ECE 1000 Final Report: Automatic Plant watering System

Hossana Haileleul, Erdinc Ozturk, Jack Bender,

Tennessee Technological University
Department of Electrical and Computer Engineering
Cookeville, TN, USA
hhaileleu42@tntech.edu , eozturk42@tntech.edu, jbender42@tntech.edu

***Abstract*—The Automatic Plant Watering System outlined in this report embodies an interdisciplinary approach, merging mechanical engineering, physical electronic components, and microcontroller programming to address the critical need for efficient water management in agriculture. Centrally governed by the Raspberry Pi Pico microcontroller, the system autonomously monitors soil moisture levels using a soil moisture probe and initiates watering cycles as needed. Through the integration of a DC motor water pump, water tank, and tubes, precise irrigation is achieved, optimizing resource utilization while promoting plant health. Additionally, the inclusion of an LED indicator enhances user interaction by visually signaling when the water pump is active, while a user interface allows for manual intervention if required. This report explains the design, functionality, and potential impact of the Automatic Plant Watering System, highlighting its contribution to environmental sustainability and agricultural efficiency.**

I. Introduction

Motivated by the desire to optimize water usage in agriculture and promote sustainable practices, we identified the need for a solution that integrates mechanical engineering, physical electronic components, and microcontroller programming. This project holds significant importance as it aligns with our commitment to environmental sustainability and offers a practical application of engineering principles to address real-world challenges. Comprised of Hossana Haileleul , Erdinc Ozturk, and Jack Bender, our team is dedicated to exploring the potential of automation in enhancing plant hydration and advancing sustainable agriculture practices. As we delve into the background and implementation details of our project, we aim to provide insights into its design, functionality, and potential impact on agricultural sustainability.

II. Background

In developing our automatic plant watering system, we extensively relied on diverse resources. We referenced YouTube tutorials for Raspberry Pi programming, circuitry design, and 3D printing techniques. Tinker cad's open-source diagrams aided in visualizing components. Web articles provided insights into plant watering systems and sensor technologies, while open-source repositories offered 3D printable designs. Our citation section below acknowledges these sources for transparency and proper attribution.

III. Project Description and Formulation

Materials:

1. Raspberry Pi Pico (RPP) : Serves as the central processing unit, responsible for data processing, decision-making, and controlling other components.
2. Soil Moisture Probe: Measures the moisture level of the soil at regular intervals. It typically consists of two electrodes that gauge the soil's electrical conductivity, correlating with its moisture content.
3. Water Tank (plastic cup): Stores the water to be used for irrigation.
4. Tubes: Convey water from the water tank to the plants' root systems.
5. DC Motor Water Pump: Draws water from the tank and pumps it through the tubes to irrigate the plants.
6. User Interface : Allows users to interact with the system, providing manual override capabilities or monitoring functionalities.

Diagram:

The diagram below depicts the usage of an Arduino instead of a Raspberry Pi, which is due to a limitation in the availability of tools within Tinker cad. It is important to note that despite this difference, the circuit operates identically, with the code being seamlessly integrated in Python for the Raspberry Pi Pico (RPP). This further highlights the adaptability of the system across different microcontroller platforms.

