

**FPR**

**UMassAmherst**  
COLLEGE OF ENGINEERING



# **Lazy Bob - SDP23 Team 5**

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Movement and Power



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EE

Design Lead  
Design



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CompE

Software Lead  
Sensors



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CompE

Integration Lead  
Positioning



William Leonard  
Advisor

# The Team

# 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?**

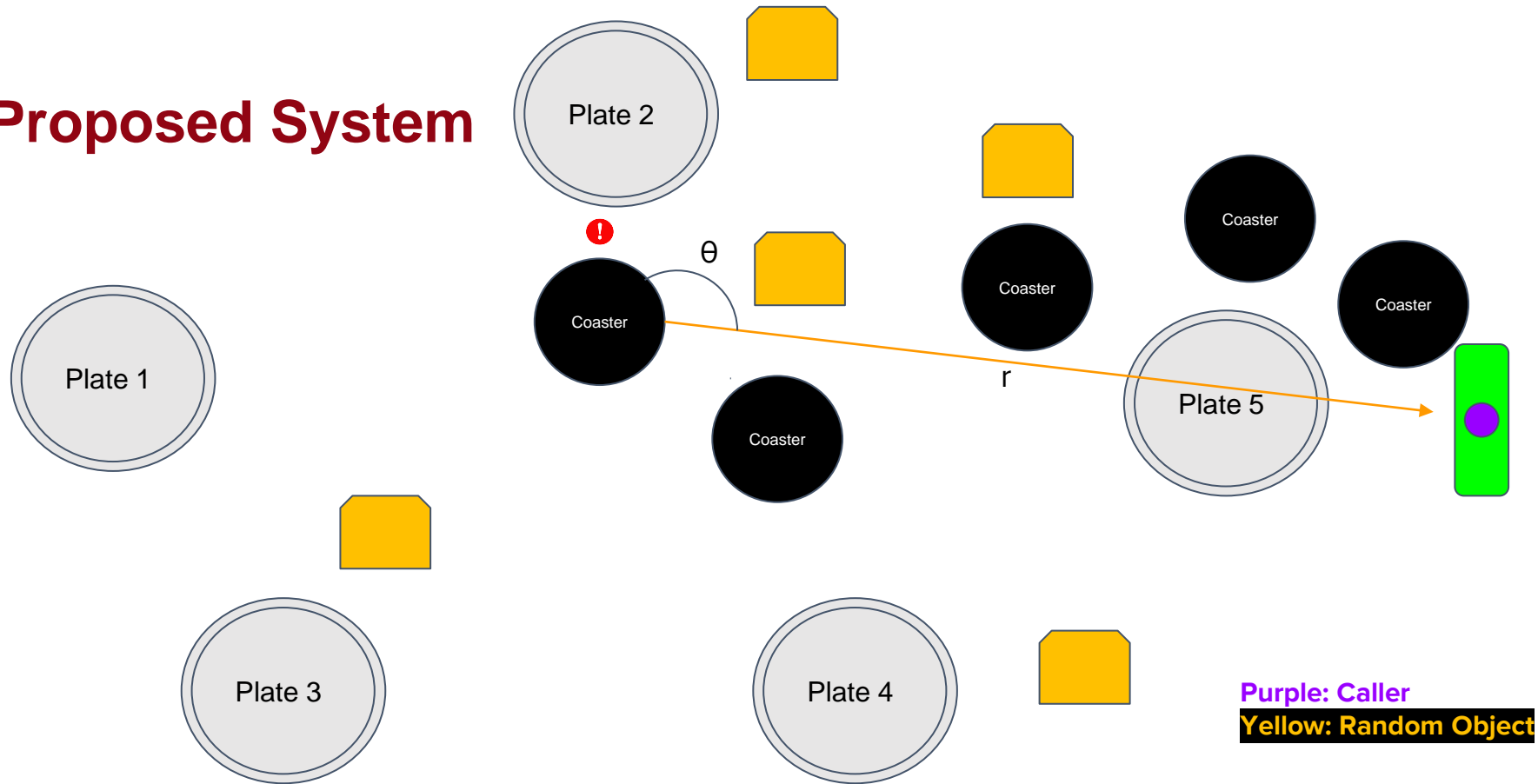


# Our Solution

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

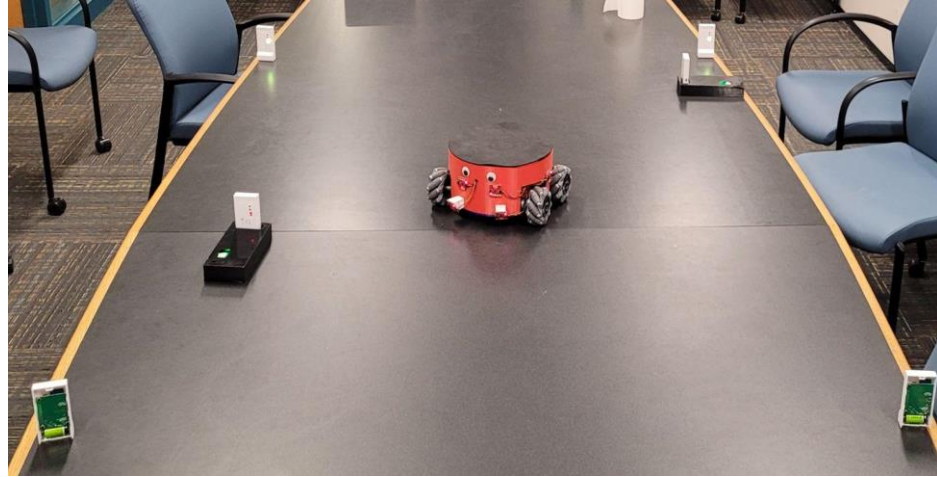
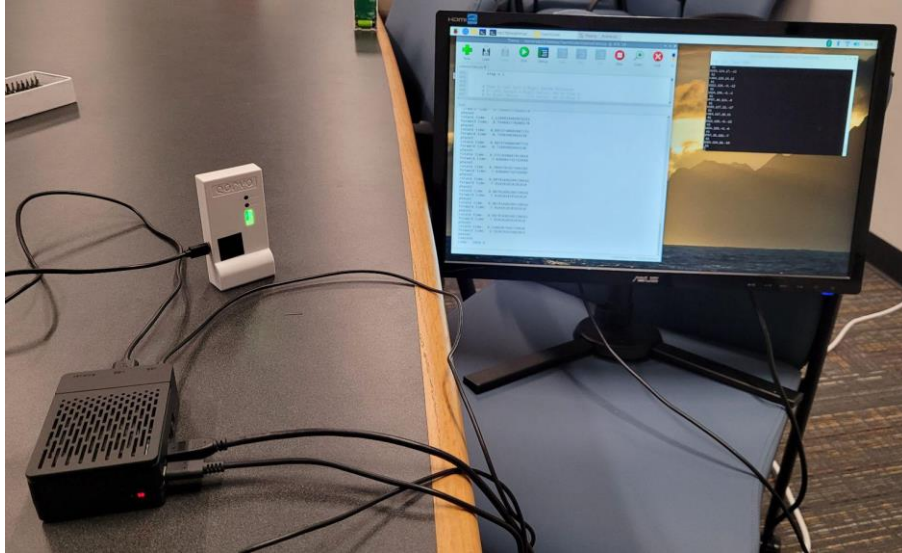
1. Stably transport items around a table to different users
1. Provide a method for the user to call the moving coaster
1. Adapt to the environment

# Proposed System





# Delivered System



# System Specification

# System Specifications

1. Mostly full container of liquid doesn't spill when moving
