FAMU-FSU
College of
Engineering

NSWC - RoboBoat
Team 521

April 4, 2024 | Engineering Design Day

Team Introductions (ME)

Ivanna Caballero
Quality Engineer

Andly Jean
Mechatronic Engineer

Nicholas Norwood
*Mechanical
Systems Engineer*

Makenzie Wiggins
Design Engineer

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Ivanna
Caballero

Team Introductions (EE)

Sophia Barron
Electrical
Systems Engineer

Michael Fitzsimmons
Electronics Engineer

Lucca Meyer
Test Engineer

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Engineering

Ivanna Caballero

Sponsor and Mentor

<u>Engineering Mentor/Sponsor</u>
Dr. Damion Dunlap
Naval Surface Warfare Center

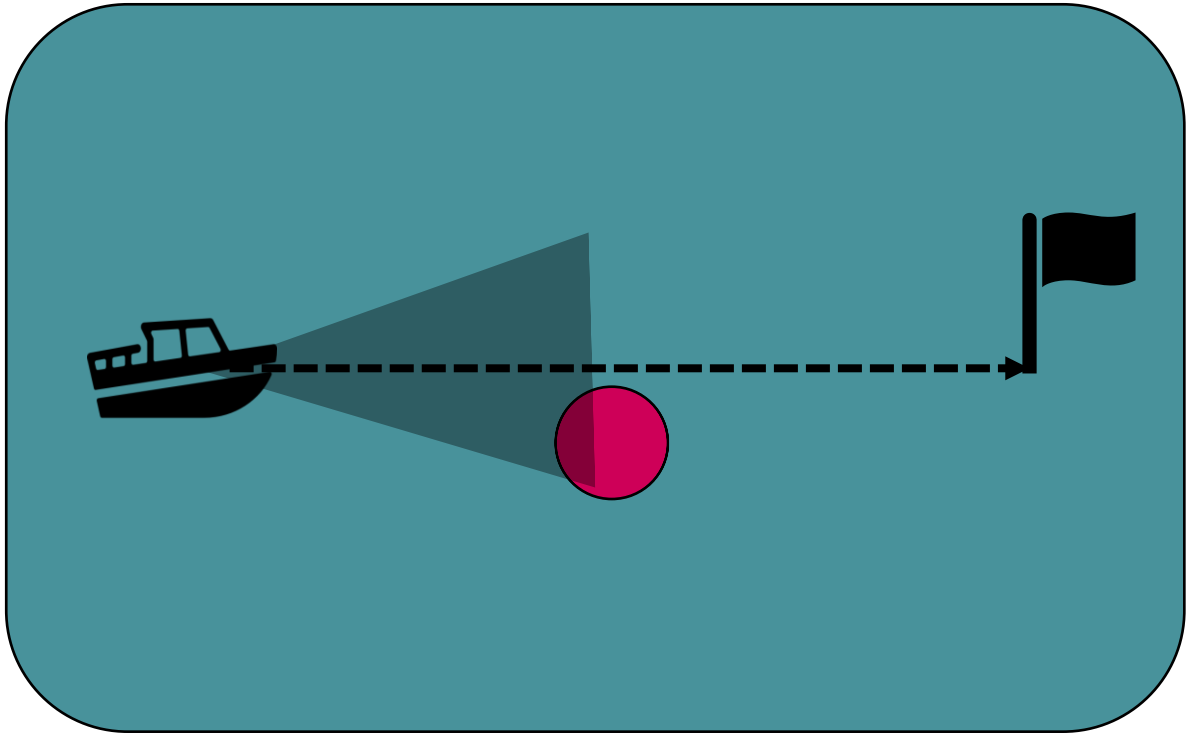
NAVSEA
NAVAL SEA SYSTEMS COMMAND

Ivanna
Caballero

Project Objective

The objective of this project is to design, build and program an autonomous surface vehicle capable of completing several tasks in the following categories:

- Navigation
- Detection
- Object avoidance



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Background

RoboBoat

- Program at RoboNation
- An international student competition
- Design autonomous, robotic boats to navigate through a challenge course
- Tackle tasks that mimic real-world challenges

Ivanna Caballero

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Ivanna
Caballero

Key Goals

- Reliable Safety System
- Accurate Navigation System
- Modular Code Architecture
- System Designed Around Modular Components

Ivanna
Caballero

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Ivanna Caballero

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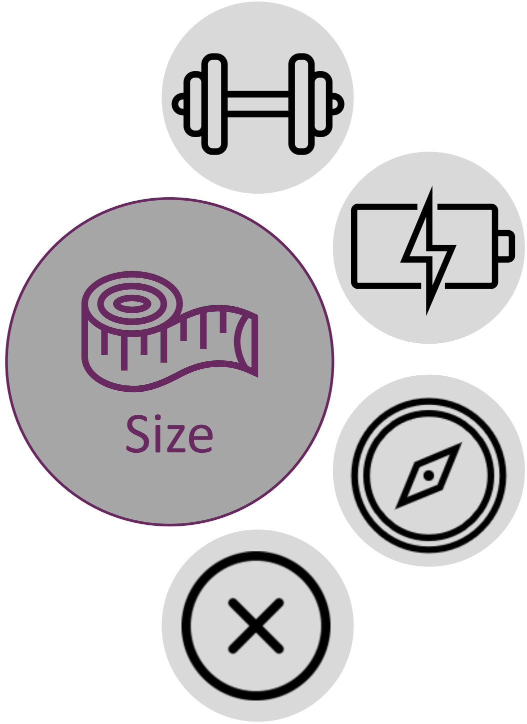
Targets and Metrics

The vehicle must fit within a 6 feet x 3 feet x 3 feet box



Ivanna Caballero

Targets and Metrics

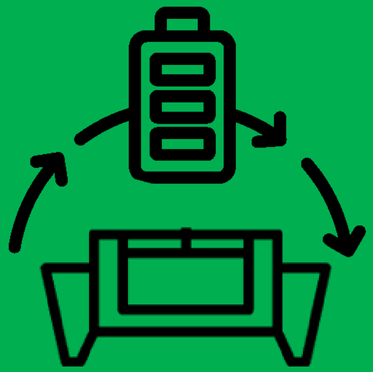
The entire maritime system must weigh less than 140 lbs

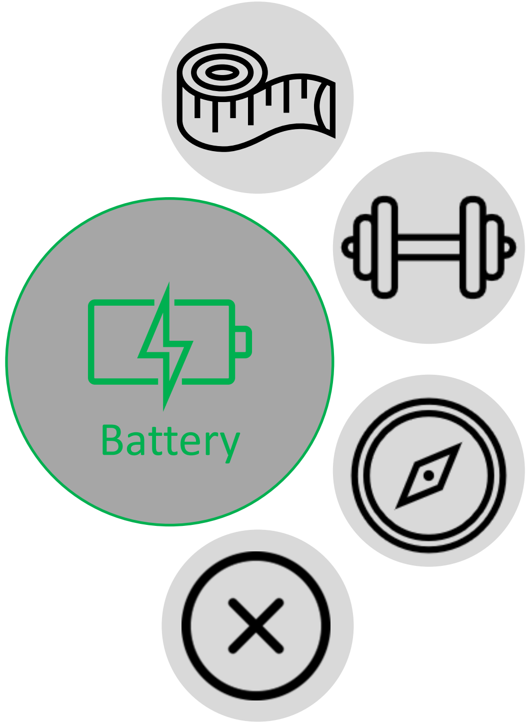
Weight

Ivanna Caballero

Targets and Metrics

The vehicle must be battery powered and have a lifetime of at least 30 minutes

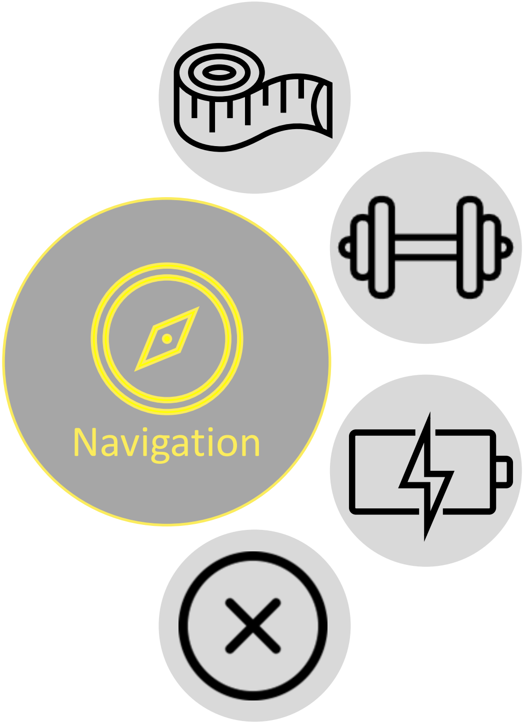




Ivanna Caballero

Targets and Metrics

The vehicle must be autonomous



Ivanna Caballero

Targets and Metrics

The vehicle must have two kill switches: a red stop button and a remote kill switch

Safety

Concept Generation

Biomimicry

Anti-Problem

Crap Shoot

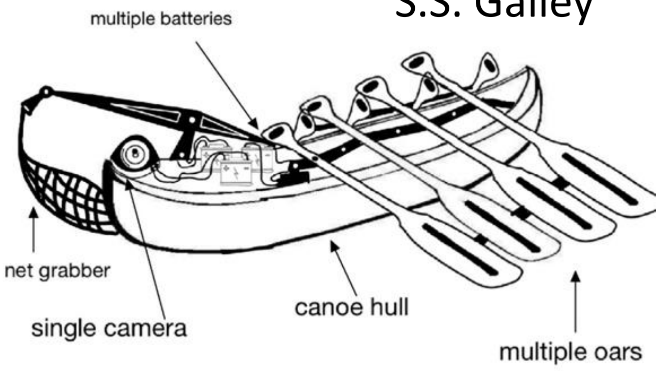
Forced Analogy

Morphological Charts

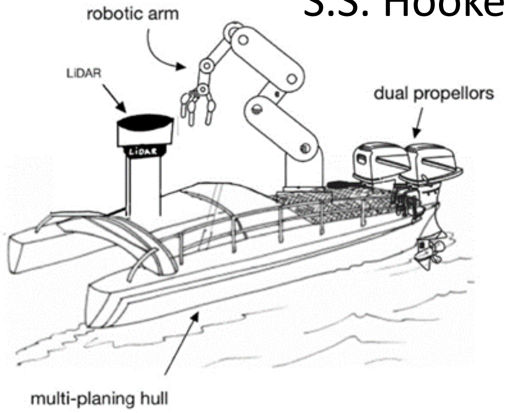
Michael Fitzsimmons

5 Medium Fidelity Concepts

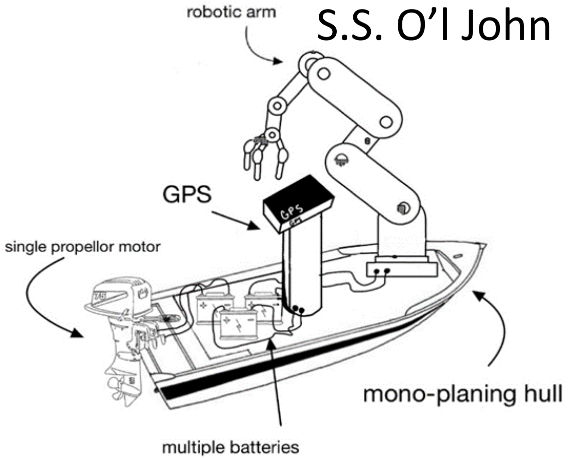
S.S. Galley



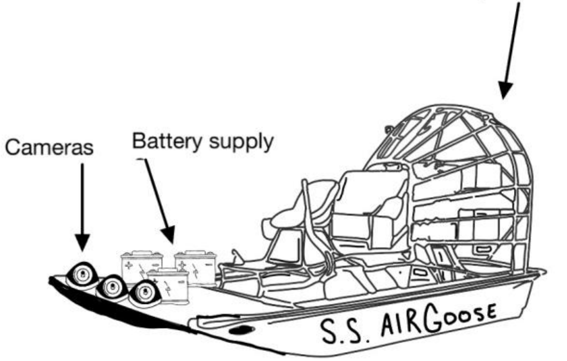
S.S. Hooker



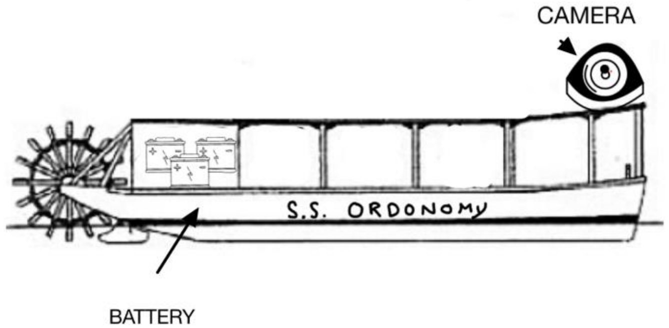
S.S. O'l John



S.S. Air Goose



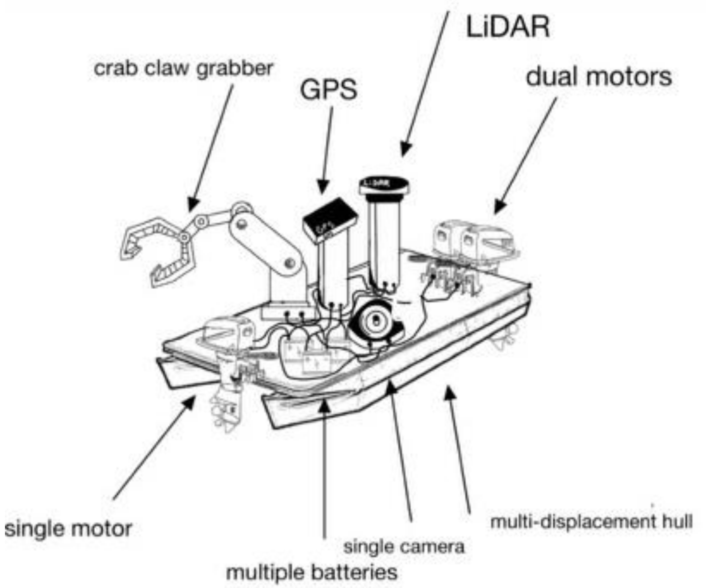
S.S. Ordonomy



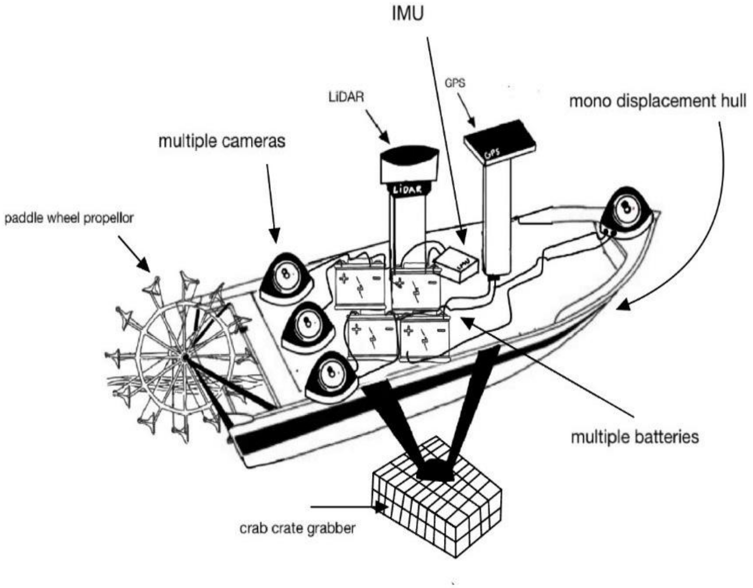
Michael Fitzsimmons

3 High Fidelity Concepts

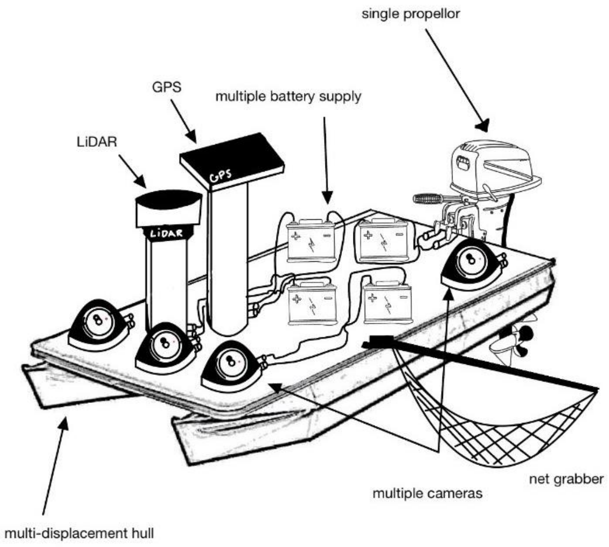
S.S. Shayne 1.0



S.S. Octo



S.S. Slow N' Steady



Concept Selection

Pairwise
Comparison

House of
Quality

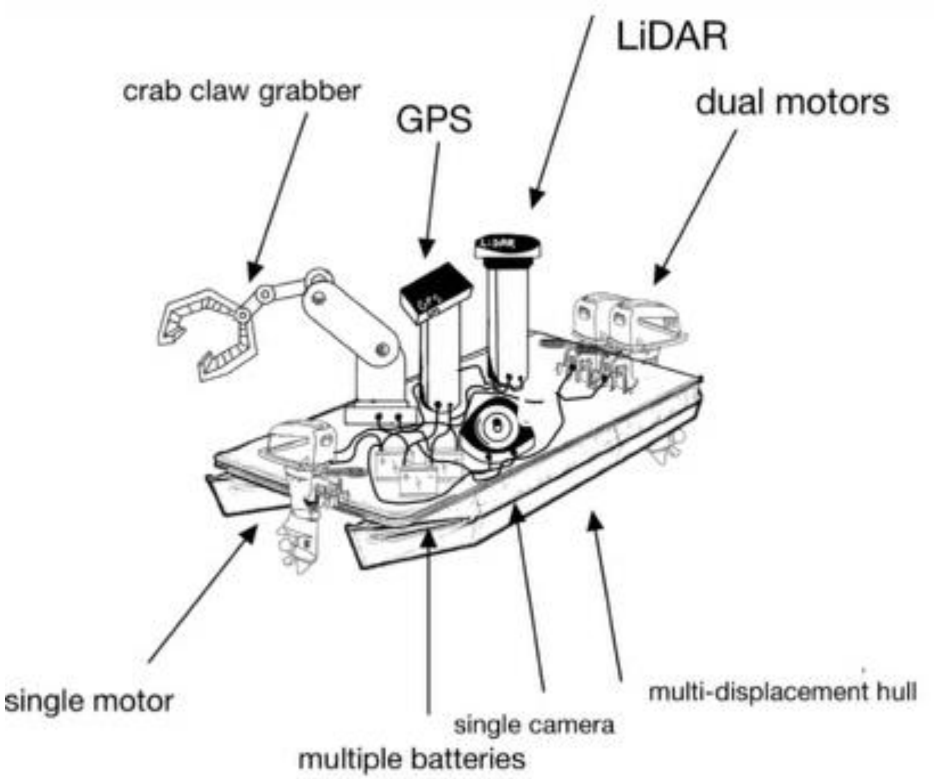
Pugh
Charts

Analytical
Hierarchy

Michael Fitzsimmons

Selected Concept

S.S. Shayne 1.0



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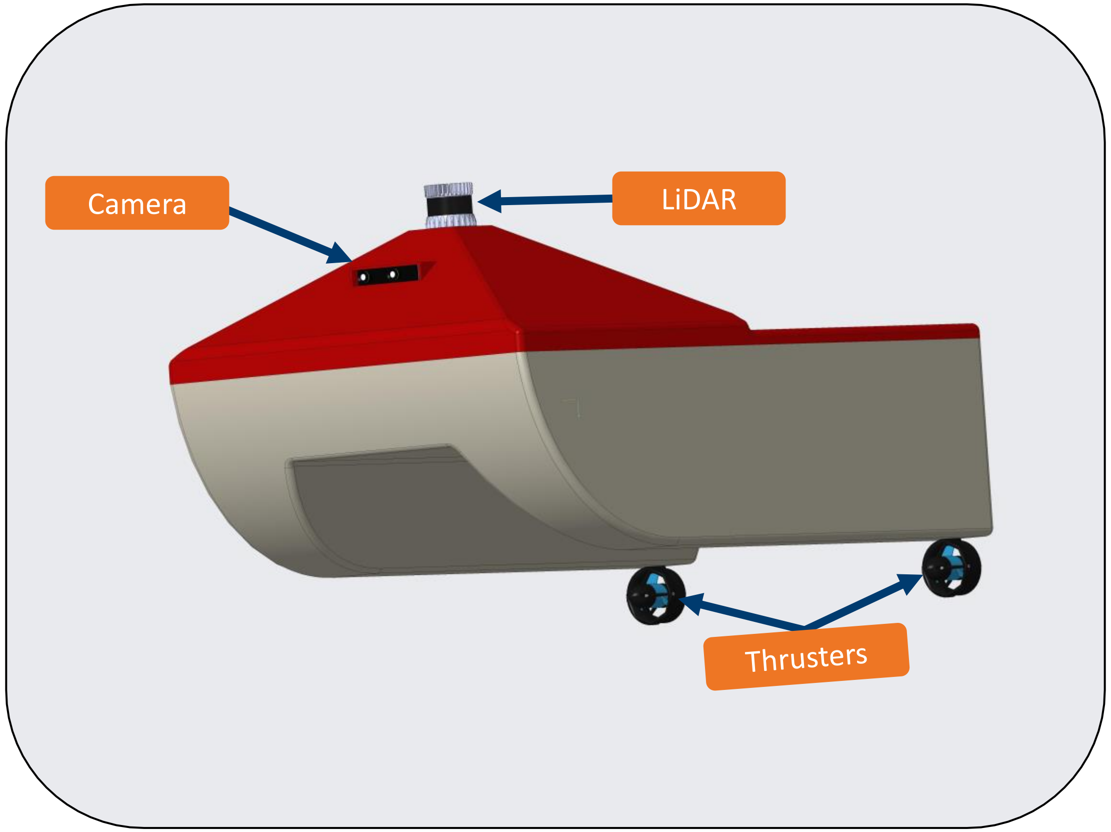
Makenzie Wiggins

Initial Design



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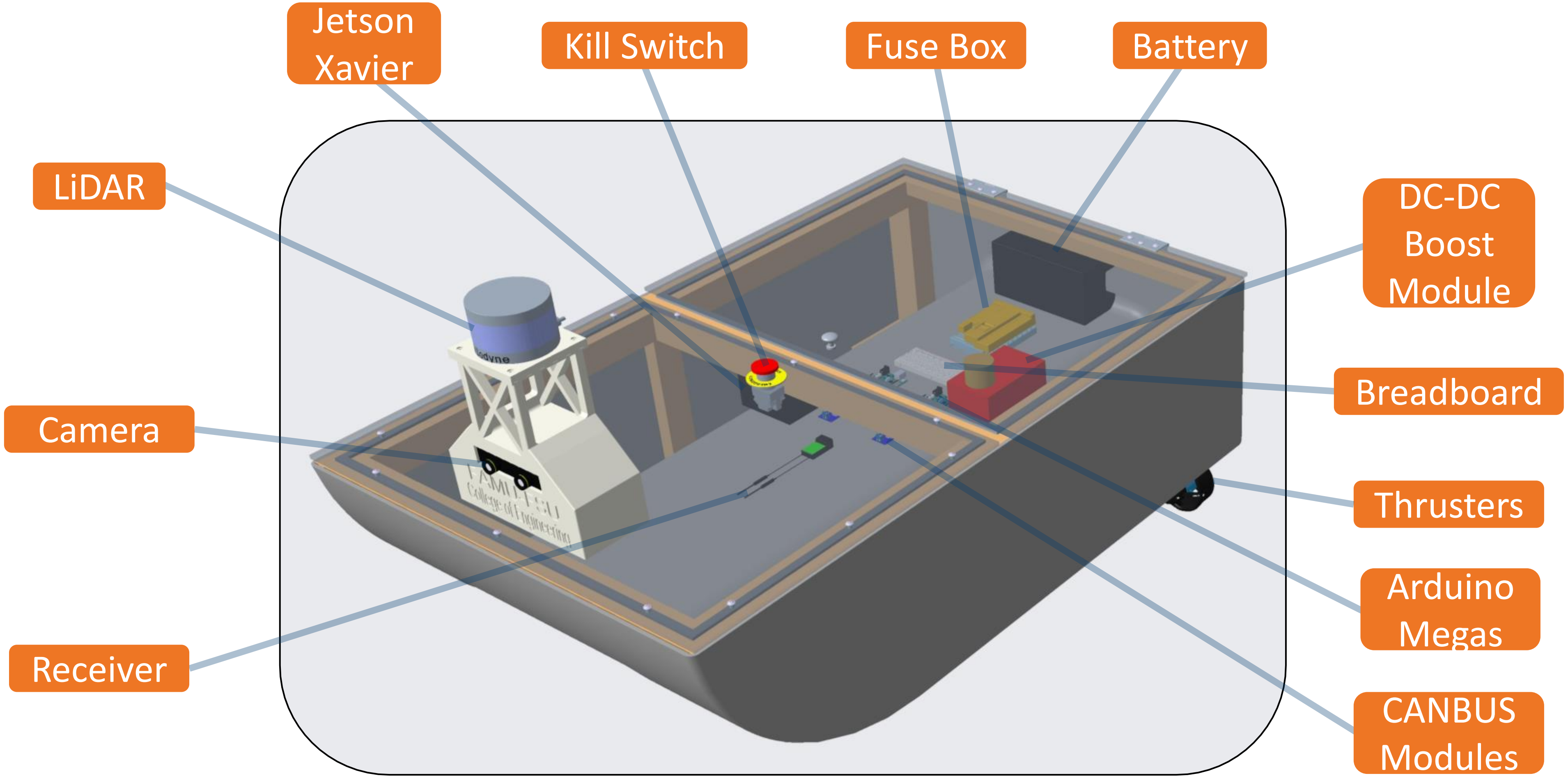
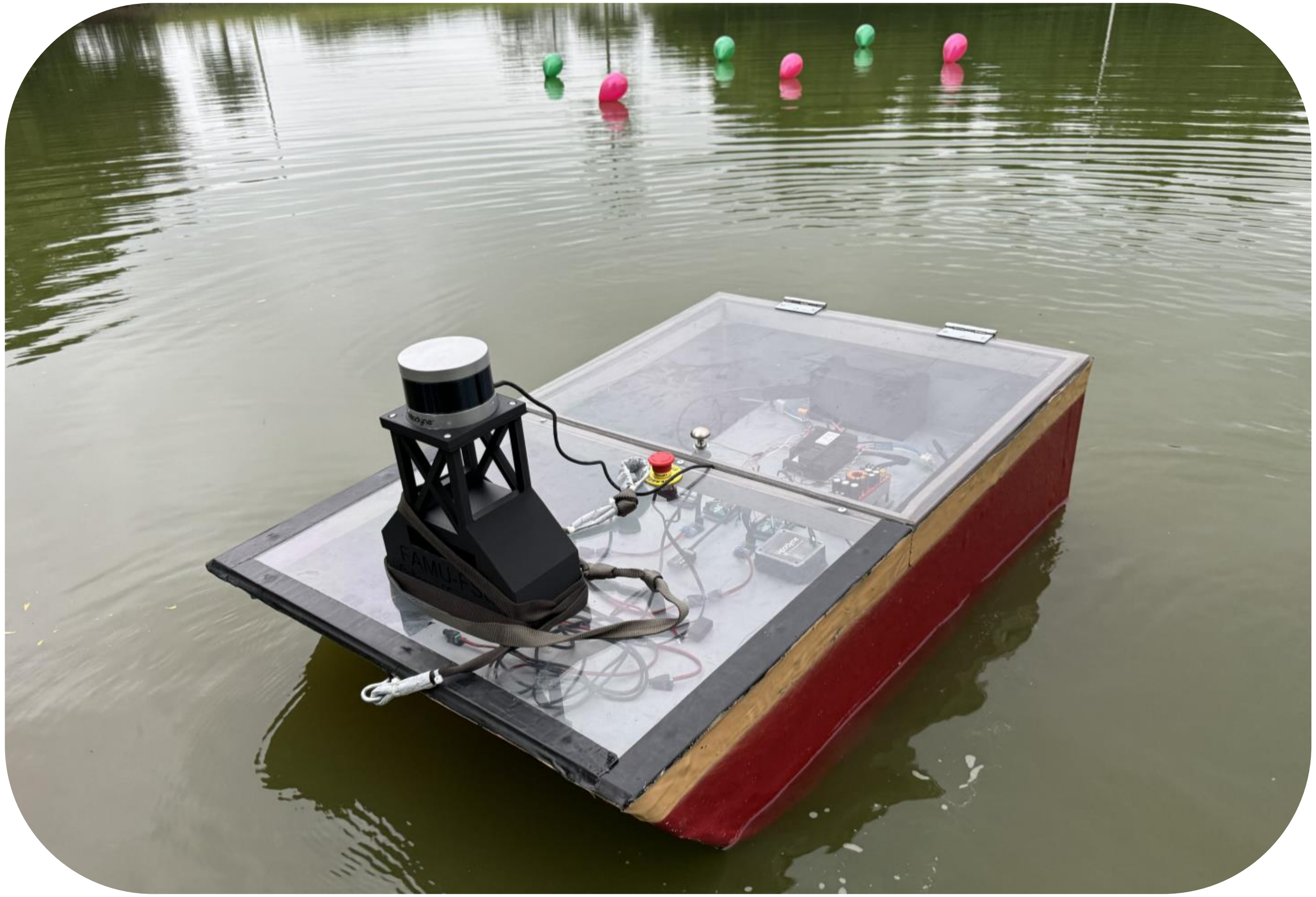
Current Design



Makenzie
Wiggins

Current Design



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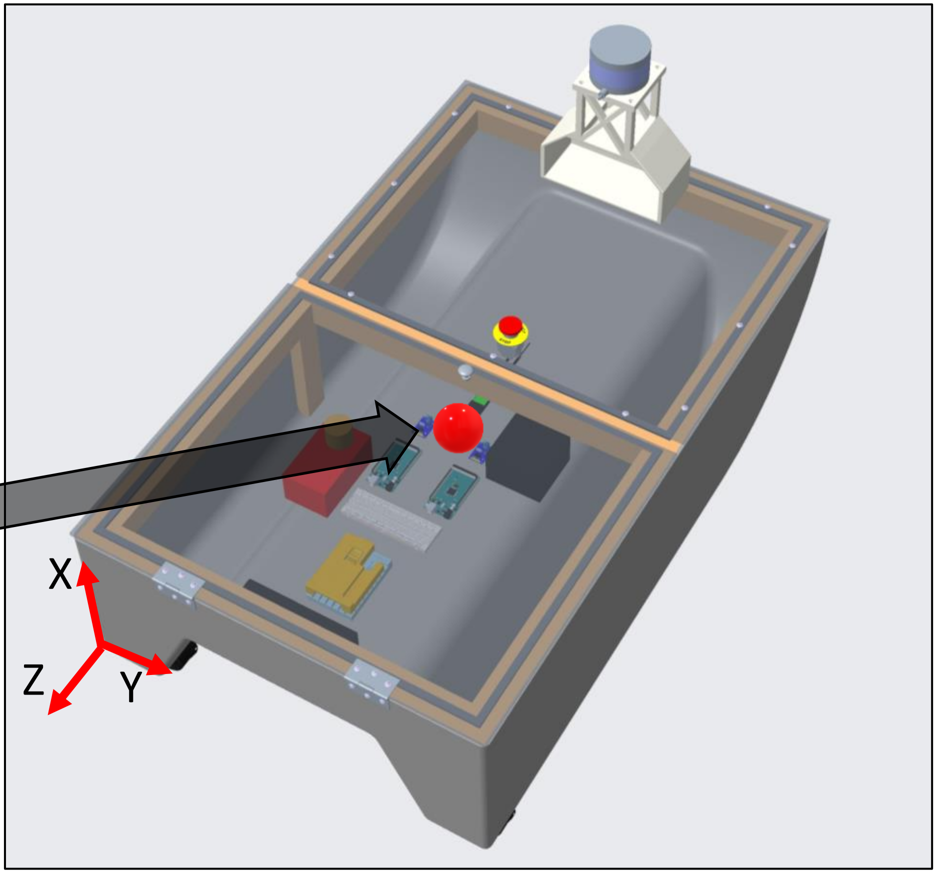
CAD and Center of Mass

- Dynamics
- IMU

Center of mass with components



Electronics Design

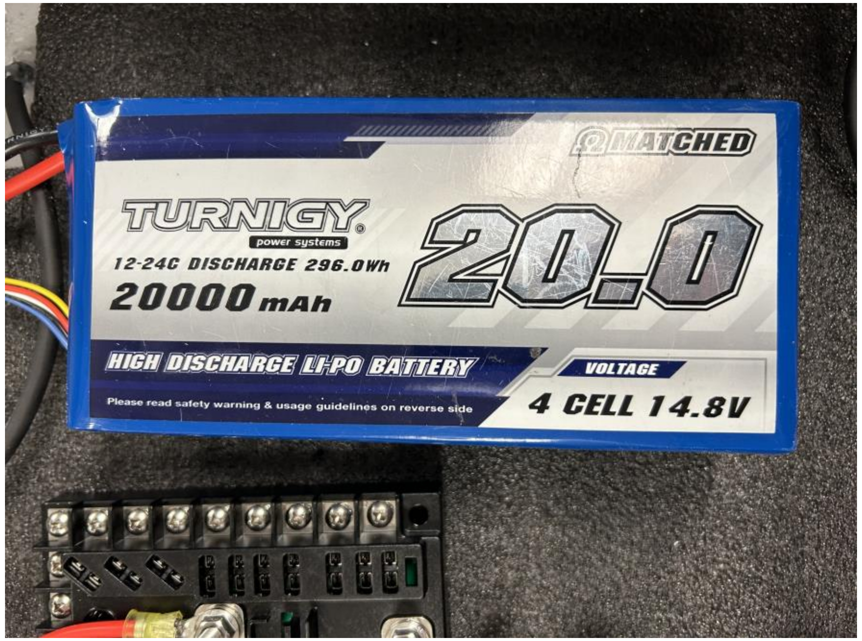
Electrical System

Battery:

- 14.8V battery as main power source

Fuse Panel:

- Delivers power to all components
- Including thrusters, boost converter, and voltage regulator circuit


MATCHED
TURNIGY
power systems
12-24C DISCHARGE 296.0Wh
20000mAh
20.0
HIGH DISCHARGE LI-PO BATTERY
Please read safety warning & usage guidelines on reverse side
VOLTAGE
4 CELL 14.8V

Electronics Design

Power Distribution

T200 Thrusters:

- Powered by fuse panel and ESCs

Voltage Regulator Circuit:

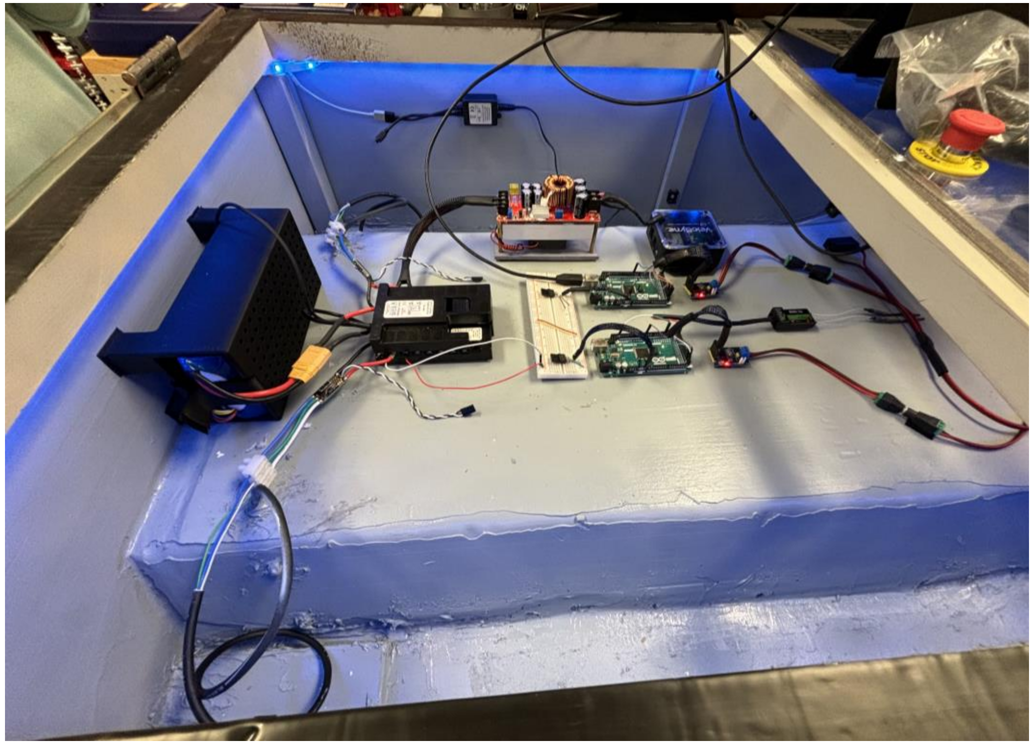
- Arduino microcontrollers receive appropriate voltage level

Boost Converter:

- Steps 14.8V battery up to 19.5V

Velodyne LiDAR:

- Receives 19.5V due to connection with boost converter



Electronics Design

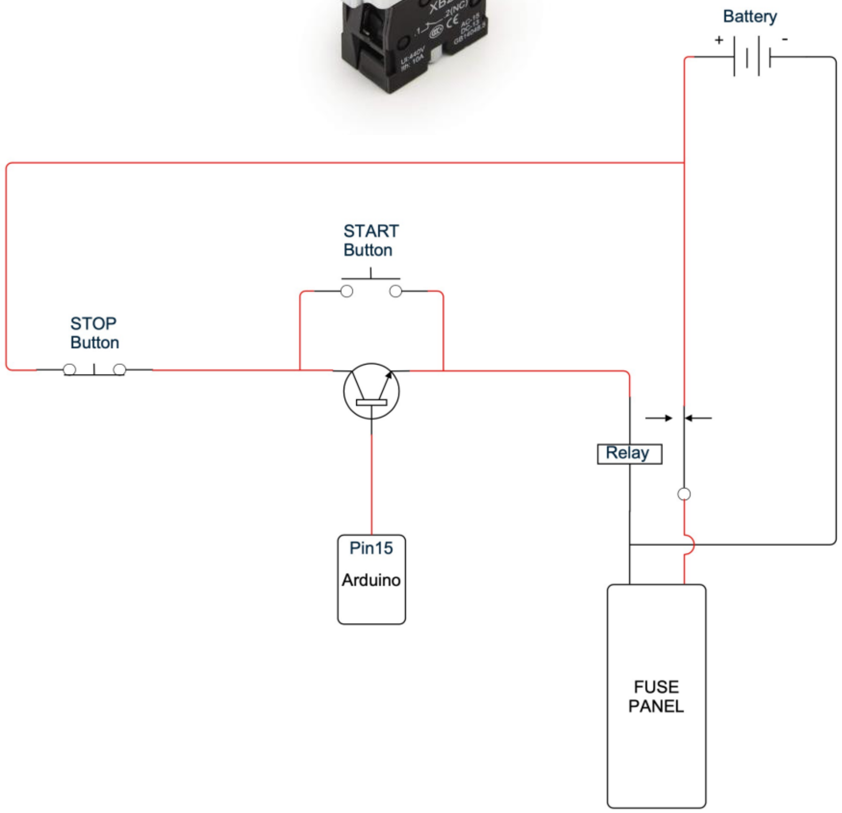
Kill Switch

Emergency Kill Switch Integration:

- Located on the top of the boat for easy access

Relay at Battery Terminal:

- 80A relay takes input from Arduino and E-Stop Button
- All power completely disconnected
- Designed to work within current limits of system

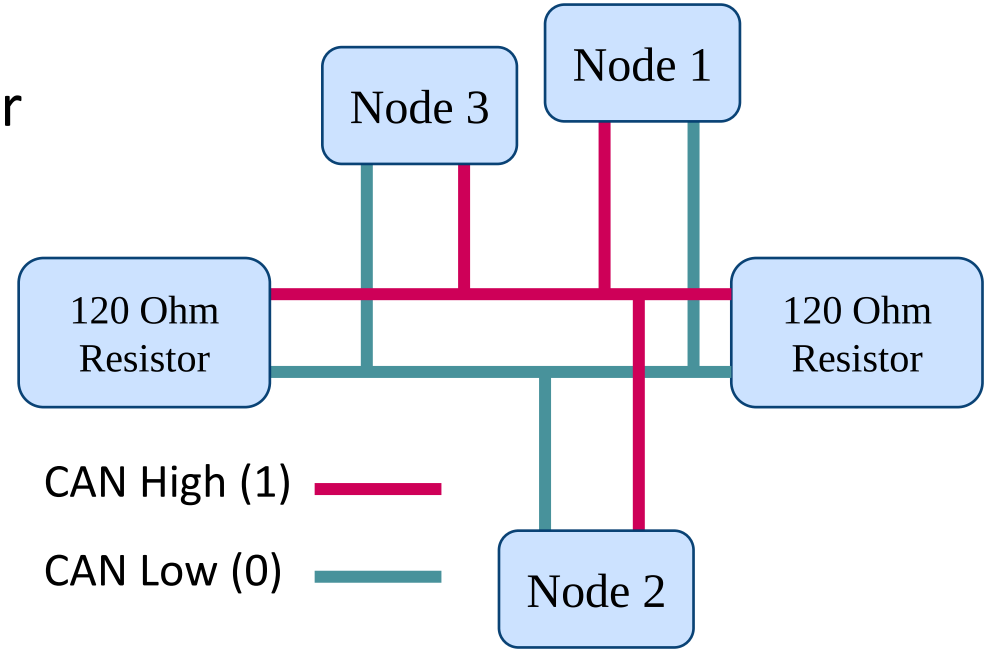


Andly Jean

Mechatronics Design

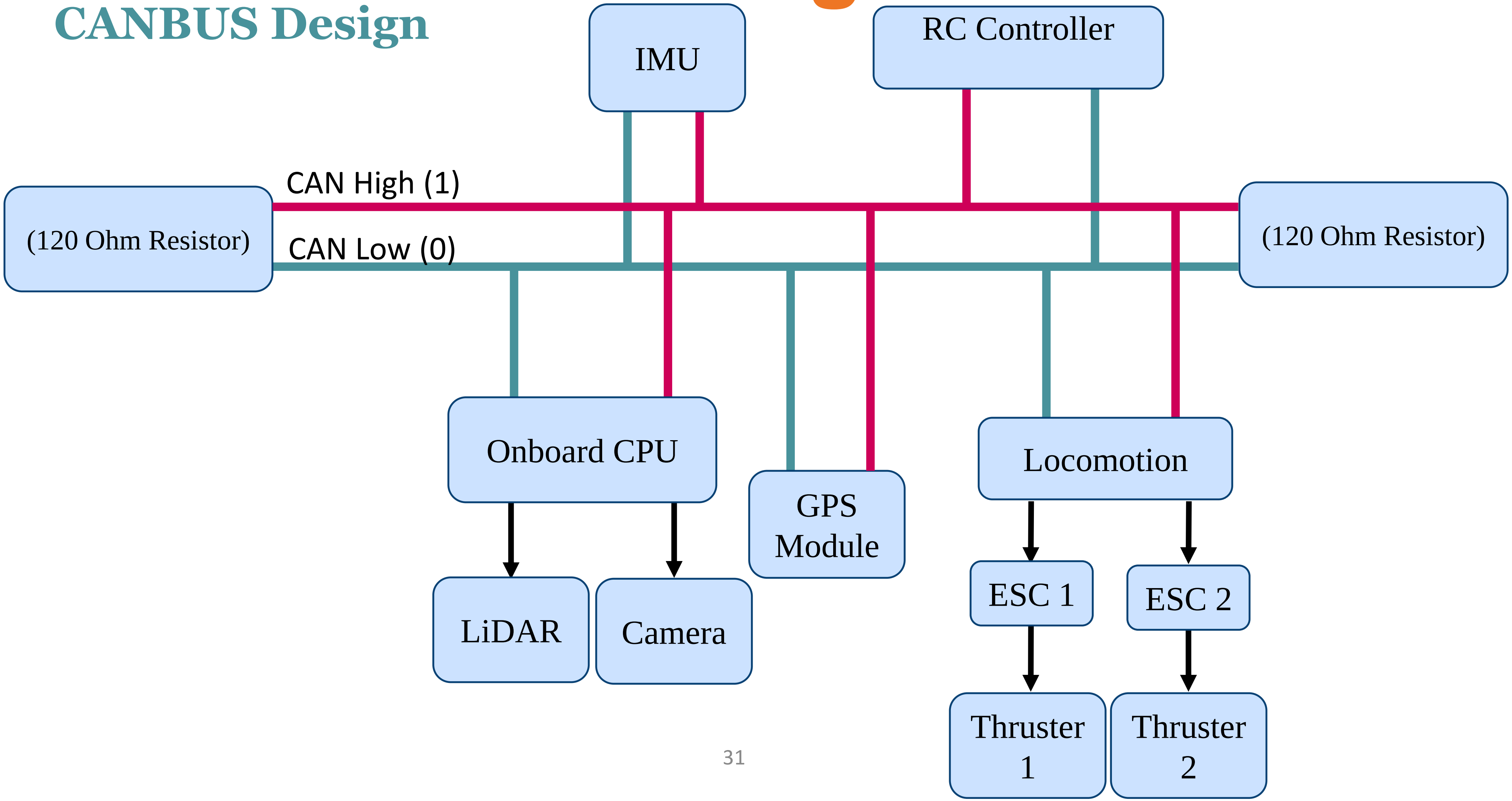
CANBUS Design

- Controller Area Network (CAN)
- Resistors help pull lines back together
  - Remove noise
- 16 AWG (Gauge)Wires
- CAN ID: 0x02
  - Lower ID = Higher Priority
- CAN DLC: Data Length
- MCP2515 – max 8 bits (0-255)
- Only 1 message on the line at a time



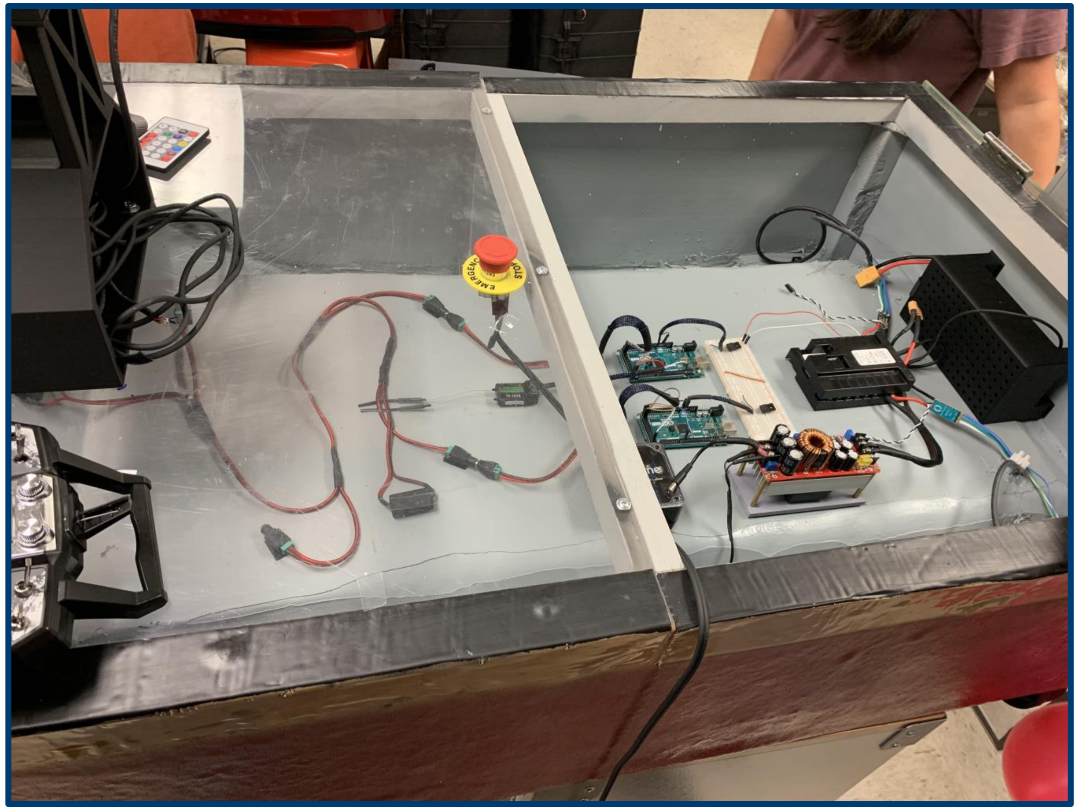
Mechatronics Design

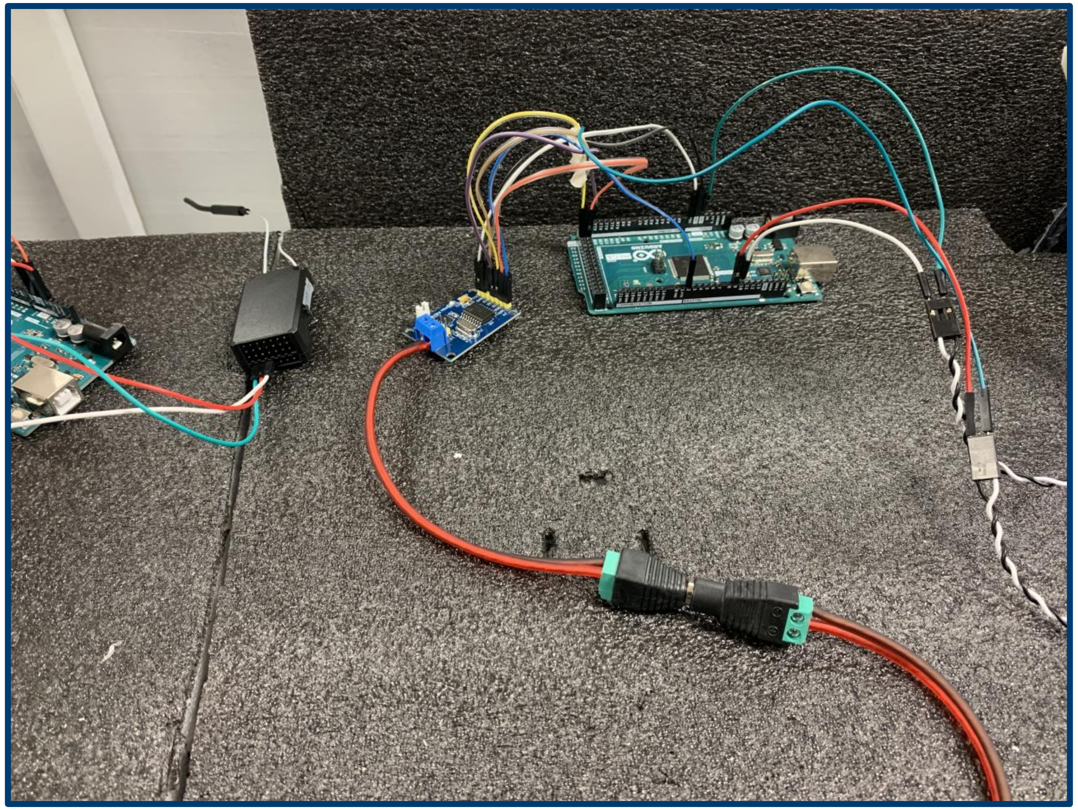
CANBUS Design



Mechatronics Design

CANBUS Design





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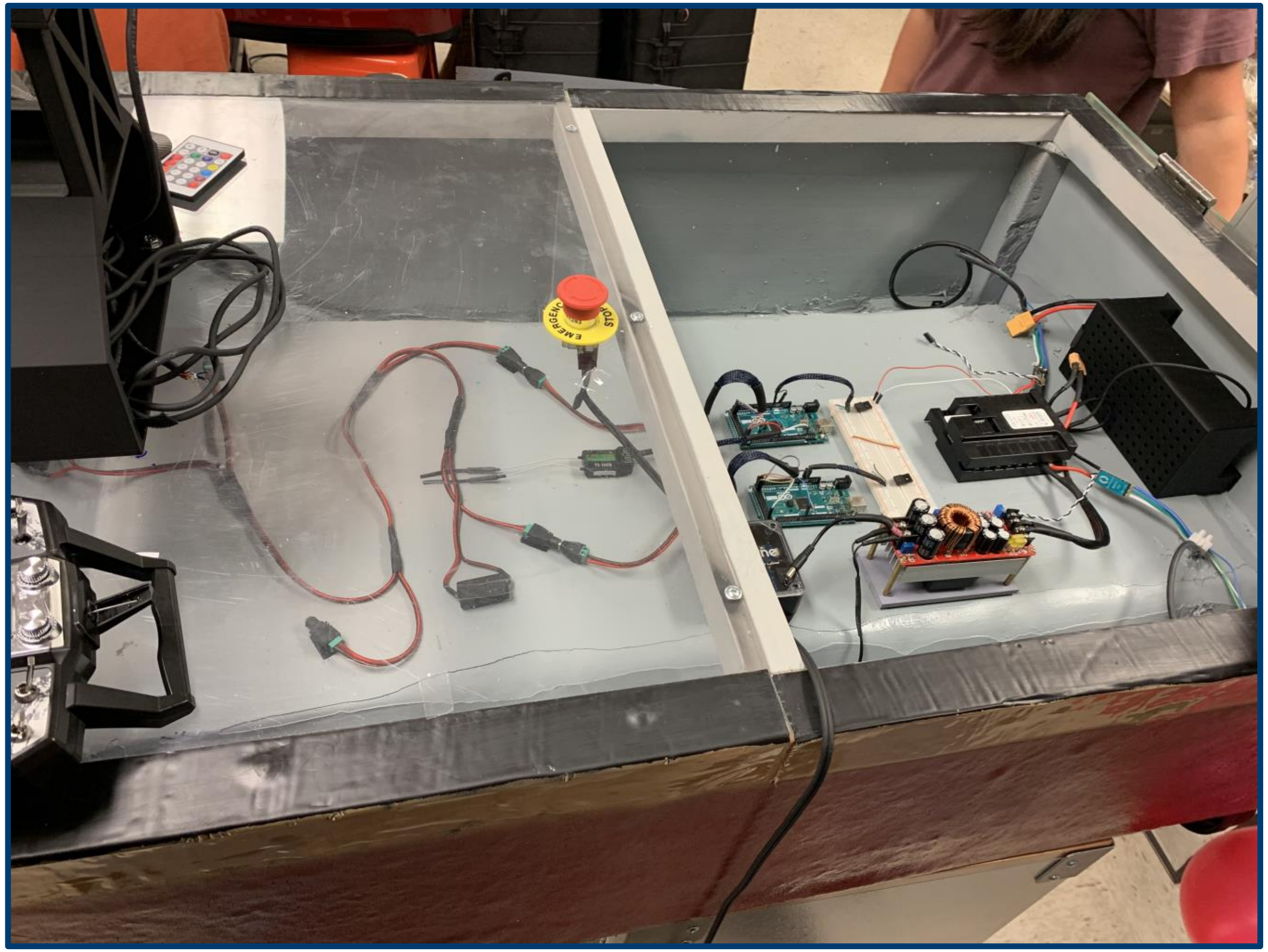
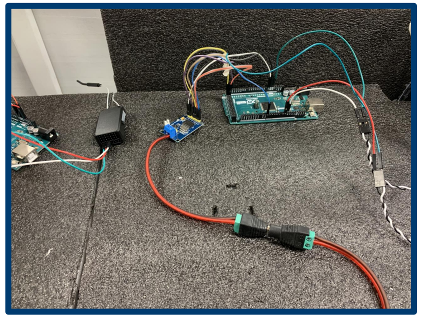
Mechatronics Design

CANBUS Design





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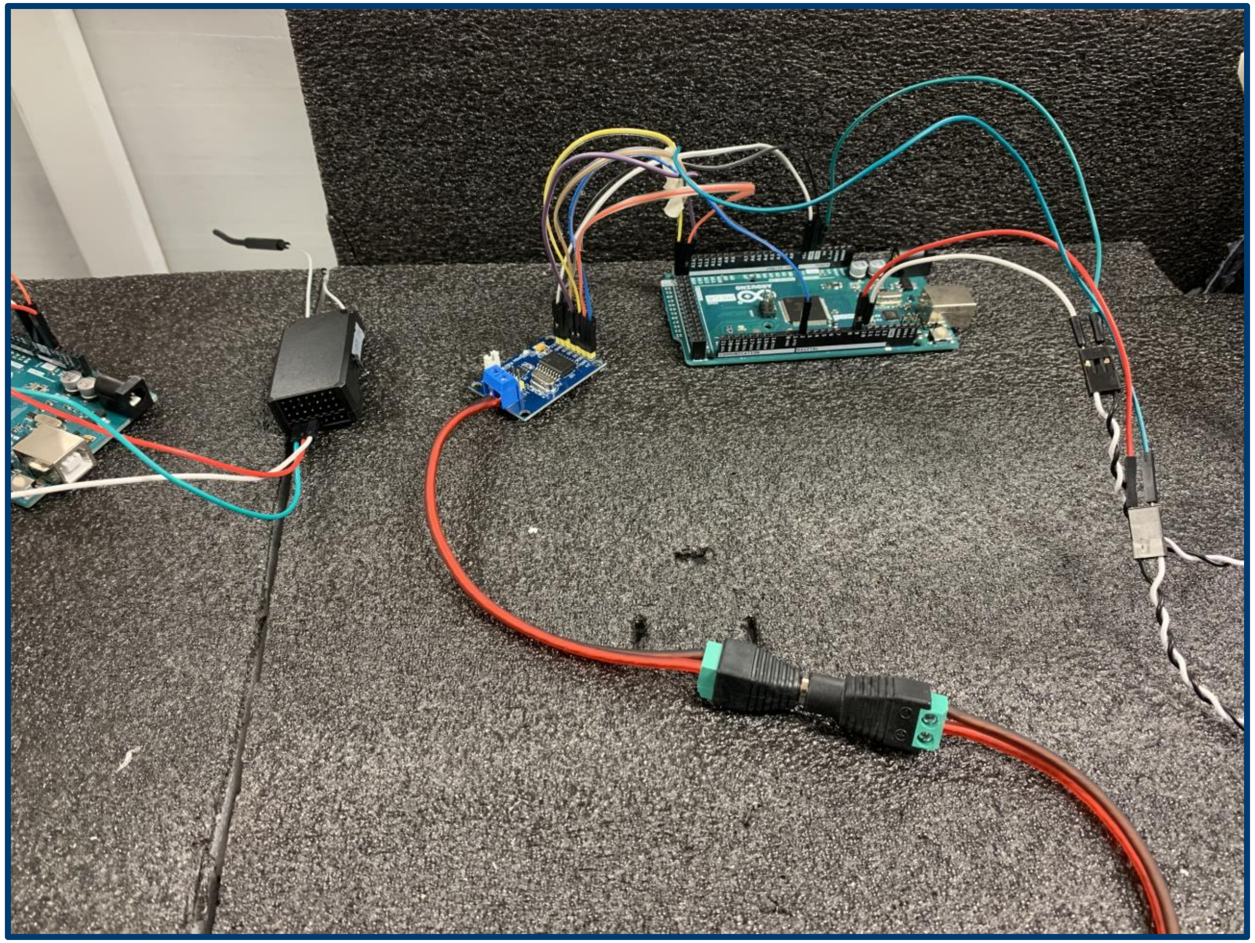
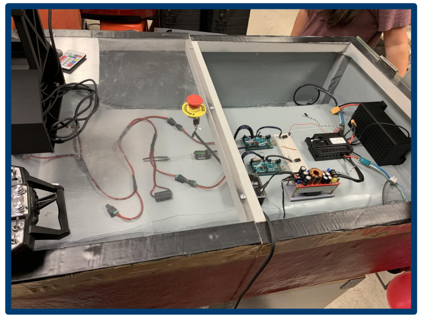
Mechatronics Design

CANBUS Design

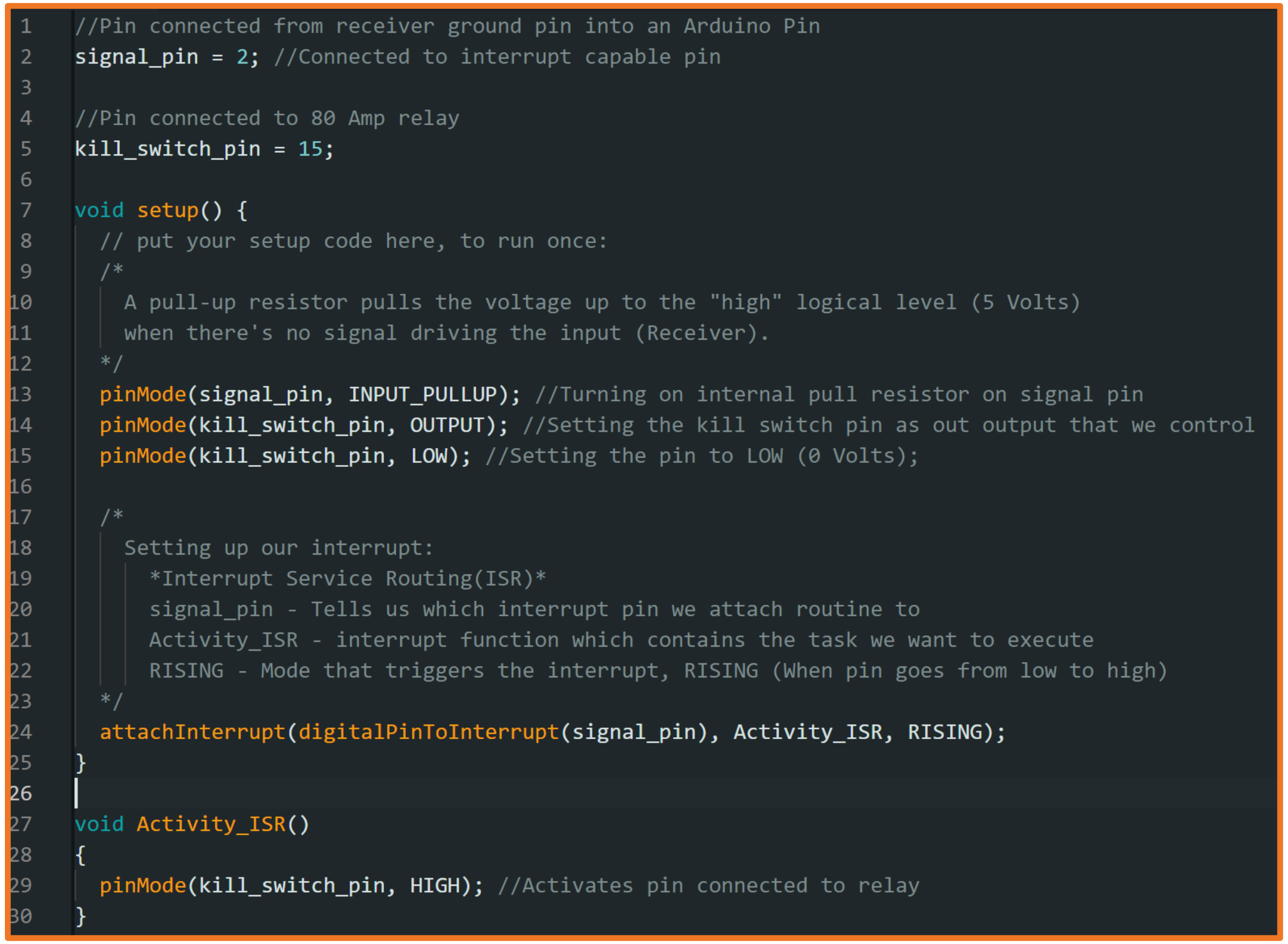




Andly Jean

Mechatronics Design

Remote Control is King



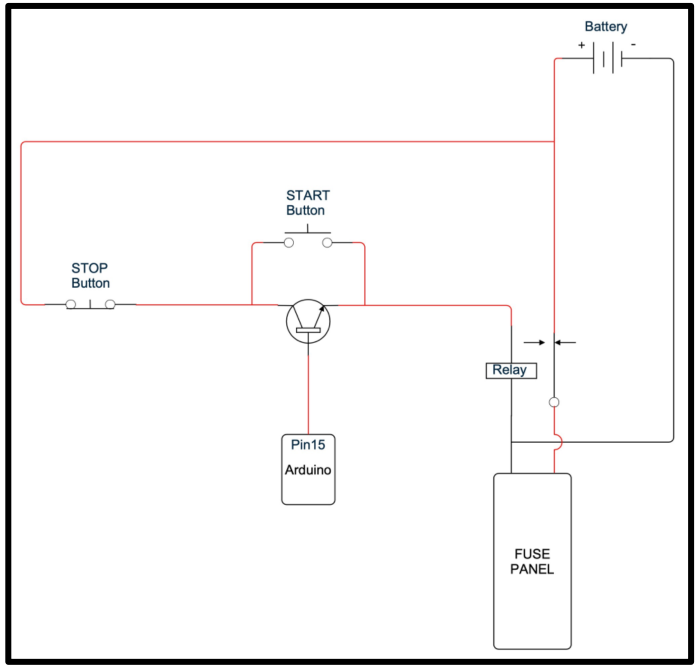
```
//Pin connected from receiver ground pin into an Arduino Pin
signal_pin = 2; //Connected to interrupt capable pin

//Pin connected to 80 Amp relay
kill_switch_pin = 15;

void setup() {
  // put your setup code here, to run once:
  /*
    A pull-up resistor pulls the voltage up to the "high" logical level (5 Volts)
    when there's no signal driving the input (Receiver).
  */
  pinMode(signal_pin, INPUT_PULLUP); //Turning on internal pull resistor on signal pin
  pinMode(kill_switch_pin, OUTPUT); //Setting the kill switch pin as out output that we control
  pinMode(kill_switch_pin, LOW); //Setting the pin to LOW (0 Volts);

  /*
    Setting up our interrupt:
      *Interrupt Service Routing(ISR)*
      signal_pin - Tells us which interrupt pin we attach routine to
      Activity_ISR - interrupt function which contains the task we want to execute
      RISING - Mode that triggers the interrupt, RISING (When pin goes from low to high)
  */
  attachInterrupt(digitalPinToInterrupt(signal_pin), Activity_ISR, RISING);
}

void Activity_ISR()
{
  pinMode(kill_switch_pin, HIGH); //Activates pin connected to relay
}
```



Andly Jean

Object Detection

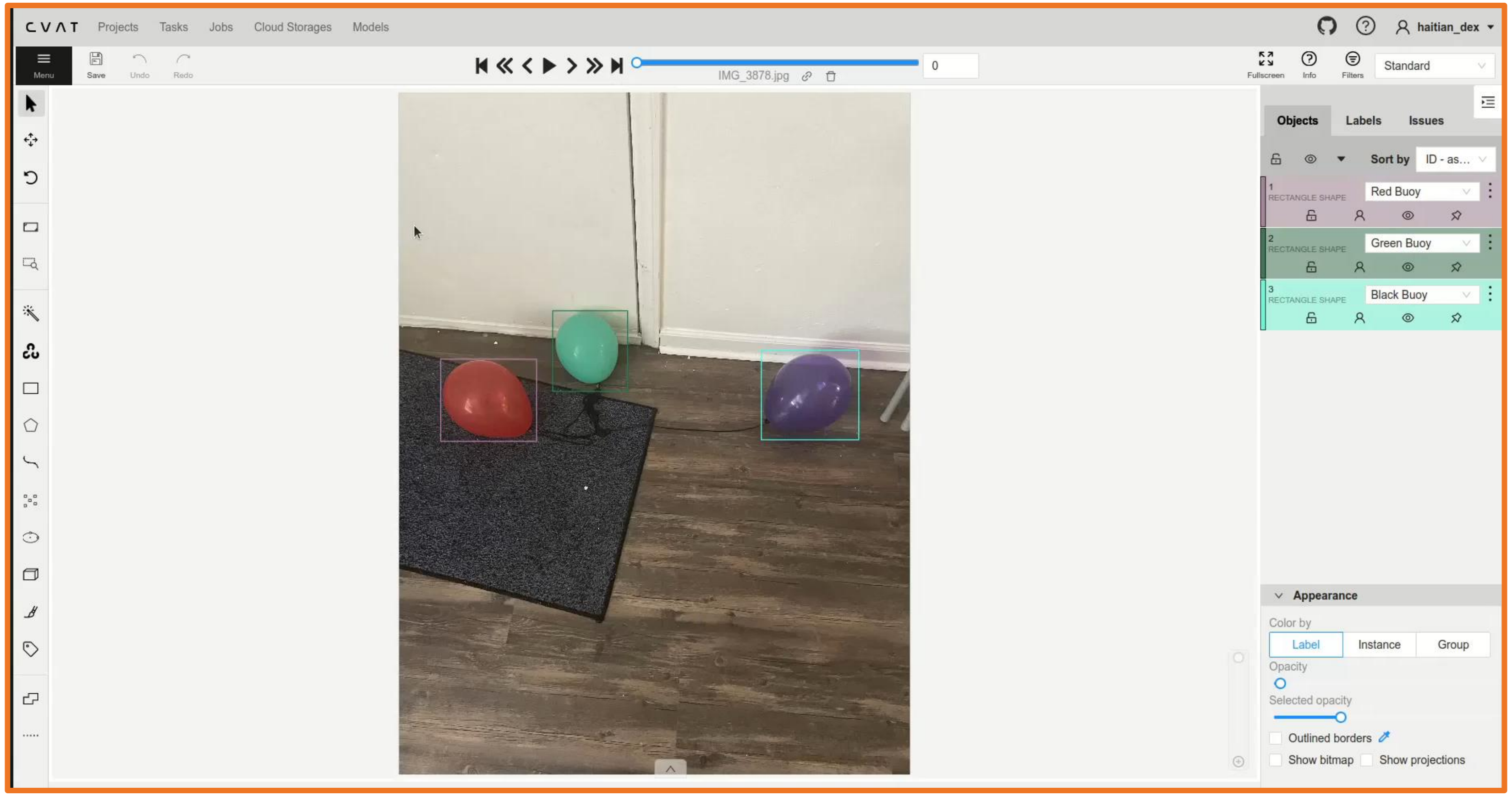
Requirements

- Recognize red and green buoys as desired channel
- Recognize yellow buoys and keep track of count
- Recognize black buoys as object to avoid

Training Process

- Input and annotate data set (Images)
- Feed data set to object detection model (YOLOv8)
- Test model on separate validation data set
- Optimizes to best fit data set

