MDR

UMass Amherst
COLLEGE OF ENGINEERING

Lazy Bob - SDP23 Team 5

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The Team

Omar Areiqat
CompE
Budget Lead
Movement and Power

Jina Song
EE
PCB Lead
Design

Vedatman Soham Basu
CompE
Software Lead
Sensors

Redwan Rahman
CompE
Logistic Lead
Positioning

William Leonard
Advisor

Problem Statement

Some people struggle with mundane actions in life, such as passing dishes on a large table.

Lazy Susans are nice, but only work on round tables and requires user to have reach.

What if there was a small, portable device that can move dishes across any table of arbitrary shape?

Our Solution

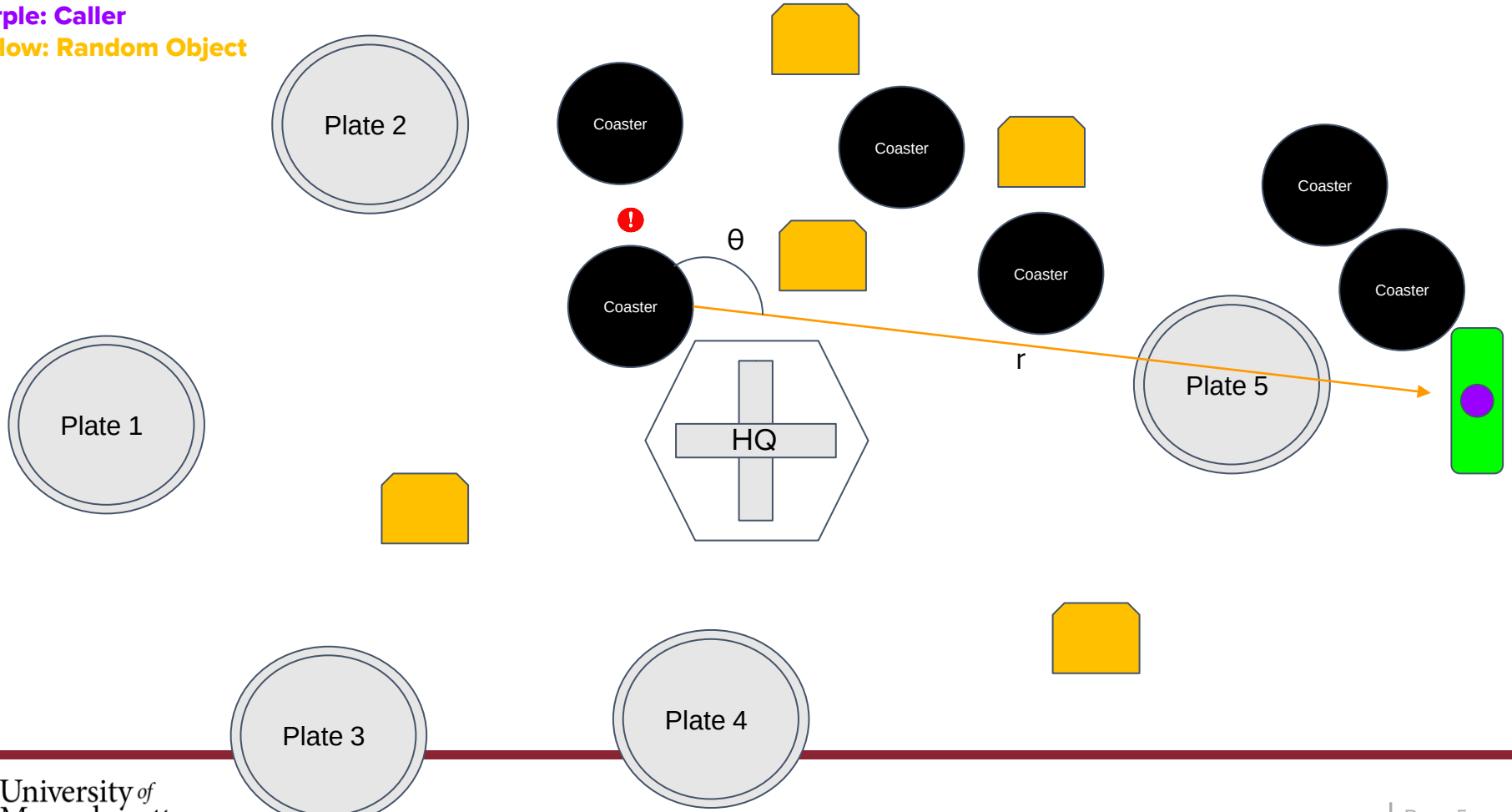
“Lazy Bob”: A moving coaster that approaches the user when called.

