SMART PLANT CARE SYSTEM

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering
With Specialization in Artificial Intelligence and machine learning for
the course Design Thinking and Innovation- SCSBDPROJ

By

RESHMA G.V.S. (Reg.No – 43611113)

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
CATEGORY - 1 UNIVERSITY BY UGC
Accredited with Grade "A++" by NAAC I Approved by AICTE
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SCHOOL OF COMPUTING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

APRIL - 2025

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BONAFIDE CERTIFICATE

This is to certify that Design Thinking and Innovation- SCSBDPROJ is the Bonafide work **S.REENA-[43611112], RESHMA G.V.S. -[43611113], A.ROMITHA-[43611116], SRI SOUNDARYA- [43611134], N.J.TSHREYA- [43611144], JANLLYN - [43611173]** who carried out the Design Product entitled **"Smart plant care system"** as a team under my supervision from January 2025 to April 2025.

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Ms Shiela David M.E.,

For 24/4/25

Head of the Department

Dr. A. MARY POSONIA, M.E., Ph.D.

Submitted for Design Thinking and Innovation Examination held on 24/04/25

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Internal Examiner

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DECLARATION

I **RESHMA G.V.S.–[43611113]** hereby declare that the Design Product Report entitled **"SMART PLANT CARE SYSTEM"** done by me under the guidance of **Ms Shiela David M.E.,**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering with specialization in Artificial Intelligence And Machine Learning.**

DATE: 24/04/25

PLACE: Chennai

SIGNATURE OF THE CANDIDATE

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ABSTRACT

In the current era of automation and smart living, daily responsibilities are increaingly being managed by intelligent systems. However, plant care remains one of the most frequently neglected tasks, often overlooked due to demanding work schedules, frequent travel, and inconsistent attention. Many individuals lack the time or resources to ensure that their plants receive proper care on a regular basis. Recognizing this challenge, the Smart Plant Care System has been designed to provide a reliable, automated solution that minimizes human involvement while ensuring optimal plant health and growth.This system automates the maintenance of plants by integrating a series of sensors, microcontrollers, and wireless communication modules, resulting in a self-regulating and user-friendly plant care mechanism. The main objective is to maintain appropriate soil moisture levels and environmental conditions through real-time monitoring and intelligent control. The project began with a basic prototype consisting of a water level sensor, LED indicators, and a buzzer to alert users when water levels were low. While effective for initial awareness, this version required manual intervention and lacked environmental awareness.To improve performance and automation, successive versions of the system introduced a soil moisture sensor to measure the dryness of the soil, a relay module to switch the pump on or off, a water pump for automatic irrigation, and a DHT11 sensor to monitor ambient temperature and humidity. These upgrades enabled the system to respond more intelligently to the actual needs of the plant based on varying environmental factors.The final prototype employs an Arduino Uno microcontroller as the central processing unit of the system. An MH-series soil moisture sensor provides accurate analog readings of soil moisture, ensuring that irrigation is triggered only when necessary.

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CHAPTER 1

INTRODUCTION TO DESIGN THINKING

1.1 OBJECTIVE

The primary objective of the Smart Plant care System is to modernize and optimize Plant care through the application of Internet of Things (IoT) technology. This project was designed with a clear vision to bring automation and intelligence into everyday gardening, especially for urban and semi-urban users. The key objectives are:

1. Automate plant care using IoT sensors.
2. Monitor soil moisture, temperature, and humidity.
3. Optimize water usage through adaptive algorithms.
4. Offer a scalable and cost-effective gardening solution.
5. Educate users on smart gardening techniques.
6. Reduce water wastage by more than 30% compared to manual methods.

1.2 Origin

The project originated from the common struggles identified during a user survey:
78% of respondents owned plants but faced difficulty in maintaining them. Key issues included inconsistent watering, lack of time, and climate adaptability. Existing systems were either too costly or not suitable for Indian conditions, especially power outages and diverse local environments. This prompted the development of an affordable, rugged, and regin-specific automated plant care system.

1.3 Purpose and Innovation

The purpose of this project is to make plant care easier and more effective.

1. To simplify plant maintenance for home gardeners and urban farmers by automating core tasks.
2. To conserve water and improve plant health through real-time monitoring and adaptive responses.

Key Innovations:

1. Vernacular alerts through a mobile app for regional accessibility.
2. Modular design: Easily expandable for different plant quantities.
3. Battery backup: Ensures operation during power cuts.
4. Auto-drainage/Monsoon mode: Protects against overwatering in rainy conditions.
5. Cost-effective: Priced under ₹4,000 (~$50), cheaper than imported alternatives.

