

Engineering & Project Management

ACDA5025A

BEng Electrical & Electronic Engineering

Joe Williams 2413881

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1. Introduction

In recent years, there has been a significant surge in interest surrounding indoor gardening and plant care, driven by increasing awareness of environmental sustainability, mental wellbeing, and the aesthetic benefits of greenery in interior spaces [1].

As urban living continues to grow, with more people residing in apartments or homes with limited outdoor space, indoor plants offer a manageable and appealing way to bring nature indoors. Studies have shown that houseplants can contribute to improved air quality, reduced stress, increased productivity, and enhanced overall mood, making them a popular choice among individuals seeking a healthier and more calming living environment [1].

However, maintaining healthy indoor plants can be challenging, especially for individuals with limited gardening experience or hectic lifestyles. Many plant owners struggle with understanding the specific care requirements of different species, which can lead to common issues such as overwatering, underwatering, and insufficient light exposure. These problems are not only frustrating but can also discourage people from continuing to care for plants, leading to poor plant health or premature plant death [2].

This proposal outlines a project to design and build a **Smart Plant Monitoring System**, a compact electronic device that helps users care for indoor plants by monitoring key environmental conditions. This system is intended to be simple, affordable, and educational, combining hardware and software in a practical real-world application.

2. Project overview

The Smart Plant Monitoring System is a compact and affordable electronic device designed to assist users in maintaining optimal conditions for indoor plant care. Its core functionality revolves around monitoring four key environmental parameters: soil moisture, ambient temperature, humidity, and light intensity. By collecting real-time data through a set of reliable sensors, the device provides users with immediate feedback on the health of their plant's environment. This feedback is delivered through a simple 16x2 LCD display for numerical readouts, and an RGB LED system that visually indicates the plant's status, green for ideal conditions, yellow for moderate attention, and red for urgent intervention.

The system is designed with usability and accessibility in mind. It will be powered via USB or battery, ensuring portability and flexibility for placement anywhere in a home or indoor environment. Housed in a 3D-printed or recycled enclosure, the device is compact and durable, making it suitable for a variety of settings including homes, classrooms, or offices. Its functionality is aimed at reducing user error, such as overwatering or insufficient lighting, which are common causes of poor plant health.

In addition to aiding casual users or beginner gardeners, this device also has educational potential. It can serve as a practical demonstration of electronics, sensor integration, and basic programming for students or hobbyists. Overall, the project combines accessible technology with an everyday application to promote both sustainability and learning.

3. Aim and objectives

3.1. Aim

To design and propose an electronic device - while considering project planning, potential risks, ethical concerns, and societal and environmental impacts.

3.2. Objectives

1. **Define the functional requirements**, including key parameters to be measured (soil moisture, temperature, humidity, light intensity).
2. **Specify the hardware components** and system specifications, such as sensor types, microcontroller selection, power requirements, and display/interface options.
3. **Outline a detailed project plan** identifying tasks, activities, dependencies, and estimated durations for each stage of the design and build process.
4. **Identify key milestones and deliverables** throughout the project timeline, such as completion of design schematics, component selection, prototype simulation, and final documentation.
5. **Analyse potential risks** involved in the project and proposed risk mitigation strategies to address technical, time, and resource-related challenges.
6. **Evaluate the environmental and societal impacts** of the proposed device, including resource use, energy consumption, and benefits to plant care and sustainability.
7. **Discuss ethical considerations** related to the device's production, use, data privacy, and possible misuse, ensuring responsible and fair implementation.

4. Background Research

Plant care depends on maintaining ideal environmental conditions. Different species require varying levels of moisture, sunlight, and temperature. Overwatering is a common problem, often causing root rot and fungal infections. Conversely, underwatering can lead to dehydration and wilting [3].

Traditional soil moisture meters are analogue and require manual inspection. Similarly, light and temperature conditions are not typically monitored unless the user actively checks them [4]. A smart, automated solution bridges this gap, combining sensor technology with user feedback to improve care quality.

4.1. Existing Systems:

- Products like Xiaomi's "Mi Flora" or the Parrot Flower Power offer plant monitoring but are either expensive or limited in functionality.
- DIY communities have successfully created similar devices using Arduino and ESP microcontrollers [5].
- Research suggests that users are more likely to engage in plant care when provided with simple, timely reminders (e.g., blinking LED or phone alerts [6]).

Modern technology plays a crucial role in sustaining agricultural productivity, especially when resources are limited. It enables farmers to effectively monitor environmental conditions, assess soil nutrient content, optimise water usage, and manage agricultural data more efficiently. With the advent of various sensors and computing devices, it is now possible to gather and analyse real-time data from crops, supporting timely and well-informed decision-making [7].

