Growth Enhancement & Regulation Module (GERM)

TEXAS A&M UNIVERSITY Engineering

Project Lead: Jordan Durst

Members: Emiliano Grajales-Mora, John Lindemann, Alejandro Loredo, James Oliphint, Jacob Reichek, Mya Tinsay, Bethany Tran, Lucian Webster

TEXAS A&M UNIVERSITY
ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Problem Definition

The goal of this project is to create a robot that can grow plants autonomously using adjustable lighting, an aeroponics system, and temperature control. Traditional planting systems are affected by external factors such as overwatering, temperature fluctuations, and insufficient lighting, all of which hinder plant growth. These challenges are addressed in the design of a system that operates without human intervention.

Methodology

The project is split into two subsystems:

Electrical & Software

- Completed the overall schematic and component layout
- Integrated the LEDs, pump, and cooling subsystems with centralized power sources
- Implemented protective measures for all components
- Constructed controls algorithm

Mechanical

- Developed internal layout of the water system
- Integrated a recycling sink
- Attached diffusers
- Mounted the cooling system

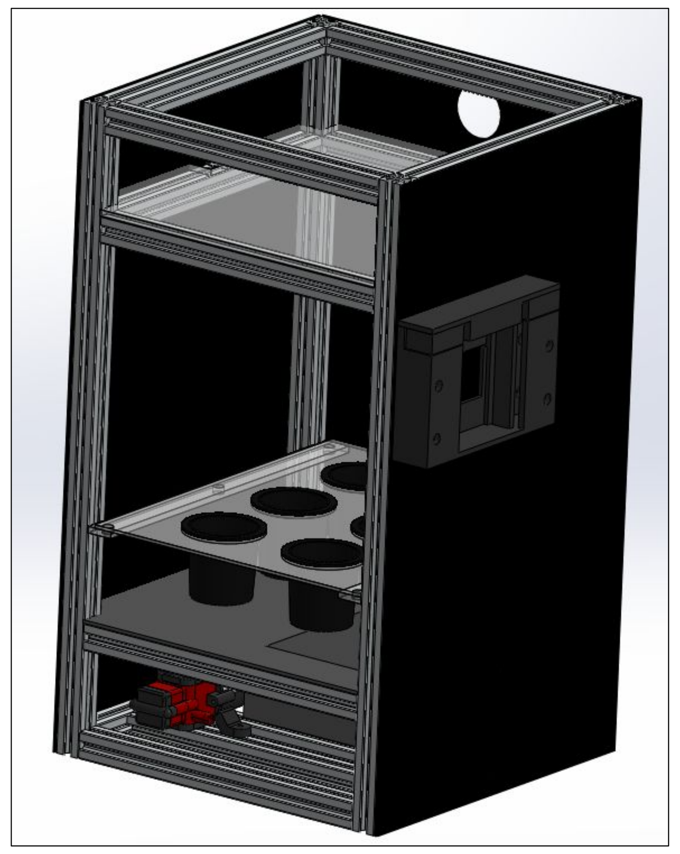

Figure 1. *GERM CAD Model.*

Mechanical

Water Sealing

To protect electronics from water and prevent leaking, several measures have been taken:

- Closed cell silicone foam tape around the wet regions of GERM.
- Redesigned sink to hold water, prevent leaking, and acts as the inlet to the pump.
- Redesigned door to keep electronics sealed and plants accessible.
- Silicone molding to prevent leaks while keeping GERM modifiable.

Software

Started the software team to implement controls algorithm for light, pump, and cooling systems. Created the outline for the controls that will be unique for each plant grown by GERM.

Table 1. *Algorithm for plant controls.*

Step #	Description of Step	Input(s)	Output(s)	Notes/Comments
1	Retrieve plant parameters from database	Plant species ID/name	Operating temperature range, pump cycle settings, LED pattern	Query database once per cycle or on species change
2	Read current environment sensors	Temperature, humidity, time	Real-time sensor values	Inputs update continuously
3	Compare temperature to thresholds	Current temperature, Low/High Temp, Low/High Cutoff	Control signals for cooling/heating system	If temp < Low Cutoff, turn on heater; if temp > High Cutoff, turn on cooler
4	Control pump cycle	Cycle Period, Spray Duration, timer	Pump ON/OFF signals	Use system clock to trigger pump spray duration repeatedly within defined period
5	Control LED system: color & intensity	Color Mixing Instructions, Intensity	LED MiniPuck control signals	Convert hex/mixing rules into RGBW output at specified brightness
6	Control LED timing	LED Cycle Period, On Duration, timer	LED ON/OFF state	Cycle light according to defined period (simulate day/night)
7	Update system state & log actions	Control outputs, sensor values	Log record, feedback loop	Logs useful for debugging and performance tracking
8	Repeat loop continuously	N/A	Continuous control	Cycle repeats at fixed interval (e.g., every second)

Electrical

Source

- System operates using a 120V AC wall input, which is stepped down to 15V DC through a converter.
- Cooling intensity is controlled by a variable power source that adjusts the current supplied to the fans.
- Three fuses safeguard the primary branches of the circuit against power surges.