1.4 Creativity and Collaboration

CREATIVITY:

The system integrates common components (Arduino, sensors, pumps) in a novel way tailored to Indian conditions.

Incorporation of vernacular language support, solar-powered options, and community gardening models enhances usability and reach.

Includes educational applications (e.g., STEM kits) to promote IoT and sustainability learning.

COLLABORATION:

A team of six students worked under the guidance of a mentor from the Department of Computer Science and Engineering.

Collaboration included user-centric design via surveys, interdisciplinary hardware-software integration, and iterative prototyping with feedback loops.

CHAPTER 2

PROCESS OF DESIGN THINKING

2.1 Empathize

We spent time engaging with gardeners plant owners and 78% of them struggle with maintenance. We understood the challenges like over or under-watering, lack of time, climate adaptability, struggles with climate unpredictability, and the limitations of manual methods. Through, interviews, and contextual inquiry, we identified their need for a solution that could simplify and improve productivity.

2.2 Problem Statement

Traditional plant care fails in India's diverse climates, with urban gardeners struggling to maintain healthy plants due to extreme heat, erratic monsoons, and busy lifestyles. Existing smart systems are either too expensive or not adapted to local conditions like power cuts and hard water. Most solutions also ignore regional plant varieties and language barriers. This leads to wasted water, dead plants, and missed benefits of urban greenery. Our system addresses these gaps with affordable, rugged automation designed specifically for Indian homes.

2.3 Ideation

We explored a variety of ideas, from simple timer-based systems to AI-powered platforms. After evaluating feasibility, cost, and usability, we decided on a modular IoT approach using Arduino Uno , moisture sensors, weather API integration, and mobile app control.

2.4 Prototype

Initial prototypes included basic moisture sensor setups. We then added the Arduino-based controller, automated pumps, and the weather API link. A mobile app interface was developed for data display and control. Field tests helped refine the system, improving sensor calibration and communication stability.

2.5 Testing

The prototype underwent three major levels of testing:

1.Unit Testing**:**

- Verified the accuracy and responsiveness of individual components:
- Soil moisture sensor readings.
- Temperature and humidity sensor outputs.
- Ensured each sensor could reliably trigger alerts or actions independently.

2.Integration Testing:

- Focused on the coordination between the sensors and the pump:
- Checked the logic that triggers the pump when soil is dry.
- Verified proper functioning of the relay and Arduino logic.

3.System Testing:

- Simulated full usage scenarios:
- Monitored plant conditions under varying temperature and humidity.
- Confirmed real-time data transmission to the mobile app.
- Evaluated battery backup under power failure situations.
- Tested monsoon mode with simulated rainfall to check drainage logic.
- Stress-tested the setup under extreme weather conditions (e.g., 45°C, 90% humidity).

CHAPTER 3

EXISTING PRODUCT

3.1 FEATURES

In order to create this product, we must create both hardware and software components

- Arduino UNO R4
- Relay Module
- Soil Moisture sensor
- Water Pump

3.2 HARDWARE REQUIREMENTS

3.3 Arduino UNO R4:

The Arduino UNO R4 is a 32-bit microcontroller that acts as the brain of a smart Plant Care system. It reads data from soil moisture sensors to check if the soil is dry, and can trigger watering, send alerts, or log data. With sensors, it can also monitor power usage for efficiency.

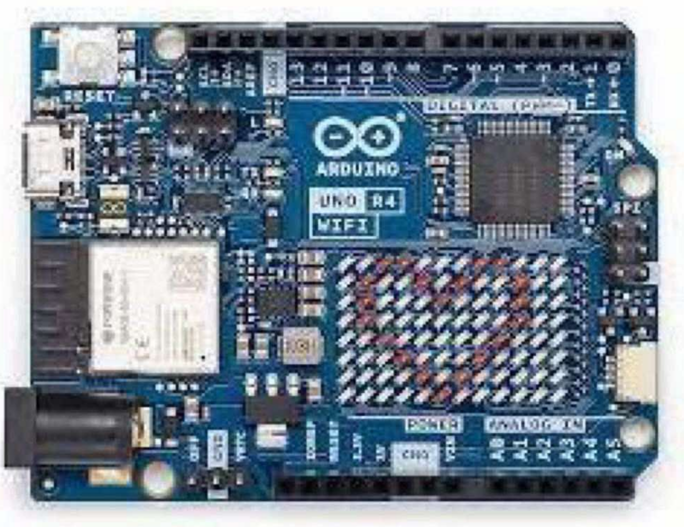

Fig-3.3 Arduino UNO R4

3.4 Relay Module:

The relay module with a single channel board is used to manage high voltage, current loads like solenoid valves, motor, AC load & lamps. This module is mainly designed to interface through different microcontrollers like PIC, Arduino, etc.

