GrowingGreen

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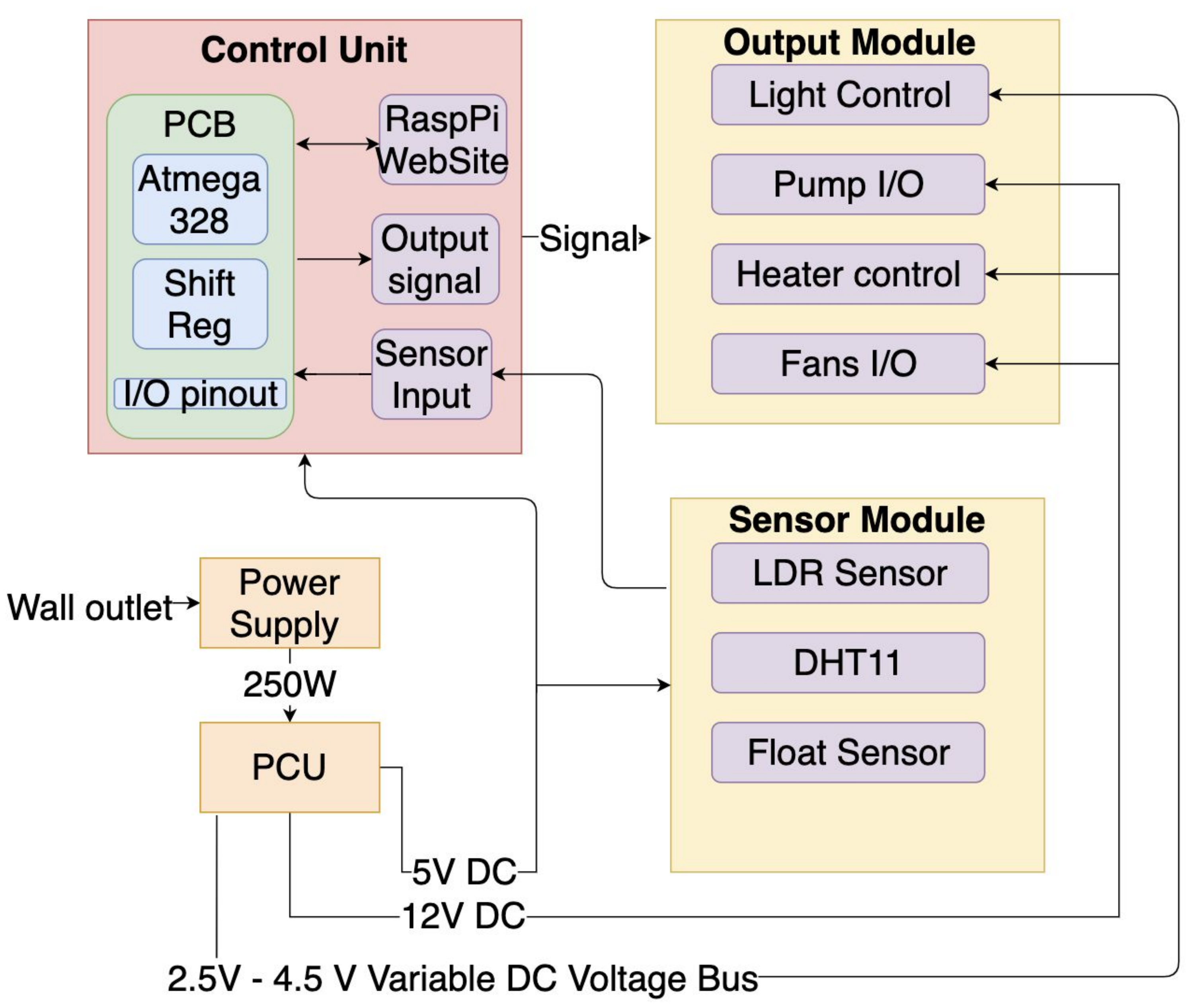
Abstract

The GrowingGreen system is a fully automated, energy efficient, in-house growsite with focus on supplying the grower edible vegetation with minimal effort.

