting information. While suitable for small to medium-scale applications, the study acknowledges the challenges of scaling up the e-irrigation system for larger agricultural areas or commercial farming operations. Despite these drawbacks, the research underscores the significant benefits of the e-irrigation system in terms of efficiency, convenience, and plant health, making it a valuable tool for agricultural and horticultural irrigation management.

Protik Parvez Sheikh, *et al.* (2024), the research conducted by the authors focuses on the development of an Arduino-based automated gardening system aimed at facilitating efficient and sustainable plant growth. The study explores the integration of Arduino microcontroller technology, sensors, and actuators to monitor crucial environmental parameters such as soil moisture, temperature, and light intensity. By employing intelligent control algorithms, the system automates essential gardening processes including watering, climate control, and lighting adjustments. This automation is customized to meet the specific requirements of different plant species, resulting in optimized resource utilization, minimized manual intervention, and enhanced plant health. Acquiring the necessary components for building an Arduino-based automated gardening system can be expensive. The initial investment may deter some users, particularly those with limited budgets or resources. Designing and assembling an Arduino-based automated gardening system requires a certain level of technical expertise in electronics, programming, and circuitry. Novice users may find the setup process challenging and may require guidance or resources to navigate through it effectively. Continuous operation of the system necessitates a stable power supply. Dependence on electricity may pose challenges in off-grid or remote locations where access to power is limited or unreliable. Like any automated system, the Arduino-based gardening system requires regular maintenance to ensure optimal performance. Components such as sensors, actuators, and electrical connections may require calibration, cleaning, or replacement over time, adding to the ongoing maintenance workload. The accuracy and reliability of the sensors used to measure environmental parameters such as soil moisture, temperature, and light intensity are crucial for the system's effectiveness. Variability or inaccuracies in sensor readings could lead to suboptimal gardening decisions, potentially affecting plant health and overall system performance. While suitable for small to medium-scale applications, scaling up the Arduino-based gardening system for larger or more complex environments may present challenges.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

To develop an automated plant watering system that is composed of soil moisture sensor, a water level sensor, a microcontroller for data processing, and actuators like water pumps to administer water to plants as required.

3.2 SCOPE

- **Efficient Water Usage:** By utilizing soil moisture sensors, the system can precisely determine when plants require watering, enabling efficient water usage by delivering water only when necessary. This approach minimizes water waste and promotes sustainable irrigation practices, contributing to environmental conservation efforts.
- **Improved Plant Health:** By maintaining optimal soil moisture levels, the system ensures that plants receive the correct amount of water, reducing the risk of over or under-watering. This promotes healthier plant growth, reducing the likelihood of stress, disease, and other issues associated with improper watering.
- **Automation:** With automation, the system removes the requirement for manual watering, efficient plant care and reducing the time and effort needed for maintenance tasks. This convenience enhances the user experience, allowing individuals to focus on other activities while ensuring their plants receive consistent and timely watering.
- **Customization:** Through customization, users can program the system to water different plants according to their unique requirements, adjusting watering schedules and durations as needed. This flexibility ensures that each plant receives tailored care, optimizing growth and health outcomes for diverse plant species within the same environment.
- **Water Conservation:** By constantly monitoring water levels in the tank, water level sensors prevent wasteful overflow and ensure an adequate water supply for the plants. This approach to water management promotes conservation efforts, minimizing water waste and contributing to sustainable irrigation practices.
- **Data Logging and Monitoring:** Through data logging capabilities, the system records soil moisture and water level data, providing users with valuable insights into plant health. This continuous monitoring facilitates informed decision-making, enabling users to adjust watering schedules and system settings as needed to optimize plant care and performance.

CHAPTER 4

MATERIALS AND METHODS

4.1 MATERIALS

4.1.1 ARDUINO UNO

The Arduino Uno plays a central role in an automated plant watering system, that coordinates and controls the various components of the system. As the main microcontroller, the Arduino Uno receives input from sensors such as soil moisture sensors and water level sensors, allowing it to constantly monitor the moisture levels in the soil and the water levels in the tank. Based on this input, the Arduino Uno executes programmed logic to determine when watering is needed and how much water should be dispensed. It then triggers the water pump to activate and deliver water to the plants as required.



FIGURE 4.1.1: Arduino Uno
(source: researchgate.net)

4.1.2 MINI WATER PUMP

In an automated plant watering system, a mini water pump serves the crucial function of delivering water from a water tank to the plants. When triggered by the control system, typically an Arduino microcontroller in this case, the water pump activates and pumps water through tubing or pipes to the plant's root systems. This ensures that plants receive the necessary hydration, and the pump's size and flow rate are often tailored to suit the system's requirements for precise and efficient water delivery.



