Smart Tree Care System Utilizing Internet of Thing (IoT)

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the Requirements forthe **Degree of Bachelor of Science in Computer Science and Engineering**

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APPROVAL

This Project titled **" Smart Tree Care System Utilizing Internet of Thing"**, submitted by Name: **Aditya Chakraborty** ID No: **211-15-4019** to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 12 January, 2025.

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I hereby declare that this project has been done by me under the supervision of **Dr. Md. Fokhray Hossain Professor**, Department of Computer Science and Engineering, Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree.

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ABSTRACT

The "Tree Care System Based on IoT" is a smart and automated solution designed to simplify and enhance plant care. This system integrates Internet of Things (IoT) technology with sensors and a mobile application to monitor and maintain the health of trees and plants efficiently. The system employs a soil moisture sensor and a humidity sensor to continuously measure environmental conditions. If the soil moisture level drops below 20%, the system automatically activates a motor to irrigate the soil, ensuring optimal hydration. Additionally, a mobile application allows users to monitor real-time data such as soil moisture and humidity levels directly from their smartphones. Users can also manually control the irrigation system through the app, providing flexibility and convenience. This dual-mode operation automatic and manual makes the system versatile and user-friendly. The Tree Care System aims to minimize water wastage, reduce human effort, and promote sustainable gardening practices. It is particularly useful for busy individuals and large-scale agricultural applications where consistent monitoring and timely watering are essential. By leveraging IoT technology, this project demonstrates an innovative approach to modern tree and plant.

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Chapter 1

Introduction

1.1 Introduction

As individuals look to improve their living spaces, raise fresh vegetables, and re-establish a connection with nature, home gardening has become more and more popular in recent years. It can be difficult, though, to keep a healthy garden, particularly for people with hectic schedules or no gardening experience. Plants may become overwatered or under watered because of using conventional watering techniques, such as hand watering with a hose or watering can, which are sometimes ineffective and unreliable. The unique plant watering system for home gardening has evolved as a solution to these problems. This system provides an automated and exact method of delivering water to plants, ensuring that they receive the proper amount of moisture at the appropriate time. Whether it is a little balcony garden, a backyard vegetable patch, or an indoor herb garden, plant watering systems offer several advantages that improve the gardening experience for gardeners of all levels. The core of this system lies in its ability to monitor soil moisture and environmental humidity, ensuring that trees receive adequate water when needed. The system utilizing a soil moisture sensor and a humidity sensor to gather real-time data on the tree's immediate environment. When the soil moisture level falls below 20%, an automated motor is triggered to activate the water pump, ensuring the tree receives the necessary hydration without human intervention. This prevents under-watering or over-watering, both of which can harm the tree's growth and health. One of the best features of this system is its mobile application, which provides users with manual control and real-time monitoring. Through this app, users can check the current soil moisture and humidity levels and remotely operate the water pump easily, offering flexibility and convenience. This manual override function is especially useful in cases where the user wants to water the tree despite the automated system not being triggered or during specific weather conditions. For instance, if a user notices a prolonged dry spell or extreme heat, they can manually initiate watering without waiting for the soil moisture level to drop the threshold. This system addresses several common challenges in tree care, particularly for individuals who have busy or are away from home for maximum time. By automating the watering process and providing remote access through a mobile application, the Tree Care System Based on IoT ensures that trees are continuously cared for, even when users are not physically present. This is especially beneficial for urban environments where green spaces are limited, and tree health is crucial to maintaining ecological balance.

1.2 Motivation

In today's fast-paced world, where urbanization is expanding rapidly, the importance of maintaining tree cannot be overstated. Trees and plants play a vital role in improving air quality, providing shadow, and maintaining ecological balance. However, caring for trees, especially in urban areas, can be challenging due to time constraints, lack of knowledge about plant care, and the increasing need for automation to make our lives easier. This is where the motivation for the "Tree Care System Based on IoT" arises. The primary goal of this project is to encourage people to adopt tree gardening by simplifying and automating the maintenance process. One of the most common reasons people avoid planting and maintaining trees is the difficulty in ensuring consistent care, especially watering. Overwatering and under watering are both harmful to plant health, and many people struggle to monitor soil moisture levels regularly. This inspired the idea of developing a system that could automatically manage plant watering and make the process more user-friendly. The system uses IoT technology, integrating a soil moisture sensor, a humidity sensor, and a water motor to monitor the tree's environment continuously. When the soil moisture level drops below 20%, the system automatically activates the motor to water the tree. This ensures the tree gets the necessary amount of water at the right time, reducing the risk of human error. Additionally, a mobile application adds another layer of functionality and convenience. Through the app, users can check real-time soil moisture and humidity levels directly on their smartphones. The app also allows users to manually control the watering process, giving them flexibility and control over their plants even when they are away from home. This feature is especially beneficial for people who travel frequently or have a busy schedule. This project aims not only to assist individual users in tree care but also to promote environmental sustainability. By making tree care simpler and more accessible, it encourages people to plant and maintain more trees, contributing to greener spaces in urban and rural settings alike.The "Tree Care System Based on IoT" represents a step forward in smart gardening solutions, combining technology and environmental awareness to create a system that benefits both people and nature. It is a solution born out of the desire to bridge the gap between technology and environmental care, empowering individuals to take part in preserving our planet while enjoying the beauty of healthy trees.

1.3 Objectives

The primary objective of this research is to design and develop an IoT-based Tree Care System that simplifies the process of tree maintenance for individuals. This system aims to:

1. Monitor Soil Moisture and Humidity: Accurately measure soil moisture levels and humidity using sensors to assess the tree's environment.
2. Automate Watering: Automatically activate a motor to water the tree when the soil moisture level falls below 20%, ensuring optimal hydration.
3. Enable Remote Control via Mobile Application: Provide users with a mobile application that allows them to:
    a. Monitor real-time data on soil moisture and humidity.
    b. manually control the watering system from their smartphone, offering flexibility and

convenience.

4. Promote Tree Care and Gardening: Encourage users to engage in tree planting and gardening by reducing the effort required to maintain healthy trees.

This system seeks to integrate technology and sustainability, making tree care more accessible and efficient for everyone.