1. Stably transport items around a table to different users

1. Provide a simple way to interface with all coasters

1. Adapt to the environment

Purple: Caller
Yellow: Random Object



System Specifications: Functional

	Test Plan
1. Mostly full container of liquid doesn't spill when moving	1. Place an 80% full glass/bowl of water and visibly check that the moving coaster doesn't spill
1. Transport items without the items falling off	1. Put objects on moving coaster and watch if object falls
1. Detect the edges of the table and avoid falling off	1. Watch if the moving coaster falls off when caller is away from the table
1. Avoid objects that are in the coaster's moving path	1. Put objects in path and check if moving coaster bumps into object
1. Arrive at the caller or hub to an accuracy of 10 cm	1. Use a tape measure to check the distance from destination
1. Support up to 3 lbs.	1. Place an object that weighs 3 lbs and check if system is stable while moving

System Specifications: Design

7. Move back to the coaster's hub once determined not in use

8. System supports at least 2 coasters at the same time

9. Coaster diameter is within 25 cm

10. Be able to use the moving coaster regardless of table shape

11. If no path to caller is available, indicate to caller

Test Plan

7. Watch the moving coaster move towards hub on a given signal

8. Call both coasters on a collision course and see if they collide

9. Use tape measure to check coaster size

10. Find and put on irregular shaped tables and check if they fall off

11. Line up objects to allow no path to caller, see if system notifies caller

MDR Deliverables

A. 1 Moving Coaster

a. Moves properly and accurately
b. Accurately detects positioning
c. Goes to location when called
d. Detects and stops if an object is in the way

A. 1 Caller

a. Can send signal to coaster and hub

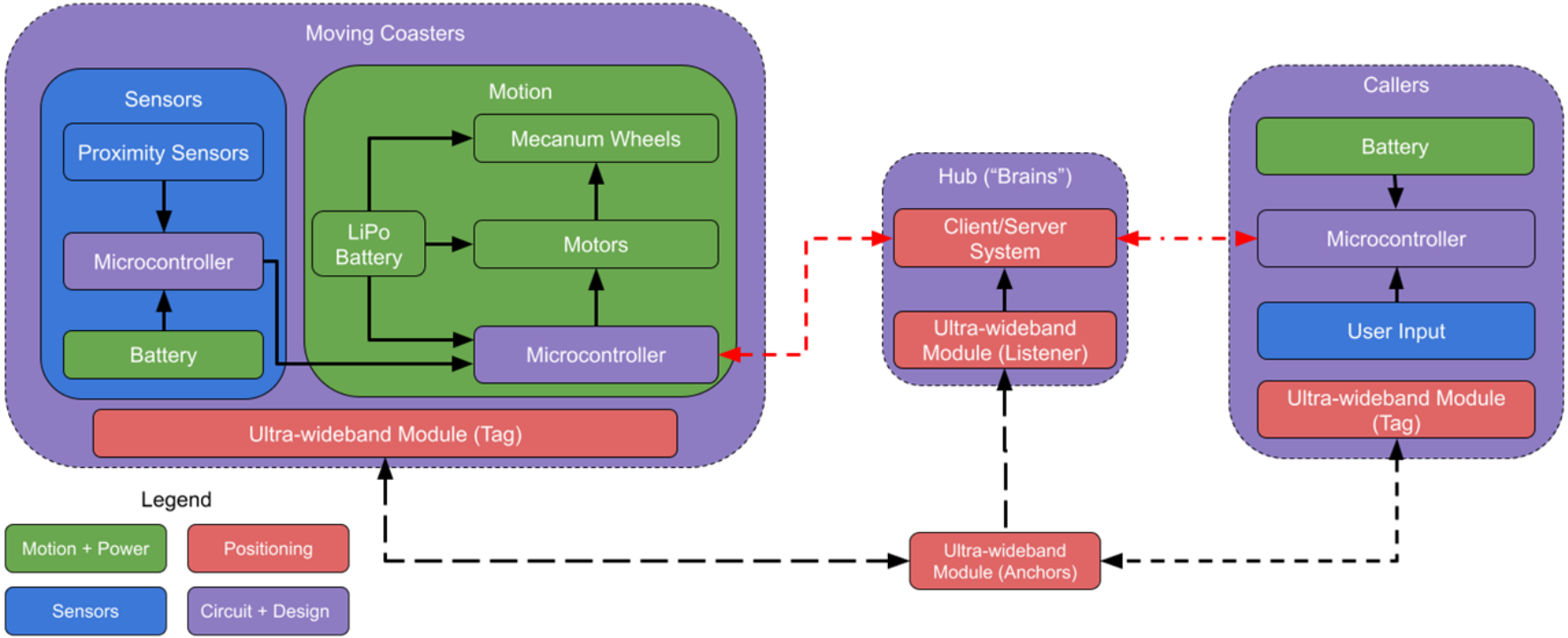
A. 1 ~~Charging~~ Hub - “Brains”