FIGURE 4.1.2: Mini Water Pump
(source: projecthubbharat.com)

4.1.3 LCD DISPLAY

The LCD display serves as a user interface in an automated plant watering system, providing valuable feedback and information to the user. It allows users to view real-time data such as soil moisture levels, water tank levels, and system status briefly. This enables users to monitor the health of their plants and the performance of the watering system conveniently. Additionally, the LCD display may also display alerts or notifications, such as when the water tank needs refilling or if there are any system errors or malfunctions.



FIGURE 4.1.3: LCD Display
(source: cytron.io)

4.1.4 CONNECTING WIRES:

Connecting wires play a fundamental role in an automated plant watering system by establishing electrical connections between the various components of the system. These wires facilitate communication between sensors, actuators, and the microcontroller, enabling data transmission and control signals. By ensuring reliable connectivity, the connecting wires enable the system to operate efficiently and accurately respond to changes in soil moisture levels, water tank levels, and other environmental factors. Connecting wires are the backbone of the automated plant watering system, enabling the integration and coordination of its components to effectively automate plant care tasks.



FIGURE 4.1.4: Connecting Wires
(source: researchgate.net)

4.1.5 SOIL MOISTURE SENSOR

The soil moisture sensor is a critical component in an automated plant watering system, responsible for monitoring the moisture levels in the soil. By measuring the conductivity or resistance of the soil, the sensor provides real-time data on the moisture content, allowing the system to determine when watering is required. When the soil moisture drops below a preset threshold, indicating dryness, the sensor triggers the watering mechanism to supply water to the plants. This ensures that plants receive the appropriate amount of hydration, promoting healthy growth and vitality while preventing overwatering or underwatering. The soil moisture sensor enables the system to intelligently regulate watering cycles based on the specific moisture needs of the plants, optimizing water usage and plant health.

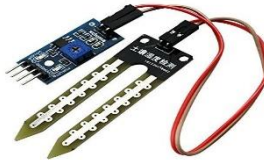


FIGURE 4.1.5: Soil Moisture Sensor
(source: myinnovation.in)

4.1.6 WATER LEVEL SENSOR

The water level sensor serves a crucial role in an automated plant watering system by monitoring the water level in the reservoir or water tank. This sensor detects changes in water level and provides feedback to the system, ensuring that an adequate supply of water is available for plant irrigation. When the water level falls below a certain threshold, indicating the need for refilling, the sensor triggers alerts, or notifications to prompt the user to replenish the water tank.



FIGURE 4.1.6: Water Level Sensor
(source: aaloktech.in)

4.1.7 SINGLE CHANNEL RELAY MODULE

The single channel relay module serves as a control mechanism in an automated plant watering system, allowing the Arduino microcontroller to switch power to connected devices such as water pumps or solenoid valves. Acting as a switch, the relay module can be triggered by the microcontroller based on predefined conditions, such as soil moisture levels or watering schedules. When activated, the relay module completes or interrupts the electrical circuit, enabling or disabling the flow of electricity to the connected devices, thus initiating or stopping the watering process as required. This functionality enables precise control over the timing and duration of watering cycles, ensuring efficient water usage and optimal plant care.



FIGURE 4.1.7: Single Channel Relay Module
(source: hdelectronicseg.com)

4.1.8 9V BATTERY

The power supply for the automated plant watering system is provided by a 9V battery, ensuring reliable operation and flexibility to move, especially in areas where mains power may be inaccessible or unreliable. The 9V battery serves as a stable source of energy to power the various components of the system, including sensors, microcontroller unit, and communication modules. This battery setup offers portability and ease of installation, allowing the system to be deployed in diverse environments, such as agricultural fields, urban gardens, or remote locations.

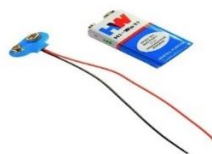


FIGURE 4.1.9: 9V Battery
(source: graylogix.in)

4.2 METHODOLOGY

This methodology content provides a structured overview of how the automatic plant watering system was designed, implemented, and validated using Arduino.

4.2.1 System Design

The system was designed to automate the watering of plants based on soil moisture levels and water flow. Arduino was chosen as the microcontroller platform due to its flexibility and ease of use. Sensors, including a water flow sensor and a soil moisture sensor, were selected to measure the relevant parameters.