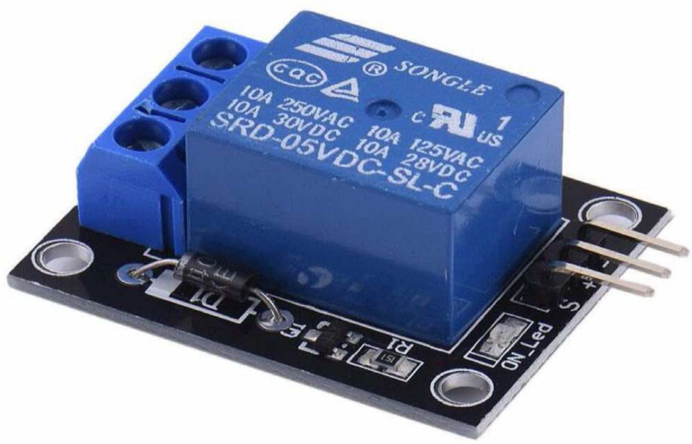

Fig-3.4 Relay module

3.5 Soil moisture sensor:

A soil moisture sensor measures how wet or dry the soil is. In a smart irrigation system, it sends this data to a controller like the Arduino UNO R4, which decides whether watering is needed helping save water and keep plants healthy.

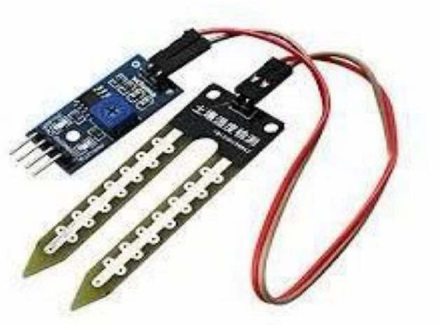

Fig-3.5 Soil moisture sensor

3.6 Water Pump:

A water pump primarily serves the purpose of transferring water between two points or eliminating excess water. The two main types of water pumps are centrifugal pumps and positive displacement pump

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Fig-3.6 Water pump

CHAPTER 4

SOFTWARE AND HARDWARE REQUIREMENTS:

4.1 SOFTWARE REQUIREMENTS

S.No	Software	Purpose
1.	Embedded C++	Programming language used for microcontroller logic
2.	MIT App Inventor	To develop a user-friendly mobile app interface
3.	Firebase (Optional)	For cloud-based data logging and analytics
4.	OpenWeatherMap API	For rainfall forecasting and weather adaptation logic
5.	WiFi Library (ESP*)	Optional if using ESP32/8266 for internet connectivity

4.2 HARDWARE REQUIREMENTS:

s.no	Component	Description
1.	Arduino UNO R4	A powerful microcontroller board based on the Renesas RA4M1 (32-bit ARM Cortex-M4); offers faster processing and more memory for advanced projects.
2.	DHT11 Temperature and Humidity Sensor	Provides digital readings of temperature and humidity; commonly used for environmental monitoring.
3.	Relay Module	An electrically controlled switch used to safely control high-voltage devices like water pumps with the Arduino.
4.	Soil Moisture Sensor	Detects moisture levels in soil; helps automate irrigation by signaling when the soil is dry.
5.	Water Pump	A small DC pump used for delivering water in irrigation systems; controlled via a relay.
6.	HC-05 Bluetooth Module	Enables wireless communication between Arduino and mobile devices using Bluetooth; ideal for remote control applications.
7.	16x2 LCD with I2C Module	A character LCD that displays data like temperature and soil moisture; the I2C module simplifies wiring.

CHAPTER 5

STANDARD SPECIFICATIONS

The Smart Plant Care System is an automated IoT-based solution designed to optimize plant maintenance through real-time monitoring and intelligent irrigation. Functionally, it automates watering based on soil moisture levels, monitors environmental conditions such as temperature and humidity, and allows remote control via a mobile app that supports vernacular languages for better accessibility.

The system features a local 16x2 LCD display for direct readouts and includes battery backup for uninterrupted operation during power outages.

