Senior Design Proposal

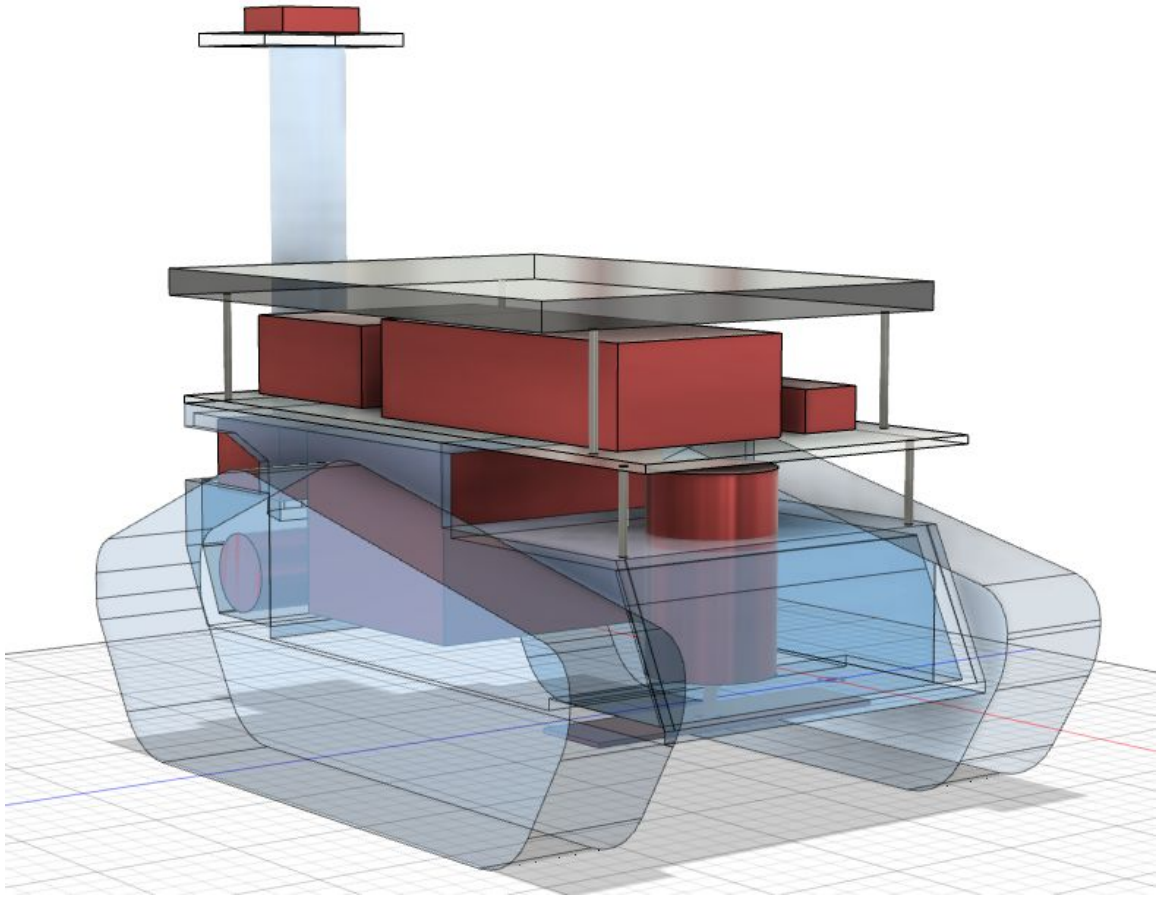
P.A.L.M.

Personal
Automated
Lawn
Mower

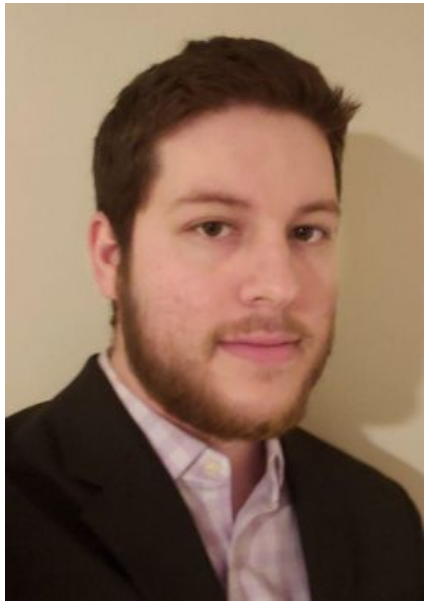
BRIAN DARLING AND GABRIEL DE LA TORRE

SUPERVISING ADVISOR: PROFESSOR ALI NOTASH

HTTPS://PALMMOWER.COM/



About Us



Gabriel De La Torre

- Planning to graduate from Valencia College July 2021 with a B.S. in Electrical and Computer Engineering Tech, Computer Systems Concentration
- A.S. in Electrical Engineering Tech, Electronics Concentration

Brian Darling

- Planning to graduate from Valencia College July 2021 with a B.S. in Electrical and Computer Engineering Tech, Electronics Systems Concentration
- A.S. in Electrical Engineering Tech, Electronics Concentration and Lasers and Photonics Concentration
- Experienced Manufacturing Engineer and Process Description Writer for PCBAs and electronic assemblies

Overview of Presentation

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Motivation

- Lawn maintenance can be time consuming and exhausting, especially for a highly active family or those with health conditions.