1.4 Methodology

Research methodology used in developing the Tree Care System. It details the hardware and software components used, such as the soil moisture sensor, humidity sensor, motor, and mobile application. It also describes the system design, including how data is collected from the sensors, processed, and used to control the motor for automatic watering. The mobile application is explained as a tool for manual control and monitoring, allowing users to view moisture and humidity levels in real-time. This chapter includes technical specifications and explains the step-by-step process for setting up and testing the system.

1.5 Project Outcome

The IoT-based Tree Care System efficiently automates plant watering by monitoring soil moisture, temperature, and humidity in real-time data. The system activates the water pump when soil moisture drops below 20%, ensuring proper hydration for plants. Users can also monitor environmental data and manually control the pump using a mobile app, I provide flexibility and convenience. This project enhances water conservation also reduces manual effort, and provides an easy way to care for plants, making it suitable for home gardening and smart agriculture. It combines automation and user control for effective and sustainable tree care system.

1.6 Organization of the Report

This report is organized into six chapters, each covering a specific aspect of the "Tree Care System Based on IoT" project. Below is an overview of each chapter:

Chapter 1: Introduction
This chapter provides an overview of the project, explaining the motivation, objectives, and expected outcomes. It introduces the problem has being addressed, the system's functionality, and its relevance in the context of modern gardening challenges.

Chapter 2: Background
This chapter discusses the basic knowledge required to understand this project. It includes a literature review summarizing similar studies, applications, and methodologies, as well as a gap analysis to highlight the uniqueness of my work compared to existing solutions.

Chapter 3: Research Methodology
This chapter outlines the methodology and design specifications used in this project. It includes details about the hardware and software components, functional and non-functional requirements, system design, and user interface design. It also describes alternate solutions considered and the rationale behind the selected approach.

Chapter 4: Implementation and Results
This chapter focuses on the implementation of the system and presents the results obtained. It describes the whole environment setup, testing procedures, evaluation metrics, and a discussion of the outcomes. Any challenges encountered during implementation and their resolutions are included.

Chapter 5: Engineering Standards and Design Challenges
This chapter evaluates the project's compliance with relevant engineering standards and discusses my project impact on society, the environment, and sustainability. It also includes a financial analysis, explores complex engineering problems encountered, and details how my project addressed.

Chapter 6: Conclusion
The final chapter summarizes the project's findings, highlights its limitations, and suggests potential future improvements. This structure ensures a clear presentation of the project, making it accessible to readers of diverse technical backgrounds.

Chapter 2

Background

2.1 Introduction

The project focuses on developing an IoT-based Smart Tree Care System to make tree maintenance easier and more efficient for users. By integrating sensors such as the DHT11 for temperature and humidity, and a capacitive soil moisture sensor, the system monitors environmental factors and automates irrigation. The ESP32 microcontroller acts as the core of the system, enabling real-time data collection and remote control via a mobile app. Challenges like ensuring sensor accuracy, effective data collection, and user-friendly mobile application design were addressed. The project highlights the potential of IoT to transform traditional gardening into a smarter, automated process, reducing water wastage and improving plant health. It demonstrates how advanced technologies can be used to simplify home gardening and promote sustainable resource management, offering a practical solution for tree care in modern homes.

2.2 Literature Review

This chapter reviews existing research, technologies, and systems related to soil moisture sensing, IoT applications in agriculture, and mobile-based plant care system. It explores different soil moisture level, their accuracy, and the role of humidity sensors in tree health. The chapter also compares various automated irrigation systems and IoT-based gardening solutions to establish the context of my project project. The review identifies gaps in current systems and emphasizes the need for Tree Care System, which integrates remote monitoring and control through a mobile application.

Table 2.1: Summary of Literature Reviewed

Author (s)	Year	Title	Methodology	Key Findings
G. P. Pereira, M. Z. Chaari, and F. Daroge	2023	IoT-enabled smart drip irrigation system using ESP32	Developed an IoT-based smart drip irrigation system using ESP32 to monitor and optimize water usage.	Efficient water use and remote management of irrigation enhanced agricultural productivity.
K. Shah, S. Pawar, G. Prajapati, S. Upadhyay, and G. Hegde	2019	Proposed automated plant watering system using IoT	Designed an automated watering system using sensors and IoT to detect soil moisture and control water supply.	Improved plant growth and reduced water wastage through automation.
W. Al-Gumaei, S. K. Selvaperumal, R. Abdulla, and C. Nataraj	2018	Smart tree care system with Internet of Things	Developed an IoT system for monitoring tree health using environmental sensors and data analysis tools.	Enabled real-time monitoring of tree health, supporting proactive interventions.
V. Matasov et al.	2020	IoT monitoring of urban tree ecosystem services: Possibilities and challenges	Explored IoT-based monitoring systems to evaluate urban tree ecosystem services and their challenges.	Identified potential for better urban tree management but highlighted technical and practical challenges.
B. Sridhar, S. Sridhar, and V. Nanchariah	2020	Design of novel wireless sensor network-enabled IoT-based smart health monitoring system for thicket of trees	Implemented a wireless sensor network to monitor the health of dense tree clusters using IoT devices.	Demonstrated improved monitoring accuracy and better forest health insights.
Oma, S. Nakamura, T. Enokido, and M. Takizawa	2018	A tree-based model of energy-efficient fog computing systems in IoT	Developed a tree-structured model for energy-efficient fog computing to enhance IoT system performance.	Improved energy efficiency and processing latency in IoT-based systems.

S. S. Kumar, V. C. R. Prasad, and P. R. Rao	2020	Anti-poaching of trees in forest-based on IoT	Designed an IoT-enabled anti-poaching system using sensors to detect illegal logging and transmit alerts.	Successfully detected and reduced poachin g incidents with timely alerts.

