Mushroom Nursery

An autonomous environment for enhanced primordia formation and fruit body development of mushroom cultures.

University of Central Florida
Department of Electrical Engineering and Computer Science

Group #5
John Farriss, CpE
Mardochee Cajuste, CpE
David Booth, CpE

Motivation

- Mushrooms are delicious and good for you.
- Most people only get one type: Portobello
- Gourmet and dietary supplement varieties are difficult to find locally.
- Commercial growers have difficulty growing certain varieties in bulk.
- Commercial growers have difficulty shipping most varieties due to their fragile nature and short shelf life.

Project Goals

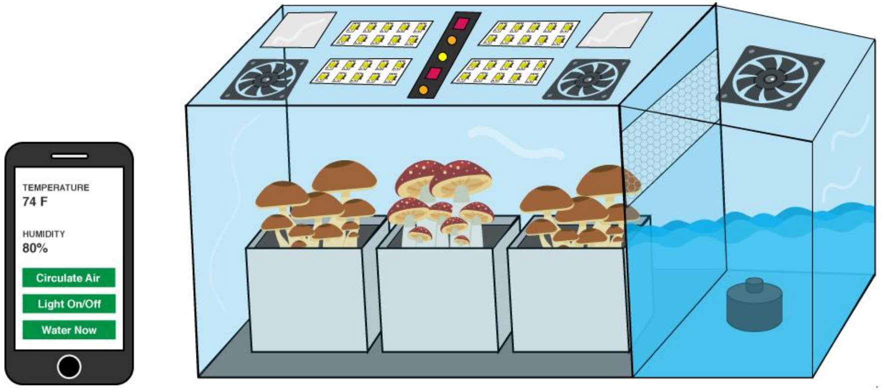
- Give consumers access to a large variety of fresh mushrooms.

- Enable users to easily grow their favorite mushrooms at home.

- Build a self maintaining mushroom nursery.

Proposed Implementation

- Table top grow house that monitors and controls the grow environment for ideal conditions.
- WiFi connected controller that sends sensor data to a web server.
- Web & Mobile App that allows for remote monitoring & management.



Project Design

- Features are prioritized using a House of Quality Score.
- Circuits are evaluated and fine tuned via breadboard prototyping.
- Controllers are evaluated and troubleshooted via Development Boards.
- PCB design is created using Easy EDA and printed and assembled by PCBWay.
- Software and Hardware will be designed for unit testing and extendability.

Core Specifications

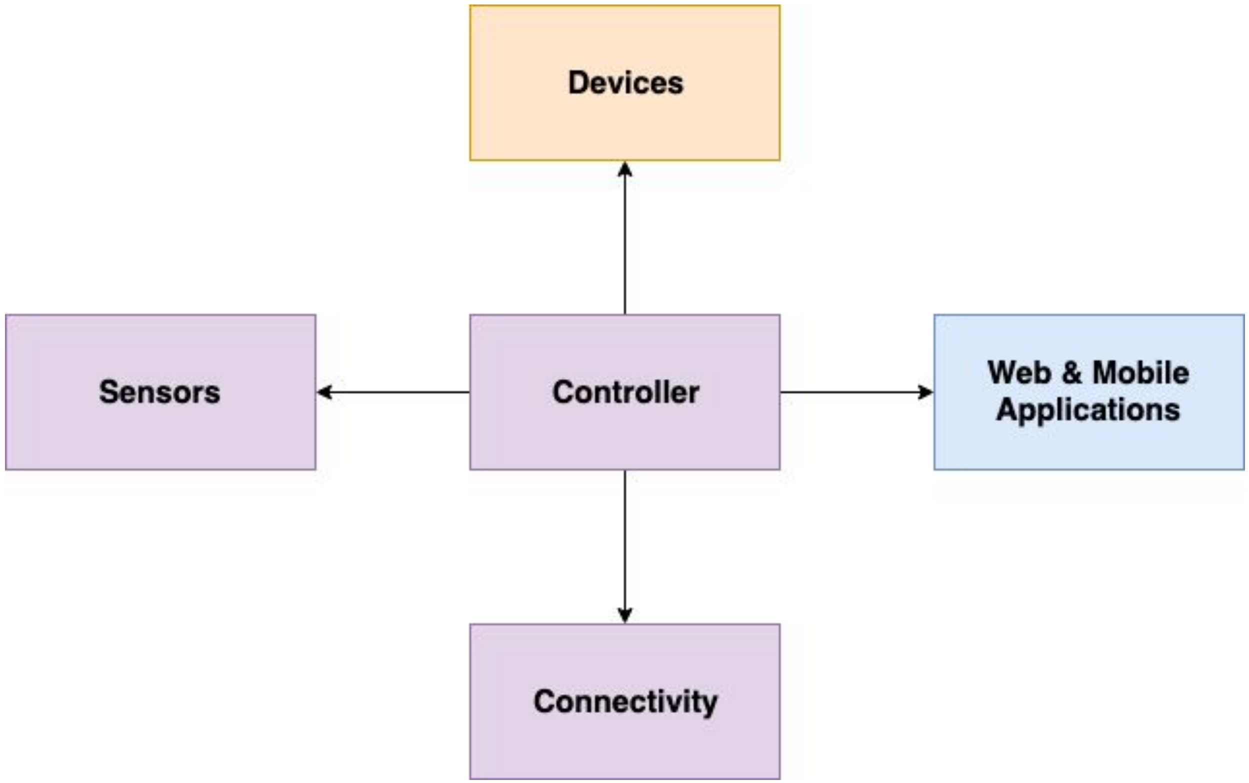
- Ability to read the temperature and humidity inside the grow area every 5 seconds.

