I.S.H.O.P.

Comprehensive Design Review Presentation for Team 5

University of Massachusetts Amherst
BE REVOLUTIONARY™

Team Members

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Problem statement

In the past year the Covid-19 pandemic necessitated curbside pickup orders because individuals tried to avoid contact with the others. With the current online ordering system, there is still the need for employees to go and pick up the items in the store and hand them to the customer, which introduces more person to person contact. This also means that employees need to stop helping the customers in the store to grab online orders, which slows the process of moving inventory.

Specifications & Verification

Spec	*Description*	*Verification type*	*Verification Description*
1	Collector will be able get all items from space in 2 minutes or less	**Demonstration Test**	Place an order for all items in the space and time the collector from start to finish.
2	Collector will be able to hold a max load of 2lbs. in its internal storage	**Demonstration**	Place a 2lb. load in collector and have it traverse the guiding path.
3	Collector sensors will scan visual indicator on shelf to obtain nearby product information and update current location*	**Demonstrative Test**	Create a test program where the collector goes back and forth on the guiding path, stopping to scan the sensor below each item.
4	Collector can pull items off shelf into internal storage with a custom-made electromechanical arm	**Demonstration**	Show the collector pulling an item off of the shelf into its internal storage.
5	Collector will have 1 cubic foot of internal storage	**Inspection**	Take photos of internal storage with tape measures to show dimensions.

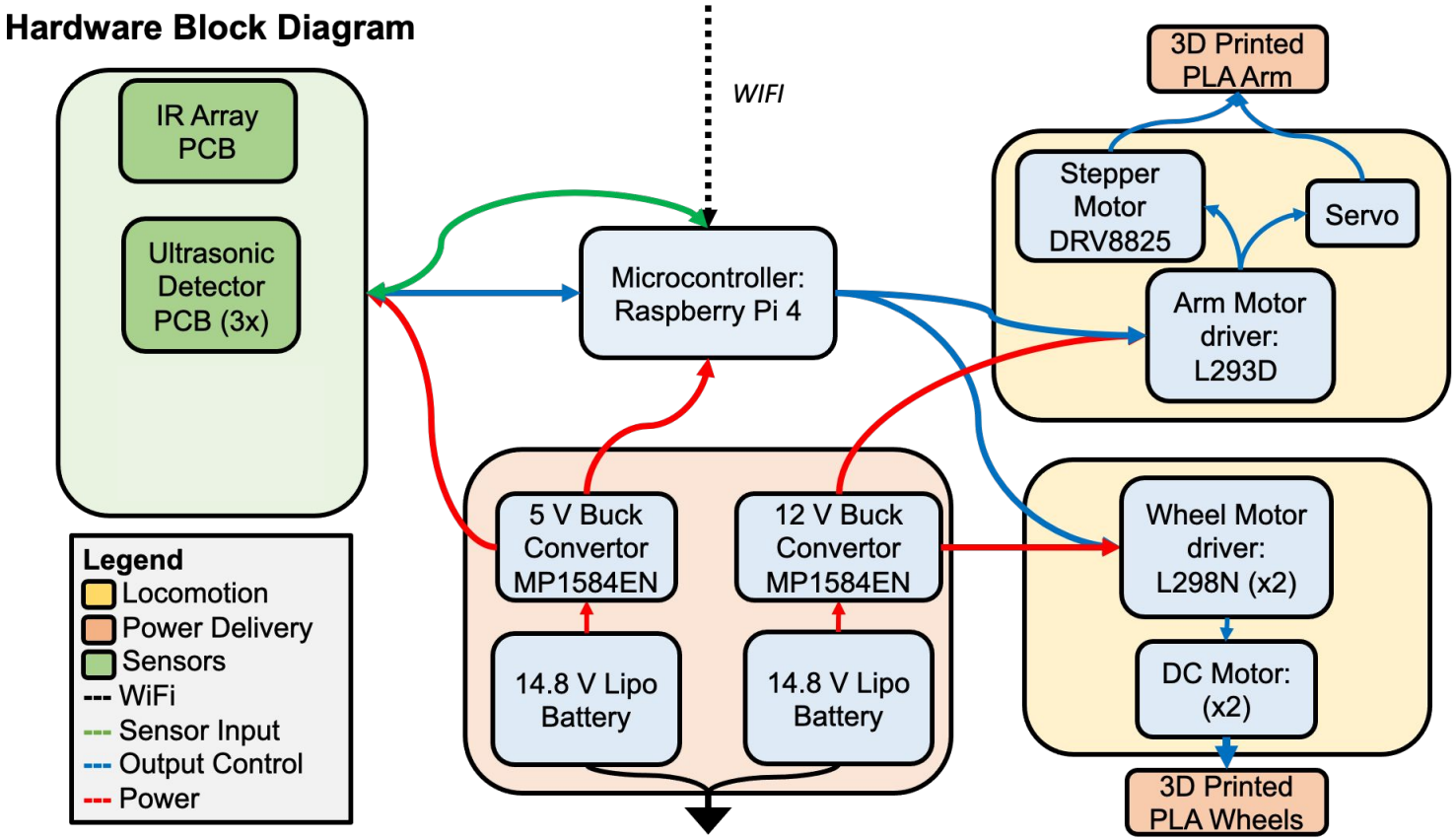
Specifications & Verification

Spec	*Description*	*Verification type*	*Verification Description*
6	Storage environment unit cell will contain 2 shelfs with 4 items on each shelf*	**Inspection**	Take a photo of the storage environment with stocked shelves to show the arrangement.
7	Guiding path for collector will allow collector to traverse back and forth on either side of shelf in addition to providing 8a connecting path to both sides.	**Demonstrative Test**	Create a test program where the collector goes back and forth on one side of the guiding path, then cross over to other side a then goes back and forth on the other side.
8	There will be a designated start and stop location for collector	**Demonstration**	Place an order for the collector and show it start and stop at the designated location.
9	Individuals will be able communicate with collector wirelessly via a digital interface	**Demonstrative Test**	Show an individual placing an order on the digital interface and then the subsequent fulfilment of that order.
10	Collector will have sensors that allow for emergency stops when path is obstructed.	**Demonstration**	Place a cardboard box on the guiding path and then place an order that requires the obstructed path to be used. Then show the collector stoping before the obstruction.

