University of Central Florida

Mushroom Nursery

Divide and Conquer, Version 2.0!
Senior Design I, Summer 2019

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Group Members

We are group # 5,which composed of three students. John Farriss-Computer Engineering Major , Mardochee Cajuste- Computer Engineering Major, and David Booth- Computer Engineering Major.

Sponsors

As of now, we don't have any sponsors for this project. This will be self funded among us, to buy or acquire any components needed to accomplish or finish the project.

Purpose

Motivation: There are some species of mushrooms that can be difficult to obtain in a manner similar to obtaining fruits and vegetables at the supermarket. There are many factors that play a role in this problem such as price, the mushrooms not being local to the area, or the mushrooms just being out of season. The Mushroom Nursery provides a solution to this problem by allowing the user to grow their desired mushroom species under optimal conditions specific to that strain of mushroom.

Project Goals: The goal of the Mushroom Nursery is not only to allow the user to grow their desired strain of mushroom but to allow the mushrooms to grow in a more than ideal environment. By growing the mushrooms in an autonomous and controlled environment, the chances of a failed harvest are greatly reduced. Such factors as pests, pesticides, change in temperature, or lack hydration are completely eliminated.

Objectives:

- Produce a yield far healthier and more plentiful than what would be capable in the wild.
- Provide an easy grow experience with a completely automated environment.
- Allow the environment to be adapted for different species of mushrooms.

Functionality: The Mushroom Nursery will require some mushroom spawn from the user. Once the spawn, any necessary food, and sensor settings have been appropriately adjusted the user will not be required to interact with the Nursery (except for refilling the water tank periodically) until the mushrooms have reached maturity. The Nursery will provide ideal conditions such as appropriate temperature, humidity, watering cycle, and airflow throughout the mushroom's growth period.

Influence: Certain species of mushroom can be hard to come by and tough to grow. Mushrooms generally require a contaminant free environment and very strict conditions. This makes the price of certain mushrooms very high or can even make the mushrooms unobtainable during certain seasons. We came up with the idea of the Mushroom Nursery to solve these problems and hopefully allow everyday consumers easy access to their favorite mushrooms.

Functions

Controller

This project will be composed of various components including lights, temperature and humidity sensor, water spritzers/humidifier and one or more fan(s) to aid in regulating temperature, humidity, and airflow. All these components will require control signals, the controller unit of the system is in charge of the various sensors and mechanism to stabilize the fungus environment.

Additionally the controller will interact with the Web Server (described below) via a WiFi module. This communication will be bidirectional allowing the user to submit commands to the controller as well as the controller uploading sensor readout values to the server.

Sensors

We have identified that temperature and humidity are two parameters impactful to mushroom growth & development, and hence are planning to include sensors that allow the measurement of these values. These values will aid the user in determining if any action is needed, and will conveniently be available on the users smartphone and computer.

Watering & Humidity

Mushrooms require a moist environment in order to develop fruiting bodies (i.e. develop what the layman considers the mushroom). Consistently high humidity is crucial in this stage of the fungi life cycle as the body does not have a protective skin layer, hence moisture is easy lost. However it is also just as easy to drown the mushroom in too much humidity preventing it from properly engaging in gas exchange. Besides humidity some research suggest that spritzing water droplets onto the newly formed fruiting bodies enhances their growth. We will employ a mechanism to maintain a stable humidity level and possibly a water spritzing apparatus.

Light

Lighting plays a very important role in the growth and life cycle of mushrooms cultivation. Mushrooms use light in many ways. For instance, it helps produce the actual mushroom fruit body as well as maintaining the natural day/night cycle. Furthermore, good lighting and a regulated lighting cycle are important factors in plant growth. As a result, our system will provide both of these qualities, by utilizing LED light that provides only the desired wavelength output for perfect plant development. Another key factor of using LEDs is that, not only they are great for encouraging plant/mushroom growth, they are very energy-efficient, meaning that they are require very little power to produce light. Additionally, the user will be able to set a lighting schedule that is optimized for the organisms inside, once set the system will automatically regulate the lights as desired. A manual overwrite option will be provided to the user as well, allowing for on demand enhancements to the light cycle.