1. Transport items without the items falling off
1. Detect the edges of the table and avoid falling off
1. Avoid objects that are in the coaster's moving path
1. Arrive at the caller to an accuracy of 15 cm between the closest points of the coaster and caller

## Test Plan

1. Place an 80% full glass/bowl of water and visibly check that the moving coaster doesn't spill
1. Put objects on moving coaster and watch if object falls
1. Watch if the moving coaster falls off when caller is away from the table
1. Put objects in path and check if moving coaster bumps into object
1. Use a tape measure to check the distance from destination



# System Specifications

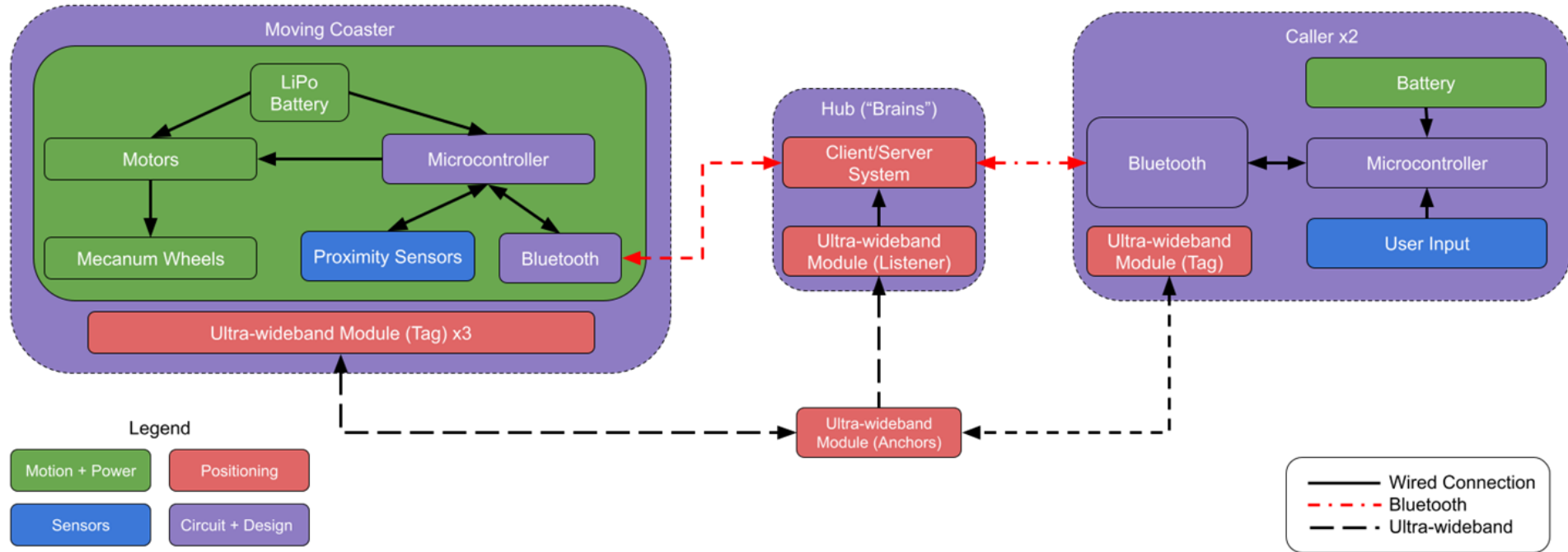
6. Support up to 3 lbs
7. System supports at least 2 callers at the same time
8. Coaster diameter is within 30 cm
9. Be able to use the moving coaster regardless of table shape