a. Can send signal to coaster and callers
~~b. Potentially charges system~~

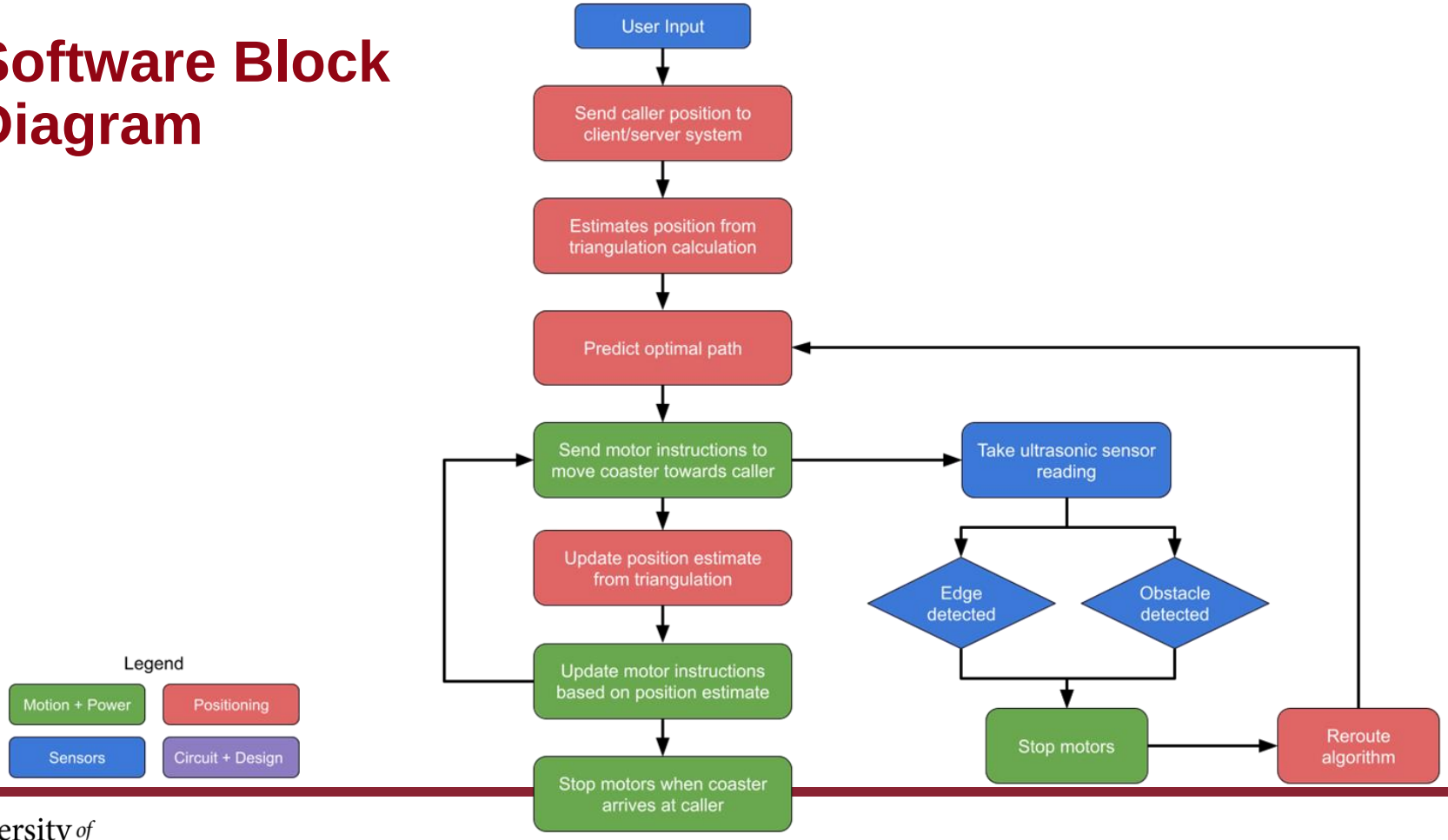
D. Functional PCB

a. Microcontroller with user input method (button)

