Meeting 1: 2/23

- Goals:
    - Complete first draft of PoC specifications

First draft of PoC specs (for PoC1 - only need specs for Task 1 and Task 2)

Customer Need	**Technical Need**	**Technical Requirement**	**Target Value**
The LARIS should be able to accurately make point turns	LARIS center point must not move too far from the origin point in any turning maneuver, [cm]	LARIS center point should not move more than 5 cm away from origin for any turn angle	LARIS center point should move less than 3 cm in any turning maneuver
The LARIS should be able to accurately make point turns	LARIS should be able to turn accurately within a given [degree] accuracy	LARIS must be able to turn accurately within a 10 degrees for every 90 degrees of turn	LARIS turns accurately within 5 degrees for every 90 degrees of rotation
LARIS should be able to navigate using walls as reference	LARIS should navigate to end destination accurately using walls within a given linear distance [cm]	When using walls to navigate, the LARIS should arrive at its destination within 5 cm of desired end location	LARIS should be able to navigate within 2 cm of desired end location when using walls
LARIS should be able to navigate using walls as reference	Distance of closest point of LARIS perimeter to wall, [cm]	When the LARIS is within 7 cm of a wall, it should engage appropriate avoidance maneuver	When the LARIS is within 5 cm of a wall, it should engage appropriate avoidance maneuver

Ryan Pearson

Elijah Peters

Thanoshi Balasuriya

Meeting 2: 2/26

- Goals:
    - Finalize PoC specifications for PoC1
    - Build first iteration of robot (specific to PoC 1)
        - Code for PoC1 robot
    - Project management decisions
        - Gantt chart (based on current given information → only up to PoC1)
        - Roles
        - Functional Block Diagram

Final PoC1 specs

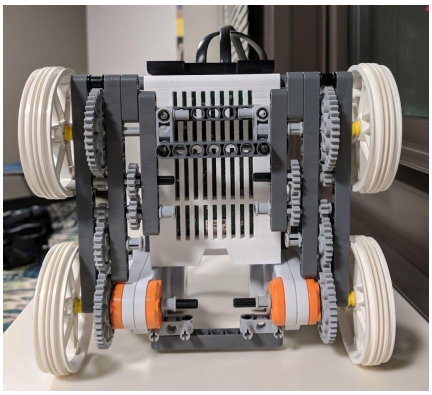
Customer Need	**Technical Need**	**Technical Requirement**	**Target Value**
The LARIS should be able to accurately make point turns	LARIS center point must not move too far from the origin point in any turning maneuver, [cm]	LARIS center point should not move more than 5 [cm] away from origin for any turn angle	LARIS center point should move less than 3 [cm] in any turning maneuver
The LARIS should be able to accurately make point turns	LARIS should be able to turn accurately within a given [degree] accuracy	LARIS must be able to turn accurately within a 10 [degrees] for every 90 [degrees] of turn	LARIS turns accurately within 5 [degrees] for every 90 [degrees] of rotation
LARIS should be able to navigate using walls as reference	LARIS should navigate to end destination accurately using walls within a given linear distance [cm]	When using walls to navigate, the LARIS should arrive at its destination within 5 [cm] of desired end location	LARIS should be able to navigate within 2 [cm] of desired end location when using walls
LARIS should be able to navigate using walls as	LARIS should a minimum range in [m] for most	LARIS should have a minimum range of 100 [m]	LARIS should have a minimum range of 150 [m]

reference	emergency responders' needs		
LARIS should be able to navigate using walls as reference	LARIS should be able to identify an intersection (in any direction) when within a given distance [cm]	LARIS should locate intersections within 10 [cm]	LARIS should locate intersections within 15 [cm]
LARIS should be able to choose a given path at an intersection	LARIS should choose desired path at an intersection based on sensor inputs [success rate]	LARIS should choose desired path at an intersection 80% of the time	LARIS should choose desired path at an intersection 90% of the time
LARIS should be able to navigate using walls as reference	Distance of closest point of LARIS perimeter to wall, [cm]	When the LARIS is within 7 [cm] of a wall, it should engage appropriate avoidance maneuver	When the LARIS is within 5 [cm] of a wall, it should engage appropriate avoidance maneuver