## Test Plan

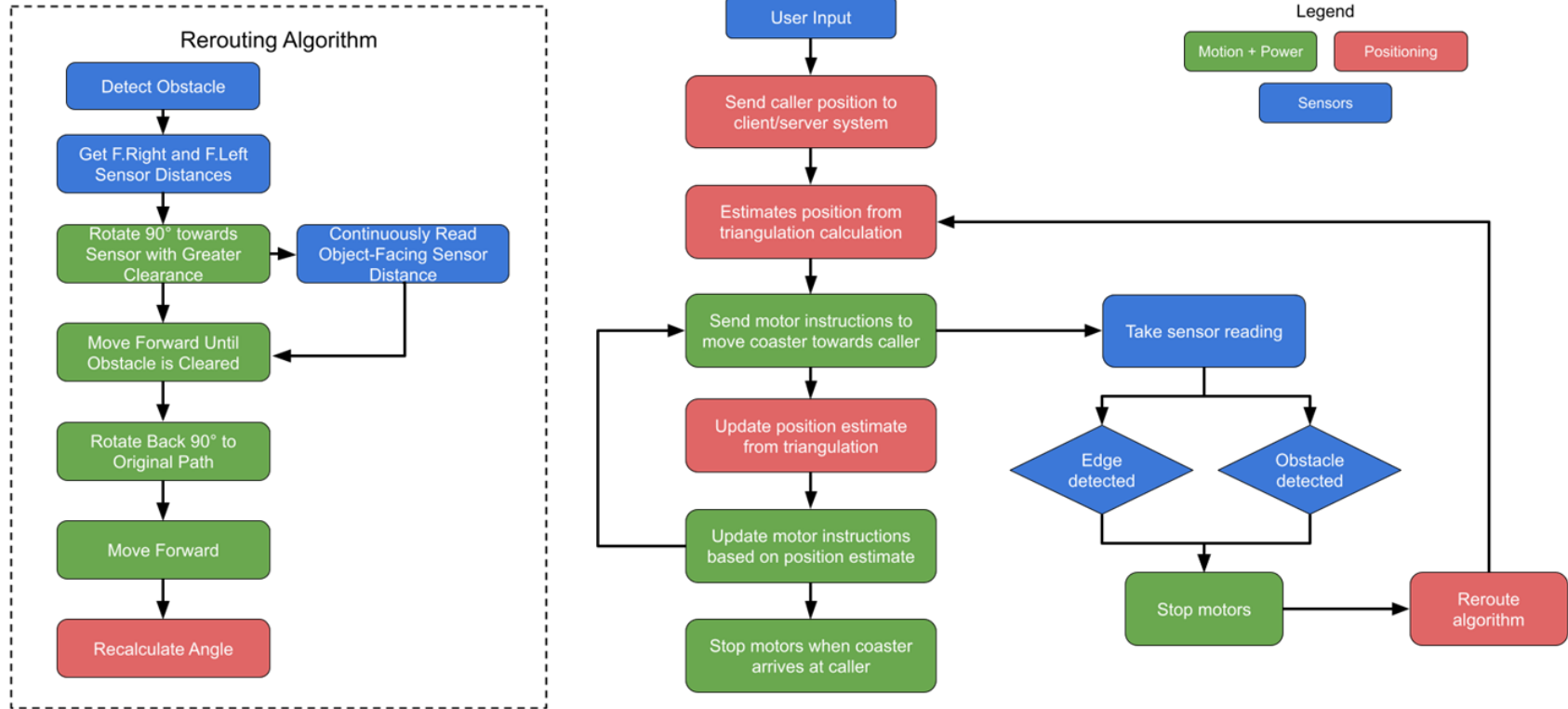
6. Place an object that weighs 3 lbs and check if system is stable while moving
7. Press both callers and see if the coaster moves to the first caller only
8. Use tape measure to check coaster size
9. Find and put on irregular shaped tables and check if it falls off

