PDR

UMass Amherst
COLLEGE OF ENGINEERING

Lazy Bob - SDP23 Team 5

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The Team

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Movement and Power

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EE
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Design

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Software Lead
Sensors

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CompE
Logistic Lead
Positioning

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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

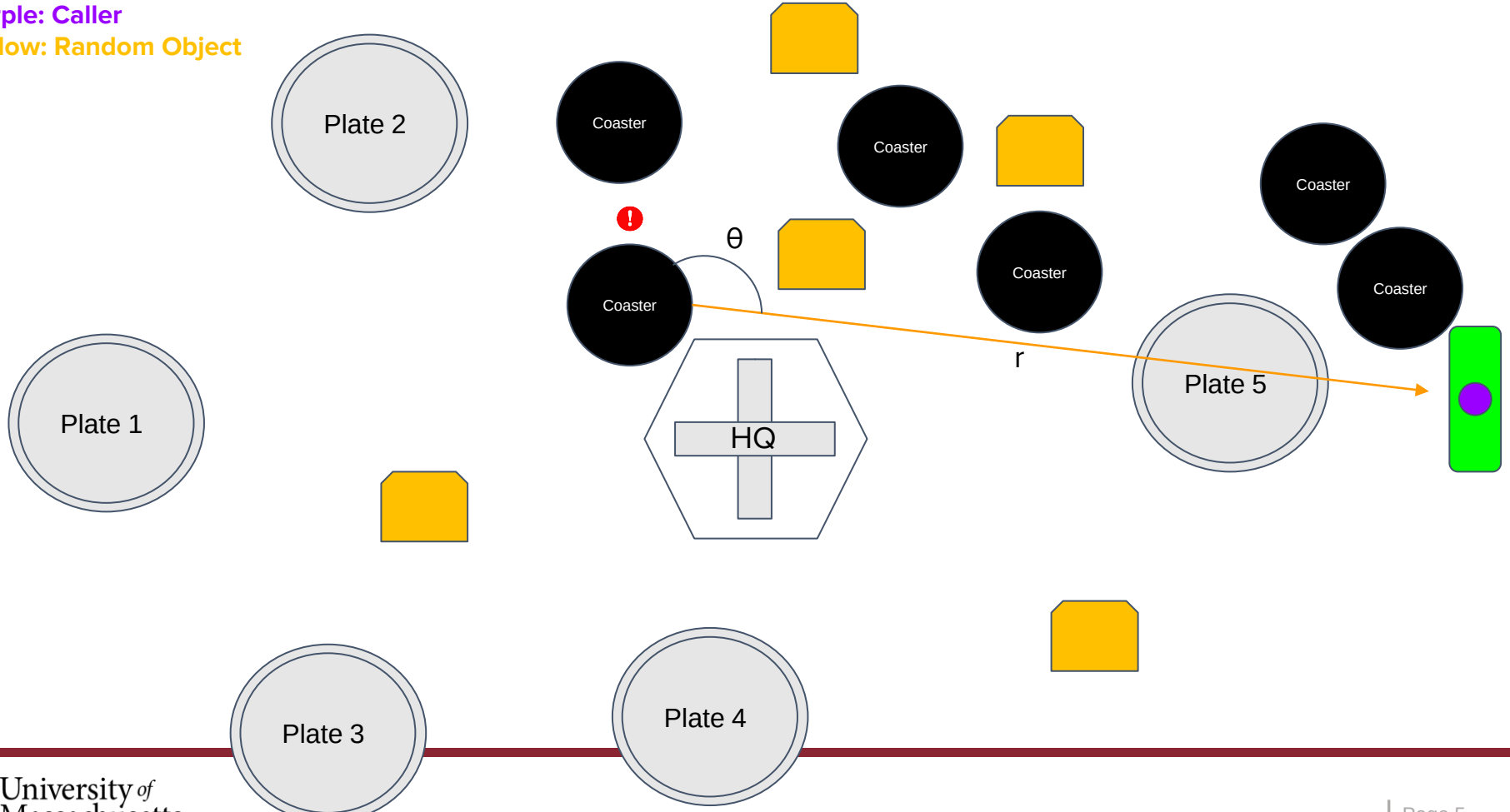
“Lazy Bob”: A moving coaster that approaches the user when called.