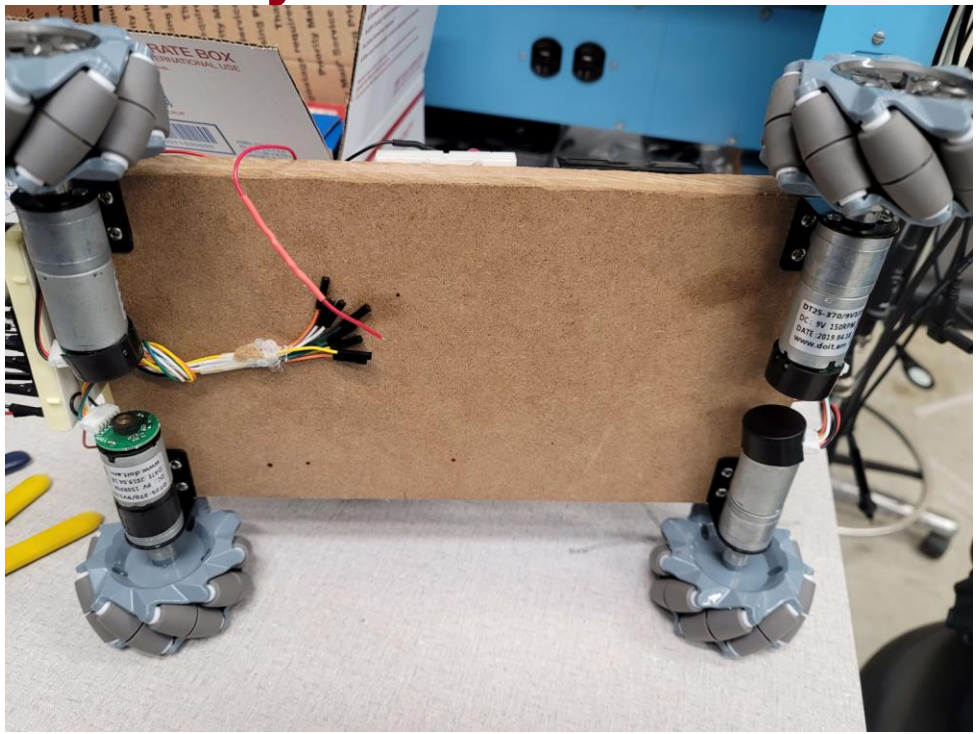
Hardware Block Diagram

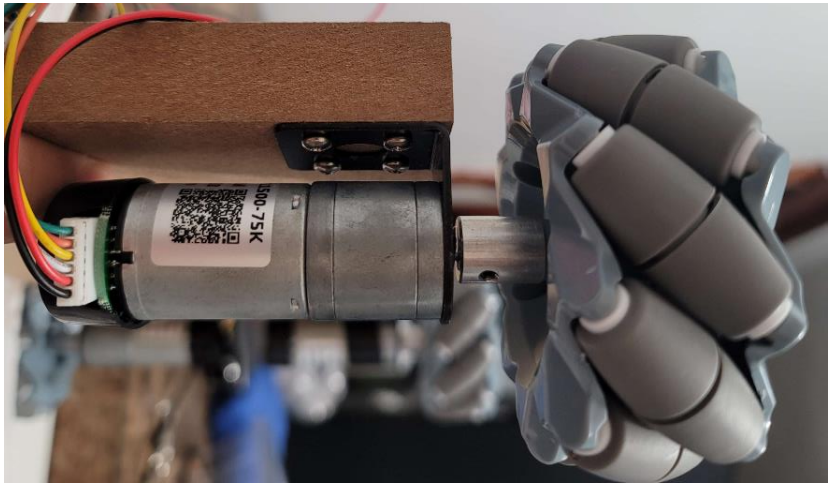


Software Block Diagram

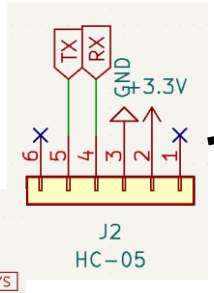


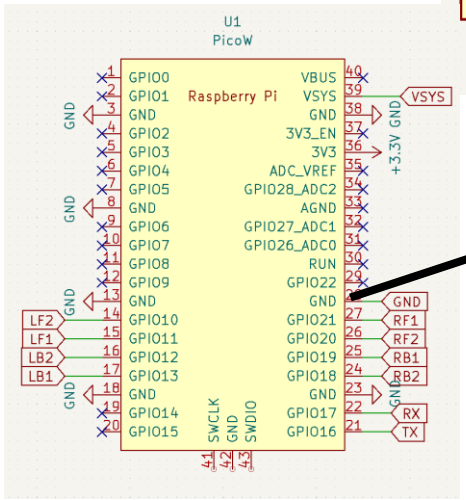