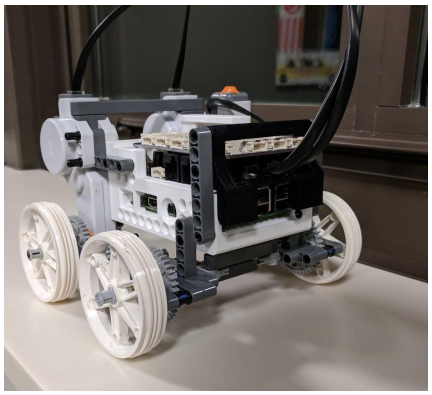
- Edits to PoC specs:
    - Based on feedback from our TA, we needed to make sure that our specifications could be applied in whatever situation our robot was placed in - so basically, we had to take in considerations about limitations.
        - Therefore, we added in specifications regarding intersections and a minimum range

Iteration 1 of the robot (PoC1-specific) - Angela

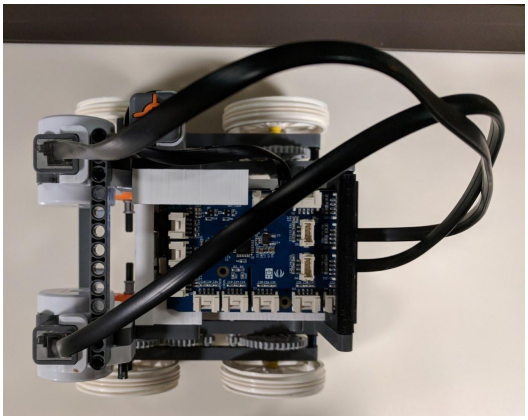
Bottom view of the robot:



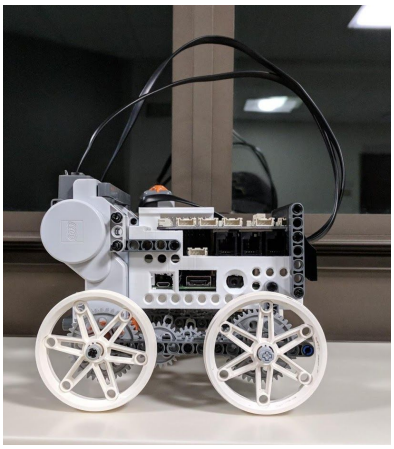
Back view of the robot:



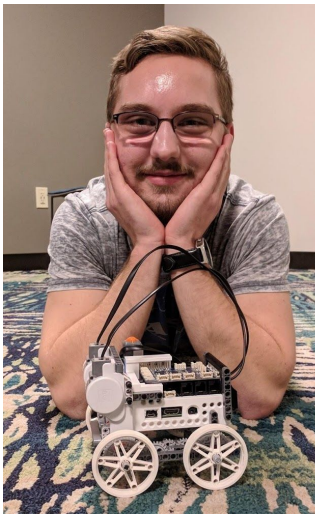
Top view of the robot:



Side view of the robot:



Elijah with the robot:



- Design decisions:
    - Treads vs. wheels?
        - Based on our different experiences from ENGR161 last semester, we had differing opinions on whether treads or wheels would be better, specifically for turning, which we decided would be a significant portion of the design based on the project description and PoC tasks. Treads have a lot of pros, such as obstacle avoidance and lower center of gravity, but wheels tend to have more success with turning. Thus, with further research, we came to

a conclusion that we need to test different designs before our final design.

- However, with limited time, we landed on wheels for PoC1, which depends heavily on the turning of the robot, especially zero-point turns.

