TEXAS A&M UNIVERSITY Engineering

Automatic Aeroponic Plant System (GERM)

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TEXAS A&M UNIVERSITY ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Problem Definition

The goal of this project is to build a robot that can grow plants autonomously using adjustable lights, an aeroponics system, and temperature control.. Traditional planting systems are subject to external factors such as overwatering, temperature fluctuations and inadequate lighting which impact plant growth negatively. These are considerations taken into account when designing a system without human intervention.

The first batch of test plants (Cherry Belle Radishes) are currently growing.

Approach & Methods

This project was split into two different subsystems which are listed below:

Electrical

- Focused on creating a timed RGB light system with adjustable lighting colors in order to provide the appropriate lighting for the current stage of the plant's growth cycle.

Mechanical

- Focused on creating inner structure supports to separate electrical system from plan environment as well as integrating the lighting system.

Mechanical

Chassis

One of the primary constraints of the system was to keep the electrical components dry and insulated from an inherently moist environment that facilitates plant growth. This was achieved primary by laser cutting 6mm clear acrylic, machines for a light force fit with the rest of the chassis, and supported at the beam points from below.

The upper section of the chassis, separated by the acrylic, will be sealed with flex paste at the border of the acrylic when the dimensions are finalized.

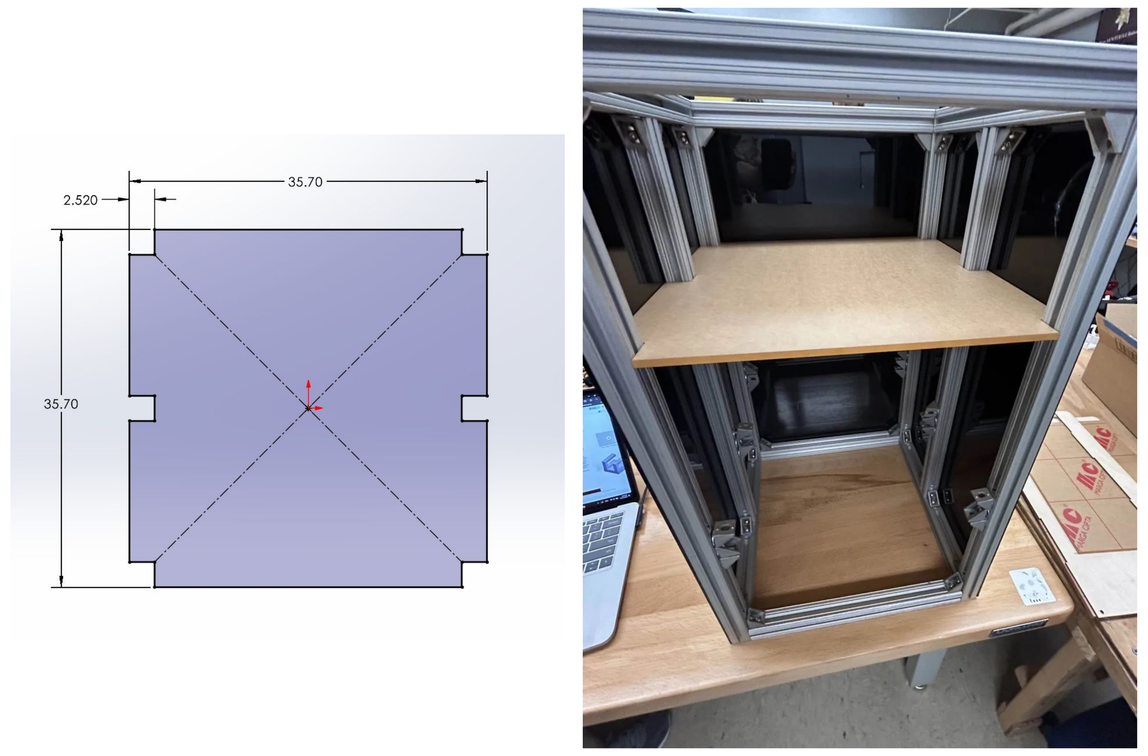

Figure 1. Acrylic Shelf CAD File (left) and in Chassis (right)

Electronics Shelf Layout

A shelf design will be used to hold the electronics and lights above the waterproofed acrylic shelf. Light Holders will be glued to the bottom of a separate acrylic layer where lights will be held. Five rows of four lights will be wired through the acrylic layer where they will be controlled by an Arduino on top. A diaphragm pump will also be on top of this layer and the tubing will be fed beneath the plant holder to water.

A flex seal foam will then be used around the Acrylic Shelf to seal the layer.

Figure 2.Light Holder Model

Electrical

LIght System

The grow light system designed with optimal grow yield in mind: Low to medium light plants require 15-20 watts/ft2. This system outputs an acceptable 18 watts/ft2. The 4-color RGBW LEDs are controlled by an Arduino-decoder combination. The lights are timed to go on and off in 12-hour intervals, and are color controlled by Arduino binary input into a 2:4 decoder. BJT NPN Mosfets are used at every branch, the source and drain drawn from a 12V source and the gate controlled from the aforementioned decoder. This ensures proper current flow through the lights as well as allowing for color control at every branch. Specific combinations of light wavelength have marked benefits on growth at different stages in a plant's life, for this reason, each row can be turned to a different color depending on the plant being grown and its maturity level.