2.2.1 Related Research

Related work in the field of IoT-based gardening systems has shown how technology can help improve plant care and farming. Many studies focus on using sensors to monitor important factors like soil moisture, temperature, and humidity, which are all essential for healthy plant growth. Some research has led to automated watering systems that water plants when the soil becomes dry, saving time and effort. These systems often connect to mobile apps, which allow users to check the condition of their plants and control watering remotely from their phones. For home gardening, most projects try to create simple and easy-to-use systems for people who want to take care of their plants without giving too much effort. Some systems use moisture sensors to water plants automatically when the soil is too dry, but there is need for improvement in terms of accuracy and easy of use. Some studies are also focused on making these systems more efficient in terms of water usage and energy consumption.However, most of the existing systems are designed for larger farms, and they can be too complicated or expensive for home gardeners. This project, called the "Tree Care System Based on IoT," aims to fix that by developing an easy-to-use, affordable system for home gardening. It uses sensors to check soil moisture and humidity, and when the moisture level goes below 20%, it automatically waters the plants. A mobile app also lets users control the system manually, so they can check the moisture and humidity levels and water the plants when it's needed. The goal is to make home gardening simpler and more accessible for everyone, encouraging people to take better care of their plants.

2.3 Gap Analysis

Table 2.2: Gap Analysis

Features	**Workin g Principl es of ES P32 (2021)**	**Automate d Plant Watering System (2019)**	**IoT Monitori ng of Urb an Trees (2020)**	**Health Monitori ng for Tr ees (2020)**	**IoT-Enabled Smart Drip Irrigation System (2023)**	**My system**
Soil Moisture Monitoring	No	Yes	Yes	Yes	Yes	Yes
Humidity Monitoring	No	Yes	Yes	No	Yes	Yes

Temperature Monitoring	No	Yes	Yes	No	Yes	Yes
Automatic Watering Based on Sensor Data	No	Yes	No	No	Yes	Yes
Mobile App for Monitoring/Control	No	Yes	No	Yes	Yes	Yes
Display for showing data	No	No	No	No	No	Yes
Manual control mode Ussing switch	No	No	No	No	No	Yes

2.4 Summary

This chapter reviews research on IoT-based systems for agriculture and tree care. It highlights studies on soil moisture and humidity sensors, automated irrigation, and mobile app integration for plant monitoring. Key findings include improved water efficiency, enhanced agricultural productivity, and better tree health monitoring through IoT technologies. Gaps in current systems, such as limited energy efficiency and scalability, are identified. These gaps justify the need for the proposed Tree Care System, which combines soil and humidity sensors with a mobile app for real-time monitoring and control, aiming to improve tree maintenance in home gardening.

Chapter 3

Research Methodology

3.1 Methodology

The methodology for this Tree Care System based on IoT focuses on automating the plant watering process while enabling remote control using a mobile application. The core components include an ESP32 microcontroller, which manages all data from various sensors like the DHT11 for humidity and temperature, and a capacitive soil moisture sensor for detecting soil moisture levels. When moisture level below 20%, the system automatically activates a 12V water pump using a TIP122 transistor. A mobile app, connected through Wi- Fi, allows users to monitor and control the system remotely, adjusting settings or manually triggering the water pump. The system also includes an OLED display for real-time local monitoring. With this setup, the system ensures plants receive proper water while offering users flexibility and control, people can optimizing watering schedules based on real-time data.

3.2 Overview

The "Tree Care System Based on IoT" integrates technology and sustainability to simplify tree maintenance. Using soil moisture and humidity sensors, it automates watering when moisture levels fall below a threshold, ensuring optimal hydration. A mobile app enhances convenience, offering real-time monitoring and manual control. This system addresses common challenges in gardening, promotes environmental sustainability. With a focus on user-friendliness, automation, and water conservation, the project represents a significant step in smart gardening solutions, bridging the gap between technology and ecological care while making tree management accessible to everyone.

3.3 Proposed Methodology

The Tree Care System uses IoT technology to automate tree watering and provide remote monitoring. It consists of an ESP32 microcontroller connected to a soil moisture sensor, humidity sensor, and water pump. When the soil moisture drops below 20%, the system automatically activates the pump to water the tree.

A mobile app, built using Blynk, allows users to monitor soil moisture and humidity levels and manually control the water pump. This method ensures trees get proper care, reduces water waste, and provides an easy to use interface for users to manage tree health remotely.

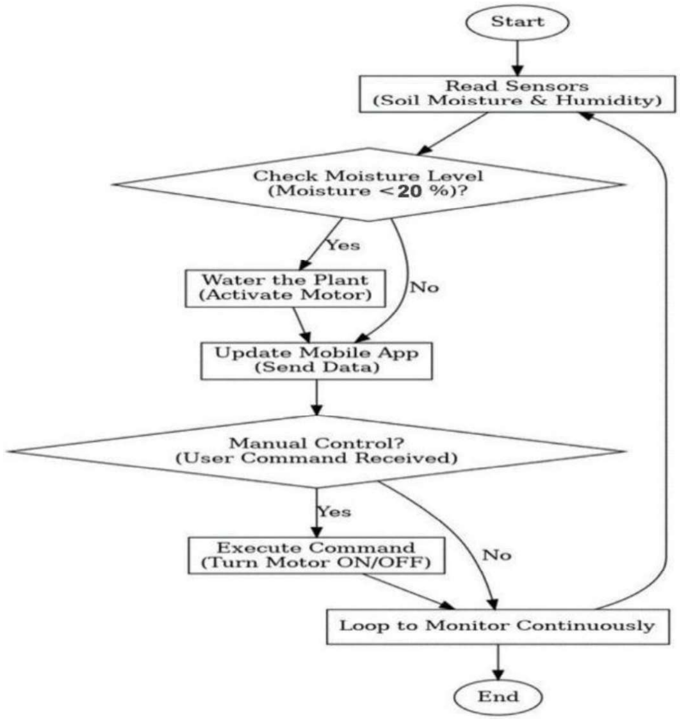

Figure 3.1: Flowchart

3.4 Functional and Nonfunctional Requirements

Functional Requirements:
Functional requirements describe the key features and operations of the system, ensuring it performs its intended purpose.

1. Soil Moisture Monitoring
    a. The system must continuously monitor soil moisture levels using a soil moisture sensor.
    b. It should accurately determine whether the moisture level is below the set threshold (20%) for automatic activation of the watering motor.
2. Humidity Monitoring
    a. The system should gather real-time environmental humidity data using a humidity sensor and display this information in the mobile application.

3. Automatic Watering System
    a. When soil moisture levels drop below 20%, the system should automatically activate the water pump to provide hydration to the plants.
    b. The motor should deactivate once sufficient moisture is

achieved, preventing overwatering.