Hardware components include the Arduino UNO R4 microcontroller (based on a 32-bit ARM Cortex-M4), soil moisture and DHT11 temperature/humidity sensors, a single-channel relay module to control a DC water pump, an HC-05 Bluetooth module for wireless connectivity, and a 9V battery or external power supply. On the software side, the system uses the Arduino IDE with Embedded C++ for logic implementation, a mobile app developed using MIT App Inventor, and optionally Firebase for cloud-based logging and the OpenWeatherMap API for rainfall prediction.The system is designed to respond in real time, with adjustable moisture thresholds and fast sensor-actuator interaction.

With an estimated cost of ₹2000–₹2500 (approximately $25–$30), the system is cost-effective, scalable, and suitable for home gardeners, urban farms, and educational use. It has been tested for performance under various environmental conditions, and future enhancements could include AI-based plant diagnostics, solar power integration, cloud analytics, and voice assistant compatibility, making it a robust, sustainable, and user-friendly smart gardening solution.

CHAPTER 6

PROPOSED PRODUCT

6.1 FLOWCHART

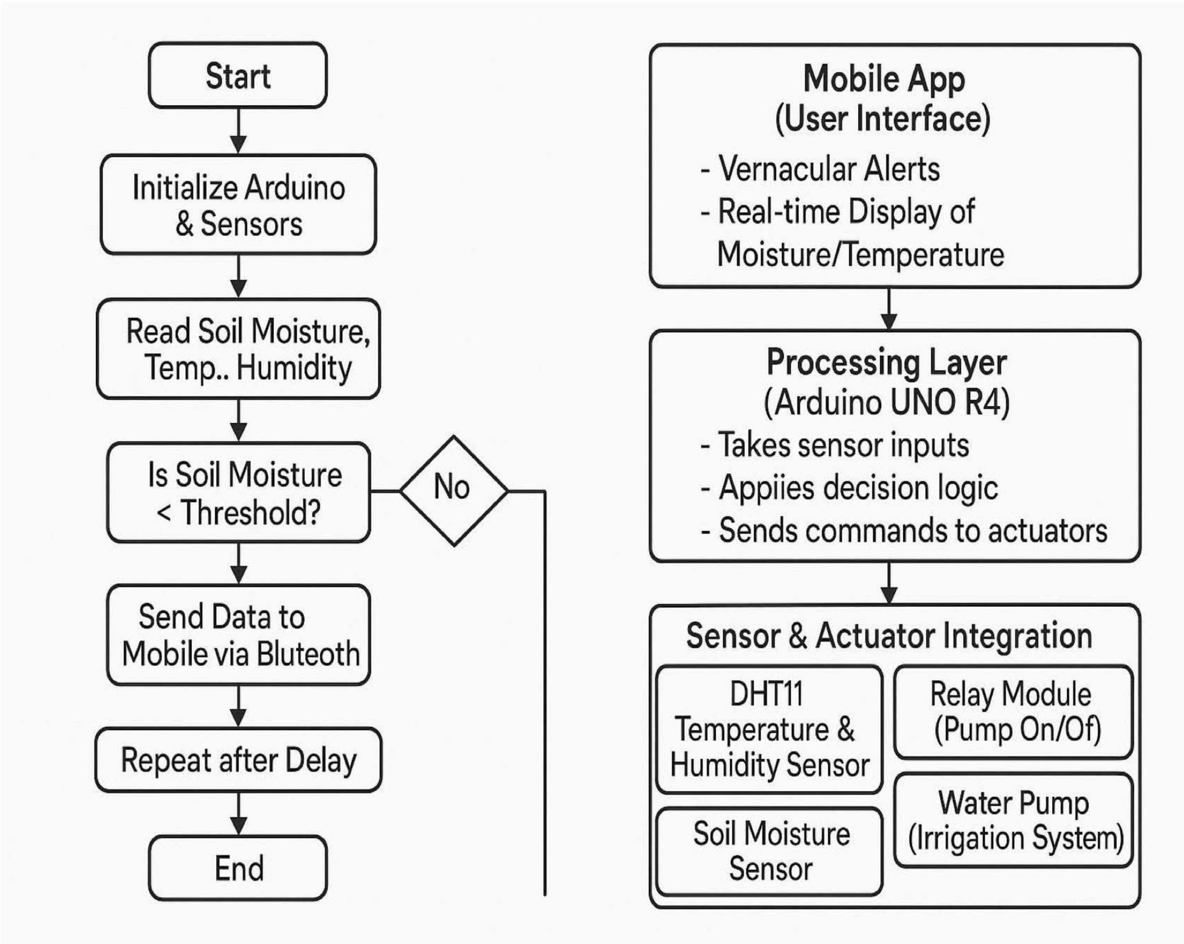

Fig 6.1 **Flowchart**

6.2 ARCHITECTURE DIAGRAM

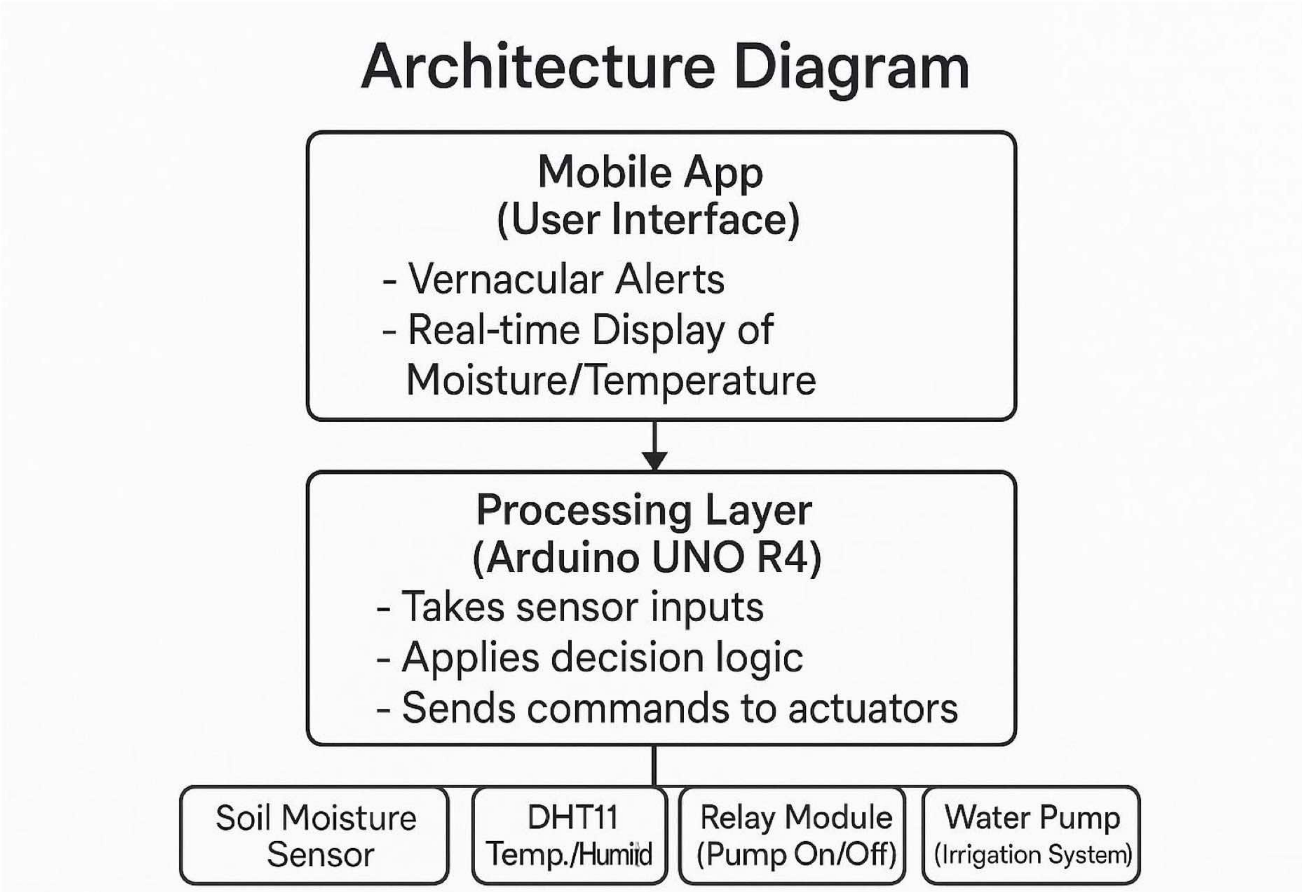

Fig-6.2 **Architecture Diagram**

CHAPTER 7

FEASABLITY STUDY

Feasibility Study for Smart plant care System:

7.1 Technical Feasibility

The Smart Plant Care System is highly feasible from a technical standpoint. It employs well-supported and widely used microcontroller platforms such as the Arduino UNO R4, which offers sufficient processing power and I/O capabilities for integrating multiple sensors and actuators. Sensors like DHT11 for temperature/humidity and soil moisture sensors provide reliable digital input data, while the relay module and water pump act as simple yet effective actuators. Communication via the HC-05 Bluetooth module ensures low-latency, wireless data exchange with a mobile app, while the I2C-based LCD enhances the user interface directly on the device. All components are compatible and supported by open-source libraries, reducing development complexity and risk.