5. Project design

5.1. Hardware Components

Microcontroller: Arduino Uno

Sensors:

- Capacitive soil moisture sensor for long life (corrosion resistant material [8]).
- DHT22 sensor for temperature and humidity.
- Light-dependent resistor (LDR) for ambient light.

Display: Small 16x4 LCD display for real-time readings.

RGB LED: Green = good, Yellow = moderate, Red = warning.

Power Supply: USB or battery pack (5V regulated).

Enclosure: 3D printed box or recycled plastic housing.

5.2. Software functions

- Code will be written in C++ using the Arduino IDE.
- Sensor readings will be processed and displayed every 10 to 30 seconds.
- Thresholds will be set for soil moisture, light, and temperature.
- Alerts will be triggered based on deviation from ideal conditions.

5.3. Operational Logic

- Read data from sensors.
- Compare with predefined thresholds.
- Trigger visual alerts
- Log readings (optional for future version).

6. Prototype drawing

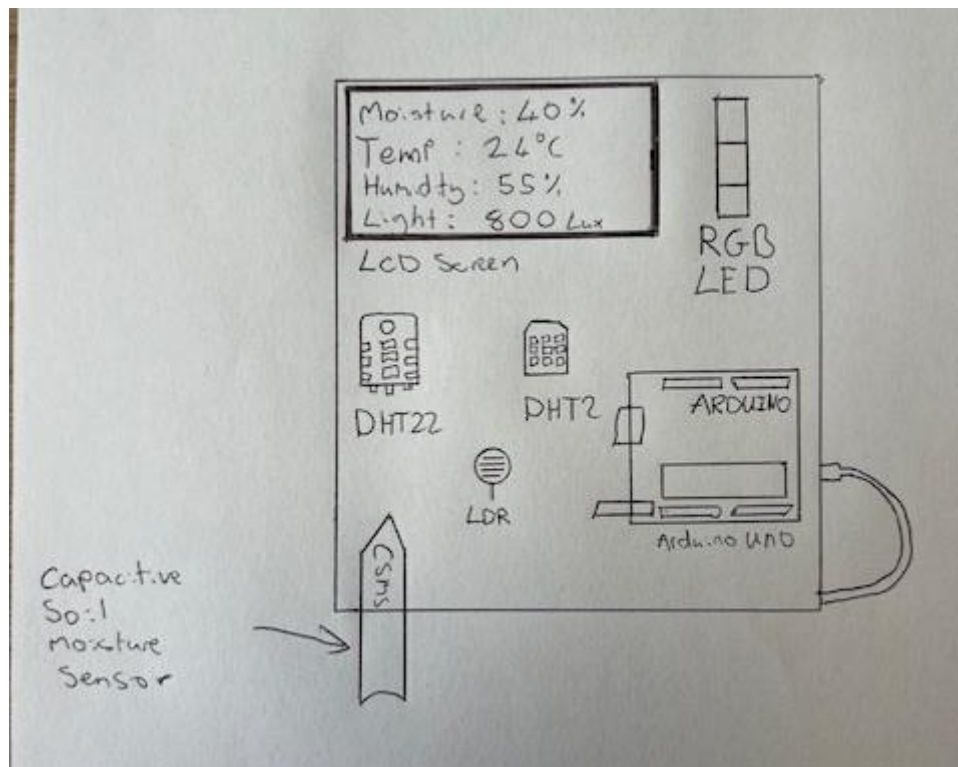


Figure 2. Paper drawn prototype of the smart plant monitoring system

Figure 2. Visual Prototype of the Smart Plant Monitoring System

This illustration represents the final design concept of the Smart Plant Monitoring System. The device includes a compact enclosure housing a 16x4 LCD display, RGB status LED, and environmental sensors. The capacitive soil moisture sensor extends into the plant pot to monitor water levels, while the DHT22 sensor and LDR measure temperature, humidity, and ambient light respectively. The system is powered via USB or battery and is designed to be affordable, portable, and user-friendly.

7. Resources

7.1. Hardware resources

The Smart Plant Monitoring System relies on a range of electronic components that work together to collect environmental data and provide real-time feedback to the user. Each hardware component was chosen for its functionality, availability, cost-effectiveness, and ease of integration with the Arduino Uno microcontroller.

Table 1. Shopping list

Table 1 shows a component shopping list for the project.

Component	Cost
Arduino UNO	£15
Capacitive soil moisture sensor	£4
DHT22 Sensor (Temp & Humidity)	£8
LDR (Light Dependent Resistor)	£2
16x4 LCD Display	£10
RGB LED	£1
Wires	£2
Enclosure	£4
Estimated Total cost: £46	

This estimated total provides a rough budget for prototyping the Smart Plant Monitoring System. Costs may vary slightly depending on the supplier, bulk ordering, or availability of components. However, keeping the total under £50 makes the project affordable for students and hobbyists alike.