4. Mobile Application Integration

a. The application must display real-time soil moisture and humidity levels.

b. Users should have the ability to manually trigger the water pump through the mobile app for added flexibility.

5. Alert Notifications

a. The system should send notifications to the user via the mobile app in cases such as low soil moisture, motor activation, or sensor malfunction.

6. System Calibration

a. Users must be able to set thresholds for soil moisture and humidity levels through the mobile app to suit the requirements of different plants.

7. Nonfunctional Requirements:

8. Nonfunctional requirements specify the system's performance, reliability, and user experience characteristics.

9. Usability

a. The mobile application interface must be user-friendly, with intuitive navigation for users of varying technical expertise.

b. Data visualization (e.g., graphs for soil moisture trends) should be clear and accessible.

10. Scalability

a. The system must support expansion to monitor multiple plants or garden zones.

b. It should be adaptable to work with additional sensors or upgraded hardware.

11. Reliability

a. The system must function accurately and consistently in various environmental conditions (e.g., outdoor gardens, indoor settings).

b. Sensors and the motor must be robust and able to withstand fluctuations in temperature and humidity.

12. Performance

a. The system should process sensor data and trigger motor actions within a 1- second delay to ensure real-time responsiveness.

13. Security

a. Communication between the mobile application and the IoT system must be encrypted to prevent unauthorized access.

14 .Energy Efficiency

a. The system components must be energy-efficient to minimize electricity consumption, especially for continuous sensor operation and motor usage.

15 .Cost-Effectiveness

a. The hardware and software design should aim for affordability, making the system accessible to a wide range of users without compromising quality.

3.5 Context Diagram

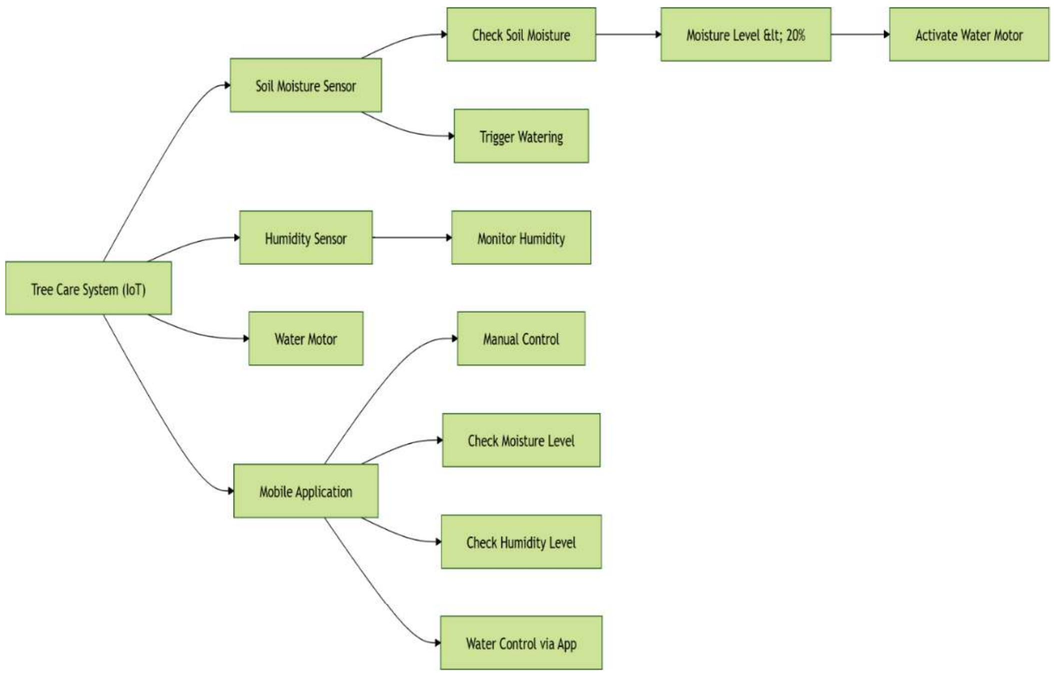

Figure 3.2: Context Diagram

3.6 UI Design

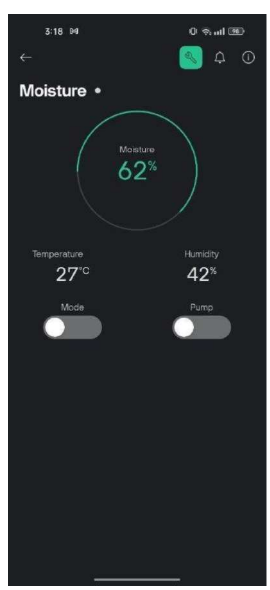

Figure 3.3: App Interface

3.7 Detailed Methodology and Design

Equipment's:

1. NodeMCU: The ESP32 microcontroller is the main component that reads sensor data and regulates actuators. Its roles include reading sensor data, delivering signals to other components, and making decisions based on the moisture condition.
2. DHT11: The DHT11 sensor measures humidity and temperature. It measures temperature within a range of 0 to 50°C with an accuracy of ±2°C. It measures relative humidity from 20% to 90% with an accuracy of ±5%.
3. Capacitive Soil Moisture Sensor: The moisture level in the soil is determined with a capacitive soil moisture sensor.
4. OLED Display: It shows the information like moisture, temperature, humidity that get from the sensors.
5. LED: Used as an indicator for mode, wi-fi connectivity, pump on/off.
6. Power: 12V Power Supply to run the project
7. 7805 Voltage Regulator: The 7805 Voltage Regulator ensures a steady voltage supply by converting 12V DC to 5V DC to power components that need 5V.
8. 12V solenoid pump: It controls the water supply to the plants. The ESP32 triggers it to start or stop watering in according with the information from the moisture sensor or the manual command.
9. Diode: It is used for one direction current flow. We used It to protect the circuit from the potential back generated by 12V pump.

10. TIP122 Transistor: It permits the high-current device to be controlled by the low-voltage signal. We used for controlling the 12V solenoid pump with ESP32 signals.
11. Resistors and Capacitors: Resistors is mainly used to limit current flow for protect the components. Capacitors used for filtering and stabilizing the power supply.