In addition to the LED lights, we will also be using an ultraviolet (UV) Air Purifier Light, this invisible form of light can safely kill germs, mold, and in some cases even bacteria and viruses. This light will protect the mushrooms from any virus or bacteria that would otherwise destroy or affect its ability to grow healthy. UV air purifiers are designed to use short-wave ultraviolet light (UV-C light) to inactivate airborne pathogens and microorganisms like mold, bacteria and viruses. The wavelength of UV light is shorter than visible light, but longer than X-rays. It's estimated that UV light makes up about 10% of the sun's output. Additionally the literature suggests that exposing mushrooms to UV light increases their Vitamin D production.

Temperature & Air Flow & Humidity Control

To aid in temperature, air flow and humidity regulation we will include a fan that will automatically trigger if a threshold for one of the applicable parameters is exceeded. For temperature and humidity the thresholds are in terms of max/min temp and humidity while for air circulation it may be a time regulated value. We are also exploring the option of introducing active heating and cooling mechanisms to allow for a growing environment that vastly differs in temperature from the grow location.

Web Application

The mobile responsive web application will allow the user view and manage the fungi environment via their mobile device and computer. The user will have access to features such as most recent temperature, humidity readings, control of the lights, fan and water/humidity dispensers. Secondary features to manage registration and user accounts that have access to the environment will also be included.

Features such as a set list of fungi grow environment profiles, data logging and graph/chart representation of logged data and harvest results are optionally planned to be included.

Web Server & Database

To serve the web application and to allow for data receival & publication a web server will be required, the web server will both serve the static assets required for the web application as well as an API to allow for data focused interaction between the web server and controller as well as live updates on the web application.

The database will store user account related information, plant environment information, required scheduling information and a sensor read out history.

Requirements specifications

Core Feature Requirements

#	Requirement	Reason	Additional Notes
CF1	The system will be able to read the temperature inside the grow area.	In order to upload the temperature to the server and in order to regulate temperature as described in SGF1 and SGF2.	
CF2	The system will be able to log sensor readings and device actions such as lights ran for X minutes, humidified for Y minutes.	In order to further analyze this information at a later time.	
CF3	The controller will be able to connect to a Wifi network.	In order to submit data to the web server.	
CF4	The system will be able to read the relative humidity inside the grow area.	In order to upload the value to the server and regulate humidity as described in SGF1 and SGF2.	
CF5	The system will be able to engage/disengage a fan. The fan will provide an air filter.	In order to reduce contamination and to regulate air flow, humidity and temperature.	See M4.
CF6	The system will include a controller unit, that is installed near or on the case.	In order to control the devices and sensors interacting with the grow box and to interact with the web server.	
CF7	The system will include a web server, that is hosted remotely.	In order to provide an interface for web or mobile applications to fetch data from and in order to provide an interface to receive data from the grow box.	
CF8	The system will include a database, that is hosted remotely.	In order to reliably store data received from the controller, user related and other data.	

CF9	The system will include a web application.	In order to allow a user to access and modify the grow information.	
CF10	The system will include a light.	In order to provide light when required.	
CF11	The system will have means for automatically turning on and off the light described in CF10.	In order to allow the automation of the light cycle.	
CF12	The system will have means for increasing humidity inside the grow area.	In order to achieve optimally high humidity inside the grow area.	See M4 & M5.
CF13	The web server shall require authenticated access prior to accepting or releasing any data.	In order to prevent malicious or unapproved access.	
CF14	The web server shall expose an application programming interface (API).	In order to allow the web/mobile applications and controller to engage with the server.	See M6.
CF15	The web application shall be mobile responsive.	In order to allow it to be easily used on desktop and mobile devices.	See M7.
CF16	The web application shall allow user to view current sensor readings.	In order to allow user to check condition of the grow environment remotely.	
CF17	The web application shall allow user to modify grow environment configuration.	In order to allow for manual optimization of environment.	
CF18	The web application shall allow user to manually enable/disable light, humidifier and fan.	In order to allow for manual optimization of environment.	

Advanced Feature Requirements

#	Requirement	Reason	Additional Notes
AF1	The system shall be able to represent logged data in a report style format, including graphs and charts.	In order to easily represent and visualize the logged data.	
AF2	The system will provide a set of preconfigured growing environment configurations that the user can apply via the web interface.	In order to make it easy for the user to grow a variety of different fungi or other organisms without having to modify the growing parameters directly.	