- Ability to connect to 2.4GHz WiFi networks, and submit and read data from Web Server.

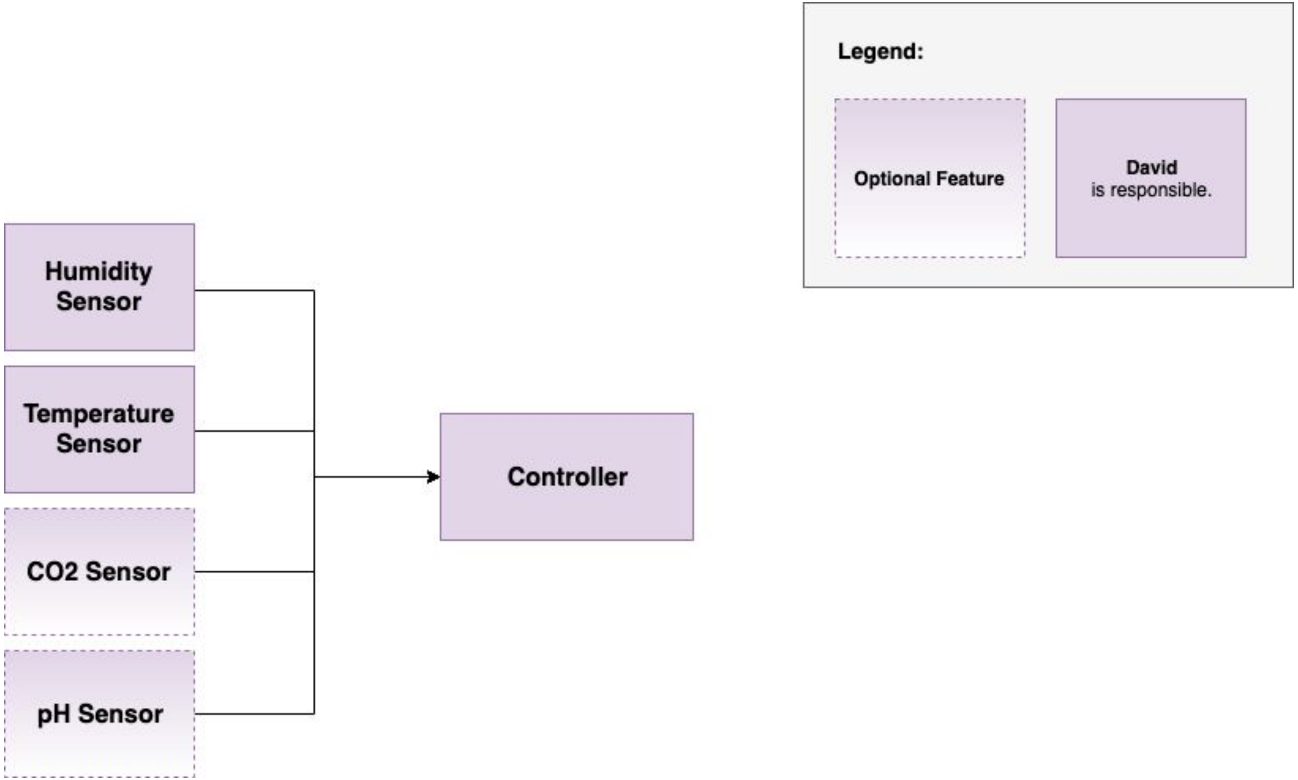
- Ability to automatically engage and disengage internal fans, lights and a humidifier in order to maintain a predefined set of environmental parameters.

- Ability to manually engage and disengage fans, lights and humidifier via a web application.