Light System & Controls

- Signals from the Arduino UNO board manage the LED color mixing and fan power state through PWM.
- Arduino UNO controls the timing for the cooling, pump, and light system power states.
- LED color is controlled by PWM signals from the MiniPucks, providing variable light wavelengths to support optimal plant growth at different developmental stages.
- The light component shown below represents a single module within a 4x5 array of lights.

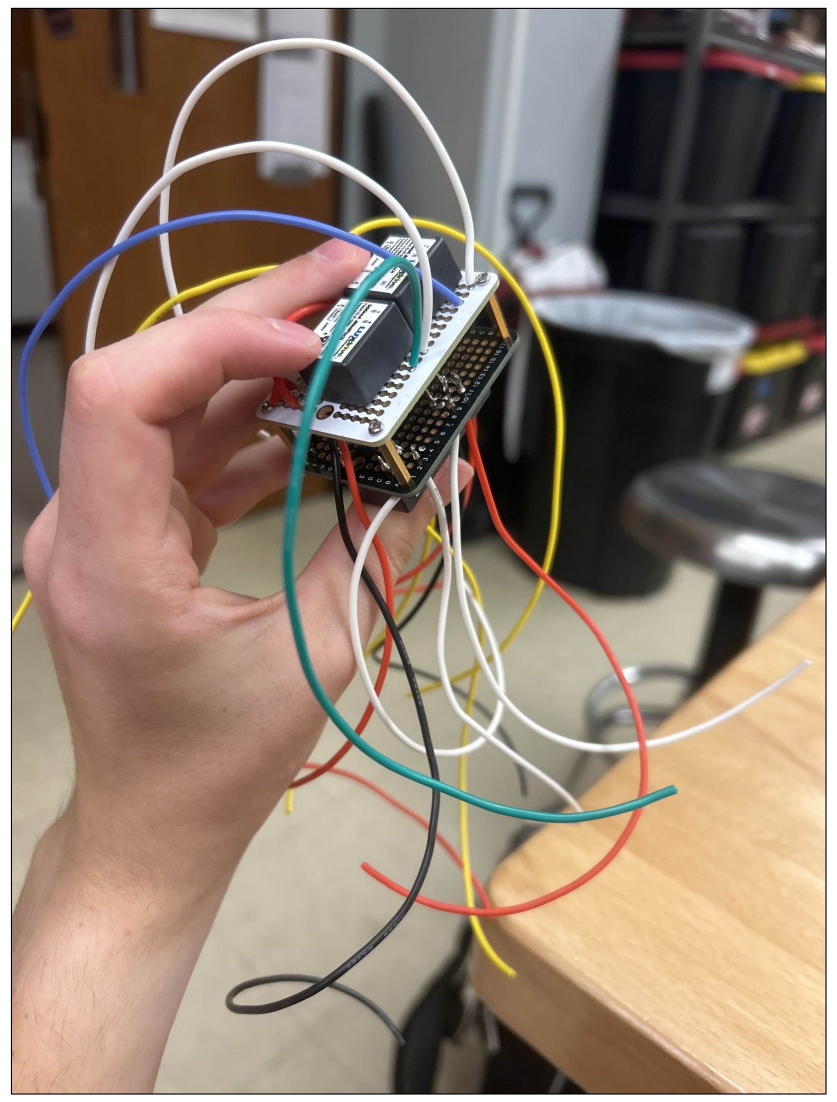

Figure 2. *MiniPucks that provide PWM.*

