



Talaria Robotics

Mail Delivery System

4/25/2025

Final Technical Presentation

Agenda



- **Introduction**
- **Project Overview**

Conceptual Block Diagram

Functional Block Diagram

- **Design Details**

Software Design

Electrical Design

Mechanical Design

- **Testing Plan**
- **Current Progress**
- **Next Steps**



Talaria Robotics

Introduction

The Team



Dr. Logan Porter
Sponsor & Advisor



Anna Wagner
Project Manager
Class of 2025



Joshua Askharoun
Software Engineer
Class of 2025



Zach Plyler
Mechanical Engineer
Class of 2025



Bianca Youlton
Test Engineer
Class of 2025



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Project Overview

Problem Statement

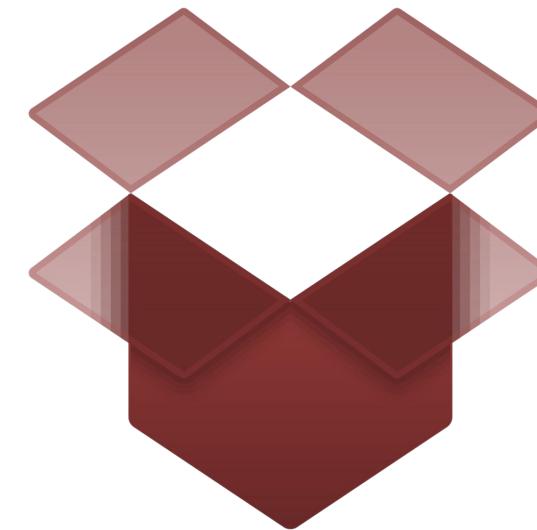


Trips to the mailroom can quickly become tedious and time consuming. Office mail rooms can quickly become overloaded with mail, increasing the chance of smaller packages and files getting overlooked.

Recommended Solution



A lightweight autonomous mail delivery robot with a clean and professional design capable of delivering mail in a typical office environment.



Implemented Solution



Key Deliverables and Requirements



Deliverable	Technical Requirement
Mail storage	<ul style="list-style-type: none">• Max package size of 15" x 11" x 10" (L x W x H)• All folders will be letter size, 9" x 11", or smaller• Combined weight of packages and folders will not exceed 15 pounds
Battery-powered	<ul style="list-style-type: none">• Rechargeable• One hour of non-continuous operation per day
Obstacle avoidance	<ul style="list-style-type: none">• Avoid static and dynamic obstacles• Stops if an object is within 6 inches
Easy-to-use touchscreen UI	<ul style="list-style-type: none">• Responsive when touched• Touchscreen UI is clearly labeled
Autonomous navigation	<ul style="list-style-type: none">• Indoor navigation only• Programmable route
Chassis	<ul style="list-style-type: none">• Mail is secured• Robot volume will not exceed 24" x 28" x 24" (L x W x H)

Assumptions:

- Everyone acts in good faith (no theft or vandalism)
- Indoor-only operation
- Space can be mapped ahead of time
- Operation is limited to a single floor
- Doors are open

Out-of-scope:

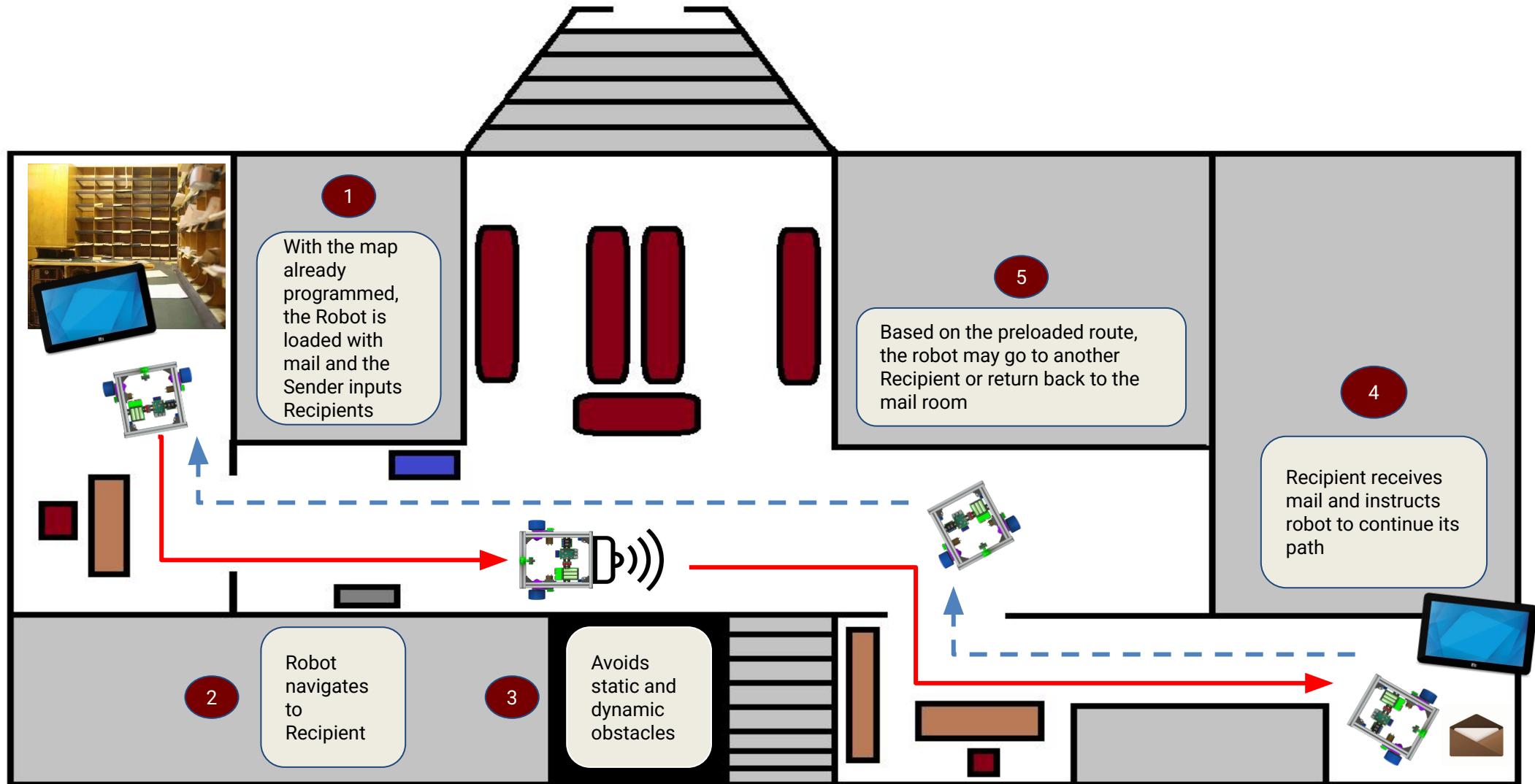
- Protection from weather
- Any kind of security system
- Multi-floor navigation
- Transporting of excessively large or heavy packages



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Conceptual Block Diagram

Conceptual Block Diagram





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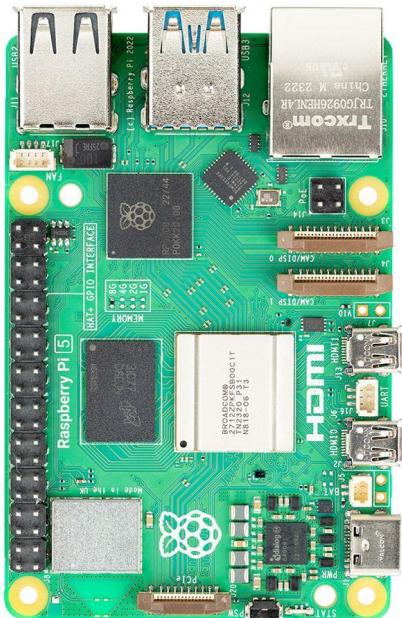
Functional Block Diagram