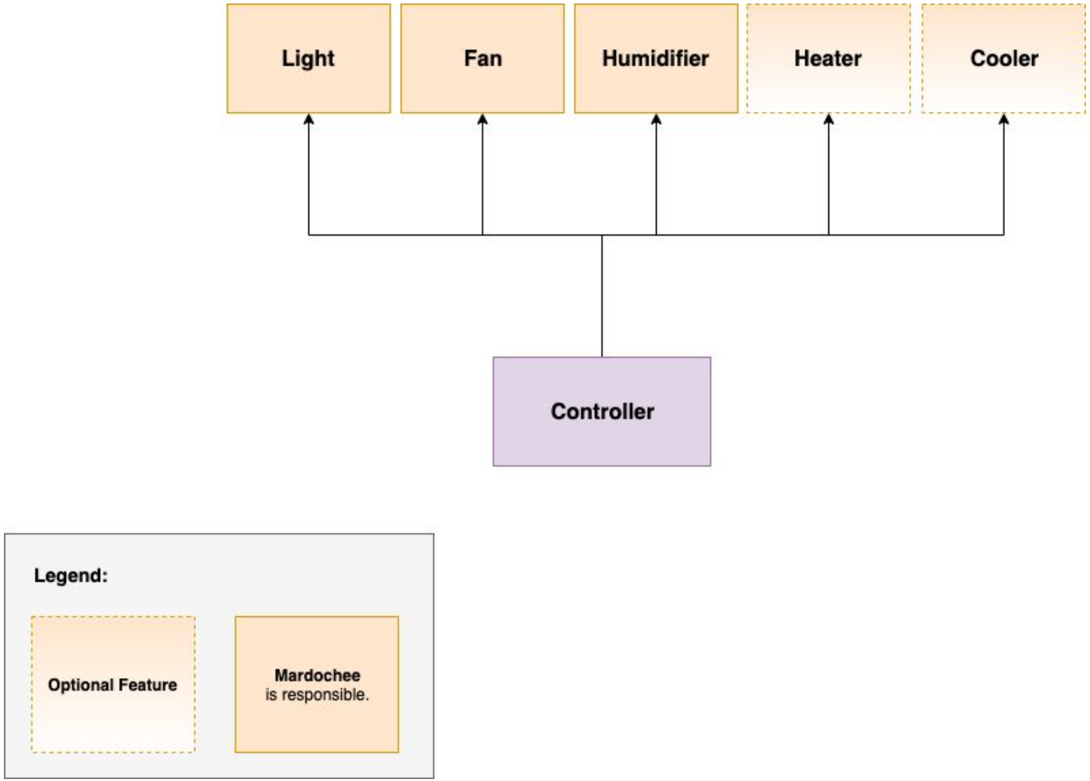
Sub Systems Overview



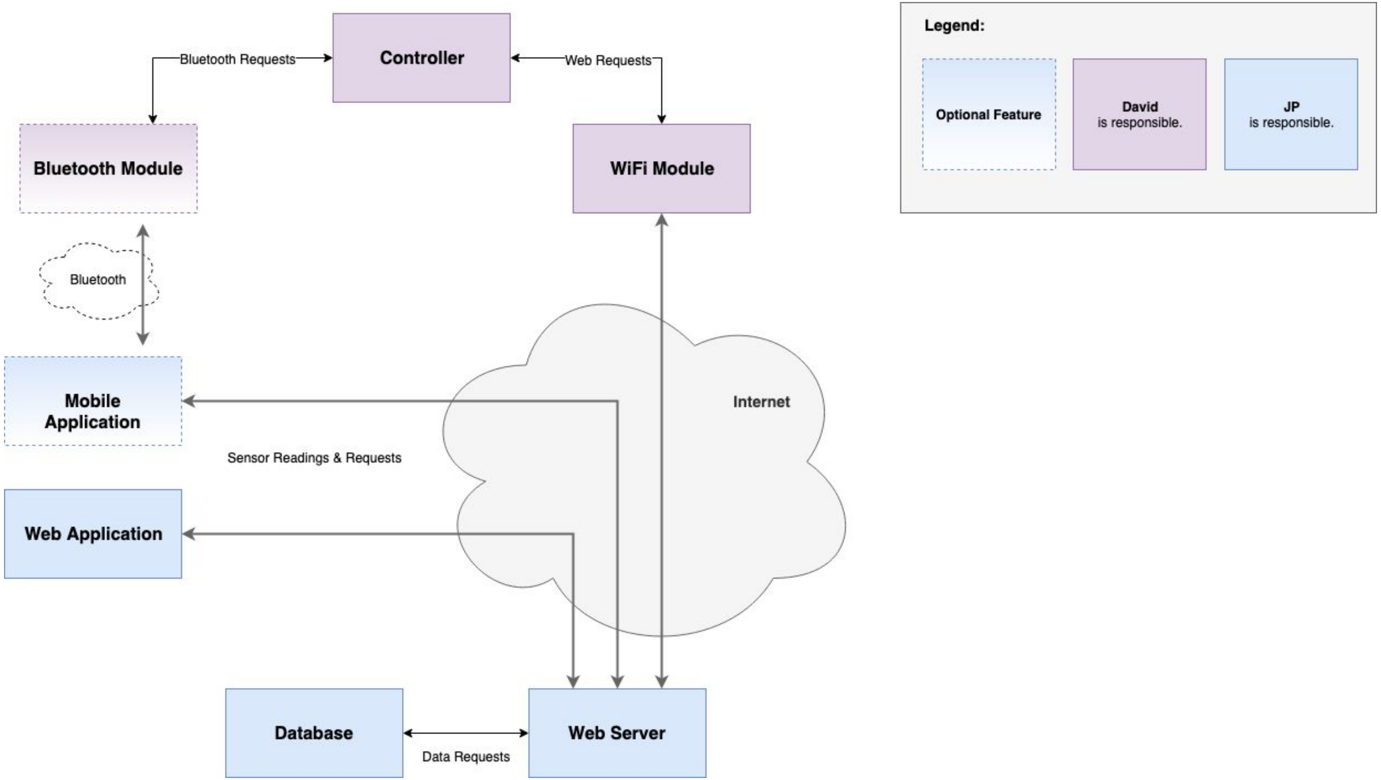
Sensors


Legend:
Optional Feature
David
is responsible.
Humidity Sensor
Temperature Sensor
CO2 Sensor
pH Sensor
Controller

Devices


Light
Fan
Humidifier
Heater
Cooler
Controller
Legend:
Optional Feature
Mardochee
is responsible.