Annotate



1 RECTANGLE SHAPE: Red Buoy

2 RECTANGLE SHAPE: Green Buoy

3 RECTANGLE SHAPE: Black Buoy

Color by: Label | Instance | Group

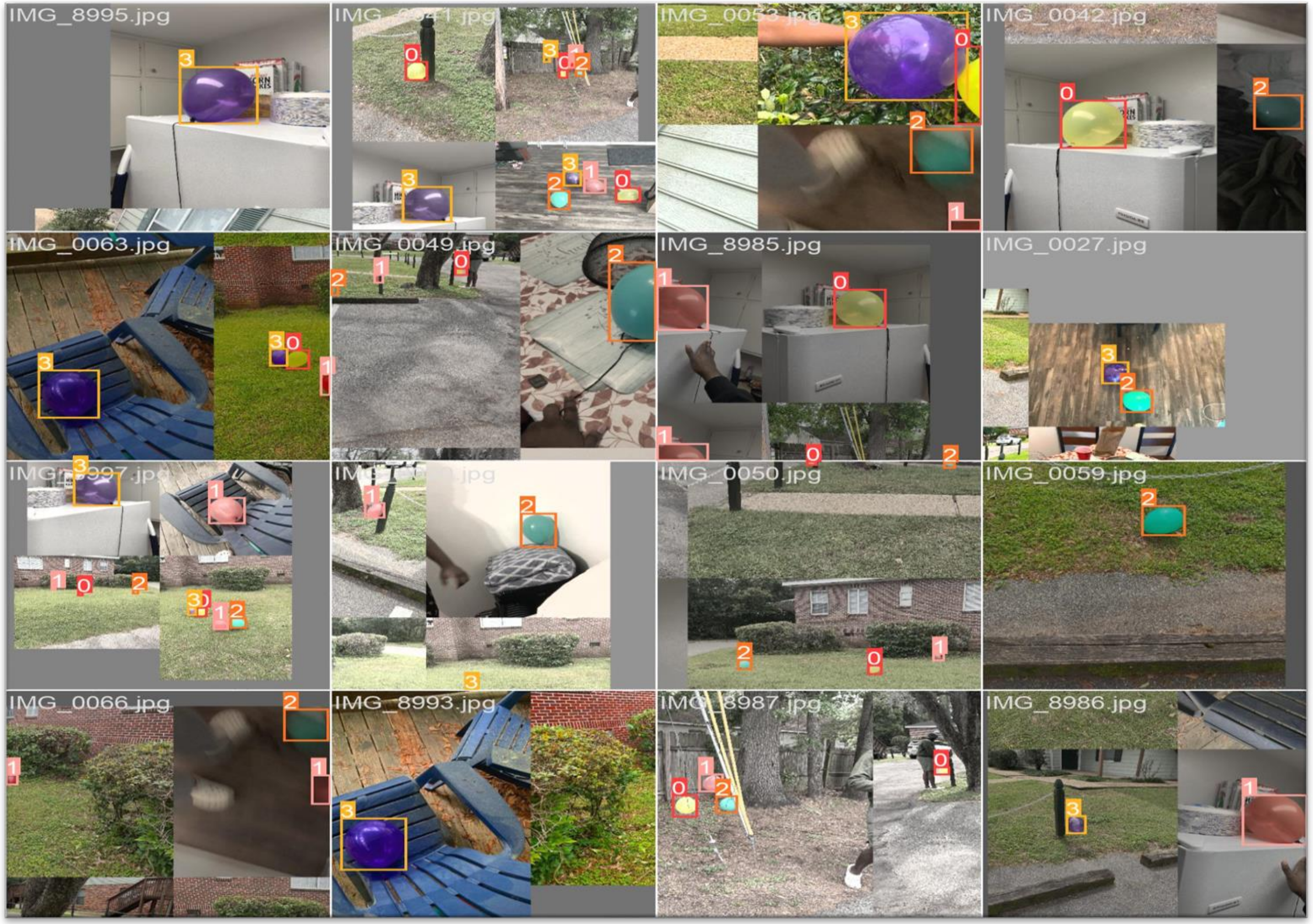
Opacity

Selected opacity

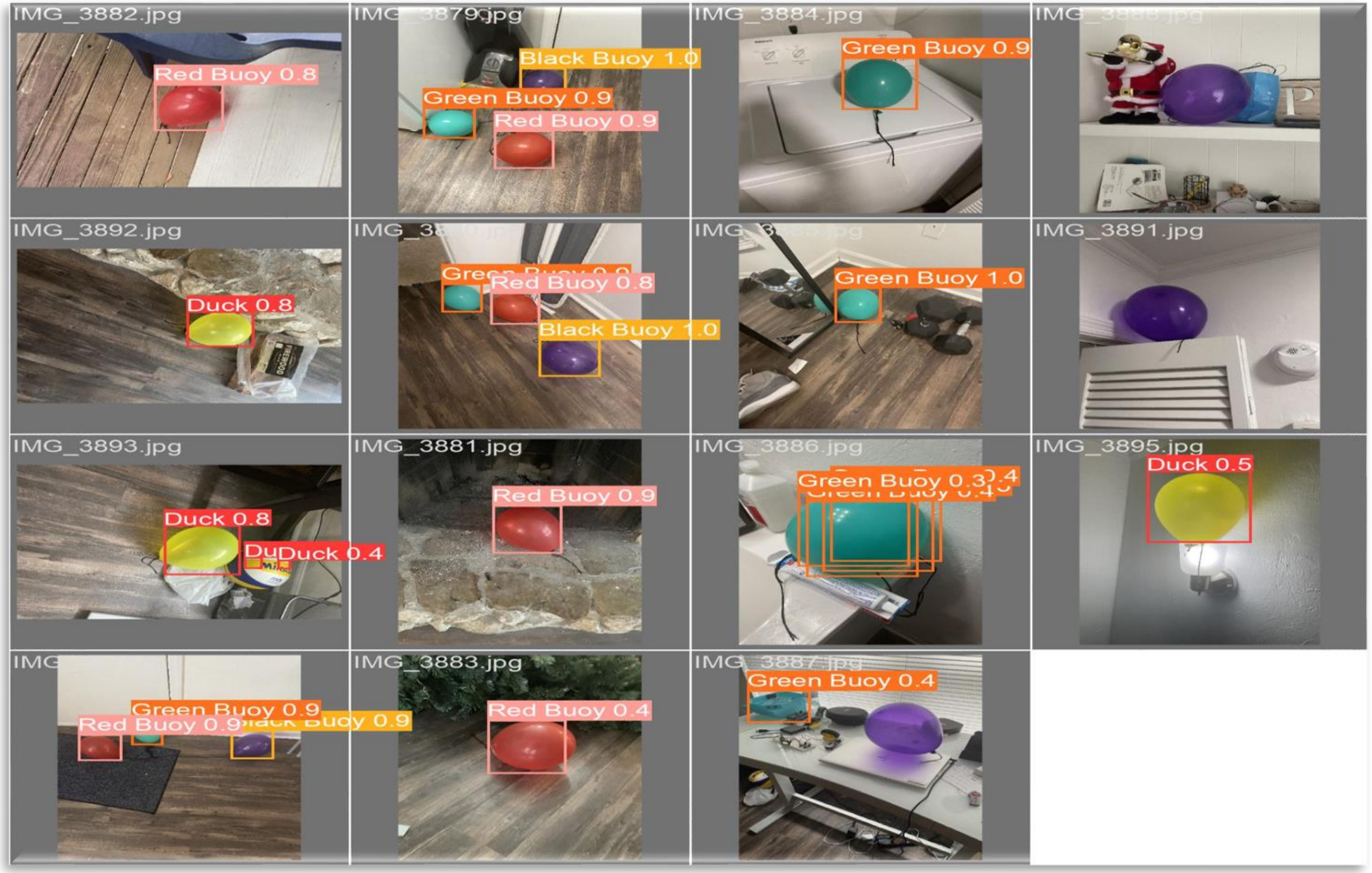
□ Outlined borders

□ Show bitmap □ Show projections

Train


IMG_8995.jpg
IMG_0053.jpg
IMG_0042.jpg
IMG_0063.jpg
IMG_0049.jpg
IMG_8985.jpg
IMG_0027.jpg
IMG_0050.jpg
IMG_0059.jpg
IMG_0066.jpg
IMG_8993.jpg
IMG_8987.jpg
IMG_8986.jpg

Validate


IMG_3882.jpg
Red Buoy 0.8
IMG_3879.jpg
Black Buoy 1.0
Green Buoy 0.9
Red Buoy 0.9
IMG_3884.jpg
Green Buoy 0.9
IMG_3892.jpg
Duck 0.8
Red Buoy 0.8
Black Buoy 1.0
Green Buoy 1.0
IMG_3891.jpg
IMG_3893.jpg
Duck 0.8
Duck 0.4
IMG_3881.jpg
Red Buoy 0.9
IMG_3886.jpg
Green Buoy 0.3
IMG_3895.jpg
Duck 0.5
Green Buoy 0.9
Red Buoy 0.9
Black Buoy 0.9
IMG_3883.jpg
Red Buoy 0.4
Green Buoy 0.4

Navigation

Controller Playback

- Record RC inputs and play them back
- Semi-Autonomous
- Easier to setup
  - Meant as a backup alternative

Waypoint Following

- List of waypoints through the course
- Semi-Autonomous
- More efficient

Nicholas Norwood

Navigation

Controller Playback

- Made up of 3 modes
- Mode 1:
  - Operates as normal RC vehicle
- Mode 2:
  - Operates as normal RC vehicle
  - Stores current inputs being send to thrusters
- Mode 3:
  - Playbacks recorded input from first to last

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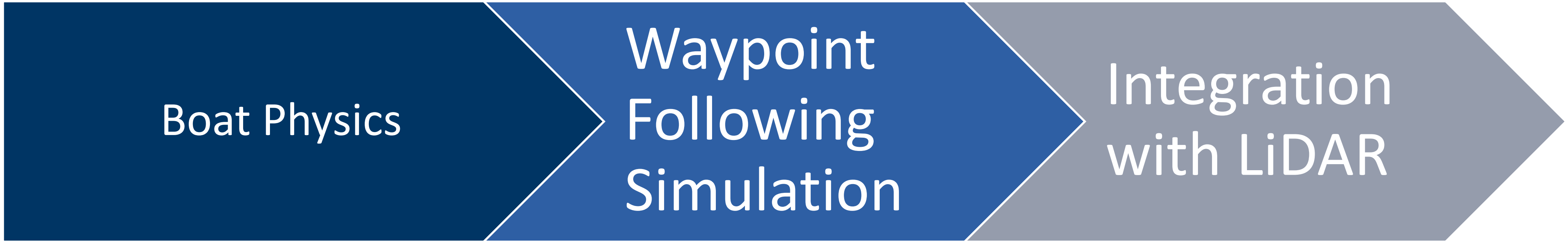
Nicholas Norwood

Navigation

Waypoint Following


Boat Physics

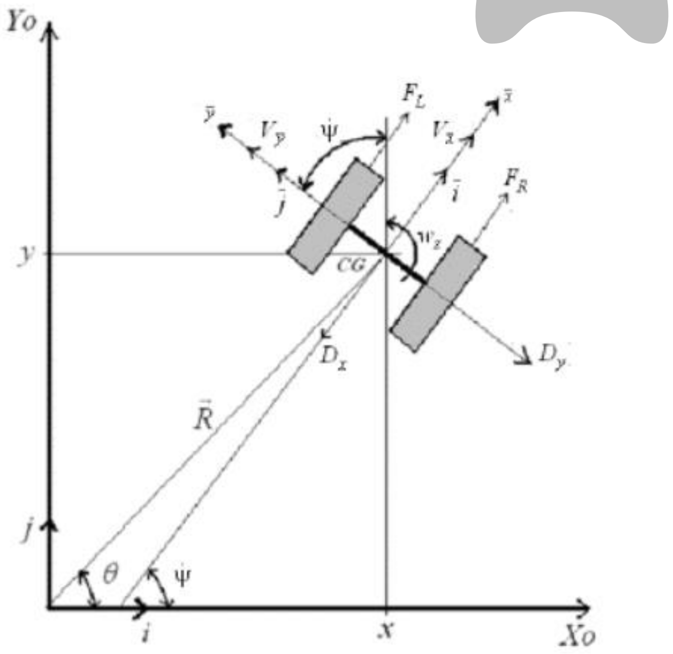
Waypoint Following Simulation

Integration with LiDAR

Navigation

Boat Physics

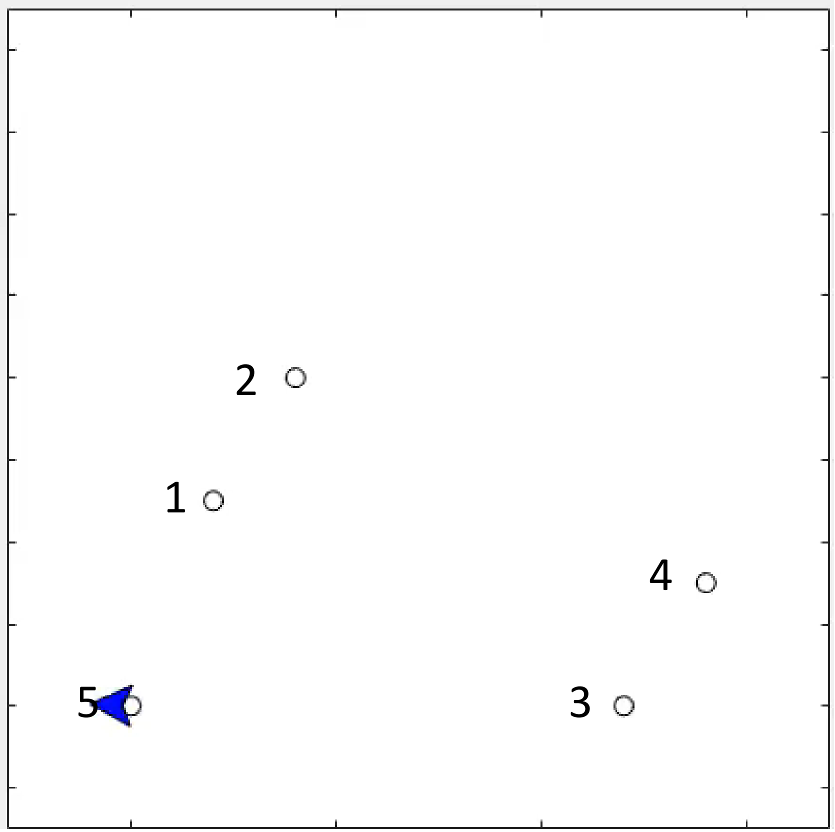
- Free Body Diagram to find forces on the boat
- Use F=ma to create equations that model boat dynamics
- Convert equations into state-space representation
- Constants needed for accurate modeling
  - Mass
  - Moment of Inertia
  - Drag Coefficients



$$\begin{bmatrix} \dot{V}_x \\ \dot{V}_y \\ \dot{p}_x \\ \dot{p}_y \\ \dot{\psi} \\ \dot{w}_Z \end{bmatrix} = \begin{bmatrix} \omega_z V_{\bar{y}} + (F_R + F_L - sign(V_{\bar{x}}) K_x V_x^2))/m \\ -w_z V_{\bar{x}} - sign(V_{\bar{y}}) K_y V_{\bar{y}}^2/m \\ V_{\bar{x}} \cos\psi - V_{\bar{y}} \sin\psi \\ V_{\bar{x}} \sin\psi + V_{\bar{y}} \cos\psi \\ w_z \\ ((F_R - F_L)d - sign(w_Z) K_Z w_Z^2)/J \end{bmatrix}$$

Navigation

Waypoint Following Simulation



- Inputs
  - Waypoints
  - Initial guess of motor commands
- Outputs
  - List of commands for motors
  - Time interval for between each waypoint
- List of commands converted from force inputs to motor signals

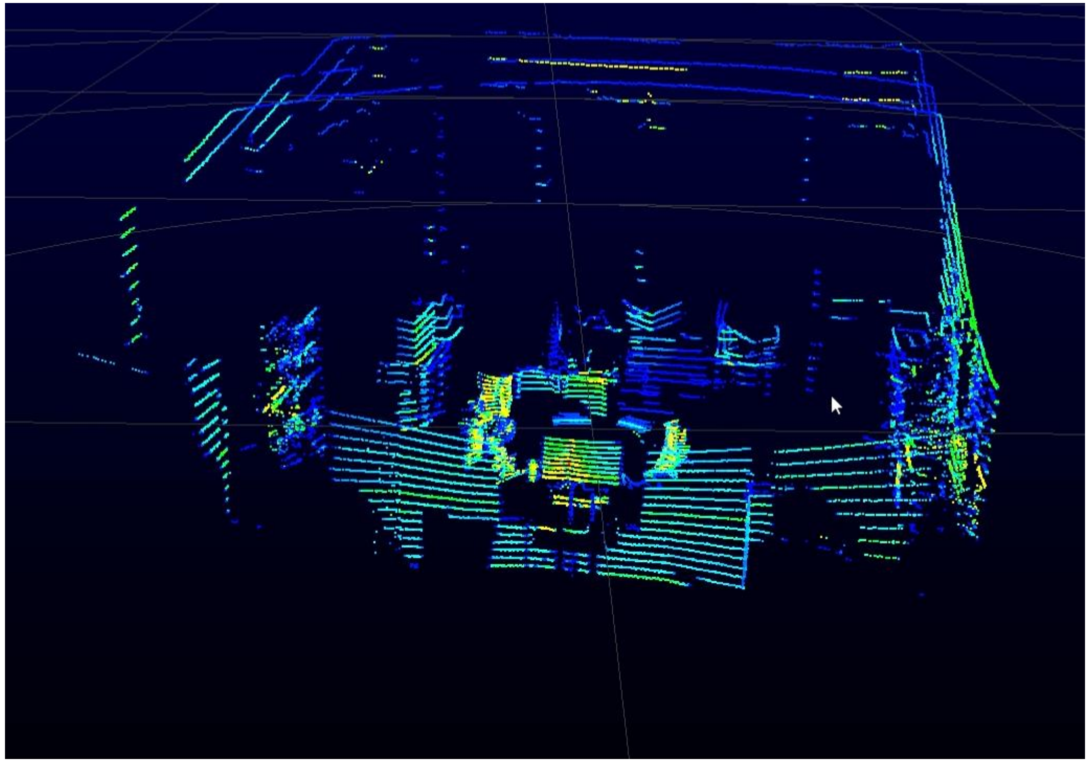
Nicholas Norwood

Navigation

Integration with LiDAR

- Map challenge course with LiDAR
- Select waypoints using LiDAR map
- Feed waypoints into Matlab Simulation
- Transfer motor commands to Microcontrollers

LiDAR Map



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Testing and Validation

- Hull taking on water at the bottom of boat
  - Tested by spray painting the inside
- RC Controls & Waypoint following
  - Tested in COE lake
- Main battery power control
  - Tested by multimeter & power getting to individual parts

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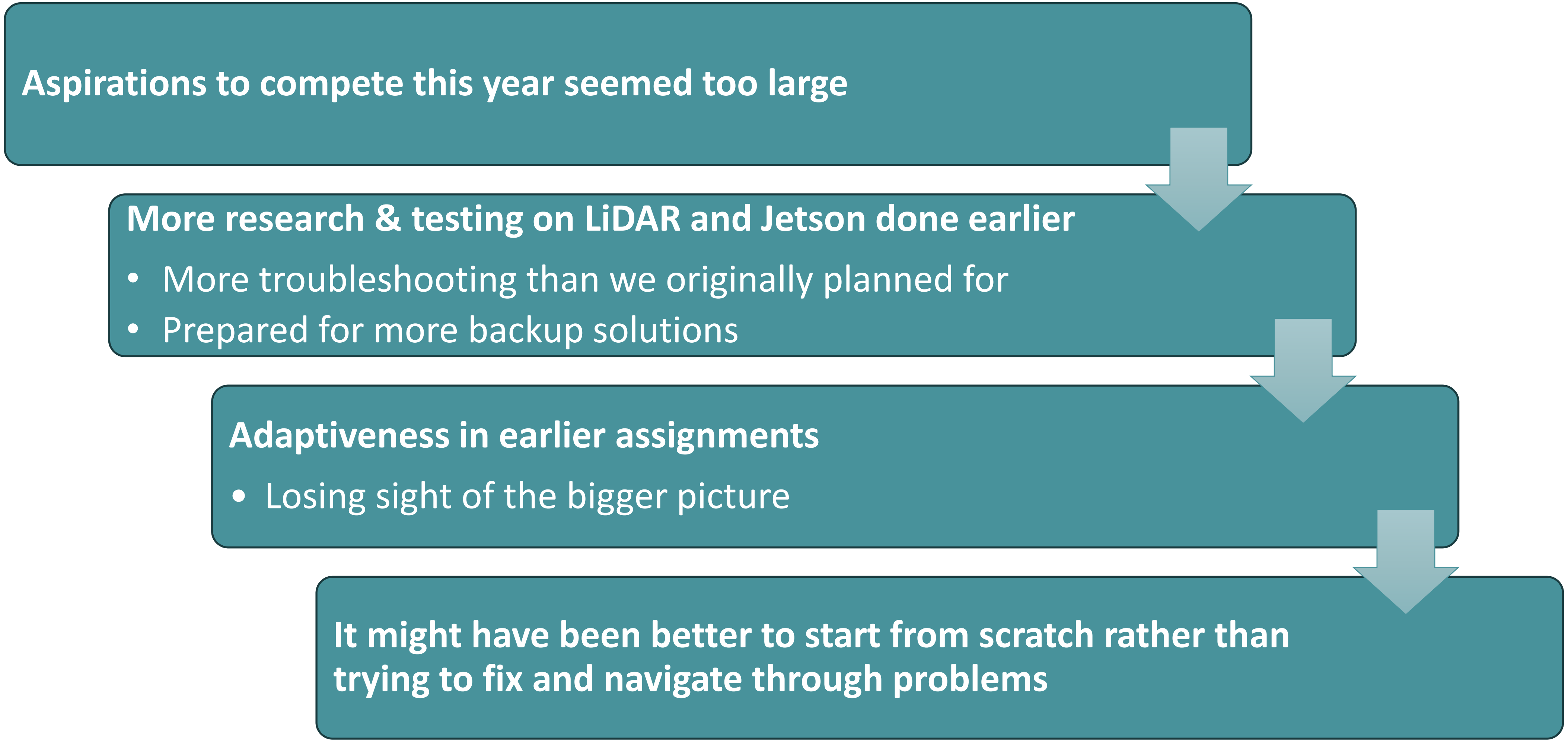
Lessons Learned



Aspirations to compete this year seemed too large

More research & testing on LiDAR and Jetson done earlier

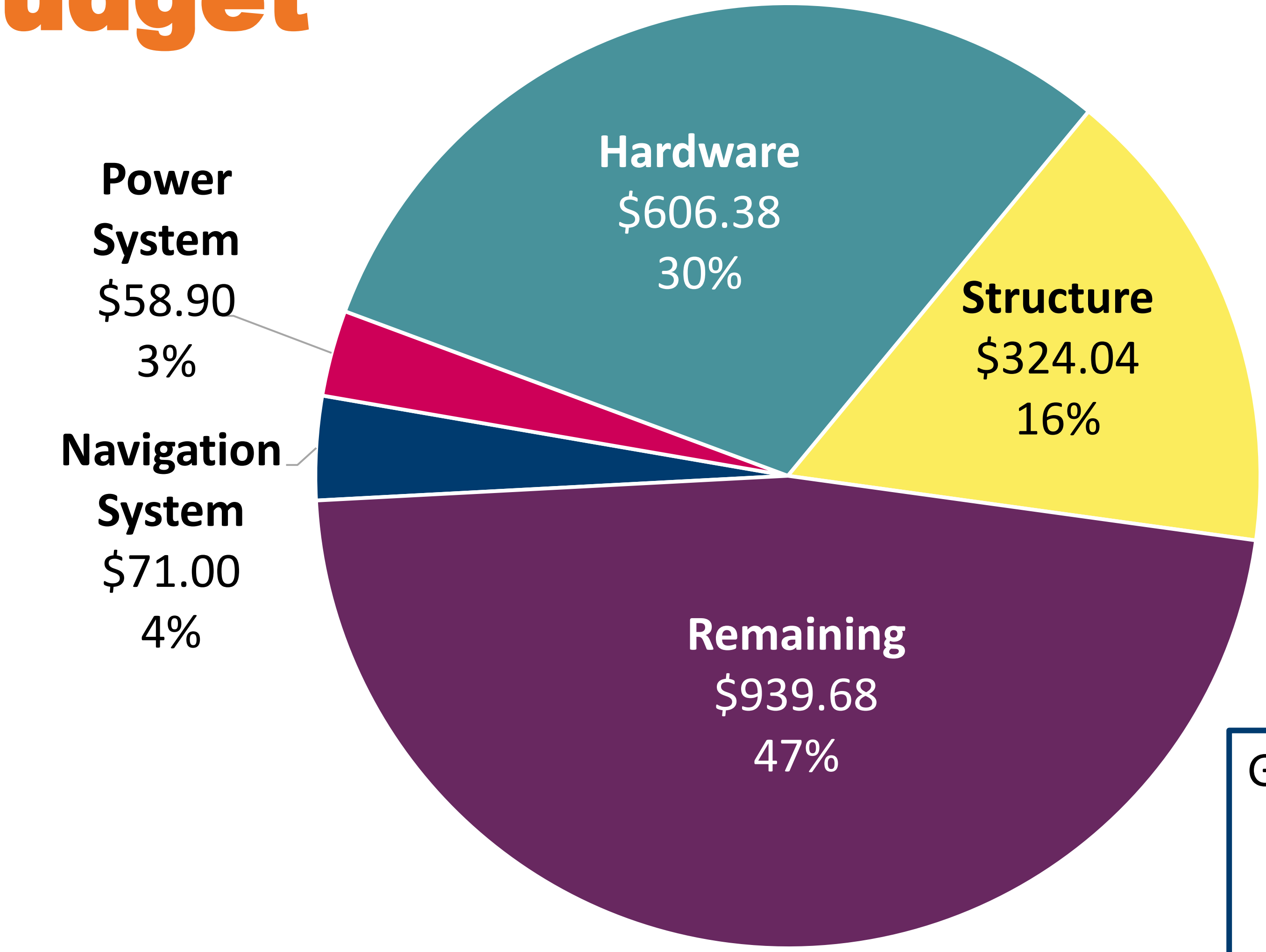
- More troubleshooting than we originally planned for
- Prepared for more backup solutions

Adaptiveness in earlier assignments

- Losing sight of the bigger picture

It might have been better to start from scratch rather than trying to fix and navigate through problems

Budget



Gifted: $9,098.00

Jetson Nvidia: $1,099.00

Velodyne LiDAR:$7,999.00

Total Spent: $1060.32

Lucca Meyer

Future Teams Work

Utilization of modular systems

Any necessary updates for future competition

Performance test and analysis of results

Future team participates in competition

References

About. RoboBoat. (2021, March 13). https://roboboat.org/about/

Past programs. RoboBoat. (2019, September 27). https://roboboat.org/past-programs/

RoboBoat 2024. RoboBoat. (2023, October 13). https://roboboat.org/programs/2024/

Tel Aviv Competition Strategy Video. (2022, May 16). https://www.youtube.com/watch?v=qss0lyN3KJ8

Thank You

Backup Slides

Critical Targets

Size:
≤ 6 ft x 3 ft x 3ft

Weight:
≤ 140 lbs

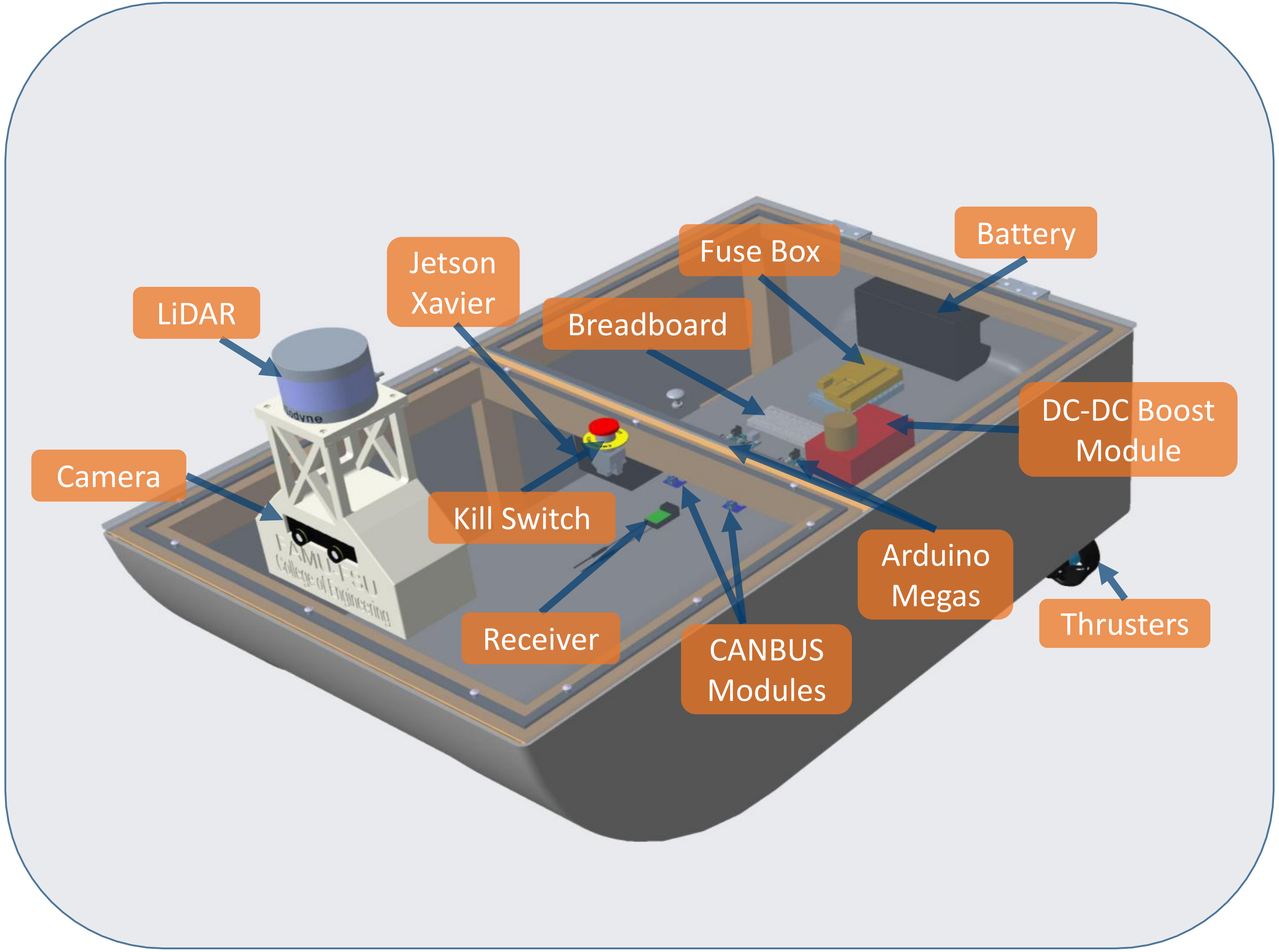
Battery Life:
> 30 min

Autonomous Navigation:
True

Kill Switch Integration:
True

Makenzie
Wiggins

Current Design



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Nicholas
Norwood

Contact Us!