A Tale of Two Cities



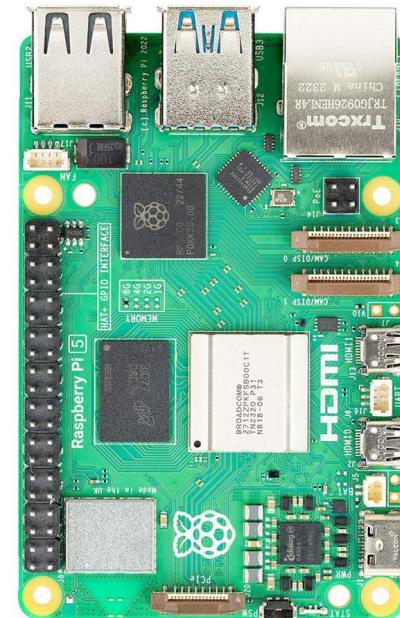
Control Panel

Primary interface between the user
and the robot



Navigator

Brains of the SCUTTLE, which all
navigation sensors are connected to

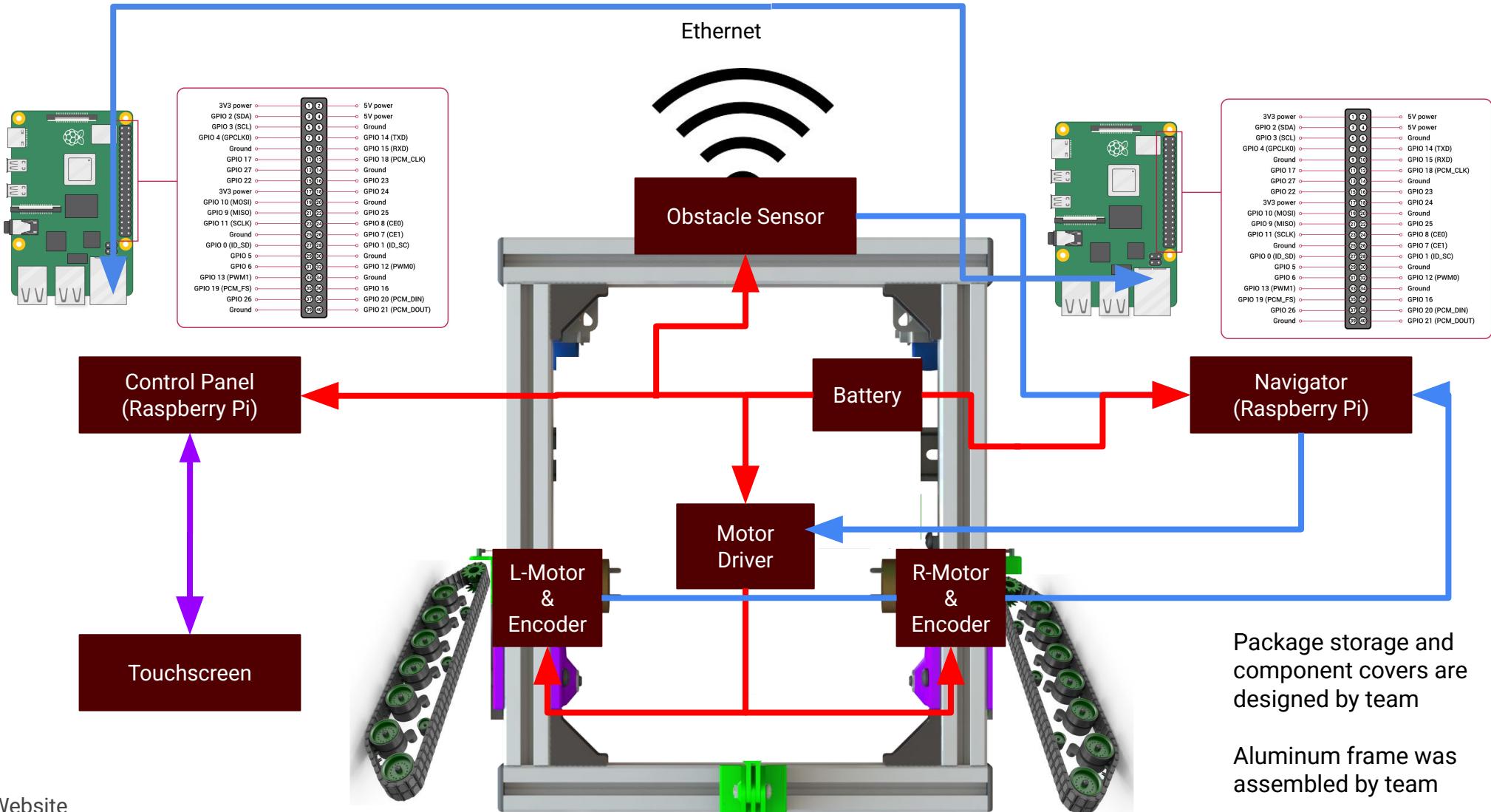


High-Level FBD

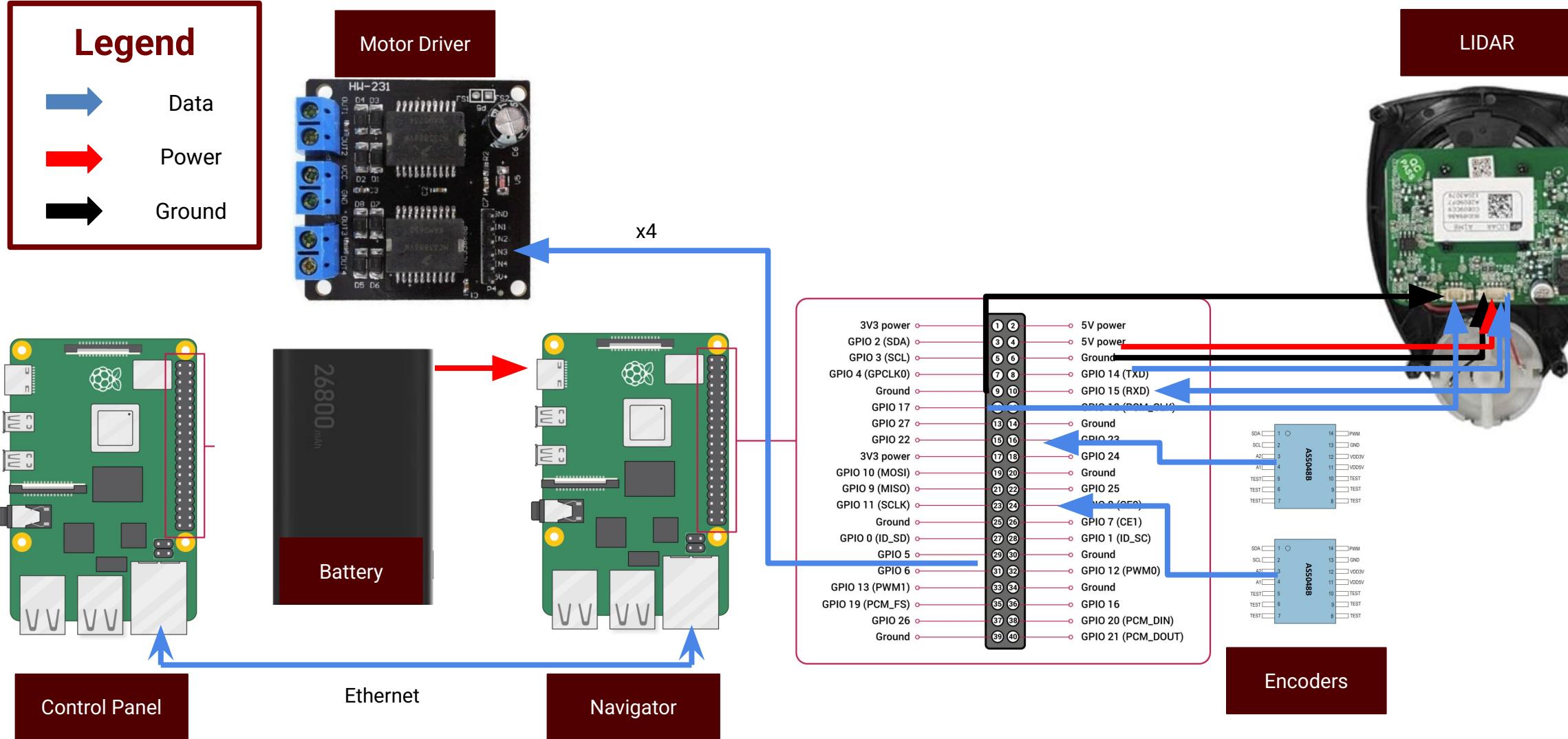


Legend

- Data
- Power & Ground
- Both



Connection Details - Navigator

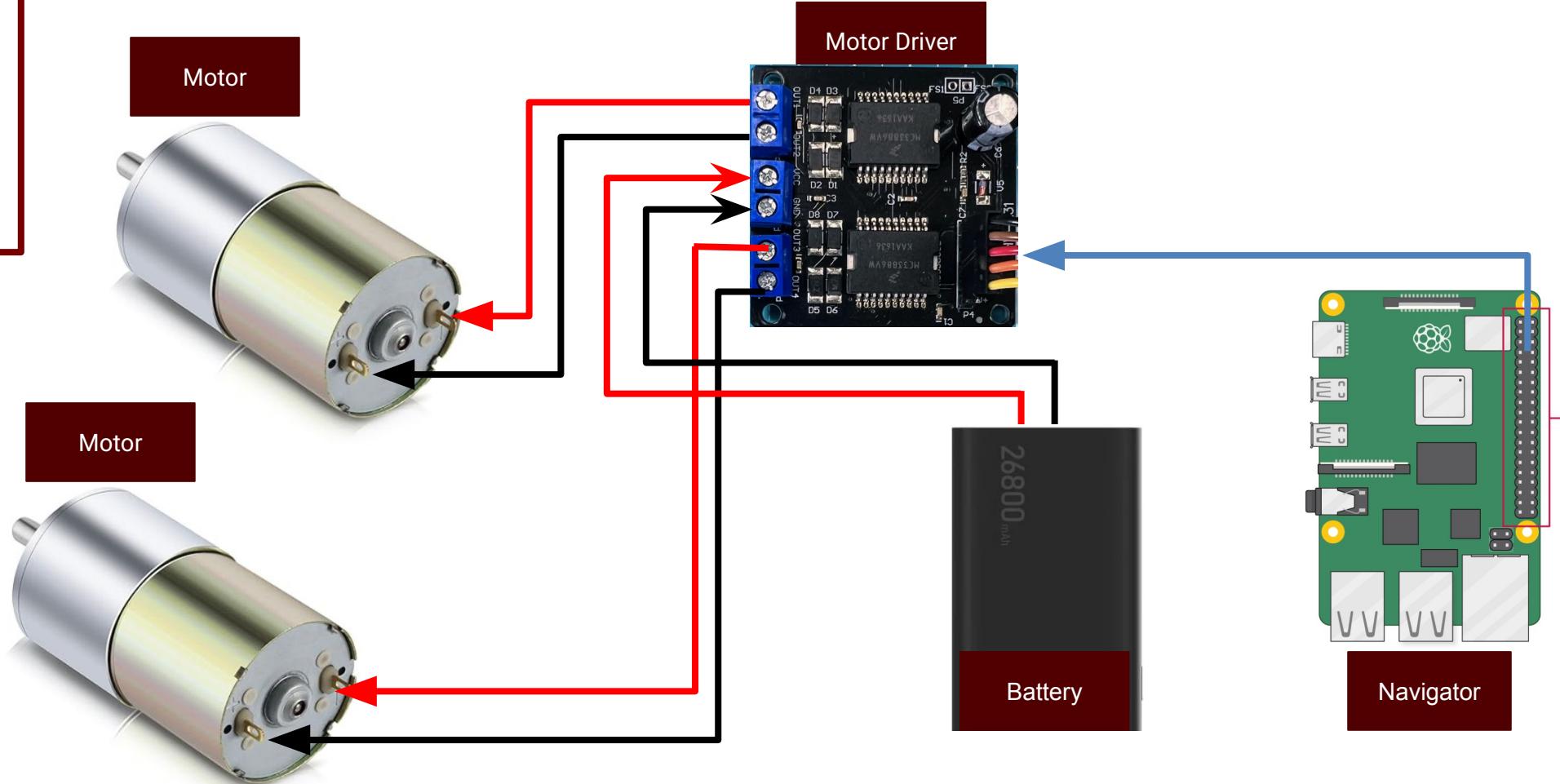


Connection Details - Motors

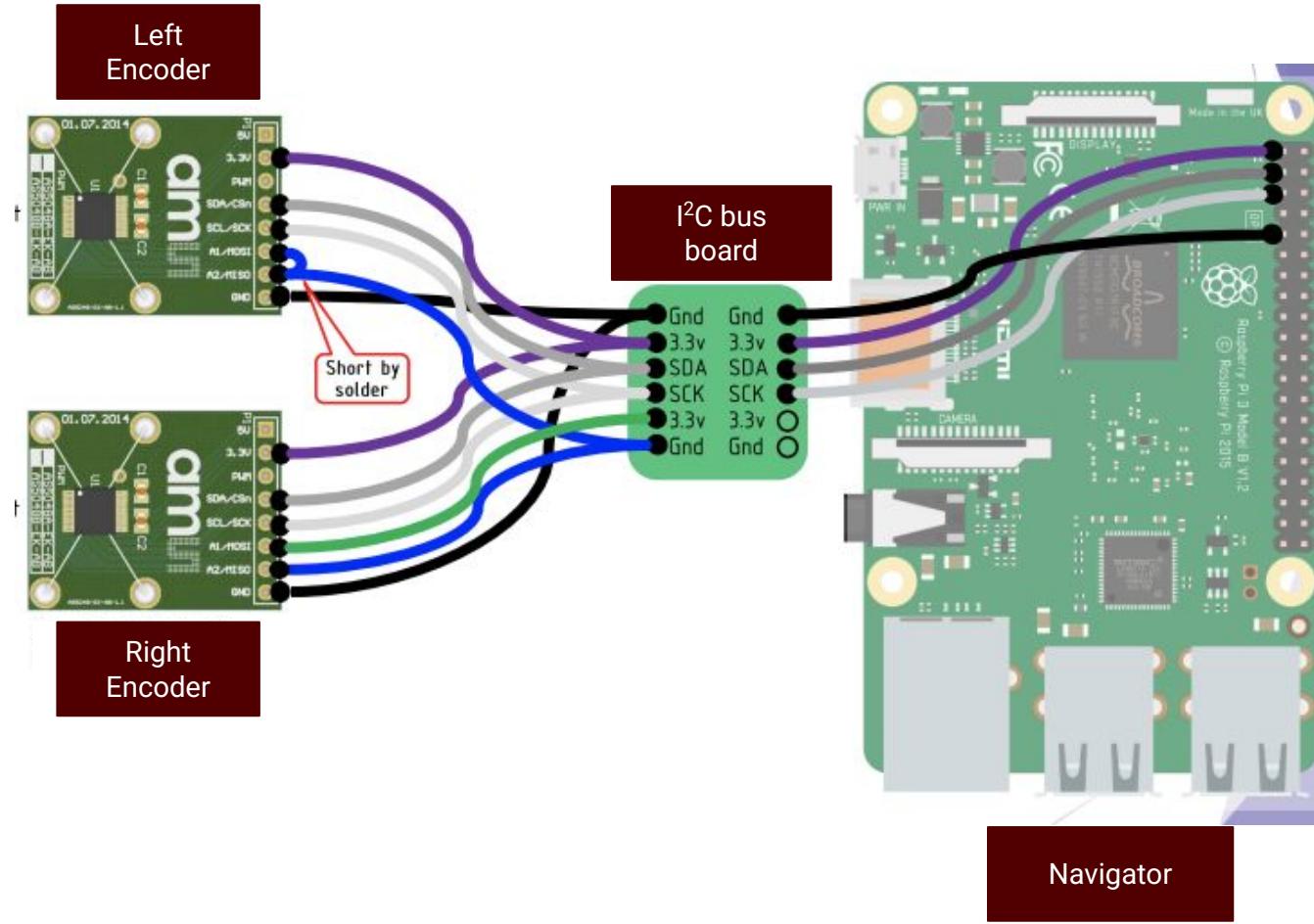


Legend

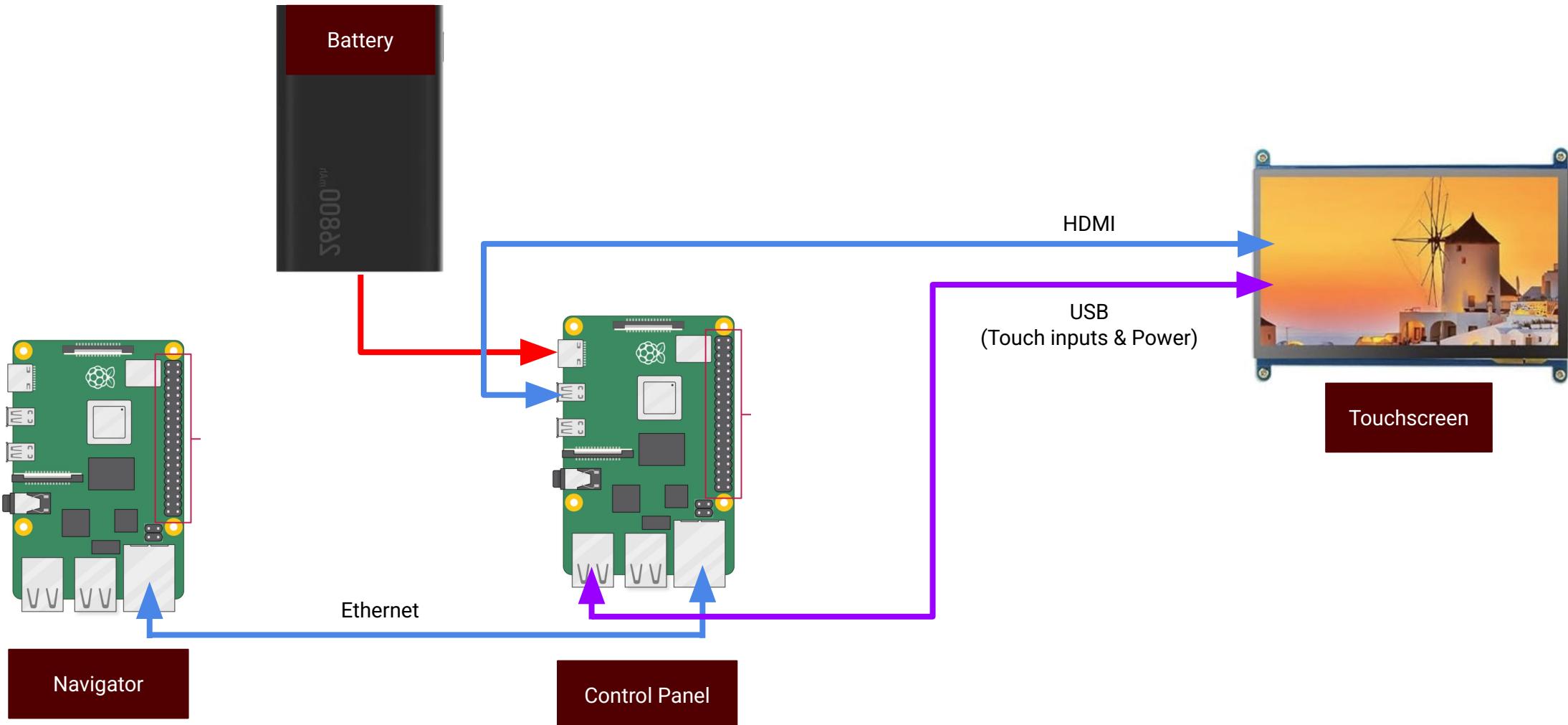
- Data
- Power
- Ground



Connection Details - Encoders