Stretch Goal Feature Requirements

#	Requirement	Reason	Additional Notes
SGF1	The system will be able to cool the inside of the grow area.	In order to maintain ideal growing conditions.	
SGF2	The system will be able to heat the inside of the grow area.	In order to maintain ideal growing conditions.	
SGF3	The system will be able to measure pH level of the spawn substrate.	In order to upload this information to the web server.	pH levels of the substrate may or may not have a major impact on growth as long as they are in a normal range. See M1.
SGF4	The system will include a mobile application.	In order to allow a user to access and modify the grow information.	

Cited Standards

#	Name	Link	Notes
S1	WiFi 802.11	https://ieeexplore.ieee.org/document/7786995	
S2	ARM v7 Architecture	https://static.docs.arm.com/ddi0403/ed/DDI0403E_d_armv7m_arm.pdf	
S4	JSON	https://tools.ietf.org/html/rfc7159	
S5	REST API	https://www.ics.uci.edu/~fielding/pubs/dissertation/rest_arch_style.htm https://en.wikipedia.org/wiki/Representational_state_transfer	
S6	I2C	https://en.wikipedia.org/wiki/I%C2%B2C	
S7	SPI	https://en.wikipedia.org/wiki/Serial_Peripheral_Interface	

Cited Reference Materials

#	Name	Link	Notes
M1	Do PH Levels matter?	https://mycotopia.net/topic/89009-do-ph-levels-matter/	
M2	IEE 802.11 Wiki	https://en.wikipedia.org/wiki/IEEE_802.11	
M3	WiFi Wiki	https://en.wikipedia.org/wiki/Wi-Fi	
M4	Environment for Mushroom Growth	https://homeguides.sfgate.com/environment-mushroom-growth-28551.html	

M5	Relative Humidity Wiki	https://en.wikipedia.org/wiki/Relative_humidity	
M6	Application Programming Interface (API) Wiki	https://en.wikipedia.org/wiki/Application_programming_interface	
M7	Responsive Web Design	https://en.wikipedia.org/wiki/Responsive_web_design	
M8	UV light increases Vitamin D production in mushrooms	http://sciencenordic.com/uv-light-turns-mushrooms-vitamin-d-bombs	

Design Constraints

#	Constraint	Additional Notes
DC1	The API will return results in JSON format.	
DC2	The controller should communicate via WiFi.	
DC3	The server and database should be hosted remotely in the "cloud".	
DC4	The light utilized should be LED.	

Similar Projects

1. **Plant Automated Sustainable System, Auto Plant Feed System, Autobott, LeafAlone Hydroponics System, WaterWise**

These senior design projects are very similar to ours in that it allows a user to read data about the plant inside a growth chamber and allows the user to adjust the conditions from a mobile interface. Some key differences from these projects and our project is that all these projects focused on plant life whereas our project will focus on mushrooms.

2. **Smart Plant Pot: Portable Plant Monitoring Environment**

This senior design project is similar to ours in that sensors are used to record data about the plant's health and growth cycle. This project also used an enclosure around the plant, however, our enclosure will be to sustain the necessary environment for the plant.