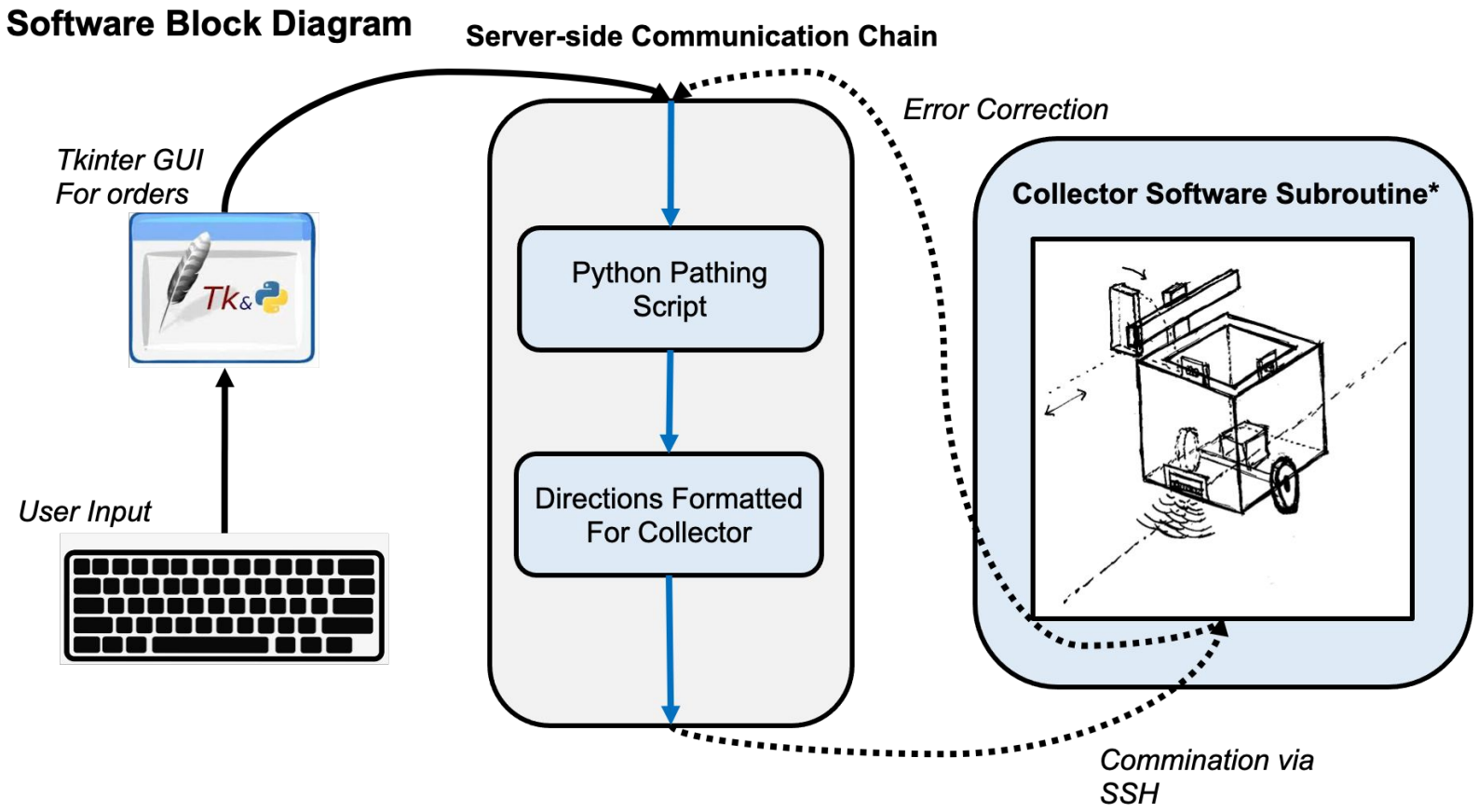
Specifications & Verification

Spec	*Description*	*Verification type*	*Verification Description*
11	Collector will follow a guiding path and automatically make locomotive corrections when deviating from path.	**Demonstration**	Placed the collector so it is deviated from the path and allow it to automatically correct itself
12	Collector will initiate a turn at designated junction and will stop turning when guiding line is centered perpendicular to front of collector	**Demonstration**	When placing an order, the collector will turn at various designated junctions, demonstrating its ability to turn accurately.
13	The collector will stop in front of ordered items to initiate a collection sequence	**Demonstration**	After placing an order, collector will only stop at items it is ordered to...