- Decided on wheels without the rubber tires so it doesn't jump as much
- Coding
  - Coded the point turn code

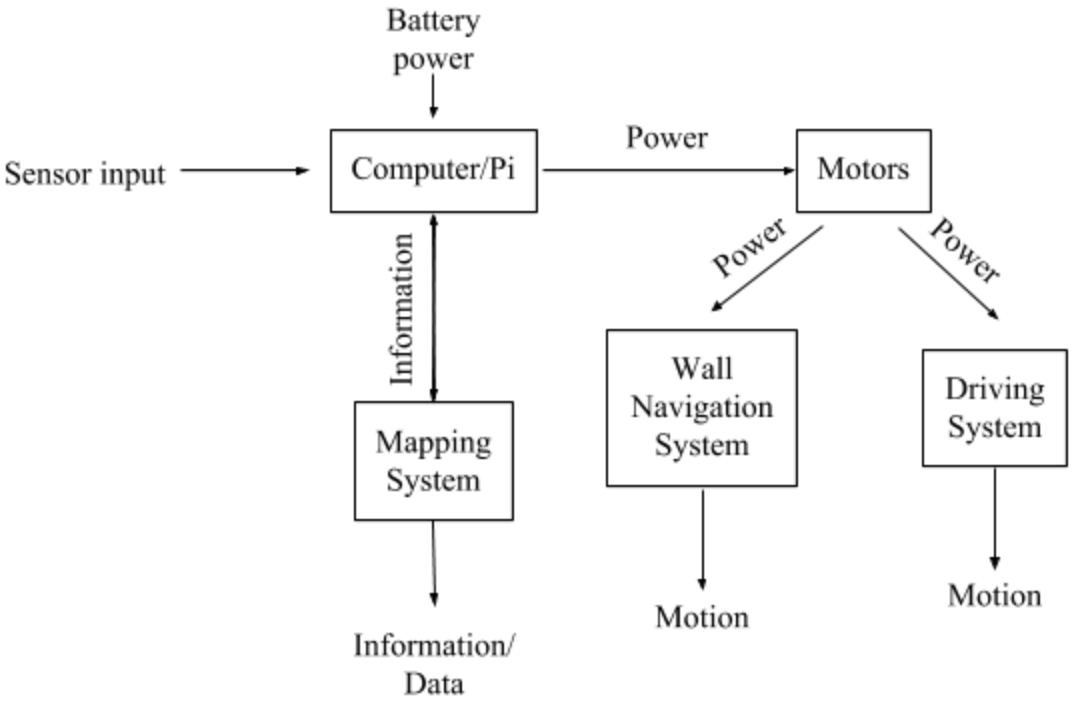
- Testing
  - Tested the point turn code with the robot
    - The robot was quite jumpy/jerky, but after adjusting the code to reflect whether the robot overshot/undershot the required angle, it would at least successfully turn to the desired angle

- Project management

  Initial Gantt chart (up to PoC1)

  - General Roles:
    - Building - Ryan and Elijah
    - Coding - Elijah and Ryan
    - Documentation - Thanoshi