Web & Mobile Applications

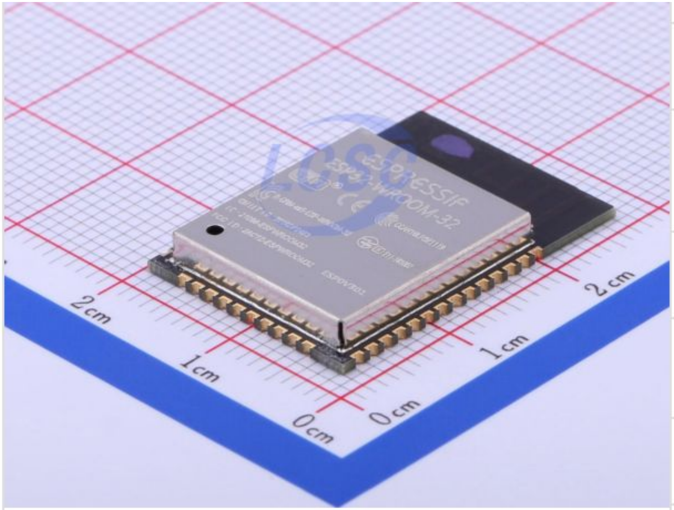


Controller & Connectivity Solution

- Evaluated MCUs and SoCs from Microchip, Espressif and TI.
- Explored option of MCUs with external WiFi modules.
- Explored option of SoCs with internal WiFi modules.
- Researched complexity of programming, flashing and troubleshooting the controller.