Connection Details - Control Panel





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Design Details



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Material Selection

Electrical Components



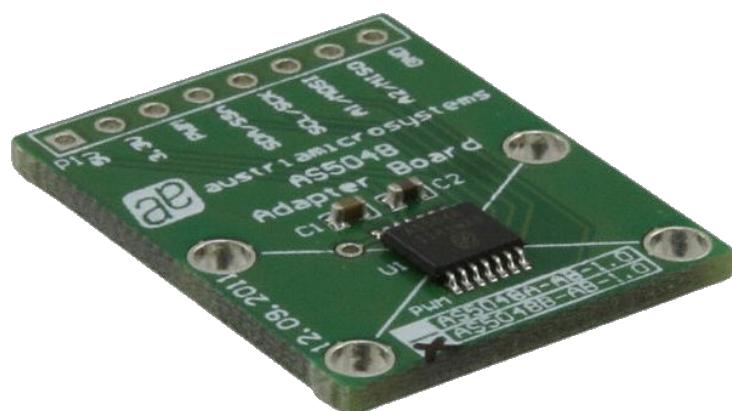
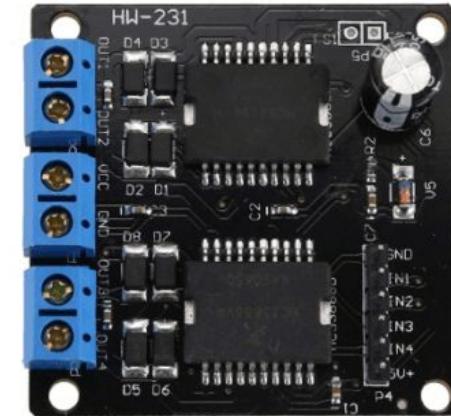
- **j5create USB-PD 65W Power Bank**
4 ports, 26800mAh, 4.45 in x 2.77 in x 1.65 in, 18 oz
- **Raspberry Pi Model 4B**
2 units, one 2 GB and one 4 GB
- **Elecrow RC070 Touchscreen**
7" diagonal, capacitive touch, 1024×600 LCD
Switched from 4D Systems due to driver requirements
- **RPLIDAR A1M8**
360° sweep up to 12 meters



Electrical Components (cont.)