Upon powering up, it initializes sensors, LEDs, and the LCD display, and sets up Arduino pins. It reads analog values from the water flow and soil moisture sensors, converting them to milliliters and percentages, respectively. These values are displayed in real-time on the LCD screen, providing feedback on water level and soil moisture. The system uses predefined thresholds to decide whether to activate the pump; if soil moisture is low, the pump is activated via a relay. Additionally, LEDs indicate when the reservoir needs refilling. Users can monitor system status through the LCD display and visually through the LEDs.

4.2.2 Hardware Setup

The soil moisture sensor was connected by attaching its VCC pin to the Arduino's 5V pin, its GND pin to GND, and its signal pin (AO) to the Arduino's analog pin A0. Similarly, the water flow sensor was connected by linking its VCC and GND pins to the Arduino's 5V and GND pins, respectively, and its signal pin (AO) to analog pin A1 on the Arduino. The LCD display, featuring an I2C interface, was connected with its SDA pin connected to the Arduino's analog pin A4, its SCL pin to A5, its VCC to 5V, and its GND to GND. Additionally, three LEDs were connected to digital pins 3, 4, and 5.

The pump, controlled by the relay module, was connected by attaching its positive wire to the relay and its negative wire to GND. Lastly, the relay module was connected by attaching its VCC pin to 5V, its GND pin to GND, and its IN1 pin to digital pin 6 on the Arduino.

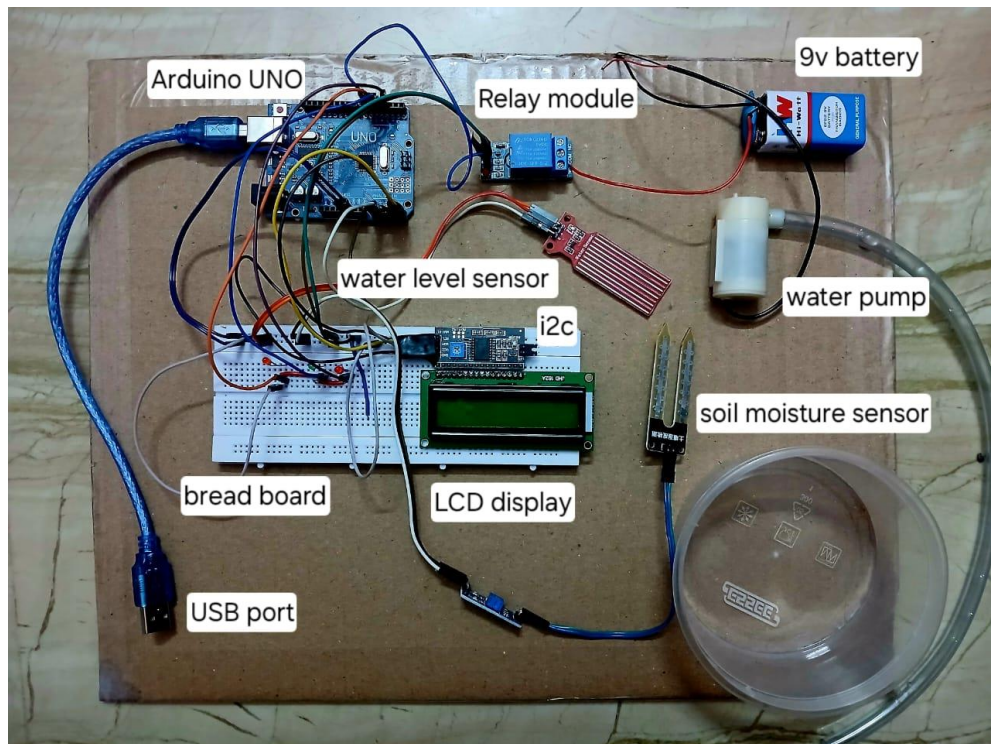


FIGURE 4.2.1: Automated plant watering system setup using Arduino.

4.2.3 Software Implementation

A program code, or Arduino sketch, was created in Arduino version 1.8.19 to read sensor values, control LEDs, and activate the pump based on predefined thresholds. This sketch utilizes the `wire` and `LiquidCrystal_I2C.h` libraries for I2C communication and LCD control, respectively. These libraries were downloaded, zipped, and then added to the Arduino software.



Arduino IDE 1.8.19

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

Refer to the [Arduino IDE 1.x documentation](#) for installation instructions.

SOURCE CODE

Active development of the Arduino software is [hosted by GitHub](#). See the instructions for [building the code](#). Latest release source code archives are available [here](#). The archives are PGP-signed so they can be verified using [this](#) gpg key.