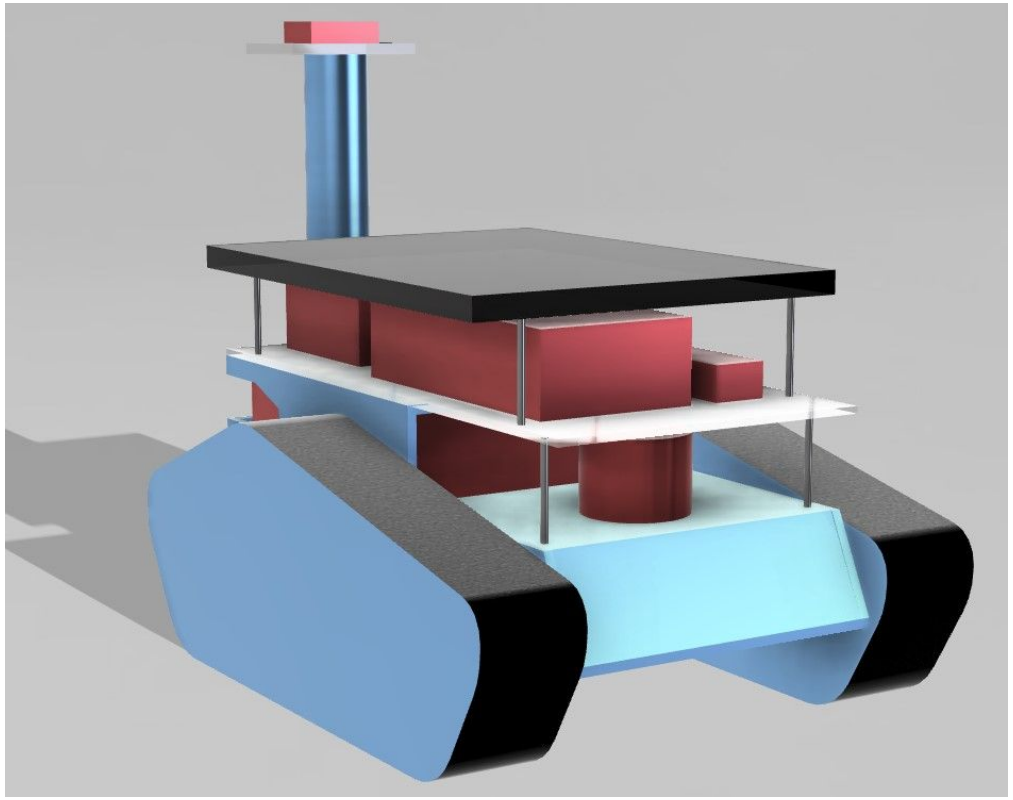
- A fully automated lawn mower that can maintain the yard for the user can help time restricted families maintain their lawns and keep them out of the brutal summer heat.

Proposed Project

The P.A.L.M. will be a fully automated lawn mower system that will cut the grass on autopilot with the users preferred cutting consistency.

Features:

- Hands Free Mowing
- GPS Guided
- Solar Powered
- Object Avoidance
- Rain Detection



