Plantmosphere

Progress Report

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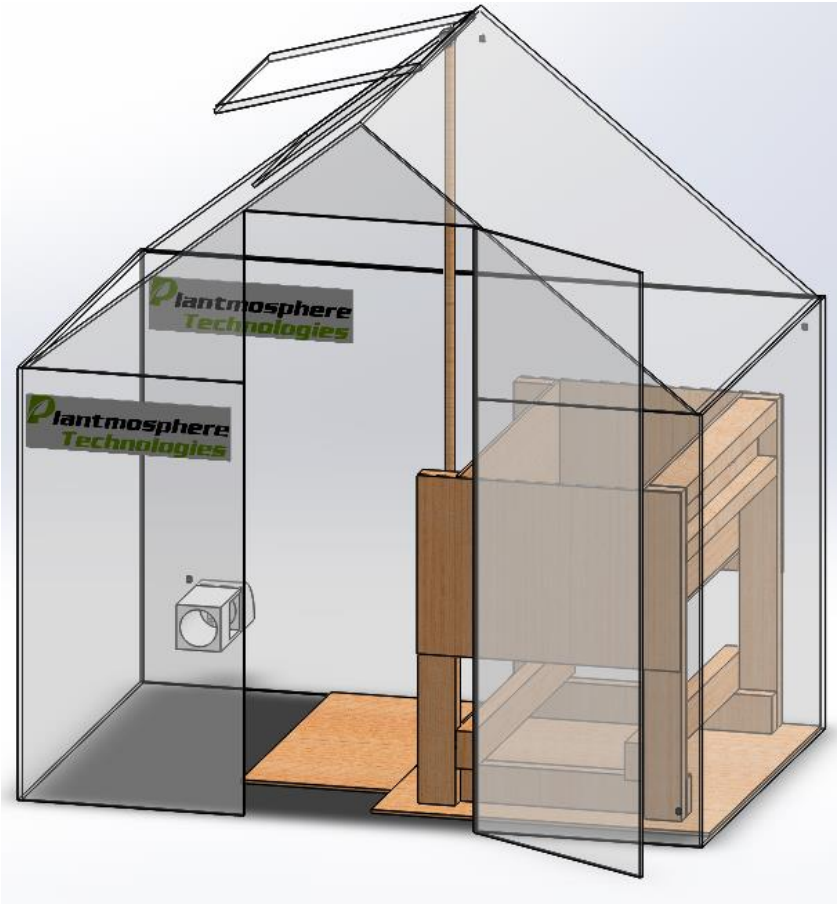

Figure 1: The Greenhouse Structure

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1 Introduction

The Plantmosphere is a revolutionary gardening tool designed to nurture plant growth with automated environment control. The prototype combines structural, mechanical, electrical, and software design elements in order to control the following subsystems: irrigation, humidification, lighting, ventilation, and soil heating.

This document outlines the development progress for the prototype of the Plantmosphere. We will address our current financial status, development schedule, and plans for remediation to mitigate unexpected development obstacles.

2 Financial Status

Our initial forecast of approximately $1300 has been exceeded. We have spent $1627.85 in total, so far. Reasons for exceeding our budget include:

- Purchasing excess quantity of certain items
- Surrogate parts, used to get an early start on development work before choosing an implementation
- Incomplete understanding of the project scope in the proposal phase, leading to under-estimation
- Unforeseen inability to use salvaged parts due to safety and reliability concerns

Our sources of funding are the ESSEF fund, from which we have received $750, and the Wighton Fund, from which we hope to be reimbursed the remainder of our project-related expenditures.

3 Schedule

The difference between our original project timeline (Figure 2) and the updated timeline (Figure 3) is minimal.

Figure 2: Original Timeline

Figure 3: Current Timeline

We had originally targeted November 17th to have the project completed so that we would have a month to grow plants and execute our test plan. This timeline was deemed unrealistic as the design document was delayed by three days, due to its length, and shipping times for some parts were longer than expected. We decided a more realistic goal would be to have the project completed by November 30th. This still gives us two weeks to grow plants and thoroughly test the prototype. Overall, we still have plenty of time to complete and test the product.

4 Progress

In order to determine the best way to design our greenhouse, we solicited advice from a professional greenhouse consultant from GardenWorks. We spent an hour discussing the project and how best to ensure plants would grow during the Vancouver winter. Overall, she provided positive feedback on our greenhouse design, but recommended that we purchase a heating lamp.

4.1 Arduino

Currently, each team member is writing Arduino functions pertaining to subsystem control based on the implementation descriptions outlined in the design document. These functions are being tested separately and are already being integrated into the main program, which is responsible for control of all of the Plantmosphere's subsystems. Code is in place that successfully allows the Arduino to interface with the data logging shield and real-time clock. This program generates tabular data files containing time-stamped sensor data that can be plotted via Excel or LabVIEW for signal data analysis during test plan execution.