7.2 Operational Feasibility

The system's operation is intuitive and user-friendly, especially with the inclusion of a mobile app interface that supports vernacular languages, enhancing accessibility across different demographics. Users can monitor real-time soil and atmospheric conditions, receive alerts, and control irrigation remotely. The automation reduces the need for manual intervention, making it ideal for home users, working professionals, and elderly plant lovers. Furthermore, the modular design allows the system to be scaled for multiple plants or garden zones. The learning curve is minimal, and basic setup instructions can be easily followed even by non-technical users.

7.3 Economic Feasibility

From an economic perspective, the Smart Plant Care System is cost-effective and offers high value for money. Most of the hardware components (e.g., sensors, relay, pump, and Arduino) are low-cost and widely available in the market. The overall setup can be completed with a budget of under ₹2000–₹2500 (approximately $25–$30), making it affordable for students, hobbyists, and small-scale farmers. Maintenance costs are negligible due to the robustness of components and low energy consumption. The system also offers long-term savings by preventing overwatering and optimizing water usage,which is crucial in areas facing water scarcity.

7.4 Legal and Environmental Feasibility

Legally, the system complies with electronics standards and poses no regulatory concerns, as it does not use any restricted components or radio frequencies beyond safe limits (Bluetooth operates within the ISM band). Environmentally, the system is designed to promote sustainable agriculture by optimizing water usage and reducing plant stress due to under/overwatering. It encourages eco-friendly practices and supports the broader agenda of smart farming and urban greening. Additionally, with a battery backup option for power outages, it ensures operational continuity without reliance on conventional energy sources, thereby enhancing environmental friendliness.

7.5 Schedule Feasibility

The development and deployment schedule is realistic and achievable. A prototype can be completed within 1–2 weeks, including hardware assembly, coding, and testing. With clear modular stages (sensor setup, data processing, communication, UI), tasks can be parallelized for faster development. Time is also saved thanks to the availability of extensive online resources, libraries, and community support. The system is thus well-suited for academic projects, hackathons, and quick pilot implementations in real-world environments.

CHAPTER 8

PROTOTYPE AND IMPLEMENTATION

The prototype of the Smart Plant Care System is designed as a compact, functional model that demonstrates the core features of automated plant monitoring and irrigation. The initial prototype integrates basic sensors and actuators into an Arduino UNO R4 microcontroller. Key hardware components include the DHT11 sensor to monitor ambient temperature and humidity, and a soil moisture sensor to assess the water content in the soil. These sensors feed data into the Arduino, which processes the inputs and triggers actions based on pre-defined conditions. The Arduino logic is implemented using the Arduino IDE with C/C++ language, allowing for real-time, event-based automation of irrigation tasks.

The relay module acts as an interface between the low-power Arduino and the high-power water pump, ensuring safety and efficiency in switching the pump on or off. When the soil moisture falls below a critical threshold, the relay activates the water pump to irrigate the plant. This action continues until the soil moisture returns to an optimal level, at which point the system turns off the pump, conserving water and energy. This feedback loop provides the fundamental automation that defines the system’s smart behavior.

To improve user interaction and remote control capabilities, the prototype includes Bluetooth connectivity using the HC-05 module. This allows the system to transmit real-time data from the sensors to a mobile application developed using MIT App Inventor. The mobile app interface is simple and intuitive, showing live updates of soil moisture, temperature, and humidity. Users can receive alerts, monitor plant health, and even manually control irrigation via the app. Additionally, the app can be localized in multiple regional languages, increasing accessibility for non-English speaking users.

A 16x2 LCD with I2C interface is added to the prototype to provide a local display of sensor data. This feature ensures that users can view environmental readings directly at the device, even in the absence of the mobile app.

The prototype is powered by a 9V battery or external power supply and can be enhanced with a battery backup system to ensure operation during power outages—a vital consideration in rural or power-unstable regions.

Implementation involves assembling the components on a breadboard or PCB, wiring the sensors and modules to the Arduino, and uploading the control logic through the Arduino IDE. The system is then tested in a controlled environment to validate the logic for sensor thresholds, Bluetooth communication, and pump activation. This prototype provides a robust foundation for real-world applications, and its modular design allows it to be easily scaled or extended to support multiple plant units, additional sensors, or features such as solar power, rain detection, or cloud-based monitoring in future iterations.