- Functional Block Diagram



Thanoshi Balasuriya

Elijah Peters

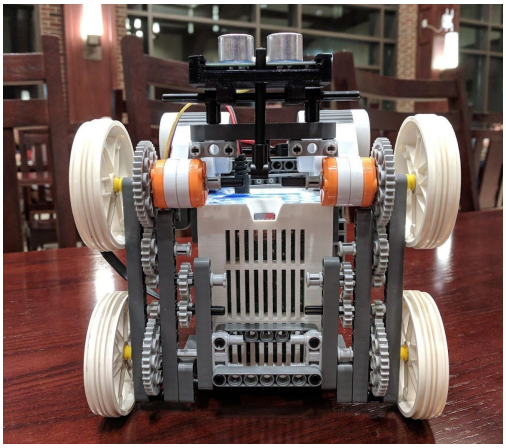
Ryan Pearson

Meeting 3: 2/28/2018

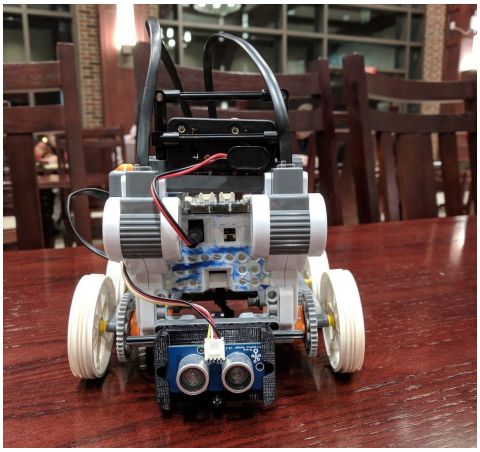
- Goals:
  - Code for PoC Task 2
  - Test
  - Go to the PoC and complete the possible tasks

Iteration 2 of the robot (PoC1 final) - Bandit

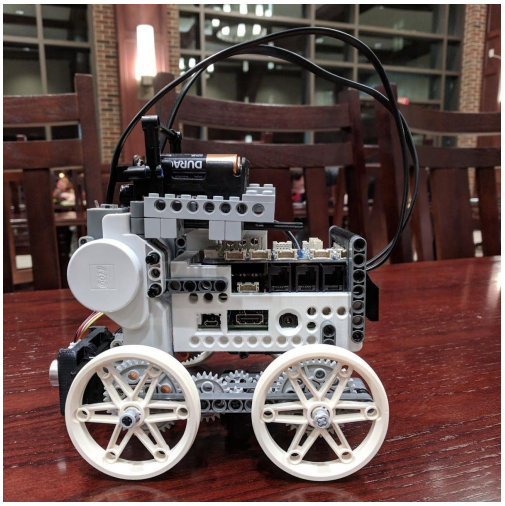
Bottom view of the robot:



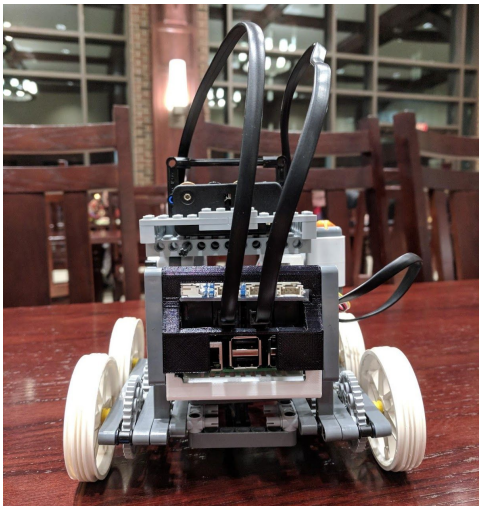
Front view of the robot:



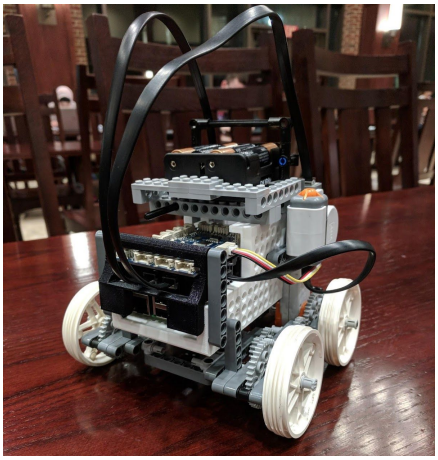
Side view of the robot:



Back view of the robot:



Angled view of back of robot:



- Design decisions:
    - Once again, we went back and forth between wheels and treads because there was a lot of drifting away from the center point whenever the robot would have to do point turns, and so we thought maybe treads would help with slippage, but it actually made it worse, so we went back to the original PoC1 wheel/gear system
    - Mounted the ultrasonic sensor to the front of the robot
    - Coding
        - We also coded the wall following code, using an ultrasonic sensor on the front
- Testing
    - We tested the point turn code yet again and tried to see if we could fix the drifting away from the center point problem, and even after switching how our wheels/treads/wheels worked, we weren't fully able to fix it. But by driving the robot relatively fast, it didn't necessarily have enough time to drift too far away → temporary fix.
    - We also tested the wall following code, and it was quite successful at recognizing a wall and turning 90 degrees
- PoC1
    - Successfully passed the integrated course - therefore, successfully passed the first two tasks

Elijah Peters

Thanoshi Balasuriya

Ryan Pearson

Meeting 4: 3/23/2018

- Goals:
    - Update PoC specifications for PoC2

Draft of PoC2 Specs (Task 1 - 6)

Customer Need	**Technical Need**	**Technical Requirement**	**Target Value**
The LARIS should be able to accurately make point turns	LARIS center point must not move too far from the origin point in any turning maneuver, [cm]	LARIS center point should not move more than 5 [cm] away from origin for any turn angle	LARIS center point should move less than 3 [cm] in any turning maneuver
The LARIS should be able to accurately make point turns	LARIS should be able to turn accurately within a given [degree] accuracy	LARIS must be able to turn accurately within a 10 [degrees] for every 90 [degrees] of turn	LARIS turns accurately within 5 [degrees] for every 90 [degrees] of rotation
LARIS should be able to navigate using walls as reference	LARIS should navigate to end destination accurately using walls within a given linear distance [cm]	When using walls to navigate, the LARIS should arrive at its destination within 5 [cm] of desired end location	LARIS should be able to navigate within 2 [cm] of desired end location when using walls
LARIS should be able to navigate using walls as reference	LARIS should a minimum range in [m] for most emergency responders' needs	LARIS should have a minimum range of 100 [m]	LARIS should have a minimum range of 150 [m]
LARIS should be able to navigate using walls as reference	LARIS should be able to identify an intersection (in any direction) when within a given distance [cm]	LARIS should locate intersections within 10 [cm]	LARIS should locate intersections within 15 [cm]
LARIS should be able to navigate	LARIS should not come to close to the	LARIS should remain at least 1	LARIS should remain at least 1.5

using walls as reference	walls [cm]	[cm] clear of the walls	[cm] clear of the walls
LARIS should be able to navigate using walls as reference	Distance of closest point of LARIS perimeter to wall, [cm]	When the LARIS is within 7 [cm] of a wall, it should engage appropriate avoidance maneuver	When the LARIS is within 5 [cm] of a wall, it should engage appropriate avoidance maneuver
LARIS should be able to choose a given path at an intersection	LARIS should choose desired path at an intersection based on sensor inputs [success rate]	LARIS should choose desired path at an intersection 80% of the time	LARIS should choose desired path at an intersection 90% of the time
Demonstrate LARIS ability to navigate using magnetic and infrared (IR) sources.	LARIS should not come within a given radius of magnetic and (IR) sources [cm]	LARIS should not come within a 10 [cm] radius of magnetic and (IR) sources	LARIS should not come within a 12 [cm] radius of the magnetic and (IR) sources
Demonstrate LARIS ability to navigate using magnetic and infrared (IR) sources	LARIS successfully navigates to desired endpoint within a given radius [cm]	LARIS navigates to within 5 [cm] of the target	LARIS navigates within 3 [cm] of the target
Demonstrate LARIS ability to perform point-to-point navigation in a grid.	LARIS is able to come within a given radius of each of the four specified points [cm]	LARIS is able to come within 4 [cm] of each of the specified points	LARIS is able to come within 2 [cm] of each of the specified points
Demonstrate LARIS ability to perform point-to-point navigation in a grid.	LARIS pauses for a certain amount of time [seconds] after reaching the specified point so the accuracy can be measured	LARIS pauses for 10 [seconds]	LARIS pauses for 15 [seconds]
Demonstrate LARIS ability to	LARIS gathers data points about the	LARIS gathers 3 data points (left,	LARIS gathers 3 data points (left,