Objective

Our goal is to increase the availability and desire of home growing by simplifying the process through the automation of manual processes, lessening of power consumption, and use of a user console and alerts to keep growers engaged and on schedule. By growing in-house, users will decrease their environmental impact by reducing their carbon footprint and pesticidal use on plants.

Block Diagram



Specifications

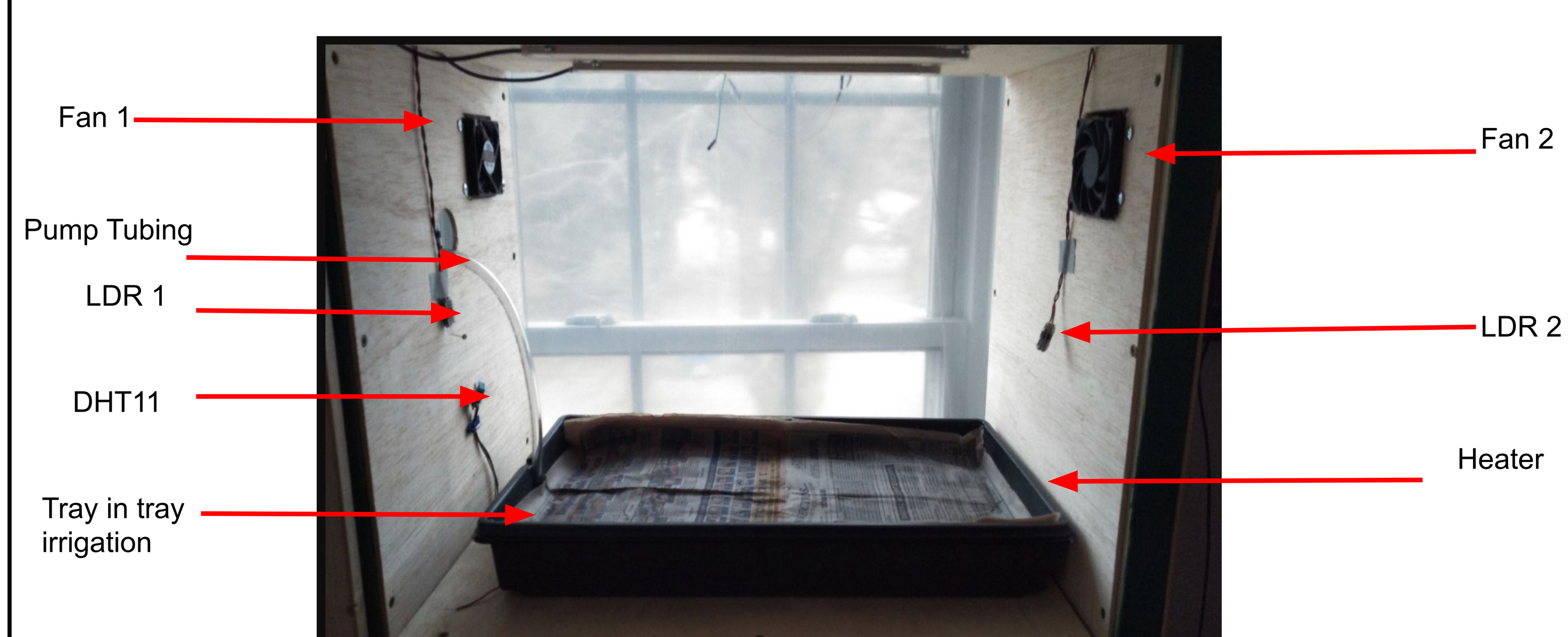
Feature	Specification
Reduce power by 3x the standard	<200W consumption
Functional all year	R-value >5, 12 oz microgreens/wk
Simplify growing process	Environmental Automation
Data available to user	Logs and trends updated every 15 min
Must fit against a typical window	39x27 in.

System Overview

The GrowingGreen automated greenhouse is a fully autonomous system designed to grow plants without user interference. The system controls temperature, humidity, and light exposure through data input and output control. The system needs user input to set the environmental conditions needed to grow a specific plant. Then the system collects temperature, humidity, and LDR values continuously and records the data for manipulation. Based on the data collected, the system will control fans, heaters, lights, and water pumps to autonomously grow a plant in the desired conditions. The system is meant to be energy efficient and has the following energy controls..

