Middlesex University Mauritius

CST2560
Project Management & Professional Practice

Coursework 4 – Individual Project Proposal

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Automatic Plant Watering System using Arduino

Key words: Arduino Uno, soil Moisture sensor, automatic plant watering system, plant care, sustainability, smart irrigation system.

Introduction

With the increasing demand for sustainable living practices, there is a growing interest in automating everyday tasks such as plant care. This project aims to develop an Automatic Plant Watering System using Arduino. The system will utilize sensors to monitor soil moisture levels and trigger the watering mechanism when necessary, ensuring optimal hydration for plants without human intervention.

Conventional methods of watering plants and crops often lead to situations where some areas receive too much water while others don't get enough. When there's not enough water, plants can't grow properly, and when there's too much, it can also harm their growth. In these traditional irrigation systems, different parts of the fields can end up with uneven water levels because the soil holds water differently, water doesn't soak in evenly, and some of it runs off. Places with too much water can suffer from issues like soil becoming too compact because there's not enough air in the soil, which can harm plant roots. On the other hand, areas that don't get enough water experience stress. That's why it's important to manage water efficiently in agriculture. *(Okandeji et al., 2020).*

Evidence of requirements

The requirements for the project will be derived from an analysis of existing automatic watering systems.

Joaquín Gutiérrez and his colleagues developed an automatic plant watering system that utilizes temperature and soil moisture sensors placed in the plant's root zone. These sensors send data to a gateway unit, which then transmits the information to a web application. The system incorporates an algorithm programmed into a microcontroller to regulate water quantity based on preset threshold values from the sensors. Moreover, testing over 142 days demonstrated a 92% water saving compared to traditional watering methods. The system has been successfully replicated in other locations for up to 1 year and 6 months, making it suitable for water-limited and geographically isolated areas due to its cost-effectiveness. *(Gutierrez et al., 2014).*

Thomas J. Jackson and his team proposed an automatic irrigation system driven by a controller and powered solely by solar energy. Various sensors placed in a rice field monitor water level, sending alerts to farmers via cellular phones. Farmers can control the irrigation motor remotely through their phones, ensuring timely intervention if water levels become critical. *(Jackson et al., 2010).*

Samysadeky, Ayoub al-Hamadiy, and others developed an acoustic-based technique to measure soil moisture content in real time. This technique relies on the relationship between the speed of sound and soil moisture saturation levels. By detecting changes in sound speed, the system accurately determines soil moisture levels, aiding in effective irrigation management. *(Adamo et al., 2004).*

Iia Uddin, S.M. Taslim Reza, Qadernewaz, Jamal Uddin, and their team designed an automatic irrigation system based on ARM technology and GSM communication. Soil moisture sensors placed in paddy fields monitor water levels, with data transmitted in real time via GSM technology. The ARM processor communicates with a centralized unit through GSM, providing users with climate and field condition updates via SMS commands. *(Uddin et al., 2012).*

Ms. Sweta S. Patil and Prof. Mrs. A.V. Malvijay introduced an automatic irrigation technique utilizing a wireless sensor network (Zigbee) and internet technology. Sensors placed in the farm continuously gather data, which is then transmitted to a central monitoring station. This data is used to automatically control irrigation systems via the internet, aiming to improve efficiency and reduce water usage costs. *(Patil & Malvijay, 2014).*

Problem definition

Water is one of the basic needs for plants to grow. However, we need to consider two key issues: overwatering and underwatering. Overwatering occurs when plants receive too much water, which can lead to root rot and other health problems. On the other hand, underwatering happens when plants don't receive enough water, causing them to wilt and potentially die. Striking the right balance in watering is crucial for maintaining plant health and avoiding water wastage. *(Lwin et al., 2018).*

Inadequate plant watering poses a significant challenge for individuals, particularly when they are away on vacations or lead busy lives, resulting in plant damage *(Bhardwaj et al., 2018)*. The manual task of watering plants is often forgotten due to hectic schedules and can be labor-intensive. Additionally, the modern lifestyle demands automation and remote-control capabilities for convenience *(Bains et al., 2017)*. Despite the simplicity and affordability of manual irrigation systems, they require constant monitoring and significant labor input. This not only leads to potential water wastage but also undermines plant health and overall productivity *(Lwin et al., 2018)*. Therefore, there is a pressing need for an automated solution that simplifies plant care and conserves water resources effectively *(Bains et al., 2017)*.