Controller & Connectivity

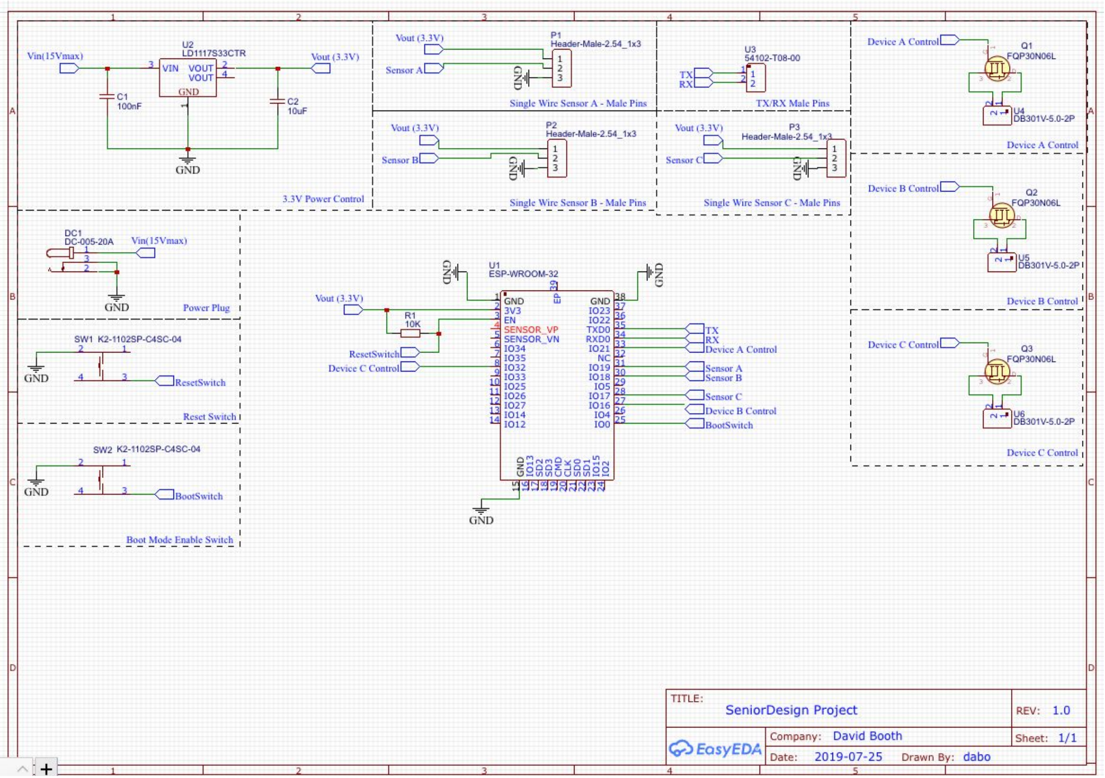
- Decided on ESP32 SoC in the WROOM-32D packaging.
- 21 GPIO Pins, including DACs and ADCs.
- An Internal WiFi Module.
- Enough internal flash for current and future features.
- Protective metal casing with antenna.



Controller & Connectivity

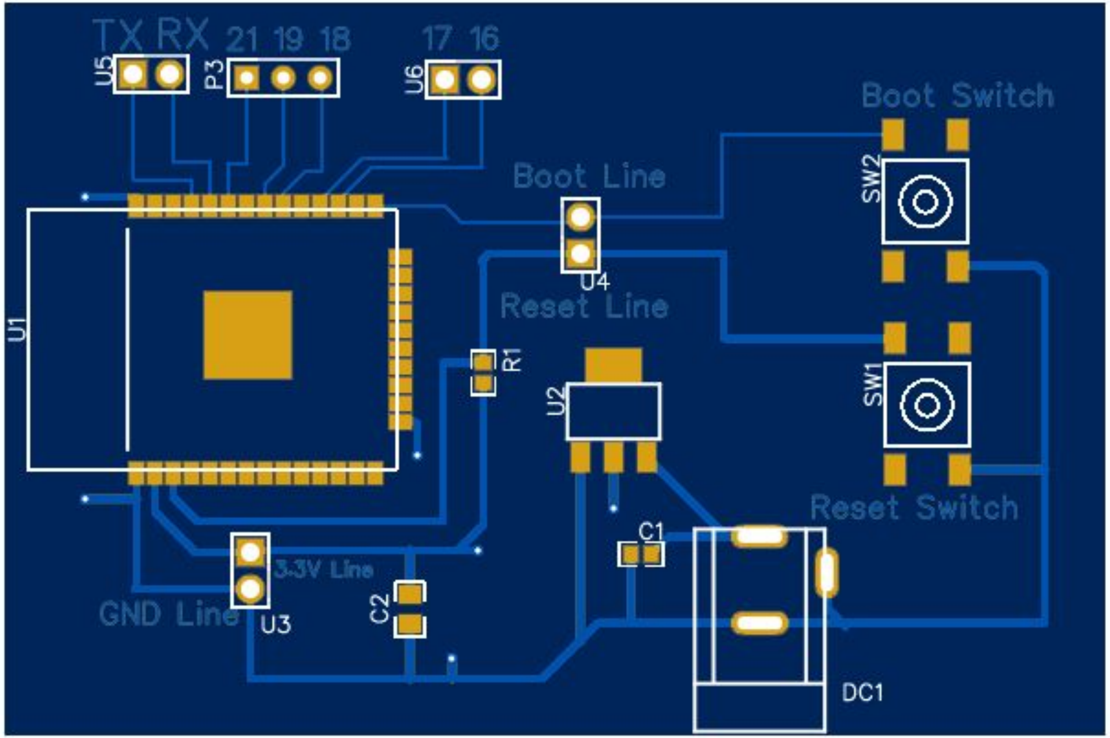
Internal Flash Memory	16 MB
Wireless Connectivity	2.4 GHz WiFi supporting 802.11 b/g/n Bluetooth 4.2 including Bluetooth LE
Number of GPIOs	21
Wired Protocols	UART, SPI, I2C, I2S
Operating Voltage	3.3 V
Processor	Xtensa dual-core 32-bit LX6