CHAPTER 9

TESTING

Testing is a crucial phase in the development of the Smart Plant Care System to ensure its reliability, accuracy, and responsiveness under real-world conditions. The testing process begins with unit testing, where each individual hardware component and code module is verified for proper functioning. For instance, the DHT11 sensor is tested to confirm that it accurately reads ambient temperature and humidity within its specified range. Similarly, the soil moisture sensor is evaluated in various soil conditions (dry, moist, and wet) to ensure it provides consistent and reliable readings across different moisture levels.

Following unit testing, the project undergoes integration testing, where components are connected and tested as a whole system. Here, the focus is on verifying whether sensor readings are correctly interpreted by the Arduino and whether the logic for controlling the relay module and water pump is functioning as intended. When the soil is dry, the system should activate the pump, and when the moisture is adequate, it should stop the watering automatically. This stage helps identify any mismatches in logic or hardware communication and ensures a seamless flow of data and actions between all parts of the system.

Bluetooth communication is another critical aspect that undergoes rigorous testing. Using the HC-05 module, the system must consistently transmit sensor data to the mobile app developed on MIT App Inventor. The app is tested for real-time responsiveness, stability during extended connections, and usability under different signal conditions. The testing also includes verifying whether vernacular alerts and real-time updates are properly displayed, offering users a meaningful and smooth interaction with the system. Special attention is given to ensuring that commands sent from the app (such as manual control of the water pump) are executed accurately.

Additionally, system testing is conducted in a simulated environment mimicking real planting conditions—such as outdoor and indoor settings, varying humidity, temperature fluctuations, and intermittent power supply. This helps assess the system's performance in different weather scenarios, particularly its resilience to power outages using battery backup. It is also tested for power efficiency and robustness of component behavior over longer durations, ensuring the setup remains stable and efficient.

Finally, user testing and feedback collection are performed to evaluate the user experience. Volunteers from the target audience (e.g., students, home gardeners) interact with the system and app, providing insights into usability, convenience, and areas for improvement. This stage validates the practicality of the design and the effectiveness of the automation in real-life use. Based on feedback, refinements are made to the interface, sensor calibration, and alert thresholds, leading to a more polished and user-friendly system.

CHAPTER 10

APPLICATIONS

Home Gardening

1. Automated Watering: Sensors detect soil moisture levels and activate irrigation when needed.
2. Light Monitoring & Control: Monitors natural light and activates grow lights to optimize photosynthesis.
3. Plant Health Alerts: Sends notifications for under/over-watering, temperature drops, or pests.
4. Voice Assistant Integration: Control plant care via Alexa, Google Assistant, etc.
5. Mobile App Dashboard: Real-time monitoring of plant status with recommendations.

Smart Agriculture

1. Precision Irrigation: Uses IoT sensors to water only when and where needed, conserving water.
2. Fertilizer Optimization: Analyzes soil nutrients and advises ideal fertilizer amounts and timing.
3. Pest & Disease Detection: Uses image recognition or sensor data to detect early signs of infestation or disease.
4. Climate Monitoring: Tracks environmental conditions (temp, humidity, CO_2) for greenhouse or open field crops.
5. Yield Prediction: Uses historical and real-time data to forecast crop yield.

Commercial Plant Maintenance

1. Indoor Plant Management: Office buildings, malls, or hotels can automate watering and lighting for aesthetic plants.
2. Vertical Farming Automation: Controls and optimizes microclimate conditions for hydroponic/vertical farms.
3. Maintenance Alerts: Notifies staff for pruning, pest control, or system maintenance.

Environmental and Educational Use

1. Urban Greening Projects: Helps maintain plants in public parks or smart cities.
2. Education & Research: Used in schools and universities for learning plant biology and sustainability practices.
3. Community Gardens: Shared systems for community-managed plant spaces.

CHAPTER 11

FUTURE ENHANCEMENTS

Future enhancements for the Smart Plant Care System can significantly elevate its efficiency, intelligence, and user experience. One promising direction is the integration of AI-powered plant diagnostics using computer vision and machine learning to detect issues such as leaf discoloration, wilting, pests, or fungal infections, enabling real-time health assessments through a mobile app. Cloud-based analytics can be incorporated to store and visualize sensor data over time, allowing users to track trends, monitor growth patterns, and compare performance across different environments or regions.

Predictive maintenance using AI can analyze historical data to forecast when plants might experience stress due to nutrient deficiencies or changing weather conditions. Additionally, robotic assistance—through mobile bots or drones—can automate tasks such as watering, fertilizing, and visual inspections. Integration with weather forecast APIs would enable the system to adjust irrigation schedules intelligently, avoiding overwatering and optimizing resource use.