Environment setup:

To write codes and configure Node-MCU I am using Arduino IDE. Also, use Mobile App Integration with Blynk to control and showing data over the internet.

1. Arduino IDE: Commonly used to program microcontrollers such as Arduino and Node- MCU. For writing, compiling, and uploading code to the hardware, it offers an easy-to- use interface.
2. Blynk: For creating smartphone applications that manage and track hardware projects, Blynk is a robust and intuitive Internet of Things platform. It provides a full range of capabilities and tools to less effort manage Internet of Things devices and link hardware to the internet.

Libraries:

1. Adafruit_SSD1306.h: This library is used to interface with SSD1306-based OLED displays.
2. WiFi.h: This library handles Wi-Fi connectivity for ESP32 microcontrollers.
3. WiFiClient.h: This library is mainly use for creating network clients that can connect with servers.
4. BlynkSimpleEsp32.h: This library integrates the ESP32 with the Blynk platform.
5. DHT.h: This library is used for interfacing with DHT11, DHT22, and similar temperature and humidity sensors.
6. AceButton.h: This library is used for managing button input.

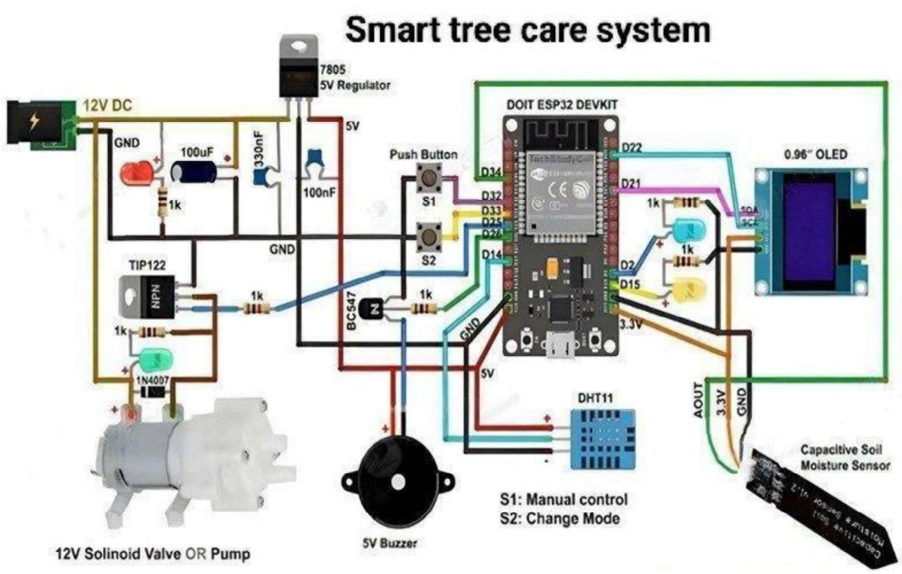

Figure 3.4: Circuit Design

Data Collection Procedure:

The data collection procedure for the plant watering system involves collecting environmental data from various sensors in order to monitor and regulate plant watering. The primary components of information gathering are as follows:

DHT11 Sensor: the DHT11 sensor collects Temperature and humidity data at regular intervals. The ESP32 reads this data via a digital pin attached to the sensor.

Capacitive Soil Moisture Sensor: The soil moisture sensor produces analog data that corresponds to the moisture level in the soil. The ESP32 reads this data via an analog pi.

Data Collection Log (Sample):

Table 3.1: Data Collection Log

Day	Date	Soil Moisture (%)	Humidity (%)	Temperature (°C)	Motor Activation	Manual Watering	Notes
1	2024-11-14	38	75	27	Yes (Auto)	No	Soil moisture below 20%, motor activated.
2	2024-11-15	45	78	29	No	No	Moisture adequate; no watering needed.
3	2024-11-16	35	70	28	Yes (Auto)	No	Auto watering triggered.
4	2024-11-17	47	80	26	No	Yes	User triggered watering manually.
5	2024-11-18	42	74	27	No	No	Moisture level sufficient.
6	2024-11-19	33	69	28	Yes (Auto)	No	Auto watering activated.
7	2024-11-20	50	82	25	No	No	Rainfall increased moisture naturally.
8	2024-11-21	37	76	27	Yes (Auto)	No	Motor activated automatically.
9	2024-11-22	40	77	30	No	Yes	User opted for manual watering.
10	2024-11-23	36	73	28	Yes (Auto)	No	Soil moisture below 20% , motor run.

Key Considerations:

1. Soil Moisture: Measured by the soil moisture sensor. The system automatically activates the motor when levels drop below 20%.
2. Humidity: Affects plant health and water evaporation rate, monitored by the humidity sensor.
3. Temperature: Although not directly tied to the motor's actions, it's important for analyzing trends in soil moisture loss.
4. Manual App Control: Logs manual actions taken by users, reflecting user interaction with the mobile app.
5. Rainfall: Document natural events that affect soil moisture (e.g., rain).

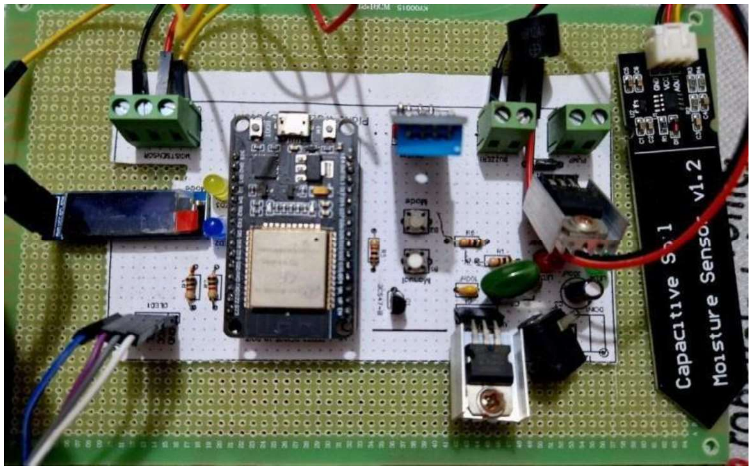

Figure 3.5: Circuit System

Data Preprocessing:

To make the data easier to interpret, normalize the soil moistening sensor results to a consistent scale (for example, 0 to 100%). And set up checks to handle invalid or out-of- range numbers. For example, if the DHT11 sensor returns a temperature or humidity value that is outside of the intended range, the readings can be disregarded or highlighted for further evaluation.