Controller & Connectivity Solution



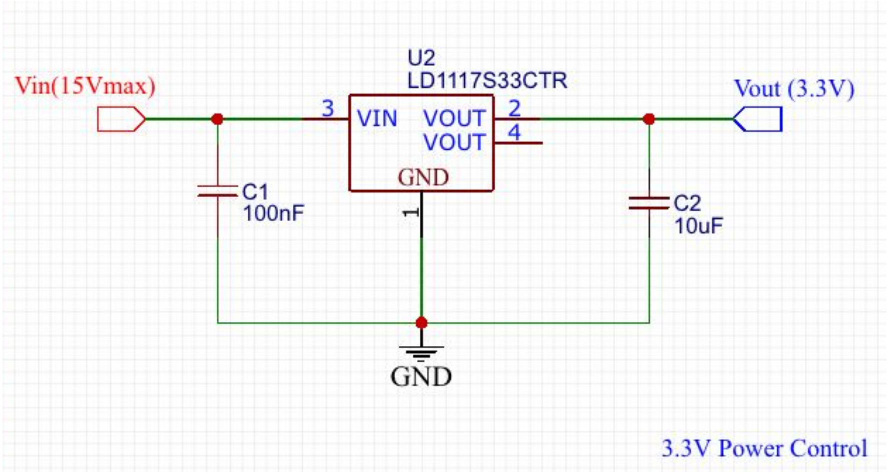
Controller & Connectivity Solution

- First Prototype Board
- Additional troubleshooting breakouts.
- No Device Control Circuit.



Board & Sensor Power Solution

- Board is powered by AC-DC Wall adapter connected via barrel jack.
- Voltage Regulator regulates up to 15V input to 3.3V.
- The Controller and Sensors are powered from the 3.3 V line.



Power Solution

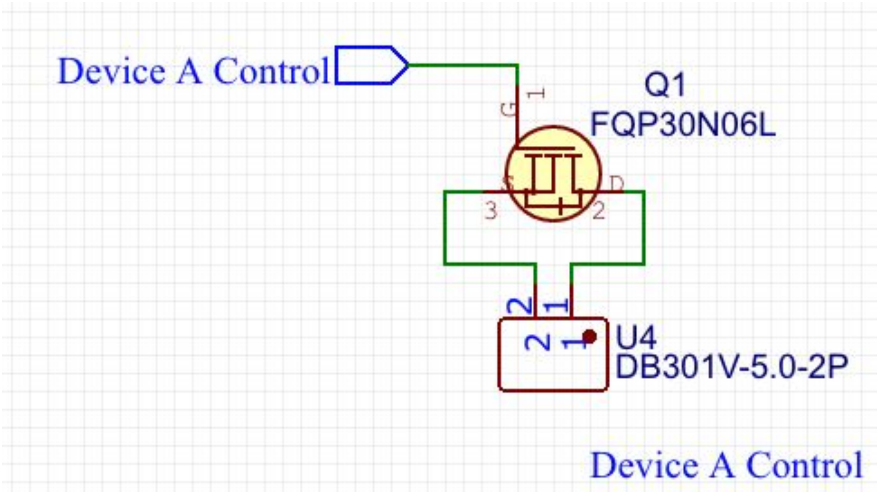
- Chosen Regulator is the LD1117 by STMicroElectronics.

- Operating Temperature estimated to be 49C, assuming 5V DC Input and 300mA draw.

LD1117	
Max. Input Voltage	15 V
Fixed Output Voltage	3.3 V
Max. Output Current	800 mA
Package	TO-220
Junction to Ambient Thermal Resistance (*RθJA)*	50 C/W
Max. Operating Temp.	125 C
Cost	$0.15

Device Power Solution

- Devices are powered with Wall Adapter AC-DC Converters.
- Devices are enabled/disabled via MOSFETs.
- Devices are wired into circuit via screw terminals.



Device Power Solution

- MOSFET used is Fairchild FQP30N06L.
- Temperature rise for devices have been estimated on next slide.