DOWNLOAD OPTIONS

Windows Win 7 and newer
Windows ZIP file

Windows app Win 8.1 or 10 [Get](#)

Linux 32 bits
Linux 64 bits
Linux ARM 32 bits
Linux ARM 64 bits

Mac OS X 10.10 or newer

[Release Notes](#)

[Checksums \(sha512\)](#)

FIGURE 4.2.3: Arduino IDE 1.8.19

4.2.4 Flowchart of the System

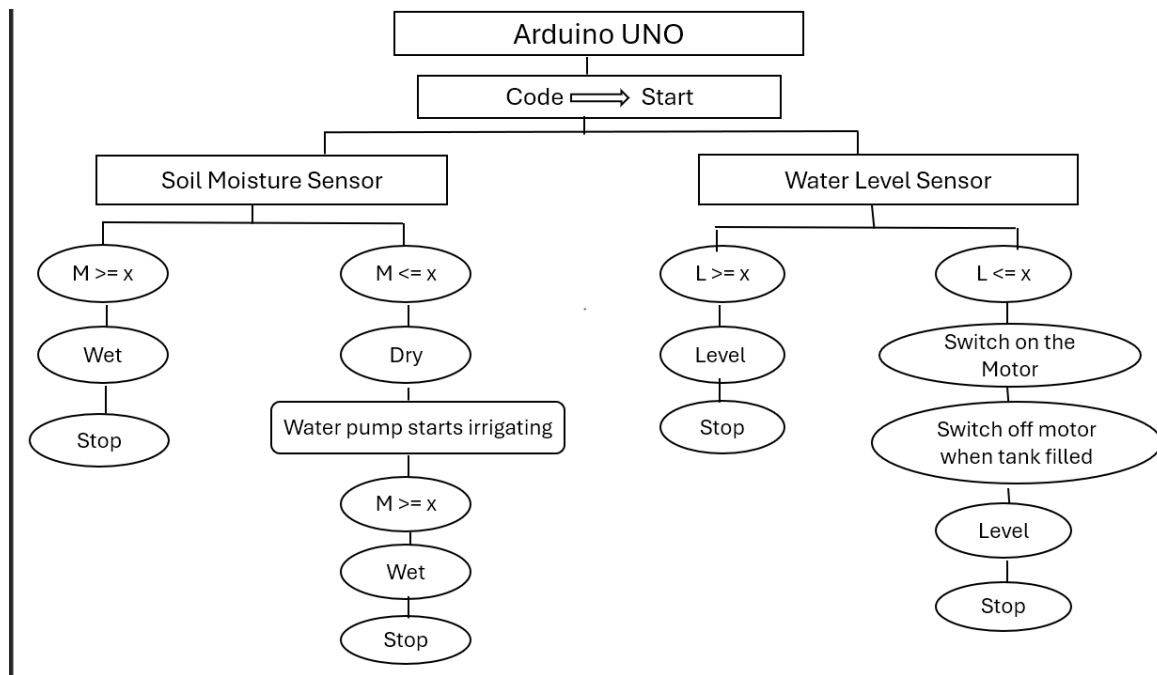


FIGURE 4.2.3: Working Of the Model

4.2.5 Testing and Validation

The system was tested by simulating different soil moisture levels and water flow rates. The functionality of the LEDs and the pump activation were verified based on the sensor readings. The system's responsiveness and accuracy in watering plants were evaluated.

4.2.6 Arduino Sketch

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

// Pins
const int waterFlowSensorPin = A1;
const int soilMoistureSensorPin = A0;
const int led1Pin = 3;
```

```

const int led2Pin = 4;
const int led3Pin = 5;
const int relayPin = 6;
const int numReadings = 10; // Number of readings to average
int waterSensorReadings[numReadings]; // Array to store sensor readings
int waterSensorIndex = 0; // Index for the current reading
float waterAmountAvg = 0; // Average water amount

int soilMoistureValue;
float soilMoisturePercentage;

LiquidCrystal_I2C lcd(0x27, 16, 2); // Address 0x27 for a 16 chars and 2 lines display

void setup() {

    lcd.begin();
    lcd.backlight();
    pinMode(waterFlowSensorPin, INPUT);
    pinMode(soilMoistureSensorPin, INPUT);
    pinMode(led1Pin, OUTPUT);
    pinMode(led2Pin, OUTPUT);
    pinMode(led3Pin, OUTPUT);
    pinMode(relayPin, OUTPUT);
}

void loop() {
    // Read water flow sensor
    int sensorValue = analogRead(waterFlowSensorPin);
    waterSensorReadings[waterSensorIndex] = map(sensorValue, 0, 1023, 0, 200); //
    Assuming 200ml is the maximum capacity of the bowl
    waterSensorIndex = (waterSensorIndex + 1) % numReadings; // Move to the next
    index, looping back if necessary