# Block Diagrams

# Hardware Block Diagram



# Software Block Diagram

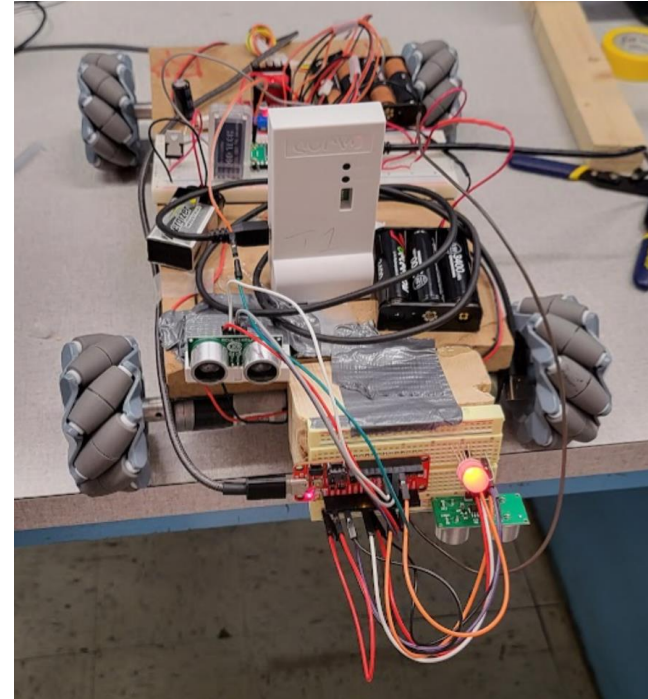
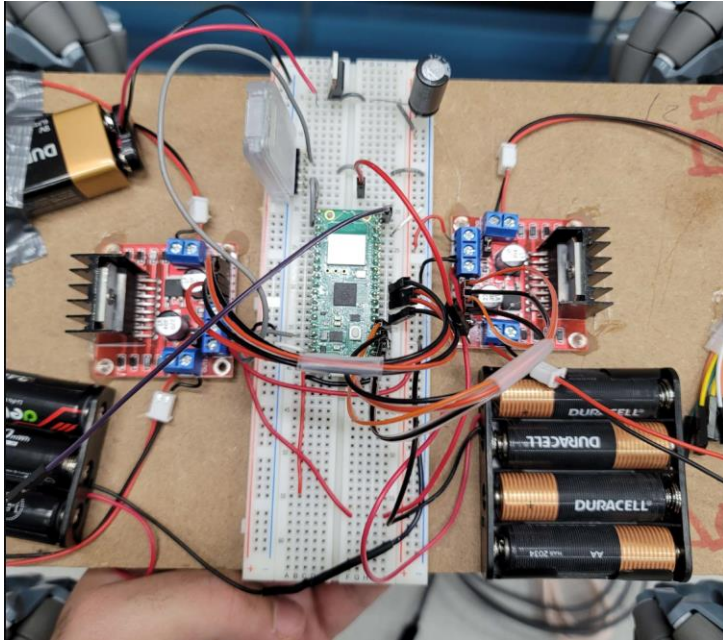


# System Hardware

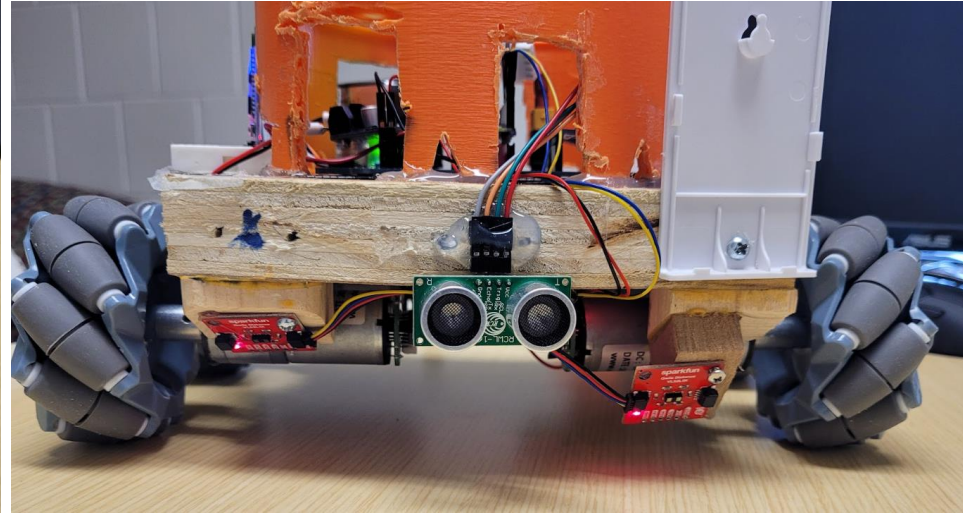
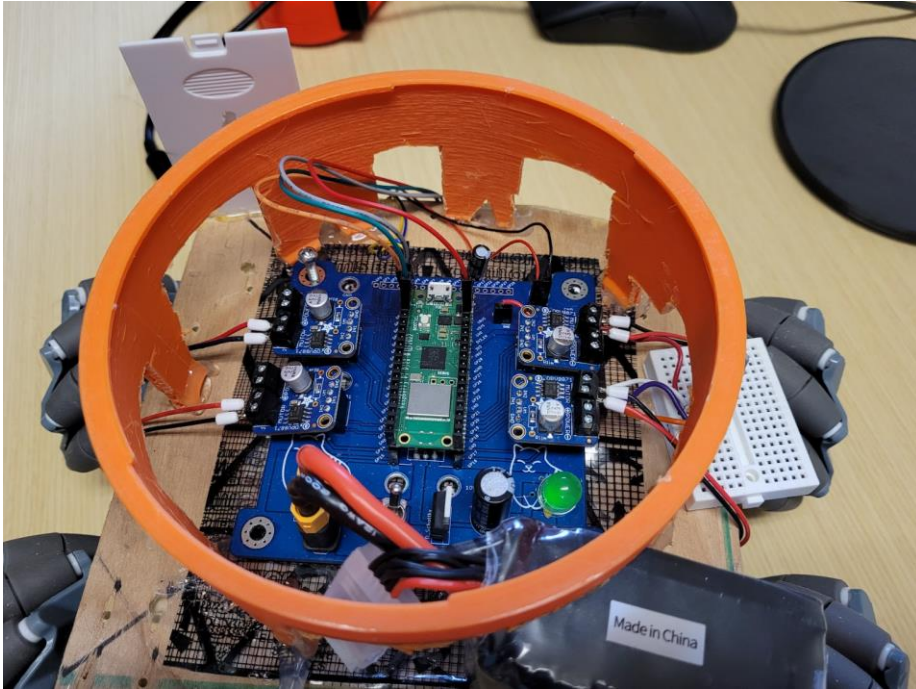
# Coaster



