Introduction to the Automated Irrigation System Project

This project focuses on creating an automated irrigation system using an Arduino microcontroller, a real time clock RTC module, an EEPROM module, and relay modules. The primary purpose of this system is to efficiently control the water supply for plants based on soil moisture levels, reducing water waste and ensuring plants receive adequate hydration without human intervention. This is particularly useful for remote or small-scale agriculture setups, such as balcony gardens, where constant monitoring may not be feasible.

Circuit Overview and Main Components

1. Arduino Uno: The main control unit of the system, responsible for receiving time information from the RTC and controlling the relay to turn the water pump on and off according to a set schedule.
2. RTC (Real-Time Clock) - PCF8563: This component provides real-time tracking, allowing the Arduino to follow a programmed schedule. The RTC ensures that the irrigation system activates the water pump at specific times of the day, making the system more autonomous and precise.
3. Relay Module: The relay functions as an electronic switch, controlled by the Arduino. When the programmed time is reached, the Arduino activates the relay to turn on the water pump.
4. Water Pump: Connected to the relay, the pump supplies water to the plants. It operates on a timed schedule managed by the RTC and Arduino, ensuring consistent irrigation.
5. EEPROM - AT24C256: Used for non-volatile storage, allowing the system to save irrigation schedules and settings even if the power is turned off. This ensures that schedules are maintained without needing reprogramming after a reset.
6. Power Supply: Powers the circuit, including the Arduino, RTC module, and pump.

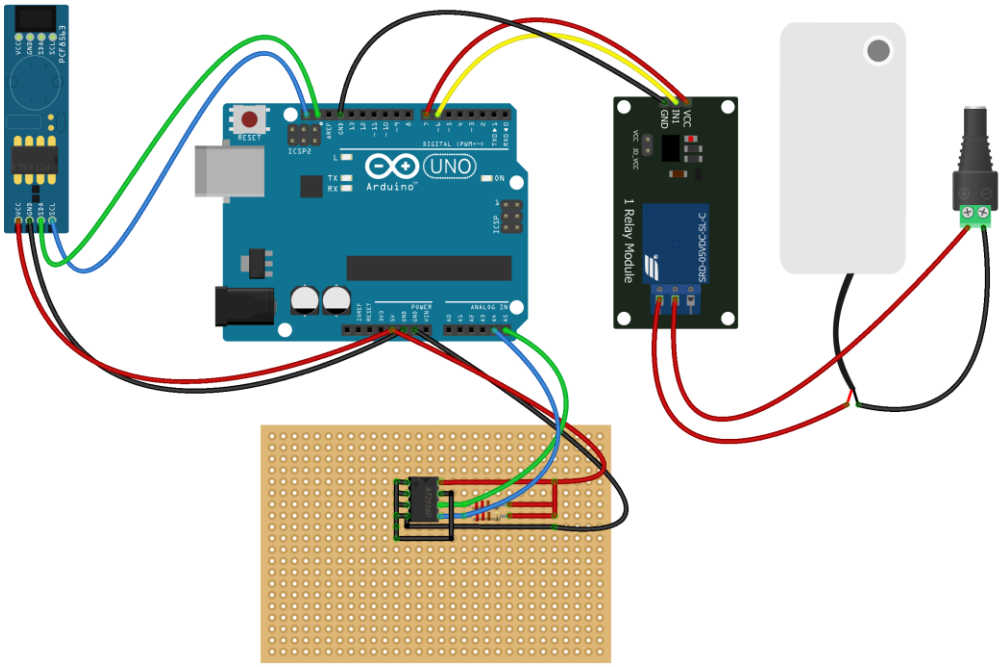

Figure 1 showing the schematic of the electronics components.

Irrigation Requirement

Plant Type: Small Mulberry Tree
Soil Type: Clayey Sandy
Location: Balcony
Assumptions: Moderate climate conditions

1. Calculation of Available Water Capacity (AW)

Available Water (AW) is the amount of water the soil can hold that is accessible to the plant.

- **Field Capacity ($\boldsymbol{\theta_{FC}}$)**: *0.25* (fraction)
- **Wilting Point ($\boldsymbol{\theta_{WP}}$)**: *0.10* (fraction)
- **Available Moisture ($\boldsymbol{\theta_m}$)**: $\boldsymbol{\theta_{FC}} - \boldsymbol{\theta_{WP}} = 0.25 - 0.10 = 0.15$
- **Soil Bulk Density ($\boldsymbol{\gamma_b}$)**: *1400 Kg/m³*
- **Root Depth (D)**: *0.3 m*

Equation:

$$AW = \theta_m \times \gamma_b \times D$$

Calculation:

$$AW = 0.15 \times 1400 \times 0.3 = 63 \ {}^{mm}/_{m}$$

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2. Crop Water Requirement ($\boldsymbol{d_n}$)

The water requirement is determined by the available water and the crop coefficient (P).

- **Crop Coefficient (P)**: 0.5 for small mulberry trees

Equation:

$$\boldsymbol{d_n} = AW \times D \times P$$

Calculation:

$$\boldsymbol{d_n} = 63 \times 0.3 \times 0.5 = 9.45 \ mm$$

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3. Irrigation Water Requirement ($\boldsymbol{d_g}$)

To determine the irrigation water requirement, we factor in the application efficiency ($\boldsymbol{E_a}$).

- **Application Efficiency (E_a)**: 0.75
- **Leaching Requirement (LR)**: 0 (no additional salt leaching needed)

Equation:

$$d_g = \frac{d_n}{E_a \times (1 - LR)}$$

Calculation:

$$d_g = \frac{9.45}{0.75 \times (1 - 0)} = 12.6\ mm$$

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4. Weekly Water Volume

Given that the tree's root zone area is approximately 1 square meter:

Calculation:

$$Weekly\ Water\ Volume = d_g \times Area = 12.6 \text{ Liters}$$

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5. Frequency Between Irrigations (F)

To calculate the irrigation interval, we divide the plant's water requirement by the daily evapotranspiration rate (ET_c).

- **Daily Evapotranspiration (ET_c)**: Assumed 4 mm/day

Equation:

$$F = \frac{d_n}{ET_c}$$

Calculation:

$$F = \frac{9.45}{4} = 2.36 \approx 3\ days$$

Result: Approximately every 3 days.

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6. Water Volume per Irrigation

Assuming 3 irrigation events per week:

Equation:

$$\text{Water per Irrigation} = \frac{Weekly\ Water\ Volume}{\text{Number of Irrigation per Week}}$$

Calculation:

$$\text{Water per Irrigation} = \frac{12.6}{3} = 4.2\ Liters$$

Result: Approximately 4-4.5 liters per irrigation.

Summary

- **Weekly Water Requirement:** 12.6 liters
- **Irrigation Interval:** Every 3 days
- **Water per Irrigation Event:** 4-4.5 liters