Automated Rotating Solar Plant Rack with Self-Care Capabilities

Group 23

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Our Team

Melissa Rose
Electrical Engineering

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Introduction

- Gardening is a wonderful hobby that not only provides comfort and food to billions but also enriches the Earth by reducing carbon output.
- However, plant maintenance can be time-consuming and easy to blunder. Those with a busy schedule and/or lack of a green thumb may avoid gardening because of this.
- All those setbacks can be eliminated with an automated plant care tools! Sensors, water pump and soil piping, shading, rotation, and plant settings application will allow one to have plants without worrying about maintenance.

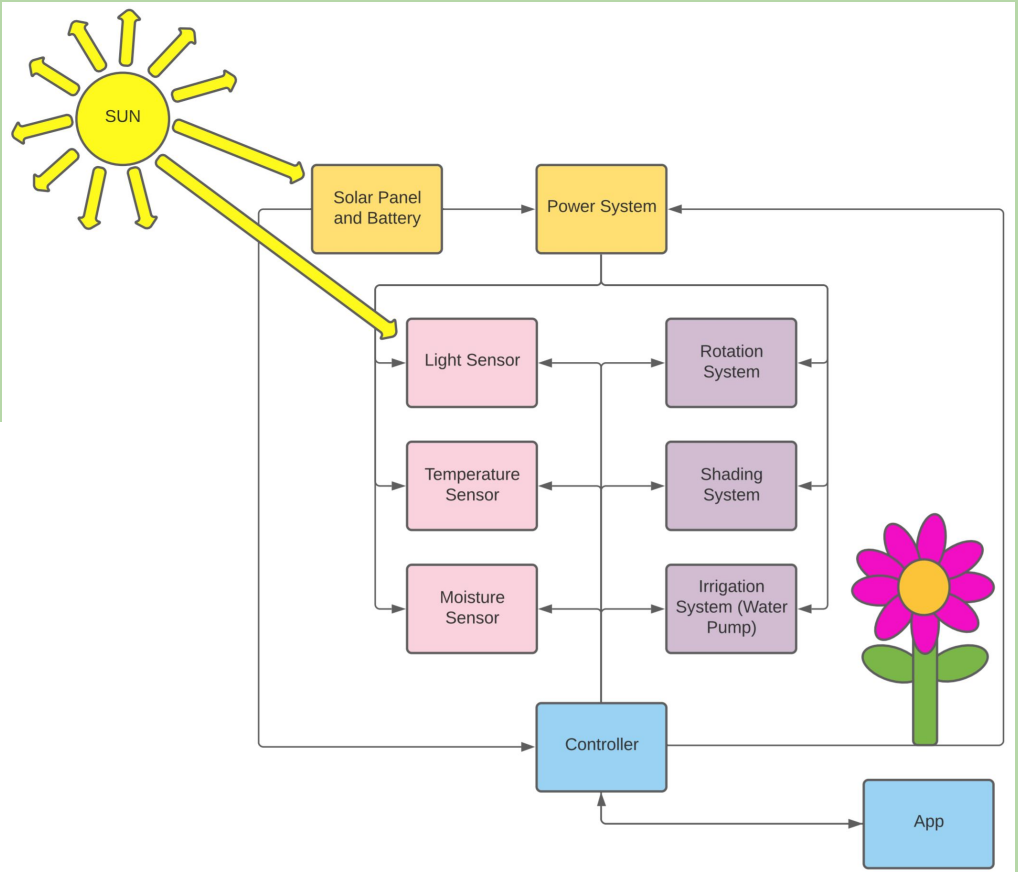
Project Goals & Objectives

- To create a system that will autonomously provide water and sunlight to a plant
- To create a system that can assure its plant grows straight up rather than towards the light source
- To provide a method for caring for a plant when one cannot be present
- To create an easy-to-use interface that can be leaned in a short period of time

Motivation

- Interest in Smart Home Technology
- Previous Experience with Plants

Block Diagram



Brian Geibig - Electromechanical Output Systems

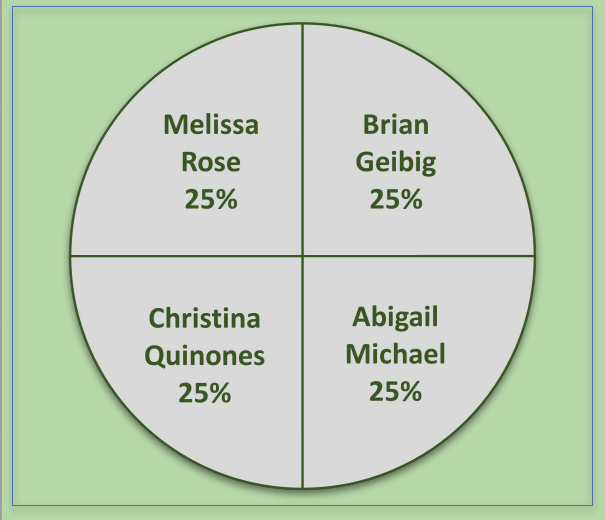
Abigail Michael - Application and Software Development

Christina Quinones - Power System and Electromechanical Input Systems

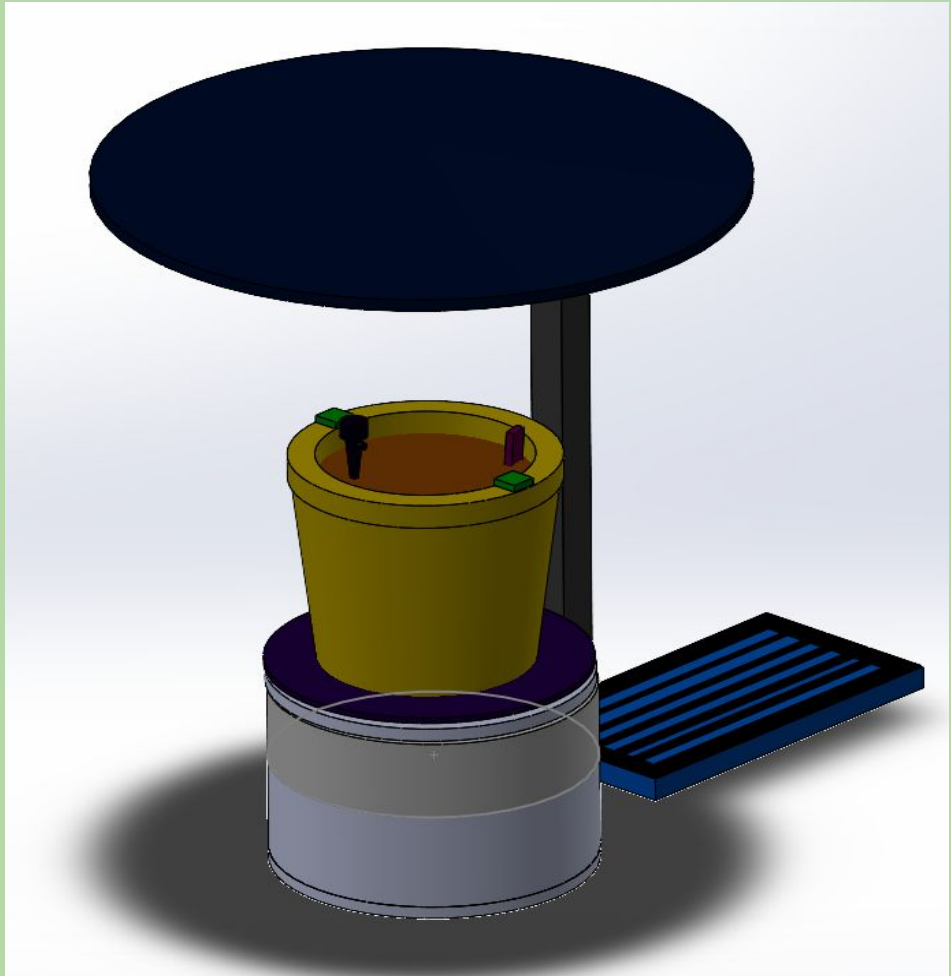
Melissa Rose - Sensors and Controller/Application Development