4.2 Structure

We've constructed the greenhouse. Additionally, we've designed, built, and installed the trough. Given the positions and worst-case power consumptions of each of the electrical components, and the connections that must be made between them, we calculated the required gauge and length of wire.

4.3 Water Reservoir

The subsystem is designed and we have purchased a 55 gallon barrel to store the rainwater. We have to drill and install the tubing that will collect and guide the rain water from the gutters to the barrel. Also, we have to install the tubing that will take the excess water from the trough back to the reservoir to maximize water recycling.

4.4 Humidification and Irrigation

We have completed the research, design, and ordering of parts, though some still have not been delivered. We are developing Arduino code to control the pump and solenoids based on soil moisture and air humidity levels obtained from sensor readings. The program will also control the ventilation system interaction and the adjusting of the soil moisture levels based on the effect of soil temperature. Once the irrigation and humidification components arrive, we will begin testing the developed control algorithm.

4.5 Lighting

The lighting system design is complete and we have all of the required parts. We are testing the code that is responsible for controlling the LEDs with photoresistors through the Arduino microcontroller. Testing of the lighting control code is scheduled to be completed by November 21st. Once we have tested the lighting algorithm, we will begin install the lighting system into the greenhouse for integration testing.

4.6 Ventilation

The ventilation system research and design is complete, and all of the required components are in our possession. The motor and fan control circuitry has been assembled, and the fans and sensors themselves have already undergone operational testing. The ventilation subsystem is ready to be coded to implement the already designed control algorithms. The intake manifold must then be constructed and then installed in the greenhouse along with motors and fans.

4.7 Soil Heating

We have successfully interfaced the temperature sensors with the microcontroller. All materials required for soil heating and waterproofing the sensors have been purchased. Heat shrink and silicone will be used to waterproof a temperature sensor to test it while it's immersed in soil. The plan for the week of November 17th-21st is to write code that controls the soil heating cable based on the temperature read by the sensor. Once this is completed, the test plans outlined in the design document can be executed.

4.8 Power

The Plantmosphere's power module is complete and is scheduled to be stress tested this week. The high power subsystems using Alternating Current (AC) will be powered with mains electricity directly, so we will plug them into a power strip directly to determine their performance. Moreover, our Direct Current (DC) subsystems will be tested with the computer power supply unit we have acquired, which runs on mains electricity.

4.9 User Interface

The user interface, consisting of the LCD module and numeric keypad, both of which we have unit tested, is ready to be coded and tested as an assembly. The user interface must then be installed in the greenhouse with an appropriate enclosure. It will require extensive input from non-technical personnel to ensure ease of use.

5 Remediations

In order to avoid going further over our budget, we have increased our efforts to use salvaged parts in our designs, and we are being very judicious about further purchases. Only items essential to achieving functionality will be purchased.

All sixteen analog input pins of the microcontroller are assigned to a device, so any unforeseen additional required sensors could either be configured to work in a binary fashion with the digital pins, or groups of sensors could be reassigned to a single pin by using multiplexers.

Tubing needs to be installed to connect the gutters and the bottom of the trough to the reservoir barrel. If we are unable to complete this due to time constraints we will place four buckets at each corner of the greenhouse to capture the rainwater, or we will manually transfer water to the reservoir.

The intake manifold construction will take place this week using scrap wood. The installation of all components in the greenhouse will take place once the testing and integration of the motor and fan control code is completed.

The LED strips are connected in series so if a solder joint breaks a whole strip will turn off, so we would have to manually solder the connection back together. Also, there is a possibility that the a photoresistor unexpectedly breaks and the lighting system won't turn on.

We have included a supplementary fluorescent grow lamp to heat the air in order to prevent plant death. This may prove to be insufficient, in which case we will focus on using our leftover silicone caulking to thermally insulate the greenhouse.

The salvaged enclosure may be too small to encapsulate all necessary components, and an appropriate enclosure will be immediately ordered this week. The assembly installation in the greenhouse will take place once the testing and integration of every subsystem's code is completed.

Although the AC power sources will almost certainly work as intended, the DC power supply unit may not, so we have salvaged an alternative. AC to DC power adapters are simple devices with built-in safety measures that will easily deliver power as needed. Their main drawback is that each needs its own outlet.

6 Conclusion

We have purchased and taken receipt of all the major components with the exception of the irrigation and humidification system, which is expected to arrive on November 18th. The plant trough has been built and installed, along with the wiring buses. Our next action items are to calibrate sensors, install subsystems into the greenhouse, perform all tests outlined in the design specification document, and begin growing plants. Progress has been steady, with all group members contributing to the design and implementation process on a regular basis. By continuing this way, we are confident that we will meet our schedule.