Aims

This project aims to simplify the process of watering plants at home by introducing an Automatic Plant Watering System. The system is designed to be easy to install and configure, requiring minimal effort from the user. By continuously monitoring the moisture content of the soil using a soil moisture sensor, the system ensures that plants receive the right amount of water at the right time. This not only conserves resources and energy but also prevents overwatering, which can harm plant health. With advancements in technology, the system reduces the need for human intervention, allowing for more efficient plant care. Overall, the goal of this project is to automate plant watering, providing a convenient and effective solution for home gardeners. *(Lahande et al., 2018).*

Objectives

The initial step in the development process involves conducting thorough research into the current market offerings and technological advancements in automatic watering systems and IoT solutions. This includes examining current market offerings, analyzing their features and technologies, and identifying emerging trends. The goal is to gather insights that can inform the design and development of the proposed Automatic Plant Watering System.

Following the research phase, the focus shifts to identifying suitable sensors for monitoring soil moisture levels. Various sensor options are evaluated based on factors such as accuracy, reliability, and compatibility with the Arduino platform. The objective is to select sensors that can provide real-time data for effective irrigation control.

With the sensors chosen, the next objective is to find the necessary hardware components and to develop the software required for the system. This includes selecting and assembling components such as Arduino microcontrollers, sensors, and water pumps, as well as writing code to interface with the sensors and control the watering mechanism.

Once the hardware components are found and the software is developed, the system is integrated with the Arduino platform to enable automated control. This involves connecting sensors to the microcontroller, uploading code, and testing the integration to ensure seamless communication and functionality.

The final objective is to conduct comprehensive testing to evaluate the system's functionality and performance under various conditions. This includes simulated tests in controlled environments and real-world testing in different settings. The aim is to identify any potential issues, optimize system parameters, and ensure that the system operates effectively and efficiently in different scenarios.

Brief product description

An automatic plant watering system is designed to water plants requiring minimum manual intervention. It consists of a soil moisture sensor that detects the moisture level in the soil. Based on this data, the system determines whether the plants need watering or not. When the soil moisture falls below a predefined threshold, the system activates the irrigation pump to water the plants. Conversely, when the moisture level rises above the set point, the system turns off the pump. This automated process ensures that plants receive the right amount of water for their growth and development, without the need for constant monitoring or manual watering. *(Bains et al., 2017)*.

Methods chosen for project implementation

The project will employ a combination of research methodologies including literature review, designing system, prototyping, testing, and iterative development. Hardware components will be selected based on their compatibility with Arduino and affordability. Software development will involve programming in Arduino IDE for data logging or remote monitoring.

Framework of the system:

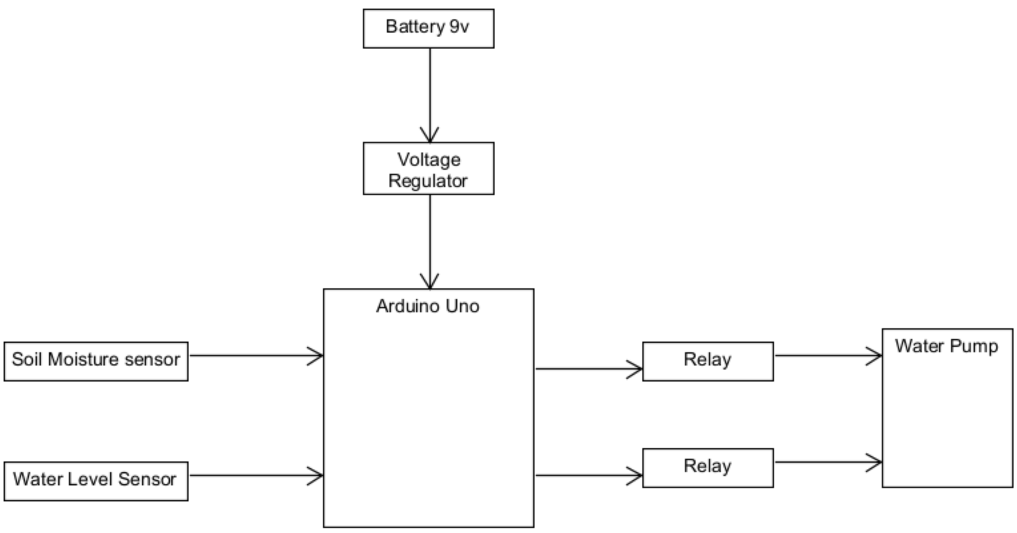

Figure 1 - Block Diagram

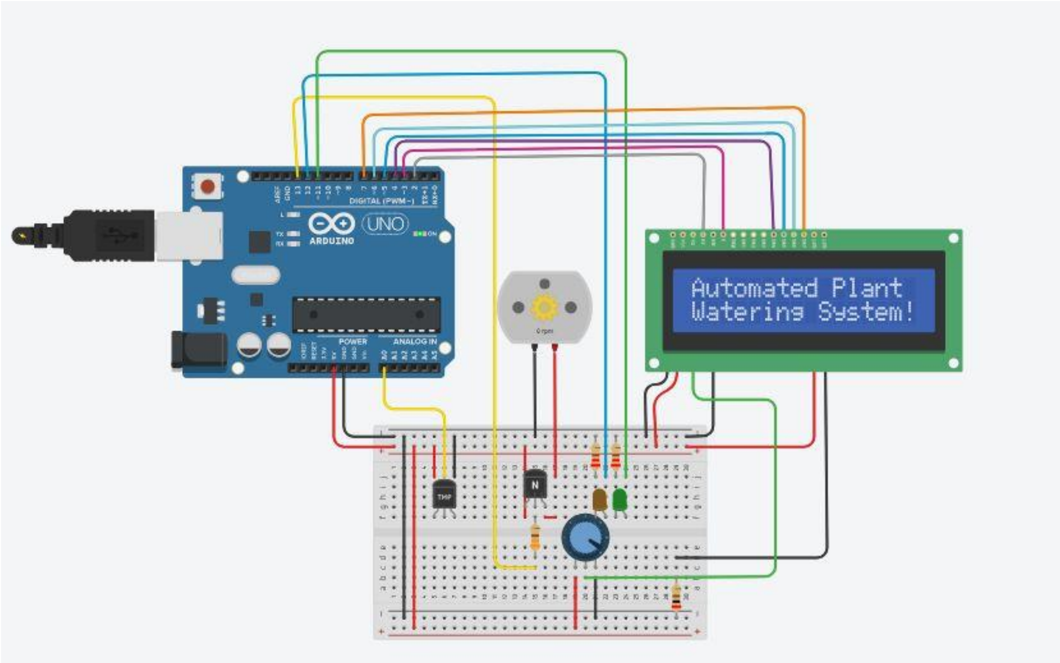

Figure 2 - Circuit Diagram

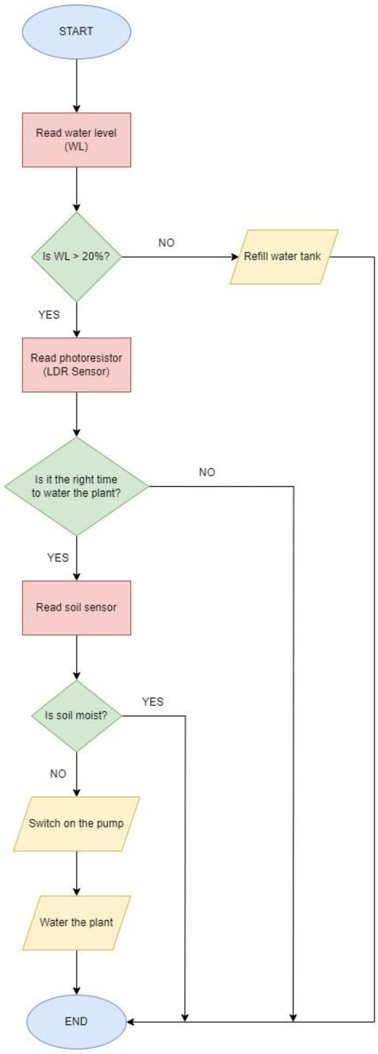

Figure 3 - Flowchart

Resources

Hardware:

- Soil moisture sensor: Used to measure the moisture content in the soil.
- Water level sensor: Monitors the water level in a reservoir or container.
- Relay: Acts as a switch to control the water pump.
- Water pump: Dispenses water to the plants.
- Hose: Transports water from the reservoir to the plants.
- LCD display: Provides visual feedback and information about the system's status.
- LED bulb: Indicates system status or alerts.
- Arduino Uno: Microcontroller used to control and coordinate the hardware components.
- Breadboard: Provides a platform for prototyping and connecting electronic components.
- Jumper wires: Used to establish connections between components.
- Battery: Power source for the system.