Workload Distribution

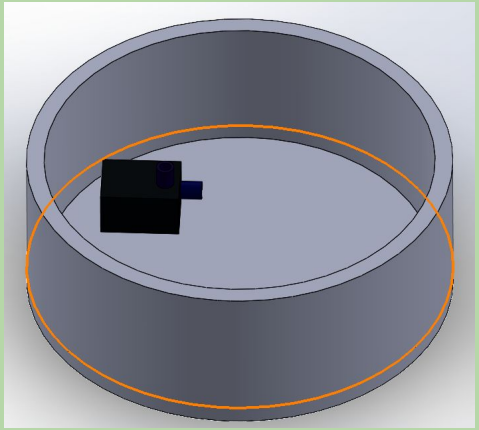
	Electromechanical Output Systems	Application & Software Development	Power Systems & Electromechanical Input Systems	Sensors, Modules, & Control
Brian Geibig	Primary		Secondary	
Abigail Michael		Primary		Secondary
Christina Quinones	Secondary		Primary	
Melissa Rose		Secondary		Primary

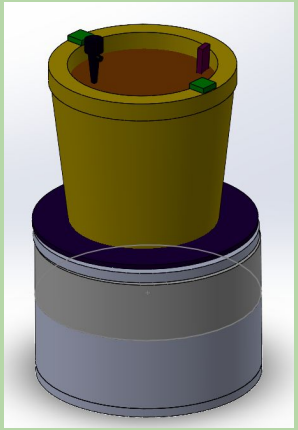


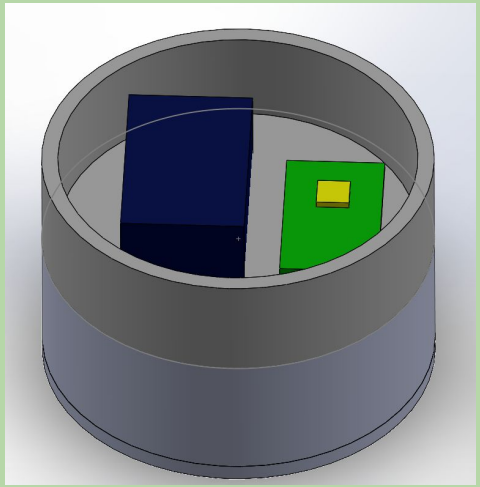
Physical Design

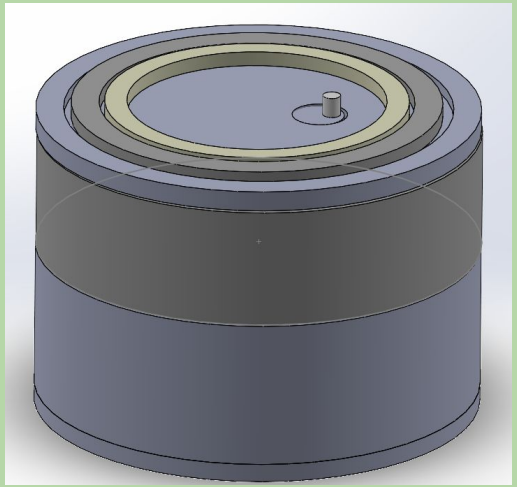


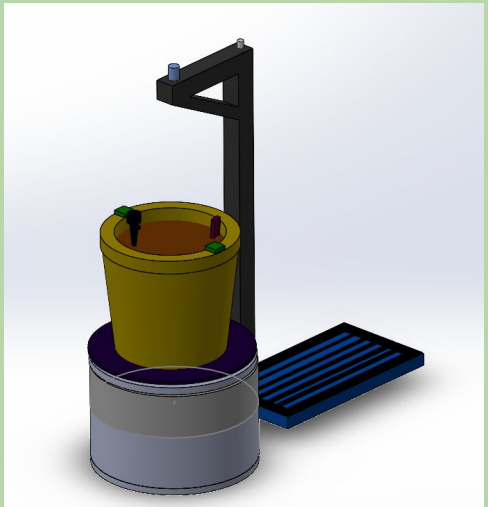
Physical Design





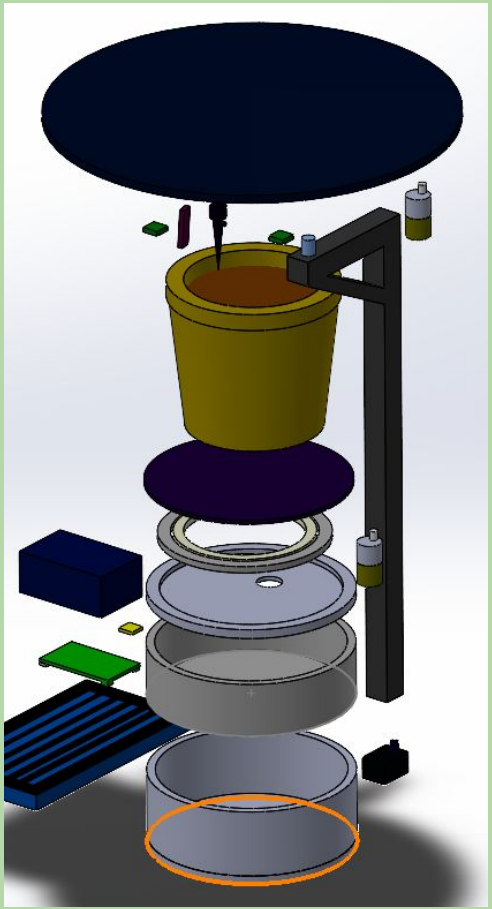


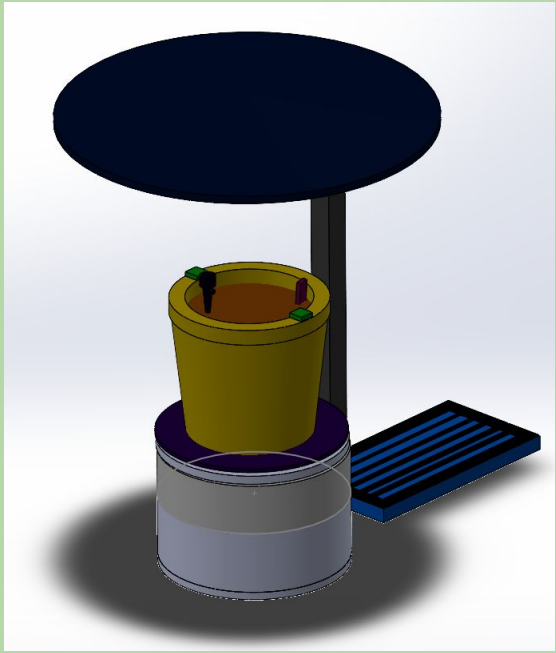




Physical Design

Height: 30”
Base diameter: 12”





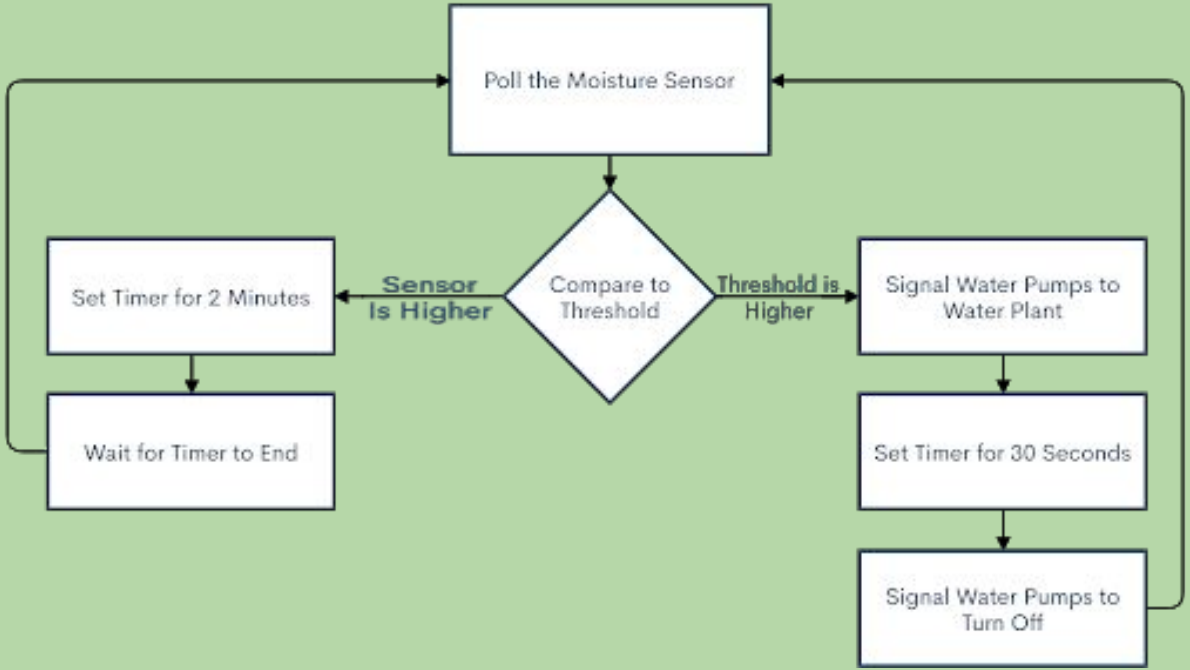
Requirements & Specifications Table - Hardware