    // Calculate average water amount

```

```

waterAmountAvg = 0;
for (int i = 0; i < numReadings; i++) {
waterAmountAvg += waterSensorReadings[i];
}
waterAmountAvg /= numReadings;

// Read soil moisture sensor
soilMoistureValue = analogRead(soilMoistureSensorPin);
soilMoisturePercentage = map(soilMoistureValue, 0, 1023, 100, 0);

// Display data on LCD
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Water: ");
lcd.print(waterAmountAvg);
lcd.print(" mL");
lcd.setCursor(0, 1);
lcd.print("Moisture: ");
lcd.print(soilMoisturePercentage);
lcd.print("%");

// Turn on/off LEDs based on water level
if (waterAmountAvg < 50) { // Adjust this threshold as needed
    digitalWrite(led1Pin, HIGH);
    digitalWrite(led2Pin, HIGH);
    digitalWrite(led3Pin, HIGH);
} else {
    digitalWrite(led1Pin, LOW);
    digitalWrite(led2Pin, LOW);
    digitalWrite(led3Pin, LOW);
}

// Turn on pump if soil moisture is low
if (soilMoisturePercentage < 40) {

```

```

    digitalWrite(relayPin, LOW);
} else {
    digitalWrite(relayPin, HIGH);
}

delay(1000);
}

```

4.2.7 Explanation of Arduino Sketch

4.2.7.1 Include Libraries:

The code includes two libraries: `Wire.h` for I2C communication and `LiquidCrystal\_I2C.h` for interfacing with the LCD display.

4.2.7.2 Pin Definitions:

Pins are defined for the water flow sensor, soil moisture sensor, LEDs, and relay.

4.2.7.3 Variable Declarations:

- numReadings: Number of readings to average for the water flow sensor.
- waterSensorReadings: Array to store the sensor readings.
- waterSensorIndex: Index for the current reading in the array.
- waterAmountAvg: Average water amount calculated from the sensor readings.
- soilMoistureValue: Raw value read from the soil moisture sensor.