System Overview

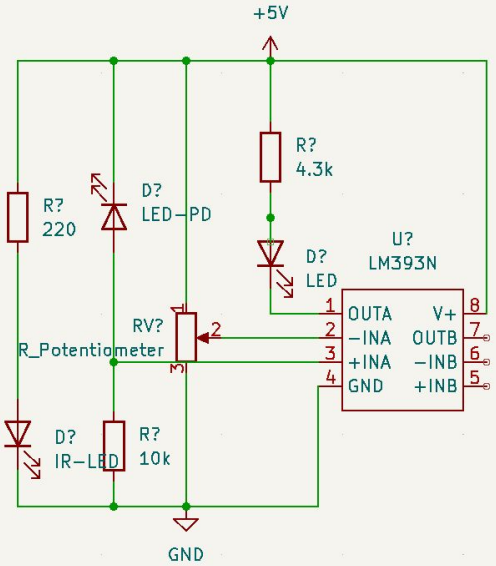


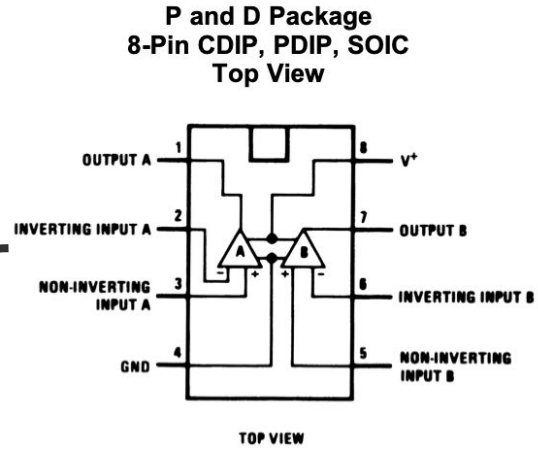
System Overview Continued



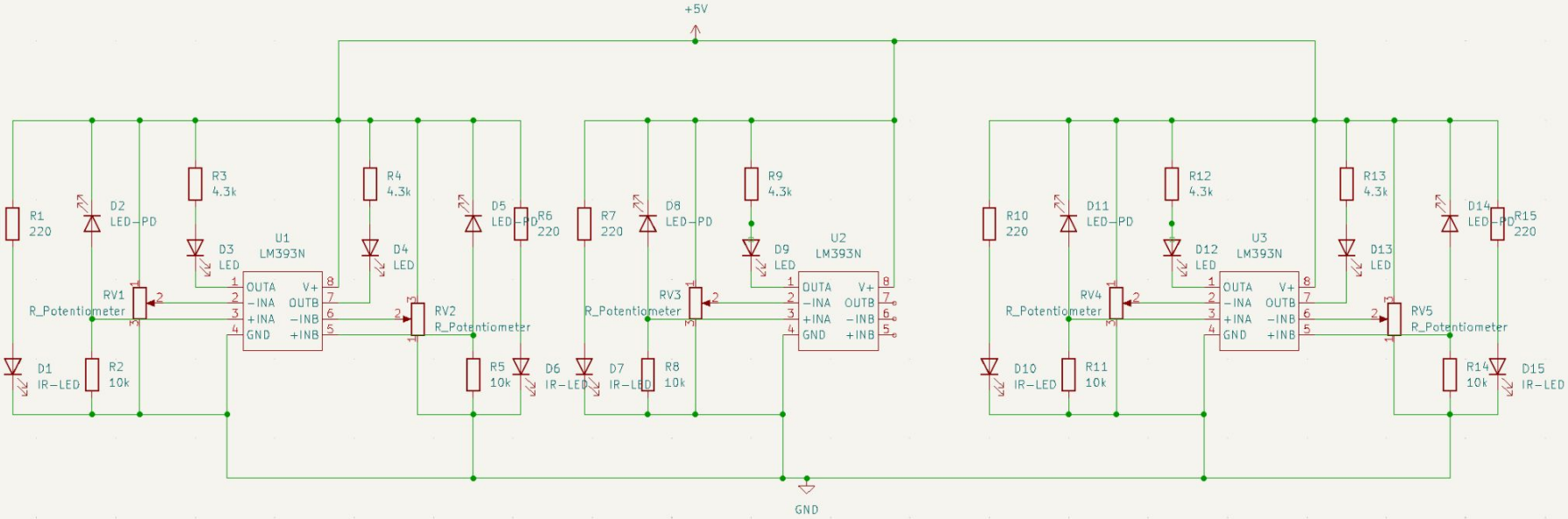
IR sensors

- LM393N
  - Comparator
- IR LEDs
  - Emitter
  - Receiver
- Potentiometer contr
  voltage reference