1. Stably transport items around a table to different users

1. Provide a simple way to interface with all coasters

1. Adapt to its environment

Purple: Caller
Yellow: Random Object



Similar Product: AirPorter

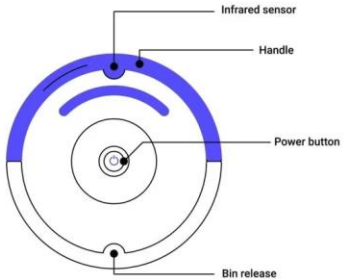
- Autonomous-driving capability that allows baggage to be delivered to the designated destination
- Obstacle avoidance capability with dynamic obstacle detection
- Size constraints, not sold commercially

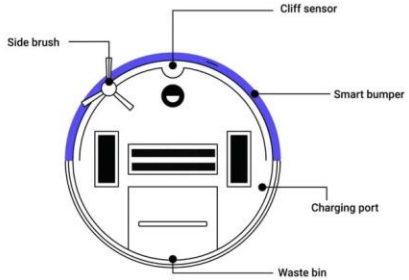
Similar Product: Starship Delivery Robot

- An autonomous device that carries items over short distances
- Uses twelve cameras, ultrasonic sensors, radar, neural networks, etc. to detect obstacles
- Uses computer vision and GPS for location

Similar Product: Robot Vacuums

- Collision avoidance
- Cliff detection
- They use image processing, sensors

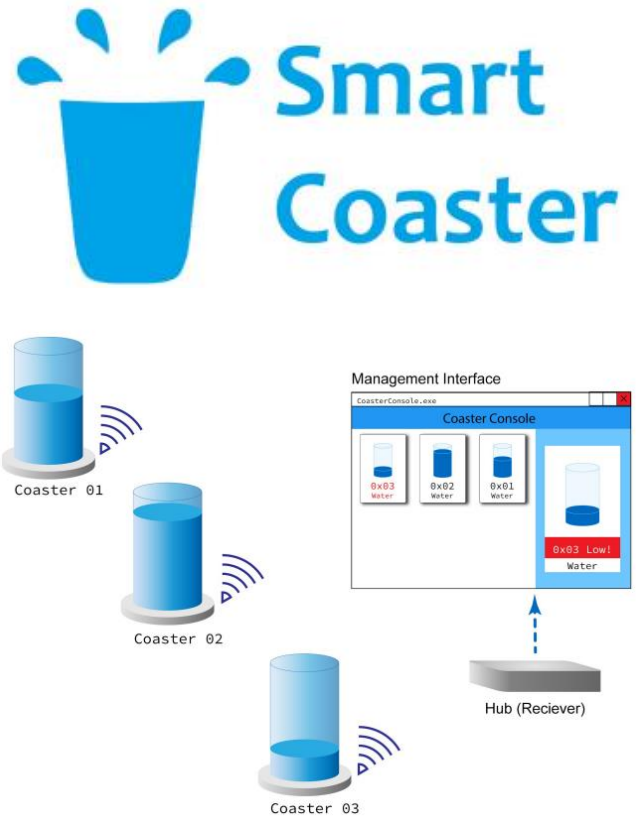




https://www.irobot.com/en_US/roomba-vacuuming/robot-vacuum-irobot-roomba-s9-plus/S955020.html
https://www.thezebra.com/resources/home/how-roomba-works/

Similar Product: Smart Coaster
(SDP 20 Team 16)

- A wireless coaster system that notifies wait staff when a customer's drink is almost empty
- Similarities: Wireless communication, rechargeable batteries
- Differences: Inanimate, different purpose



Similar Product: Comparison

	Movement	Transport	Rechargeable	Avoid obstacles	Avoid cliff	Size	Call to location	Cost
AirPorter								N/A
Starship								N/A
Robot Vacuums								
Smart Coaster								N/A
Lazy Bob								