- Variable light settings to offset the light collected from natural sunlight
- Multiple power buses to control different systems
- Data logs to understand plant grow cycles

Our system hosts a website for the user to check on the current conditions and state of the greenhouse to keep the user engaged. Data logs are manipulated upon to provide real time plotting features to better represent the conditions



Results

The GrowingGreen system is able to maintain temperature control in 60 -70 deg F consistently. This range represents the ideal temperature for most species of plants from germination to harvest. The system controlled humidity better than expected with the use of our air flow systems that circulates air. The system accurately switched on our variable light conditions based on the amount of sunlight detected through LDR sensors. Lastly, our system was able to grow plant species successfully in 2 week grow cycles autonomously, which was the ultimate test.

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ECE 415/ECE 416 – SENIOR DESIGN PROJECT 2019
College of Engineering - University of Massachusetts Amherst

SDP20

Lighting

Lighting is controlled with a 15-in LED strip outputting in the blue and red spectrum. The lights are controlled using two PMOS and one PNP BJT switches. When insolation is too low, a signal is be sent to enable one of the three switches controlling the 2.5/3.5/4.5 V bus. LDR sensors are used to collect light values and control which voltage setting should be applied

Temperature/Humidity

The temperature of the enclosure is controlled using an insulated heating cable and 12V 3" square fans. The cable and fans are powered off the 12 V supply and controlled with a NPN BJT with the base connected to the control board. The cable outputs up to 5 W/ft, it is 16-in and outputting at 6.25 W. Our air flow system is designed to circulate the air out of the enclosure when the environment is too warm and/or humid which maintains the health of the microgreens. One fan is for intake, one for exhaust. The system uses a DHT11 sensor to collect both temperature and humidity values. Each sensor is calibrated.

Irrigation

Irrigation is a tray-in-tray bottom-watering system, in which the microgreen's root system absorbs water through the holes at the bottom of the tray. To implement this design, we used a float sensor, a 12V submersible water pump, and food grade vinyl tubing. We have a reservoir that contains our pump and float sensor, both controlled by the Raspberry Pi. The float sensor is wired to a GPIO pin on the Pi and ground, while the pump is powered by the 12 V DC supply of the breadboard, and controlled with the same switching circuit as the temperature control elements.

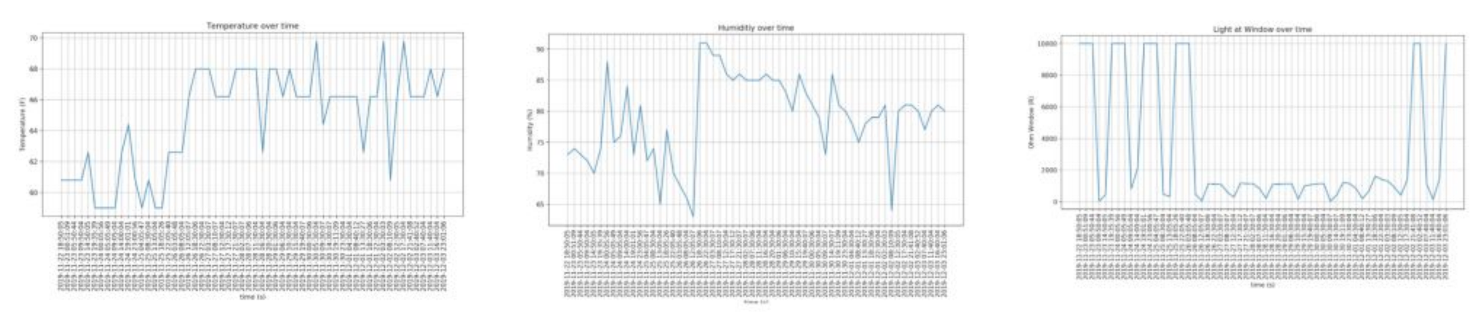
Cost Breakdown

Part	Cost ($)	
Fan	9.95	
LDR	6.45	Total Cost:
Tubing	5.99	
LED strip	63.96	$336.45
Sub Pump	15.98	
Float Sensor	10.99	Surplus Budget:
MicroSD	12.59	
Heating cable	65.50	$163.55
Trays	33.37	
Greenhouse plastic	32.99	
PSU	47.50	
Reservoir	13.99	