- **HW-231 Motor Driver**
60 W maximum per channel @ 12 V, 5 A
- **Greartisan Motors with Gearbox**
12 V, 200 RPM
- **AMS5048B Encoder**
2 units, 14-bit rotary position sensor



Mechanical Components



- **3030 T-Slot Aluminum**
- **PLA Filament**
- **Cast Acrylic Sheets**

1/4" for load bearing areas

1/8" for all other uses

- **Off-the-shelf Parts:**

File organizer

Acrylic hinges

T-slot hardware

Threaded heat-set inserts

Tank treads and related components

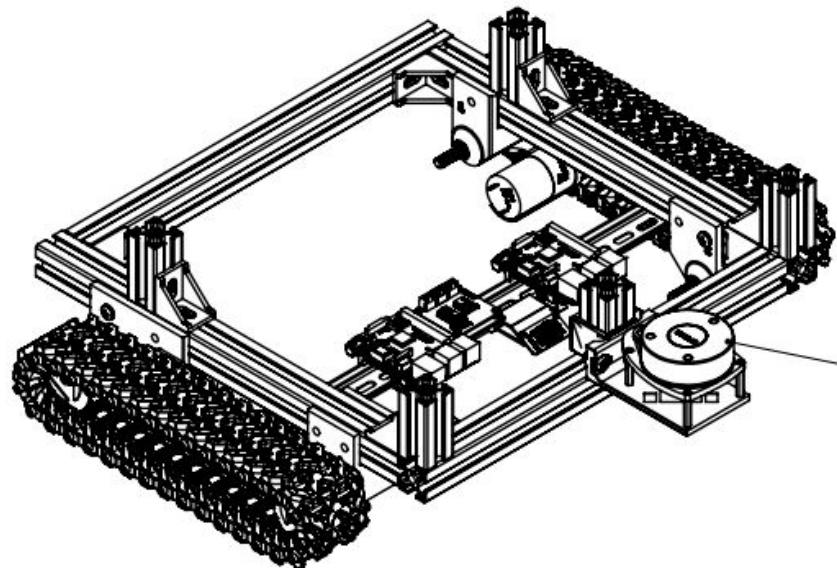




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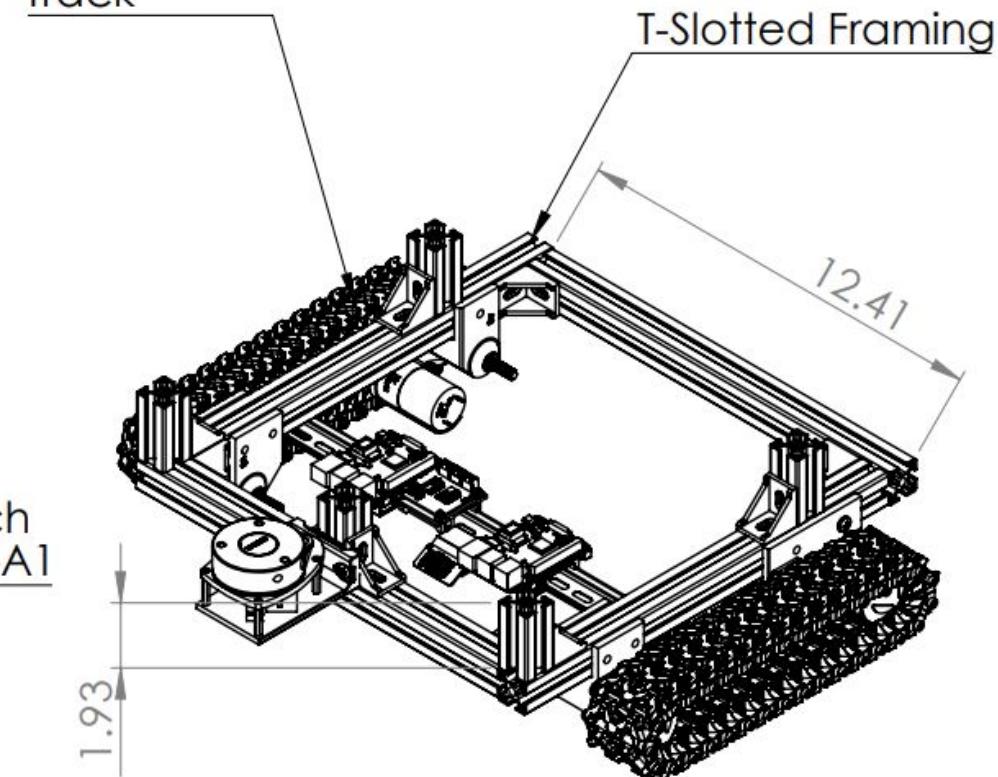
Mechanical Design