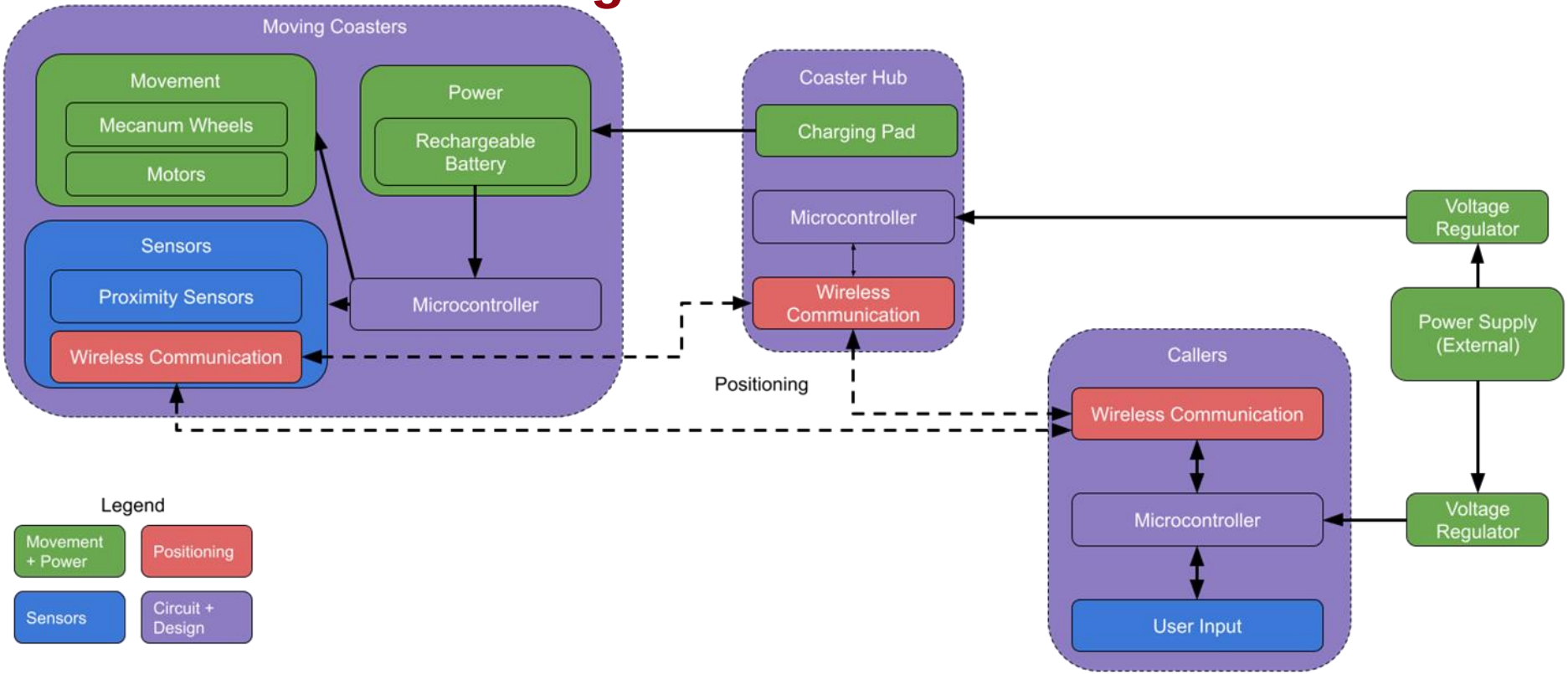
System Specifications: Functional

	Test Plan
1. Accelerate at a rate of 0.5 cm/s^2 towards the caller, up to 7 cm/s	1. Use a tape measure to check the distance travelled every second
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 it falls off when caller is away from the table
1. Avoid objects in its path and arrive at its destination	1. Put objects in path and check if it bumps into object
1. Support up to 3 lbs.	1. Place an object that weighs 3 lbs and check if system is stable while moving