Visualization:

Data visualization provides in understanding the collected data and making informed decisions. This project's visualization is accomplished by:

OLED Display: Displays real-time information about the device configuration. The Adafruit_SSD1306 library is used to communicate with the OLED display, which displays temperature, humidity, and soil moisture levels. This gives users quick feedback.

Blynk App: It allows for remote monitoring and control via a mobile app. The Blynk platform allows us to create a custom dashboard that displays collected data in real time. Users may monitor temperature, humidity, and soil moisture levels on their mobile phones.

Project implementations: The smart tree care system utilizing internet of thing using the ESP32 consists of several important steps: setting up the hardware, configuring the software, connecting to the Blynk platform, and lastly integrating and testing the entire system. Here's a thorough summary of the procedure.

Components:

Table 3.2: List of Components

Components	No
ESP32 Development Board	1
DHT11 Temperature and Humidity Sensor	1
Capacitive Soil Moisture Sensor	1
OLED Display (SSD1306)	1

TIP122 NPN Transistor	1
BC547 NPN Transistor	1
12V Pump	1
1N4007 Diode	1
Resistors (1kΩ)	1
5V Buzzer	1
7805 Voltage Regulator	1
Power Supply (12V DC)	1
Capacitors (100µF, 330nF)	1,1
Push Buttons	2
LED	4

Connecting Components:

DHT11 Sensor: Connect VCC to 5V, GND to ground, and data pin to an ESP32's D14 digital pin.

Soil Moisture Sensor: Connect VCC to 3.3V, GND to ground, and AOUT to an ESP32's D34 analog input pin.

OLED Display: On the ESP32, connect the VCC to 3.3V, GND to ground, SCL to D22 pin, and SDA to D21 pin.

Pump Control: Use the TIP122 transistor to power the 12V pump, with a 1N4007 diode in line to prevent against back EMF.

Buzzer, LED and Buttons: Use suitable 1k resistors to link the buzzer, LED and buttons to digital pins for control and indicator purposes.

3.8 Project Plan

The project will be developed over six phases:

1. Requirement analysis to identify hardware and software needs.
2. Design and prototyping, including the IoT system layout and mobile application interface.
3. Implementation of the hardware setup and app integration.
4. Testing the system for functionality, including sensor accuracy and app control.
5. Optimization based on test results to ensure reliability and user-friendliness.
6. Documentation and final presentation of the project outcomes. A Gantt chart will outline tasks, responsibilities, and deadlines to ensure timely completion.

3.9 Task Allocation

The project tasks ensure to efficient development and completion of the IoT-based Tree Care System. First I handled sensor integration and hardware setup, including the soil moisture and humidity sensors. After managed hardware I am working for software, covering real-time monitoring and manual control.

Table 3.3: Task Allocation

Timing					
	Month-1	Month-2	Month-3	Month-4	Month-5
Project Planning					
Design					
Testing					
Implementation					
Launch					

3.10 Summary

The "Tree Care System Based on IoT" provides an innovative, automated solution for plant watering, enhancing gardening easy and efficiency. This report outlines the system's design, development, and benefits, including automated soil moisture monitoring and mobile app control. It simplifies tree care by ensuring optimal hydration, reducing manual effort, and promoting environmental sustainability. By addressing challenges like overwatering and user convenience, it provides users to maintain healthy green spaces, contributing to ecological balance. The project aligns with modern engineering standards and highlights its social and environmental impacts future advancements in smart gardening solution.

Chapter 4

Implementation and Results

4.1 Environment Setup

To write codes and configure NodeMCU we use Arduino IDE. Also use Mobile AppIntegration with Blynk to control and showing data over the internet.

1. Arduino IDE: Commonly used to program microcontrollers such as Arduino and NodeMCU. For writing, compiling, and uploading code to the hardware, it offers an easy-to- use interface.
2. Blynk: For creating smartphone applications that manage and track hardware projects, Blynk is a robust and intuitive Internet of Things platform. It provides a full range of capabilities and tools to effortlessly manage Internet of Things devices and link hardware to the internet.
3. Libraries:
   a. Adafruit_SSD1306.h: This library is used to interface with SSD1306-based OLED displays.
   b. WiFi.h: This library handles Wi-Fi connectivity for ESP32 microcontrollers.
   c. WiFiClient.h: This library is used for creating network clients that can connect to servers.
   d. BlynkSimpleEsp32.h: This library integrates the ESP32 with the Blynk platform.
   e. DHT.h: This library is used for interfacing with DHT11, DHT22, and similar temperature and humidity sensors.
   f. AceButton.h: This library is used for managing button input.

4.2 Testing and Evaluation/Performance/ Comparative Analysis

The hardware-testing phase focused on verifying the accuracy and functionality of the system components. The DHT11 and soil moisture sensors were tested for accuracy by comparing their readings with reference devices, and both performed within acceptable error margins (±2°C for temperature and ±5% for humidity). Soil moisture readings were consistent with real conditions, ensuring reliable input data. The 12V solenoid pump was evaluated to confirm its activation when soil moisture fell below the threshold of 20%. It operated as expected, responding promptly to sensor inputs and manual commands. The OLED display was tested for real-time visualization, and it accurately displayed temperature, humidity, and soil moisture levels immediately. Additionally, the 7805 voltage regulator provided stable 5V power to the components, ensuring reliable operation without performance fluctuations. Software testing included evaluating the Arduino IDE code for the ESP32 microcontroller, ensuring proper execution and error-free functionality. Each sensor and output device was tested independently, and the code executed tasks reliably without significant bugs. The Blynk mobile app was tested for remote control and real-time monitoring capabilities. It functioned smoothly, providing real-time updates and responding promptly to user inputs, including pump activation and manual watering commands. These tests confirmed the system's functionality, stability, and readiness for practical use.