Subsystem: Motion

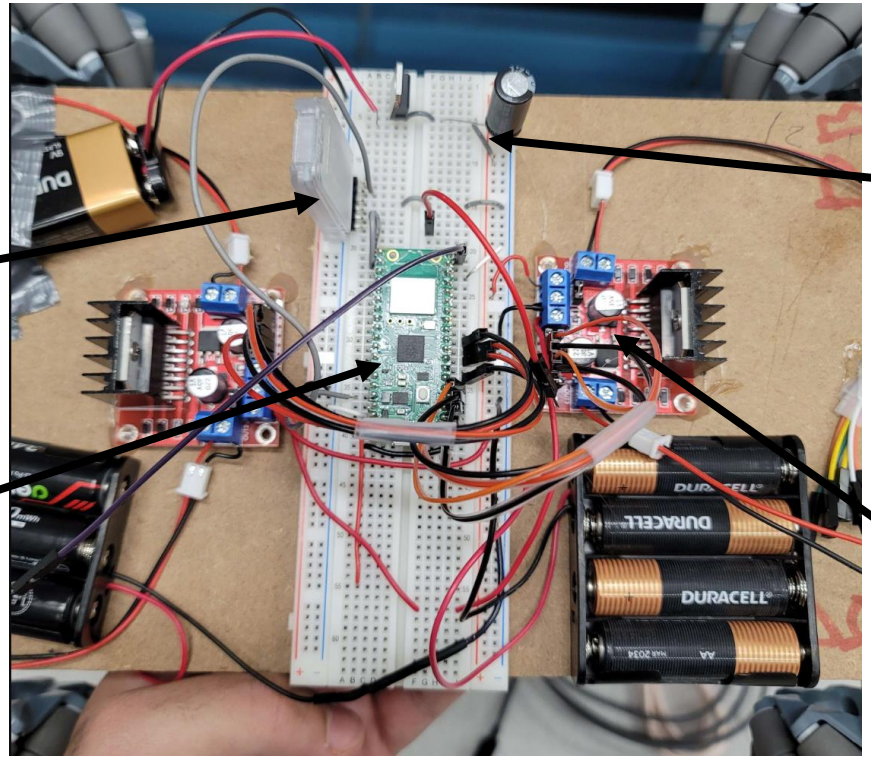


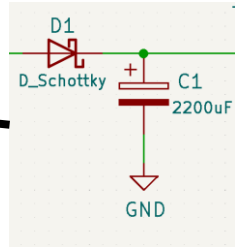


Motion: Circuit



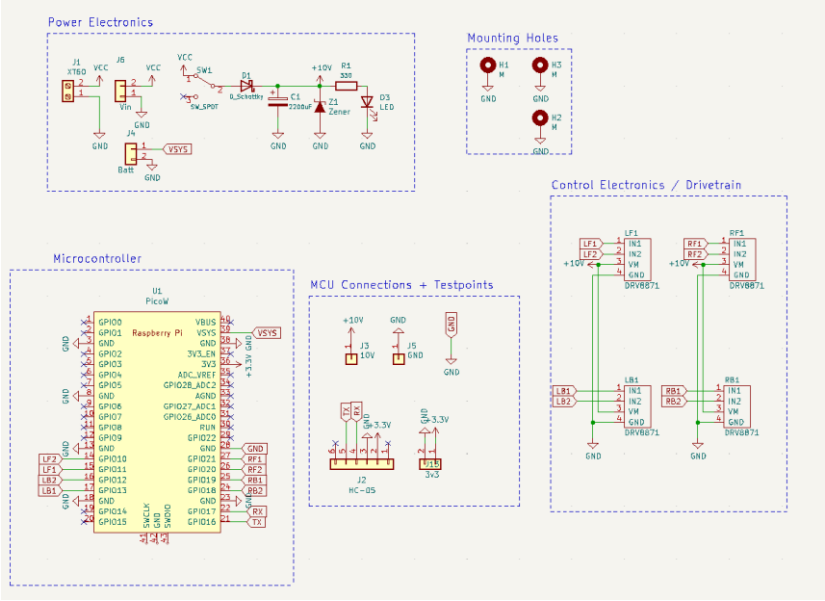


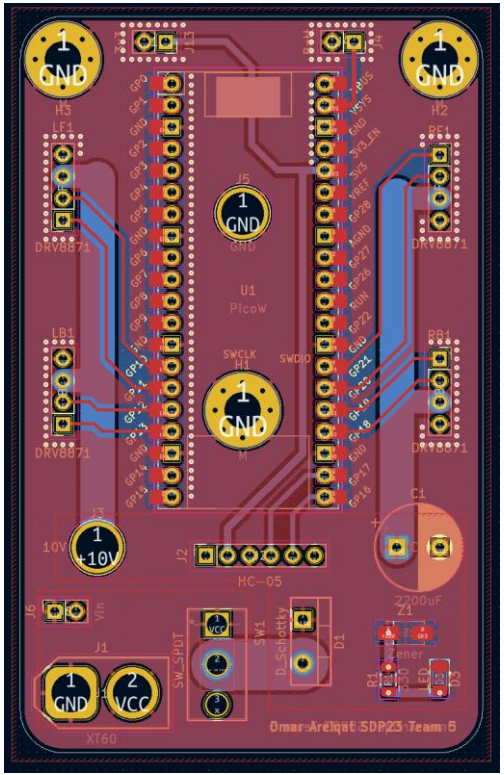