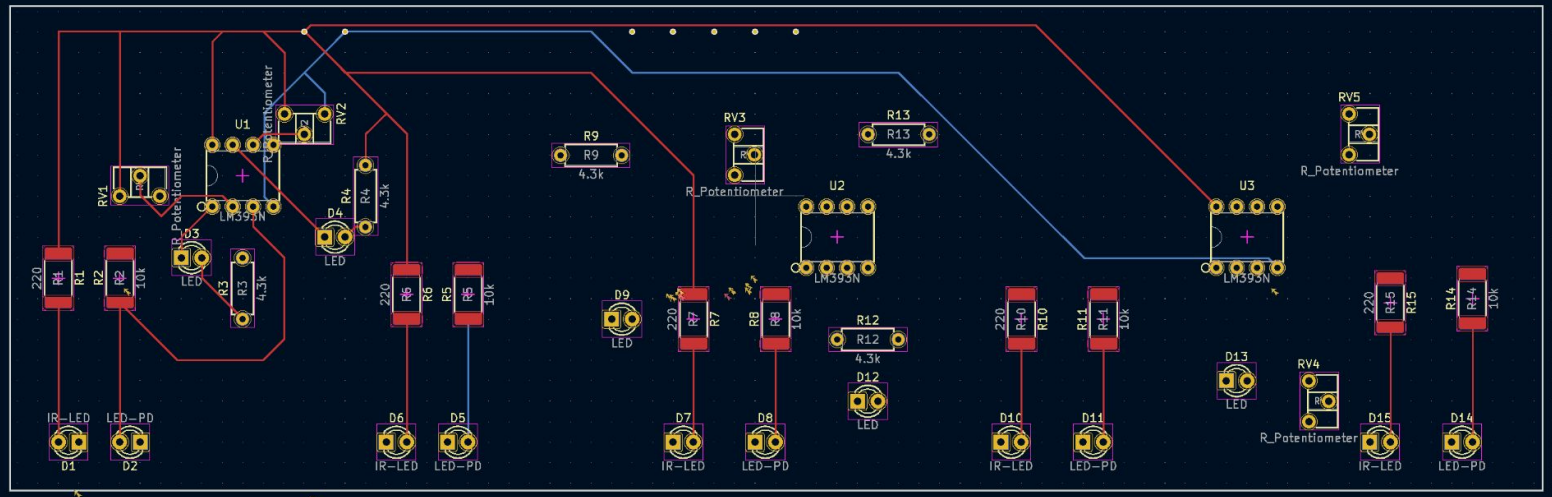




IR sensors - Schematic

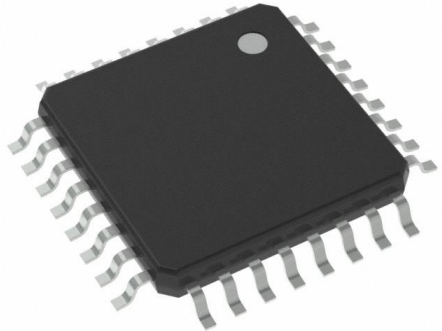


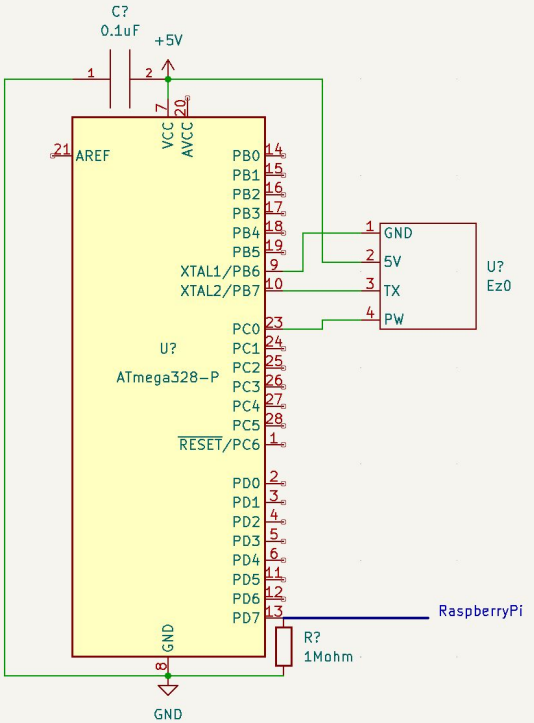
IR sensors - Layout Board



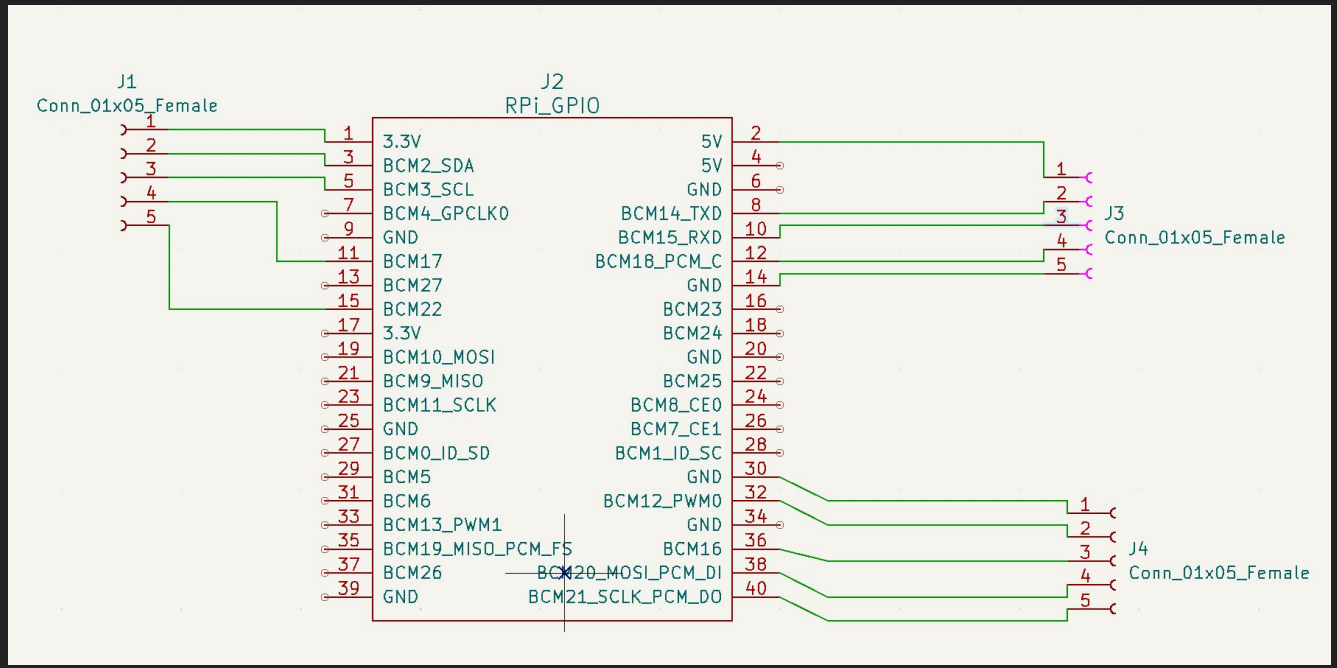
Ultrasonic Sensor

- MB1000, LV-MaxSonar-EZ0
- Atmega328P
- Interfacing with Raspberry Pi 4