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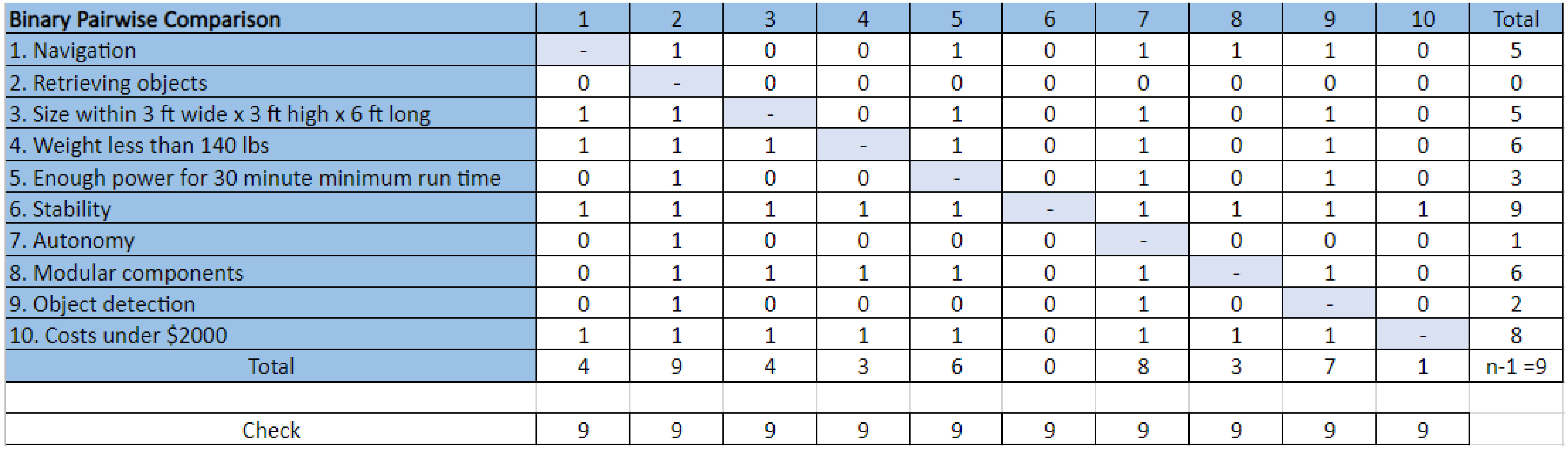
Concept Selection

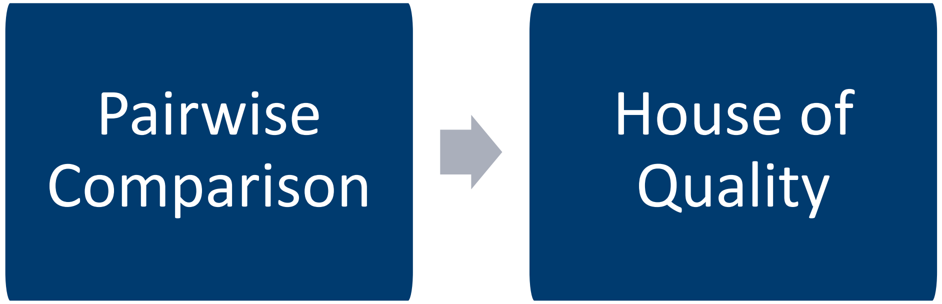
Pairwise Comparison



Binary Pairwise Comparison	1	2	3	4	5	6	7	8	9	10	Total
1. Navigation	-	1	0	0	1	0	1	1	1	0	5
2. Retrieving objects	0	-	0	0	0	0	0	0	0	0	0
3. Size within 3 ft wide x 3 ft high x 6 ft long	1	1	-	0	1	0	1	0	1	0	5
4. Weight less than 140 lbs	1	1	1	-	1	0	1	0	1	0	6
5. Enough power for 30 minute minimum run time	0	1	0	0	-	0	1	0	1	0	3
6. Stability	1	1	1	1	1	-	1	1	1	1	9
7. Autonomy	0	1	0	0	0	0	-	0	0	0	1
8. Modular components	0	1	1	1	1	0	1	-	1	0	6
9. Object detection	0	1	0	0	0	0	1	0	-	0	2
10. Costs under $2000	1	1	1	1	1	0	1	1	1	-	8
Total	4	9	4	3	6	0	8	3	7	1	n-1 =9
Check	9	9	9	9	9	9	9	9	9	9	

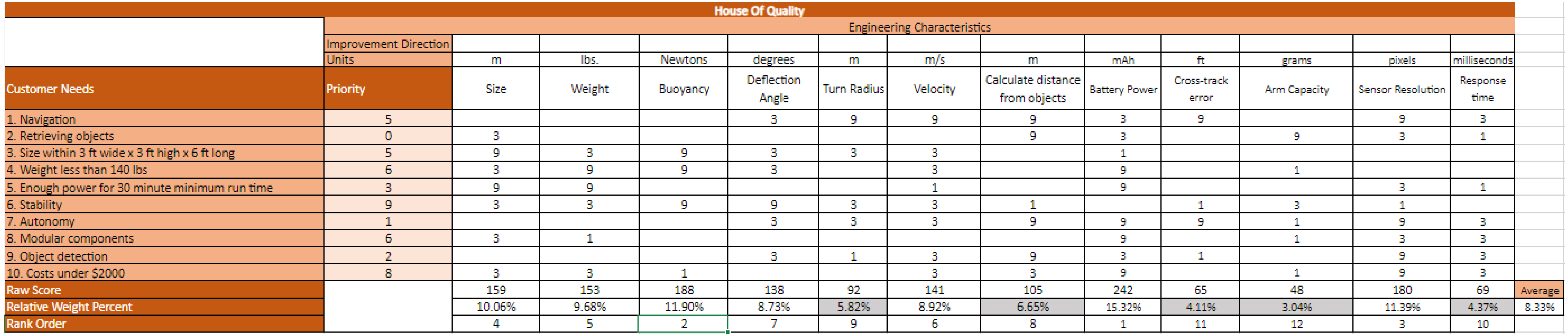
Michael Fitzsimmons

Concept Selection



Pairwise Comparison

House of Quality



House Of Quality

		Engineering Characteristics												
	Improvement Direction													
	Units	m	lbs.	Newtons	degrees	m	m/s	m	mAh	ft	grams	pixels	milliseconds	
Customer Needs	Priority	Size	Weight	Buoyancy	Deflection Angle	Turn Radius	Velocity	Calculate distance from objects	Battery Power	Cross-track error	Arm Capacity	Sensor Resolution	Response time	
1. Navigation	5				3	9	9	9	3	9		9	3	
2. Retrieving objects	0	3						9	3		9	3	1	
3. Size within 3 ft wide x 3 ft high x 6 ft long	5	9	3	9	3	3	3		1					
4. Weight less than 140 lbs	6	3	9	9	3		3		9		1			
5. Enough power for 30 minute minimum run time	3	9	9				1		9			3	1	
6. Stability	9	3	3	9	9	3	3	1		1	3	1		
7. Autonomy	1				3	3	3	9	9	9	1	9	3	
8. Modular components	6	3	1						9		1	3	3	
9. Object detection	2				3	1	3	9	3	1		9	3	
10. Costs under $2000	8	3	3	1			3	3	9		1	9	3	
Raw Score		159	153	188	138	92	141	105	242	65	48	180	69	Average
Relative Weight Percent		10.06%	9.68%	11.90%	8.73%	5.82%	8.92%	6.65%	15.32%	4.11%	3.04%	11.39%	4.37%	8.33%
Rank Order		4	5	2	7	9	6	8	1	11	12	3	10	

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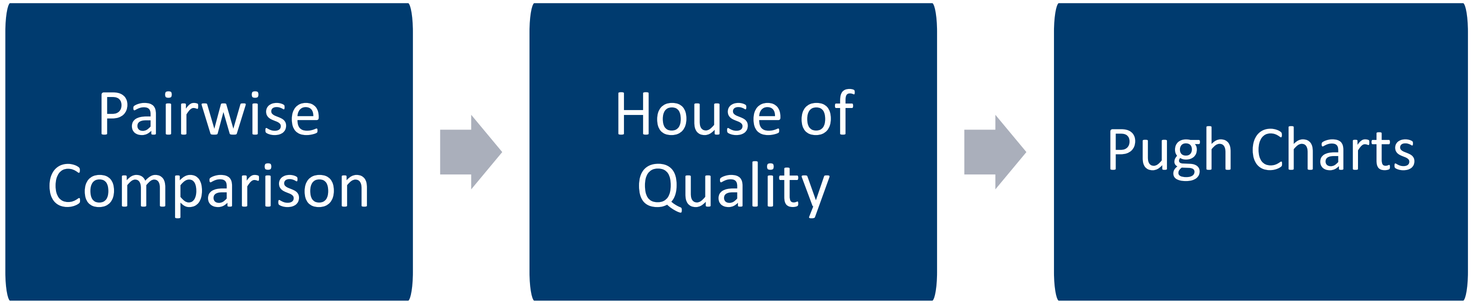
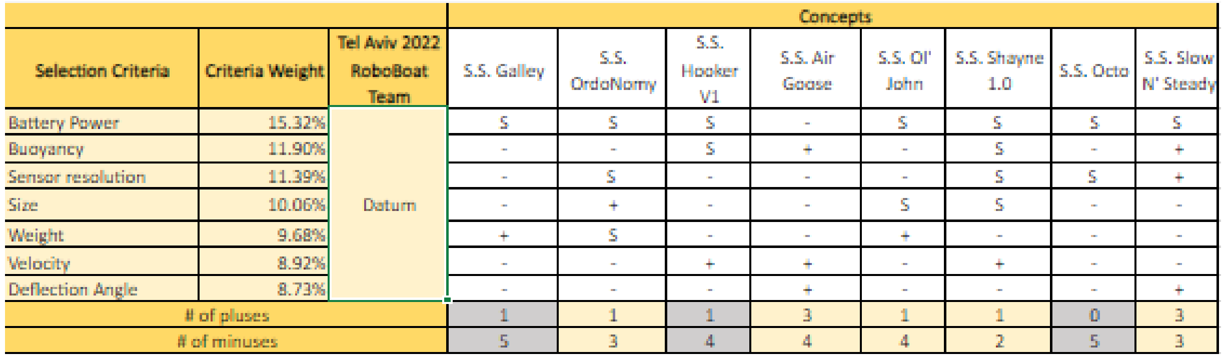
Michael Fitzsimmons

Concept Selection

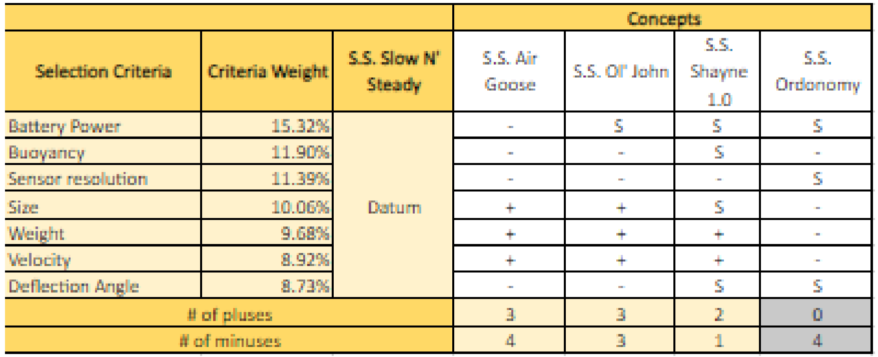

Pairwise Comparison

House of Quality

Pugh Charts



			Concepts							
Selection Criteria	Criteria Weight	Tel Aviv 2022 RoboBoat Team	S.S. Galley	S.S. OrdoNomy	S.S. Hooker V1	S.S. Air Goose	S.S. Ol' John	S.S. Shayne 1.0	S.S. Octo	S.S. Slow N' Steady
Battery Power	15.32%	Datum	S	S	S	-	S	S	S	S
Buoyancy	11.90%		-	-	S	+	-	S	-	+
Sensor resolution	11.39%		-	S	-	-	-	S	S	+
Size	10.06%		-	+	-	-	S	S	-	-
Weight	9.68%		+	S	-	-	+	-	-	-
Velocity	8.92%		-	-	+	+	-	+	-	-
Deflection Angle	8.73%		-	-	-	+	-	-	-	+
# of pluses			1	1	1	3	1	1	0	3
# of minuses			5	3	4	4	4	2	5	3



			Concepts			
Selection Criteria	Criteria Weight	S.S. Slow N' Steady	S.S. Air Goose	S.S. Ol' John	S.S. Shayne 1.0	S.S. Ordonomy
Battery Power	15.32%	Datum	-	S	S	S
Buoyancy	11.90%		-	-	S	-
Sensor resolution	11.39%		-	-	-	S
Size	10.06%		+	+	S	-
Weight	9.68%		+	+	+	-
Velocity	8.92%		+	+	+	-
Deflection Angle	8.73%		-	-	S	S
# of pluses			3	3	2	0
# of minuses			4	3	1	4

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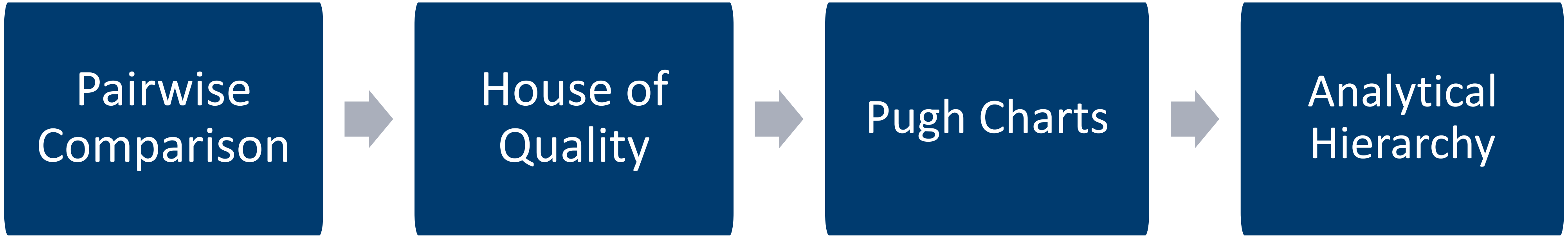
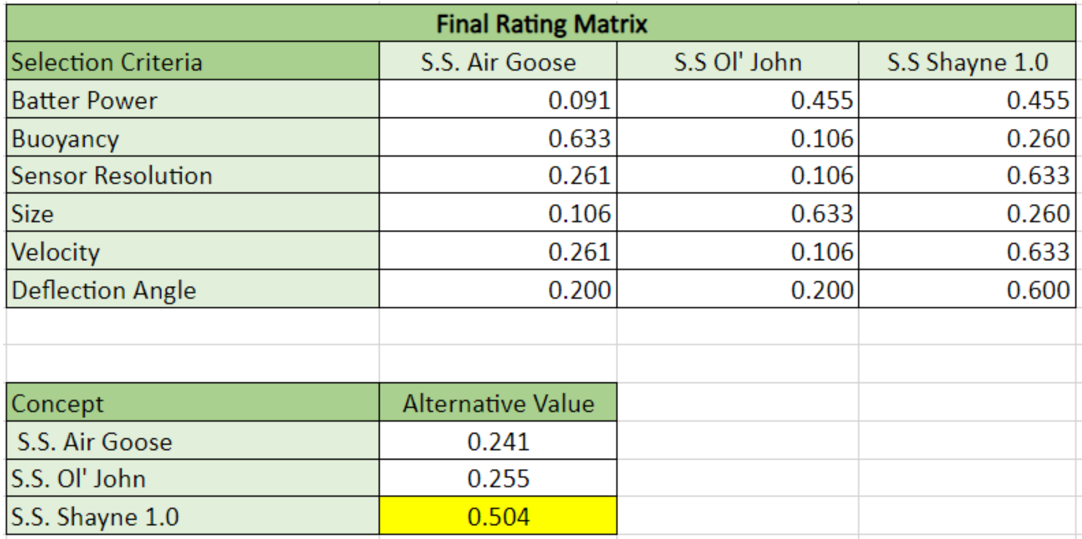
Michael Fitzsimmons

Concept Selection



Pairwise Comparison → House of Quality → Pugh Charts → Analytical Hierarchy



Final Rating Matrix			
Selection Criteria	S.S. Air Goose	S.S Ol' John	S.S Shayne 1.0
Batter Power	0.091	0.455	0.455
Buoyancy	0.633	0.106	0.260
Sensor Resolution	0.261	0.106	0.633
Size	0.106	0.633	0.260
Velocity	0.261	0.106	0.633
Deflection Angle	0.200	0.200	0.600

Concept	Alternative Value
S.S. Air Goose	0.241
S.S. Ol' John	0.255
S.S. Shayne 1.0	0.504

Current Work

Purchasing

- Receiving list
  - Thrusters (x4)
  - Electronic Speed Controlling ESCs (x4)
  - Velodyne LiDAR (x1)
- Established Source of Funding
  - Derived priority order list

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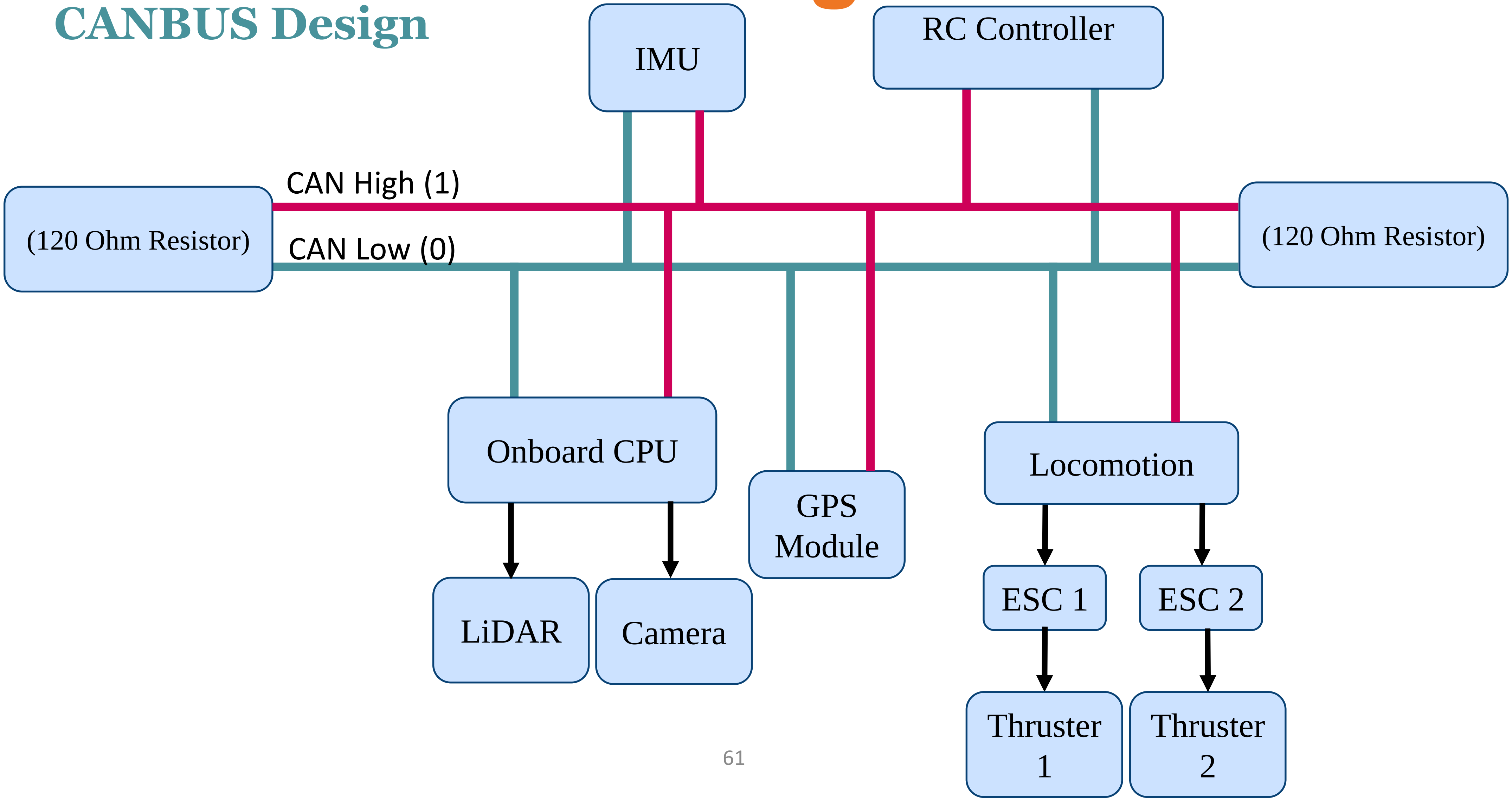
Mechatronics Design

CANBUS Design



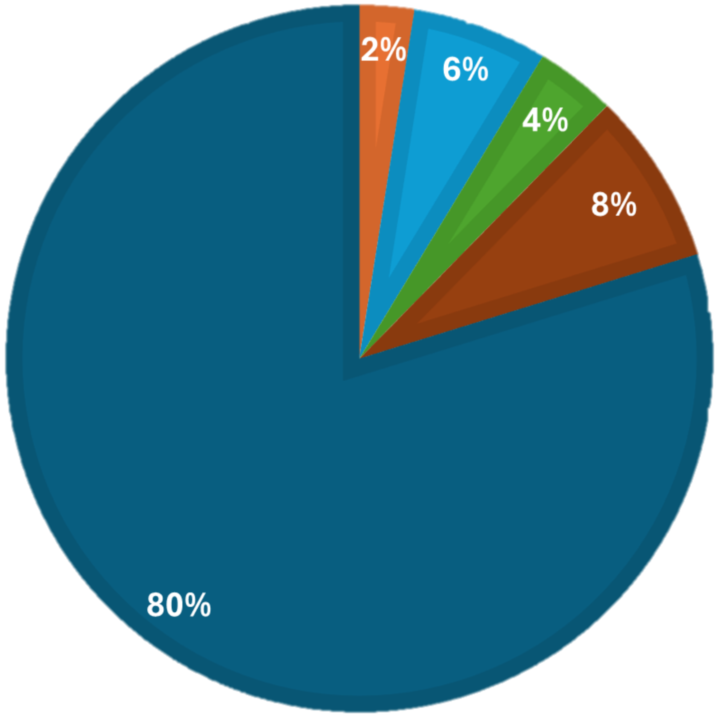
Current Work

Budget Breakdown

Total spent: $404.62

Remaining: $1595.48

- Navigation System:$50.05
- Power System:$123.57
- Hardware:$73.00
- Structure:$158.00



Current Work

Budget Breakdown

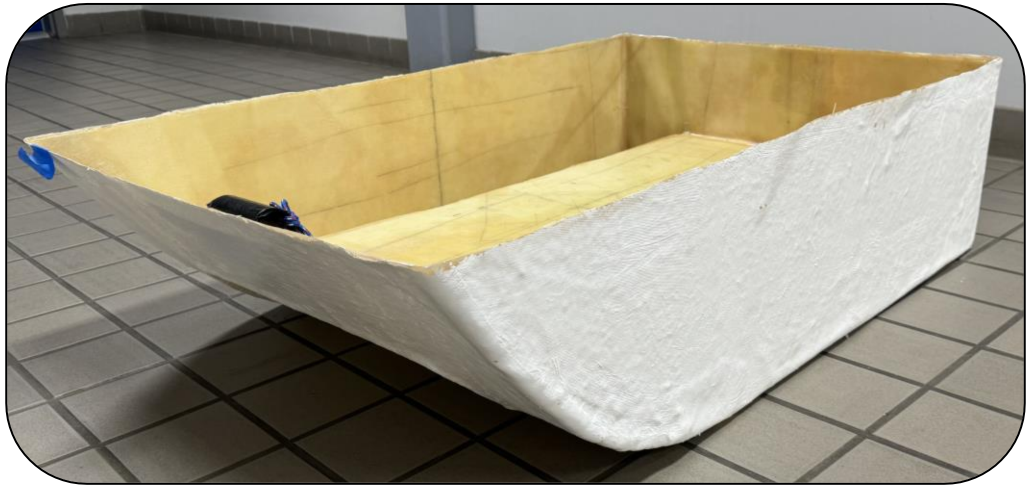
- Lidar: $4600.00
- GPS Module: $32.00
- Camera: $399.00
- Jetson: $3,000.00
- USB Port Hub: $19.99
- SD Card: $12.99
- Batteries: $169.99
- Voltage Regulators (9V): $49.98

Total
Amount Saved: **$8,284.94**

Current Work

Structure

- Tested hull with 30 lbs. weight in water
  - Leaks
- Began reinforcing structure
- Selected Material
  - 1/10 inch Plexiglass



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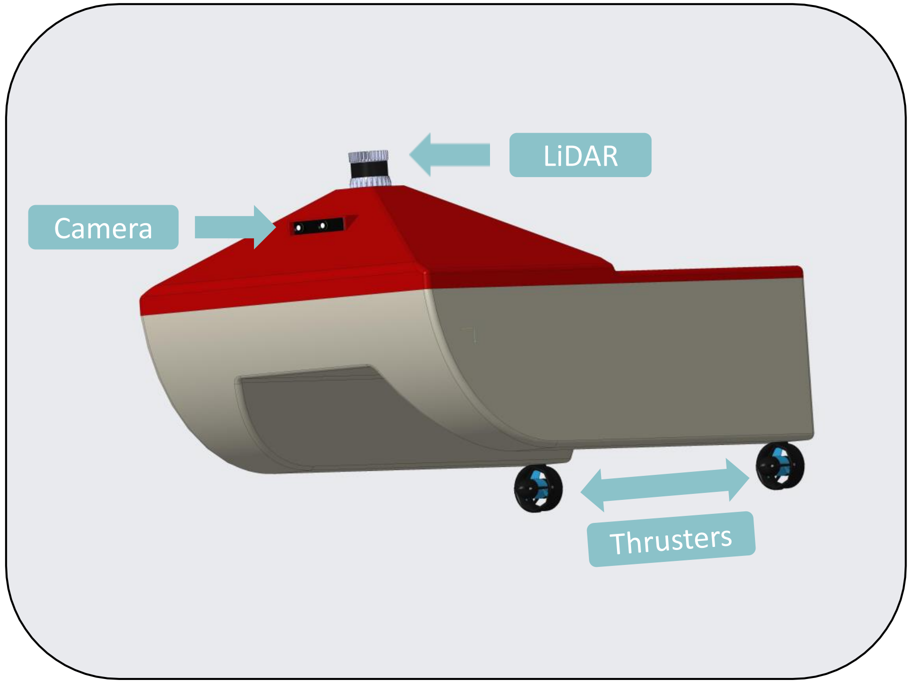
Current Work

Structure

- Designing mounts for LiDAR, thruster, and camera
- Cutting plexiglass lid to size
- Hinged lid



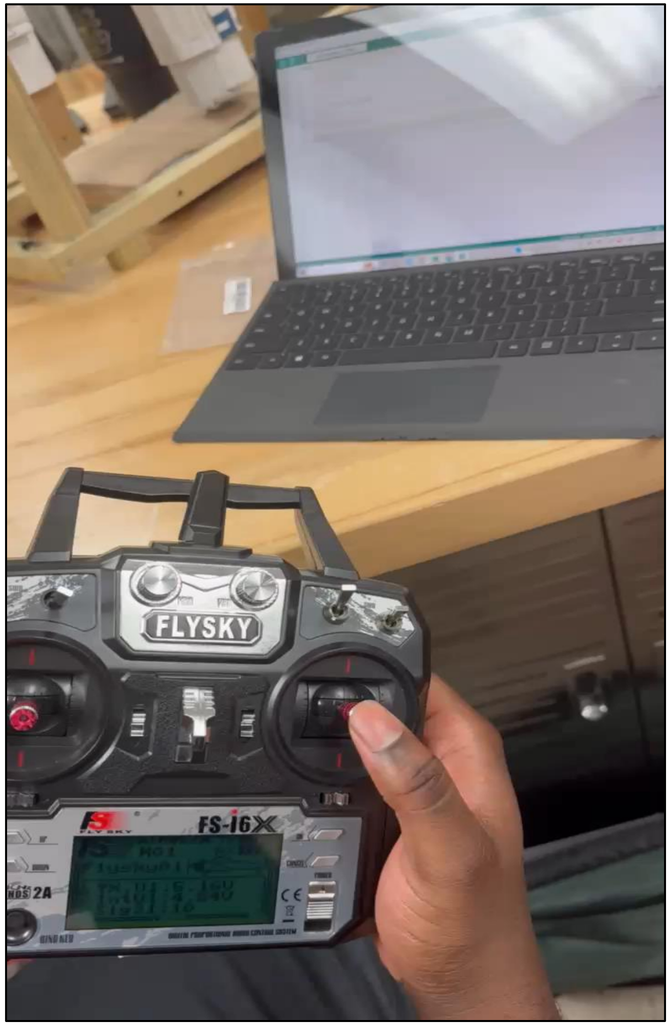
Current Work

Structure

- Mount Thrusters to hull
- Finish reinforcing Hull
- Fiberglass
- Leak prevention

Current Work
Locomotion

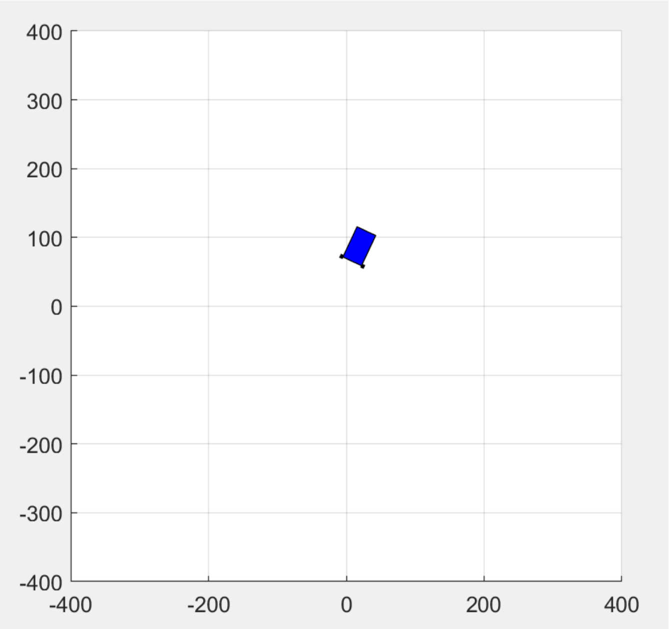
- Thrusters
  - Repaired broken ESC
  - 2 Thrusters connected and paired to RC Controller
- Can Bus Line
  - Communication logic written and formatted
  - Work out can line layout within boat



Andly Jean

Current Work
Locomotion

- Controls
  - Matlab Simulation
    - Boat Kinematics
    - Waypoint following in progress
- Relationship between PWM signal and RPM
  - Equation provided by manufacturer
    - 12 and 16 Volts
    - 14 Volts*



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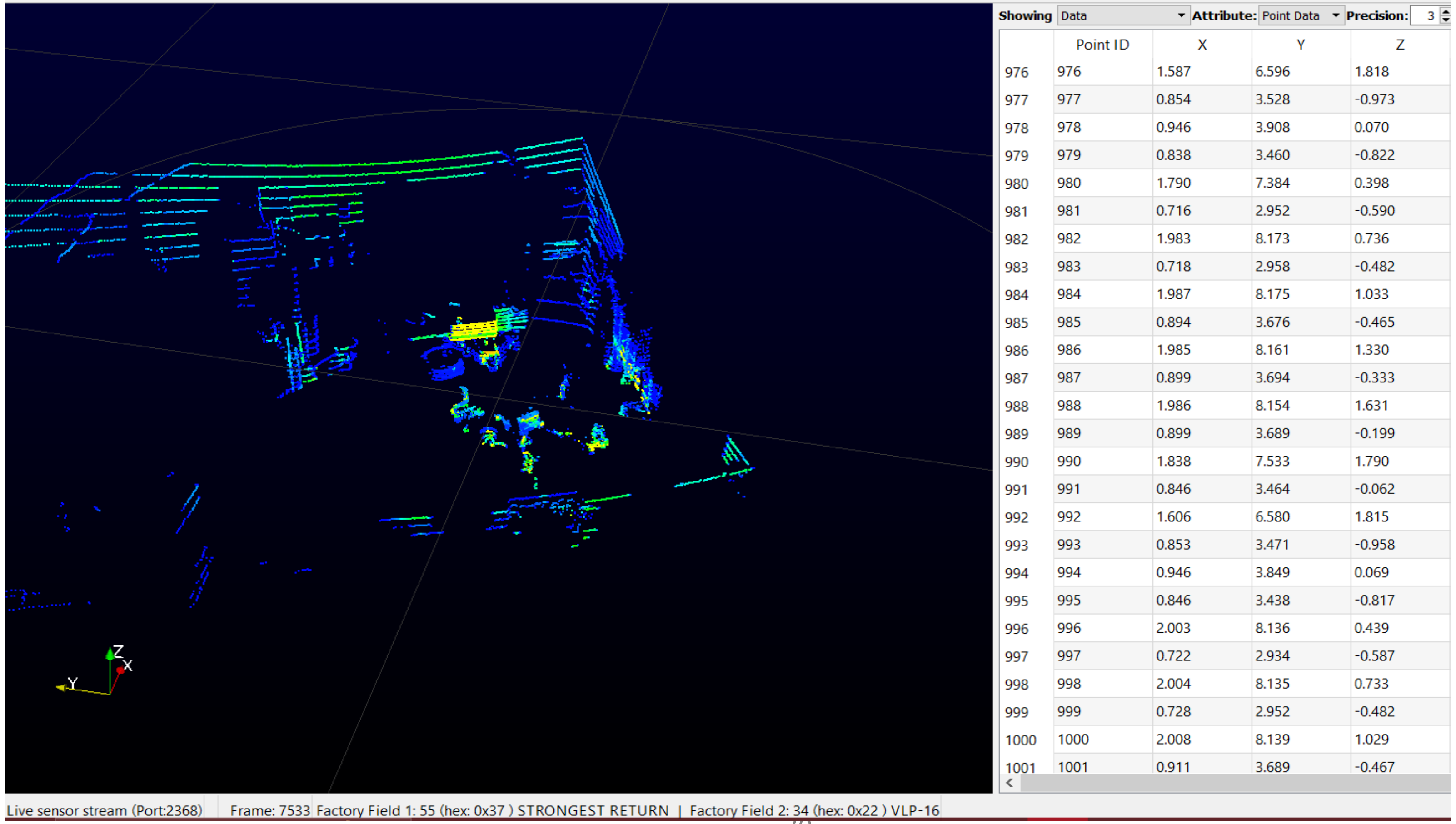
Current Work
Navigation

- Velodyne LiDAR
  - Panama City Campus
  - Internal IMU
  - Output example on next page
- Nvidia Xavier
  - Figured out and stored device password
  - Began software installs/upgrades
    - Error with update from Ubuntu 18.04 to Ubuntu 20.04

Andly Jean

Current Work
Navigation



Showing Data Attribute: Point Data Precision: 3

	Point ID	X	Y	Z
976	976	1.587	6.596	1.818
977	977	0.854	3.528	-0.973
978	978	0.946	3.908	0.070
979	979	0.838	3.460	-0.822
980	980	1.790	7.384	0.398
981	981	0.716	2.952	-0.590
982	982	1.983	8.173	0.736
983	983	0.718	2.958	-0.482
984	984	1.987	8.175	1.033
985	985	0.894	3.676	-0.465
986	986	1.985	8.161	1.330
987	987	0.899	3.694	-0.333
988	988	1.986	8.154	1.631
989	989	0.899	3.689	-0.199
990	990	1.838	7.533	1.790
991	991	0.846	3.464	-0.062
992	992	1.606	6.580	1.815
993	993	0.853	3.471	-0.958
994	994	0.946	3.849	0.069
995	995	0.846	3.438	-0.817
996	996	2.003	8.136	0.439
997	997	0.722	2.934	-0.587
998	998	2.004	8.135	0.733
999	999	0.728	2.952	-0.482
1000	1000	2.008	8.139	1.029
1001	1001	0.911	3.689	-0.467

Live sensor stream (Port:2368) | Frame: 7533 Factory Field 1: 55 (hex: 0x37) STRONGEST RETURN | Factory Field 2: 34 (hex: 0x22) VLP-16

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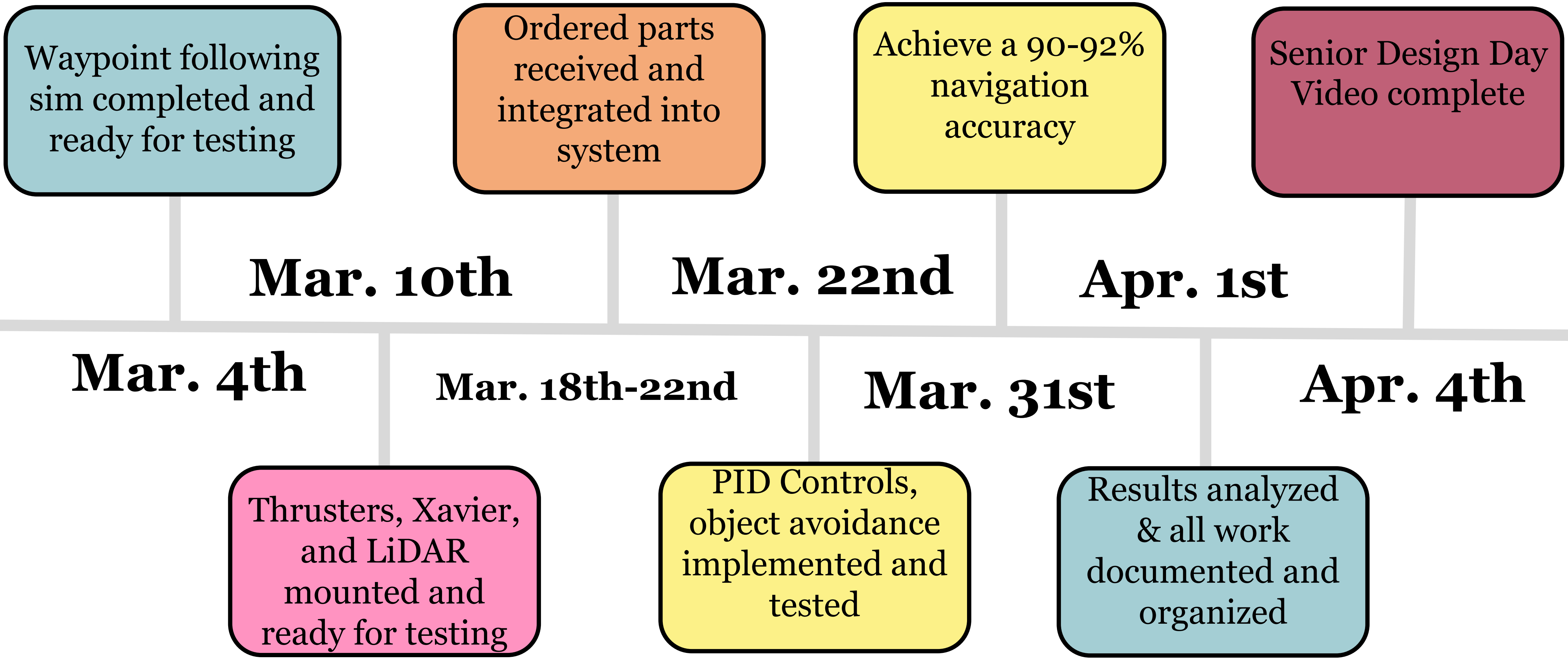
Andly Jean

