Team #28

Automated Greenhouse System

Team #28

Team Members: Violeta Intriago, Daniella Archer, Jennifer Friedl, Mason Cossey, Andrew Klotz, Chase Brower, Nick Korell
Mentor: David Merrick
Project Sponsor: GrowCery

Customer Background

The client for this project is Matthew Walsh. Matthew is a family outreach coordinator and the hydroponics teacher in an urban charter school, Anderson Preparatory Academy. He teaches an exploratory class that uses STEM to engage students in being responsible, and responsive to their natural environment, their community, and themselves. The organization that Matthew is part of, Grow Cery, focuses on using education as a mean to reducing food insecurity within food deserts.

Problem Statement / Scope of Work

GrowCery, located in Anderson, IN, looks to address food insecurity using an automated hydroponic greenhouse with the goal of growing food for the local community and serving as a teaching tool for children. Food insecurity awareness should be spread as well as viable solutions that automated hydroponic greenhouses can offer. Using these innovative technologies will allow people in Indiana to create greenhouses to provide food for their communities.

Requirements

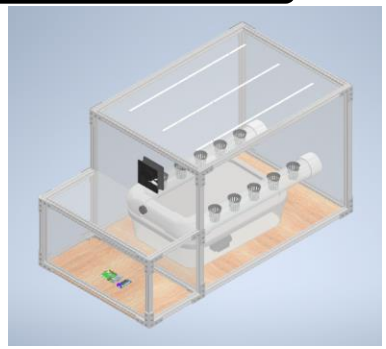
#	Requirement	Description	Test to Verify
1	Size	The build will not exceed a size of 4' x 2.5' x 4'	Measurement
	Rational: This is the maximum size allotted to this growing area.		
2	Performance	Must automate the growing vegetable produce from a seedling to a mature plant.	Demonstration
	Rational: This was a request from the client.		
3	Budget	Project budget should not exceed 1000 USD	Analysis
	Rational: The budget given for the project is 1000 dollars.		
4	Weight	The build will remain under 150 lbs.	Measurement
	Rational: Product needs to be able to be moved without heavy equipment.		
5	Material	Design should incorporate recycled and upcycled plastics.	Examination
	Rational: Greenhouse should contribute to avoiding use of single-use plastics.		
6	Performance	Plants must be fed and watered using a hydroponics system.	Demonstration
	Rational: This was a request from the client.		
7	Function	Greenhouse should grow lettuce, spinaches, collards, tomatoes, cucumbers	Analysis
	Rational: The more vegetables the greenhouse can produce, the more GrowCery can help the area's food insecurity issue.		

Experimentation and Concepts

Ebb and Flow	Deep Water Culture
Easy to set up- fewer parts required	Good for water heave plants.
Flexible with most growth mediums	Simple build and construction.
Promotes larger yields	Good for large yields
Cost effective	Assists growth for large root systems.

While both systems are sustainable, affordable, and offer unique advantages; ebb and flow was chosen for its ease of construction and use. As well as reduced power needs. As the simplest design, it serves as the perfect teaching tool.

Final Design



Fitted and sealed with plexiglass, the frame houses the greenhouse system, sensors, and water reservoir. The simple frame is best for the project, meeting the requirements of being durable and easily assembled and broken down, as well as able to fit through doors, and carried by two people. The alcove to the left of the frame houses the Arduino, as well as the sensor control systems and display. Two of the plexiglass walls are on hinges giving access to the plants and hydroponic system as well as the sensor control systems. The watering system is controlled by the Arduino, programmed to respond to the readings from the PH sensor, temperature sensor, and humidity sensor. The low powered aquarium pump waters the plants root system on a regular basis. The lighting system is a strip of lights that operate on a timer, on for 16 hours and off for eight. These lights also function as a warming system for the plants, providing heat to the greenhouse. Also functioning off the Arduino, is the ventilation system. When the humidity sensor alerts are above threshold, as well as CO_2 below the necessary threshold, the fan kicks in, bringing fresh air into the greenhouse, cycling out the stale air and lowering the humidity to acceptable levels. The sensors - pH, temperature, humidity, and a CO_2 sensor, will monitor the environment of the greenhouse, making adjustments as necessary.

FMEA

Require-ments	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Causes(s) of Failure	Occurrence	Current Design Controls Prevention	Current Design Controls Detection	Detection	RPN
Controller must turn on fan when needed to ventilate greenhouse	Fan does not turn on	CO_2 levels could become too high	7	Bad solder on components connected to fan or vent motor	5	Solders will be consistently monitored during construction	Solders will be inspected before and after testing	2	70
			7	Incorrect coding to control fan or vent motor	7	Programming will be tested and updated during construction to troubleshoot	Program will run after each update to test	2	98
	Fan turns on when not needed	Temperature and CO_2 level could be come to low	7	Bad solder on components connected to fan or vent motor	5	Solders will be monitored during construction	Solders will be inspected before and after testing	2	70
			7	Incorrect coding to control fan or vent motor	7	Programming will be tested and updated during construction to troubleshoot	Program will run after each update to test	2	98

Testing

Req. Matrix	Test Name	Specifications & Test Method	Test Description	Test Stage	Test Requirement	Test Responsibility
1	Measurement	Measurement via tape measure	Measure a length of 4 ft width- 2 ½ ft - height of 4 ft of box	DV	4ft x 21/2 ft x 4 ft	Chase
4	Weighing	Weigh via scale	Weigh to check weight requirement of < 150 pounds	DV	less than 150 pounds	Andrew
2	Demonstration	Activation	activate and observe one growth cycle of each stage of plant life	DV	produces mature lettuce leaves	Jennifer
5	Examination	Examination	examine to see that materials are recycled/upcycled	DV	materials are recycled	Andrew
7	Demonstration	activation	demonstrate water pumps activation every 7-9 hours over a week long test via observation/ coding	DV	water is pumped every 7-9 hours	Chase