4.3 Results and Discussion

The Smart Tree Care System was tested for functionality and performance. The system effectively monitored soil moisture, temperature, and humidity, providing real- time data through the OLED display and the Blynk app. The soil moisture sensor successfully activated the pump when moisture dropped below 20%, ensuring plants received water as needed. Manual control through the mobile app worked seamlessly, allowing users to water plants remotely. Challenges included occasional sensor calibration issues, which were resolved through regular monitoring and adjustments. Data visualization on both the OLED display and the app was clear and user-friendly, helping users make informed decisions. The system showed consistent performance during testing, including handling various environmental conditions like rainfall. Overall, the project demonstrated how IoT can simplify tree care, making it accessible for users with busy schedules or limited gardening experience. It highlighted the potential of smart systems to optimize resource usage and improve plant health.

4.4 Summary

The Smart Tree Care System worked well during testing, monitoring soil moisture, temperature, and humidity effectively. It displayed data in real time on the OLED and Blynk app. The pump automatically watered plants when soil moisture dropped below 20%, and manual control through the app functioned smoothly. Minor issues with sensor calibration were resolved through regular checks. Data visualization was clear, helping users make informed decisions. The system performed consistently, even in varying conditions like rainfall. Overall, the project showed how IoT makes tree care easier, saves water, and improves plant health, especially for busy peoples.

Chapter 5

Engineering Standards and Design Challenges

5.1 Compliance with the Standards

For this project, the relevant standards include sensor accuracy, power supply regulations, and IoT communication protocols. I chose the DHT11 sensor and ESP32 for their reliability, with easy to use and good performance, for its better precision but at a higher cost.

5.1.1 Software Standards

The software for this project follows basic coding standards to ensure reliability and readability and it is very easy to use. It uses well-known libraries like Blynk and DHT for smooth integration with hardware, ensuring everything works properly and is easy to understand for anyone.

5.1.2 Hardware Standards

The hardware used in the project follows standard specifications for ensure compatibility and reliable performance. Components like sensors, microcontrollers, and the pump are chosen for their accuracy, durability, and ease of integration.

5.2 Impact on Society, Environment and Sustainability

This Smart Tree Care System helps people to take better care of their plants, even those people they have busy schedules, Stop water waste and improving plant health. It's make home gardening very easy.

5.2.1 Impact on Life

Project makes tree care easy for people by automating watering and monitoring. It helps save valuable time, stop water waste, and ensures plants stay healthy, making gardening simpler for everyone.

5.2.2 Impact on Society & Environment

The Smart Tree Care System helps people take better care of their plants, even those people they have busy schedules, it saves water by only watering when needed, which is good for the environment. This system makes gardening easier and more efficient for everyone.

5.2.3 Ethical Aspects

The ethical aspects of this project focus on ensuring that the system is used responsibly and help our environment. It promotes water conservation and sustainable gardening practices, helping users take better care of their plants without wasting resources.

5.2.4 Sustainability Plan

The sustainability plan for this project involves regular maintenance of sensors and components to ensure long-term functionality. Additionally, the system can be easily updated or expanded with new features to keep it efficient and relevant for future use.

5.3 Project Management and Financial Analysis

The project management plan ensures that tasks are completed on correct time, with each. The total budget for the project is 3000 taka, covering all necessary components, including sensors, the ESP32 development board, and other parts like the power supply, resistors, and wires. This budget makes the project affordable for everyone while ensuring all required materials are available for successful completion.

Table 5.1: Financial Analysis.

Budget	
Components	**Tk**
ESP32 Development Board	480
DHT11 Temperature and Humidity Sensor	185
Capacitive Soil Moisture Sensor	300
OLED Display 0.91"	350
TIP122 NPN Transistor	25
BC547 NPN Transistor	15
12V Pump	190
1N4007 Diode	1
Resistors (1kΩ) - 6	6
5V Buzzer	25
7805 Voltage Regulator	25
Power Supply (12V DC) and Female Port	300
Capacitors (100µF, 330nF)	25
Push Buttons	10
LED	11
Vero Board	190
Pipe	60
Others	715
Total	2913

5.4 Complex Engineering Problem

Complex engineering problems are problems that have no obvious solution, involve multiple technical, social, and ethical aspects, and have significant consequences in a range of contexts. To solve complex engineering problems, engineers need to follow a systematic process that includes defining the problem, gathering information, brainstorming ideas, evaluating and selecting the best solution, planning and designing, testing and prototyping, implementing the solution, and monitoring and evaluating the results.

5.4.1 Complex Problem Solving

Table 5.2: Mapping with complex problem solving.

EP1 Dept of Knowledge	EP2 Range Of Conflicting Requirements	EP3 Depth of Analysis	EP4 Familiarity of Issues	EP5 Extent of Applicable Codes	EP6 Extent Of Stake-holder Involvement	EP7 Interdependence
✓			✓			✓

Ep1: Mechanical Engineering: The use of a motor to control the water flow is a mechanical part. Ensuring that the motor operates efficiently, the system is leak-proof, and the components like pumps and tubing work well together require knowledge of mechanical systems, which falls into engineering but not directly under computer science.

Ep4: Electrical Engineering: Sensors I use like the soil moisture and humidity sensors involve hardware and electrical engineering. Proper calibration of the sensors, understanding about their power needs, and integrating them into your system require knowledge of electrical circuits, which is the part of electrical engineering, which is not purely computer science.

Ep7: The Tree Care System based on IoT includes several components and sub-problems for successful implementation:

1. ESP32 Microcontroller: Manages sensor data, controls pump, and connects to Wi-Fi for app communication.
2. DHT11 Sensor: Measures temperature and humidity for environmental monitoring.
3. Soil Moisture Sensor: Monitors soil moisture, triggering automatic watering when below 20%.
4. Pump Control: Uses TIP122 transistor to control a 12V pump, ensuring efficient watering.
5. Manual Control: Push buttons allow user-activated watering via app or locally.
6. OLED Display: Displays real-time sensor data for immediate feedback. Mobile App Integration: Allows remote monitoring and control of watering, ensuring flexibility.