Mechanical Assembly

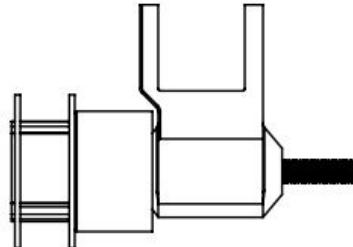


Slamtech
RPLidar-A1

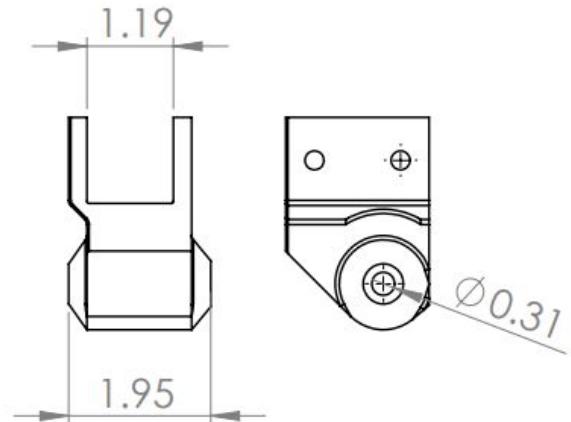
Tank Treads
Track



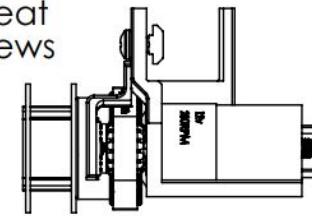
Motor Assembly



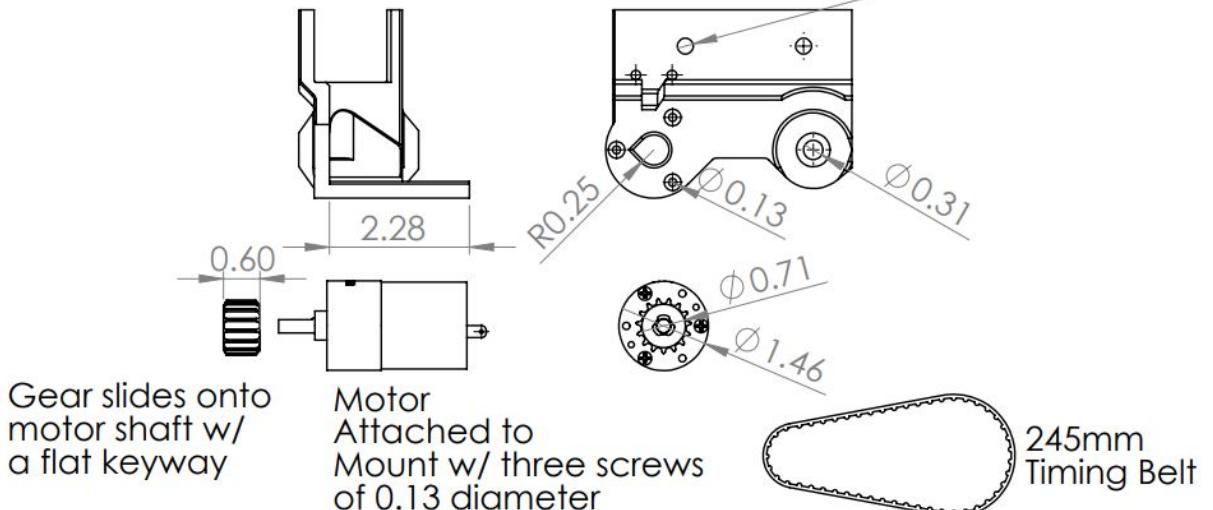
Driven Assembly



Encoder attached
to mount with 2 heat
set inserts and screws



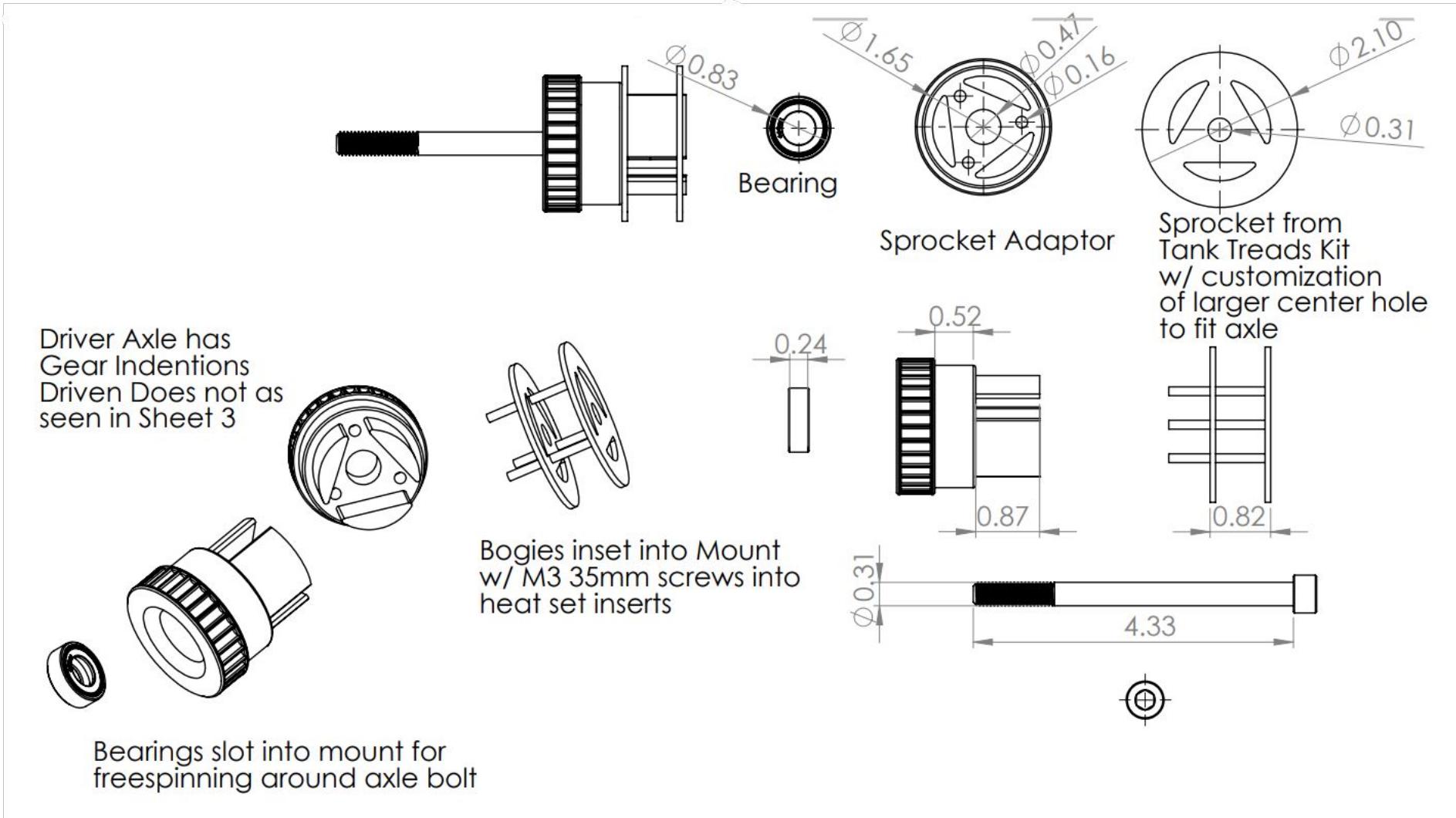
Driver Assembly $\phi 0.26$



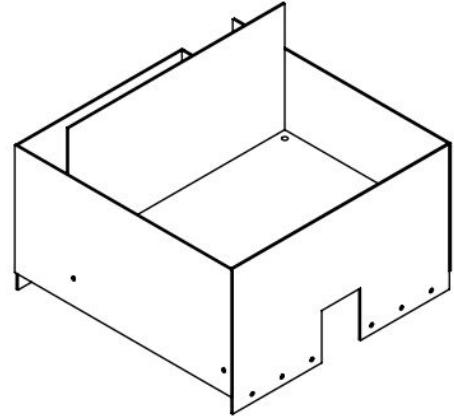
Gear slides onto
motor shaft w/
a flat keyway

Motor
Attached to
Mount w/ three screws
of 0.13 diameter

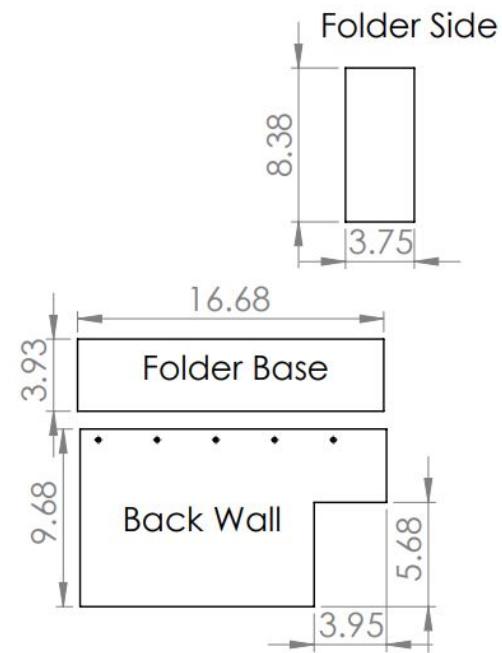
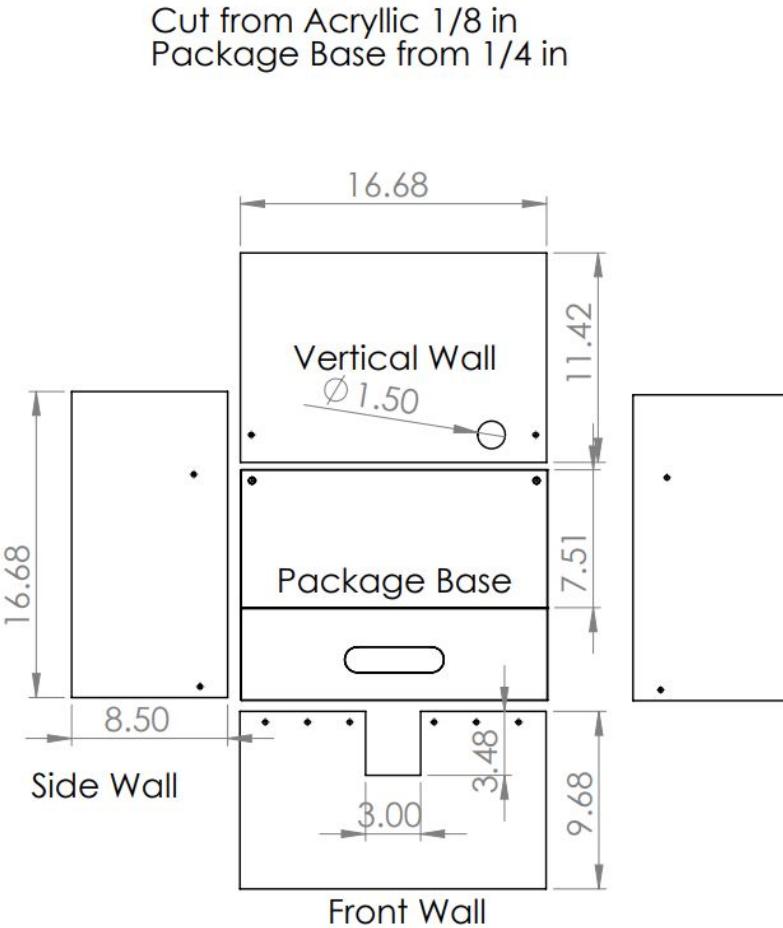
Axle Assembly