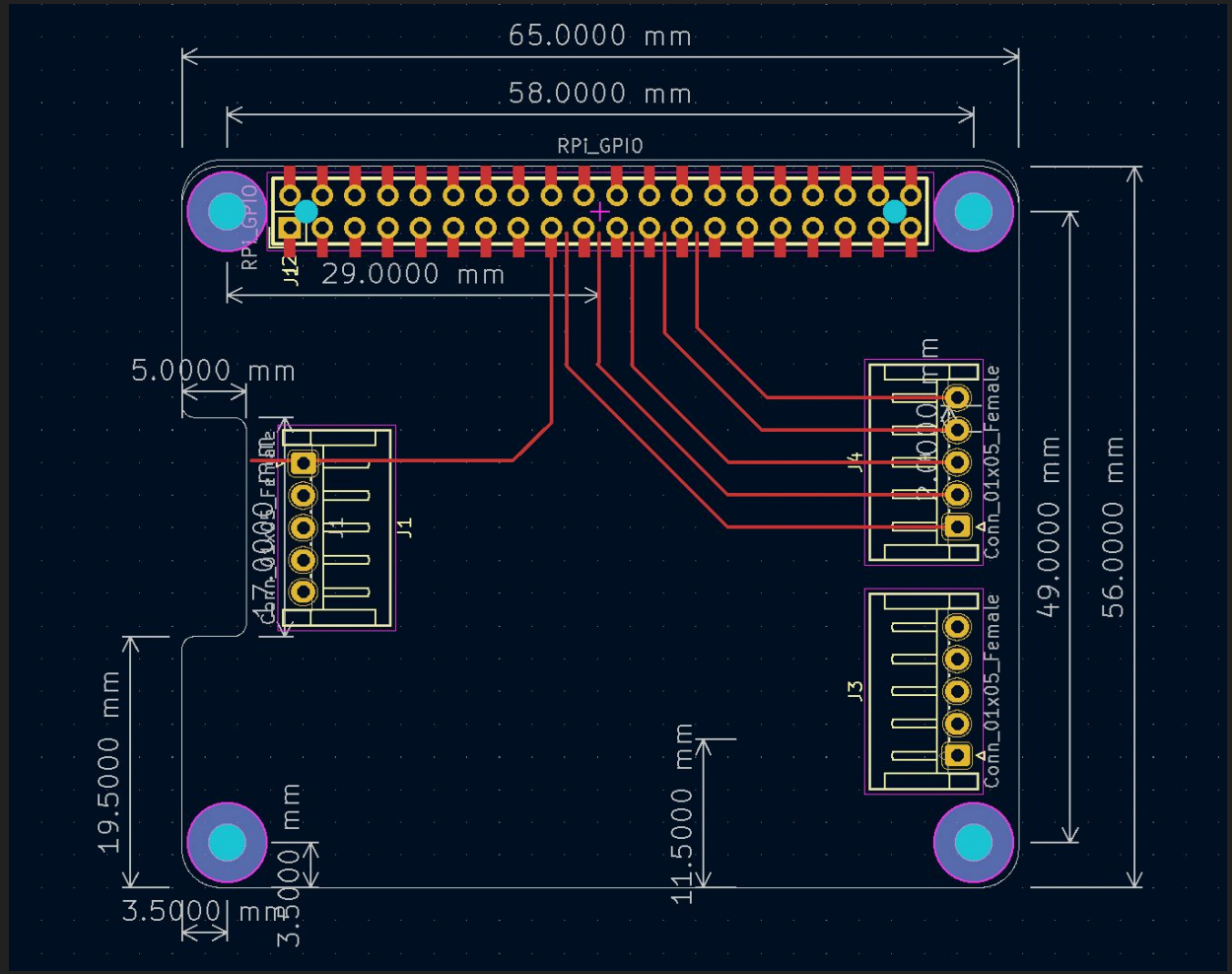




Raspberry Pi Hat Schematic

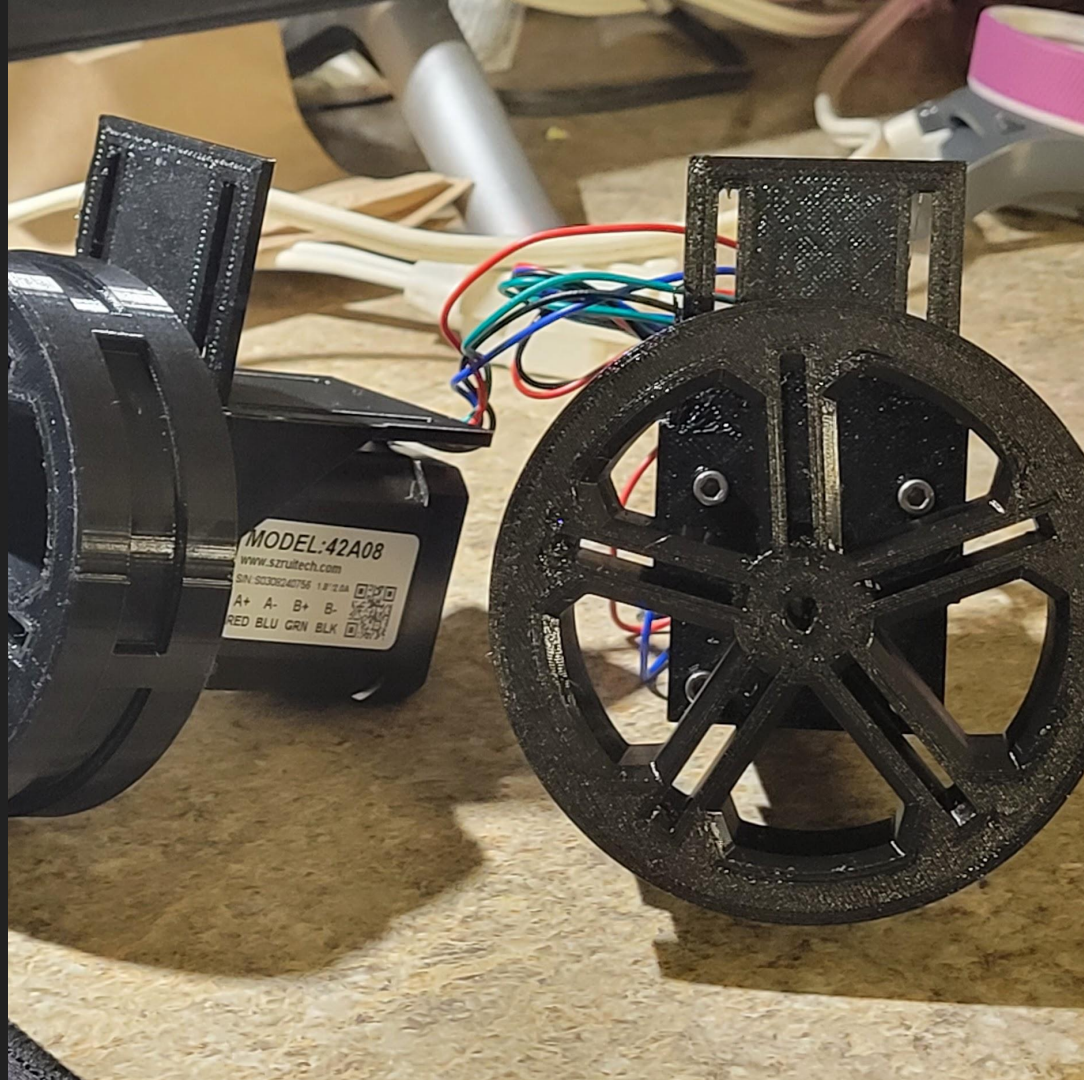


Pi Hat PCB*


65.0000 mm
58.0000 mm
RPi_GPIO
RPi_GPIO
J12
29.0000 mm
5.0000 mm
17.0000 mm
J1
Conn_01x05_Female
J4
Conn_01x05_Female
J3
Conn_01x05_Female
49.0000 mm
56.0000 mm
19.5000 mm
3.5000 mm
3.5000 mm
11.5000 mm