Part	Requirement	Justification
Power System	Output Power > 20W Efficiency > 70%	To provide power to all sensors and systems while remaining power efficient
Battery	Capacity ≥ 5 Ah	To provide a sufficient power supply to all components
Solar Charge Controllers	Output Voltage 12.6 - 13.7V	To have overcharge protection
Voltage Regulators	Output Voltage Tolerance: ±2mV	To accurately regulate 3.3V, 5V, 7V and 12V
Irrigation System	Output Rate: 0.2 liters/min	So the water can fill the pot when requested
Light Sensor	Detects >10000 lux	To accurately measure the intensity of the Sun
Moisture Sensor	Delay Cycle > 1 sec	So the sensor is power efficient
Shading System	Deploys < 1 minute	To provide a more efficient system

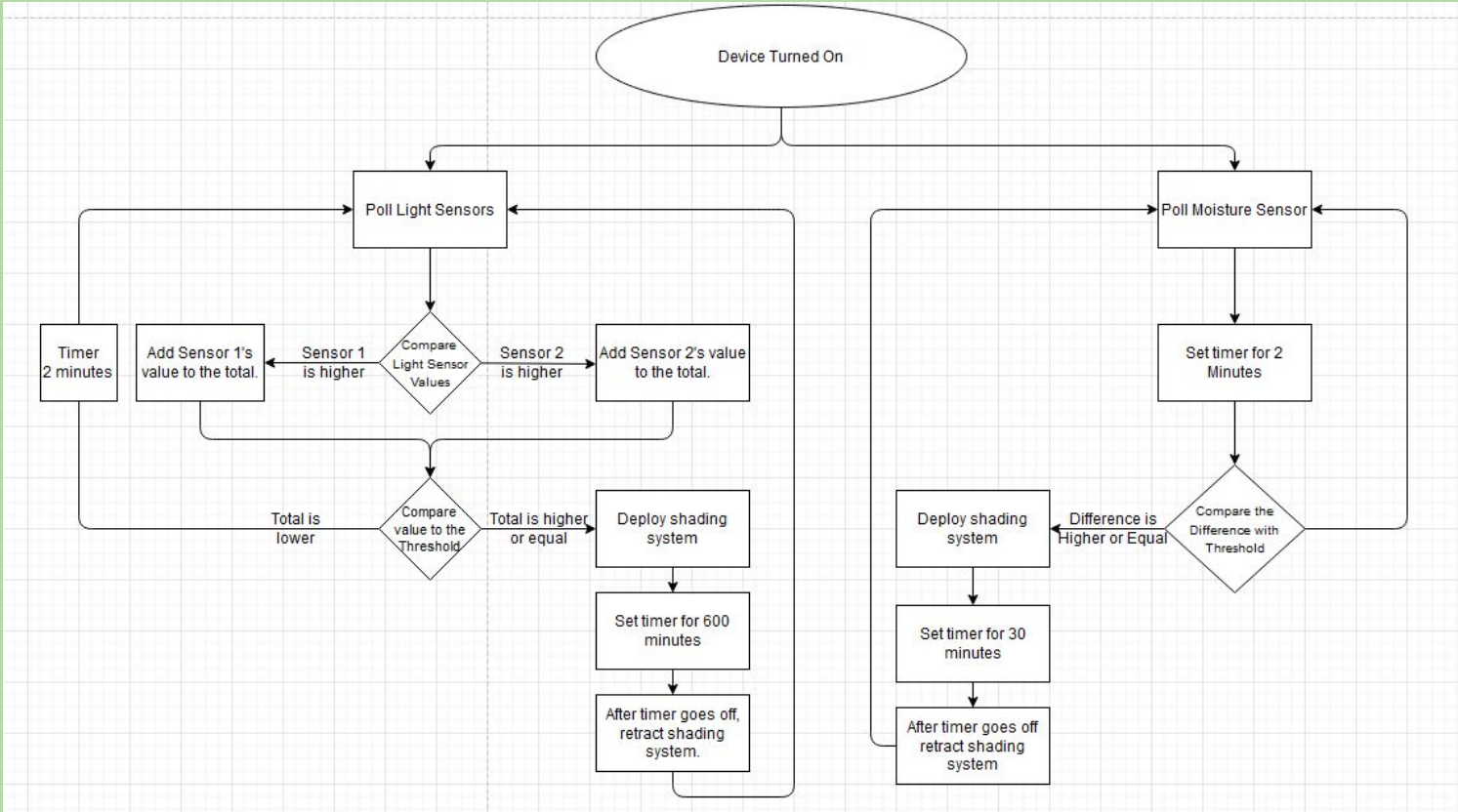
Requirements & Specifications - Software

Part	Requirement	Justification
Wi-Fi Module	Max Current < 250 mA	To provide a more power efficient system
Microcontroller	Current: < 50 mA Operating Voltage: 5V	So the microcontroller can sufficiently control the system while remaining power efficient
Application	Installation Time: < 5 minutes File Size: < 20 MB	To provide a more user friendly experience