Future Work and Timeline



Waypoint following sim completed and ready for testing

Ordered parts received and integrated into system

Achieve a 90-92% navigation accuracy

Senior Design Day Video complete

Mar. 10th

Mar. 22nd

Apr. 1st

Mar. 4th

Mar. 18th-22nd

Mar. 31st

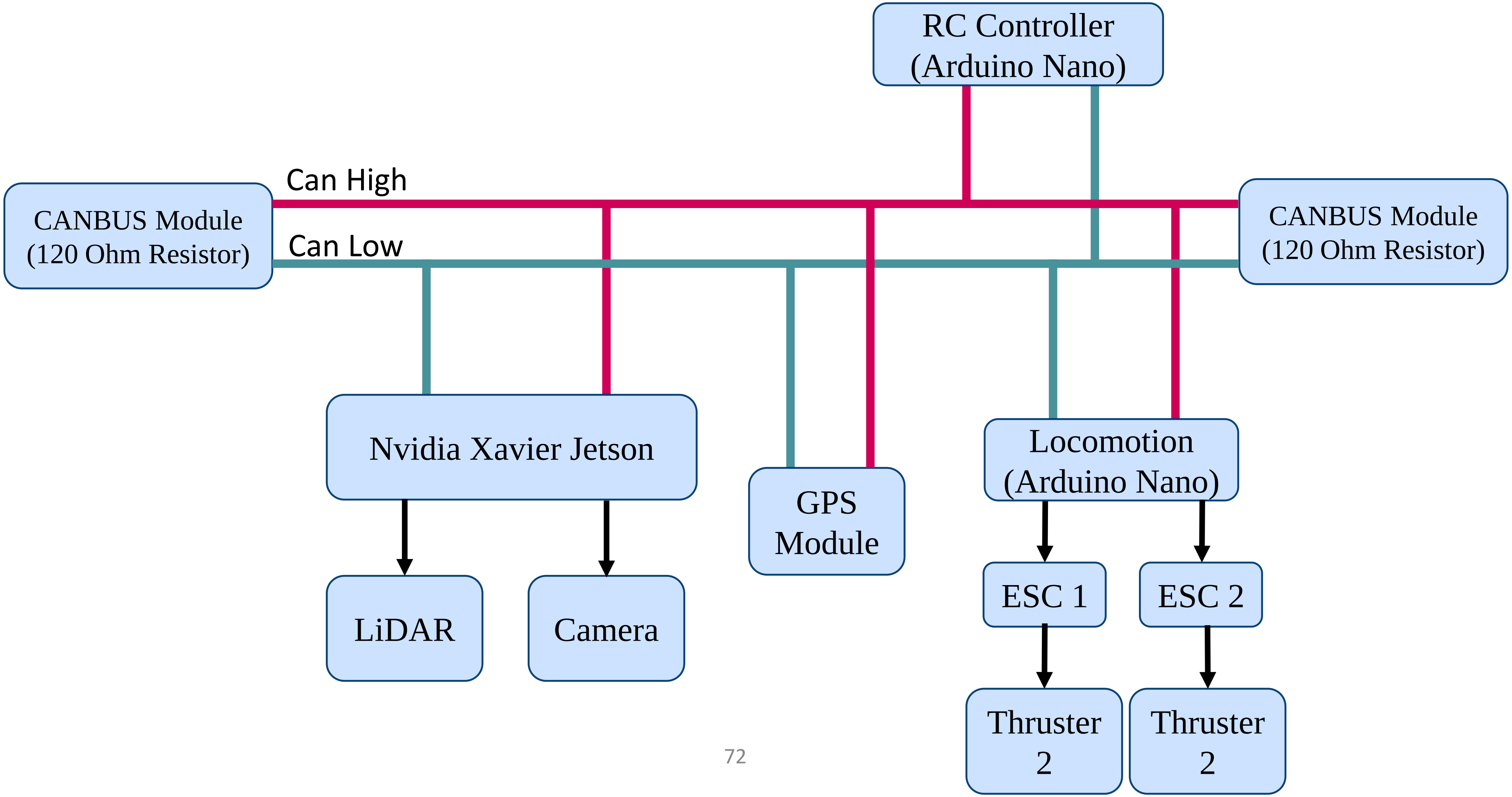
Apr. 4th

Thrusters, Xavier, and LiDAR mounted and ready for testing

PID Controls, object avoidance implemented and tested

Results analyzed & all work documented and organized

Workflow



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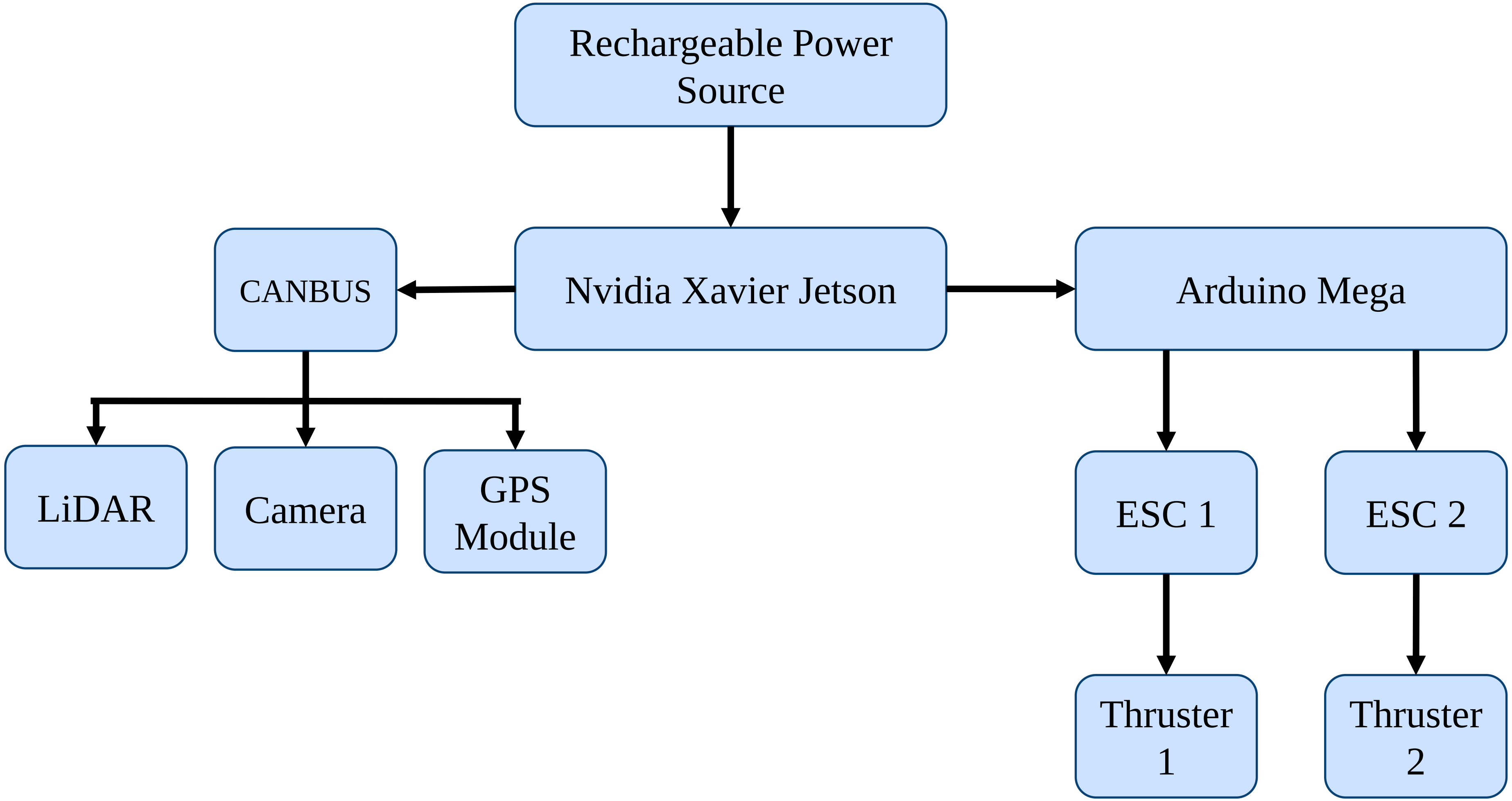
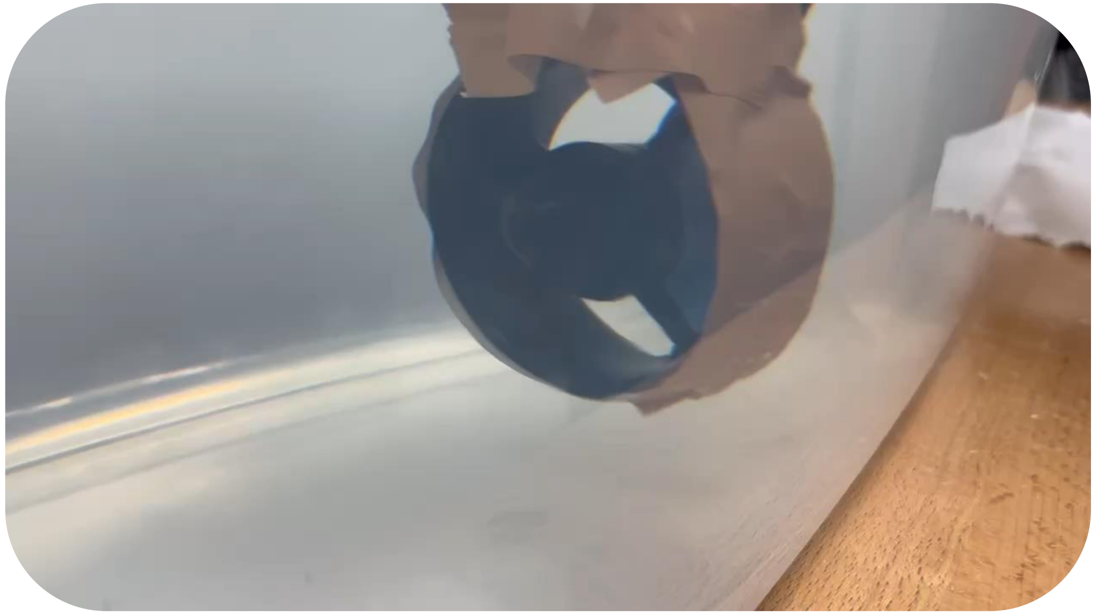
Workflow Chart



Makenzie Wiggins

Current Work
Locomotion

- One fully functional thruster with ESC
  - Need new ESC (speed controller)
  - Thruster for rear of the boat



Ivanna Caballero

Customer Needs

Navigation System

Safety System

Power/Battery System

Weight/Size Restraint

One Major Task

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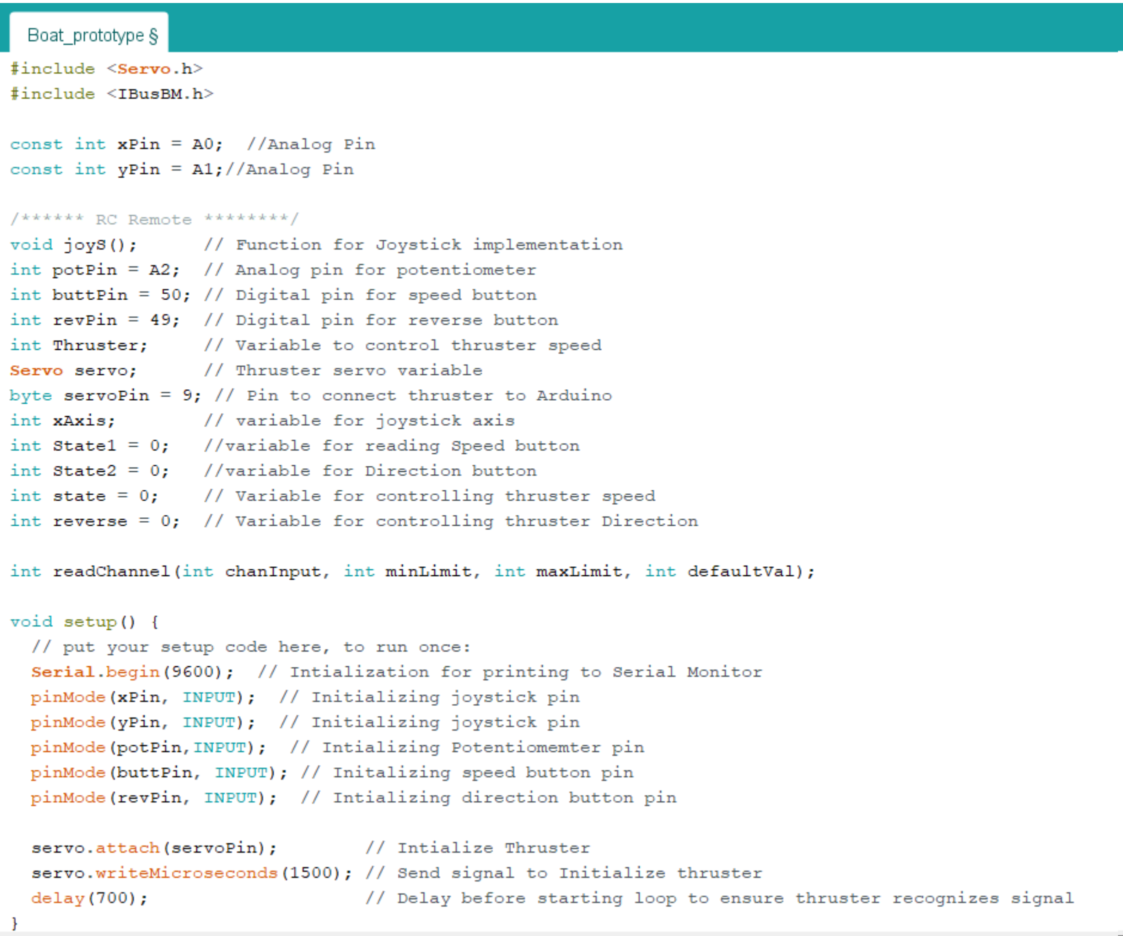
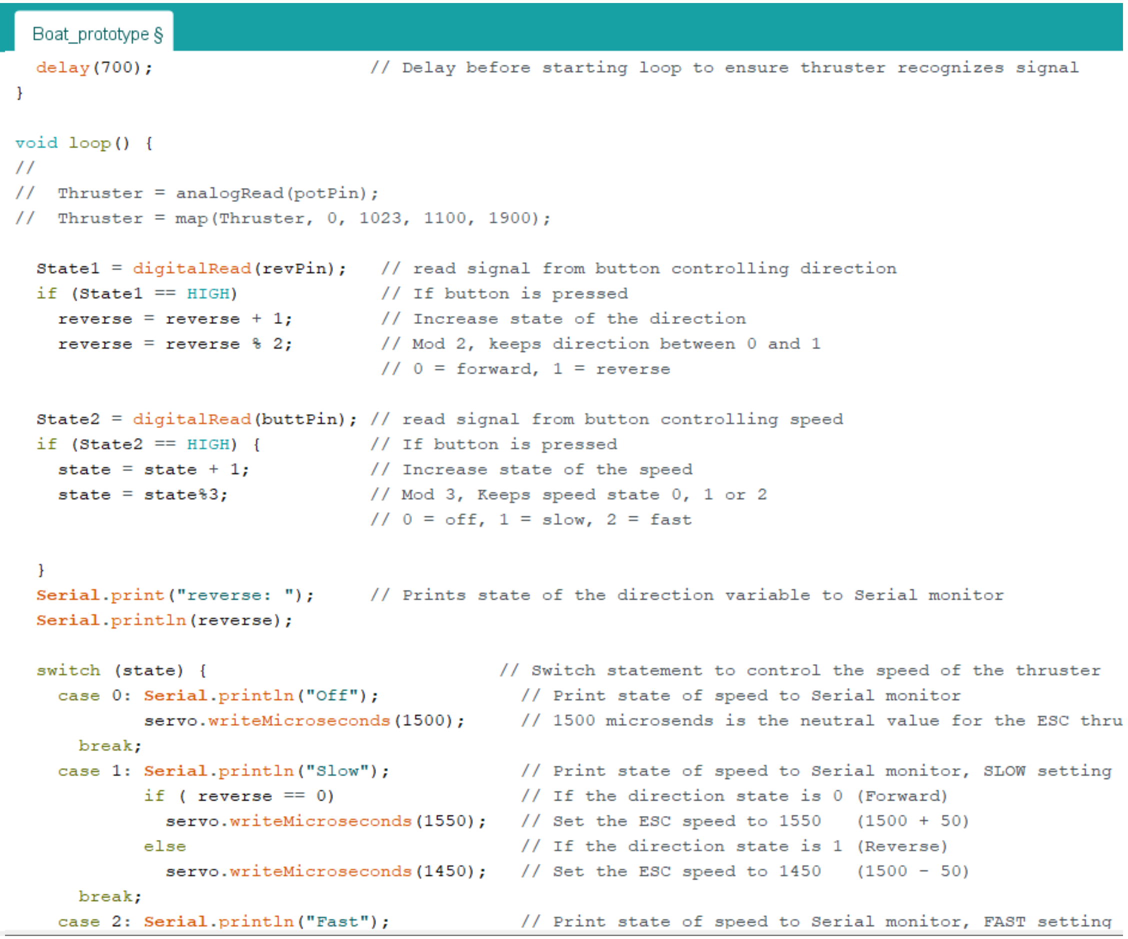
Thruster Code

Michael Fitzsimmons



Boat_prototype §

```
#include <Servo.h>
#include <IBusBM.h>

const int xPin = A0;  //Analog Pin
const int yPin = A1;//Analog Pin

/****** RC Remote ********/
void joyS();      // Function for Joystick implementation
int potPin = A2;  // Analog pin for potentiometer
int buttPin = 50; // Digital pin for speed button
int revPin = 49;  // Digital pin for reverse button
int Thruster;     // Variable to control thruster speed
Servo servo;      // Thruster servo variable
byte servoPin = 9; // Pin to connect thruster to Arduino
int xAxis;        // variable for joystick axis
int State1 = 0;   //variable for reading Speed button
int State2 = 0;   //variable for Direction button
int state = 0;    // Variable for controlling thruster speed
int reverse = 0;  // Variable for controlling thruster Direction

int readChannel(int chanInput, int minLimit, int maxLimit, int defaultVal);

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);  // Intialization for printing to Serial Monitor
  pinMode(xPin, INPUT);  // Initializing joystick pin
  pinMode(yPin, INPUT);  // Initializing joystick pin
  pinMode(potPin,INPUT);  // Intializing Potentiomemter pin
  pinMode(buttPin, INPUT); // Intializing speed button pin
  pinMode(revPin, INPUT);  // Intializing direction button pin

  servo.attach(servoPin);        // Intialize Thruster
  servo.writeMicroseconds(1500); // Send signal to Initialize thruster
  delay(700);                    // Delay before starting loop to ensure thruster recognizes signal
}
```



Boat_prototype §

```
  delay(700);                    // Delay before starting loop to ensure thruster recognizes signal
}

void loop() {
//
//  Thruster = analogRead(potPin);
//  Thruster = map(Thruster, 0, 1023, 1100, 1900);

  State1 = digitalRead(revPin);   // read signal from button controlling direction
  if (State1 == HIGH)             // If button is pressed
    reverse = reverse + 1;        // Increase state of the direction
    reverse = reverse % 2;        // Mod 2, keeps direction between 0 and 1
                                  // 0 = forward, 1 = reverse

  State2 = digitalRead(buttPin); // read signal from button controlling speed
  if (State2 == HIGH) {          // If button is pressed
    state = state + 1;           // Increase state of the speed
    state = state%3;             // Mod 3, Keeps speed state 0, 1 or 2
                                 // 0 = off, 1 = slow, 2 = fast

  }
  Serial.print("reverse: ");     // Prints state of the direction variable to Serial monitor
  Serial.println(reverse);

  switch (state) {                            // Switch statement to control the speed of the thruster
    case 0: Serial.println("Off");              // Print state of speed to Serial monitor
            servo.writeMicroseconds(1500);      // 1500 microsends is the neutral value for the ESC thru
      break;
    case 1: Serial.println("Slow");             // Print state of speed to Serial monitor, SLOW setting
            if ( reverse == 0)                  // If the direction state is 0 (Forward)
              servo.writeMicroseconds(1550);    // Set the ESC speed to 1550   (1500 + 50)
            else                                // If the direction state is 1 (Reverse)
              servo.writeMicroseconds(1450);    // Set the ESC speed to 1450   (1500 - 50)
      break;
    case 2: Serial.println("Fast");             // Print state of speed to Serial monitor, FAST setting
```

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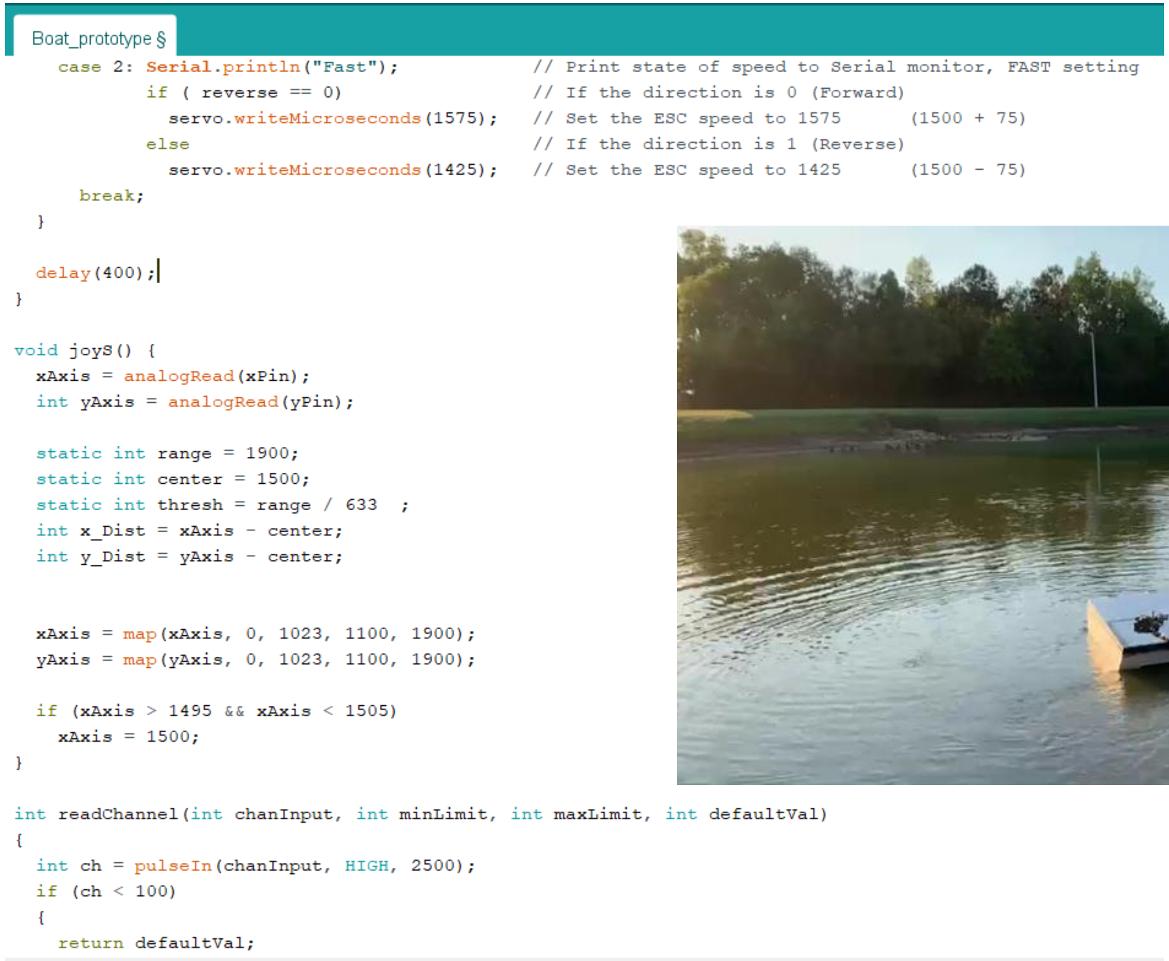
Thruster Code

Michael Fitzsimmons



Boat_prototype §

```
    case 2: Serial.println("Fast");            // Print state of speed to Serial monitor, FAST setting
            if ( reverse == 0)                 // If the direction is 0 (Forward)
              servo.writeMicroseconds(1575);   // Set the ESC speed to 1575      (1500 + 75)
            else                               // If the direction is 1 (Reverse)
              servo.writeMicroseconds(1425);   // Set the ESC speed to 1425      (1500 - 75)
      break;
  }

  delay(400);
}

void joyS() {
  xAxis = analogRead(xPin);
  int yAxis = analogRead(yPin);

  static int range = 1900;
  static int center = 1500;
  static int thresh = range / 633   ;
  int x_Dist = xAxis - center;
  int y_Dist = yAxis - center;


  xAxis = map(xAxis, 0, 1023, 1100, 1900);
  yAxis = map(yAxis, 0, 1023, 1100, 1900);

  if (xAxis > 1495 && xAxis < 1505)
    xAxis = 1500;
}

int readChannel(int chanInput, int minLimit, int maxLimit, int defaultVal)
{
  int ch = pulseIn(chanInput, HIGH, 2500);
  if (ch < 100)
  {
    return defaultVal;
```

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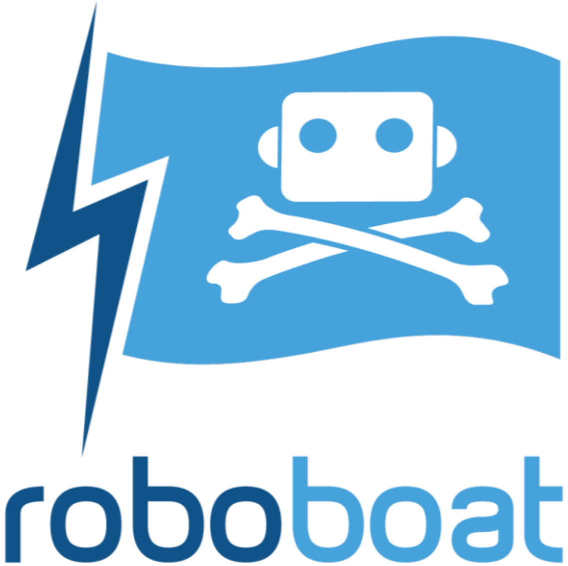
Nicholas Norwood

Project Objective

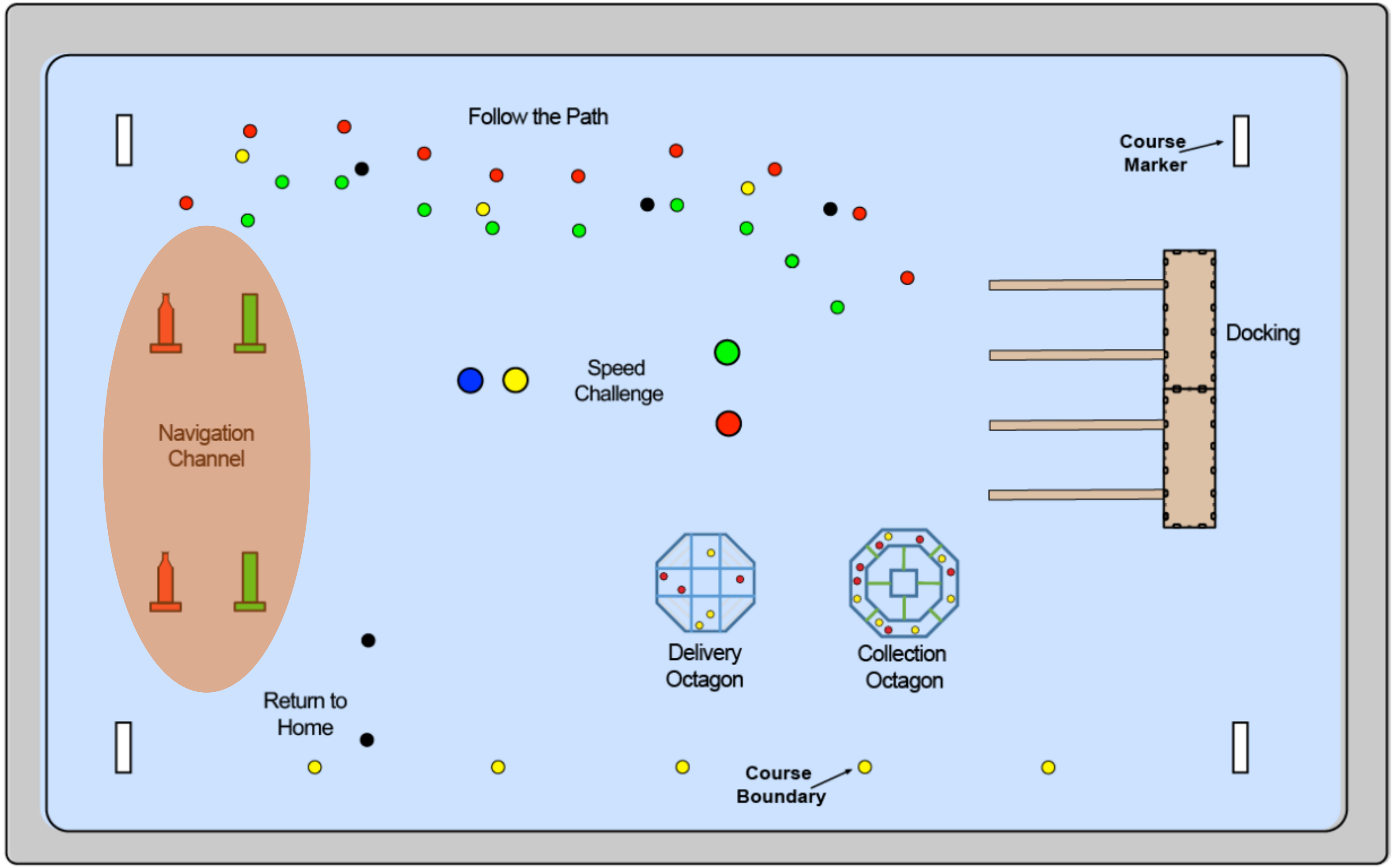
The objective of this project is to design, build and program an autonomous surface vehicle capable of completing several tasks in the following categories:

- Navigation
- Detection
- Object avoidance
- Conduct two-step behavior



Makenzie Wiggins

RoboBoat 2024 Course



Task 1:
Navigation Channel

Task 2:
Follow the Path

Task 3:
Docking

Task 4:
Duck Wash

Task 5:
Speed Challenge

Task 6:
Collection Octagon

Task 7:
Delivery Octagon

Task 8:
Return to Home

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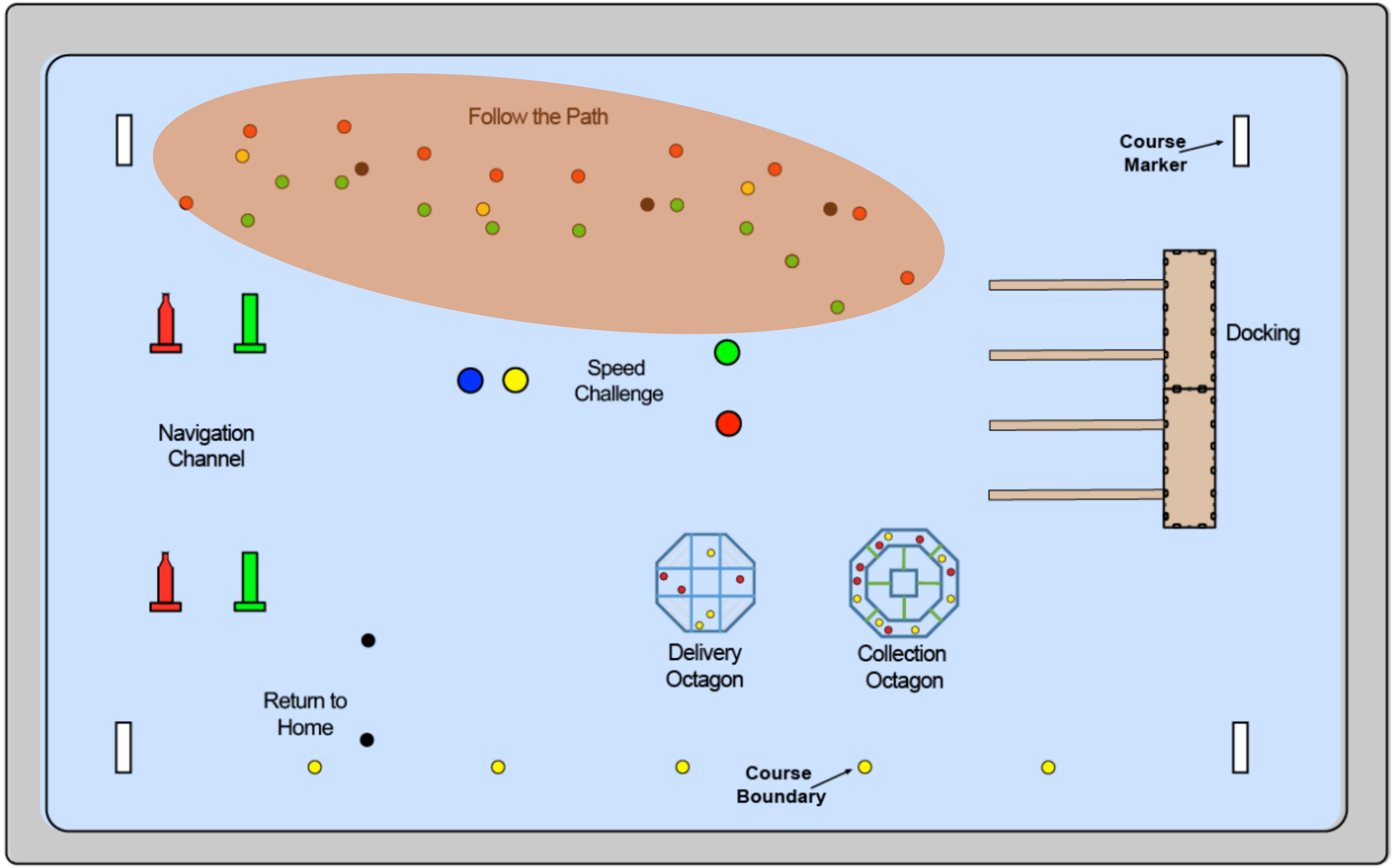
Makenzie Wiggins