Wheel Motors

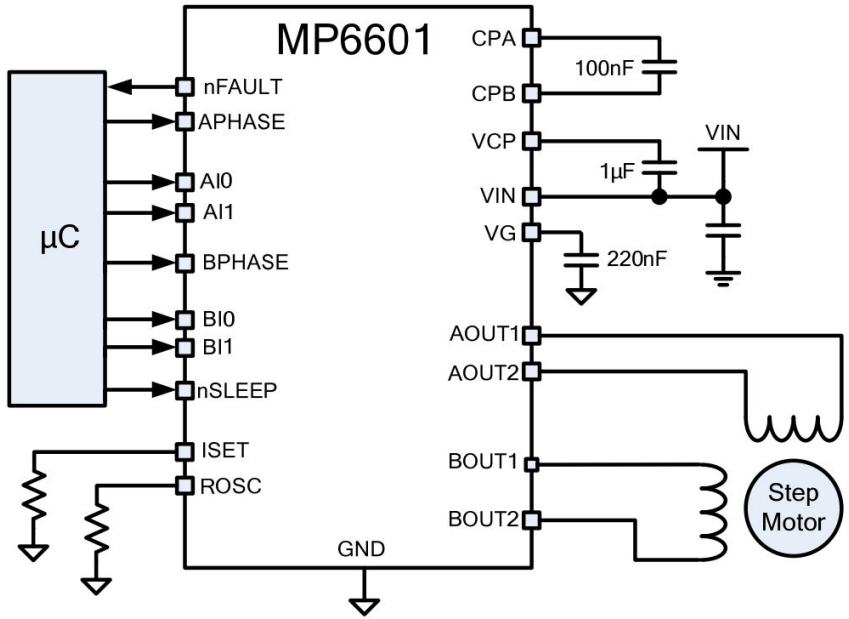
- Stepper Motor on the Wheels
  - Accuracy and Control on rotation
  - 2.5A max Current
- Stronger
- Easier to mount
- Easier to change



Motor Drivers

Bipolar Stepper Motor Driver

- Current Control
- Enable/Fault Detection
- Power Control
- Phase Control



- 3.3V and 5V Compatible Logic Supply
- Step Modes from Full-Step to Quarter-Step
- 2.5A Output Current

Controlling Stepper Motors

Step	Aout1	Aout2	Bout1	Bout2	APhase	BPhase
1	1	0	1	0	1	1
2	0	1	1	0	0	1
3	0	1	0	1	0	0
4	1	0	0	1	1	0