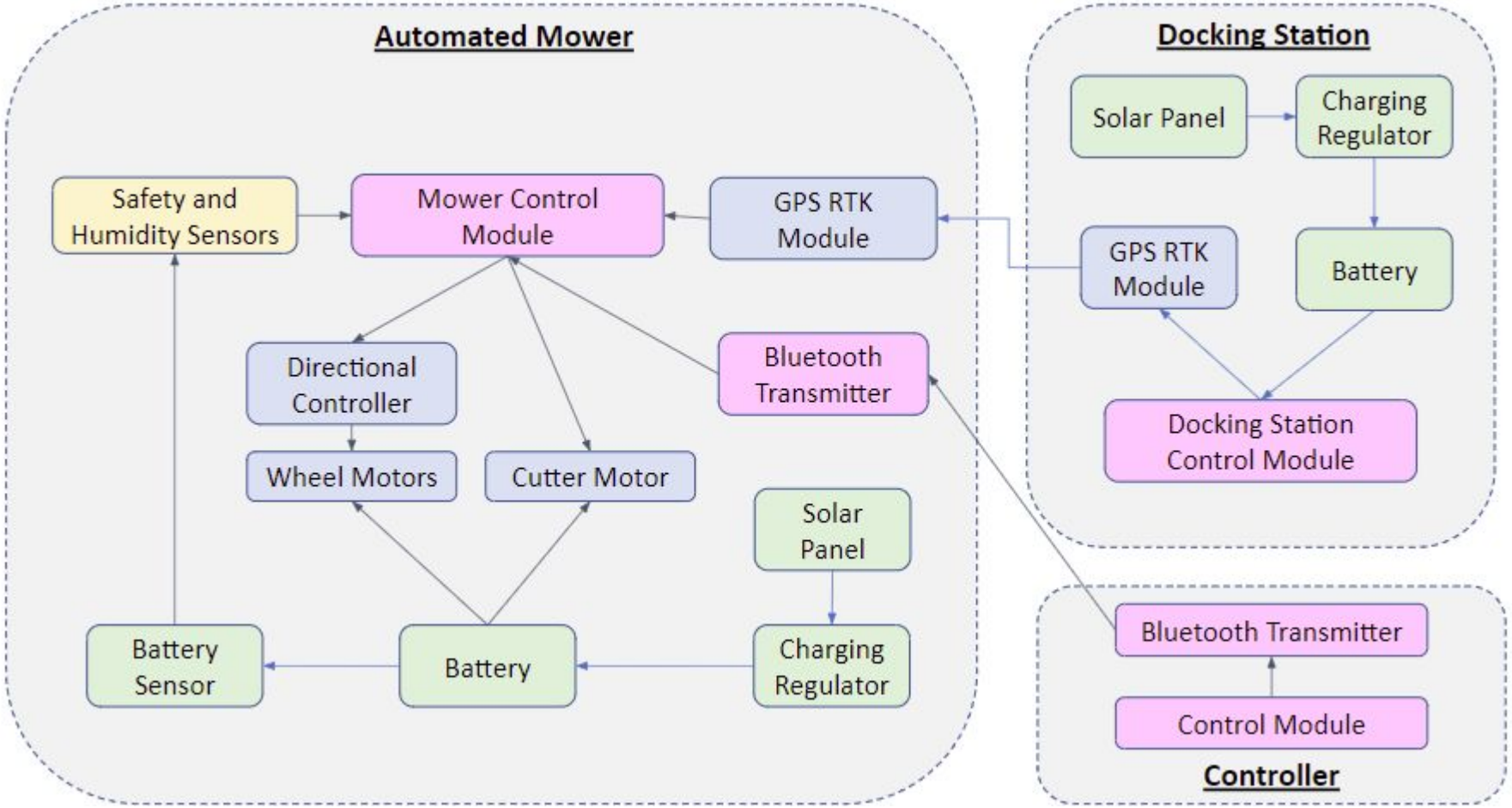
Similar Products

Image from https://www.gizmow.com/how-it-works/

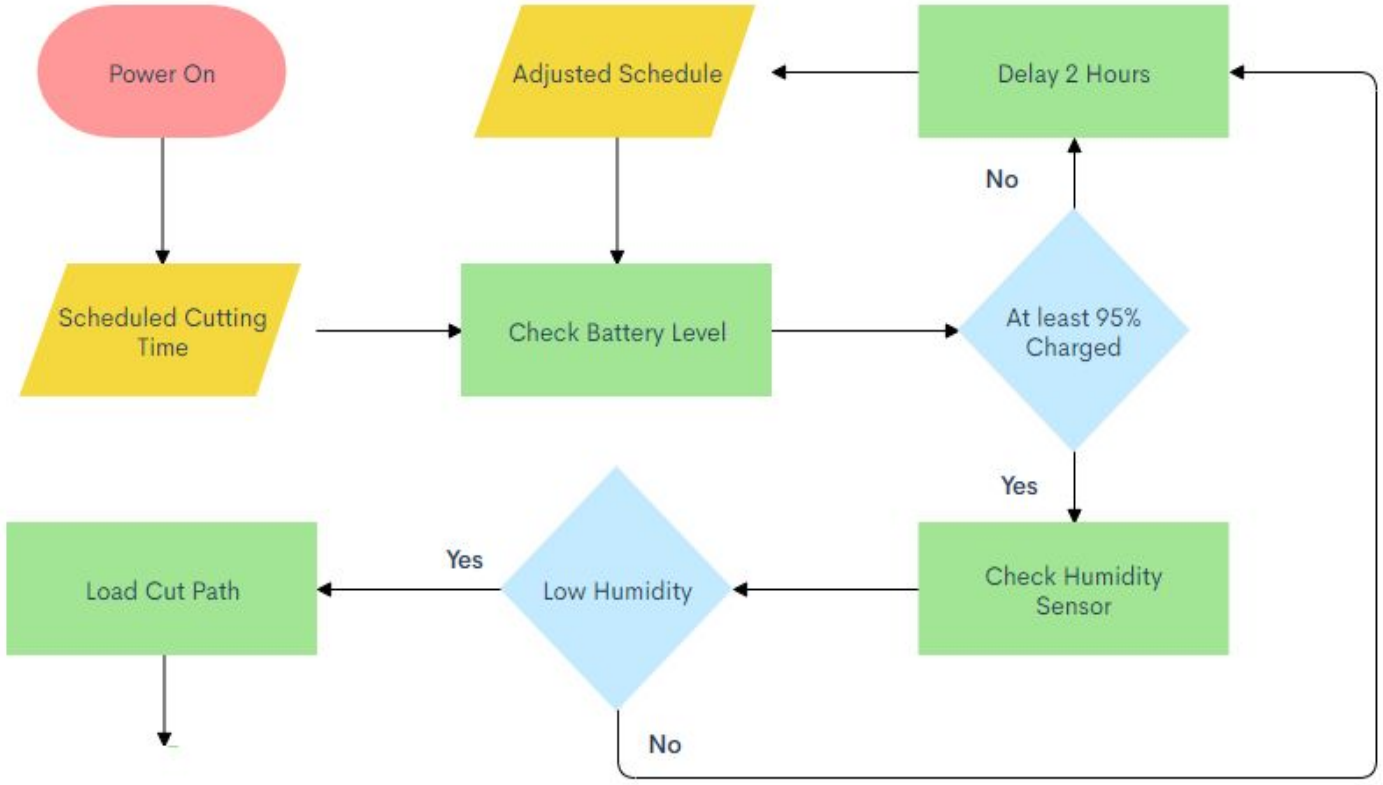
Similar Products

- Husqvarna Mowers
- MowBot
- MowRo

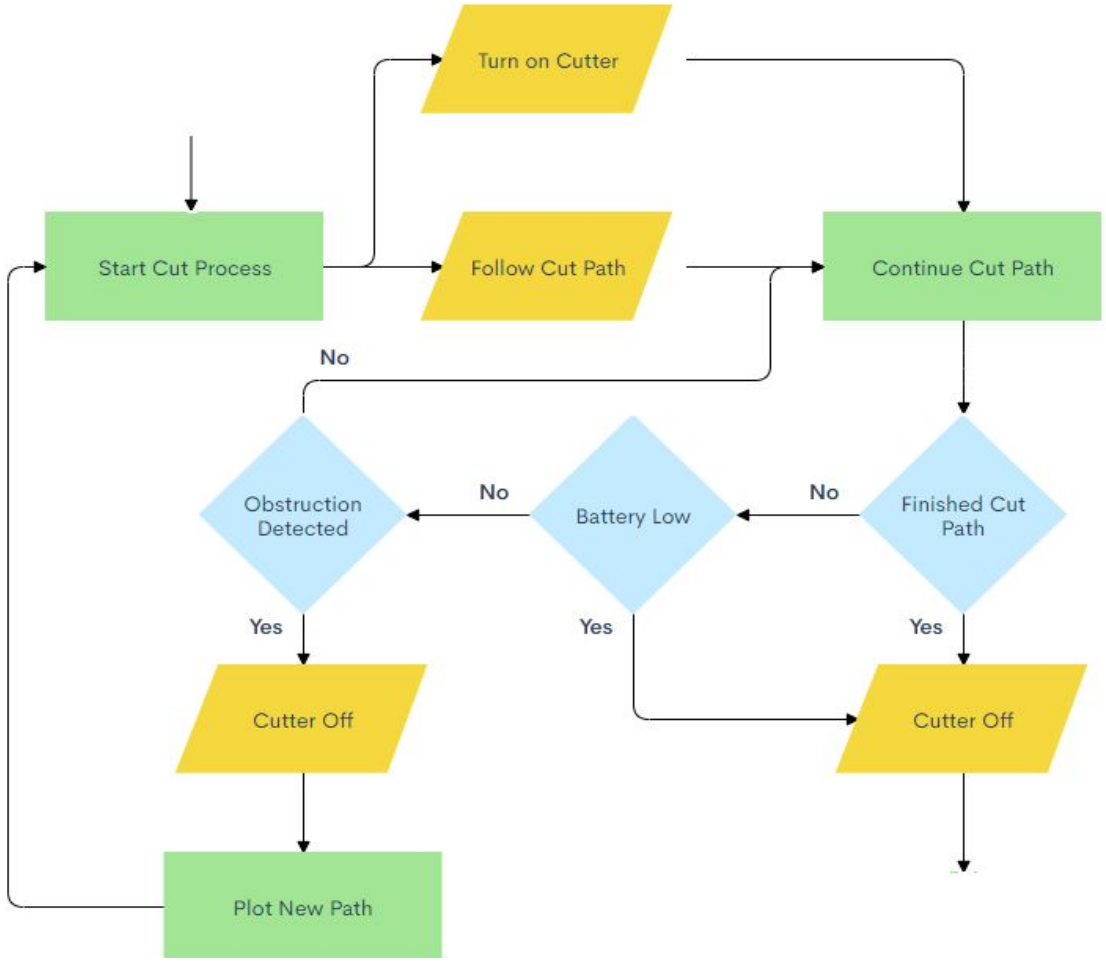
Block Diagram



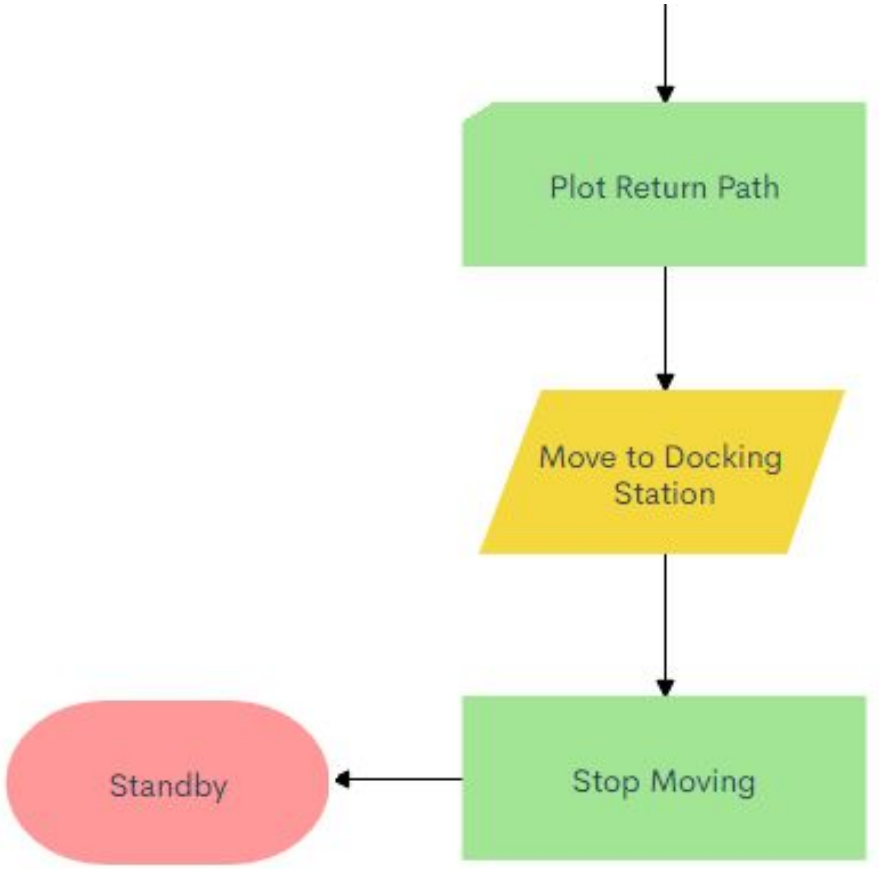
Flow Chart


Power On
Scheduled Cutting Time
Adjusted Schedule
Check Battery Level
Delay 2 Hours
No
At least 95% Charged
Yes
Check Humidity Sensor
Low Humidity
Yes
Load Cut Path
No

Flow Chart


Turn on Cutter
Start Cut Process
Follow Cut Path
Continue Cut Path
No
Obstruction Detected
No
Battery Low
No
Finished Cut Path
Yes
Yes
Yes
Cutter Off
Cutter Off
Plot New Path

Flow Chart


Plot Return Path