RoboBoat 2024 Course



Task 1:
Navigation Channel

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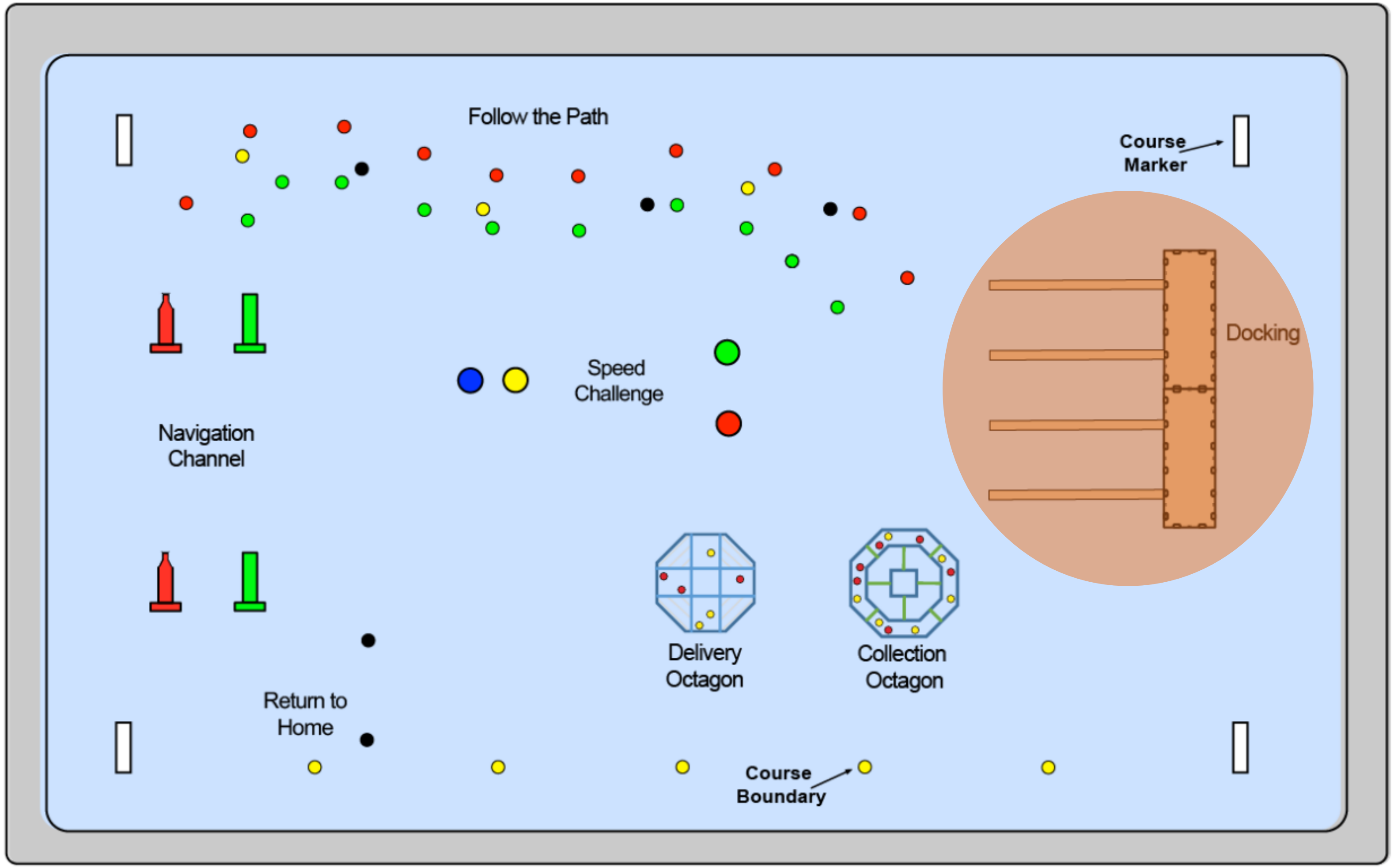
Makenzie Wiggins

RoboBoat 2024 Course



Task 1:
Navigation Channel

Task 2:
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Task 7:
Delivery Octagon

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Return to Home

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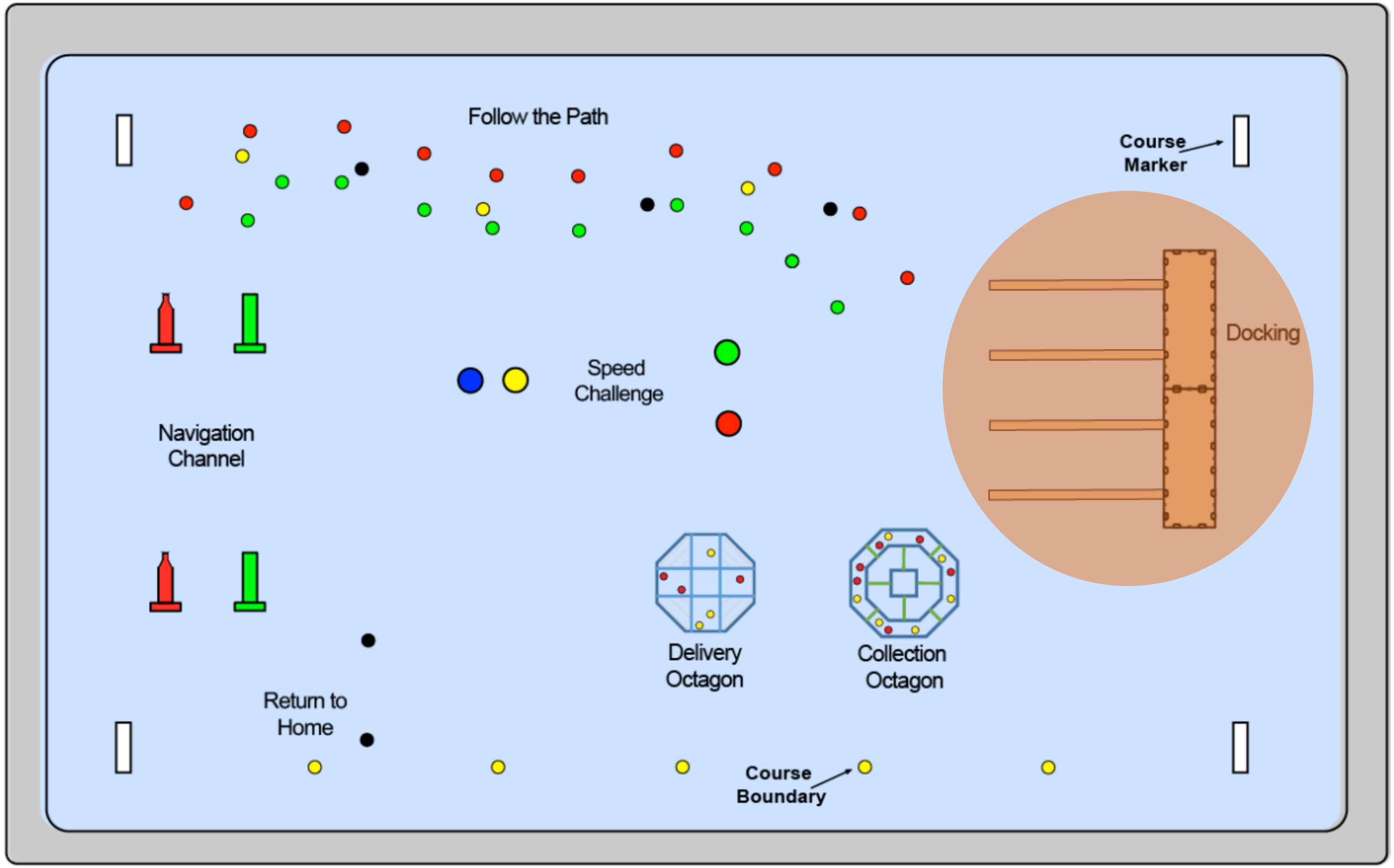

Task 1:
Navigation Channel

Task 2:
Follow the Path

Task 3:
Docking

**Task 4:
Duck Wash**

Task 5:
Speed Challenge

Task 6:
Collection Octagon

Task 7:
Delivery Octagon

Task 8:
Return to Home

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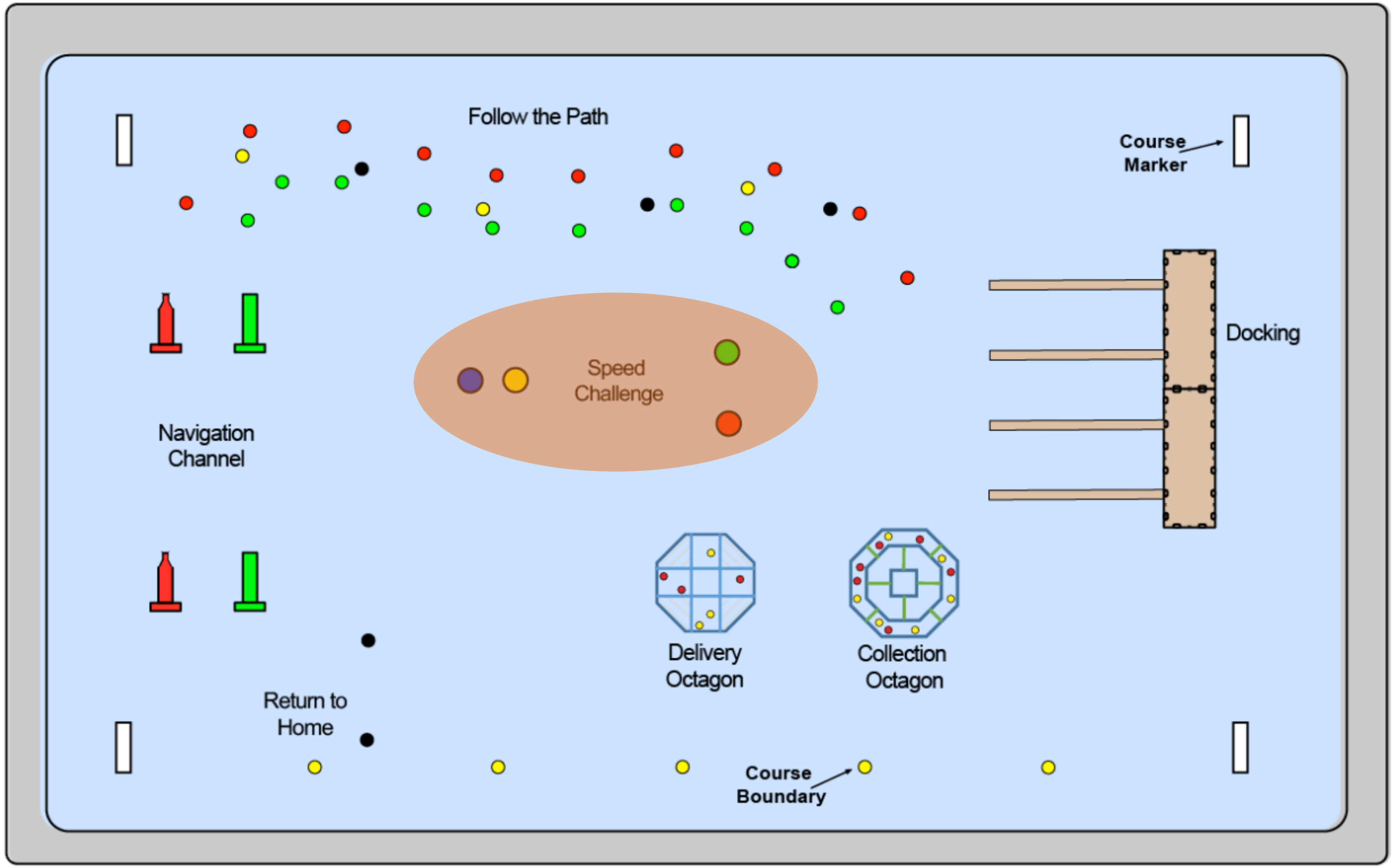
Makenzie Wiggins

RoboBoat 2024 Course



Task 1:
Navigation Channel

Task 2:
Follow the Path

Task 3:
Docking

Task 4:
Duck Wash

Task 5:
Speed Challenge

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Collection Octagon

Task 7:
Delivery Octagon

Task 8:
Return to Home

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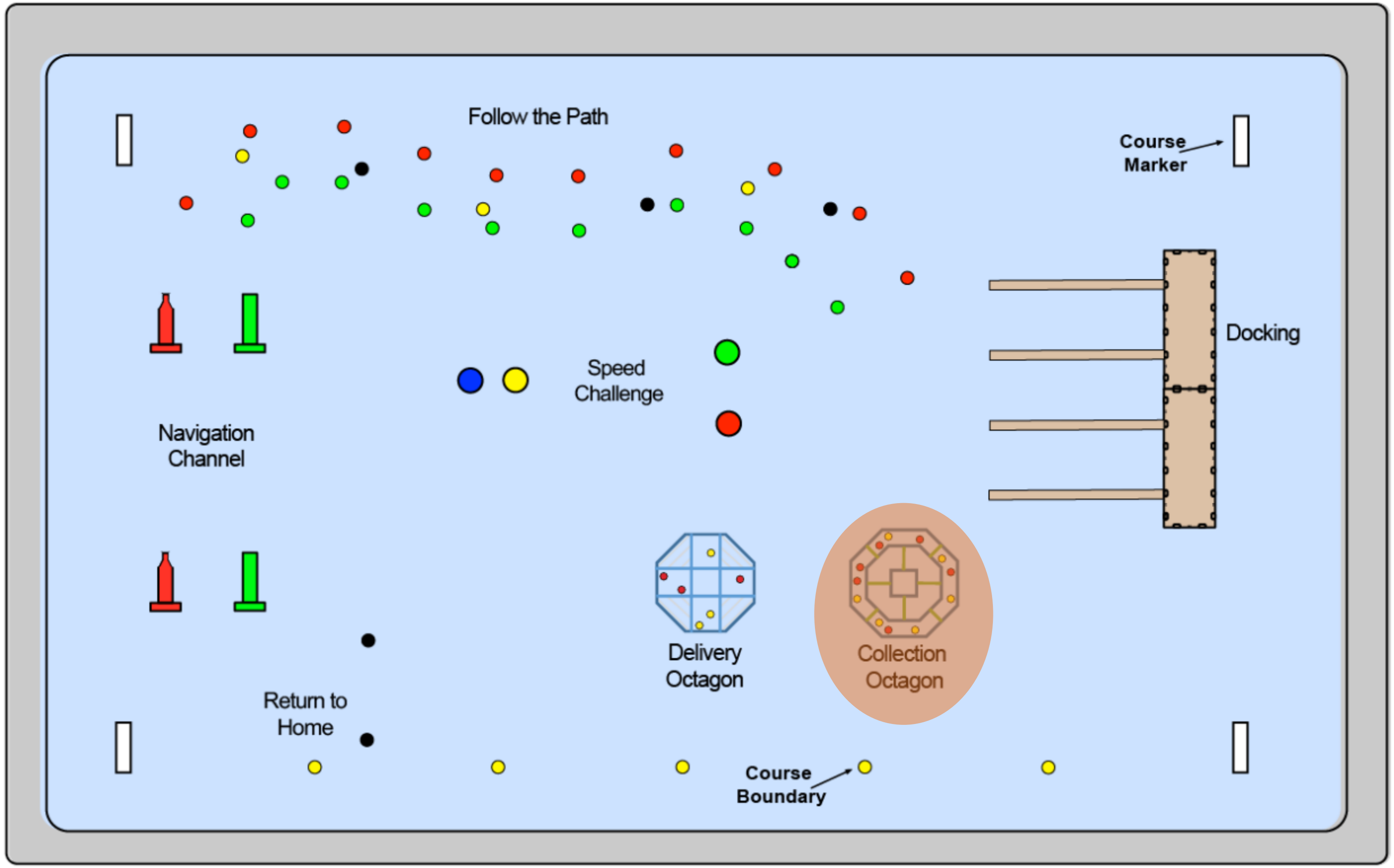
RoboBoat 2024 Course



Task 1:
Navigation Channel

Task 2:
Follow the Path

Task 3:
Docking

Task 4:
Duck Wash

Task 5:
Speed Challenge

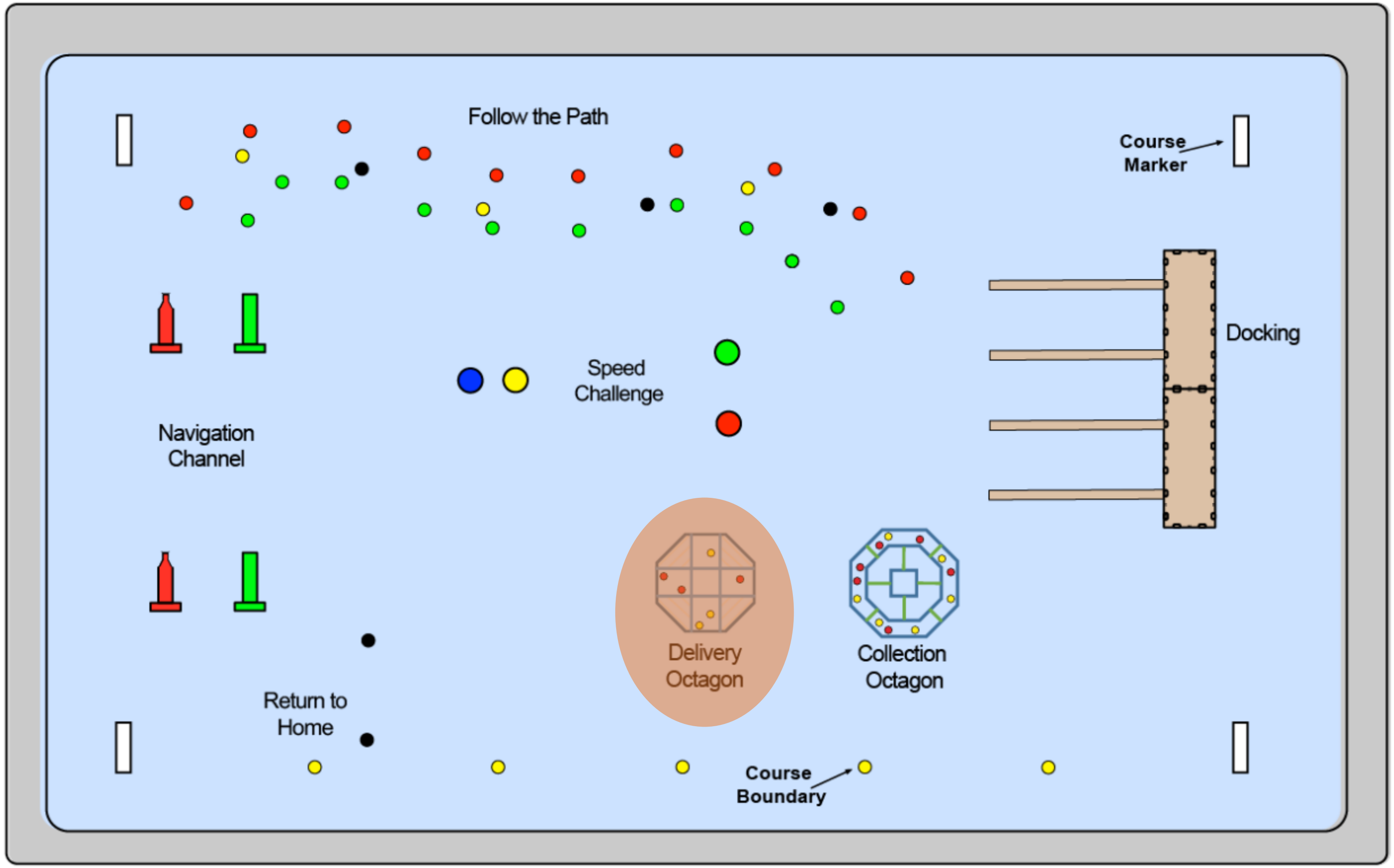
Task 6:
Collection Octagon

Task 7:
Delivery Octagon

Task 8:
Return to Home

Makenzie Wiggins

RoboBoat 2024 Course



Task 1:
Navigation Channel
Task 2:
Follow the Path
Task 3:
Docking
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Duck Wash
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Speed Challenge
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Collection Octagon
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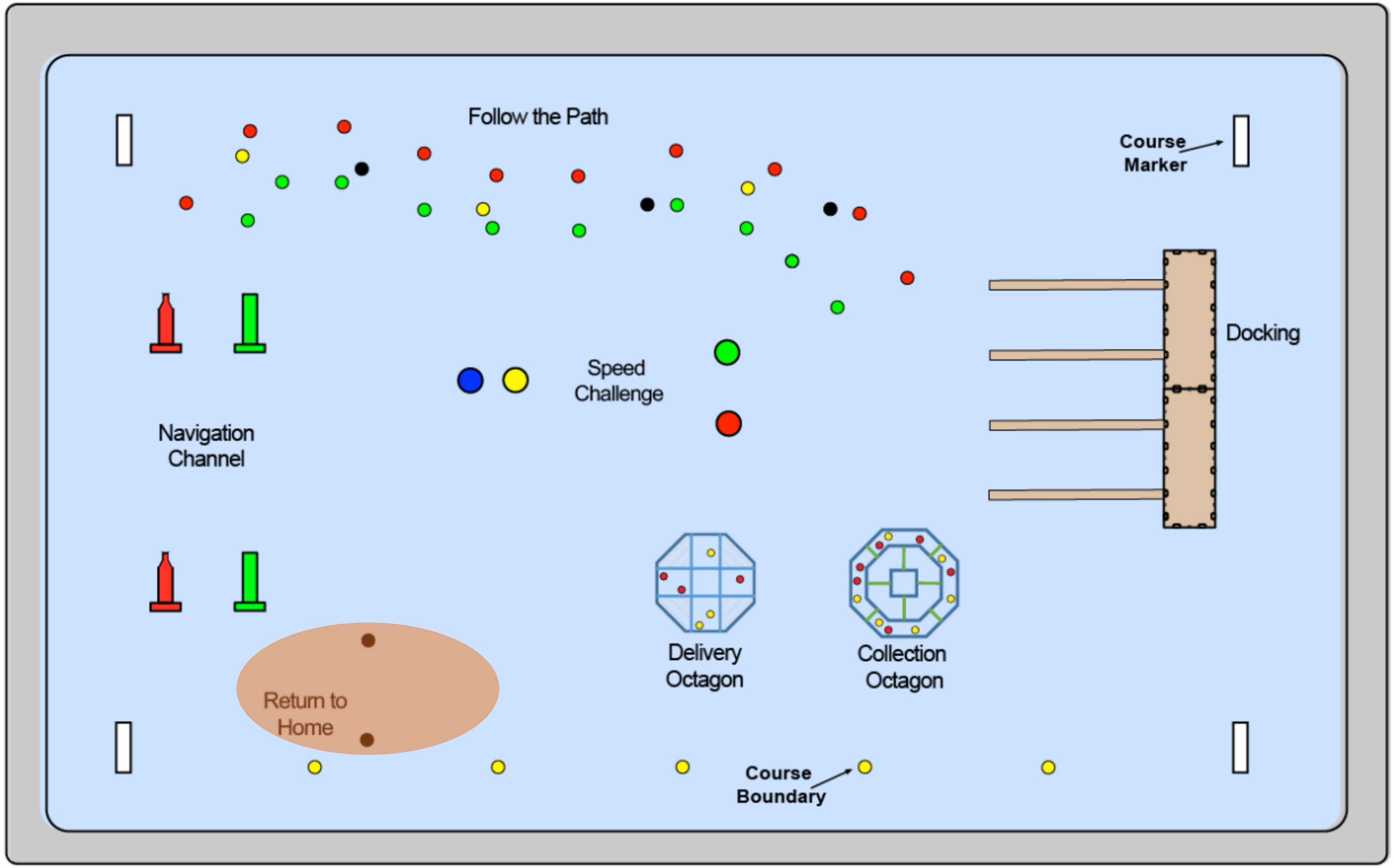
Makenzie Wiggins

RoboBoat 2024 Course



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Duck Wash

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Speed Challenge

Task 6:
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Task 7:
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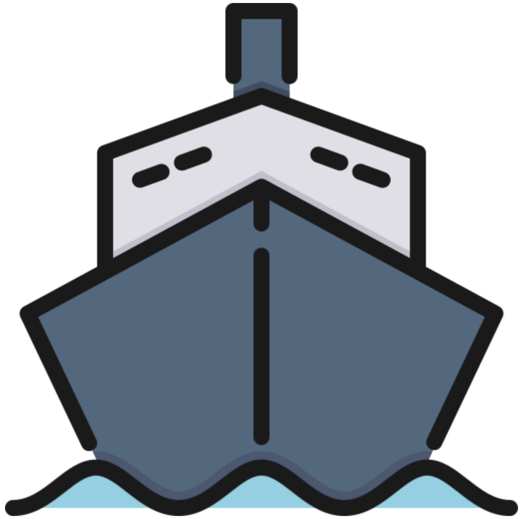
Task 8:
Return to Home

Ivanna Caballero

System: Structure

Function	Target	Metric
Length	3.94(ft)	size
Width	2.58(ft)	size
Height	2.445(ft)	size
Weight	63.25(lbs)	weight
Buoyancy	300N	force
Deflection Angle	15 degrees	angle



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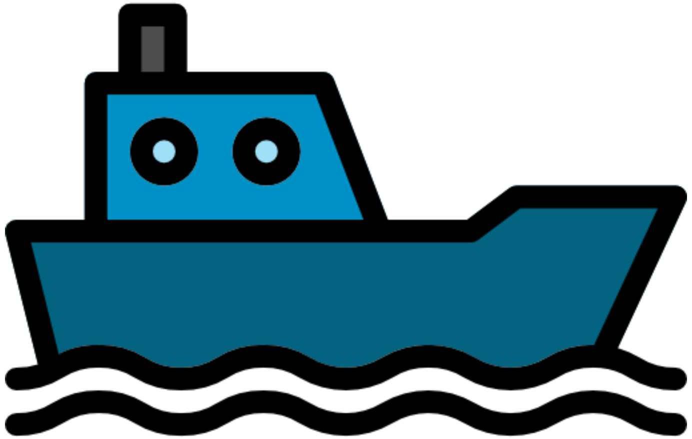
Ivanna
Caballero

System: Locomotion

Function	Target	Metric
Speed	>=1.515 (m/s)	velocity
Acceleration	0.25 (m/s)	acceleration
Thrust	14.6 (lbs)	force



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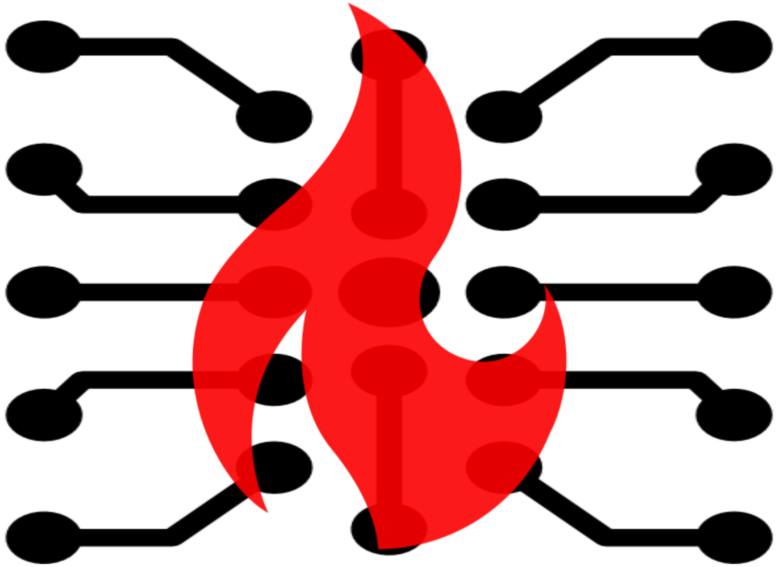
Engineering

Ivanna Caballero

System: Safety

Function	Target	Metric
Kill switch response time	0.25(s)	time
Manual-Remote kill switch integration	True	Boolean



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Ivanna Caballero

System: Navigation

Function	Target	Metric
Cross-track error of navigating to a destination	2(m)	length
Boat localization error	< 5(m)	length

Ivanna Caballero

System: Power Systems

Function	Target	Metric
Battery size	22000(mAh)	Charge capacity
Battery life	1 (hr)	Time
Capability of tracking battery life	True	Boolean

Ivanna
Caballero

System: Object Detection

Function	Target	Metric
Camera Resolution	1920x1080 (pixels)	Number of Pixels
Range of object detection	25(m)	Length
Accuracy of detecting color	95%	Percent Error
Capability of identifying different objects	Min. Of 6 objects	Number of objects

Ivanna Caballero

System: Object Detection

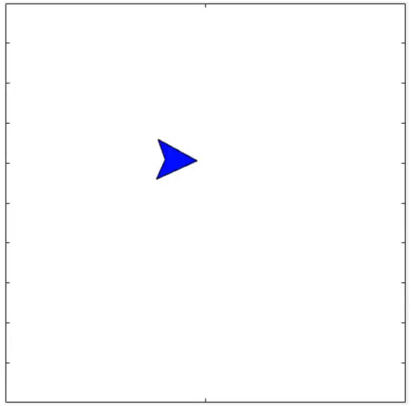
Function	Target	Metric
Camera Resolution	1920x1080 (pixels)	Number of Pixels
Range of object detection	25(m)	Length
Accuracy of detecting color	95%	Percent Error
Capability of identifying different objects	Min. Of 6 objects	Number of objects

Nicholas Norwood

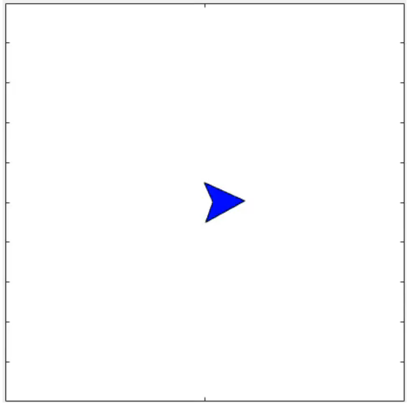
Navigation

Basic Matlab Simulation

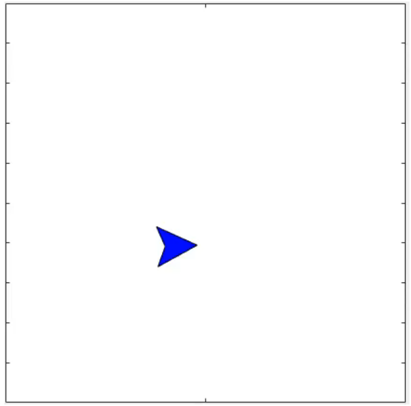
Right Turn



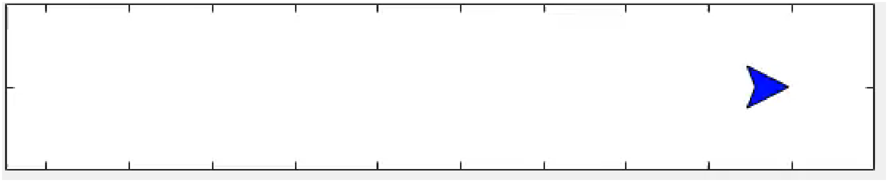
Point Turn



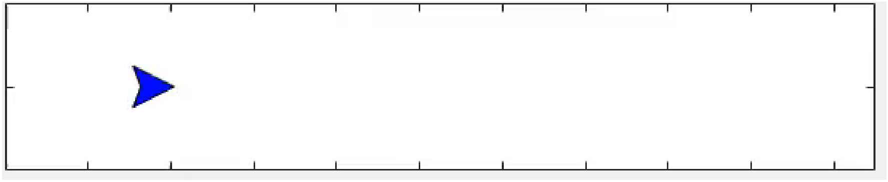
Left Turn



Forwards



Backwards



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Functional Decomposition

Locomotion

Navigation

Structure

Power Systems

Safety

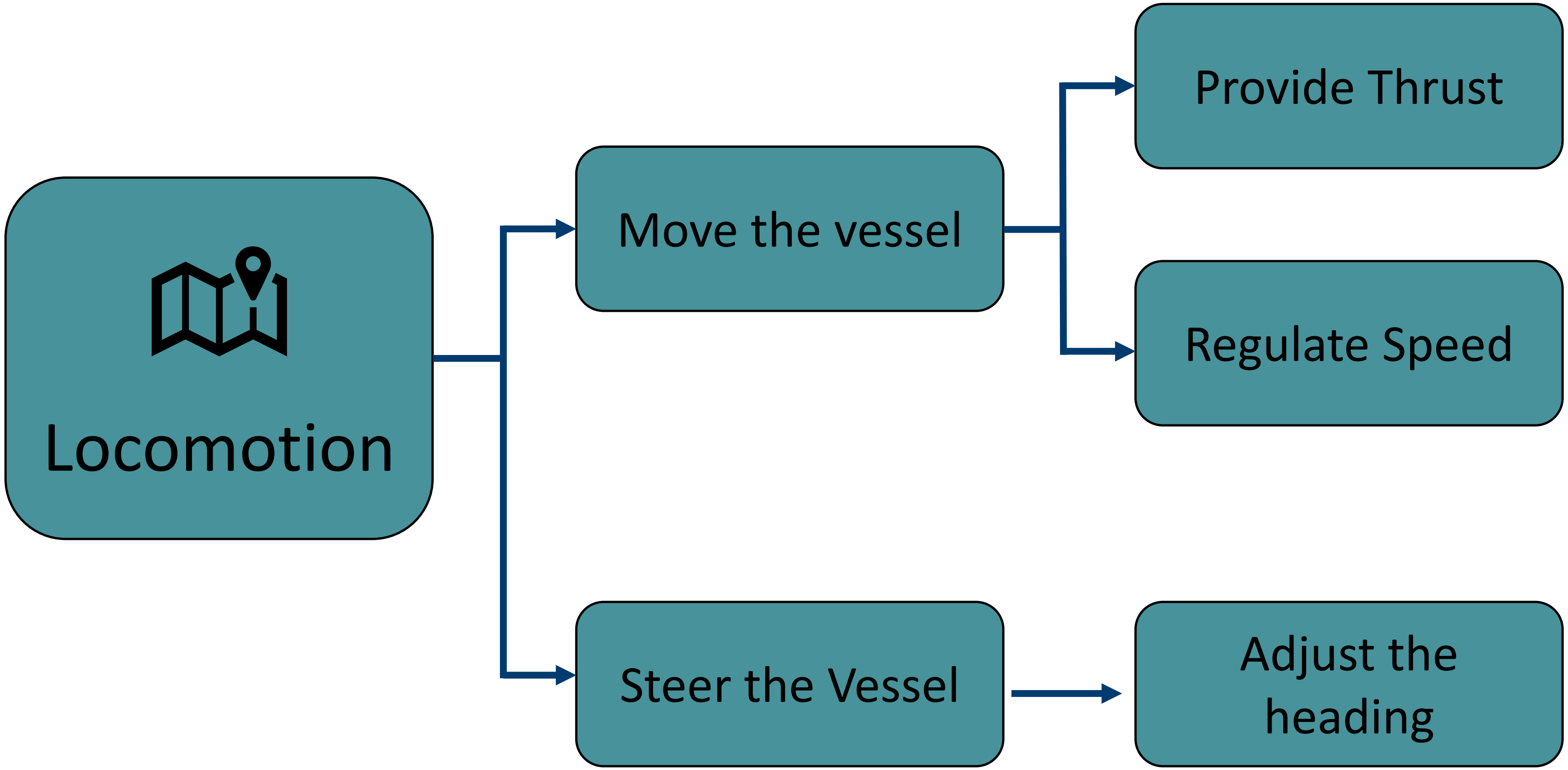
Object Retrieval

Water Spraying

Object Detection

Sophia
Barron

Functional Decomposition



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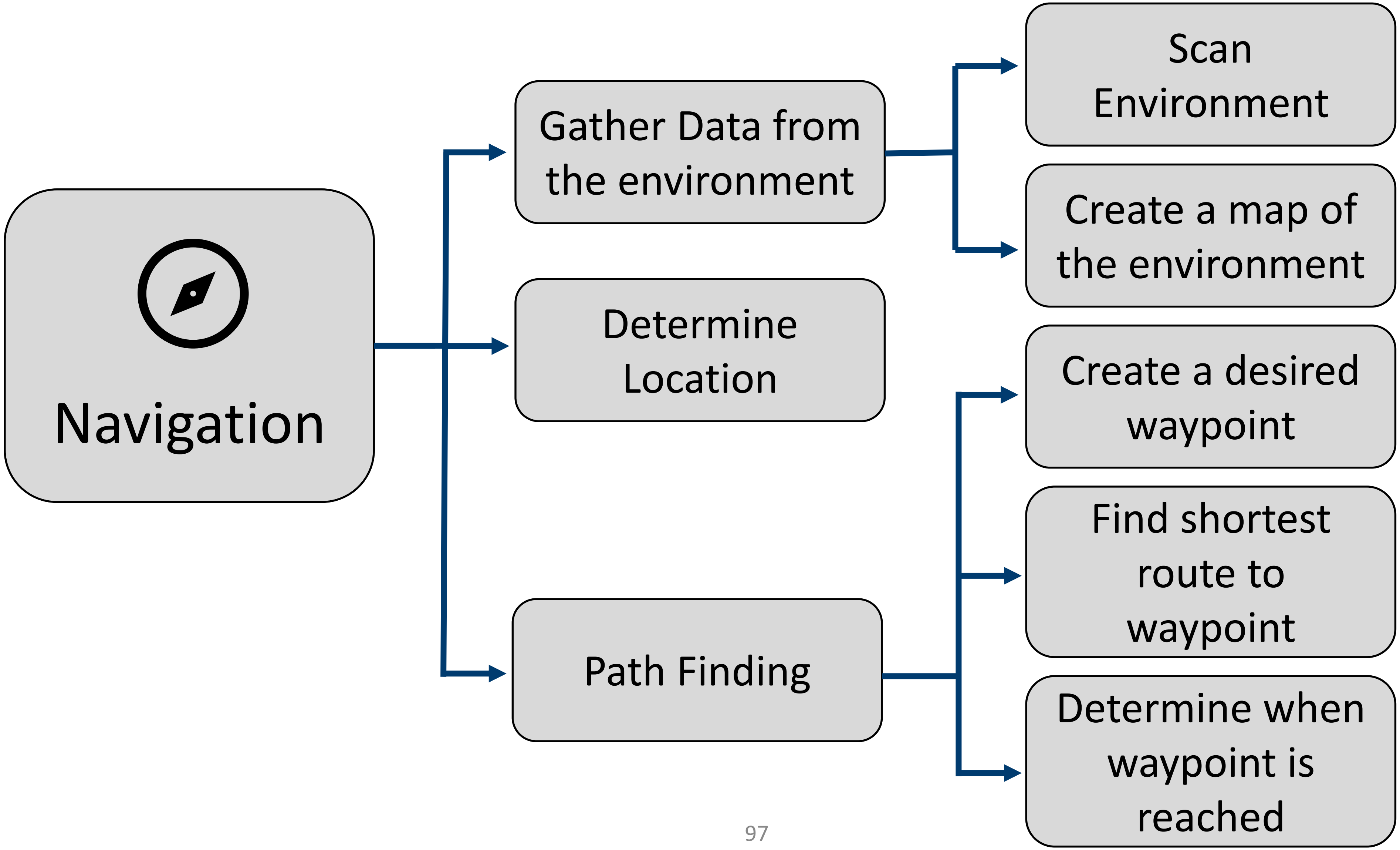
Sophia Barron