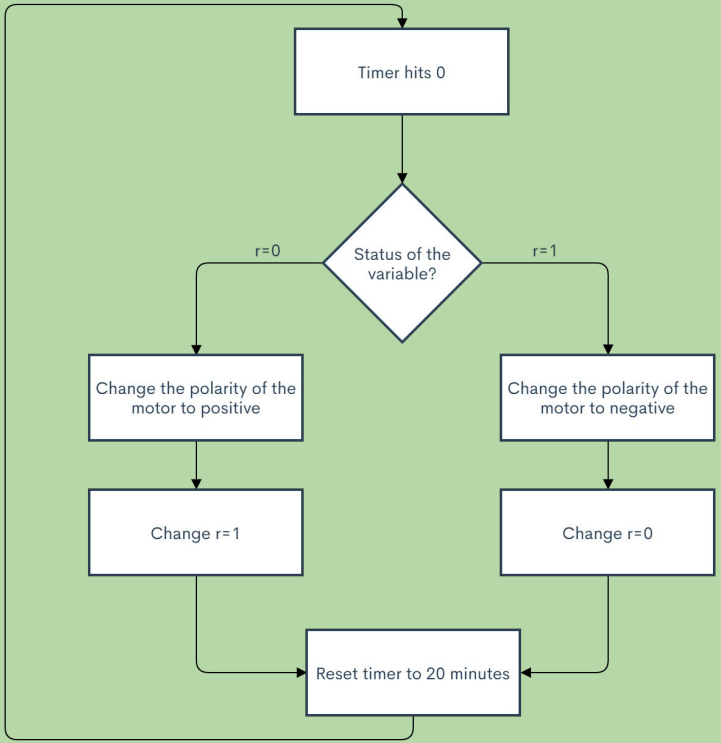
Irrigation System



Shading System

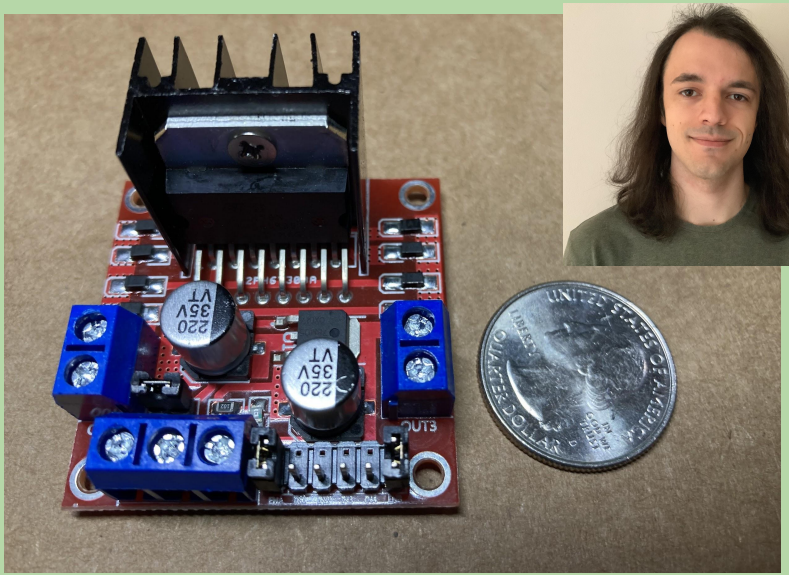


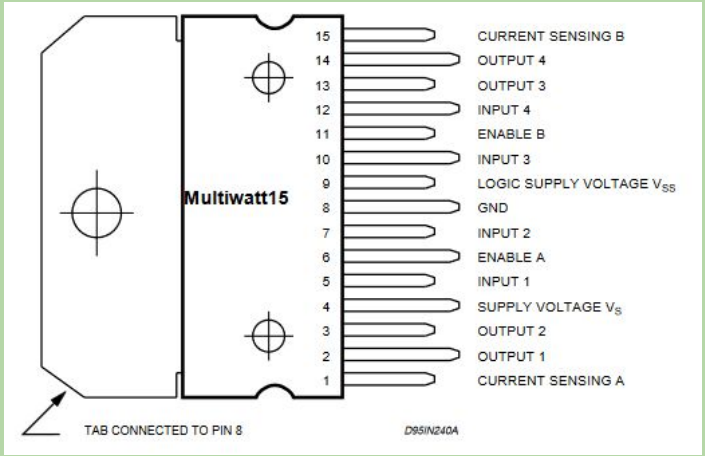
Rotational System

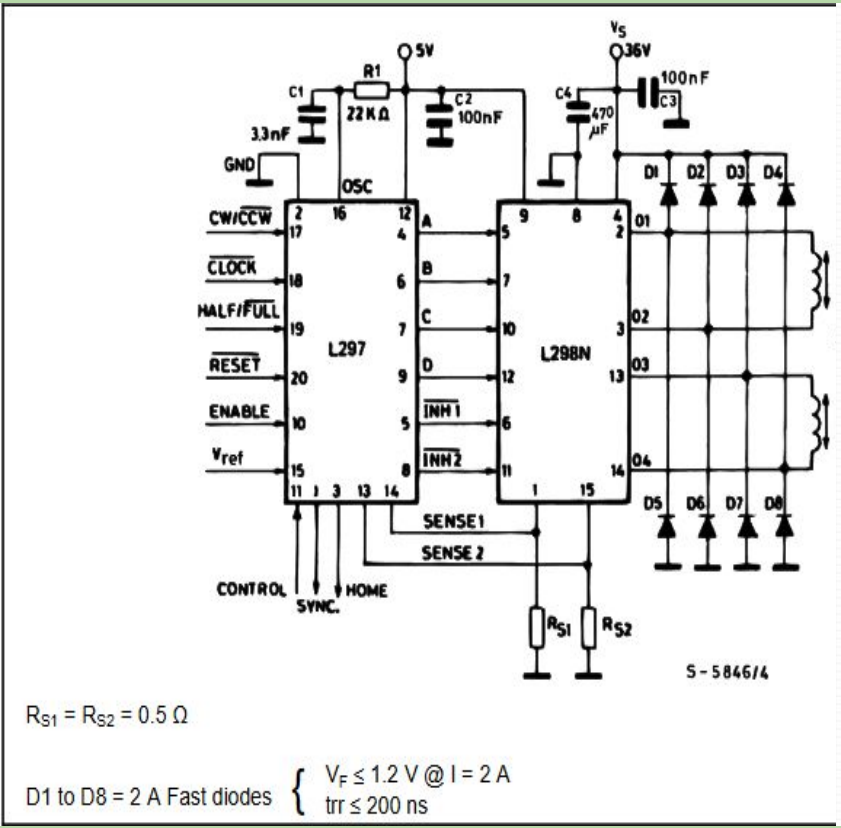


Motor Drive Controller

L298N Dual Full-Bridge Driver

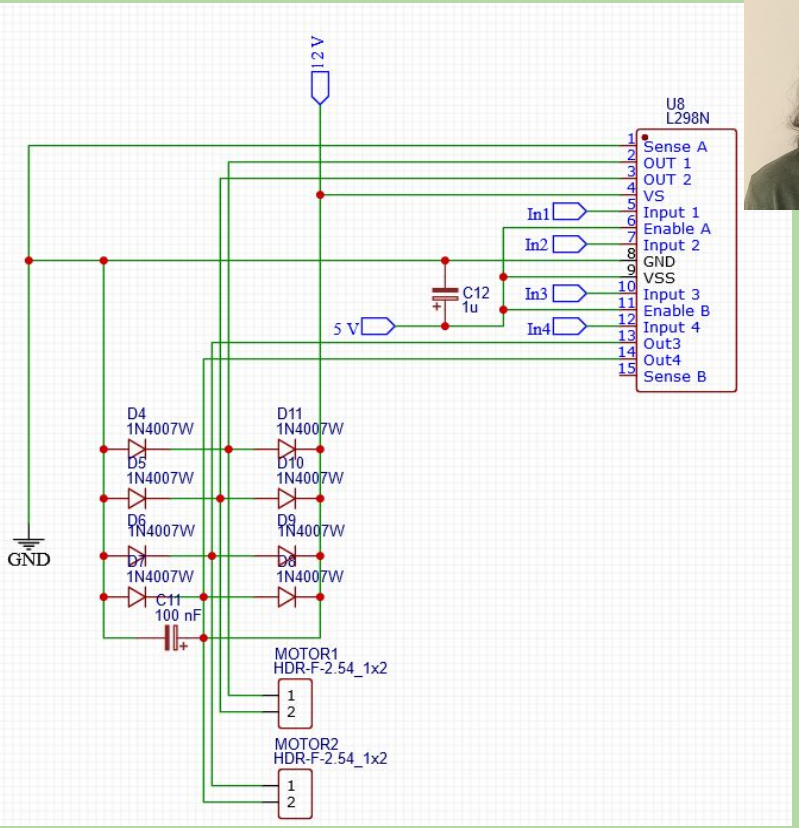






$R_{S1} = R_{S2} = 0.5\ \Omega$

D1 to D8 = 2 A Fast diodes { $V_F \leq 1.2$ V @ I = 2 A; trr ≤ 200 ns



Light Sensor

- Purpose: Sunlight Detection for Shading System
- Product: SparkFun Ambient Light Sensor with Qwiic Ports
- Onboard Light Sensor: VEML6030
- Output: Digital
- Light Detection Range: 0 - 120000 lux
- Operating Voltage: 3.3 V
- Communication Feature: I^2C
- Price: $5.25

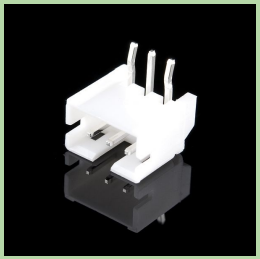
Temperature Sensor

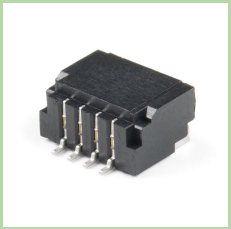
- Purpose: Temperature Measurement for the Shading System
- Product: SparkFun Temperature Sensor with Qwiic Ports
- Onboard Light Sensor: TMP102
- Output: Digital
- Temperature Detection Range: -40°C - 125°C with accuracy of 0.3°C
- Operating Voltage: 3.3 V
- Communication Feature: I^2C
- Price: $6.50

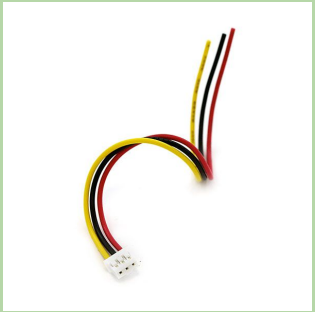
Moisture Sensor

- Purpose: Soil Moisture Measurement for the Irrigation System
- Product: SparkFun Moisture Sensor
- Onboard Light Sensor: TMP102
- Output: Analog
- Soil Moisture Detection Range (after ADC conversion): 0-1023 bits
- Operating Voltage: 3.3 - 5 V
- Price: $5.95

Sensor Connectors







- The JST/Qwiic connectors will go from the sensors on the plant's pot to the PCB.
- Ports will be soldered on to the PCB for the wire connections.
- Benefits: Modularity and Ease of Access

Microcontroller Requirements

- Must consist of multiple GPIO pins
- Must be compatible with the chosen sensors
- Must be able to conduct I2C communication
- Must have a high clock speed
- Must be small enough to fit on the PCB
- Most be cost effective