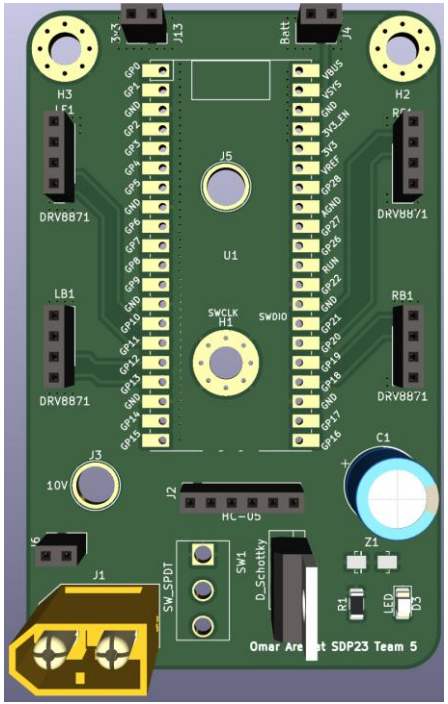


Motor Driver

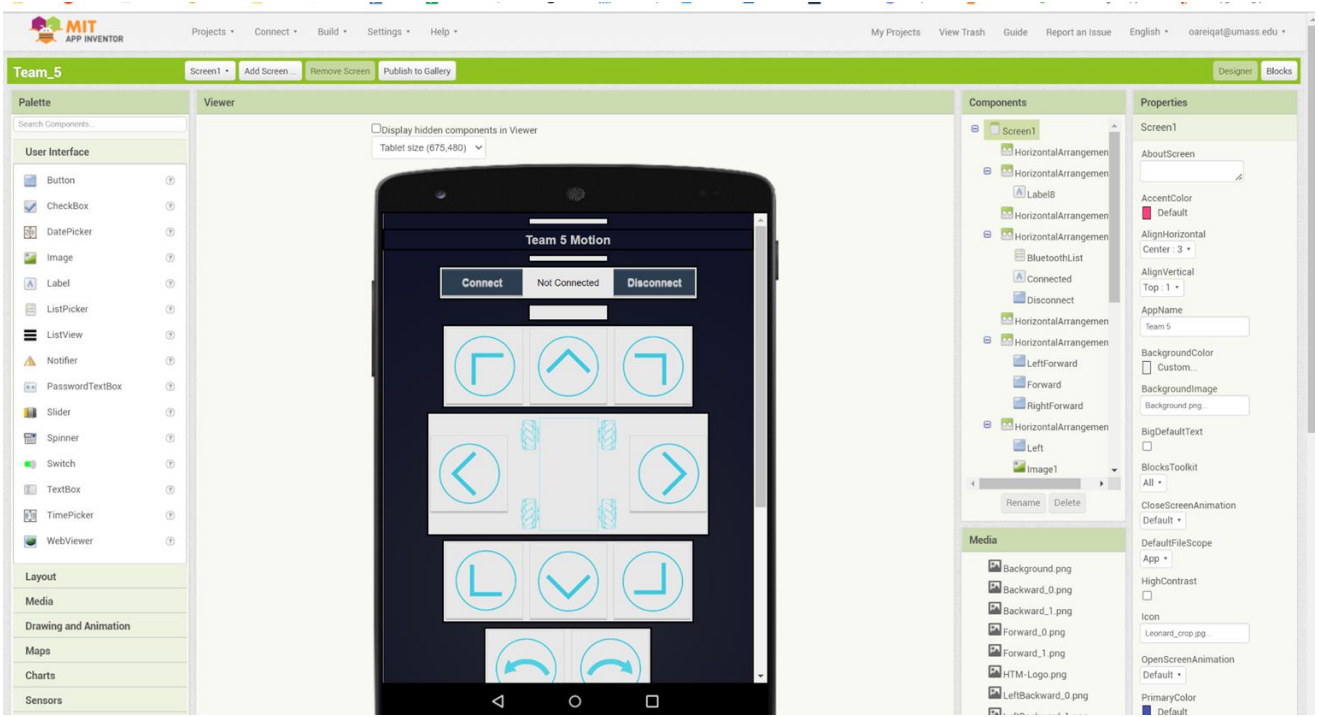
Motion: PCB


Power Electronics
Mounting Holes
Control Electronics / Drivetrain
Microcontroller
MCU Connections + Testpoints