FQP30N06L	
Max. Drain-Source Voltage	60 V
Max. Drain Current	32 A @25 C 22 A @100 C
Junction to Ambient Thermal Resistance (*RθJA*)	62.5 C/W
Rds(on)	0.035 Ohm
Max. Operating Temp.	175 C
Cost	$0.95

Device Power Solution

	Max. D-S Voltage	**Max. Current**	**Max. Temperature**
FQP30N06L	60 V	32 A @25C 22 A @100C	175 C
	Operating Voltage	**Max. Current**	**Junction Temp.**
Light	5 V DC	2 A	34 C
Fan	5 V DC	300 mA	26 C
Humidifier	24 V DC	700 mA	26 C
Heating / Cooling	15 V DC	7 A	132 C (Looking at heatsinks)

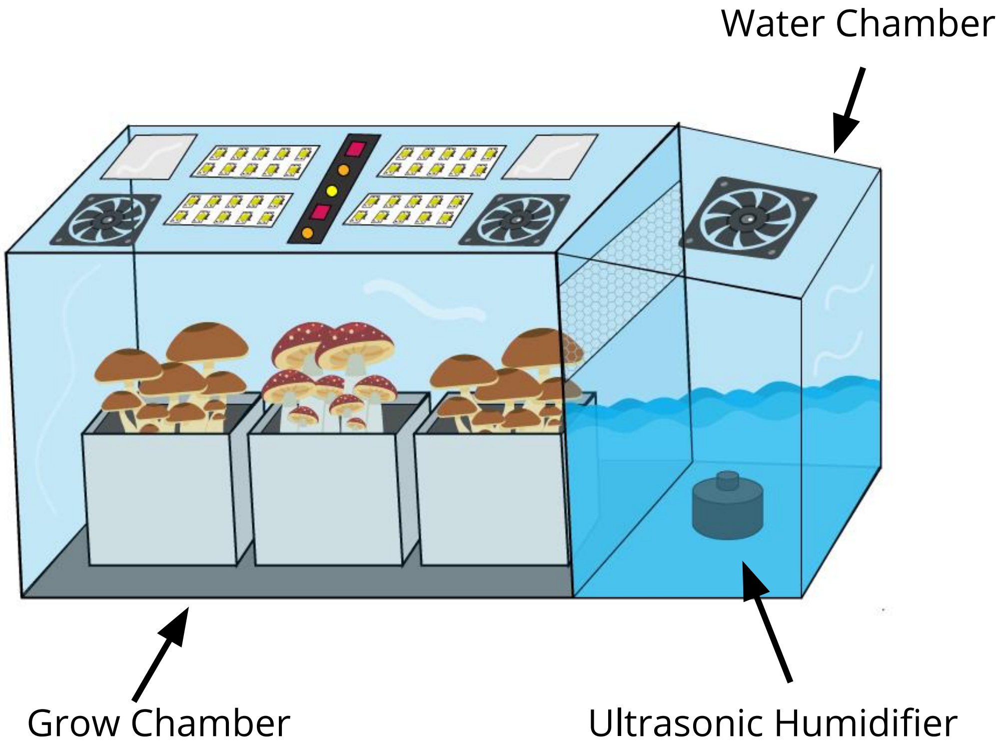
Humidification Solution

- Mushrooms require high levels of humidity (80-100% RH).
- The user is able to set the desired humidity level via the web app.
- Humidity is sensed through a humidification sensor.
- An ultrasonic humidifier is placed within a water chamber that is part of the housing.
- A fan will blow the humidified air into the growing chamber.

Humidification Solution

- The controller measures the internal humidity level and enables or disables the humidifier and fan as needed.

- The user will be required to refill the water chamber periodically.



Humidification Solution

AGPTek Ultrasonic Disc Humidifier	
Voltage	24 V DC
Max Current	700 mA
Water consumption	200-400 ml / hour
Size	3.5 cm diameter 4 cm tall
Cost	$12.99

Lighting Solution

- Minor Lighting helps with color and flavor development.
- LED light mounted inside the nursery.
- Controller schedules a set amount of light and dark time.
- User can manually override via app.

YLANK Full Spectrum Grow Light	
Voltage	5 V DC
Max Current	2 A
Cost	$12.99

Air Exchange Solution

- Mushrooms consume Oxygen and produce CO_2.
- CO_2 must be removed from the inside of the nursery and oxygen must be introduced.
- Introduction of fresh air increases contamination risk and lowers humidity.
- One or more fans will push fresh air through a HEPA filter into the nursery.

Air Exchange Solution

- Controller schedules 5 minute air exchange every hour.

- CO2 sensor may be introduced to trigger air exchange on demand.