Microcontroller Selection

MSP430FR6989

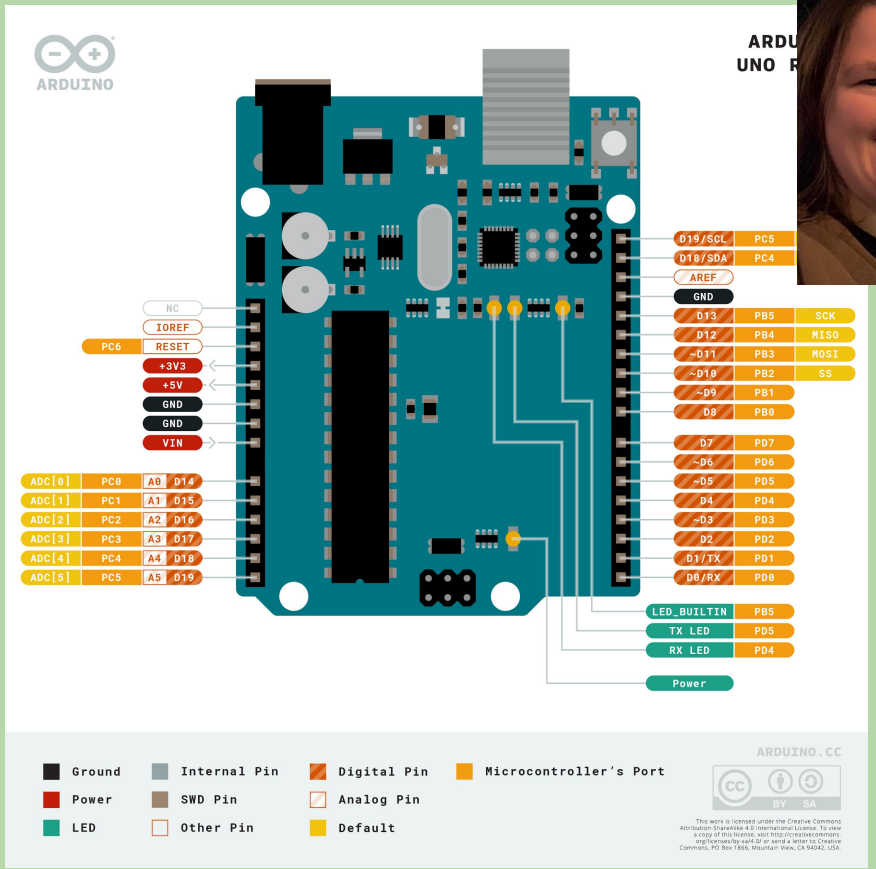
- Chip: MSP430
- SRAM: 2 KB
- Clock Rate: 16 MHz
- GPIO Ports: 83
- Cost: $20.00
- Operating Voltage: 3V

Arduino Uno

- Chip: ATmega328
- SRAM: 2 KB
- Clock Rate: 16 MHz
- GPIO Ports: 14
- Cost: $23.00
- Operating Voltage: 5V

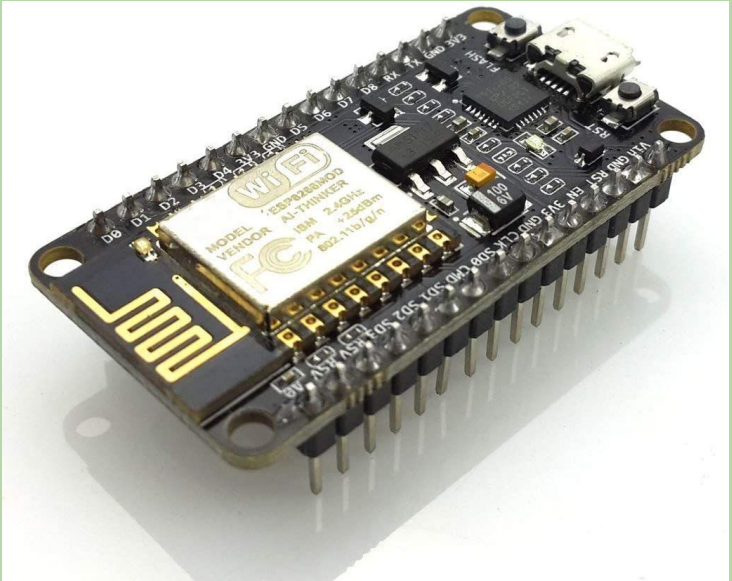
Arduino Uno

- 2 KB SRAM & 16 MHz clock rate
- 14 GPIO Ports
- Capable of both 5V and 3.3V
- Price: $23.00
- Arduino open source
- Availability of tutorials



Wi-Fi Module


ESP-01S
5 Series


Wi Fi
MODEL ESP8266MOD
VENDOR AI-THINKER
ISM 2.4GHz
PA +25dBm
802.11b/g/n

WiFi Module Comparison

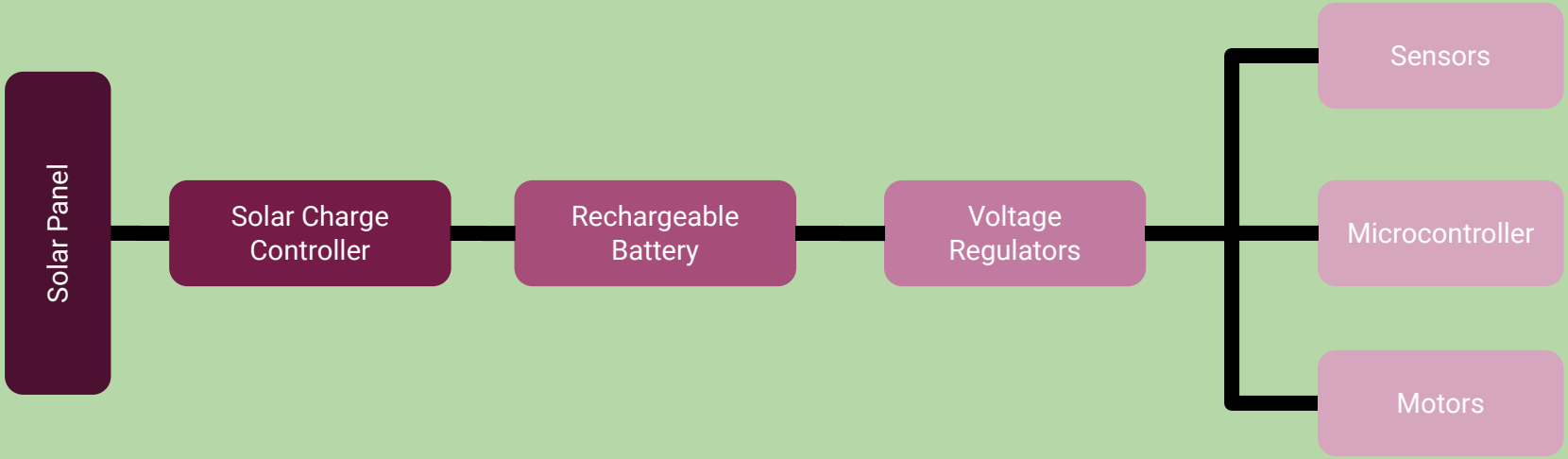
ESP-01

- Chip: ESP8266
- Operating Voltage: 3.3 V
- Maximum Operating Current: 250 mA
- WiFi Modes: 802.11b/g/n
- 2.4 GHz
- GPIO Ports: 2
- Price: $12.99 for Quantity of 4

NodeMCU

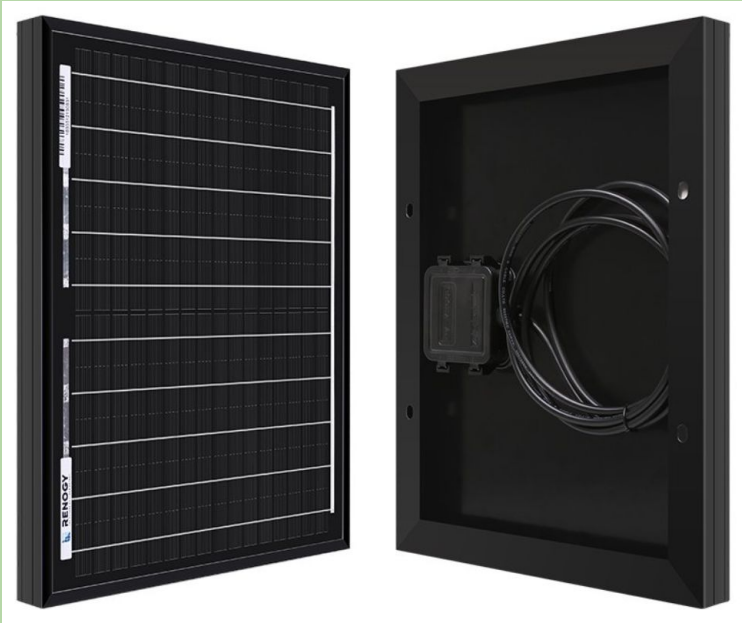
- Chip: ESP8266 (ESP-12E)
- Operating Voltage: 3.3 V
- Maximum Operating Current:
- WiFi Modes: 802.11b/g/n
- 2.4 GHz
- GPIO Ports: 16
- Price: $13.99 for Quantity of 3