- soilMoisturePercentage: Calculated percentage of soil moisture

4.2.7.4 LCD Initialization:

The LCD object is initialized with its I2C address and dimensions.

4.2.7.5 Setup Function:

Initializes the LCD and turns on the backlight.

Sets the pin modes for the sensors, LEDs, and relay.

4.2.7.6 Loop Function:

- Reads the analog value from the water flow sensor and maps it to a range (0- 200ml) assuming 200ml as the maximum capacity of the bowl.
- Calculates the average water amount over `numReadings`.
- Reads the analog value from the soil moisture sensor and maps it to a percentage (0-100%).
- Displays the water amount and soil moisture percentage on the LCD.
- Controls the LEDs: If the water amount is below a threshold (50ml), all LEDs are turned on; otherwise, they are turned off.
- Controls the relay (pump): If the soil moisture is below a threshold (40%), the relay is turned on; otherwise, it is turned off.

4.2.7.7 Delay:

There is a delay of 1000 milliseconds (1 second) between each iteration of the loop.

CHAPTER 5

RESULTS AND DISCUSSION

The automatic plant watering system effectively maintained optimal soil moisture levels for the plants, as indicated by the sensor readings and user feedback. The system successfully detected changes in soil moisture and water flow, triggering the pump to water the plants when necessary. The LCD display provided real-time information to the user, allowing them to monitor the system's operation and make informed decisions about plant care.

Condition – 1 – When the soil is Wet.

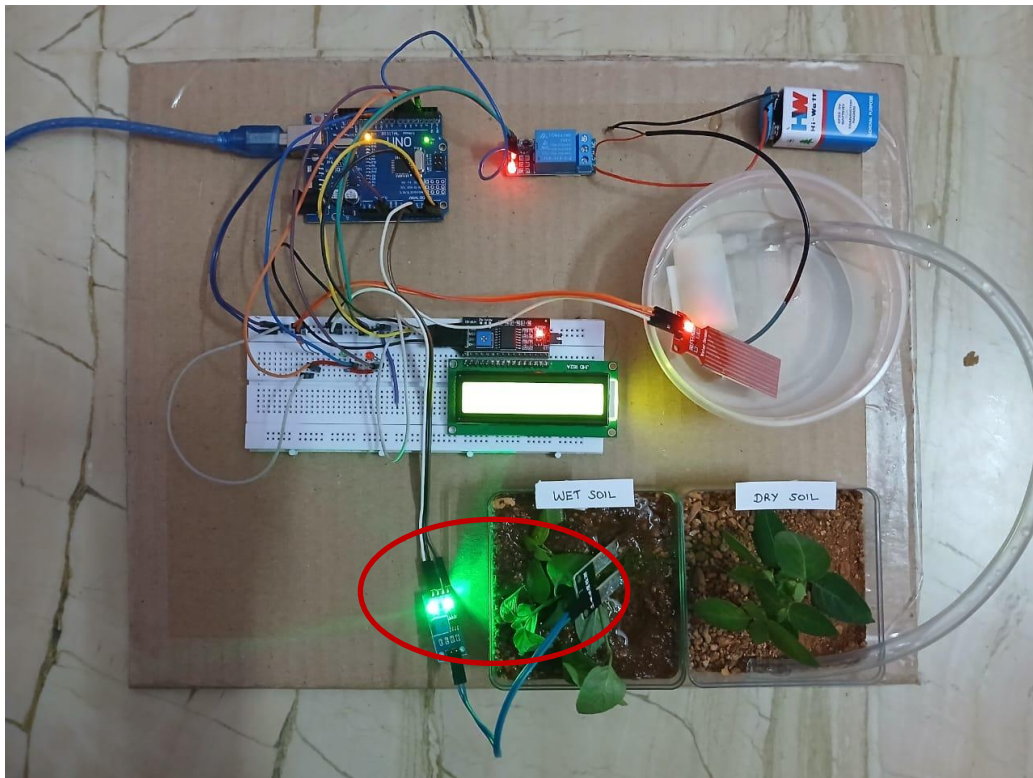


FIGURE 5.1: Soil moisture sensor in wet soil

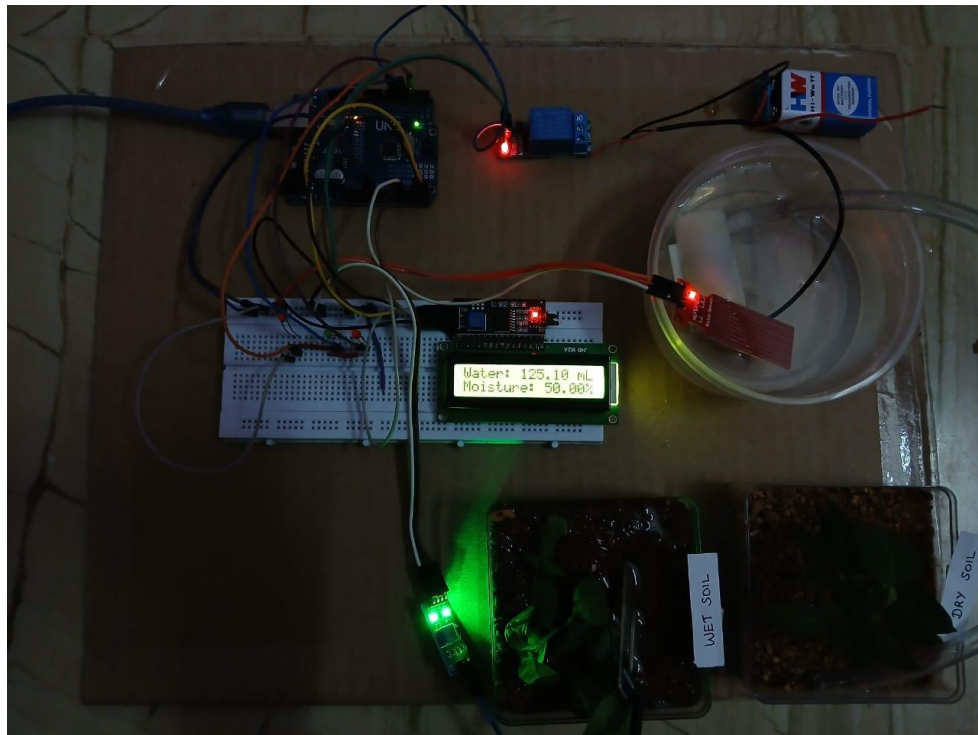