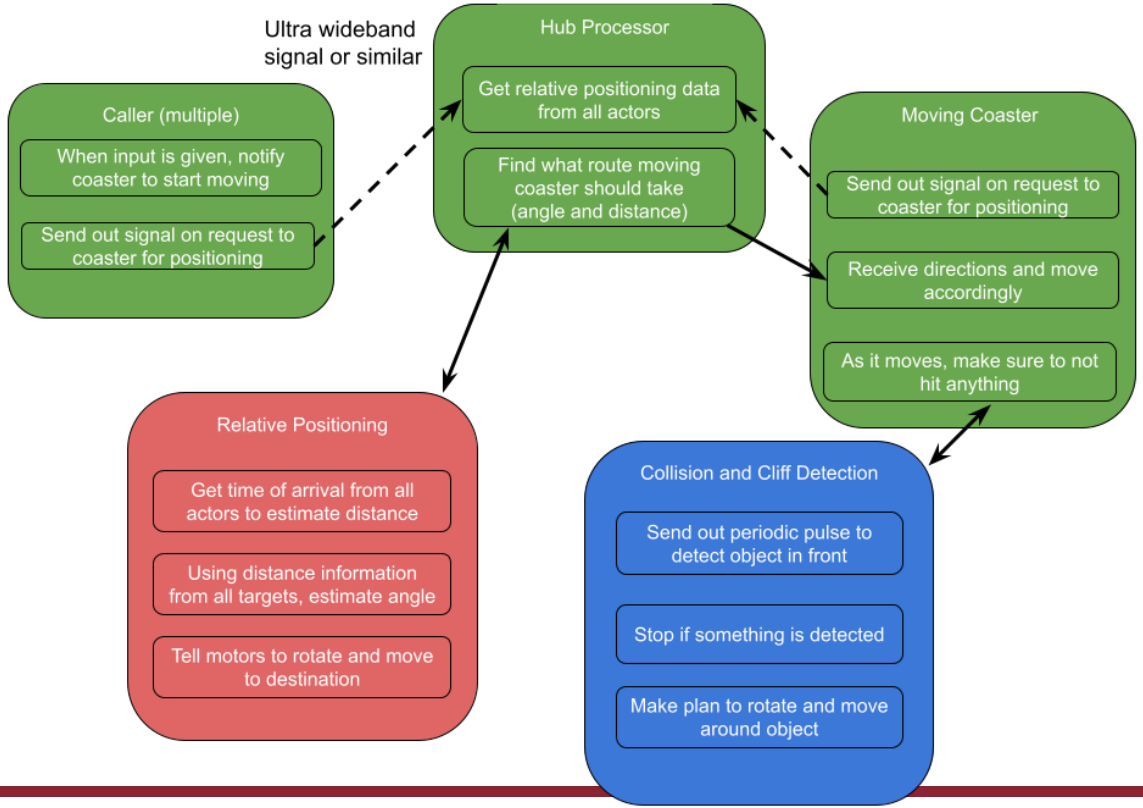
System Specifications: Design

		Test Plan
5.	Move back to its hub once determined not in use	5. Watch it move towards hub on a given signal
6.	System supports at least 2 coasters at the same time	6. Call both coasters on a collision course and see if they collide
7.	Coaster diameter is within 25 cm	7. Use tape measure
8.	Be able to use it regardless of table shape	8. Find and put on irregular shaped tables and check if they fall off
9.	If no path to caller is available, indicate to caller	9. Line up objects to allow no path to caller, see if system notifies caller

Hardware Block Diagram



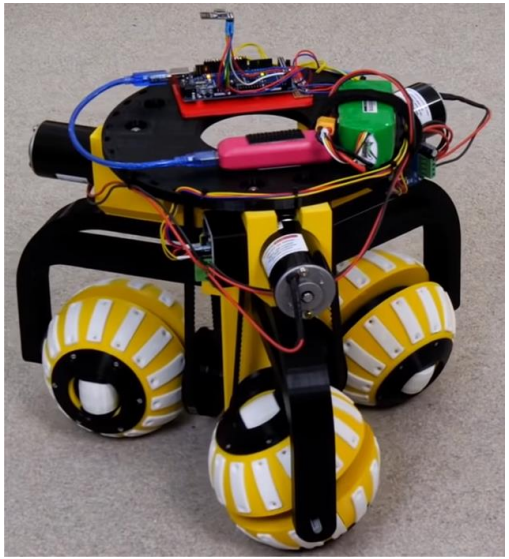
Software Block Diagram



Subsystem: Motion

Requirements:

1. Omnidirectional
2. Precise



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https://www.amazon.com/Drift-Metal-Accessories-Compatible-Wltoys/dp/B08YYR7FSY
https://www.cgtrader.com/3d-models/vehicle/industrial-vehicle/continuous-track

Subsystem: Motion

Requirements:

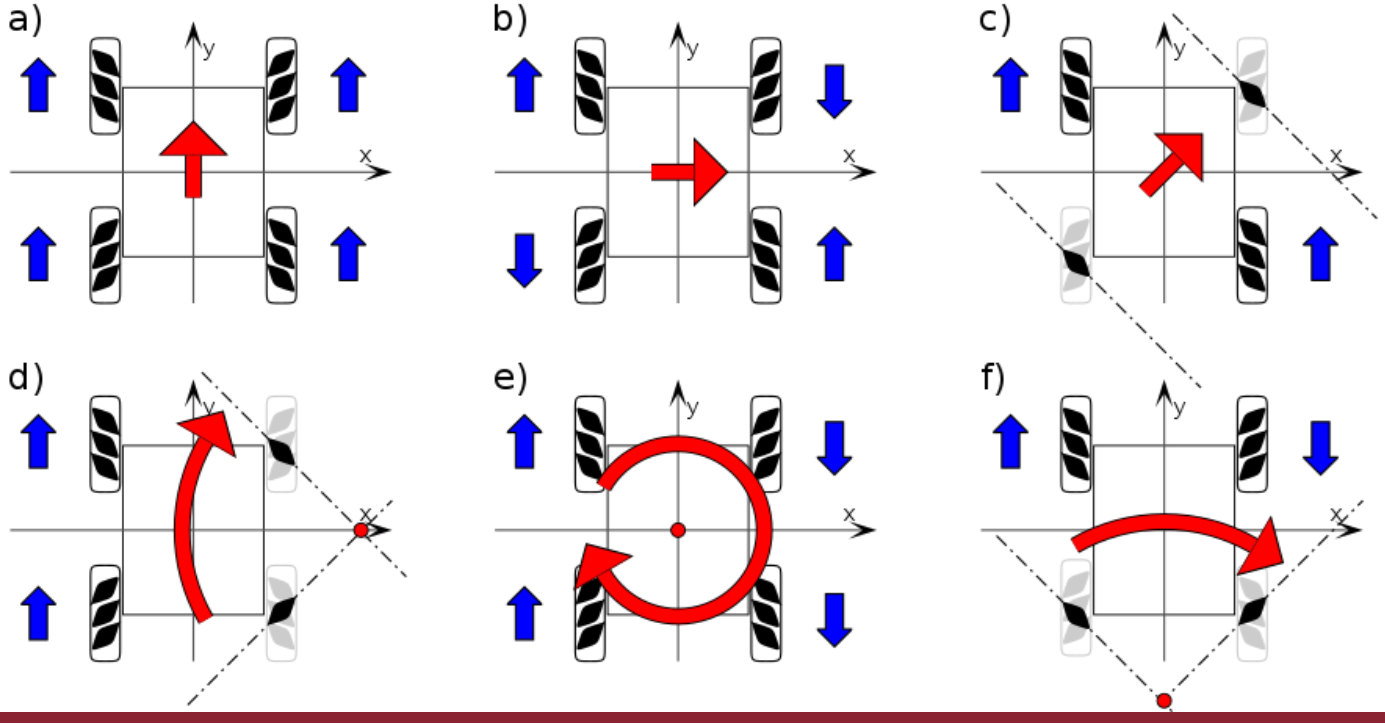
1. Omnidirectional
2. Precise

Plan:

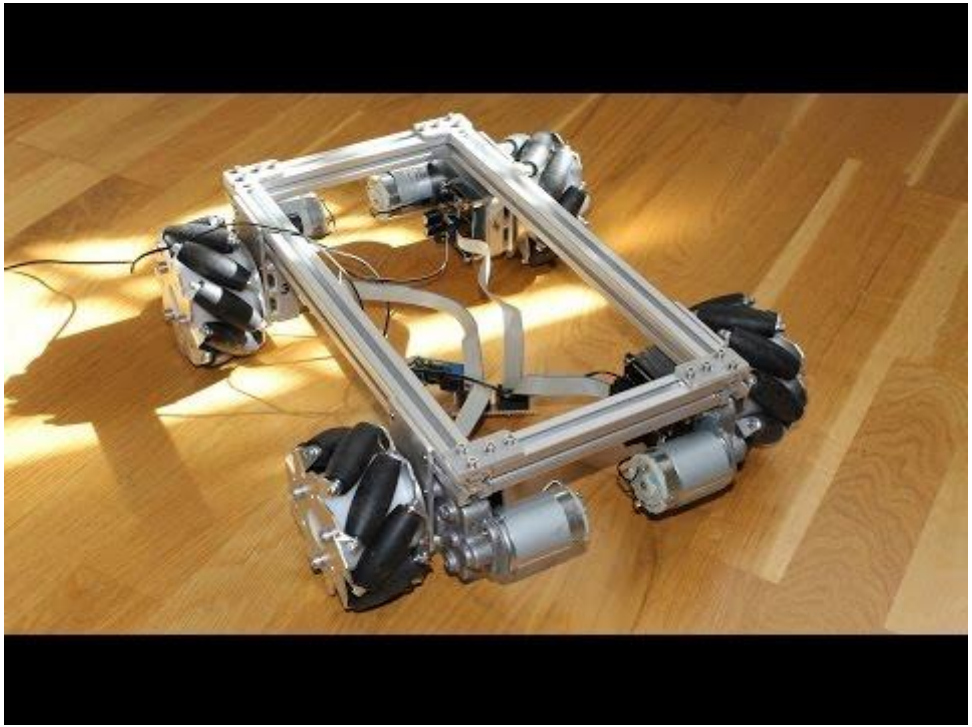
1. Motor: 4x Stepper Motors
2. Wheels: 4x Mecanum Wheels

https://www.andymark.com/products/10-in-mecanum-wheel-set-steel-body-6-hole-bore
https://www.digikey.com/en/products/detail/dfrobot/FIT0278/6588458