Move to Docking Station
Stop Moving
Standby

Goals and Design Engineering Requirements (DER)

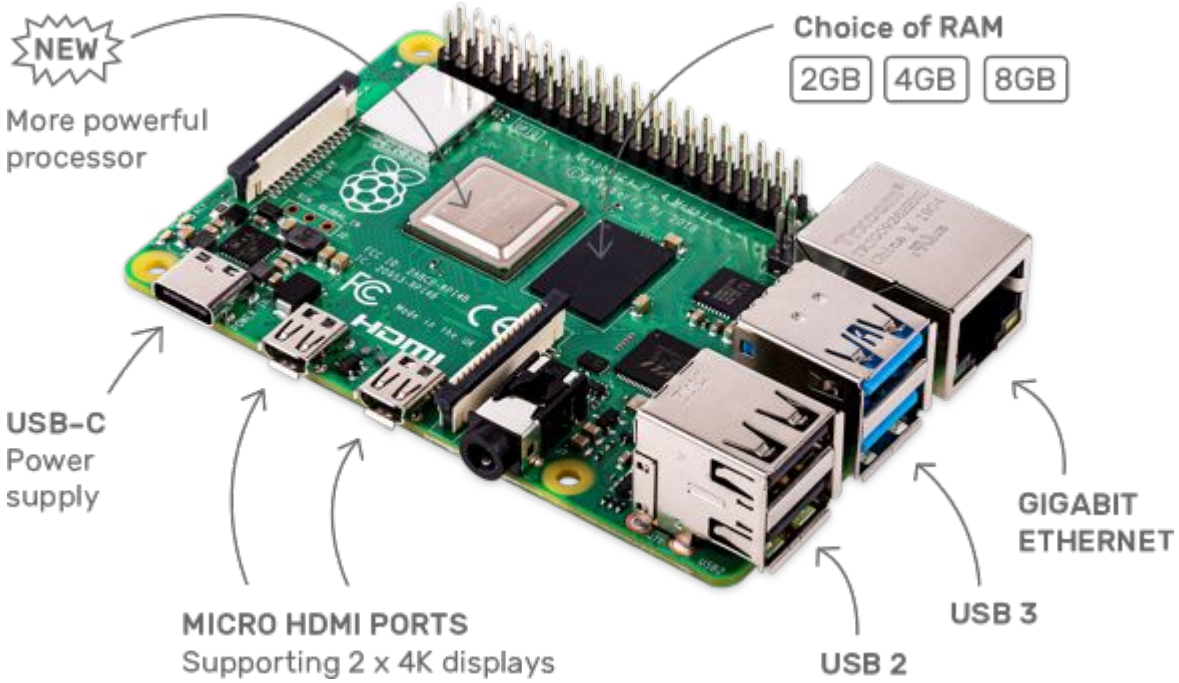
Level	Requirements	Verifications and Success Criteria Tests/Trials
High	1. The user shall be able to teach the mower which sections of the lawn to mow. 2. The mower shall be able to successfully mow a predetermined section of the lawn without further help from the user. 3. The mower shall actively charge by using the attached solar panel to extend battery life. 4. The mower shall be able to return to the docking station once it has done mowing.	• The controller interface will verify and display lawn borders. • Once the lawn borders are created and paths created, mower will follow a predetermined path. • Microcontroller will monitor the battery source and pause mowing when power levels are too low. • Once the mower has completed cutting or needs to stop, it will return to the docking station.
Mid	1. The mower shall be able to automatically avoid obstacles in the yard using sensors. 2. The mower shall remember the mowing path for future use.	• The mower will utilize sensors and move around the object(s) in its path. • The mower will follow the same repeatable path each iteration.
Low	1. The mowers power source shall provide at least 45 minutes of continuous mow time.	• Battery tests will be performed both in direct sunlight and in the shade to determine potential battery life.