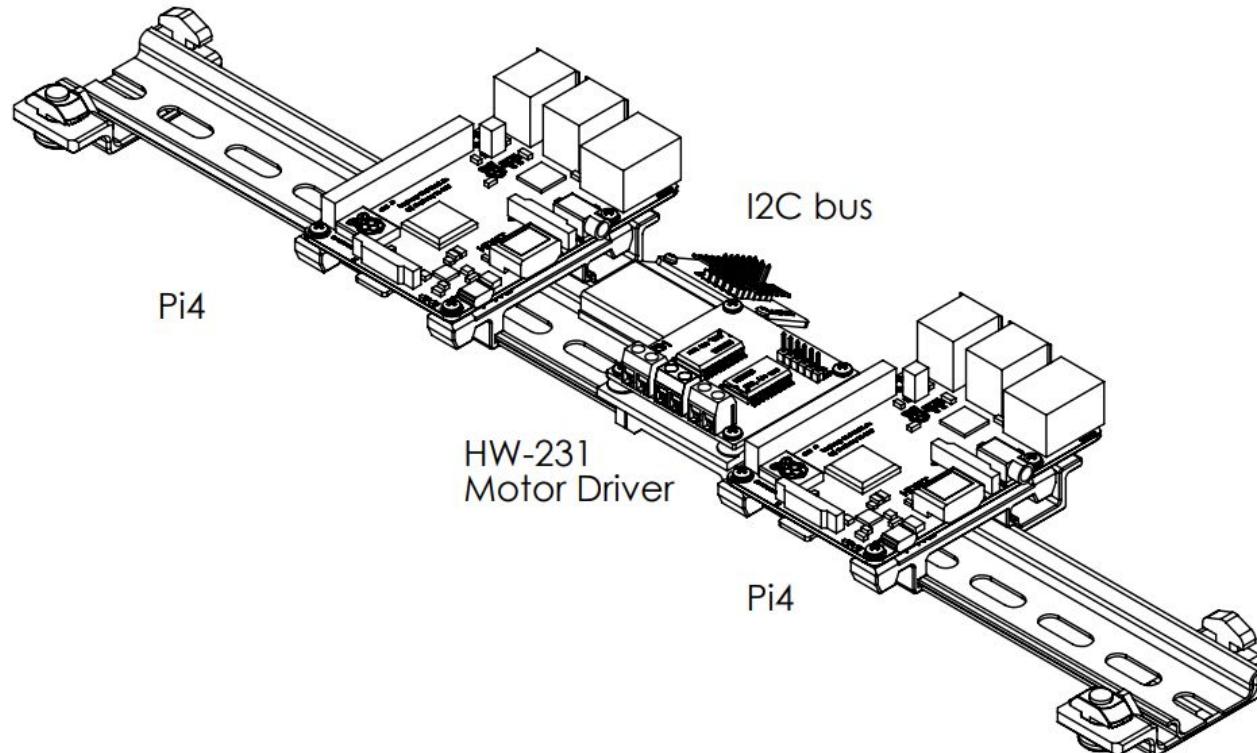
Folder Storage



Package Space attached
to chassis T-slot framing
w/ T-slot nuts and screws



Electrical Component Mounts

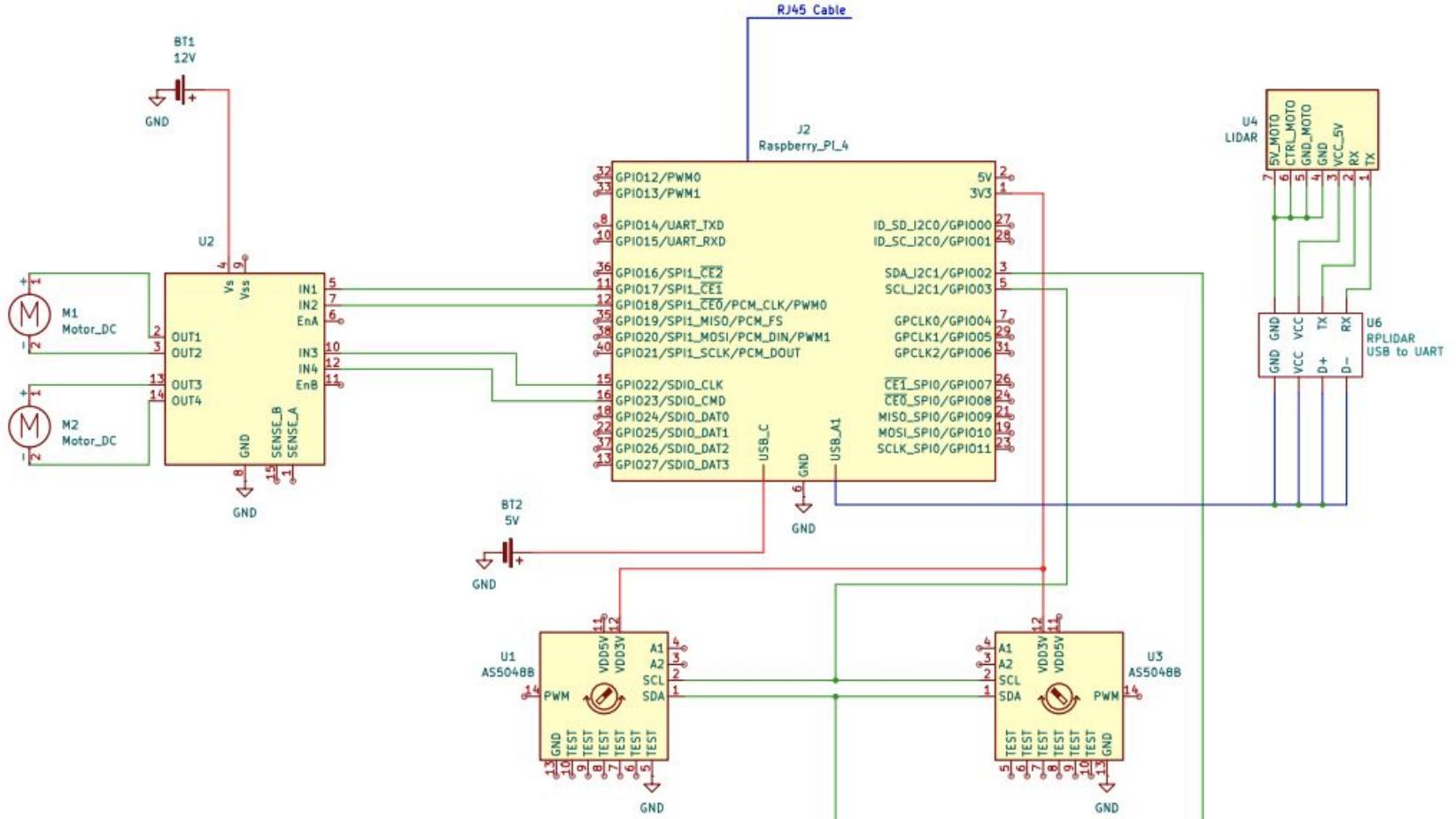




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Electrical Design

Navigator Schematic





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Software Design

| Top-level Systems



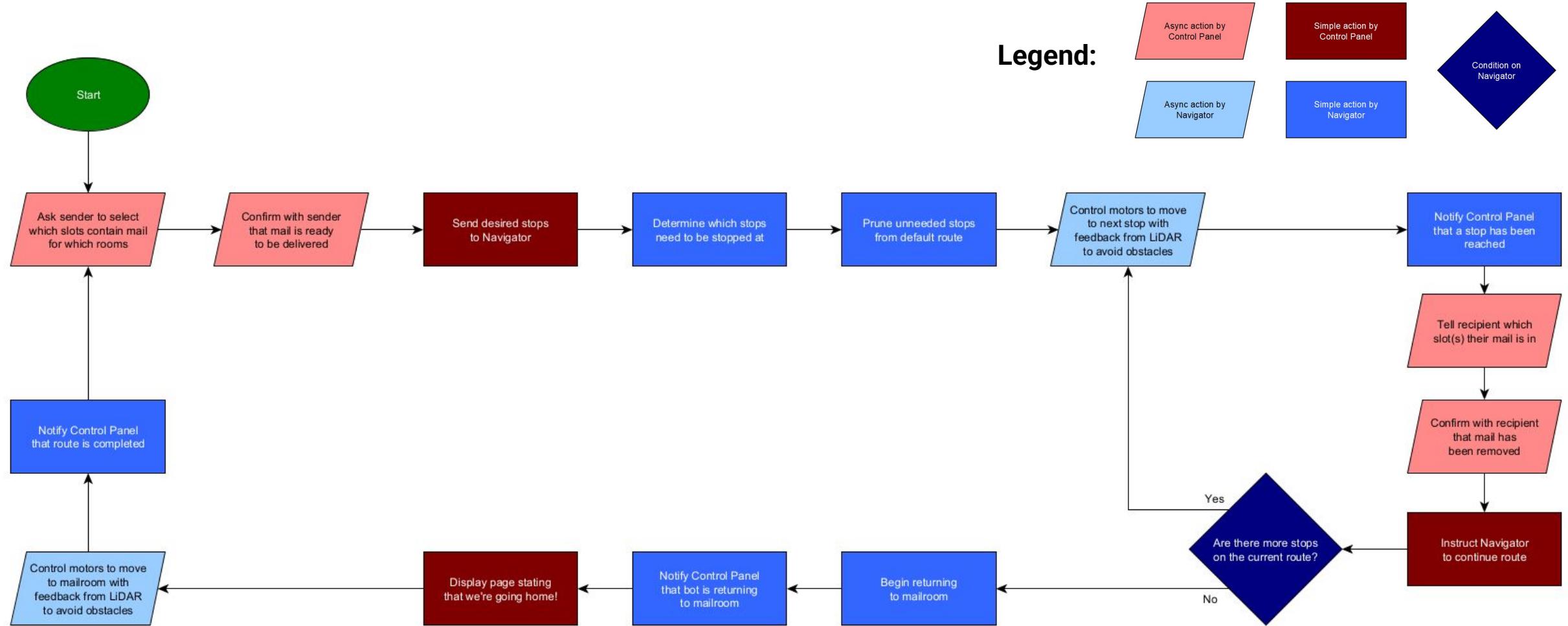
Control Panel

- Sends commands to Navigator
- Asks delivery person to specify which bins contain mail for which rooms
- Shows status messages when bot is in transit
- Allows recipients to tell the bot when they have finished retrieving their items

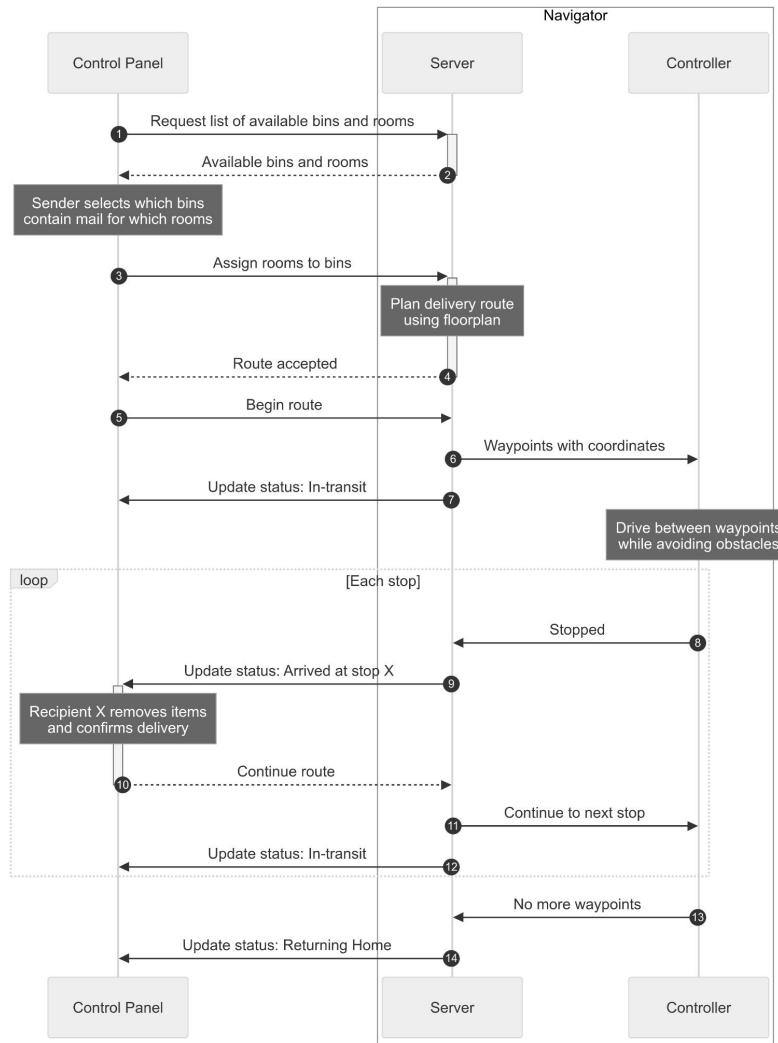
Navigator

- Receives commands from Control Panel
- Stores floor map, rooms, and available bins
- Determines most efficient order of stops
- Plans ideal driving route
- Controls motors while avoiding obstacles using feedback from LIDAR and encoders