Software:

- Arduino IDE: Integrated Development Environment used for writing, compiling, and uploading code to the Arduino microcontroller.

Deliverables

When the moisture sensor probes were placed into the dry soil, they detected the lack of moisture, triggering the automatic activation of the water pump to irrigate the plant. As the soil became adequately moist, the sensor registered the presence of moisture, leading to the automatic shutdown of the water pump. This ensures that only the necessary amount of water is dispensed, and it is directed precisely where it's needed: to the base of the plant stem through a water hose. This targeted method ensures that the roots receive optimal hydration, minimizing water wastage in the process.

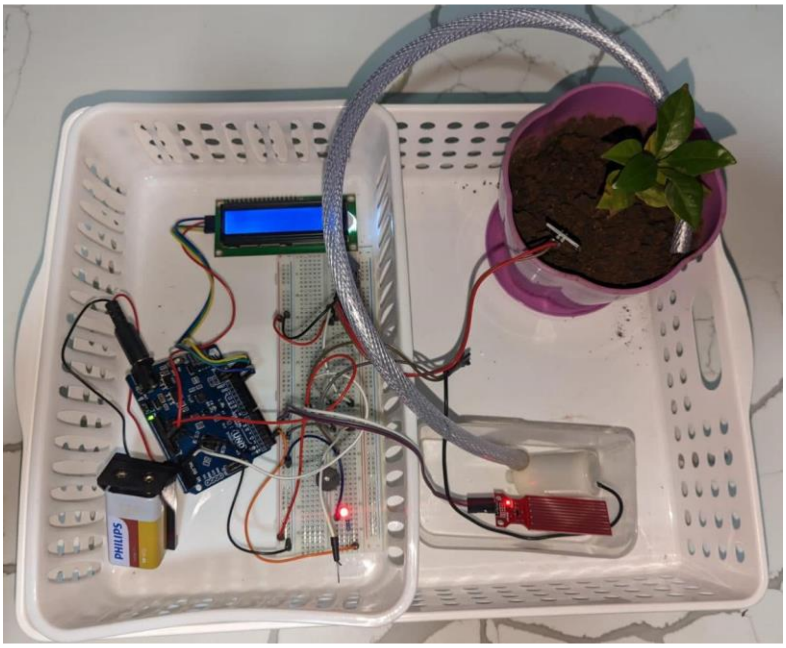

Figure 4 - Prototype

Testing approach

Unit testing: Each hardware component and software module is tested individually to verify its functionality and correctness. This includes testing the sensors, actuators, and communication interfaces to ensure they operate as expected. *(Prasojo et al., 2020).*

Test system response: Adjust the threshold values in the system's program to simulate different soil moisture conditions (dry, damp, wet) and observe if the system activates the water pump accordingly. *(Velmurugan et al., 2020).*

Soil Condition	Moisture Content	Relay Status	Water Pump Status	Test Case Status
Dry	<1000 >600	ON	ON	TRUE
Damp	<600 >400	OFF	ON	TRUE
Wet	<400	OFF	OFF	TRUE

Figure 5 - Test Case Analysis

Monitor plant growth: Set up the system for a variety of plants with different watering requirements. Monitor the health and growth of the plants over time to see if the automated watering schedule is effective. *(Prasojo et al., 2020).*

Long-term testing: Conduct the testing over an extended period to assess the system's reliability and performance under various environmental conditions. This may involve testing during different seasons or with changes in temperature and humidity. *(Prasojo et al., 2020).*

User tesing: Participants will be invited to evaluate the functionality of and usability of the system. During these sessions, feedback will be systematically gathered. Subsequently, the collected feedback will go through analysis to pinpoint areas of improvement and identify necessary modifications. This critical evaluation phase ensures that user concerns and suggestions are comprehensively addressed. Finally, based on the analysis, modifications will be promptly implemented, refining the system's functionality and enhancing its usability. This iterative approach guarantees that the Automatic Plant Watering System is tailored to meet user needs and expectations effectively. *(Prasojo et al., 2020).*