Design Engineering Specifications (DES)

Part	Specific Component	Engineering Specification	Justification & Verification
Micro Controller	Raspberry Pi 4	Must be able run off a 12V DC power source Controls motor and directional controls to determine where to move and what is left to cut. Must be able to detect at least 3 safety and detection sensors. Must be able to use a GPS and compass antennas to determine global position.	**Justification:** Needs to be able to apply custom code and respond to GPS, sensor, and pre-mapped paths. Controller also must be able to monitor speed, direction, and cutter speeds. **Verification:** Controller will verify gps and sensors are active. If pre-mapped path is not created a new path will be generated by the code or user input.

https://palmmower.com/senior-design-proposal/proposal-engineering-requirements/

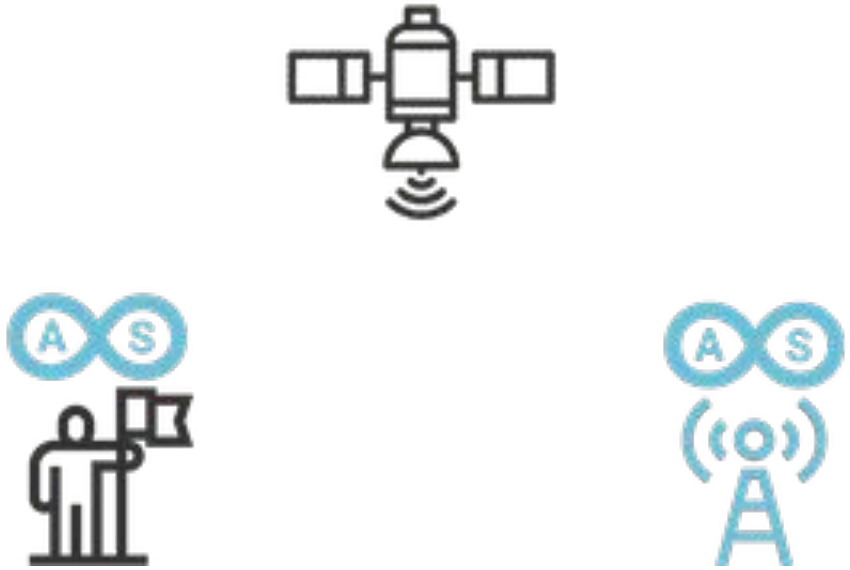
Microcontroller



Raspberry Pi 4

- Python Compatible
- Multiple Inputs and Outputs
- Up to 8 GB of RAM
- 3 to 5 volts input
- Bluetooth connectivity

GPS RTK Module



SimpleRTK2B

- Raspberry Pi Compatible
- Accuracy between 3cm and 1cm
- Allows for Accurate Pathing
- Max Range of 20km (with correct antenna modules)

Image from https://www.kickstarter.com/projects/simplertk2b/simplertk2b-the-first-multiband-rtk-shield-based-o