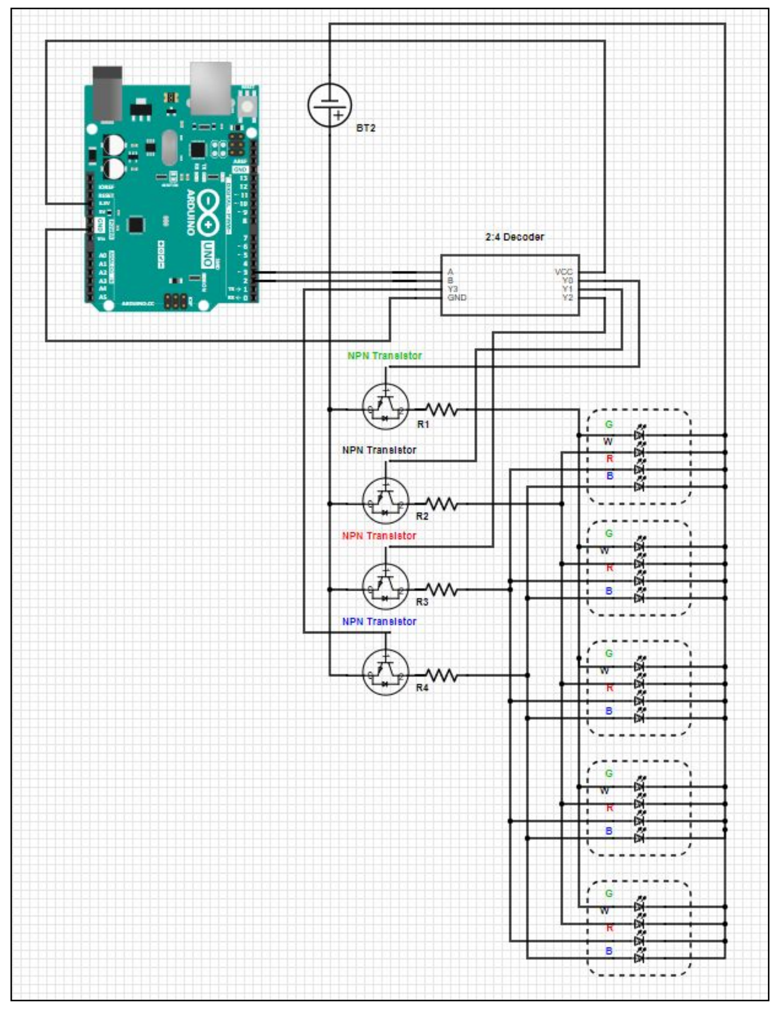

Figure 3. Schematic for Light Fixtures V1

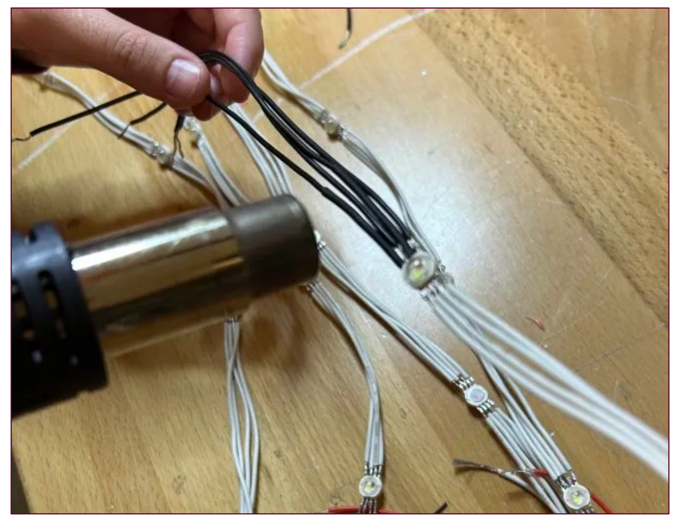

Figure 5. Heat Shrink Lights

Power Source

The system will be powered using a wall outlet. A Mean Well LRS-150-12 is used to convert 115 VAC to 12 VDC 12.5A. The pump requires 12 volts at 5.05 amps (Figure 4) to achieve 100 psi.

1.3GPM / 100PSI

12V

PRESSURE		FLOW		CURRENT
PSI	BAR	GPM	LPM	AMPS
0	0	1.24	4.70	2.49
10	0.69	1.00	3.80	2.75
20	1.38	0.86	3.24	3.14
30	2.07	0.74	2.80	3.59
40	2.72	0.55	2.10	3.63
50	3.45	0.48	1.80	3.84
60	4.14	0.42	1.60	4.02
70	4.83	0.37	1.40	4.74
80	5.52	0.32	1.20	4.87
90	6.21	0.24	0.90	4.93
100	6.90	0	0	5.04

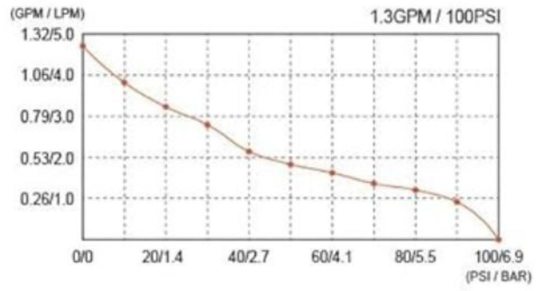

Figure 4. Pump Pressure versus Flow Rate

Outcomes

- This project will have the capability to water plants autonomously through the variety of sensors and electronics used. With the electronics integrated into the system, the project will be able to accommodate for a wider variety of plants.

Future Plans

- Calibrate system for radishes, including spray cycles, light cycles, and temperature control
- Grow a wider variety of of plants

Texas A&M University Robotics Team and Leadership Experience (TURTLE) Lab