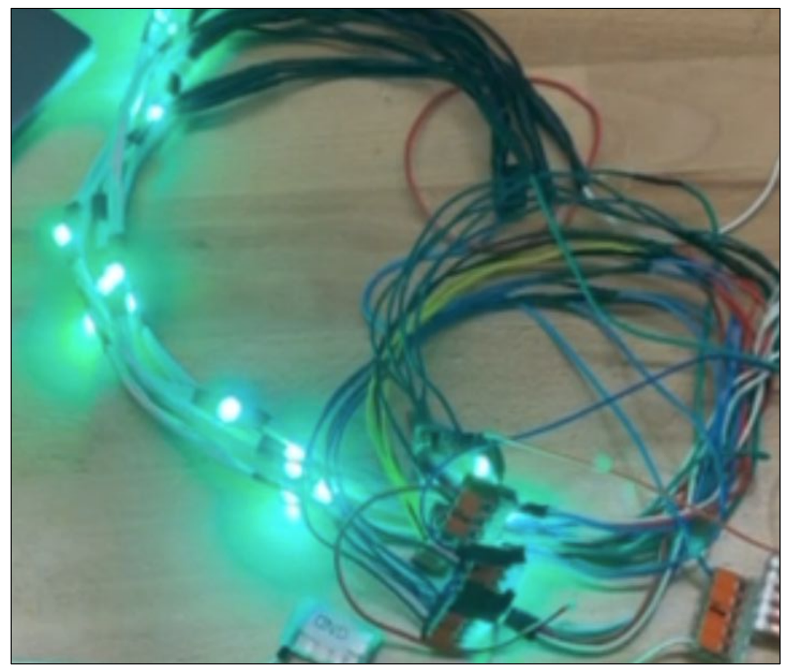

Figure 3. *LED color mixing by PWM.*

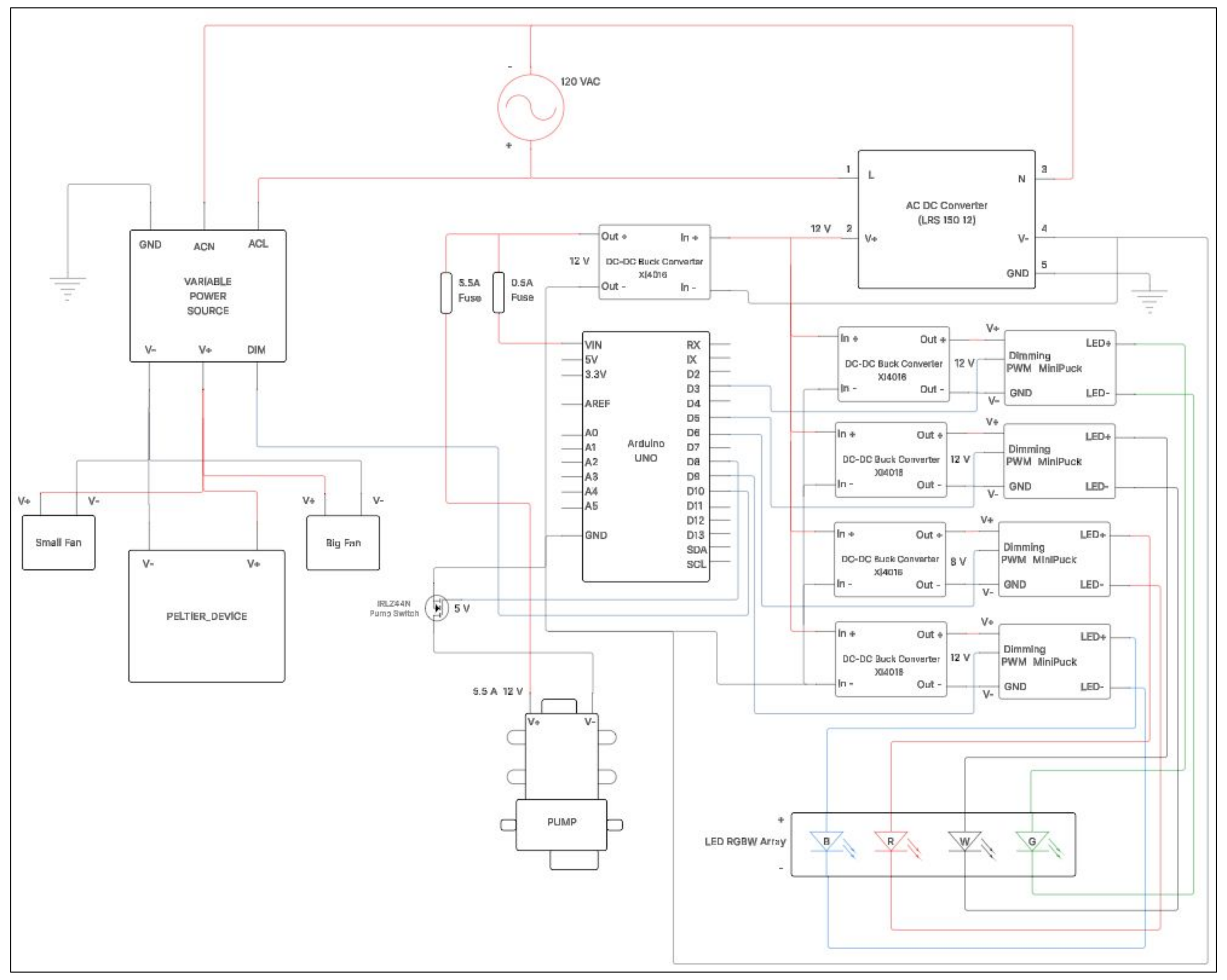

Figure 4. *Complete Schematic for System Electronics.*

Outcomes

This project is designed to autonomously water plants using an integrated system of lighting, pumping, and cooling components. With all electronics seamlessly built into the setup, it can support a diverse range of plant types and growth requirements.

Future Plans

- Calibrate the system for radishes.
- Implement AI–camera monitoring system and Human-Machine Interface (HMI).