build a map of an unknown area.	walls surrounding it each time it travels a given distance	forward, right) about the walls around it each time it travels 10 [cm]	forward, right) about the walls around it each time it travels 5 [cm]
Demonstrate LARIS ability to build a map of an unknown area.	LARIS generates an accurate portrayal of its surroundings [% accuracy]	90 [%] of the data points printed out to the map are accurate	95 [%] of the data points printed out to the map are accurate
Demonstrate LARIS ability to build a map of an unknown area.	LARIS navigates to the exit of the structure successfully [% frequency]	LARIS navigates to the exit of the structure successfully 90 [%] of the time	LARIS navigates to the exit of the structure successfully 95 [%] of the time
Demonstrate LARIS ability to identify and differentiate between unknown resources	LARIS is able to detect green vs blue [PASS/FAIL]	LARIS is able to determine color of object accurately to determine substance	PASS

Thanoshi Balasuriya

Ryan Pearson

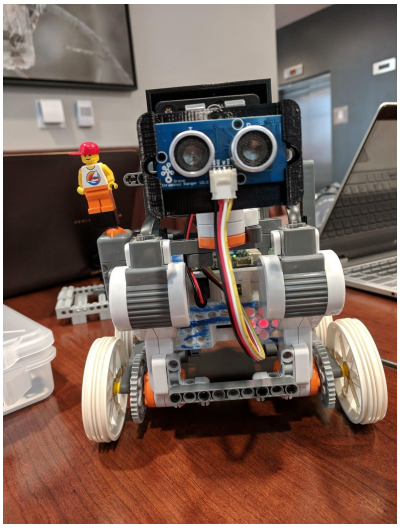
Elijah Peters

Meeting 5: 3/24/2018

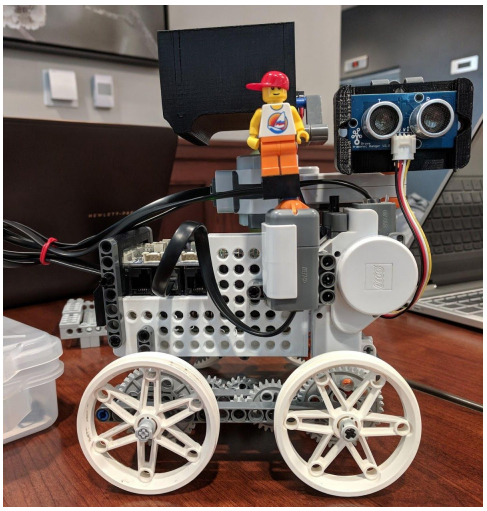
- Goals:
    - Update robot and code in order to be able to complete PoC2 tasks

Iteration 3 of the robot (PoC2-specific) - WALL-Y

Front view of the robot:



Side view of the robot:



- Design decisions:
    - Mounted the battery case to the robot - proved to be difficult because the Pi case's holes weren't quite the right size for the pins to fit sturdily, so we had to build up instead
    - Mounted the rotating ultrasonic sensor and its corresponding motor - we want the ultrasonic to rotate so that it can check the left side, forward, and then right side in order to determine whether there are walls on either side of it or in front of it (this will help with both knowing when the robot needs to turn and also will help in creating the map of the hallways)
    - Coding:
        - Coded for the ultrasonic sensor's motor → rotation

Elijah Peters

Thanoshi Balasuriya

Ryan Pearson

Meeting 6: 3/25/2018

- Goals:

    - Keep debugging and updating the code for PoC2
- Design decisions:
    - Can perform Task 1 and 2 without touching the walls
        - Issues we ran into: one of the motors wouldn't quite run, but it turned out to be a coding issue and after a lot of struggle it was debugged
- Testing
    - Built a "wall" using books and the Pi kit in order to resemble a hallway
    - Ran the robot to test how the rotating ultrasonic functions along with the code
        - At first, did not turn correctly and also tended to not correct if it drifted away from going straight
        - After debugging, however, it was able to correct itself to go straight and also turned successfully when it sensed that there was no wall on one side of the hallway

Thanoshi Balasuriya
Elijah Peters
Ryan Pearson

Meeting 7: 3/26/2018

- Goals:
    - Update the PoC2 specifications using the comments (we were only approved for Task 2-4), so that we can actually attempt the tasks at the PoC - especially Task 1, which we should be able to complete if we are given the chance with the specs

PoC2 Final Specs

Customer Need	**Technical Need**	**Technical Requirement**	**Target Value**
The LARIS should be able to accurately make point turns	LARIS center point must not move too far from the origin point in any turning maneuver, [cm]	LARIS center point should not move more than 5 [cm] away from origin for any turn angle	LARIS center point should move less than 3 [cm] in any turning maneuver
The LARIS should be able to accurately make point turns	LARIS should be able to turn accurately within a given [degree] accuracy	LARIS must be able to turn accurately within a 10 [degrees] for every 90 [degrees] of turn	LARIS turns accurately within 5 [degrees] for every 90 [degrees] of rotation
LARIS should be able to navigate using walls as reference	LARIS should navigate to end destination accurately using walls within a given linear distance [cm]	When using walls to navigate, the LARIS should arrive at its destination within 5 [cm] of desired end location	LARIS should be able to navigate within 2 [cm] of desired end location when using walls
LARIS should be able to navigate using walls as reference	LARIS should a minimum range in [m] for most emergency responders' needs	LARIS should have a minimum range of 100 [m]	LARIS should have a minimum range of 150 [m]
LARIS should be able to navigate using walls as reference	LARIS should be able to identify an intersection (in any direction) when within a given distance [cm]	LARIS should locate intersections within 10 [cm]	LARIS should locate intersections within 15 [cm]
LARIS can traverse course accurately within a given radius	LARIS can travel a given distance accurately [m]	LARIS can reach a destination accurately within a 10 [m] radius around it	LARIS can reach a destination accurately within a 12 [m] radius around it
LARIS should be	Distance of closest	When the LARIS is	When the LARIS is

able to navigate using walls as reference	point of LARIS perimeter to wall, [cm]	within 7 [cm] of a wall, it should engage appropriate avoidance maneuver	within 5 [cm] of a wall, it should engage appropriate avoidance maneuver
LARIS should be able to choose a given path at an intersection	LARIS should choose desired path at an intersection based on sensor inputs [success rate]	LARIS should choose desired path at an intersection 80% of the time	LARIS should choose desired path at an intersection 90% of the time
Demonstrate LARIS ability to navigate using magnetic sources.	LARIS should not come within a given radius of magnetic sources [cm]	LARIS should not come within a 10 [cm] radius of magnetic sources	LARIS should not come within a 12 [cm] radius of the magnetic sources
Demonstrate LARIS ability to navigate using infrared (IR) sources.	LARIS should not come within a given radius of IR sources [cm]	LARIS should not come within a 10 [cm] radius of IR sources	LARIS should not come within a 12 [cm] radius of the IR sources
Demonstrate LARIS ability to navigate using magnetic and infrared (IR) sources	LARIS successfully navigates to desired endpoint within a given radius [cm]	LARIS navigates to within 5 [cm] of the target	LARIS navigates within 3 [cm] of the target
Demonstrate LARIS ability to perform point-to-point navigation in a grid.	LARIS is able to come within a given radius of each of the four specified points [cm]	LARIS is able to come within 4 [cm] of each of the specified points	LARIS is able to come within 2 [cm] of each of the specified points
Demonstrate LARIS ability to perform point-to-point navigation in a grid.	LARIS pauses for a certain amount of time [seconds] after reaching the specified point so the accuracy can be measured	LARIS pauses for 10 [seconds]	LARIS pauses for 15 [seconds]
Demonstrate	LARIS gathers data	LARIS gathers 3	LARIS gathers 3