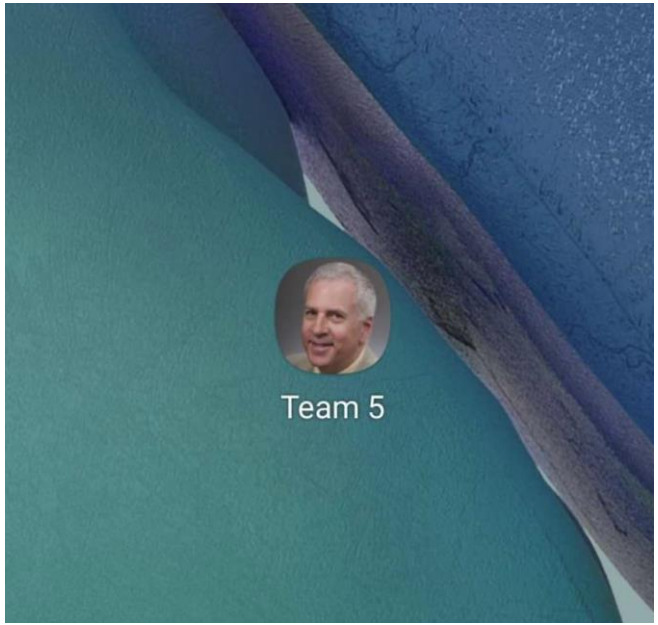


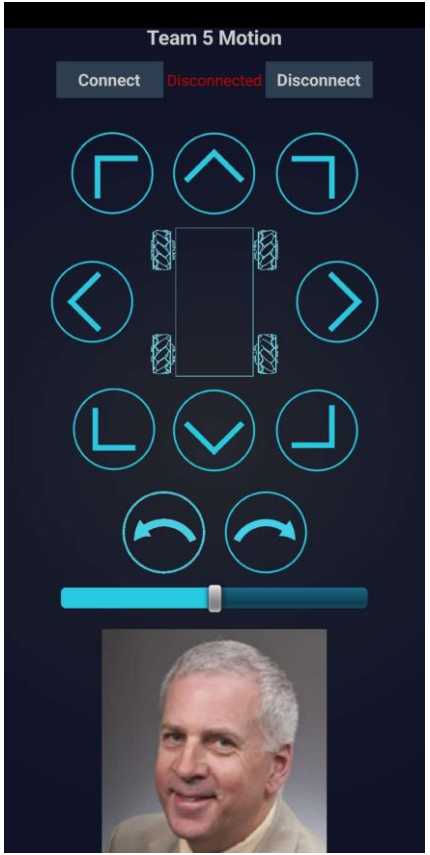


Motion: Debugging



Motion: Debugging

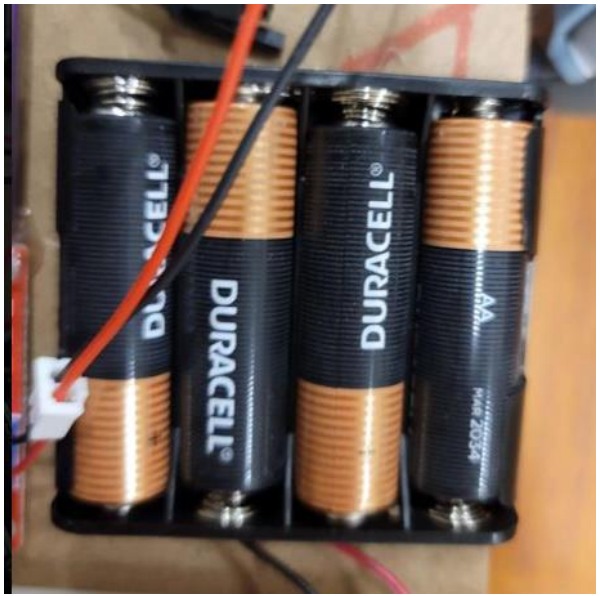




Subsystem: Power

MCU Power

Motor Driver Logic Power



Motor Driver Motor Power

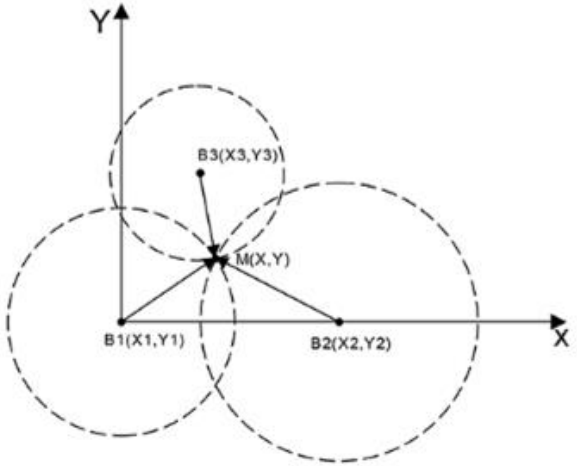
https://www.adafruit.com/product/328
https://www.adafruit.com/product/798

Subsystem: Positioning

- **Ultra Wideband Sensor**
  - Accuracy to ±1 cm
  - Program gives confidence level

- **Triangulating relative position**
  - Get position of both individually on an x,y,z plane and calculate

```
dwm> lep
dwm> POS,0,8312,-0.16,0.65,0.08,87,x00
POS,0,C404,0.16,-0.12,0.10,96,x0B
POS,0,8312,-0.18,0.67,0.02,90,x00
POS,0,C404,0.15,-0.15,0.11,87,x0B
POS,0,8312,-0.18,0.68,-0.05,88,x00
POS,0,C404,nan,nan,nan,0,x0B
POS,0,8312,-0.18,0.67,-0.10,88,x00
POS,0,C404,nan,nan,nan,0,x0B
lep
```

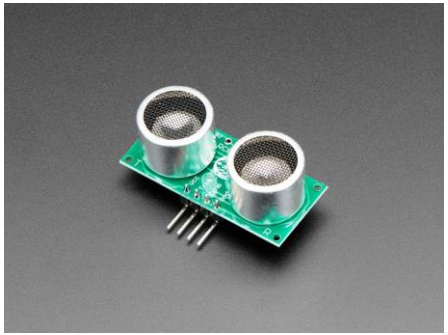


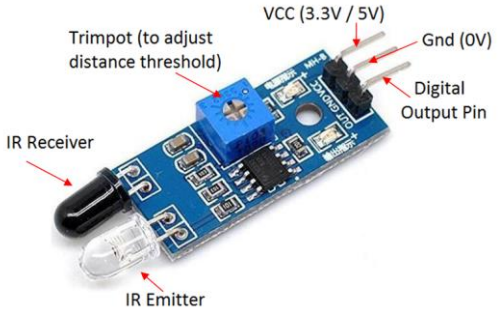
https://www.frontiersin.org/articles/10.3389/fnbot.2022.715440/full
https://www.qorvo.com/products/p/MDEK1001