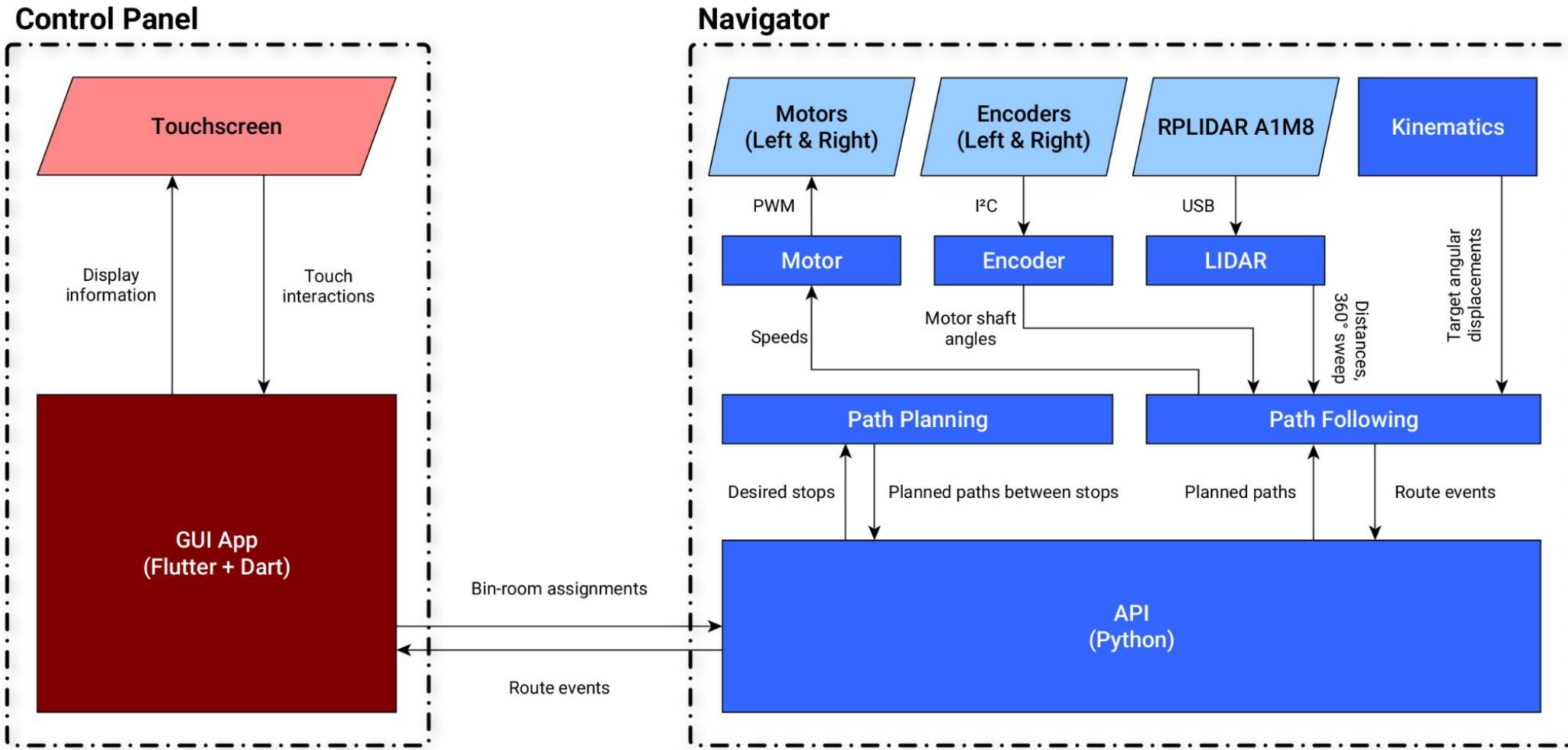
Software Process Map



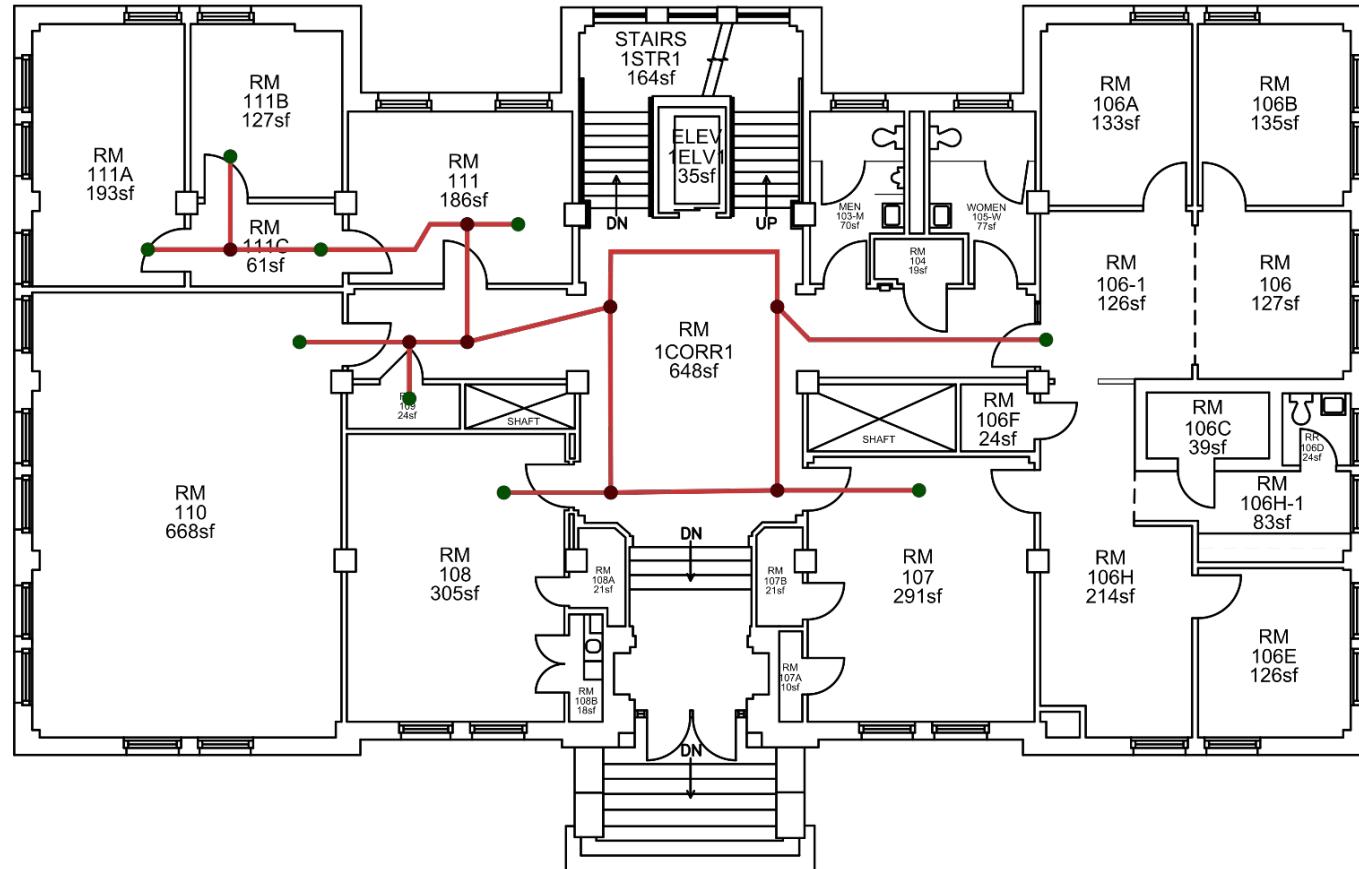
Communication Sequence



Software Modules

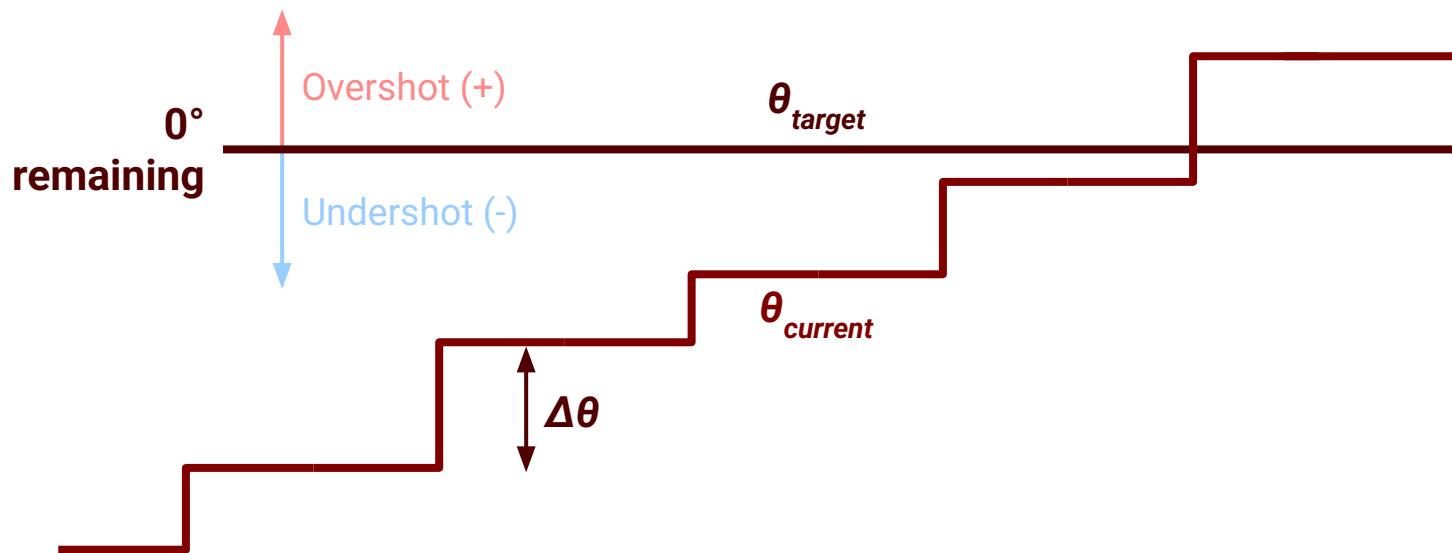


| Path Planning



- 1. Determine shortest route**
Solve Travelling Salesman Problem using Dijkstra's algorithm
- 2. Discretize paths**
Evaluate points along path to merge into linear line segments
- 3. Apply kinematics**
Compute target angular displacement required of each wheel

| Path Following



- 1. Start motors**
80% duty cycle
- 2. Read wheel angles**
Use with previous angles to compute $\Delta\theta$
- 3. Update displacement**
Compare current angular displacement with target
- 4. Stop at target**
If $\theta_{target} - \theta_{current}$ changed sign since the last iteration, by IVT the robot must have reached its target travel

User Interface



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DEBUG

Howdy
Room 1!

Your mail is in
Letter Slot 1

I have received my mail



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Testing Plan

Testing Plan



Five major tests:

- Electric Circuit
- Mechanical System
- User Interaction
- Route Planning
- Autonomous Delivery

Test Plan Document





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Current Status

Labor & Financial Status



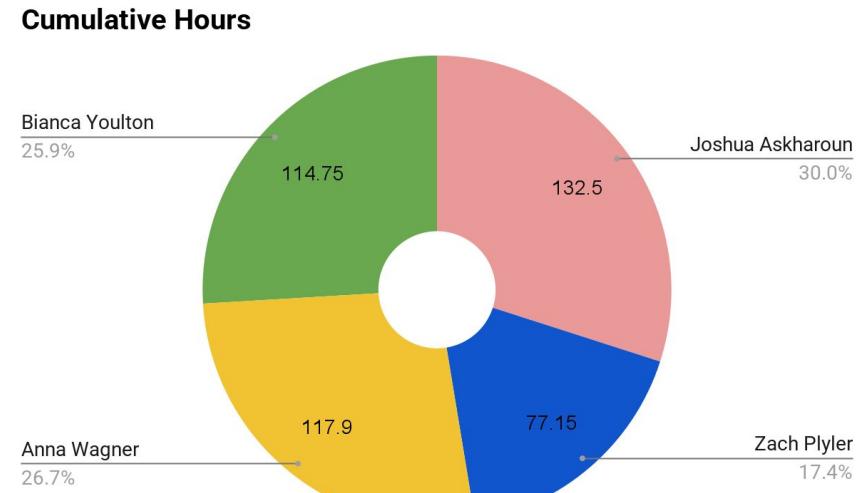
Member	Cumulative Hours	Cumulative Delta
Joshua Askharoun	132.5	22.5
Zach Plyler	77.15	-27.85
Anna Wagner	117.9	15.9
Bianca Youlton	114.75	-1.25
Team Total	442.3	

Category	Predicted	Actual	Status
Mechanical Parts	\$245.92	\$425.94	\$180.02
Electrical Parts	\$299.65	\$290.93	-\$8.72
Software Parts	\$134.95	\$138.86	\$3.91
Section Total	\$680.52	\$855.73	\$175.21
Shipping		\$157.72	
Total		\$1,013.45	

*Including official and personal purchases

Member	Cumulative Hours	Hourly Wage	Labor Cost
Joshua Askharoun	132.5	\$24.00	\$3,180.00
Zach Plyler	77.15	\$20.00	\$1,543.00
Anna Wagner	117.9	\$20.00	\$2,358.00
Bianca Youlton	114.75	\$22.00	\$2,524.50
Team Total	442.3		\$9,605.50

Member	Price
Materials	\$1,013.45
Labor	\$9,605.50
Total	\$10,618.95



Bill of Materials



Category	Part	PN	Store	Price/Unit	Amount	Price
Mechanical	1.5 ft T-Slotted Framing	5537T97	McMaster	\$10.11	5	\$50.55
Mechanical	Heat-Set Inserts for Plastic	97163A147	McMaster	\$6.88	1	\$6.88
Electrical	Lidar	B07TJW5SXF	Amazon	\$99.00	1	\$99.00
Mechanical	3030 Series A1 Connector Set	B08NC46L9K	Amazon	\$23.93	1	\$23.93
Electrical	200RPM Gear Motor	B071GTTSV3	Amazon	\$14.90	2	\$29.80
Mechanical	Tank Treads Tracks	B07HBSWR1D	Amazon	\$34.00	3	\$102.00
Electrical	3ft Ethernet cable	B00N2VISLW	Amazon	\$3.91	1	\$3.91
Mechanical	Acrylic Plastic Cement	B0149IG548	Amazon	\$23.00	1	\$23.00
Mechanical	Acrylic Hinges	B0C58C2ZTR	Amazon	\$7.90	1	\$7.90
Mechanical	Rubber Strips	B09QGJFM72	Amazon	\$13.90	1	\$13.90
Mechanical	Cast Acrylic Sheet, 12" x 24" x 1/8", Black	8505K742	McMaster	\$19.25	5	\$96.25