A recommendation engine could further personalize plant selection and care advice based on environmental conditions and user preferences. For commercial or community setups, enhanced security with role-based access and audit trails would add control and accountability. Deeper voice assistant and IoT integration could enable hands-free control and real-time updates via smart home ecosystems. Lastly, sustainability metrics can be introduced to quantify water savings, fertilizer efficiency, and overall environmental impact, especially if renewable energy sources like solar power are employed. We can further add these components to improve our product:

11.1 DHT11 Temperature and Humidity Sensor:

DHT11 is a single wire digital humidity and temperature sensor, which provides humidity and temperature values serially with one-wire protocol. DHT11 sensor provides relative humidity value in percentage (20 to 90% RH) and temperature values in degree Celsius (0 to 50 °C).

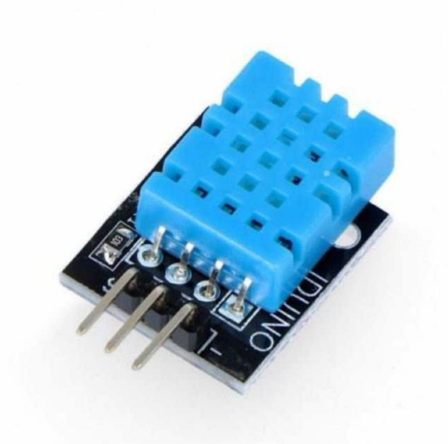

Fig 11.1 DHTT

11.2 HC-05 Bluetooth Module*:*

Wireless communication is swiftly replacing the wired connection when it comes to electronics and communication. Designed to replace cable connections HC-05 uses serial communication to communicate with the electronics. Usually, it is used to connect small devices like mobile phones using a short-range wireless connection to exchange files. It uses the 2.45GHz frequency band. The transfer rate of the data can vary up to 1Mbps and is in range of 10 meters.

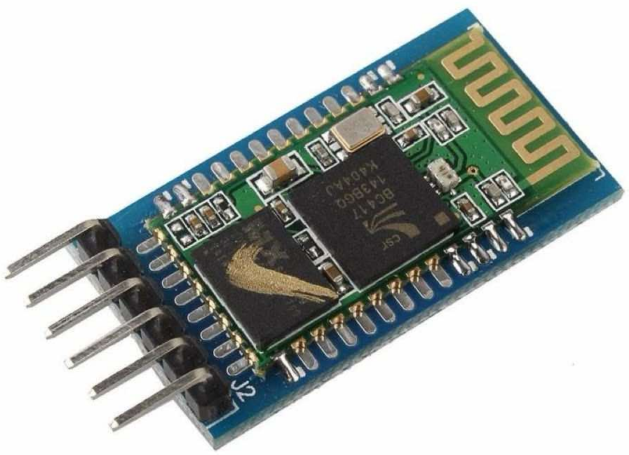

Fig 11.2 HC-05 Bluetooth module

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APPENDIX
SCREENSHOT OF THE PRODUCT

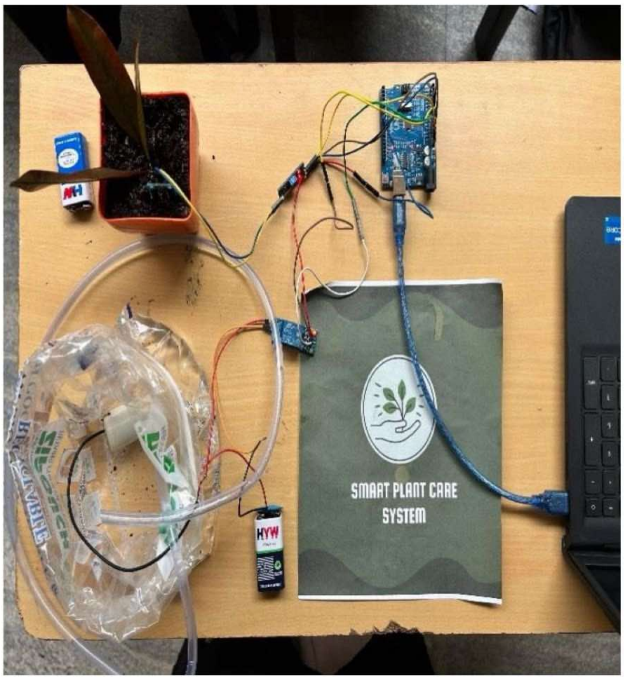

Fig 1. Working Model

Fig 2. Prototype of the product

Fig 3. Water dripping

Fig 4. Water not dripping