Furthermore, all chosen components are widely supported in online communities, making troubleshooting and future upgrades more accessible. The modularity of the hardware also allows for scalability; for instance, more sensors could be added in future iterations (e.g., CO₂, pH, or Wi-Fi modules), enabling additional functionality without significant changes to the core system.

7.2. Software tools

- Arduino IDE (For coding the Arduino)
- Proteus (For circuit diagrams)

8. Planning - Gantt Chart

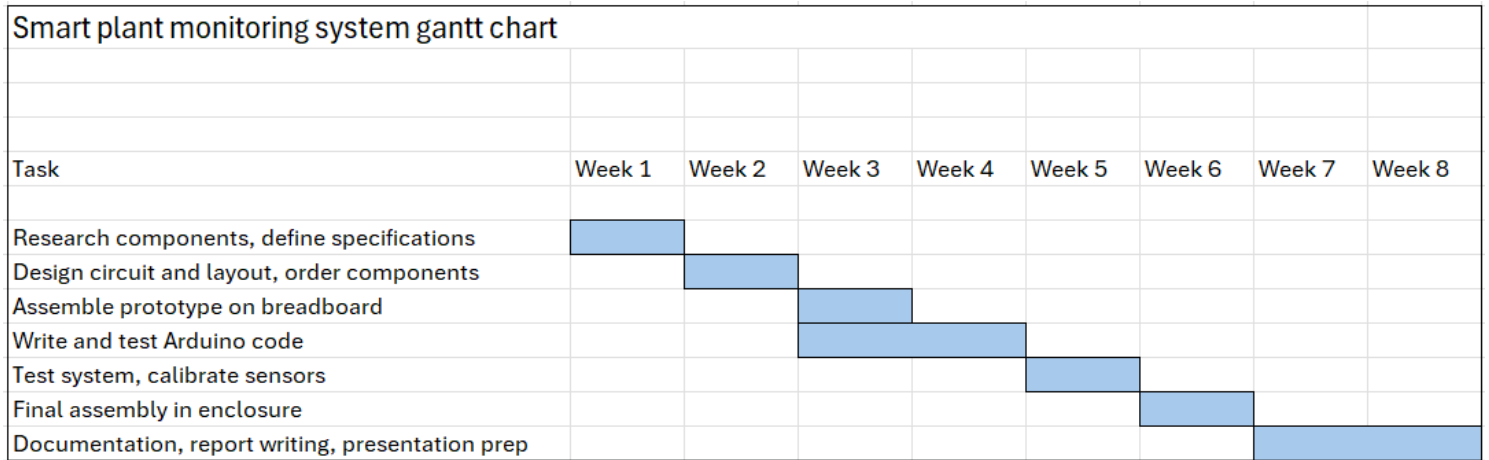


Figure 1. Gantt Chart used for project planning

Figure 2 Shows a Gantt chart to visually represent the project for easier task tracking and time management.

Gantt charts are graphical tools that illustrate project tasks in relation to a timeline. They provide key insights such as task assignments, durations, and any overlapping activities [9]. By mapping out when each task is scheduled and how they relate to one another, Gantt charts help visualize the overall project flow and progress [9].

One of their key advantages is the ability to highlight task dependencies indicating which tasks must be completed before others can begin. This allows project managers to anticipate potential bottlenecks and make informed decisions to keep the project on track [10].

9. Critical path analysis

To ensure efficient project delivery and identify tasks that directly affect the overall timeline, a **Critical Path Analysis (CPA)** was conducted. The critical path outlines the sequence of tasks that must be completed on time for the entire project to finish as scheduled. Delays in any of these tasks would directly delay the project completion.

Table 1 below shows the key tasks, their durations, and dependencies:

Table 2. Critical path analysis

Task ID	Task Description	Duration(Weeks)	Dependencies
T1	Research components, define specifications	1	-
T2	Design circuit and layout, order components	1	T1
T3	Assemble prototype on breadboard	1	T2
T4	Write and test Arduino code	2	T3
T5	Test system, calibrate sensors	1	T4
T6	Final assembly in enclosure	1	T5
T7	Documentation, report writing, presentation prep	2	T6

From this breakdown, the **critical path** is:

T1 → T2 → T3 → T4 → T5 → T6 → T7

The total duration of the critical path is **8 weeks**. This assumes no task overlap and that resources are available as planned.

Tasks such as sourcing components or enclosure fabrication could run in parallel and therefore are **non-critical**, provided they are completed before assembly.

By focusing on the critical path, time and resources can be allocated to avoid bottlenecks and maintain control over the schedule.