Subsystem: Motion

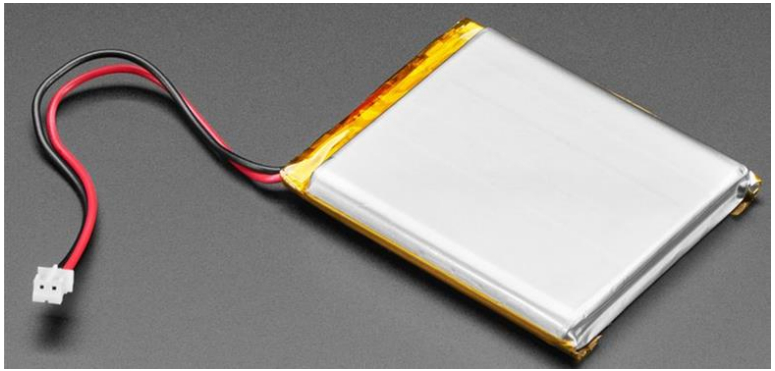


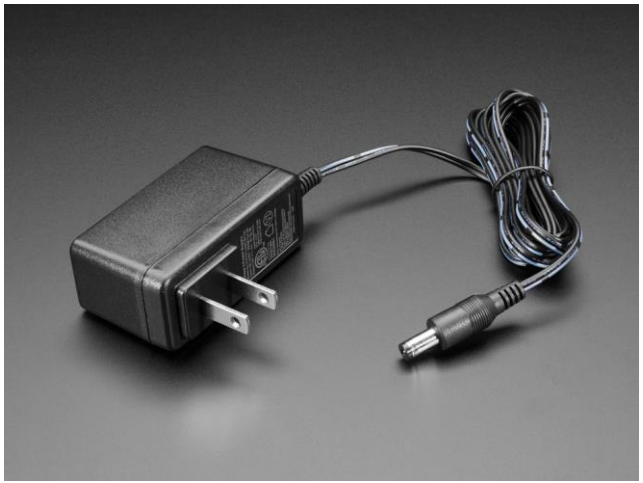
Subsystem: Motion



Subsystem: Power

- **Lithium-ion batteries**

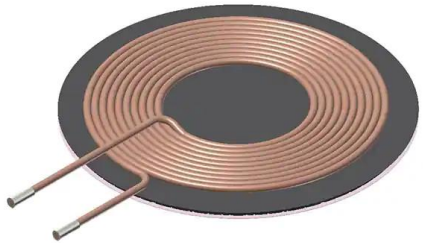




https://www.adafruit.com/product/328
https://www.adafruit.com/product/798

Subsystem: Charging

- **Connection**
  - Pogo/Magnetic Pins
  - Wireless



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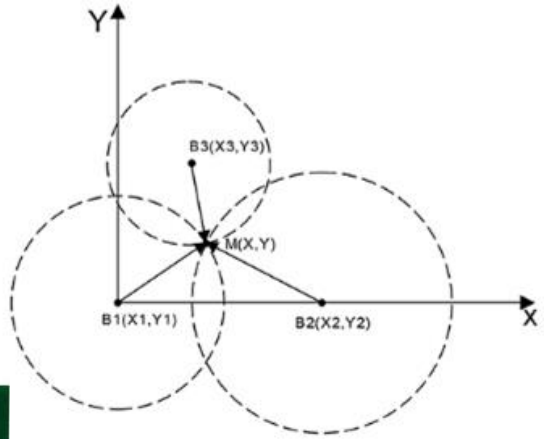
https://pogopin.net/

Subsystem: Relative Positioning

- **Triangulating relative position**
  - Coaster, Hub, Active and Inactive Caller
- **Ultra Wideband Sensor**
  - Time of arrival
  - High precision at small ranges



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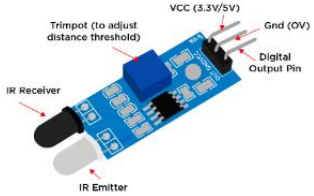
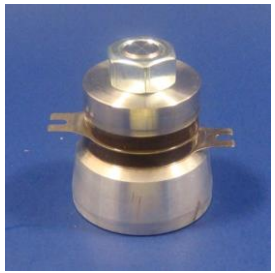
https://www.tindie.com/products/petteemfg/ultra-wideband-rtls-uwb-diy-starter-kit/#specs
https://www.frontiersin.org/articles/10.3389/fnbot.2022.715440/full

Subsystem: Collision and Cliff Detection

- **Piezoelectric**
  - Calibration
- **Ultrasonic**
  - Distance measurement
- **Photocell/Infrared**
  - Cliff Detection & Collision Detection
- **Stretch Goal: Optic Sensors**
  - Mapping





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https://www.americanpiezo.com/piezo-theory/whats-a-transducer.html
https://www.sparkfun.com/products/retired/12907

Estimated Cost

Item	Quantity	Price per	Total
MCU	6	$ 8.00	$ 48.00
UWB sensor	6	$ 17.00	$ 102.00
PCB	4	$ 25.00	$ 100.00
Motors	10	$ 7.60	$ 76.00
Wheels	9	$ 4.50	$ 40.50
Battery and Charging	3	$ 15.00	$ 45.00
Collision Sensors	5	$ 7.15	$ 35.75
Cliff Detection Sensor	3	$ 5.00	$ 15.00
Input Device	6	Owned	$ 0.00
Total			$ 462.25