Mechanical	Cast Acrylic Sheet, 12" x 24" x 1/4", Black	8505K755	McMaster	\$26.41	2	\$52.82
Electrical	ELECROW 7 Inch Touch Screen Monitor for Raspberry Pi	B01GDMDFZA	Amazon	\$45.00	1	\$45.00
Electrical	USB-A to Micro USB Charging Cable, 4	B0711PVX6Z	Amazon	\$6.95	1	\$6.95
Electrical	USB-C to USC-C Cable	B0CRZ4LR9K	Amazon	\$16.90	1	\$16.90
Electrical	j5create 26800mAh PD 65W 4-Port Power Bank	JPB26465	New Egg	\$59.99	1	\$59.99
Electrical	Dupont Connector Kit	B0B11SX39B	Amazon	\$9.99	1	\$9.99
Electrical	18 Gauge 2pin 2 Color Red Black Cable	B01LZRV0HV	Amazon	\$9.99	1	\$9.99
Mechanical	PLA 3D Printer Filament	B0D421Q2Q2	Amazon	\$14.99	1	\$14.99
Electrical	Raspberry Pi 4 Model B Kit (2 GB)	DEV-15446	Sparkfun	\$45.00	1	\$45.00
Electrical	Raspberry Pi 4 Model B Kit (4 GB)	DEV-15447	Sparkfun	\$55.00	1	\$55.00
Electrical	SD Cards	B0143RTB1E	Amazon	\$8.05	2	\$16.10
Electrical	AMS5048B Encoder	990600491	DigiKey	\$16.66	2	\$33.32
Electrical	HW-231 Motor Driver		SCUTTLE websi	\$20.00	1	\$20.00
Mechanical	Wall Mount Metal Mesh File Holder	391663456	Walmart	\$15.98	1	\$15.98
Mechanical	DIN Rail Mounting	18Z760	Grainger	\$6.87	2	\$13.74
Mechanical	Misc. nuts and screws provided by PIC				Total:	\$872.89

*All parts used in final design



Talaria Robotics

Course Quality Summary



- **Course that contributed most to capstone success**
 - MXET 300 -> Dynamics of rolling robots
- **Most important lessons learned from capstone**
 - The benefits of visualizing systems and data
- **One area of improvement to capstone**
 - Most assignments from 419 were not very helpful because of too much repetition, a lack of direction, and often little relevance to the project
 - PIC is woefully inadequate



- **Course that contributed most to capstone success**
 - MMET 361 -> Product Design
- **Most important lessons learned from capstone**
 - Make sure you have checked parts are compatible with each other.
- **One area of improvement to capstone**
 - More organization of PIC
 - 419 designed to start building and not just planning



- **Course that contributed most to capstone success**
 - ESET 333 -> Project management skills
 - MXET 300 -> Introduction to SCUTTLE frame and related skills
- **Most important lessons learned from capstone**
 - Importance of clear communication and deadlines
- **One area of improvement to capstone**
 - More cohesion between 419/420
 - Emphasis on starting physical progress early
 - PO deadlines communicated in 419 semester as well



- **Course that contributed most to capstone success**
 - MXET 300 -> Logic between global and local referencing
 - MMET 463/663 -> Understanding how to design tread tracks
- **Most important lessons learned from capstone**
 - Clearly communicating schedules as well as what was done during each work time
- **One area of improvement to capstone**
 - More design emphasis in 419, such as being able to order parts and better feedback on assignments, to prepare for 420

Questions?