# Coaster: MDR

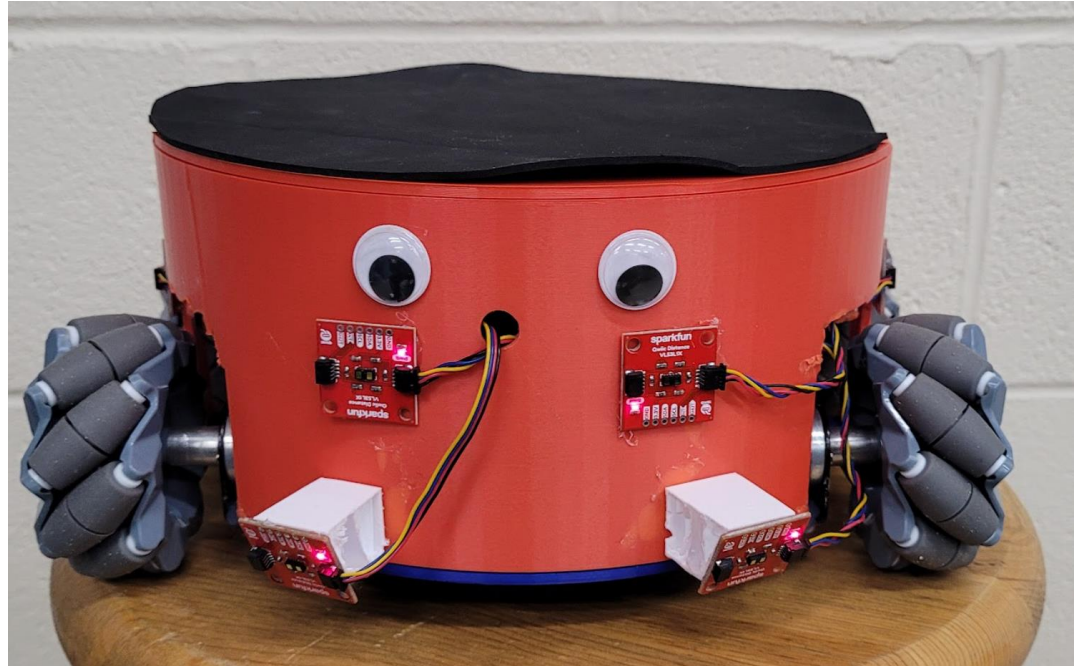
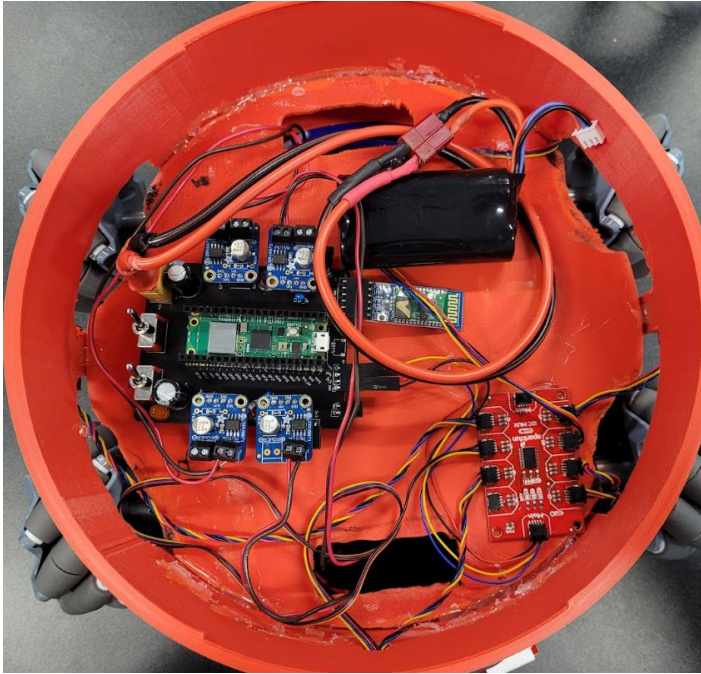