LARIS ability to build a map of an unknown area.	points about the walls surrounding it each time it travels a given distance	data points (left, forward, right) about the walls around it each time it travels 10 [cm]	data points (left, forward, right) about the walls around it each time it travels 5 [cm]
Demonstrate LARIS ability to build a map of an unknown area.	LARIS generates an accurate portrayal of its surroundings [PASS/FAIL]	LARIS generates an accurate portrayal of its surroundings as data points printed out to a map	PASS
Demonstrate LARIS ability to build a map of an unknown area.	LARIS is able to identify up to n-way intersection [number of paths]	LARIS is able to identify up to a four way intersection	LARIS is able to identify up to a four way intersection
Demonstrate LARIS ability to identify and differentiate between unknown resources	LARIS is able to detect green vs blue [PASS/FAIL]	LARIS is able to determine color of object accurately to determine substance	PASS
LARIS is able to identify and differentiate between unknown resources	LARIS is able to analyze resources of a given volume [cm^3]	LARIS can identify unknowns of dimension up to 6x6x10 [cm]	LARIS can identify unknowns of dimension up to 7x7x11 [cm]
LARIS is able to identify and differentiate between unknown resources	LARIS is able to analyze resources of a given weight [g]	LARIS can identify unknowns of weights up to 128 [g]	LARIS can identify unknowns of weights up to 150 [g]

- Edits to PoC specs
    - Made sure that we're not contradicting ourselves in values, or making our requirements % reliability
    - Adapted to depend on how long the hallway is in total
    - Separated the IR and magnetic specifications
    - Made the specs more specific to the possible objects we could run into and have to identify

Ryan Pearson

Thanoshi Balasuriya

Elijah Peters

Meeting 8: 3/28/2018

- Goals:
    - Try to see if we can code for any more PoC2 tasks
        - Test
    - Go to PoC2
- Design decisions
    - Code
        - Calibrated the robot's move forward function to move the robot forward exactly 5 centimeters
- Testing
    - Tested the robot's move forward function and the point turning on paper instead of table
- PoC2
    - Passed specifications for all the tasks except for Task 6
    - Tried integration of Task 1 and 2, but the robot moved extremely slowly and after the first turn it moved forward and then turned directly into the wall
    - Tried just Task 1, but the robot turned into the wall after the turn again
    - Tried just Task 2, but on the 180 degree point turn, the robot moved far too off center
    - Tried Task 4 but the turns were slightly undershooting, which then made it miss the points because over distance the robot would move far to the side

Elijah Peters

Ryan Pearson

Thanoshi Balasuriya

Meeting 9: 4/5/18

The team met to work out bugs that appeared in the code following PoC2. Elijah rewrote the code for tasks 1 and 2 to use the BP.set_motor_position function in place of the BP.set_motor_dps function coupled with a time variable.

Ryan Pearson

Elijah Peters

Meeting 10: 4/9/18

Office hours working with IR sensor. The team noted that the sensor had to be facing head on to get an accurate reading

IR Sensor Range (cm)	IR Sensor reading
5.08	250,250
7.62	200,200
10.16	154, 155
12.70	125, 125
15.24	110,110
17.78	93, 93
20.32	80, 80
22.86	75, 75
25.40	68, 68
27.94	60,60

30.48	58,58
152.4	46,46

Elijah Peters

Ryan Pearson

Meeting 11: 4/10/18

- Goals
    - PoC3
    - Completed tasks 1,2 and 6

Elijah Peters

Ryan Pearson

Thanoshi Balasuriya