Functional Decomposition



Navigation

Gather Data from the environment

Scan Environment

Create a map of the environment

Determine Location

Path Finding

Create a desired waypoint

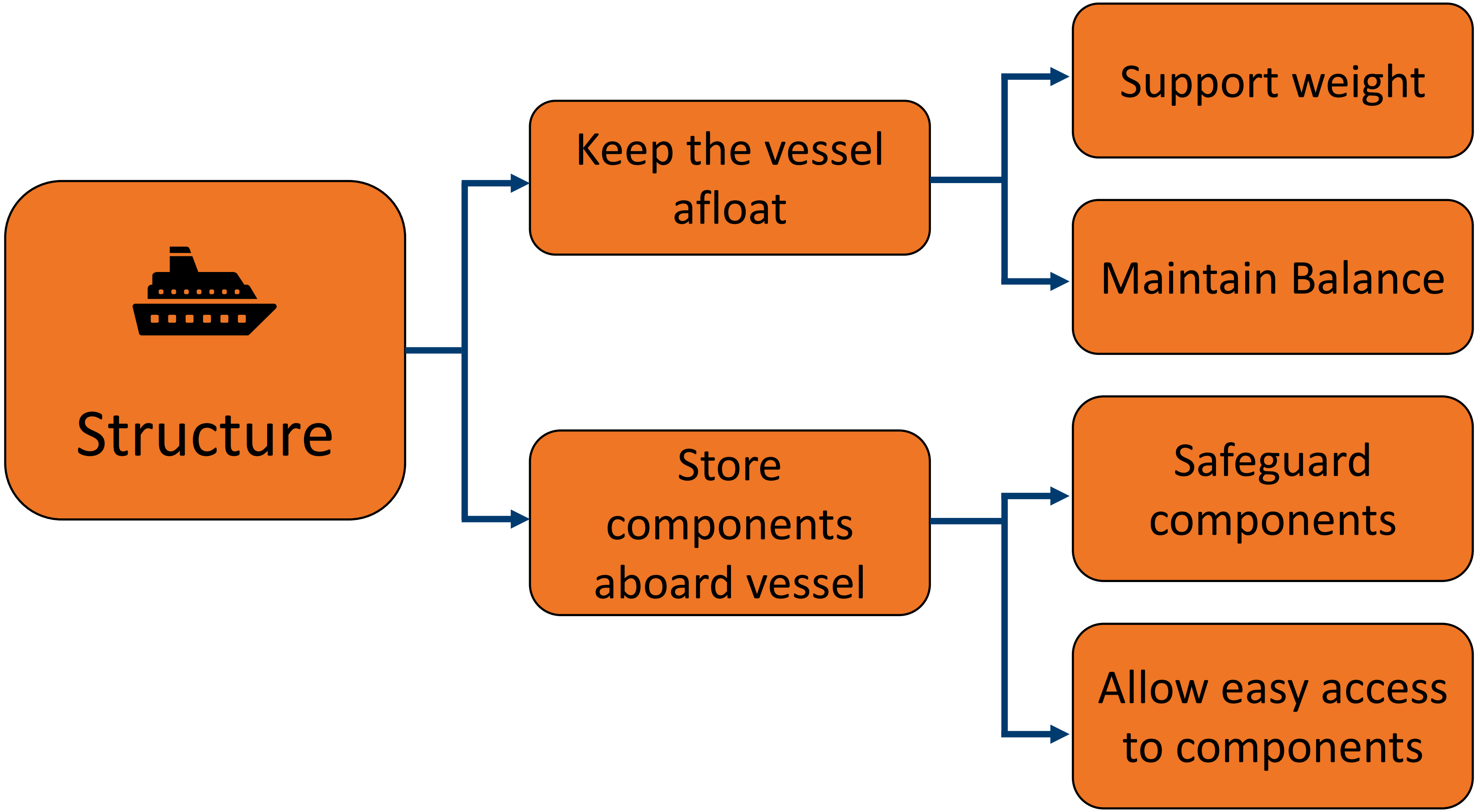
Find shortest route to waypoint

Determine when waypoint is reached

FAMU-FSU College of Engineering

Sophia Barron

Functional Decomposition



Structure

Keep the vessel afloat

Support weight

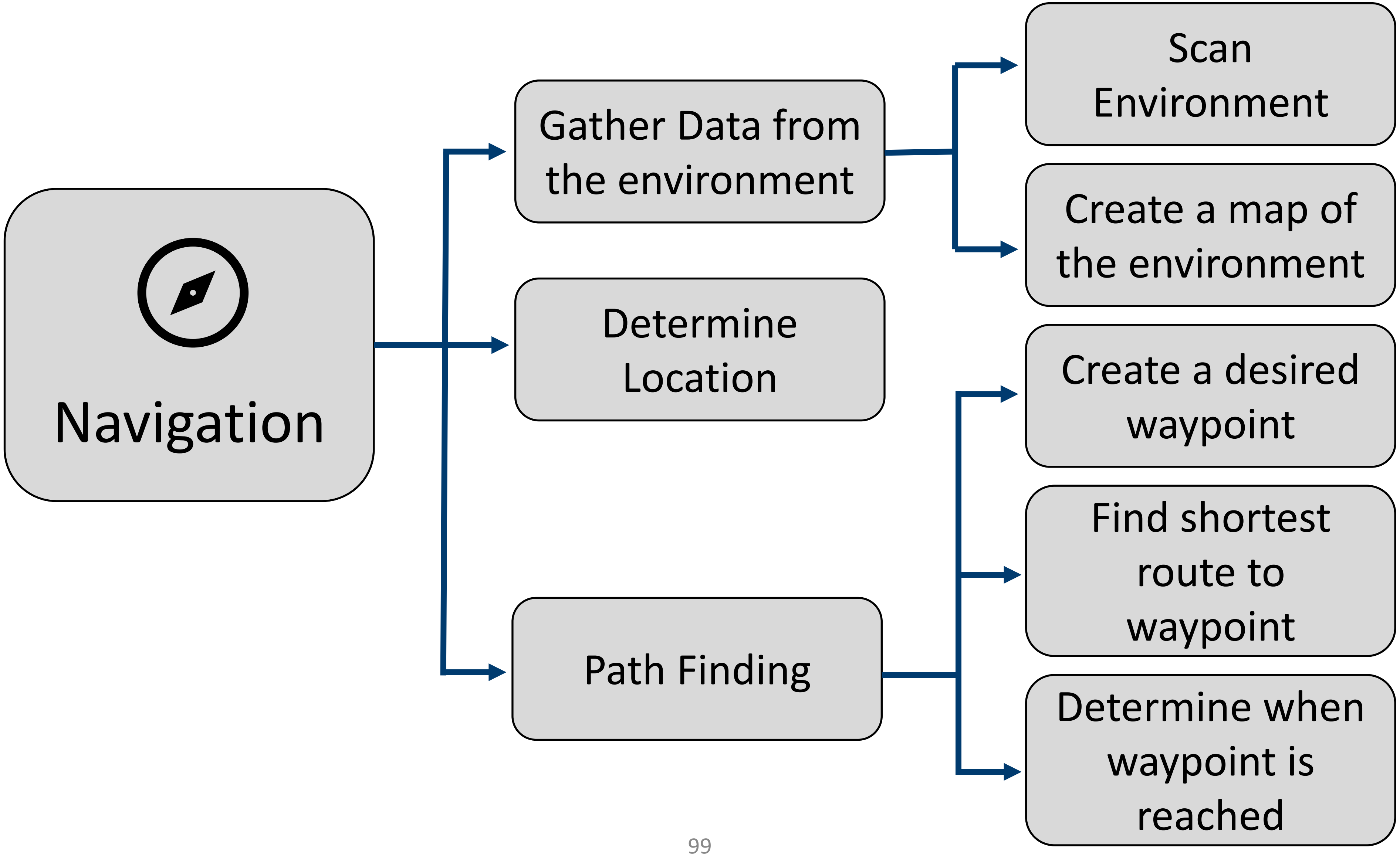
Maintain Balance

Store components aboard vessel

Safeguard components

Allow easy access to components

Functional Decomposition



Navigation

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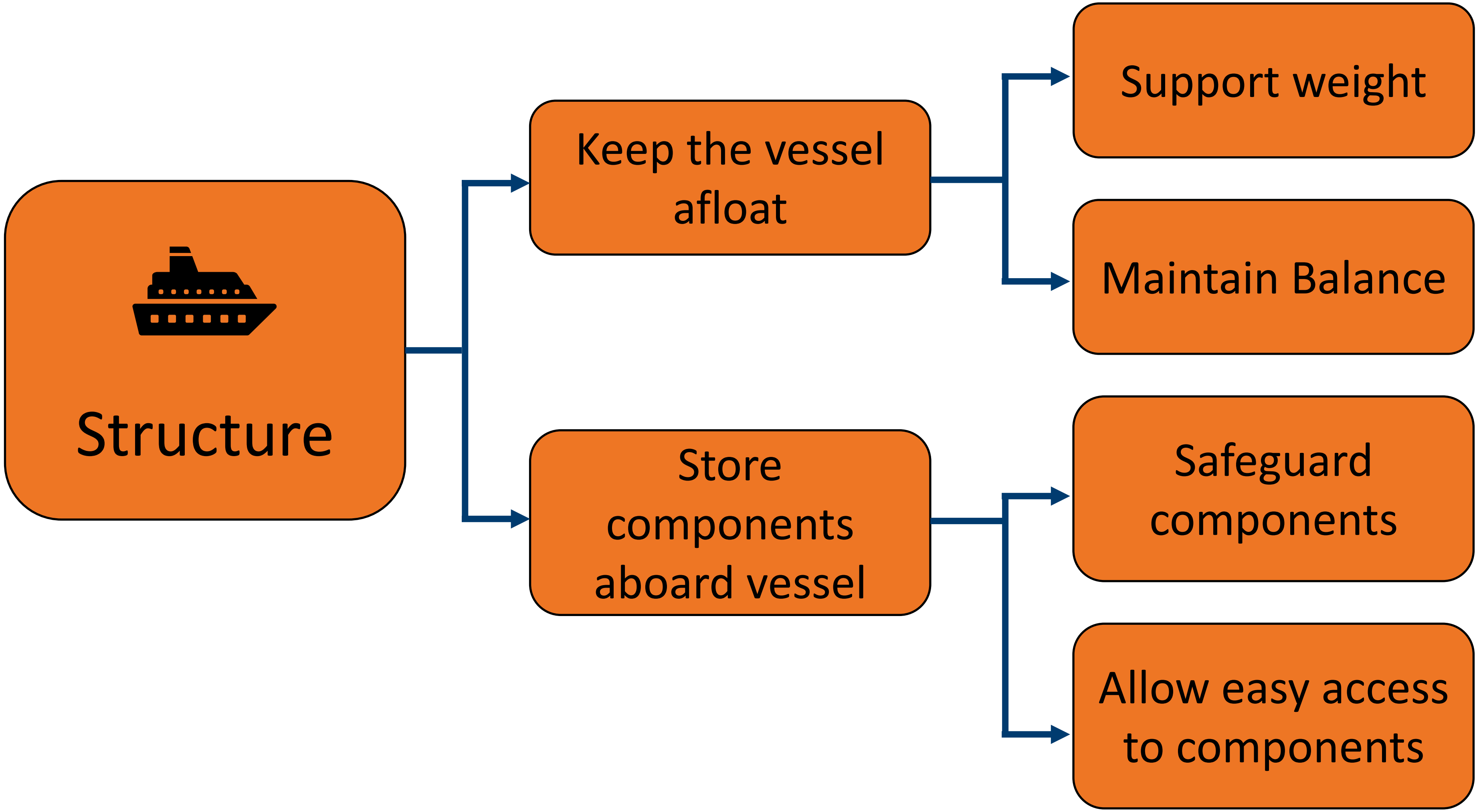
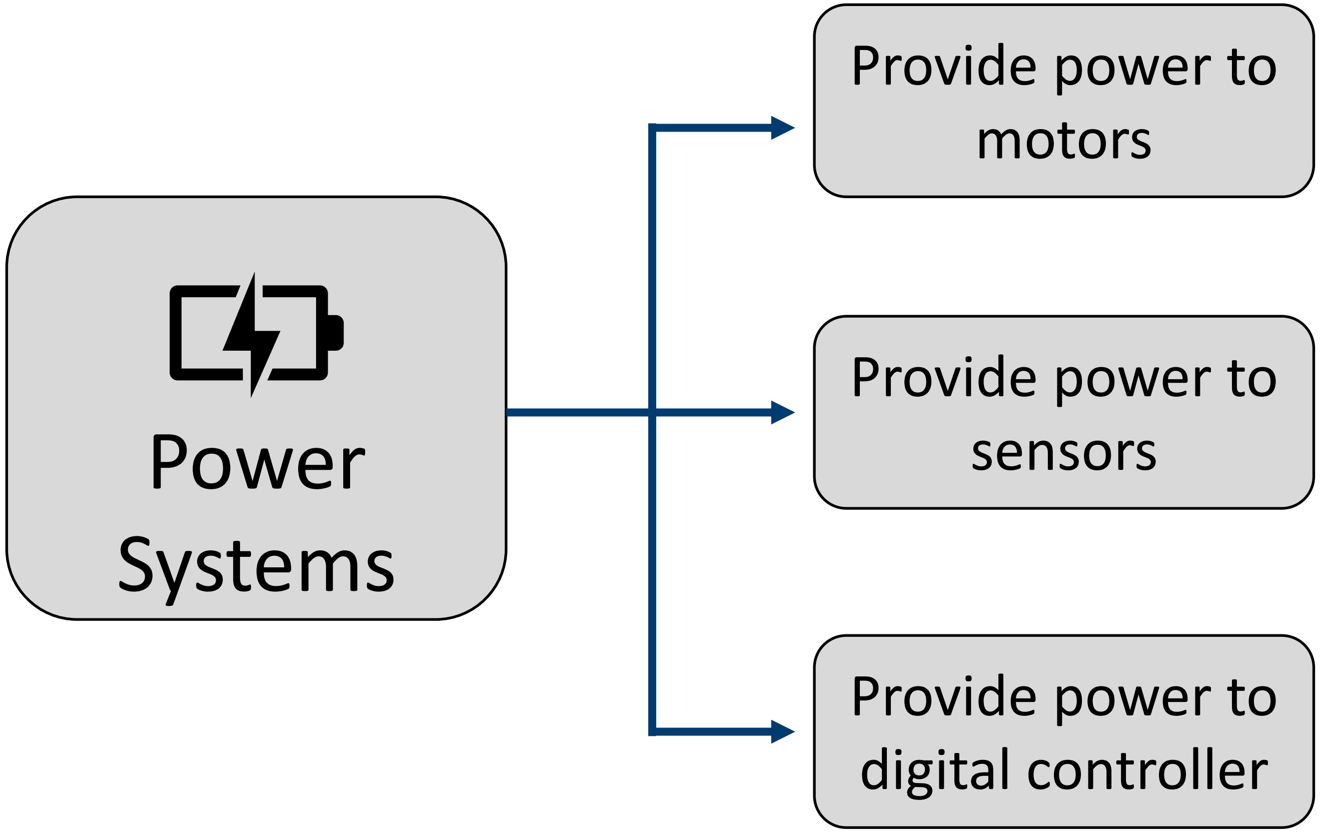
Functional Decomposition



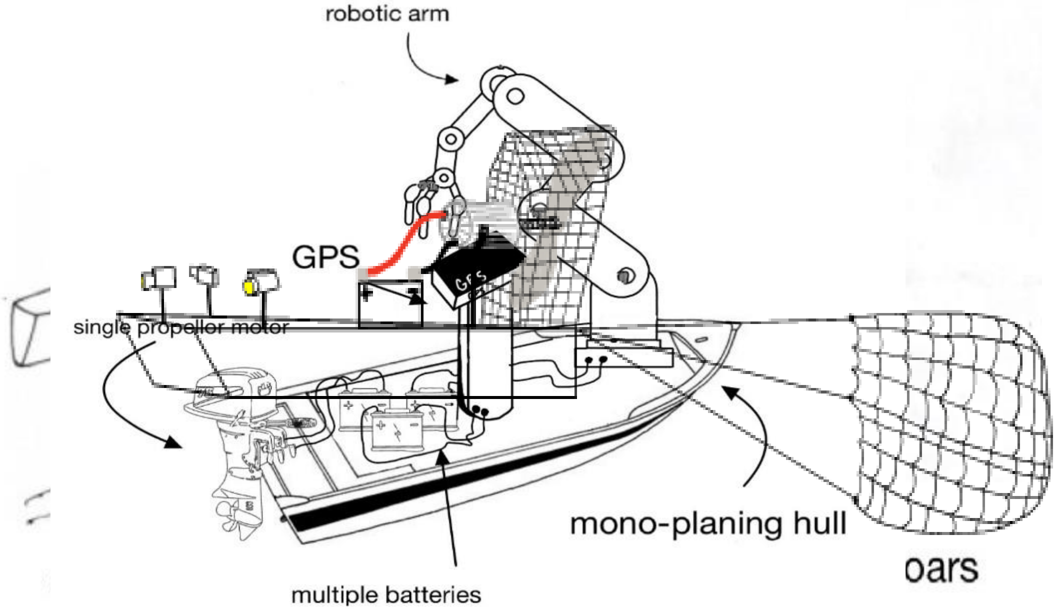
Functional Decomposition



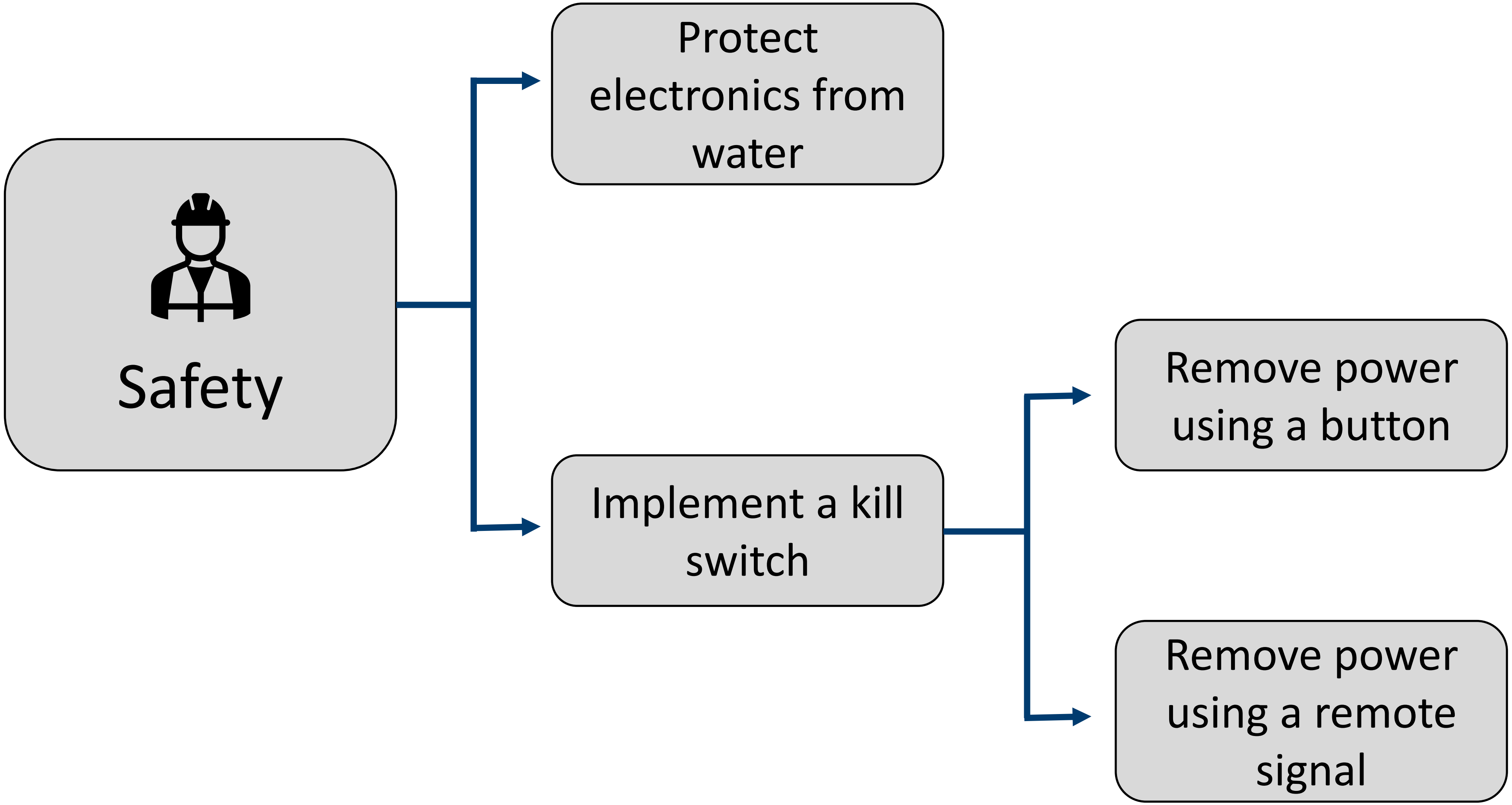
Medium Fidelity Concepts

- S.S. Galley
- S.S. Ordonomy
- S.S. Hooker V1
- S.S. Air Goose
- S.S. Ol’ John

S.S. OL’ JOHN



Functional Decomposition



Safety

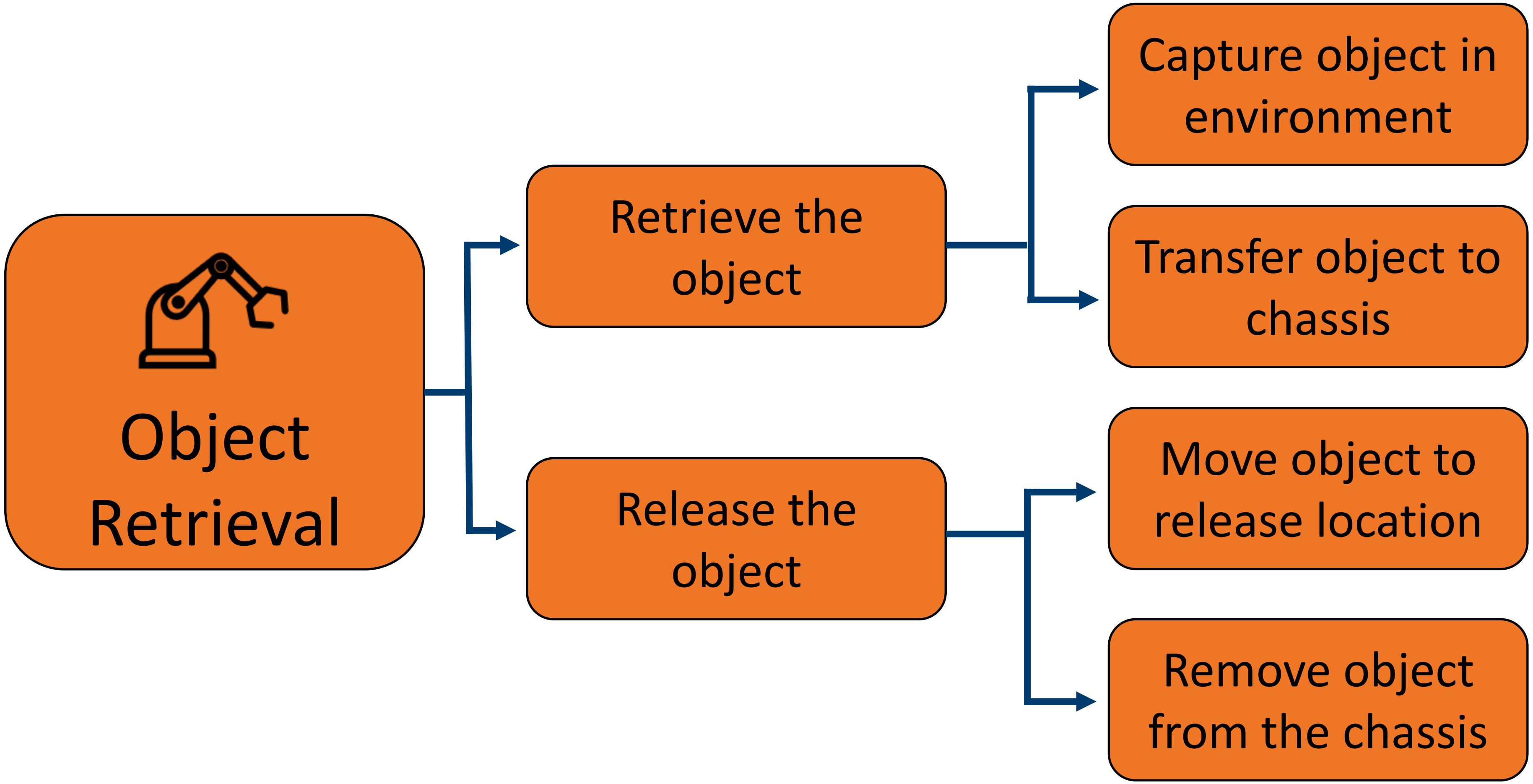
Protect electronics from water

Implement a kill switch

Remove power using a button

Remove power using a remote signal

Functional Decomposition



Object Retrieval

Retrieve the object

Release the object

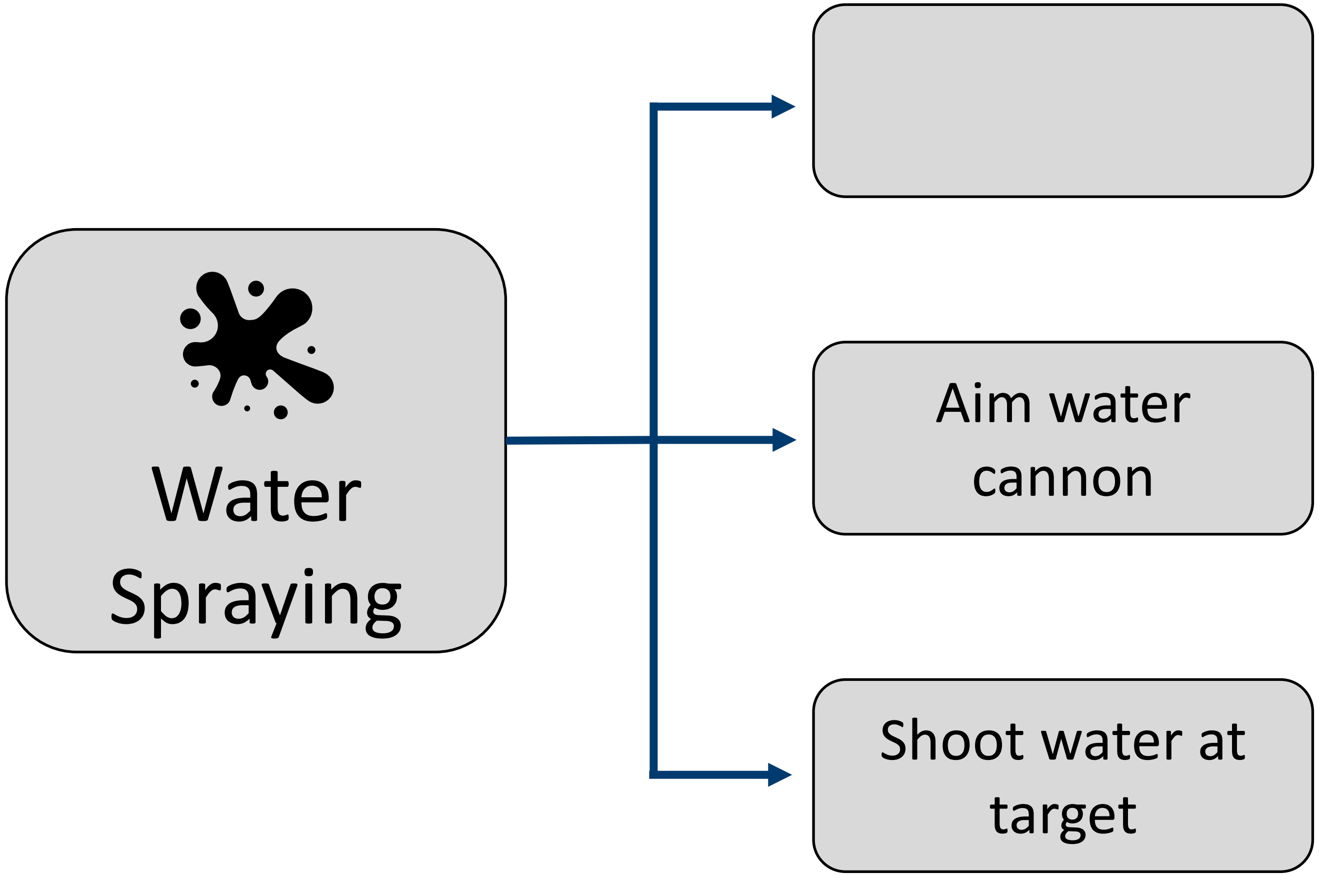
Capture object in environment

Transfer object to chassis

Move object to release location

Remove object from the chassis

Functional Decomposition

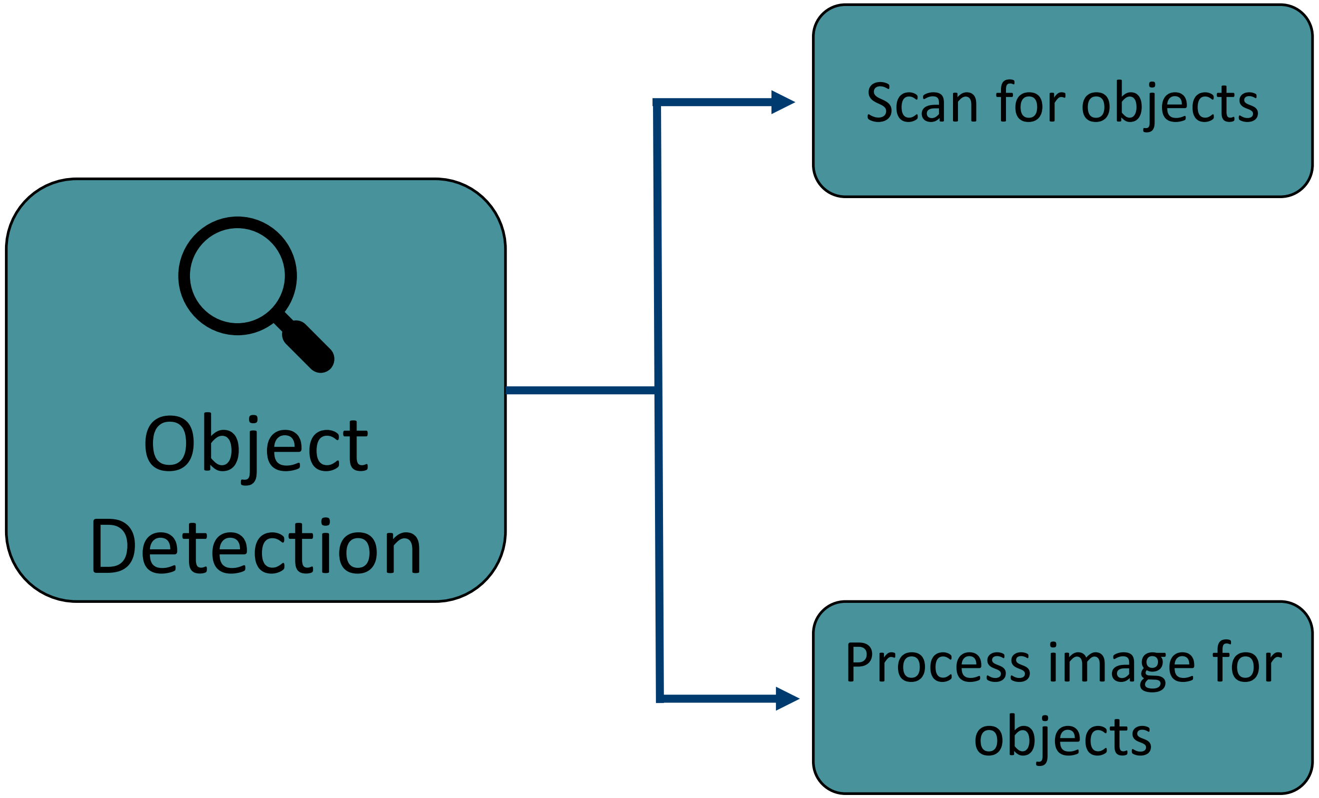


Water Spraying

Aim water cannon

Shoot water at target

Functional Decomposition



Object Detection

Scan for objects

Process image for objects

Near Future Work

- Start working on robot localization
  - Test different GPS module (found in Senior design room)
  - Draft navigation code diagram
  - Test different obstacle aversion methods on prototype
- Test given thrusters (PCB Campus)
- Start drafting and testing kill switches
  - Remote with RC transmitter
  - Physical with push button