Power System



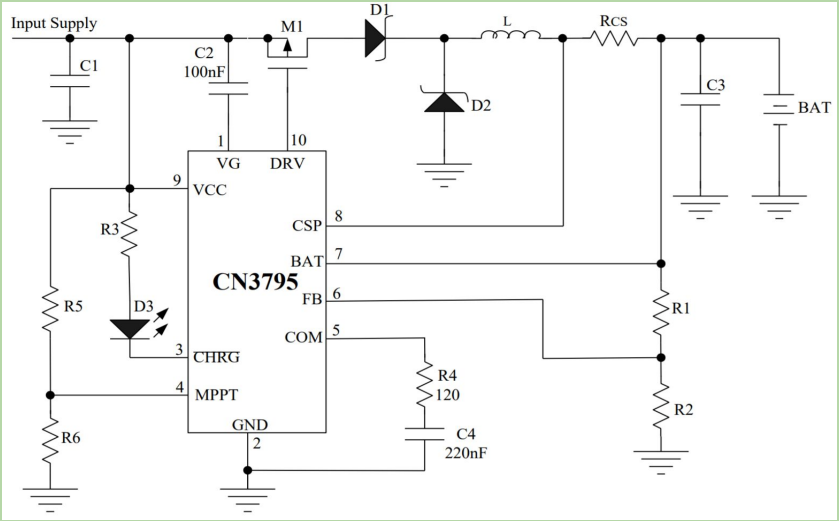
Solar Panel

- Renogy 10W 12V
- Monocrystalline
- Corrosion-Resistant
- Multi-layered Sheet Laminations
- Bypass Diodes
- Operating Temperature: -40°F to 194°F
- Efficiency 95%
- Dimensions: 10.6”x13.4”x1.0”
- Price: $33.99



Solar Charge Controller

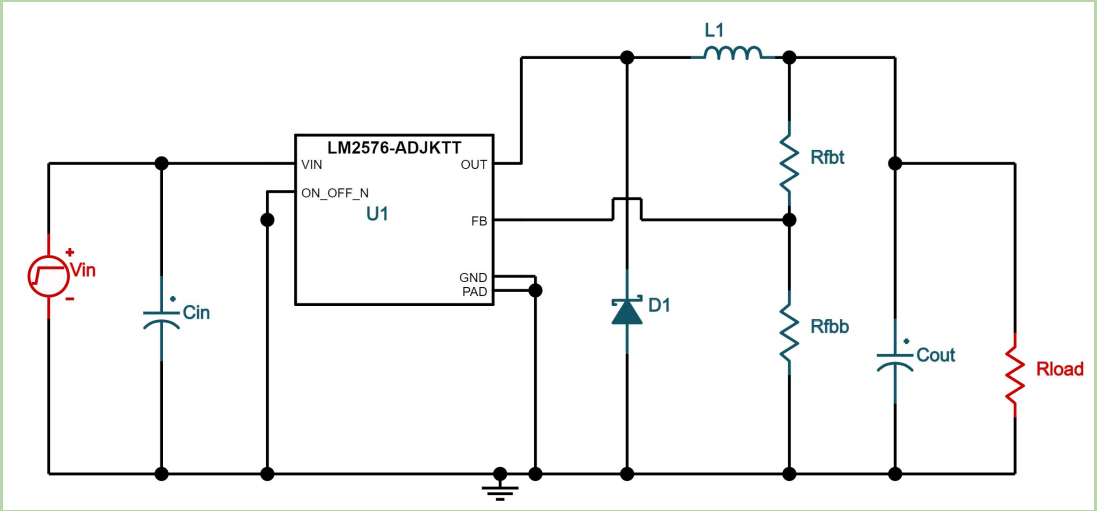
- Maximum Input Voltage: +30V
- Maximum Continuous Charge Current: 4A
- Photovoltaic Cell
  Maximum Power Point Tracking
- Step-down PWM Charge Controller
- Regulation Voltage can be adjusted
- CC and CV Charging Mode
- Automatic Recharge
- Charging and Termination Indication



Rechargeable Battery

- ExpertPower 12V 5Ah Lithium LiFePO4
- 2500-7000 Life Cycles
- Built-in BMS
- Low Self-Discharge (2%/month)
- Dimensions: 3.54”x2.76”x3.98”
- Weight: 1.7 pounds
- Price: $39.99

Voltage Regulators



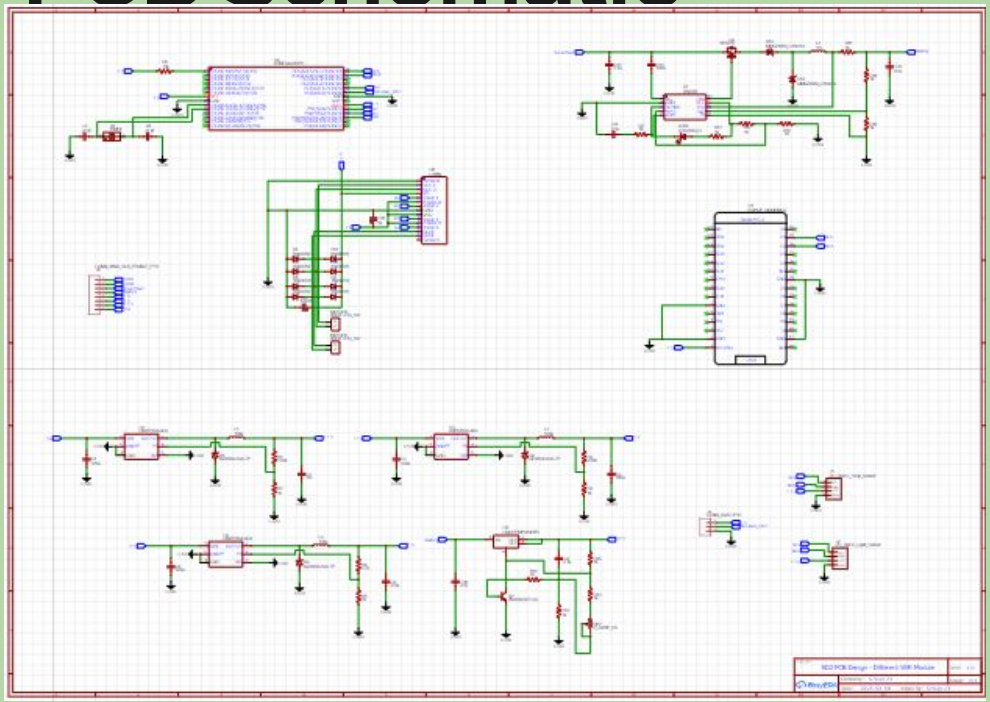
- LM2576 Switching Regulator
- Efficiency ~80-85%
- Output Current - 3A
- Output Voltage
  - 3.3V
  - 5V
  - 7V
  - 12V
- BOM Count - 7
- Experience