# Coaster: CDR



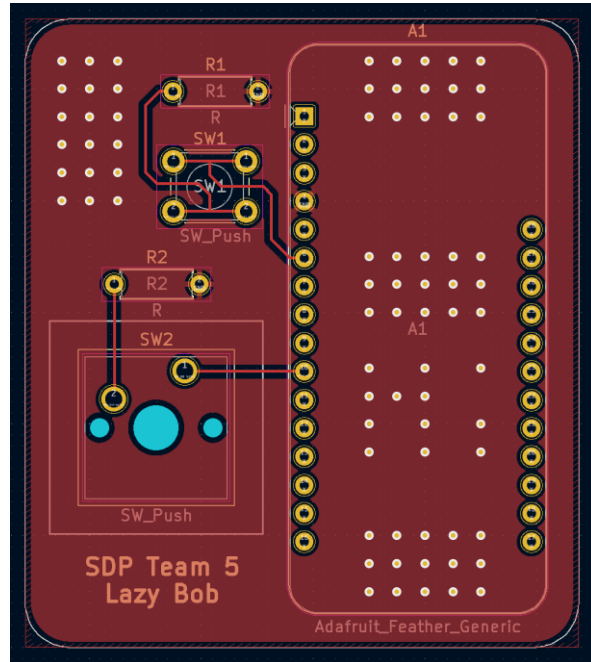


# Coaster: FPR

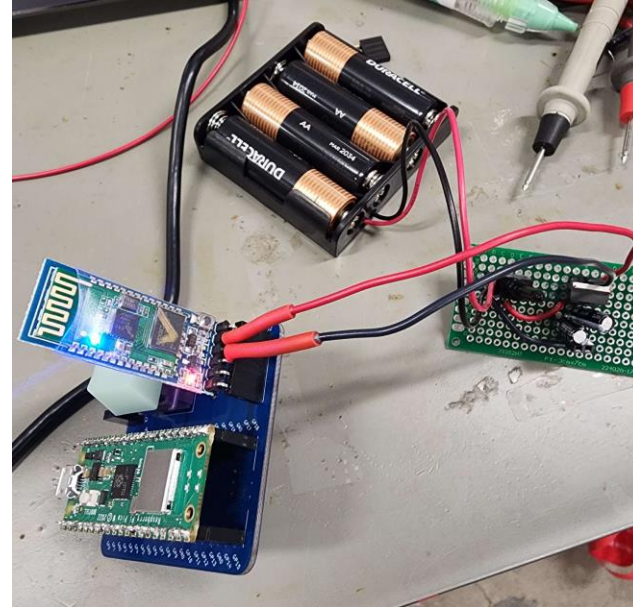
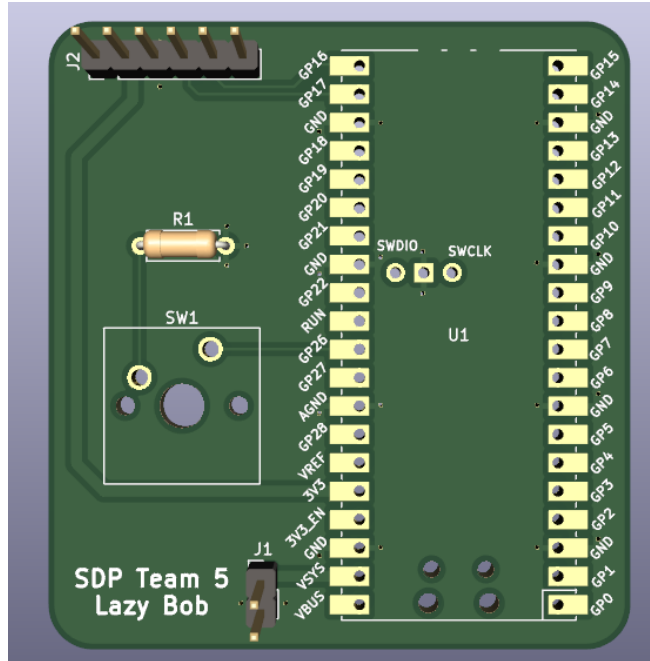


# Callers

# Callers: MDR

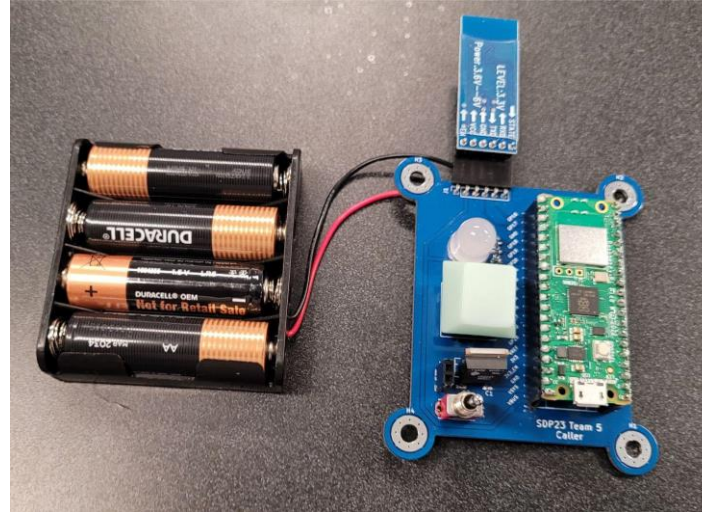
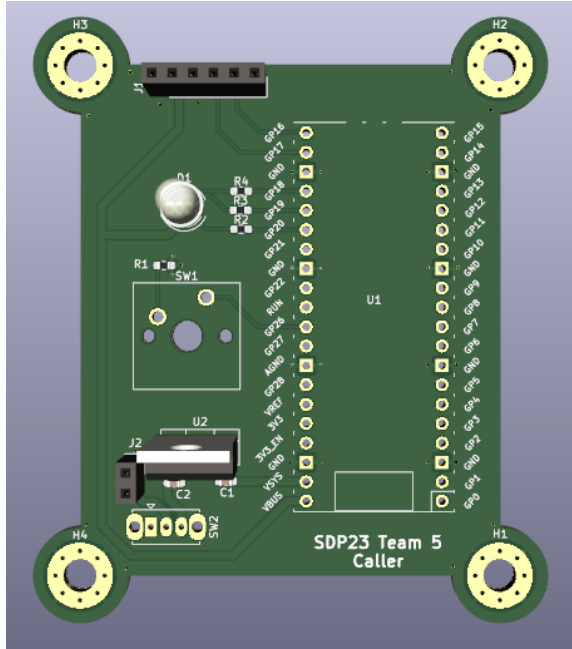