10. Expected Outcomes / Deliverables

10.1. Expected Outcomes

- **Fully Working Smart Plant Monitoring System**
A functional and reliable prototype capable of monitoring and displaying key environmental parameters that affect plant health
- **Soil moisture,**
measured with a sensor to detect when watering is needed.
- **Ambient light,**
using a light sensor to determine if the plant is receiving enough sunlight.
- **Temperature,**
to identify if the plant's environment is within an acceptable range.
A digital LCD screen will display live readings.
LED indicators will provide quick visual feedback.
- **Increased Plant Care Awareness**
The device aims to help users develop better habits in maintaining healthy plants by offering regular, easy-to-understand feedback on their condition.

10.2. Deliverables

- **Smart Plant Monitoring Device (Prototype)**
A fully assembled and operational hardware unit that includes all sensors, display, microcontroller (Arduino), and power supply.
- **Arduino Source Code**
Complete Arduino code used to collect sensor data and control the interface.
- **Circuit Diagram**
A clear diagram showing how all the components are connected.
- **Final Project Report**
A detailed write-up covering all stages of the project, including:

System design and component choices

Implementation and challenges

Testing and results

Conclusion and possible future improvements

11. Risk & Ethical Concerns

In planning a project of this nature, it is essential to consider the potential risks that could affect the progress, practicality, or integrity of the Smart Plant Monitoring System. Although this project is theoretical and does not involve actual construction, identifying these risks allows for a more comprehensive understanding of the design process and how such challenges would be addressed in a real-world scenario.

One of the most notable risks in this project would be **technical limitations or hardware compatibility issues**. For instance, integrating various sensors (such as soil moisture, light, and temperature/humidity sensors) with a microcontroller like the Arduino could lead to unexpected issues with data accuracy, power management, or pin limitations. In a practical build, poor wiring or signal interference could cause unreliable readings. These risks could be reduced through early-stage prototyping and simulation using tools like Proteus, as well as thorough research into sensor specifications and compatibility before finalising the design.

Another potential risk is **scope creep or poor time management**. Without a structured plan, the project could become overly complex or extended beyond its initial goals, especially if more features are considered mid-way. To prevent this, a clear project scope would be established at the beginning, accompanied by a detailed Gantt chart and milestone tracking. Allocating buffer time for each phase and regularly revisiting the schedule would help maintain focus and ensure that deadlines are met.

From an **ethical standpoint**, the use of electronic components raises several concerns related to **sustainability and resource consumption**. Most electronic sensors and microcontrollers are produced using finite resources and may contribute to electronic waste if not disposed of responsibly. Although the system promotes eco-conscious plant care, the production of its components may not align with sustainable manufacturing practices. Ethical design would involve selecting components that are known for longer life spans and considering recyclable or repurposed materials for the housing unit, such as 3D printing with biodegradable PLA plastic.

Overall, the risks and ethical concerns identified in this project are typical of most small-scale electronic design efforts, yet addressing them during the planning phase demonstrates a responsible engineering mindset. By considering mitigation strategies and ethical safeguards from the beginning, the proposed Smart Plant Monitoring System becomes not only more feasible but also more respectful of its users, the environment, and society as a whole.

12. Conclusion

In conclusion, the Smart Plant Monitoring System offers a practical and cost-effective solution to a widespread issue: inconsistent and inadequate indoor plant care. By integrating environmental sensors with a microcontroller and user-friendly feedback mechanisms, the device empowers users to take better care of their plants without requiring advanced horticultural knowledge or constant manual checks. It supports healthier plants through timely interventions and makes plant care more accessible to people with busy lifestyles, limited experience, or physical constraints.

Beyond its immediate functionality, the project serves as a valuable exercise in the application of electronic design principles. It brings together elements such as sensor data acquisition, data processing, user interfacing, and real-world problem-solving into a cohesive and tangible prototype. It also encourages responsible engineering through consideration of environmental impact, ethical use of technology, and sustainable design choices such as low-power components and recyclable enclosures.

This project is well-suited for academic demonstration and discussion, offering clear learning outcomes in areas like hardware-software integration, project planning, and environmental awareness. With further development, the system could be expanded to include features such as wireless connectivity, app integration, or AI-based plant care suggestions. Ultimately, the Smart Plant Monitoring System not only addresses a practical need but also represents a thoughtful approach to accessible, sustainable, and educational technology design.

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14. Appendix



**AN INTRODUCTION TO
THE PREVENT DUTY
AS IT AFFECTS
HIGHER EDUCATION**

CERTIFICATE OF COMPLETION

THIS ACKNOWLEDGES THAT

Name: Joe Williams

HAS SUCESSFULLY COMPLETED THE INTRODUCTION TO PREVENT E-LEARNING

Date: 28/05/2025



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

This is to certify that
Joe Williams
successfully completed the
Equality & Diversity Briefing
course with a score of
83%
on
28th May 2025



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