Application

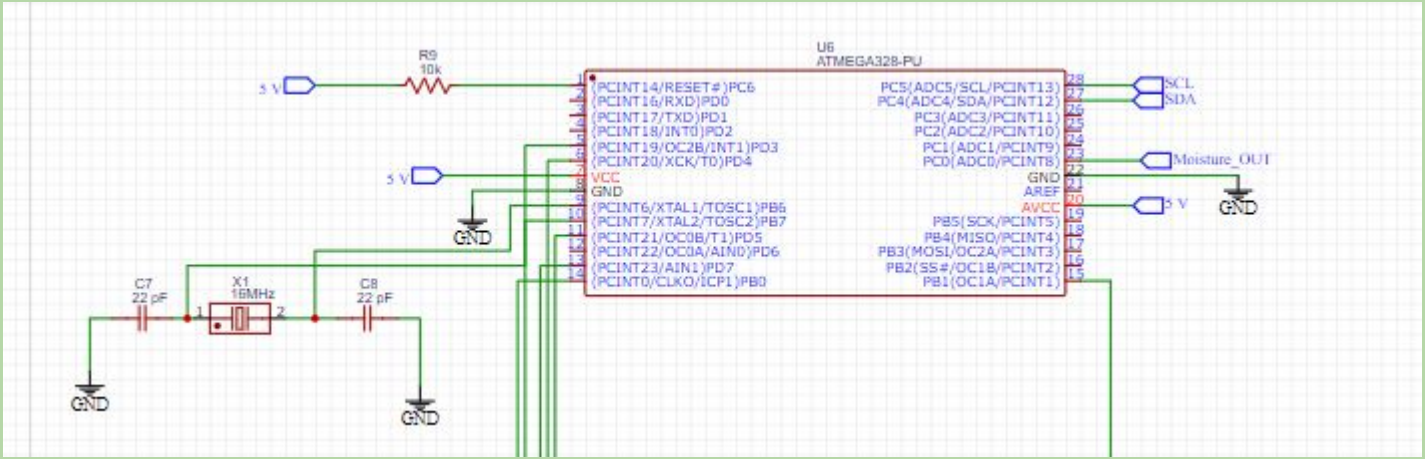
- To allow the user to insert data about the plant as well as manually control the system

- Developed with Adobe XD
- Designed for iOS & Android
- Capabilities:
  - Selecting the plant
  - Manual input of care
  - Manual control of systems

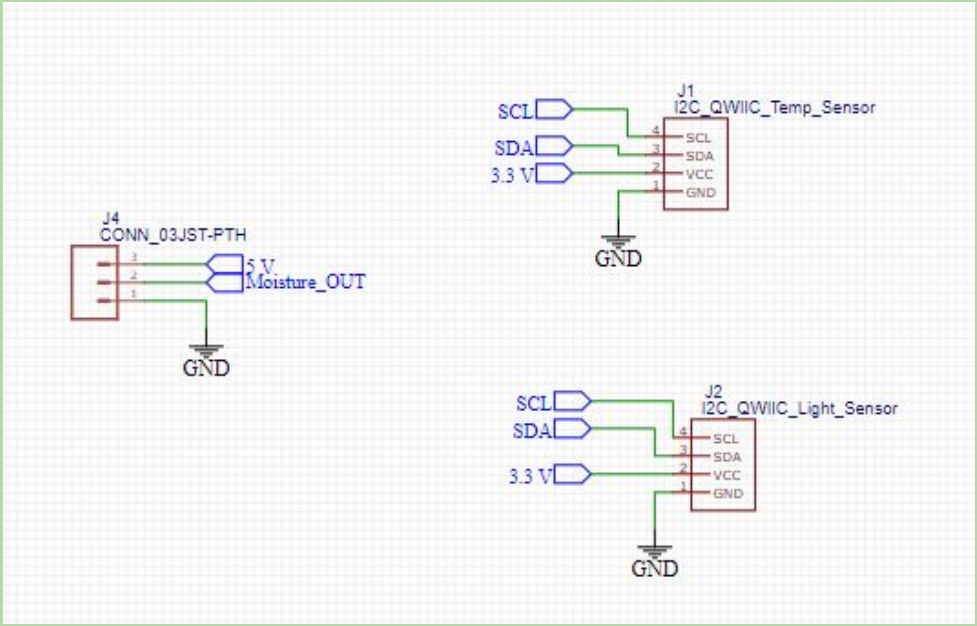
PCB Schematic

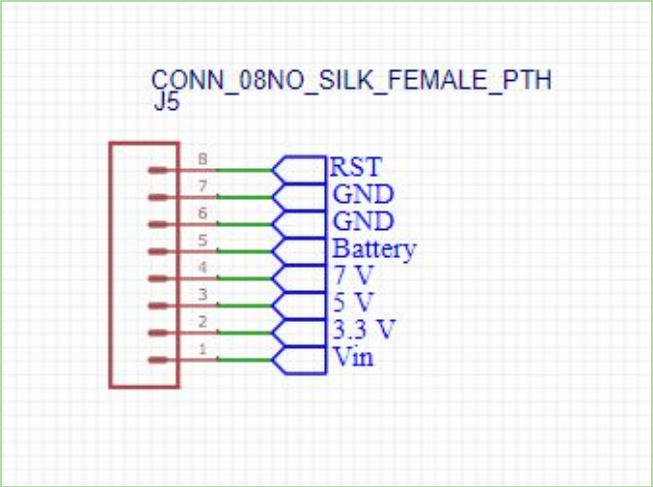


PCB Layout: Arduino Uno (ATMega328)