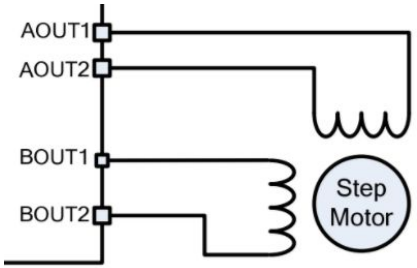


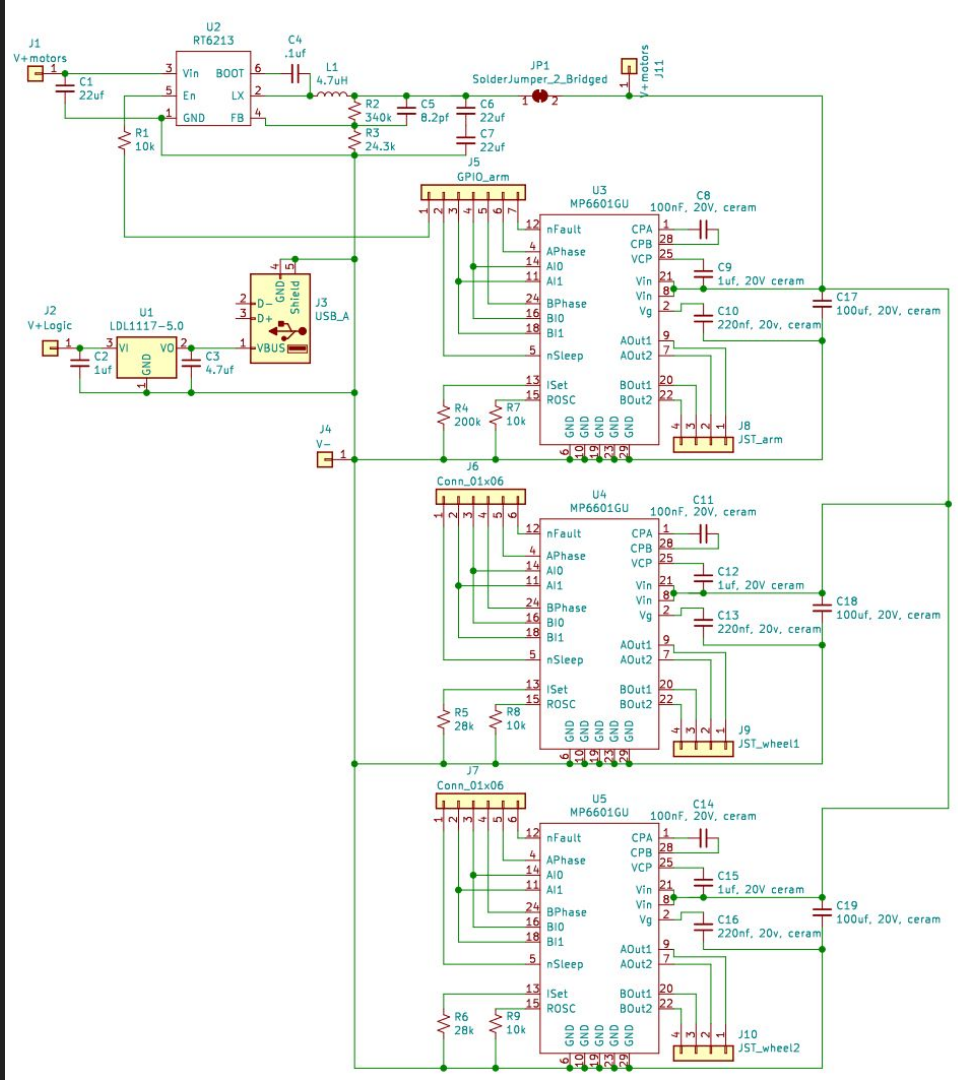
Table 1: Input Control Truth Table

xPHASE	xOUT1	xOUT2
0	L	H
1	H	L

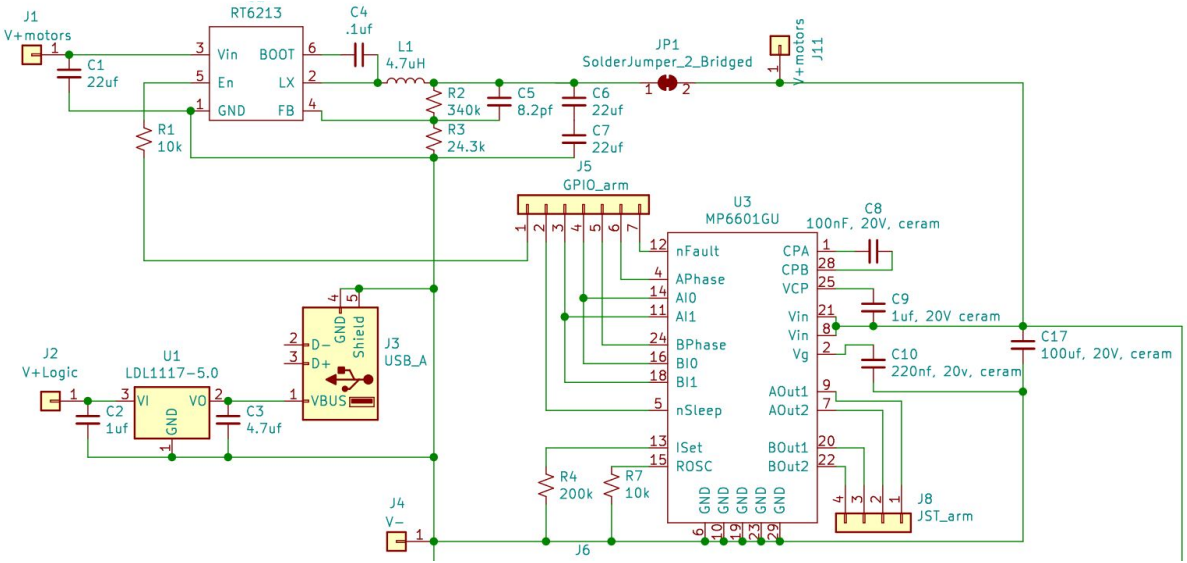
```python
def stepCW(ADIR, BDIR, steps):
    for i in range(0, steps):
        GPIO.output(ADIR, GPIO.HIGH)
        GPIO.output(BDIR, GPIO.HIGH)
        sleep(.05)
        GPIO.output(ADIR, GPIO.Low)
        sleep(.05)
        GPIO.output(BDIR, GPIO.Low)
        sleep(.05)
        GPIO.output(ADIR, GPIO.HIGH)
        sleep(.05)

def stepCCW(ADIR, BDIR, steps):
    for i in range(0, steps):
        GPIO.output(ADIR, GPIO.HIGH)
        GPIO.output(BDIR, GPIO.HIGH)
        sleep(.05)
        GPIO.output(BDIR, GPIO.Low)
        sleep(.05)
        GPIO.output(ADIR, GPIO.Low)
        sleep(.05)
        GPIO.output(BDIR, GPIO.HIGH)
        sleep(.05)
```