Data

Our system is designed to collect and store all sensor data for visualization and research. The systems microcontroller collects the data and transmits it to a raspberry pi through a serial tx/rx connection. It is stored on file systems on the raspberry pi, which automatically populates a hosted website for data visibility. Our website shows current conditions and plots over time.

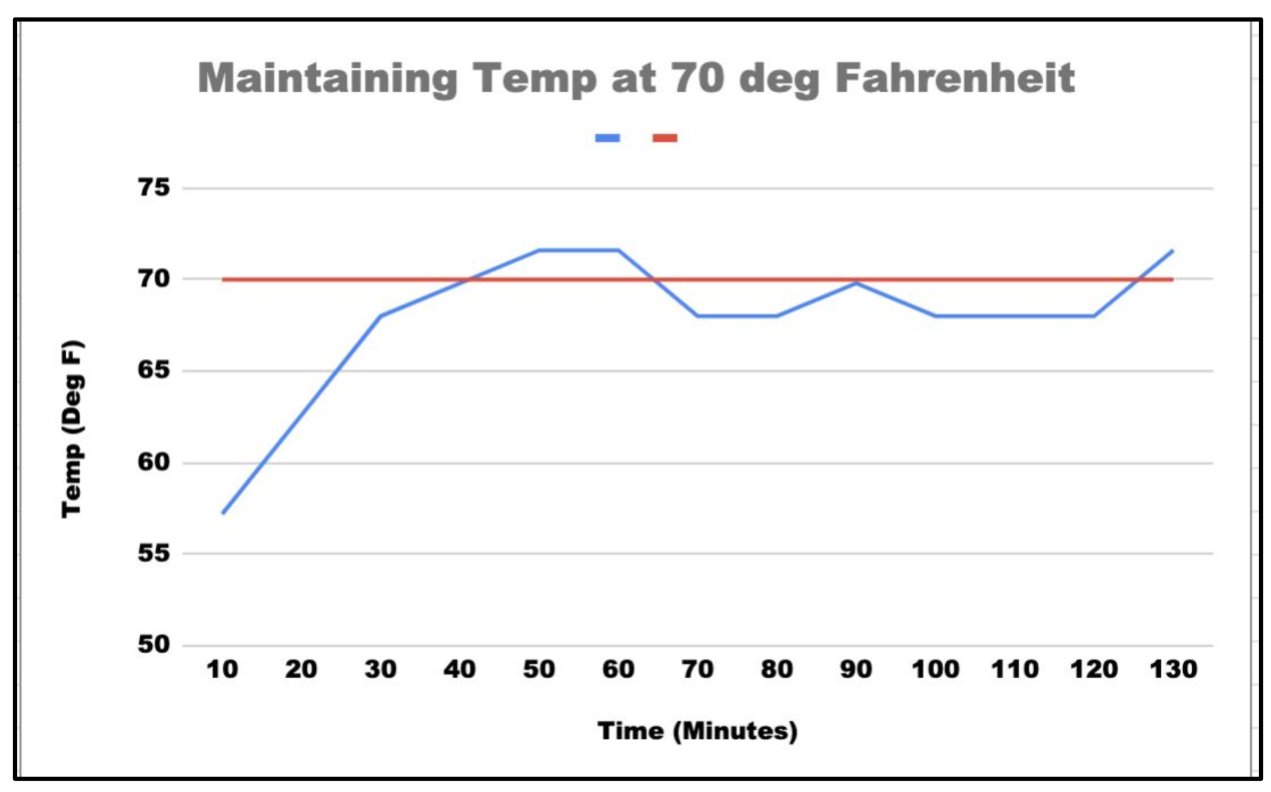
Environment Condition	Current Value
Temperature	68 degrees F
Humidity	55%
LDR Value	649
Reservoir Status	Empty!