3. **Vivo Mylar Hydroponic Growth Tent**

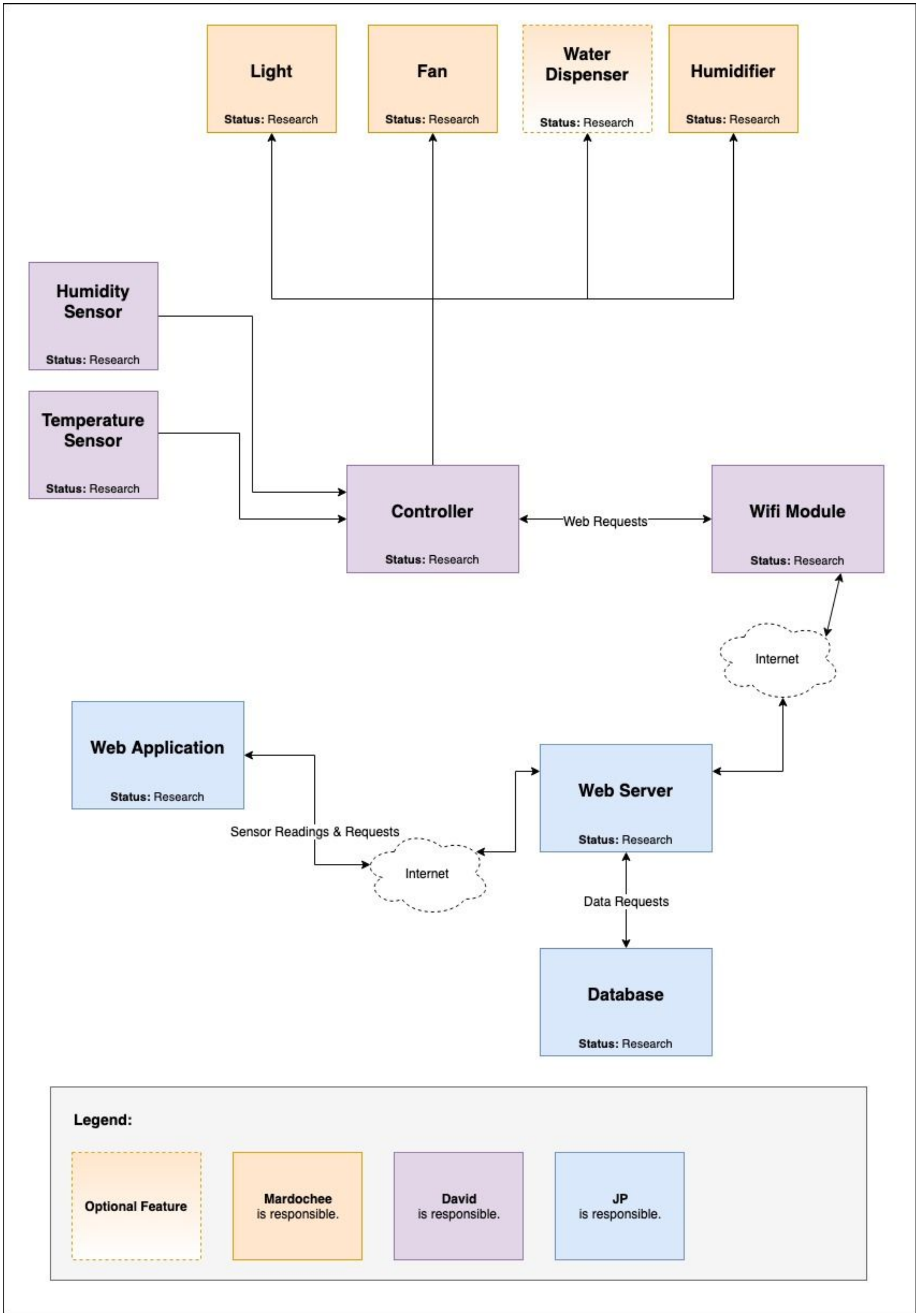
This is a product designed for developing a microclimate inside a mylar tent to provide ideal conditions for the life inside of the tent. This is similar to our project as we are also building an enclosure for this purpose. This product, however, does not automate any of the necessary functions to keep the plant alive.

4. **Portable Watering Device -**

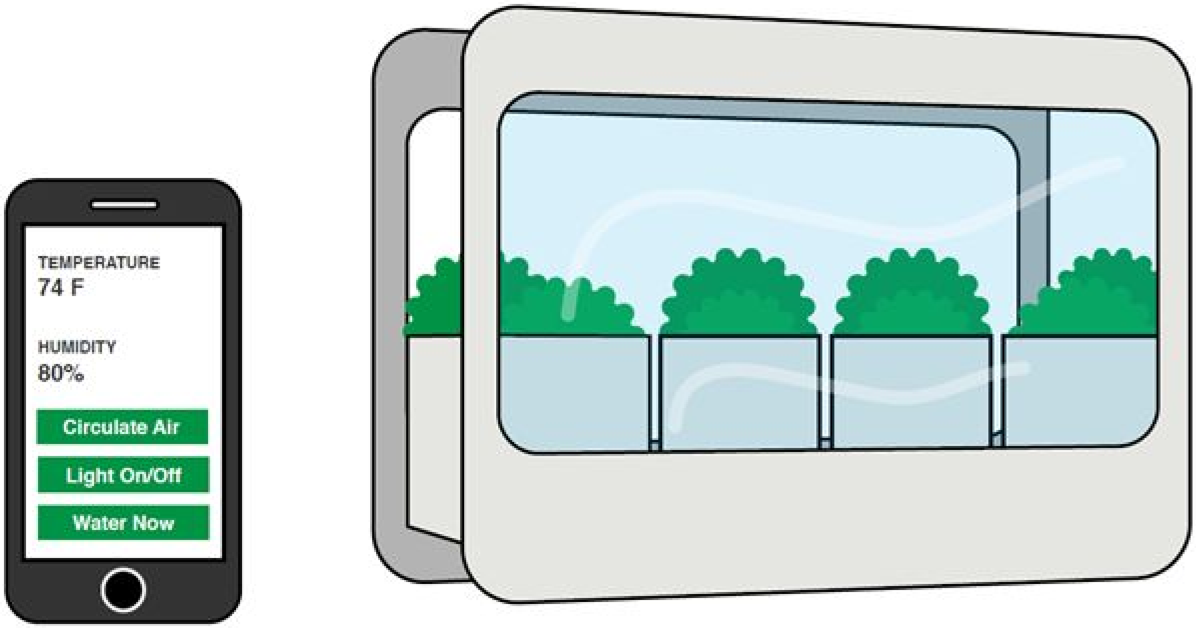
This senior design project shares our concept of automating the process of watering a plant through a mobile interface. None of the other necessary functions are automated, which our project fulfills.