Solar Panels and Battery Packs

Flexible 10W 12V Solar Panel

- Light Weight
- Low Cost
- Can be Angled Around Bends
- Lower Profile

12.8V 6Ah Lithium-Iron Battery

- Light Weight
- Low Profile
- Can be Overcharged
- More than 2000 Cycles

Cutter Motor

775 Motor

- 9 to 12 volt power source
- Sturdy Construction
- Spins up to 12,000 RPM

Cutting Blade

- Light Weight
- Low maintenance
- Easily Removed

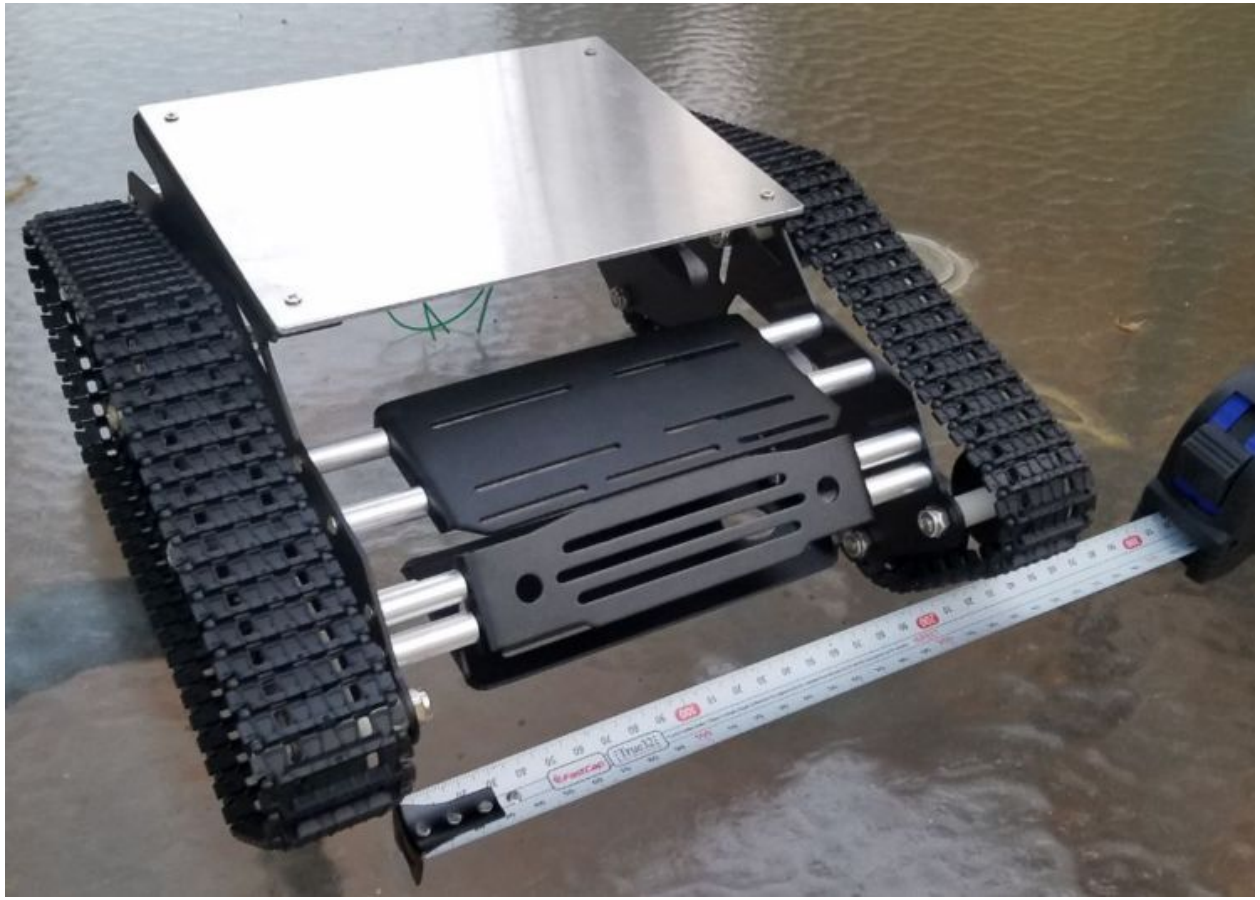
Controller

Handheld Touch Screen Device

- Bluetooth Connectivity
- Can remotely control the mower
- Modular

Image from https://www.amazon.com/STARTO-Raspberry-320%C3%97480-Resolution-Display/dp/B07S695VQM

Mower Chassis



Modified Smart Tank Chassis

- Aluminum Construction
- Can carry up to 15 lbs (7kgs)
- Tank Treads for all terrain movement
- Can climb up to 30 degree inclines

Widening modification applied to provide an extra 2” of cutting space.