# Callers: CDR





# Callers: FPR



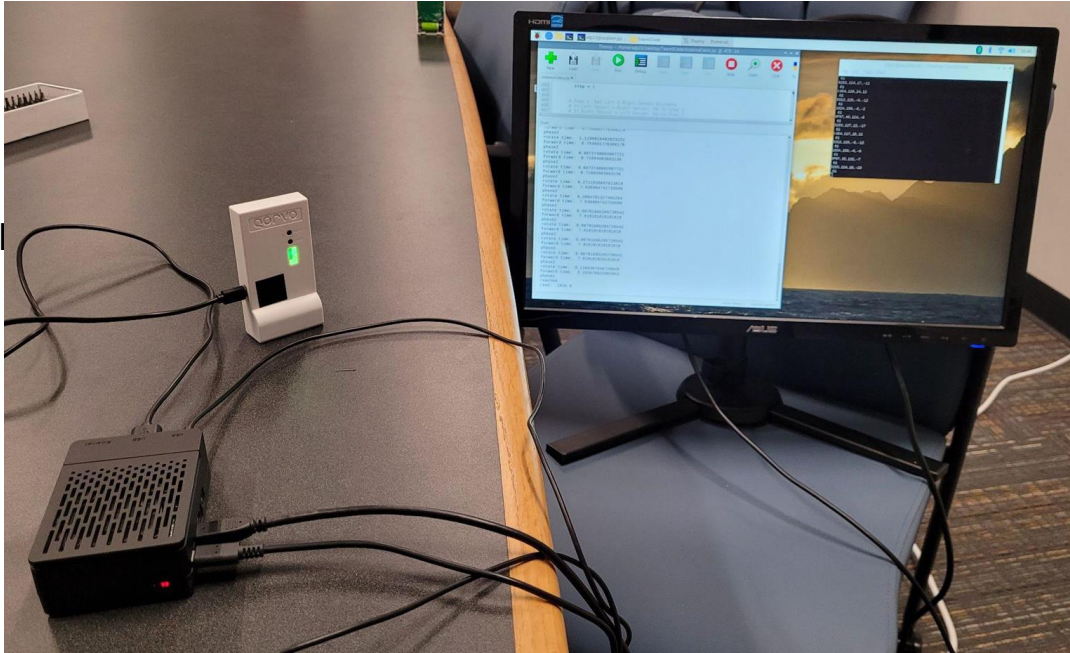
# Callers: Multiple Implementation

- Only 1 caller may request the coaster at a time
  - All other calls are ignored when in use
- LED color signifies current status
  - Green = Ready
  - Blue = On The Way
  - Red = Busy



# The “Brains”

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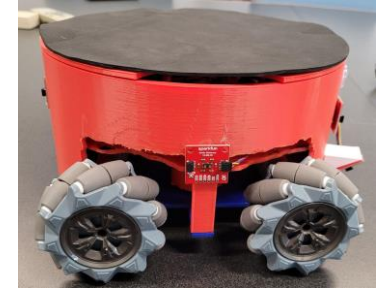
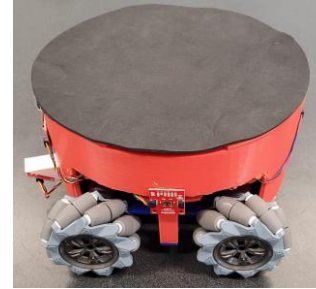
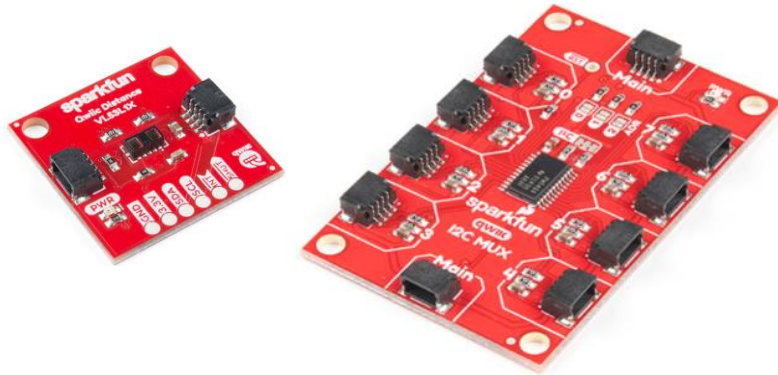


# Sensors



# Sensors: Collision and Cliff Detection

- **Light ToF**
  - Edge Detection
  - Collision Detection
  - Easy to implement many at a time