Mapping with Knowledge Profile for EP1

The project is informed by existing research on IoT applications in agriculture and tree care, with a focus on sensor-based systems and smart farming technologies that can automate plant care(k8). The project utilizes fundamental engineering principles in selecting and implementing sensors like soil moisture and humidity detectors to gather environmental data, essential for monitoring plant health (k3,k4). The integration of various components, including sensors, motors, and mobile apps, demonstrates engineering design skills to create a functional, user-friendly system. (k5). The process of combining hardware and software to build a working prototype reflects best engineering practices, ensuring reliable and efficient system operation. (k6).
This table 5.4) is designed to map the EP2 to the Knowledge Profile.

Table 5.3: Mapping with knowledge Profile.

K3 Engineering Fundamentals	K4 Specialist Knowledge	K5 Engineering Design	K6 Engineering Practice	K8 Research Literature
✓	✓	✓	✓	✓

5.5 Engineering Activities

Table 5.4: Mapping with complex engineering activities.

EA1 Range of re-sources	EA2 Level of Interaction	EA3 Innovation	EA4 Consequences for society and environment	EA5 Familiarity
✓	✓		✓	

EA1 Range of re- sources

The Tree Care System utilizes various technologies to ensure seamless operation and remote connectivity. The system relies on IoT platforms and protocols like Bluetooth or Wi-Fi, with the ESP32 microcontroller offering Wi-Fi capabilities to enable remote control and monitoring. This allows users to access real-time data and manage their plant care easily. For programming the system and integrating the hardware with mobile devices, the project uses Blynk, an intuitive platform that simplifies the creation of mobile applications for IoT projects, providing users with a user-friendly interface to interact with the system.

EA2 Level of interaction

The Tree Care System based on IoT addresses significant challenges in integrating multiple technologies for effective plant care. The primary issue is ensuring accurate soil moisture readings and timely irrigation without over-watering or under-watering. Conflicting sensor data must be resolved for reliable performance. The mobile application must also provide seamless user control while maintaining security and real-time data accuracy. Overcoming these technical challenges requires balancing sensor sensitivity, mobile connectivity, and efficient motor control, ensuring that the system operates reliably and effectively for home gardeners.

EA4 Consequences for society and the environment

Consequences for Society and the Environment

The "Tree Care System Based on IoT" can have significant positive impacts on both society and the environment:

For Society:

1. Encourages Tree Planting and Gardening: This system makes it easier for people to care for their plants and trees, encouraging more individuals to start tree gardening, even if they have busy schedules.

2. Saves Time and Effort: By automating watering and allowing remote control, it reduces the time and effort needed for plant care, making gardening more easy to everyone.

3. Promotes Smart Living: With IoT technology, people can experience a more modern and efficient way of managing their plant, contributing to the adoption of smart home practices.

For the Environment:

1. Conserves Water: The system ensures water is used only when needed, preventing overwatering and reducing water wastage.

2. Improves Tree Health: By maintaining optimal soil moisture levels, trees grow healthier, which contributes to cleaner air and better ecosystems.

3. Reduces Urban Heat: As more people plant trees and greenery, cities can experience cooler temperatures and improved air quality, helping combat the urban heat island effect.

4. Supports Sustainability: The project aligns with global efforts to protect the environment by making it easier for individuals to contribute to a greener planet.

Overall, this system not only simplifies gardening but also promotes environmental awareness and sustainability, benefiting both individuals and the planet.

5.5 Summary

The Tree Care System involves some another engineering activities, focusing on integrating technologies like soil moisture sensors, humidity sensors, and a water pump controlled by an ESP32 microcontroller. The main challenge is solving complex problems such as ensuring accurate readings from sensors and reliable things. The system needs to avoid overwatering or under-watering by handling conflicting data from the sensors, such as humidity affecting moisture readings. Another issue is maintaining smooth communication between the hardware and the mobile app for real-time data monitoring. These challenges require careful balancing of sensor sensitivity for motor control, and mobile app functionality. Successfully solving these problems ensures the system works efficiently, promoting better plant care and watering while making gardening easier and more sustainable.

Chapter 6

Conclusion

6.1 Summary

This project, "Tree Care System Based on Internet of thing," is a smart solution for efficient and automated plant care system. It integrates sensors, a motor, and a mobile application to monitor and manage soil moisture, temperature and humidity levels. By automating the irrigation process and allowing manual control through a mobile application, this system ensures that trees are watered effectively without human intervention or excessive water usage. The use of an ESP32 microcontroller and IoT technology makes the system both cost-effective and scalable, users can easily use this.

The system works by continuously monitoring soil moisture levels using a capacitive soil moisture sensor and checking humidity levels with a DHT11 sensor. When the soil moisture level falls below a preset which is 20%, the ESP32 microcontroller activates the motor to pump water to the tree. The mobile application, built using Blynk, provides real- time data on soil moisture and humidity, allowing users to track the tree's condition remotely. Users can also manually operate the water pump via the app if required. This combination of automation and manual control offers a balance of convenience and flexibility.

This system addresses the challenges of maintaining healthy trees and saving water. It ensures that trees receive adequate care while minimizing water wastage, making it an environmentally friendly solution. The mobile app adds value by giving users control over the process, promoting engagement and easy to use. Whether for home gardeners or larger-scale agricultural applications, this system highlights the potential of IoT in solving real-world problems, demonstrating how technology can make daily tasks more efficient and sustainable.

6.2 Limitation

The limitations of this project include the reliance on sensor accuracy, which are sometimes be affected by some environmental factors. The system depends on Wi-Fi connectivity, so if sometime a weak signal, that moments it may not work properly. In addition, the system only works for a small-scale setup, making it less suitable for larger gardens or farmers. The power supply is limited to a 12V source, which not be enough for larger or more complex systems.

6.3 Future Work

The Tree Care System Based on IoT is the significant potential for future improvements to enhance its efficiency for its user-friendliness, and scalability. One possible upgrade is the integration of advanced sensors, such as pH sensors, light sensors, and additional temperature sensors, to provide a more understanding of plant health. The inclusion of AI and machine learning could optimize watering schedules and predict issues is overwatering. A solar-powered system would make the technology more efficient and ideal for remote location system. Cloud connectivity would allow users to store and access long-term data, making it more useful for large- scale agricultural applications. The system could also be scaled to manage multiple plants it is integrated with smart home platforms like Alexa or Google Assistant for voice control. Finally, supporting community-level data sharing would allow users to exchange insights and improve plant care strategies collectively.

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