Subsystem: Collision and Cliff Detection

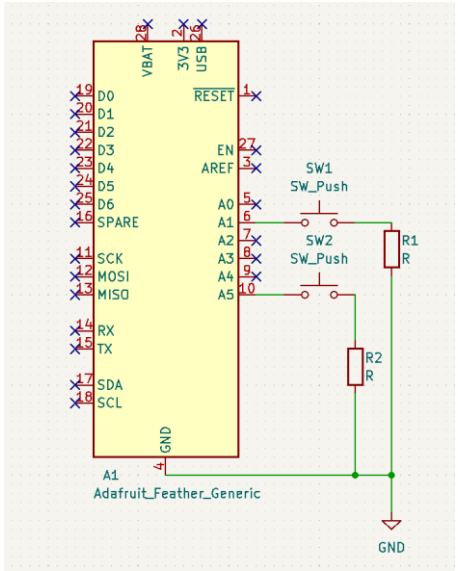
- **Ultrasonic**
  - Edge detection
  - Clear path and obstacle detection

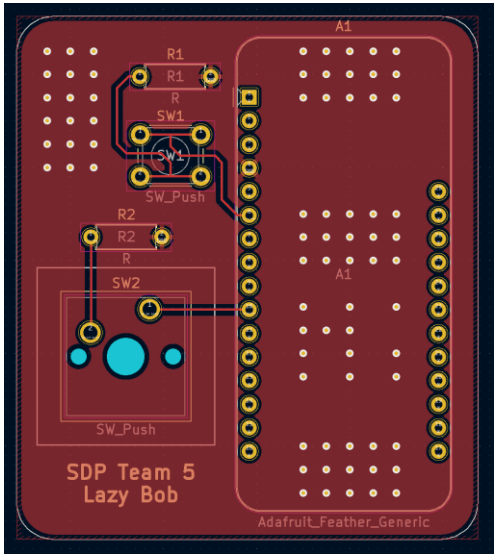
- **Infrared/Piezoelectric**
  - Collision and impassable barrier detection





Design: Chassis and PCB





CDR Deliverables

1. **“The Brains” and Live Data**
    a. Instead of laptop, use Raspberry Pi or similar to process data
    a. Setup client/server system for inputs from multiple sources
    a. Continuously update position as coaster moves (Currently uses first set of coordinates to move)

2. **Chassis for Coaster**
    a. Circular body with a platform to put objects on
    b. Able to contain all components inside

3. **PCB Plans**
    a. Motion
    b. Sensors
    c. User input

Next Semester Estimated Cost

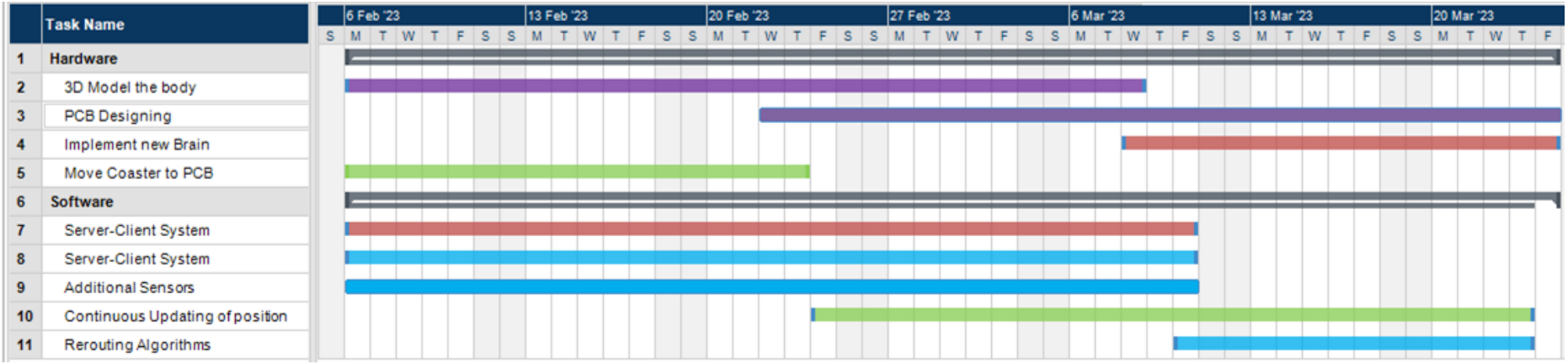
Planned List		
Item Name	Link	Price $ (with tax and shipping)
Raspberry Pi 4	SDP	–0–
PCB	JLCPCB	50.00
Sensors	M5	25.00
Motion PCB	Omar	–0–
4 x DRV8871 Motor Drivers	M5	–0–
1s 1500mAh Lipo	M5	–0–
216.95		

Total Expenses to-date

Total List		
Item Name	Source	Price $ (with tax and shipping)
UWB DIY Starter Kit	Link	74.98
2 x Pico W	Wouter	12.00
PCB1	Wouter	22.05
PCB	JLCPCB	50.00
Sensors	M5	25.00
6 x Pico W	Wouter	36.00
6 Dof Sensors	Amazon	15.95
12 x RCR132a	Amazon	40.00
Motors and Wheels	Digikey/Adafruit	50.00
325.98		

Gantt Chart

Soham | Omar | Redwan | Gina



QUESTIONS & ANSWERS

University of Massachusetts Amherst

Video (if things go awry)