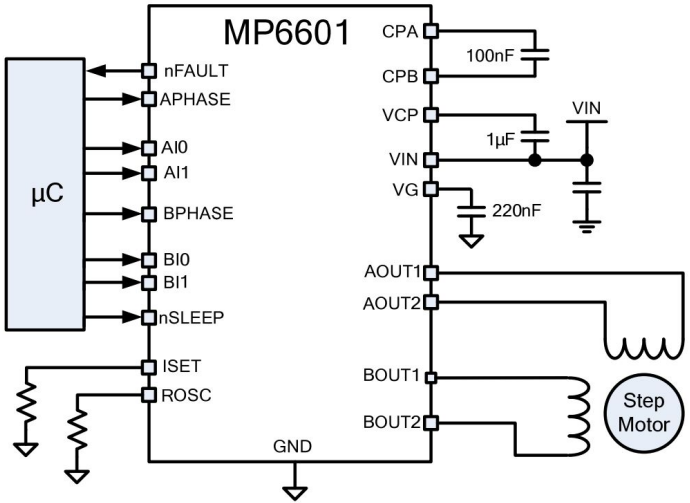
PCB Schematic

- Modular
- Clean Power
- Access to control pins
- Alternative Motor source

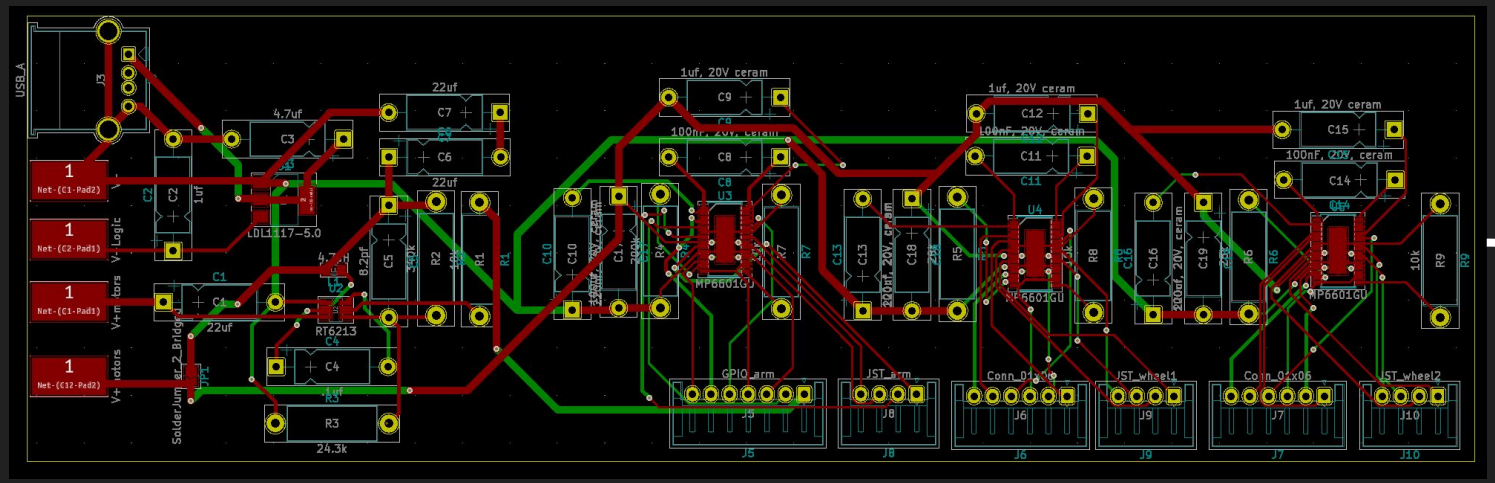


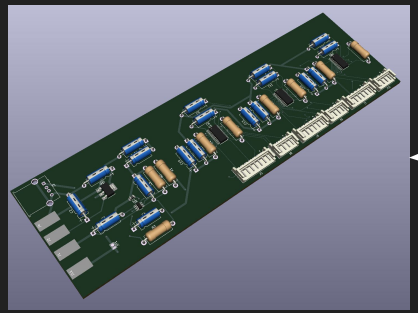
PCB Schematic





Order once, Support future changes

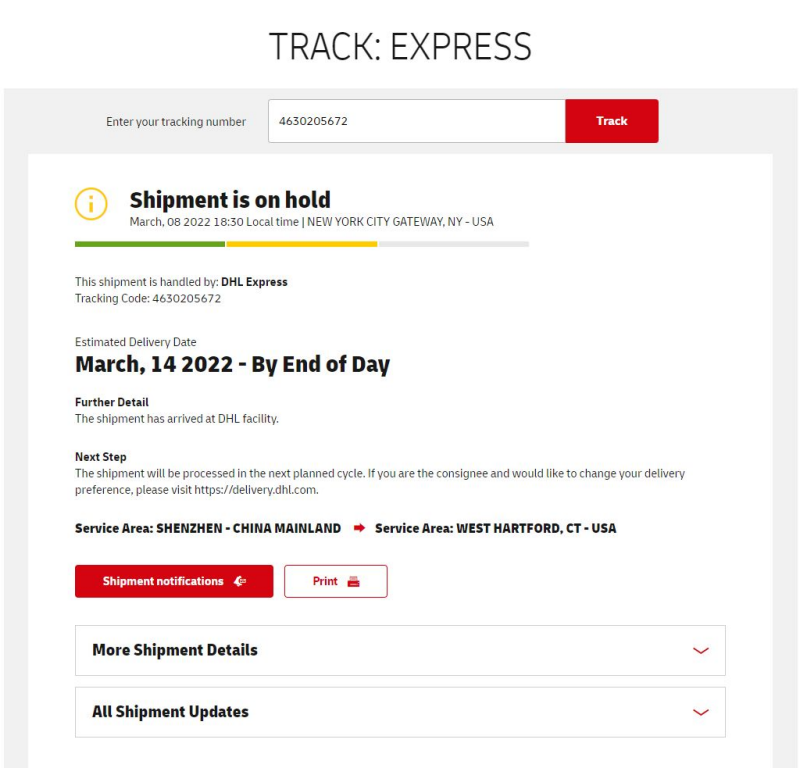




THT: Easy to solder, Parts availability,
Easy to configure, Easy to test

PCB Design

- ~~Parts Are Here~~
- ~~PCB Designed~~
- ~~PCB Ordered~~
- ~~Code Written~~
- Order Has Not Arrived



Cost analysis Current expenditures

Category	*Item*	*Name*	*Price*	*Cost*
Line Following system	Ir sensors	TCRT5000	$8	$8
	Item scanner	Pi Camera	$30	Free
Obsticle Avoidance	Ultrasonic	HC-SR04	$12	Free
Networking/controller	MCU	Raspberry Pi 4 Model B+	$55	Free
	Wifi Chip	ESP8266	$7	$7
	Stepper Motor	Motor Drivers	$16	$16
	Bipolar Step Motor	RTELLIGENT Nema	$42	$42
	Motor driver	L298N 3PCS	$8	$8
	Battery	14.8V 2PCS	$59	$59
	Wheel motor	12V DC Gear Motor - 2PCS	$60	$60
	Servo	ALMOCN 6PCS Stepper Motor Driver Module	$12	$12
	Voltage reg	DC Voltage Converter Buck Converter	$15	$15
	Battery charger	Tenergy	$33	$33
	Plastic Material	PETG, 3D printer plastic	$28	$28
Physical	Gaffer Tape		$20	$20
	shelves, frame, products, etc		$20	Free
PCB	Design		$8	$8
	Shipping	-	$20	$20
		Total Cost:	$453	$336
		Budget Remaining:		$164

Gantt Chart

Task	Team members	03/14/2022	03/21/2022	03/28/2022	04/04/2022	04/11/2022	04/18/2022
Hardware							
Design and build PCBs	R,S,E & N						
Shelves	R & E						
Power Delivery Redesign	E,N & S						
Cumulative test	R,S,E & N						
Upgrade wheels	N						
Chassis redesign	R,S,E & N						
Software							
Ultrasonic	R						
Pathfinding	S,E & N						
GUI	R						
Line Following	R,E & N						
Obstacle Avoidance	R & S						

FPR Plan

- Change prototypes with PCBs
- Upgrade wheels
- Modified Chassis
- GUI
- Website
- ***Optimization***
  - Power
  - Algorithms

Team Member Responsibilities

Edon Tuli

- Budget Management Lead
- Supporting Fabricator
- Pathing

Neil Wei

- PCB Design
- Locomotion Design
- 3D Printing/Fabricator

Rohan Sheridan

- Team Coordinator:
- On-Board Programming Lead
- Carpenter/Fabricator

Shaun Ghosh

- Software Lead
- Communication Systems
- Actuation Systems

Questions ?