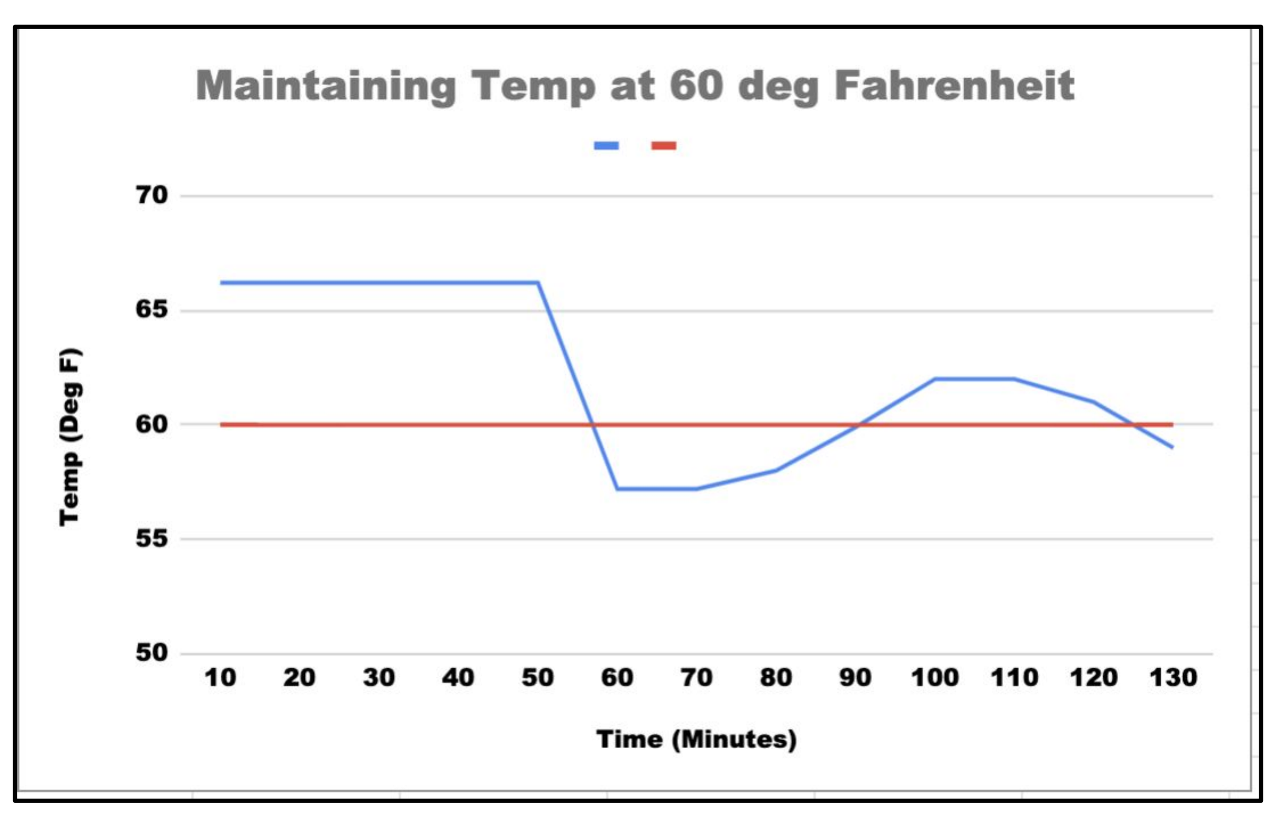


Temperature Humidity LDR Value

Experiment

The following plots visualize a temperature control experiment conducted. The red lines represent the desired temperature and the blue lines represent the temperature over time. This experiment proved our system can control heating and cooling in range of 60 - 70 deg F





Conclusion

We were able to meet our major objectives of a less than 200 W power consumption, the automation of ideal environment conditions, providing logs and trends to the user updated every 15 minutes, and the unit can fit against a typical window measuring 39 in. by 27 in. However, due to the early cancelation of SDP, we were unfortunately unable to meet our objective of having an R-value > 5.

Acknowledgement

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