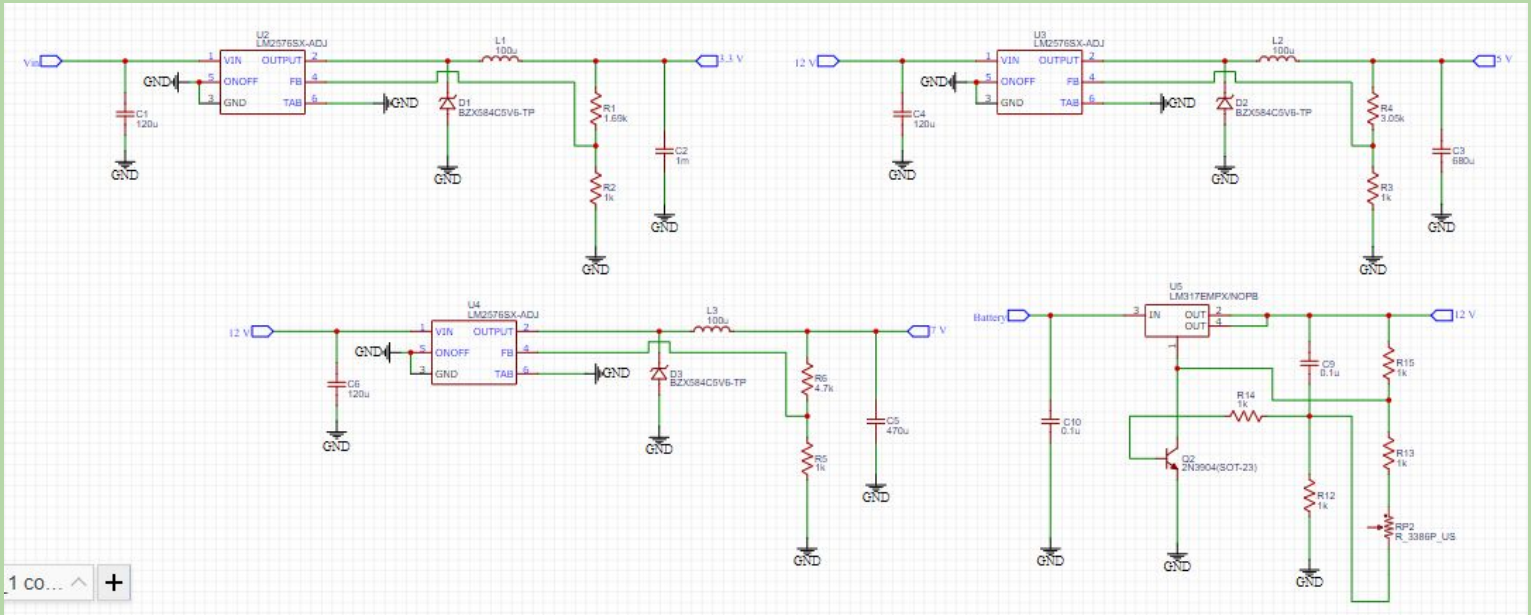


PCB Layout: Sensor Ports and Other Connectors

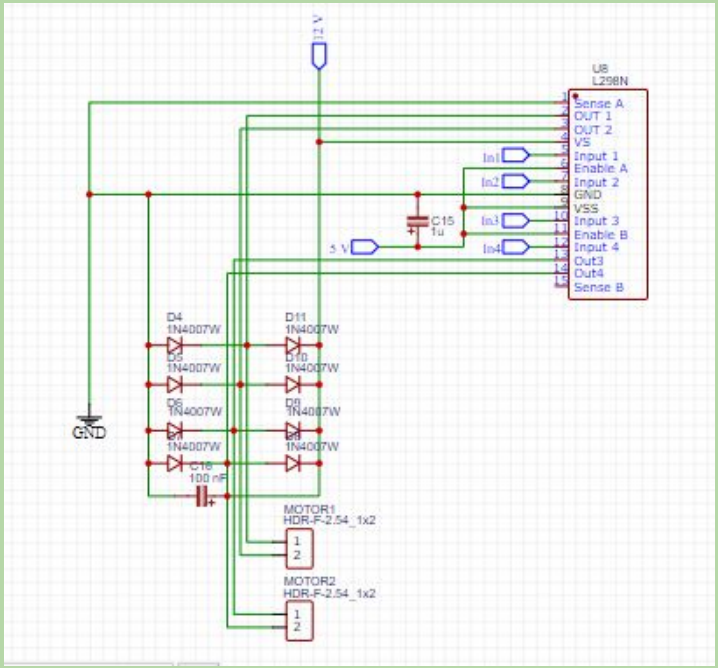




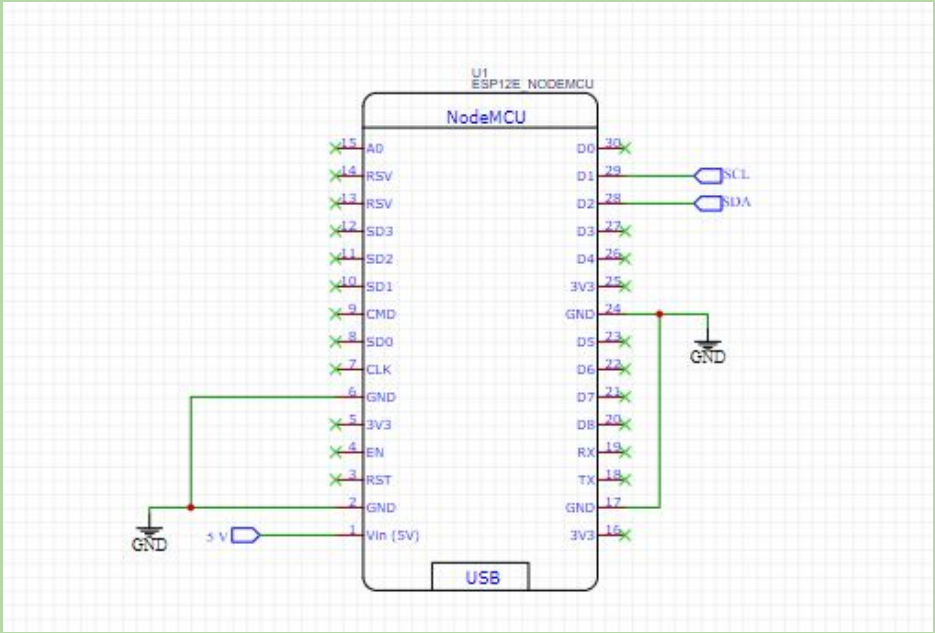
PCB Layout: Voltage Regulators



PCB Layout: Motor Driver



PCB Layout: WiFi Module



PCB Layout: Solar Power Controller

PCB Layout

Realistic Design Constraints

Economic Constraints

- Self-sponsored
- Time limit of two semesters

Environmental Constraints

- Solar power can only be generated when the Sun is out
- High temperatures
- Rain

Realistic Design Constraints

Manufacturability

- Electromechanical Systems
  - Shading System
  - Irrigation System
  - Rotational System
- Equipment Availability
- Components Selection
- Experience

Sustainability

- Climate Changes
- Corrosion Resistant
- High/Low Temperatures
- Operational Levels
- Storage of Electrical Components

Realistic Design Constraints

Health & Safety

- Water Safety
- Rotation
- Materials
- Potential Fire
- Potential Shock

Social

- Affordable
- Easy to Use
- Product Size

Realistic Design Constraints

Ethical Constraints

- Academic Integrity
- Product Honesty

Political Constraints

- No Political Constraints for this Project

Related Standards

Battery Standards

- UN/DOT 38.3
- IEC 62133
- UL 2054
- UL 1642
- UL 1973
- ANSI C18.2M

Solar Panel

- IEC 61215
- IEC 61730
- IEC 62716
- IEC 61701
- IEC 60068-2-68
- UL 1703
- UL 61730

Related Standards

Programming Language

- IEEE 1178-1990
- ISO/IEC 9899
- ISO/IEC 9899: 2011
- ISO/IEC 9899: 2018

WiFi Standards

- 802.11a/b/c/g/n

RoHS Standards

Budget

Part	Cost
Plant System	$10
Irrigation System	$60
Light Sensor	$15
Moisture Sensor	$20
Temperature Sensor	$17
Wi-Fi Module	$20
Rotational System	$30

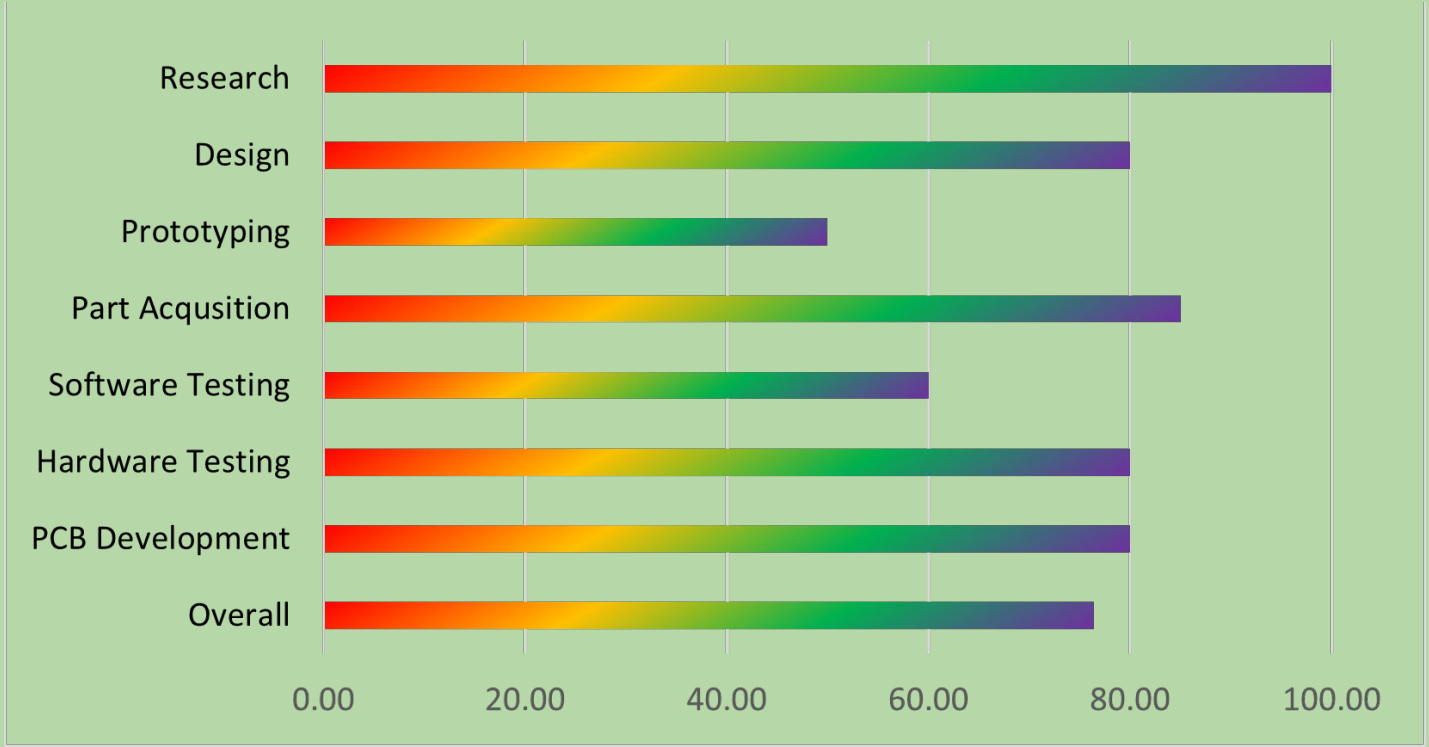
Part	Cost
Shading System	$50
Microcontroller Kit	$80
Power System	$50
Solar Panel	$34
Software Development	$0
PCB	$20
Total	**$406**

Testing

- Motors.
- Water pump.
- Mictocontroller
- Light sensor
- Moisture sensor
- Temperature sensor
- Wi-Fi Moduel

- Irrigation system
- Rotational system
- Shading system

Progress


Research
Design
Prototyping
Part Acqusition
Software Testing
Hardware Testing
PCB Development
Overall
0.00
20.00
40.00
60.00
80.00
100.00

Future Plan

- Complete Software Testing
- Complete Hardware Testing
- Finish Developing the Application
- Complete Prototyping

Thank You!

Questions?