MDR Deliverables

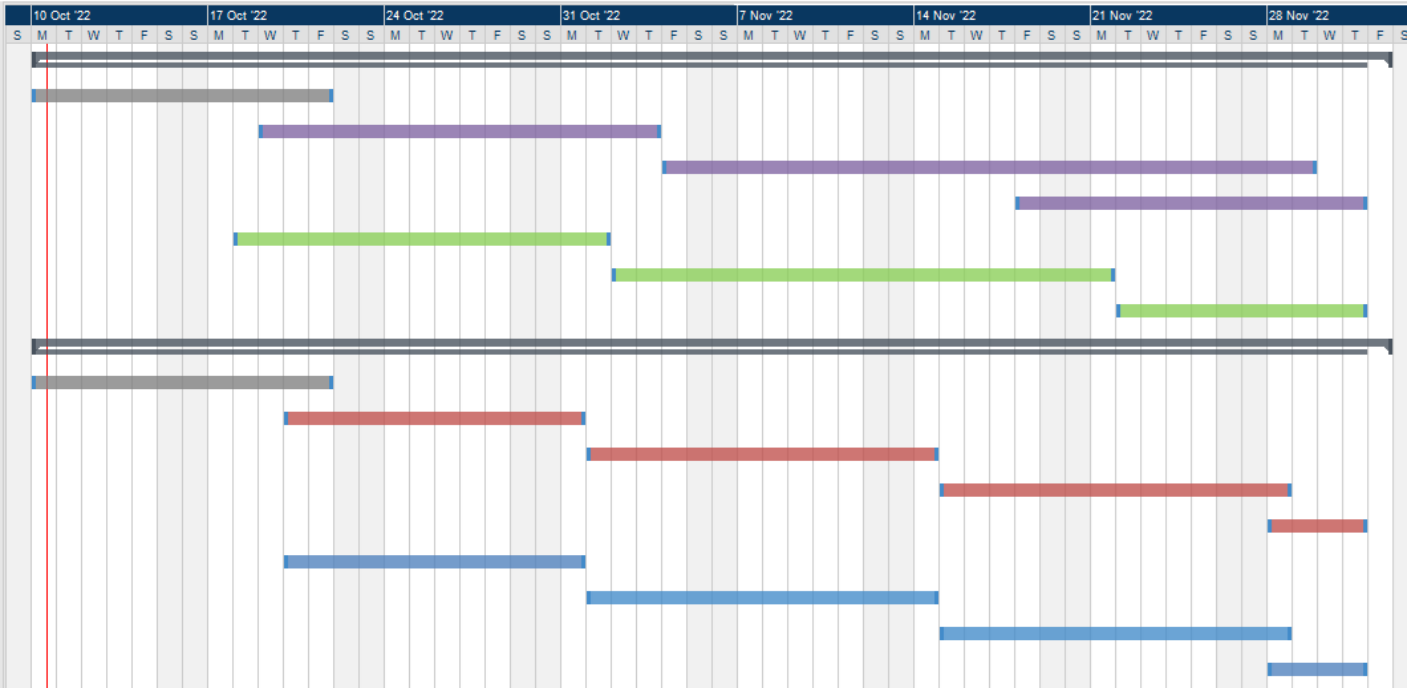
- **1 Moving Coaster**
  - Moves properly and accurately
  - Accurately detects positioning
  - Goes to location when called
  - Can detect if an object is in the way
- **2 Callers**
  - Can send signal to coaster and hub
- **1 Charging Hub**
  - Can send signal to coaster and callers
  - Potentially charges system
- **Plans for PCB**
  - Motor Pins
  - Microcontroller
    - Sensors
    - Communication
    - User input method

Gantt Chart

Legend

Jina | Omar | Redwan | Soham | Everyone

	Task Name
1	**Hardware**
2	Select and get materials
3	Breadboard circuit
4	Design and build chassis, hub, caller
5	PCB
6	Set up wheels and motors w/ code
7	Battery Power
8	PCB
9	**Software**
10	Get sensors and look at starter code
11	UWB: get signal between 3 sensors
12	UWB: Triangulate position of all sensors
13	UWB: Translate signal to motor movement
14	Debug
15	IF: Get signal from sensor
16	IF: Collision Detection
17	IF: Cliff Detection
18	Debug



QUESTIONS & ANSWERS

University of Massachusetts Amherst