Figure 1: Tinker cad simulated System

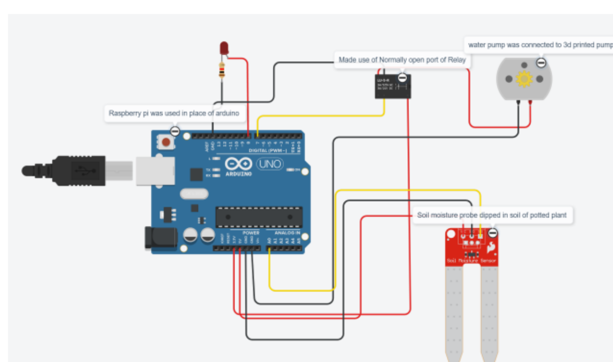


Figure 2: Circuit Schematic of System

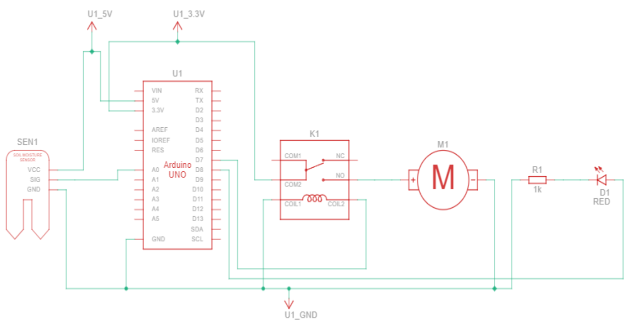


Figure 3: 3d design of DC motor pump and rotor from Thingiverse

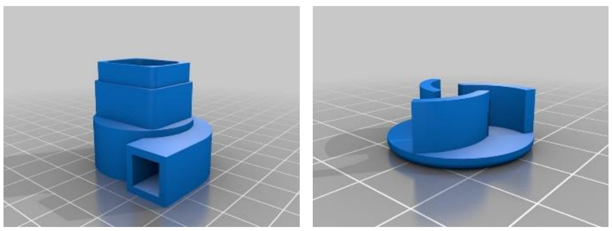
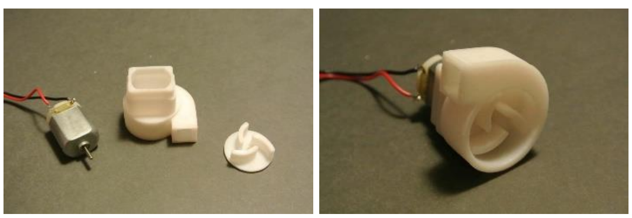


Figure 4: Printed 3d pump



The 3D print was sourced from a user named ilfrank on Ultimate Thingiverse.

Full System:

The next image does not depict our working system; rather, it is from a cited source since we neglected to capture a picture of our own implementation. They utilized an Arduino instead of a Raspberry Pi, and unlike them, we did not incorporate an LCD. Nonetheless, this image serves as the closest representation available. We acknowledge and credit the original source for this image in our citation section.

Figure 5: Full system from Mohd Shahid

Functionality:

Hardware components are interconnected and communicate through GPIO (General Purpose Input/Output) pins on the Raspberry Pi Pico (RPP) . The software running on the RPP coordinates interactions between components, ensuring seamless operation and accurate irrigation management.

The RPP periodically reads and converts the analog signal generated by the soil moisture probe into a digital signal usable by the controller. This is done by its built-in Analog-to-Digital Converter (ADC). The analog signal corresponds to the moisture level in the soil, with higher moisture levels yielding lower electrical resistances and vice versa.

Based on the moisture level readings, the RPP determines whether the soil requires watering. This decision-making process usually involves comparing the current moisture level with a predefined threshold. This threshold value determines the moisture level at which the system considers the soil to be adequately hydrated or in need of watering.

If the moisture level falls below the threshold, indicating dry soil, the RPP activates the DC motor water pump to irrigate the plants. The pump continues operation until the moisture level reaches the desired threshold.

Even after watering, the system continues to monitor soil moisture levels to ensure plants remain adequately hydrated. If users want to manually initiate a watering cycle, they can interact with the system through the user interface to override the automated process and activate the water pump as needed.

Additionally, the RPP controls an LED indicator connected to one of the GPIO pins. When the water pump is turned on and delivering moisture to the plants, the LED illuminates, serving as a visual feedback mechanism, indicating to users that the water pump is actively delivering moisture to the plants.

IV. Discussion and Results

The automatic plant watering system project yielded successful results, as the device effectively watered the plant according to the desired specifications. However, a minor issue was identified regarding the shutdown process, where the Raspberry Pi continued to activate the pump even after the code had been terminated. This flaw needs to be addressed in future iterations of the project to ensure proper functionality and power management.

Moreover, the team might consider adding features such as remote monitoring and control via a mobile app or web interface to provide users with greater flexibility and convenience. Despite the challenges encountered, the team found several aspects of the project enjoyable from the hands on aspect of building the and 3d printing the pump, the technical practice from coding the RPP, and the overall collaborative effort.

In terms of individual contributions:

Hossana Haileleul undertook the fabrication and assembly tasks, including the 3D printing, pump installation, relay configuration, and circuit diagram design.

Jack Bender was responsible for developing the Python code to control the Raspberry Pi, orchestrating the automated watering process, and ensuring seamless interaction with the hardware components.

Erdinc Ozturk conducted external research, gathering relevant information on existing plant watering systems, sensor technologies, and best practices, contributing valuable insights to the project's conceptualization and design.

By leveraging each team member's expertise and collaborating effectively, the project achieved its objectives while laying the groundwork for future enhancements.

V. Conclusion

The Raspberry Pi Pico plays a vital role in collecting and processing soil moisture data, making informed decisions about watering based on predefined thresholds, and controlling the water pump and LED indicator to ensure efficient plant hydration.

Its versatile functionality and integration capabilities make it a crucial component in the Automatic Plant Watering System, enabling seamless automation and user-friendly operation

The Automatic Plant Watering System represents a culmination of interdisciplinary collaboration and innovative engineering. By harnessing mechanical engineering, physical electronic components, and microcontroller programming, we have developed a scalable solution that addresses the critical need for efficient water management in agriculture.

Through automation, our system optimizes resource utilization, promotes plant health, and contributes to environmental sustainability.

References

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