Outcome & Project Evaluation

The outcome of this project is the successful development and implementation of an Automatic Plant Watering System, designed to alleviate the burden of manual plant watering and ensure optimal hydration for plants. Through the integration of hardware components such as soil moisture sensors, water level sensors, relays, and water pumps, coupled with the Arduino Uno microcontroller and accompanying software, the system autonomously detects soil moisture levels and dispenses water accordingly. The evaluation of this project involves assessing the functionality, reliability, and efficiency of the system under various conditions. This includes testing the accuracy of moisture sensing, the effectiveness of watering control, and the overall performance of the system in different environmental settings. Ultimately it can be said that the Automatic Plant Watering System meets the needs and expectations of users while promoting sustainable plant care practices. *(Abhishek et al., 2021)*

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Appendix A - WBS

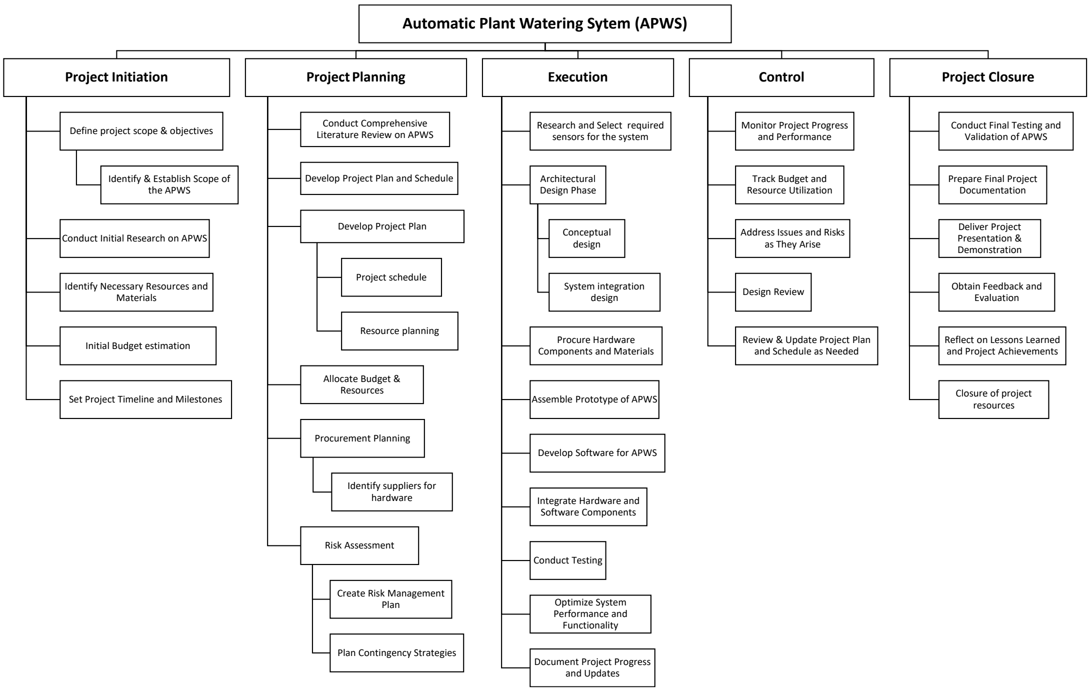

Figure 6 - WBS

Appendix B - Gantt Chart

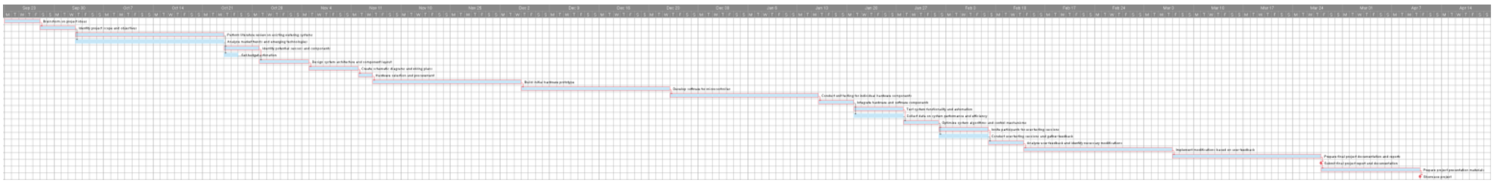

Figure 7 - Gantt Chart

PS: If ever the Gantt chart is not readable, please find a copy of the picture via this link: https://1drv.ms/i/s!AlHcsOzheiMugaBjCY7zu3SXWFChqw?e=CCeOKI