FIGURE 5.2: LCD display showing the percentage and volume of soil moisture and water respectively.

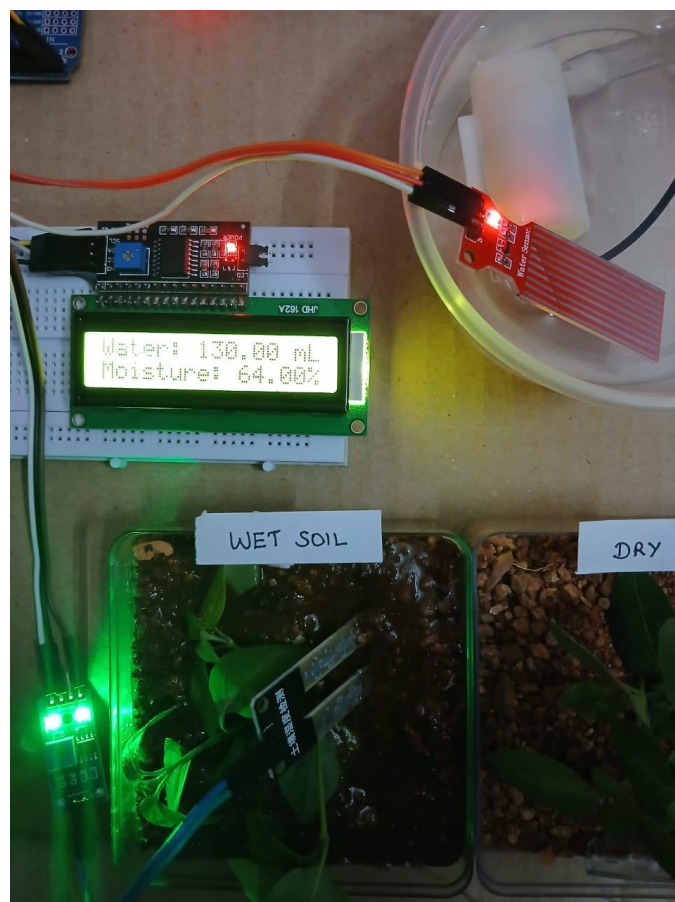


FIGURE 5.3: Moisture percentage over time

When the soil moisture sensor was placed in the wet soil, the LCD display showed a moisture level of 50-64%. Since the soil was already wet with sufficient moisture, the pump did not turn on as no additional water was required for the plant. The water level in the tub was around 125-130ml, which was above the minimum threshold of 50, according to the set up made in the code. As a result, the LEDs were off, indicating that there was enough water in the tank. These conditions are depicted in figures 5.1, 5.2 and 5.3.

Condition – 2 – When the soil is Dry.

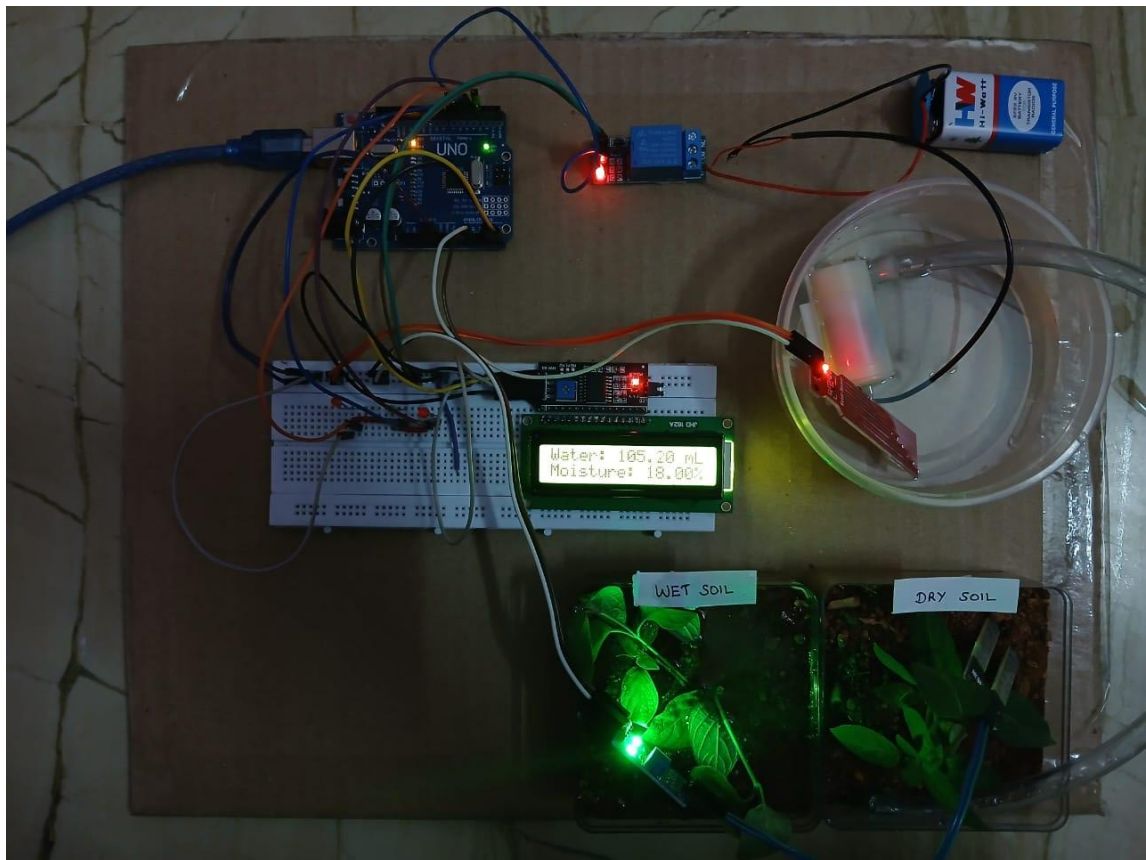


FIGURE 5.4: Soil moisture sensor in Dry soil

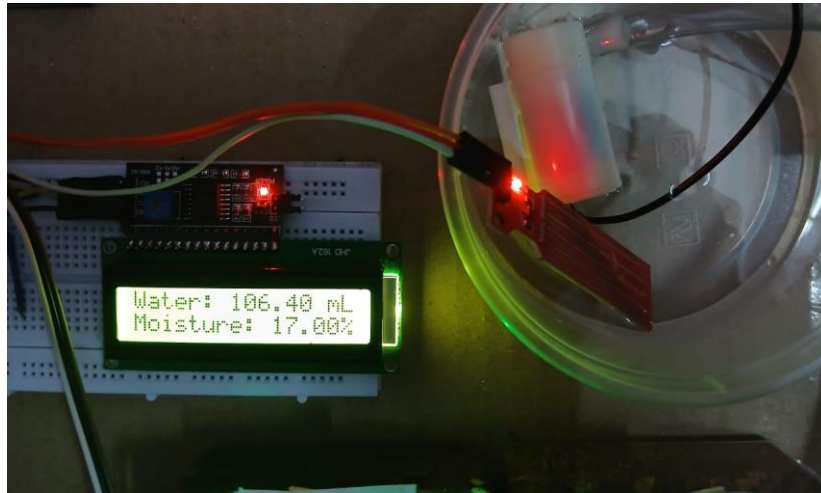


FIGURE 5.5: LCD display showing percentage of soil moisture sensor when dry and the water level remaining.



FIGURE 5.6: Water passed from the activated pump into dry soil

Similarly, when the soil moisture sensor was placed in dry soil, the moisture percentage dropped to 18%. Since this value is below the given threshold, it indicates dryness and the need for water. Consequently, the pump gets activated, and water is poured until the moisture level reaches the minimum threshold. As water is sucked up by the pump from the tub, the water level is reduced from 125-130ml to 105-106ml. Since the code has a minimum threshold of 50 and there is still 105ml left, the LEDs remain off, indicating that there is still water left until it reaches 50ml or below. These conditions are depicted in figures 5.4, 5.5 and 5.6.

CHAPTER 6

SUMMARY AND CONCLUSION

When the soil moisture sensor was placed in wet soil, the system correctly recognized the soil's moisture level and did not activate the pump. Conversely, when the sensor detected dry soil, the system activated the pump to water the plant until the moisture level reached the desired threshold. The LED indicators accurately reflected the water level in the tank, remaining off when there was sufficient water and turning on when the water level dropped below the threshold.

The automatic plant watering system offers several advantages over traditional watering methods. It reduces the risk of overwatering or underwatering plants, which can lead to root rot or dehydration. By using sensors to monitor soil moisture and water flow, the system ensures that plants receive the right amount of water at the right time, promoting healthy growth.

Additionally, the system is user-friendly and easy to operate, making it suitable for both novice and experienced gardeners. The LCD display provides clear and concise information about the soil moisture and water level, allowing users to quickly assess the situation and take appropriate action. The use of LEDs for visual feedback further enhances the system's usability, providing a simple and intuitive way to understand the system's status.

Overall, the automatic plant watering system demonstrates the potential of Arduino-based systems in improving plant care and promoting sustainable gardening practices. Its efficient operation, combined with its ease of use and effectiveness in maintaining optimal soil moisture levels, makes it a valuable tool for gardeners looking to simplify their watering routines and ensure the health and vitality of their plants.

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