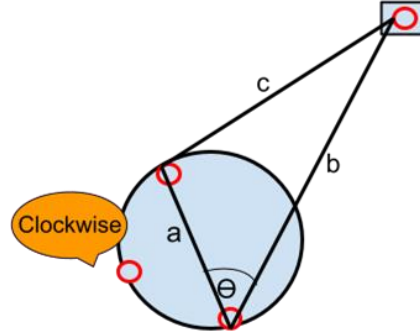
# Positioning and Rerouting

# Positioning: Ultra-wideband



```
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
```

$$\cos(\Theta) = (a^2 + b^2 - c^2) / (2ab)$$



# Rerouting Algorithm

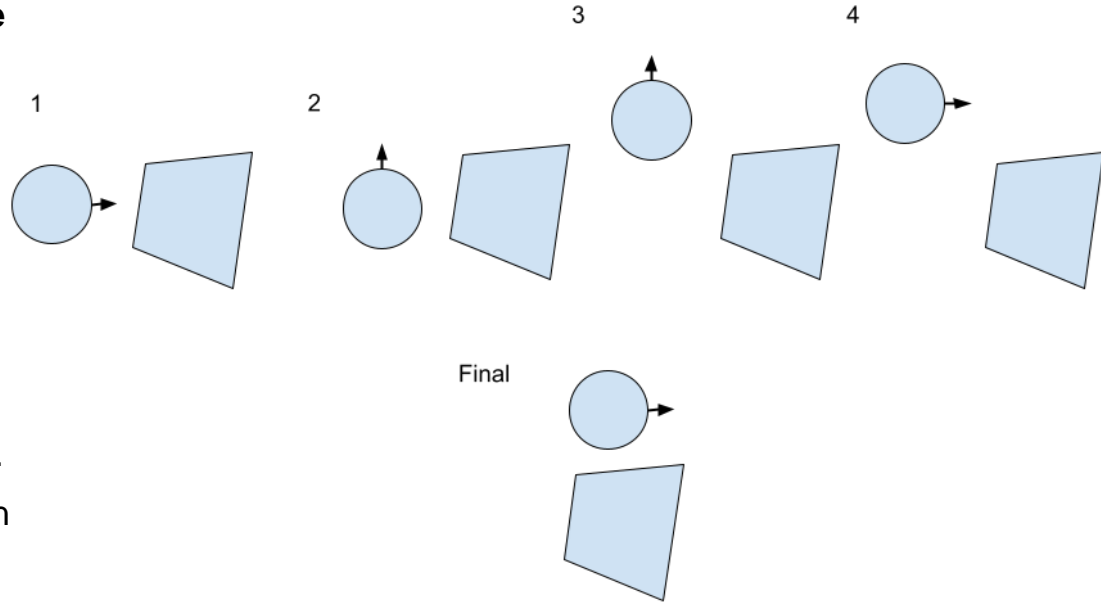
## CDR Implementation: Brute Force Avoidance

Lazy Bob will back up, make a step to a side, then move forward again and check whether it has cleared the object. This will repeat if not TRUE.

## FPR Implementation:

Lazy Bob will detect object and make a decision on which way to turn based on the greater distance of its two forward facing distance sensors. It will then turn to that side and scan along the object facing side as it moves forward.

Once there is clearance, the Lazy Bob will return back to its original orientation and proceed forward a step before calculating angle.



# Costs

# SDP Budget Used

Obtained List		
Item Name	Source	Price \$
UWB DIY Starter Kit	<a href="#">Link</a>	\$74.98
2 x Pico W	Wouter	\$12.00
Caller PCB1	Wouter	\$22.05
6 Dof Sensors	Amazon	\$15.95
New Wheels	Adafruit	\$28.17
Coaster PCB1	JLC	\$6.50
Coaster PCB2	JLC	\$6.76
10 x HC05	Amazon	\$37.98
Caller PCB2	JLC	\$15.44
3D Filament	Amazon	\$38.99
VL531x	Sparkfun	\$113.81
FPR PCBs	JLC	\$27.84
LiPo Battery	amazon	\$24.99
Wheels	amazon	\$44.99
3D Filament	Amazon	\$24.99
Motors	Amazon	\$43.56
\$539.00		

# Production Cost - for 1 Brains, 1 Coaster, and 2 Callers

Mass Production List			
Item Name	Units	\$ Unit Price	\$ Item Total
UWB Sensor	10	\$15.00	\$150.00
VL53L1X (Sensor)	7	\$3.30	\$23.10
Pico W	4	\$6.00	\$24.00
HC-05 (BLE Module)	4	\$2.38	\$9.52
Coaster Chassis	1	\$35.00	\$35.00
Caller Chassis	2	\$7.00	\$14.00
Wheel	4	\$3.00	\$12.00
PCB	3	\$1.00	\$3.00
7.4V LiPo	1	\$5.00	\$5.00
MUX	1	\$0.60	\$0.60
Motor	4	\$0.24	\$0.96
Cables	Misc.	\$5.00	\$5.00
System Total:			270.62



# Reminder of FPR Deliverables



## 1. Improved Consistency on Movement

- a. Move movement controls to the coaster itself for better consistency



## 1. Better Rerouting Algorithm

- a. Using more sensors, implement a better way to navigate



## 1. 2nd Caller



4.

## Chassis for Coaster

- a. 3D print chassis for each part of the system



5.

## Updated PCB

- a. Motion - Further optimizations
- b. User input - Add 5V and LED



Demo + Q&A

# Videos

## **Straight Shot & Edge Detection & Button Colors & Button Locking:**

[https://drive.google.com/file/d/1MCR\\_ZY55AZKxfdinNN-QkkkYKjTHUI0m/view?usp=share\\_link](https://drive.google.com/file/d/1MCR_ZY55AZKxfdinNN-QkkkYKjTHUI0m/view?usp=share_link)

## **Obstacle Avoidance:**

<https://drive.google.com/file/d/1MJIGTPBW8F-LTN8W8kColtyC7Dfij1dU/view?usp=sharing>

[https://drive.google.com/file/d/1MNN1SpP66sIA2yZz\\_bj1Dcg2ajXkuQTa/view?usp=sharing](https://drive.google.com/file/d/1MNN1SpP66sIA2yZz_bj1Dcg2ajXkuQTa/view?usp=sharing)