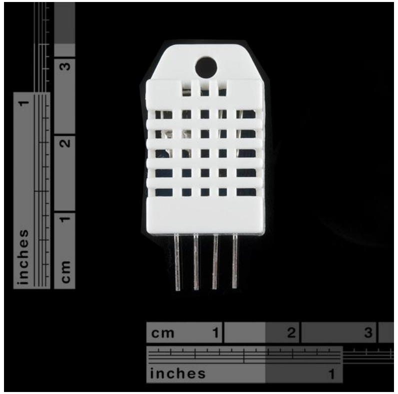
RDEXP DC Fan	
Voltage	5 V DC
Max Current	300 mA
Cost	$6.55

Temperature Solution

- Environment temperature requirements range from 50F to 90F.

- User can set the temperature requirement via the web app.

- Nursery uses a temperature sensor to determine it’s internal temperature.



MaxDetect RHT03 Temp & Humidity Sensor	
Voltage	3.3 V DC
Max Current	1.5 mA
Connectivity	1 Wire Bus
Cost	$9.95

Temperature Solution

- One Peltier Device mounted with cold side facing the grow area.

- One Peltier Device mounted with hot side facing the grow area.

- Devices are enabled or disabled for cooling or heating as needed.

- Insulation, Heatsinks and Fans for improved temperature transfer effect.

TEC112707 Thermoelectric Module	
Voltage	15 V DC
Max Current	7 A
Max Temp Diff.	150 F
Cost	$11.95

Web Application Solution

- Mobile responsive web application allows for interaction with the Nursery via computer, tablet and mobile device.

- User can manually control the devices of the nursery.

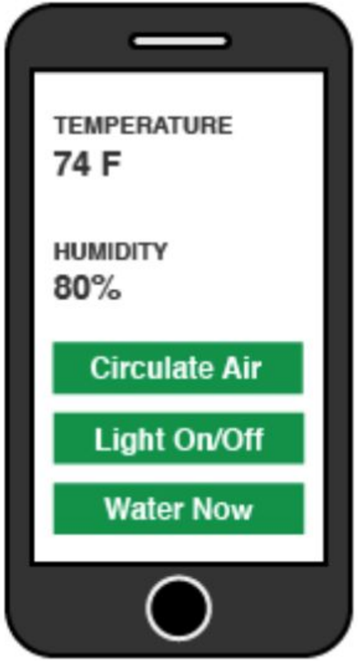
- User can view sensor readings.

- User can view historical sensor data and device operation logs.

Web Application Solution

- React JS was chosen as the Web Framework.

- Application will interact with the Web Server via a REST API.



Server & Database Solution

- A Node.js Server Application deployed on an AWS EC2 instance or a Heroku Dyno.
- Optionally an AWS API Gateway may be utilized for API design and management.
- Data will be stored in a non-relational data store such as MongoDB.
- MongoDB will be deployed on the same EC2 instance as the web application or on a dedicated instance.

Successes

- Initial prototype PCB design arrived and is functioning.

- Efficient Team member communication.

- Tasty mushrooms have been produced (and eaten).

Retrospective

- Failed attempt in one of our prototypes.
- Humidity too low - malformed fruit bodies.
- CO2 to high - elongated stems.
- Caused us to redesign the humidification & fresh air exchange system.

Progress Update

Parts Selection	80%
PCB Design	90%
Housing Design	20%
Web Application	10%
Server & Database	0%
Controller Software	20%
Project Assembly	0%

Success Plan

Completed by	Task
October 6th	David will finish up the final PCB Design and place the order for assembly.
October 15th	Mardochee will start on Housing Design for review by the team.
October 31st	David will complete the Controller Software.

Success Plan

Completed in	Task
October 31st	John will start and complete the Web Application and Database.
November 10th	Team will have tested software and hardware components.
Remainder of time.	Assembly, testing, improvement and if possible addition of feature set of final project.

Current Project Spend

SparkFun ESP8266 Thing	$17.95
SparkFun Thing Plus - ESP32	$20.95
Break Away Headers	$1.50
ESP32 DEVKIT C Version 4	$14.95
PCB Components	$7.41
Fan	$15
Ultrasonic Disc	$6.99
Tote Container	$22.37
Water Tank	$52.99

Peltier Device	$9.95
Temperature Sensor	$49.00
pH Sensor	$19.95
Humidity Sensor	$9.95
LED Light	$20.00
Components for initial PCB	$7.41
Printing & Assembly of Initial PCB	$50.00
Total:	**$326.37**

Projected Additional Spend

Housing Materials	$150
Final PCB Components	$15
Final PCB Assembly	$75
Sensors	$50
Devices	$100
Assembly Materials	$50
Total	**$440**

Thank you.

Any Questions?

Please feel free to contact us for more information.

John: johnfarriss@knights.ucf.edu
Mardochee: mdccj101@knights.ucf.edu
David: david_booth@knights.ucf.edu