#	Name	Link
SP1	Plant Automated Sustainable System	http://www.eecs.ucf.edu/seniordesign/fa2013sp2014/g31/docs/final_report1.pdf
SP2	Auto Plant Feed System	http://www.eecs.ucf.edu/seniordesign/sp2009su2009/g04/
SP3	autobott	http://www.eecs.ucf.edu/seniordesign/sp2015su2015/g02/
SP4	LeafAlone Hydroponics System	http://www.eecs.ucf.edu/seniordesign/sp2014su2014/g09/
SP5	WaterWise	http://www.eecs.ucf.edu/seniordesign/sp2016su2016/g04/
SP6	Smart Plant Pot: Portable Plant Monitoring Environment	http://www.eecs.ucf.edu/seniordesign/fa2013sp2014/g31/docs/final_report1.pdf
SP7	Vivo Mylar Hydroponic Growth Tent	https://vivosun.com/products/grow-tent-48x24x60
SP8	Portable Watering Device	https://www.cecs.ucf.edu/web/wp-content/uploads/2017/11/Fall-2017-Senior-Design-Program-and-Summaries-11-30-17.pdf

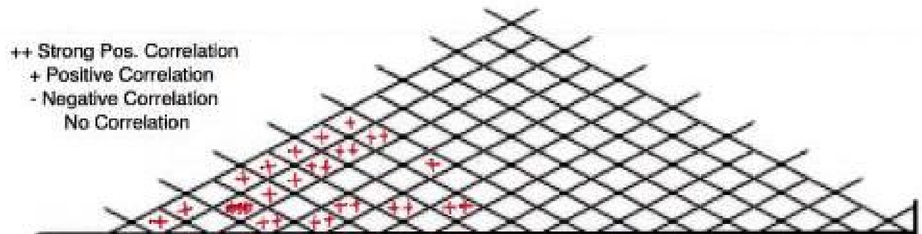
Project Block Diagram



Project Visual Illustration



HOQ Diagram



⊙ 9 Strong
○ 3 Medium
△ 1 Weak

1 = Low Priority
5 = High Priority

Customer Requirements	Priority 1 to 5	Automation	Web Application Features	Grow Volume	Weight of Box	Active Cooling/Heating	Active Humidification	Temperature Sensor	Humidity Sensor	Lighting
Maximize / Minimize		▲	▲	▲	▼	—	—	—	—	—
Ease of Use	5	⊙	⊙	○	⊙			○	○	○
Healthy Crop/Harvest	3	△				△	△	○	○	△
Large Harvest	4	○	△	⊙	○	⊙	⊙	○	⊙	△
Access to Data	3	△	⊙					⊙	⊙	△
Importance		63	76	51	57	39	39	63	87	25

Project Budget and Financing.

Item	Estimated Cost
Microcontroller	$20
Temperature sensor	$5
pH sensor	$20
Humidity sensor	$5
Plexiglass	$30
Housing	$30
Fan	$10
Humidifier	$20
Water/Fertilizer Dispenser	$30
Light	$20
Relays	$20
Total	**$210**

Milestones

1st Semester

Date	Activity
June 3	Begin researching design
June 24	Split up tasks and begin writing documentation
July 22	Individual components completed; begin comparison of parts
July 29	First draft complete; Begin revisions
August 5	Turn in completed report

2nd Semester

Date	Activity
August 22	Determine where parts will be ordered from and collect funds; Order parts
September 2	Test parts individually
September 9	Begin construction of project
October 28	Construction complete; Begin testing
November 4	Insert plant into chamber and begin collecting results