Power Budget

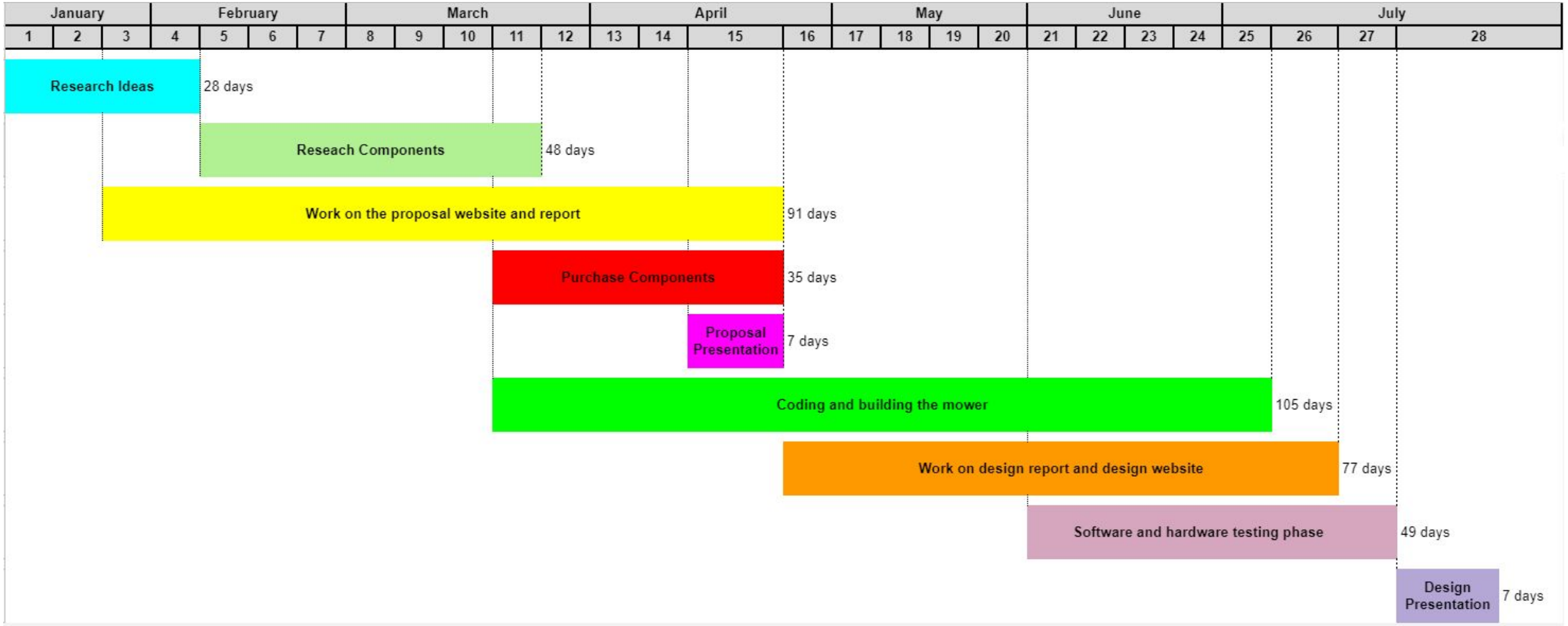
Mower						
Part	**Description**	**Qty**	**Current (A)**	**Voltage (V)**	**Power (W)**	**Extended Power (W)**
Control Module	Raspberry Pi	1	3.00	5.10	15.30	15.30
Drive Motor	Robot Smart Car Motor	2	1.20	9.00	10.80	21.60
Cutter Motor	775 Motor	1	10.00	12.00	120.00	120.00
Radio Antenna	XBee X2C	1	4.00E-02	3.30	0.13	0.13
GPS Module	simpleRTK2B	1	1.80E-01	3.30	0.60	0.60
Humidity sensors	Gowoops DHT22 Sensor	1	2.50E-03	5.00	0.01	0.01
				Total Power (W)		157.64

Docking Station						
Part	**Description**	**Qty**	**Current (A)**	**Voltage (V)**	**Power (W)**	**Extended Power (W)**
Control Module	Raspberry Pi	1	3.00	5.10	15.30	15.30
Radio Antenna	XBee X2C	1	4.00E-02	3.30	0.13	0.13
GPS Module	simpleRTK2B	1	1.80E-01	3.30	0.60	0.60
				Total Power (W)		16.03

Proposed Budget

Description	Qty	Price	Total price
Raspberry pi 4	2	$61.88	$123.76
Car Kit	1	$79.00	$79.00
Solar Panels	2	$25.99	$51.98
Cutting Blade	1	$5.68	$5.68
Docking Battery	1	$21.99	$21.99
Mower Battery	1	$32.99	$32.99
Power Converter	2	$14.99	$29.98
Humidity Sensors	1	$11.98	$11.98
Push Button	2	$7.99	$15.98
3D Printed Parts	3	$10.00	$30.00
Blade Motor	1	$29.95	$29.95
RTK Modules	2	$325.00	$650.00
GPS Module	1	$18.59	$18.59
Total	**20**	**$613.04**	**$1,111.04**

Timeline


January
February
March
April
May
June
July
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Research Ideas
28 days
Reseach Components
48 days
Work on the proposal website and report
91 days
Purchase Components
35 days
Proposal Presentation
7 days
Coding and building the mower
105 days
Work on design report and design website
77 days
Software and hardware testing phase
49 days
Design Presentation
7 days

Health and Safety

- Device must be handled properly to avoid accidental injury.
- Blade Shield protects the blade from being damaged and from causing damage to others.
- Obstacle detector avoids unwanted contact for increased safety and efficiency.
- Battery must be disposed of properly to avoid environmental damage.

Summary

Features of the P.A.L.M.

- Made for Hands Free Mowing
- GPS Guided
- Solar Powered
- Avoids Obstacles

References

[1] “Getting Started With Mowbot”, MowBot.com [Online]. Available at: https://www.mowbot.com/how-does-it-work/ [Accessed: 05/Feb/2021].
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[3] “MowRo - Easy, Safe, Fully Autonomous Lawn Mower”, indiegogo.com [Online]. Available at: https://www.indiegogo.com/projects/mowro-easy-safe-fully-autonomous-lawn-mower#/ [Accessed 05/Feb/2021].
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[5] “What is GPS RTK?”, Nathan Seidle, [Online] Available at: https://learn.sparkfun.com/tutorials/what-is-gps-rtk/all [Accessed 20/Mar/2021].

Q&A