Future Work

- Start working on materializing chosen structural design
- Start working on camera object detection
  - Geometric segmentation: Recognizing shapes
  - Semantic segmentation: Object class (Ducks, buoy, etc)
- Integrate different functional systems
  - I.e navigation w/ locomotion and object detection
- Preliminary electrical calculations/schematics
  - Power supply calculations
  - Overall block diagrams
- Finalize first draft of test code for the Autonomous navigation portion of ASV

Ivanna Caballero

Primary Markets

Secondary Markets

Ivanna Caballero

Stakeholders

NAVSEA
NAVAL SEA SYSTEMS COMMAND

FAMU-FSU
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Engineering

Markets

NAVSEA
NAVAL SEA SYSTEMS COMMAND

R
N

RoyalCaribbean

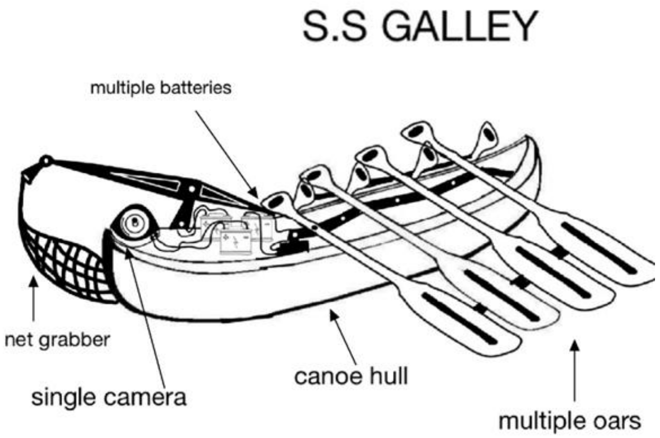
INSANE
BOATS

BOSTON
WHALER

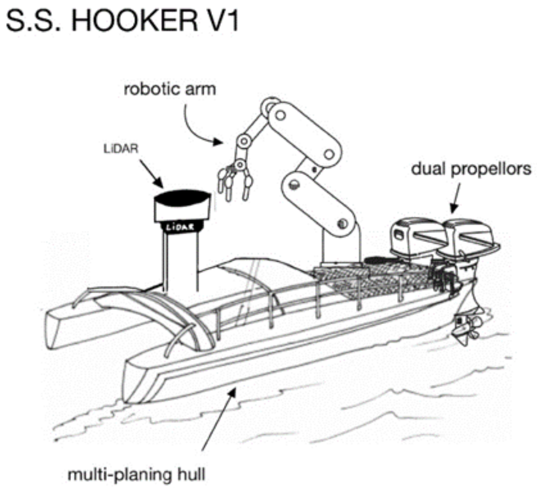
UNITED STATES COAST GUARD
1790

Medium Fidelity Concepts

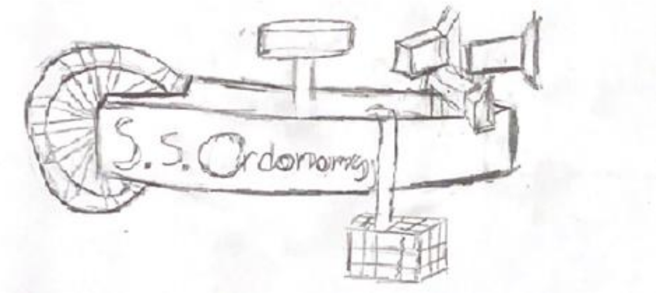
S.S Galley



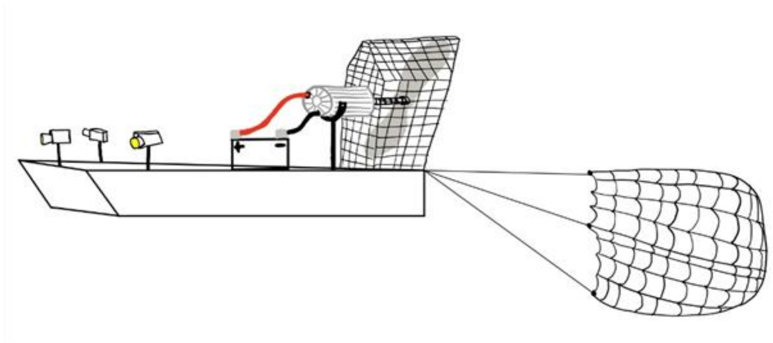
S.S Hooker V1



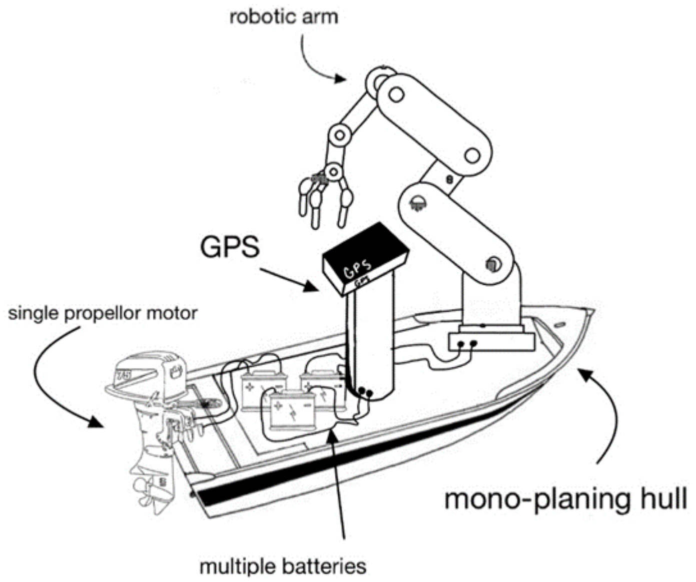
S.S Ordonomy



S.S Air Goose



S.S Ol’ John



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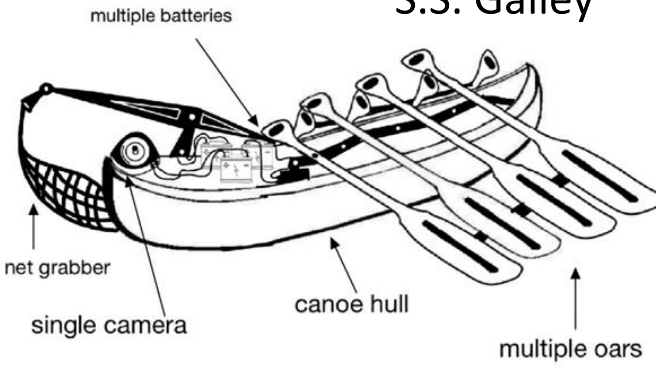
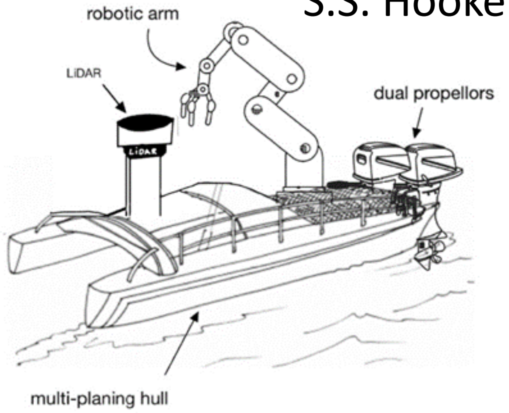
5 Medium Fidelity Concepts

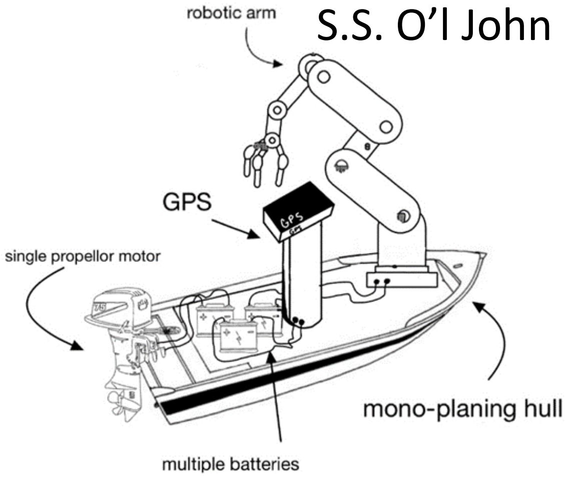
S.S. Galley



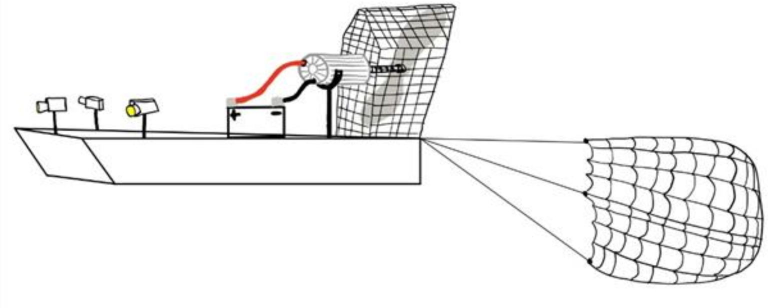
S.S. Hooker



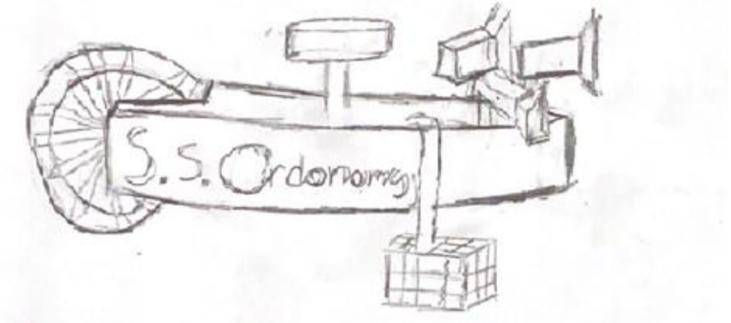
S.S. O’l John



S.S. Air Goose



S.S. Ordonomy



Michael Fitzsimmons

High Fidelity Concepts

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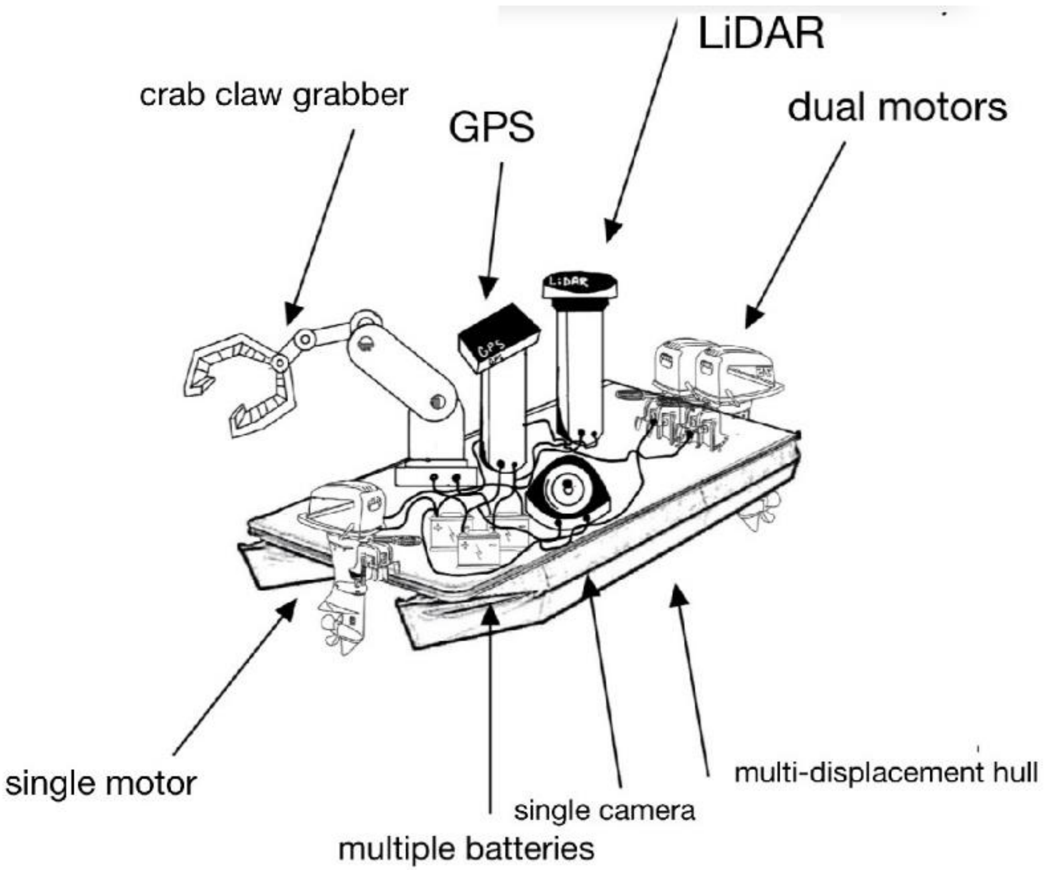
Engineering

Michael Fitzsimmons

S.S. Shayne 1.0

- Multi-displacement hull
- Dual rear propellers
- Single front propeller
- GPS, camera, and Lidar
- Crab claw grabber
- Multiple batteries



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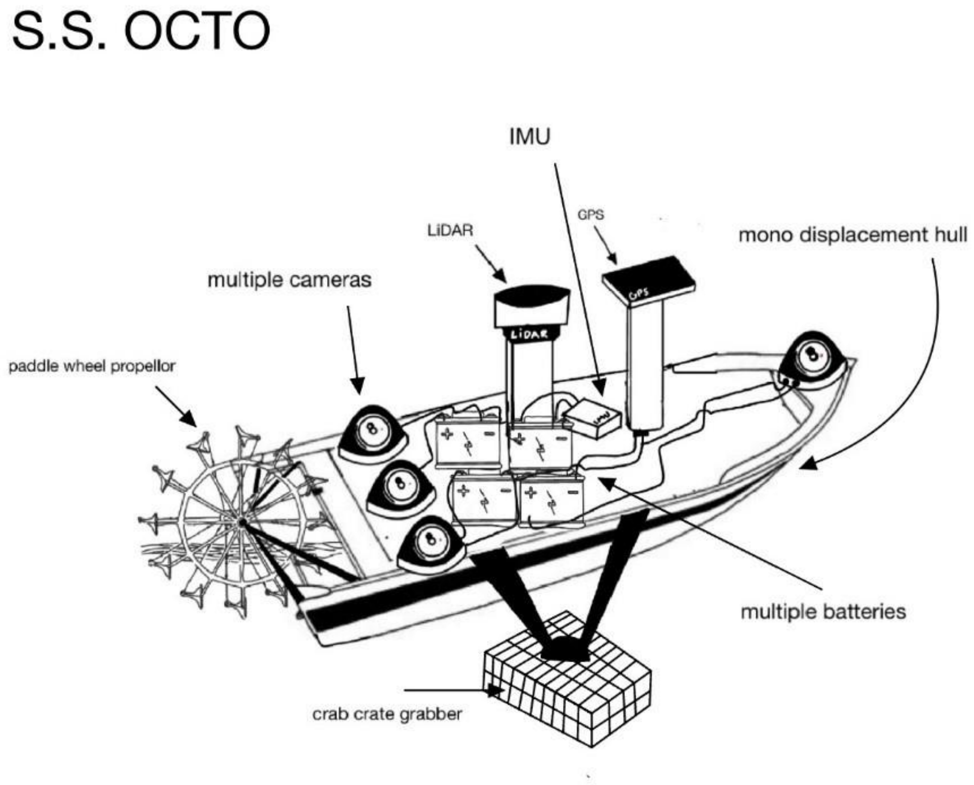
S.S. Octo

- Mono-displacement Hull
- Paddle wheel propeller
- Multiple cameras
- GPS, Lidar, IMU
- Crab crate
- Multiple batteries

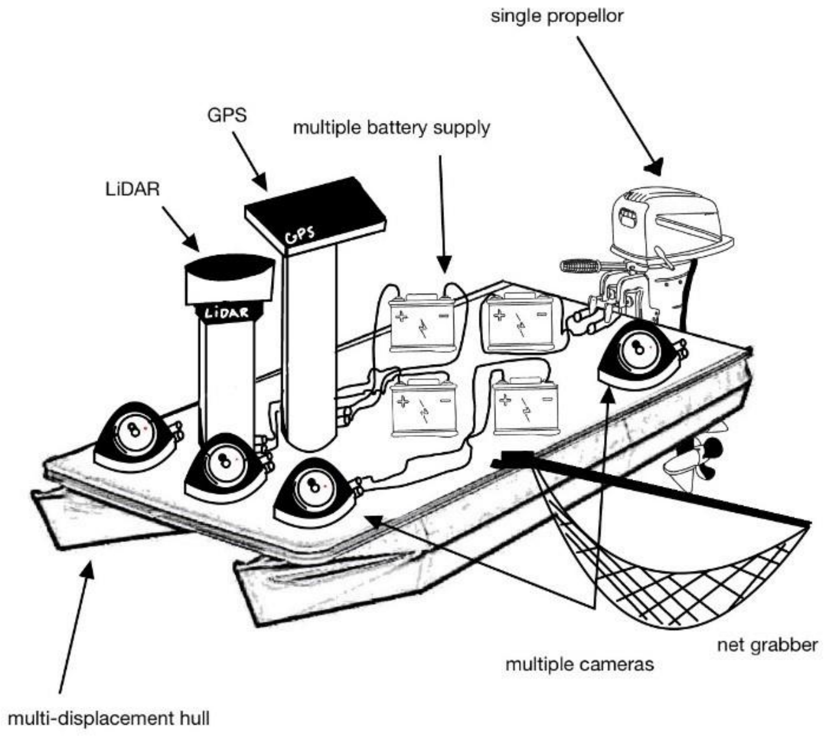


Michael Fitzsimmons

S.S. Slow N' Steady

- Multi-displacement hull
- Single propeller
- GPS & Lidar
- Multiple batteries
- Multiple Cameras
- Net Grabber

S.S SLOW AND STEADY



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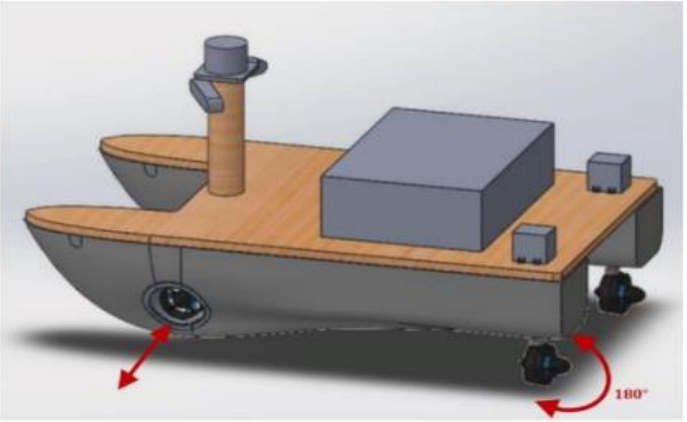
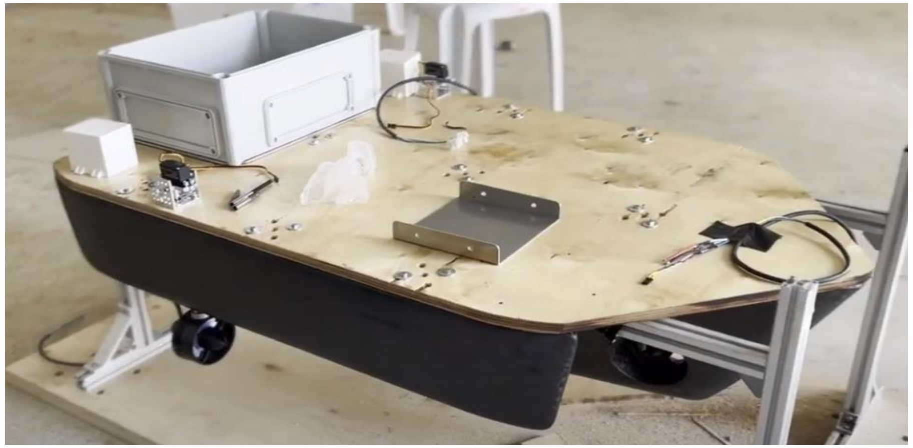
Nicholas Norwood

Pugh Charts – Tel Aviv





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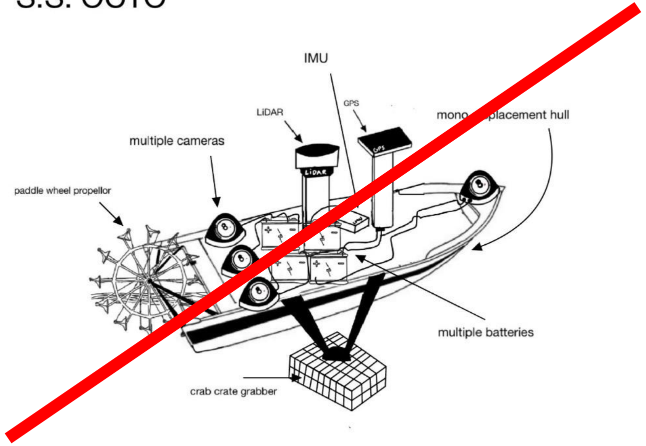
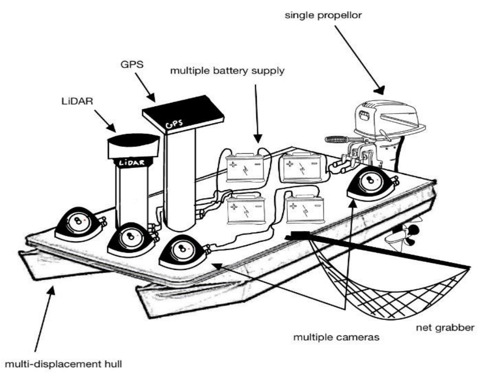
Nicholas Norwood

Pugh Charts – 1st Iteration

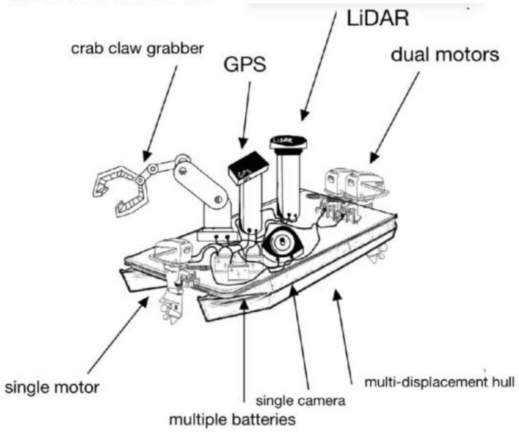
S.S. OCTO



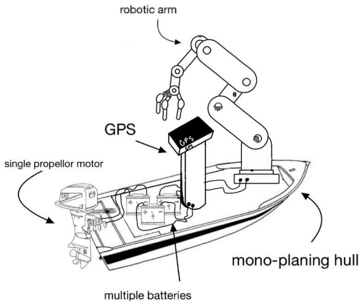
S.S SLOW AND STEADY



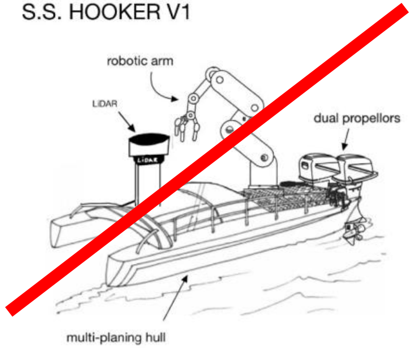
S.S. SHAYNE 1.0



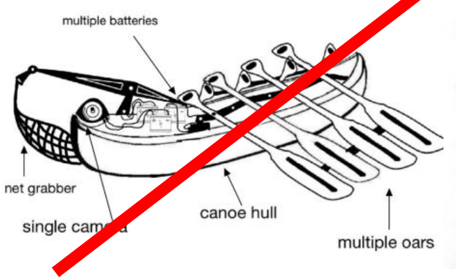
S.S. OL' JOHN



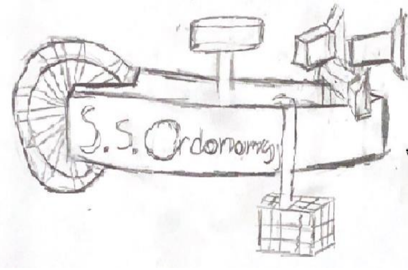
S.S. HOOKER V1



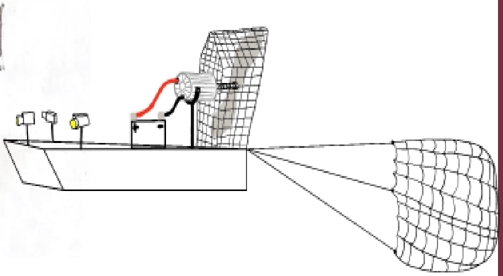
S.S GALLEY



S.S. Ordonomy



S.S. Air Goose



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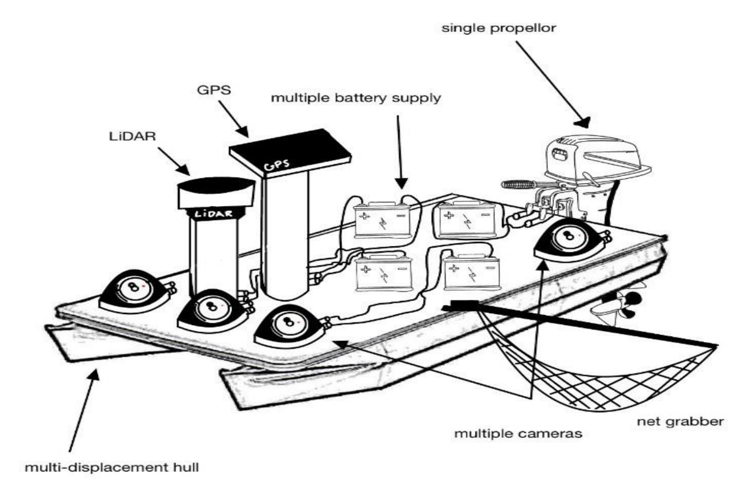
Nicholas
Norwood

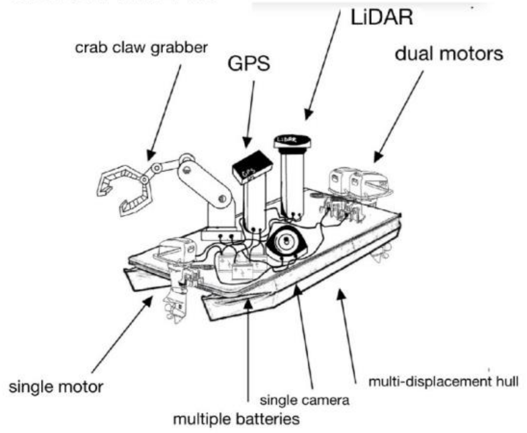
Pugh Charts – 2nd Iteration

New Datum

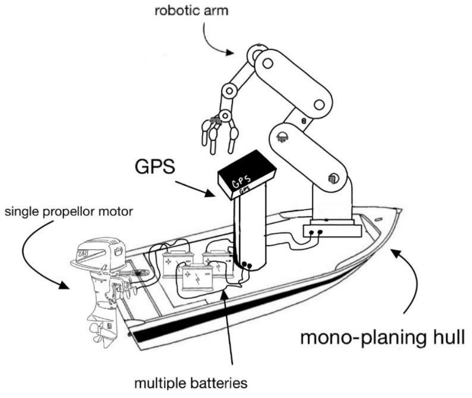
S.S SLOW AND STEADY



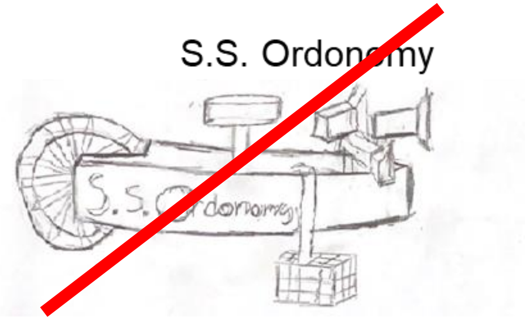
S.S. SHAYNE 1.0



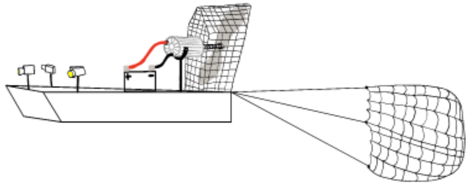
S.S. OL’ JOHN



~~S.S. Ordonomy~~



S.S. Air Goose



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Andly Jean

Functional Decomposition

- Locomotion
- Navigation
- Structure
- Power Systems
- Safety
- Object Retrieval
- Water Spraying
- Object Detection

Andly Jean

Functional Decomposition

Locomotion

Navigation

Structure

Power Systems

Safety

Object Retrieval

Water Spraying

Object Detection

Functional Decomposition

- Locomotion
- Navigation
- Structure
- Power Systems
- Safety
- Object Retrieval
- Water Spraying
- Object Detection

Functional Decomposition

Locomotion

Navigation

Structure

Power Systems

Safety

Object Retrieval

Water Spraying

Object Detection

Concept Generation

100 Concepts

5 Medium Fidelity

3 High Fidelity

Critical Targets and Metrics

Why Critical Targets Matter:

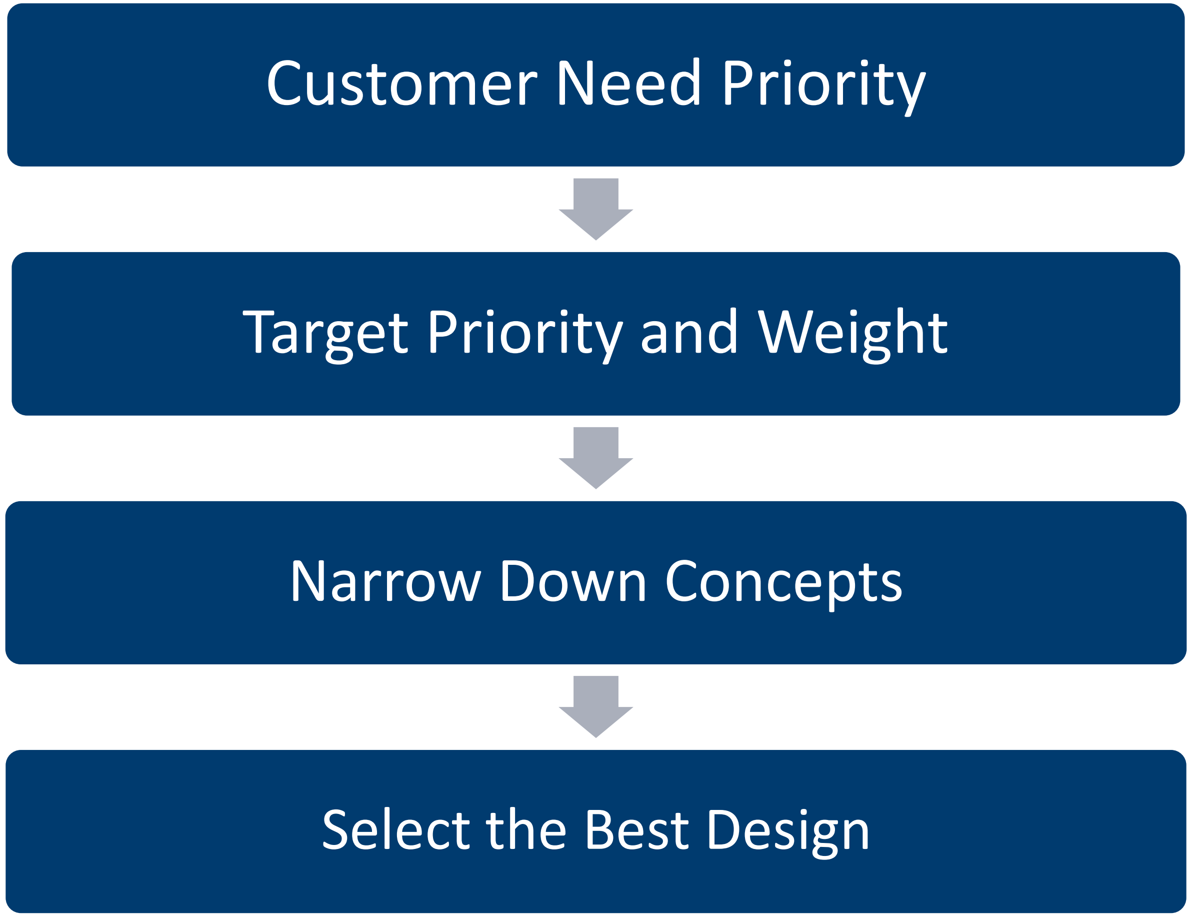
Foundation for Success

Enhanced Efficiency

Enhanced Safety

Nicholas Norwood

Concept Selection



Customer Need Priority

Target Priority and Weight

Narrow Down Concepts

Select the Best Design

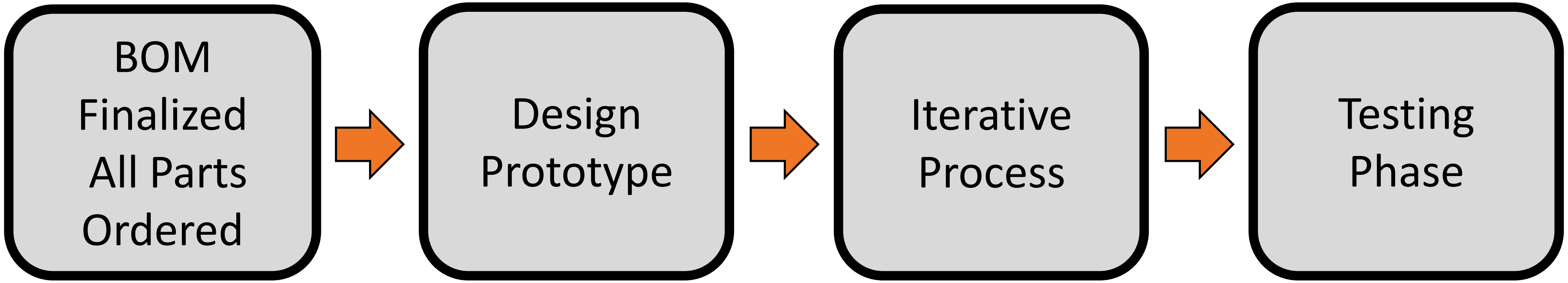
Nicholas Norwood

Concept Selection

Customer Needs	Weight
Stability	9
Cost Stays Within Budget	8
Modular Components	6
Weight	6
Size Within Competition Rules	5
Navigation	5
Run Time	3
Object Detection	2
Autonomy	1
Object Retrieval	0

Target	Priority
Battery Power	1
Buoyancy	2
Sensor Resolution	3
Size	4
Weight	5
Navigation	6
Deflection Angle	7

Future Work and Timeline



- This is 10-point
- This is 15–point Times
- This is 20–point
- This is 25–point
- This is 30–point
- This is 35–point
- This is 40–point
- This is 50–point
- This is 60–point