Neptune Knights

UCF MER Knights, Orlando, FL, US

Members

Julianna Bernal (Vice President/Hardware and Documentation), Benedetto Falin (Software Lead), Carolina Rodriguez (Secretary/Marketing), Joseph Protko (Treasurer), Victoria Maseda (Technical Documentation Lead), Alessandra Curbelo (President/Hardware), Christopher Escobar (Hardware Lead), Melanie Allen (Hardware), Mathew Robert (Hardware/Electrical)

Mentors

Don Harper and Yunjun Xu

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Abstract

2024 marks the first year UCF team the Neptune Knights will take the floor at MATE competition. Our team understands the importance of time and money striving to make our ROV as financially viable as possible while still performing effectively. As well as our team understands the importance of giving back to the community. We hold mentorship connections with schools such as Cypress Bay High School. We take the time both inside and outside the classroom connecting through our media channels with outreach to other clubs at our school and raising awareness. Our members understand the importance of the work we do and how to prepare for life beyond the classroom and beyond MATE with our club.

Project Management

Company Mission

We want to make sure our products are simple, cost effective, and efficient. While we have multiple teams spanning from accounting, marketing, technical documentation, hardware, software, electrical, etc. We make sure everyone knows about everything and all members of the team can speak on all issues. We believe being diverse in skill and mindset is important when it comes to group discussion and meetings. We make sure everyone participates especially using our engineering book daily logs where we take notes during design and build meetings making sure everyone is practicing writing and able to speak to other sections of the team through it.

Schedule

We used a calendar which was updated every month with new events ranging from workshops to design/build meetings and socials. We kept track of to do lists and having a hierarchy to make sure someone always knew who was made to do what and make sure what needed to be accomplished.

Procedures and Protocols for Communication

Our team maintained transparency when it came to communication. Making sure there was always a comfortable environment to ask questions and keep everyone informed at all times. We kept documentation up to date ranging from our group calendar, to do list, and daily logs to monitor what has been done, what needs to be done, and who needs help.

Engineering Design (hardware)

Engineering Design Rationale

Working collaboratively on this vehicle,our team started the design process with research into previous designs and competitions. Open discussion was had to discuss our expectations and what needed to be accomplished. This included work with drawings on basic designs and generalized measurements; we then used CAD drawings and models with accurate measurements for all the components.

During our frequent design meetings,all members involved gathered for open discussion to share ideas and draw out our different concepts. We set to doing research and understanding the competition, especially as a new MATE team. Our main focus was to keep our designs simple yet efficient at the lowest cost possible. Encouraging creativity but understanding the reality of our target audience and consumers.

Innovation

An example would be our use of cheap pvc and 3D printing.We hosted multiple CAD workshops through the season so that all members could work and help each other. In addition to lowering cost we collaborated with other teams in our school for parts such as motors and collaborating in workshops and joint meetings.

Systems Approach

To make sure our ROV would have a good balance between the sensors we used and what we would control ourselves we plan for two people in the control room who will be the most adept at understanding what they are seeing.

Engineering Design (hardware)

Vehicle Structure

We did our best to maintain a low cost and small ROV able to be quick and efficient. The size is 12inx12inx20in, the weight is 17 pounds, weight was added to the inside of the pvc frame to cancel out the air in the center tube to make is neutrally buoyant.

Vehicle Systems

Our decision on how to choose materials best for our design involved using a top down approach where we focused on price > functionality > quality. Researching multiple different options for each of component, our team was able to find the best fitting pieces for this project within our predetermined budget.

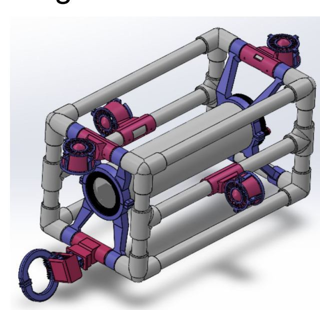
One aspect of our design that evolved to meet missions specifications was our claw. Originally, it was stationary with no movement capabilities. Movement of the ROV would allow us to accomplish tasks. We eventually decided to switch to a dynamic design that lets the claw open/close and rotate with a significantly higher range of motion

Build vs. Buy, New vs. Used

Due to our budget, we decided to build the majority of our ROV in-house, including 3D printing our own parts. By doing this, we were able to build our mounting series for the electrics with 3D printing and our frame with PVC which is easily cut and bonded.

This is the first time MERKnights is entering this competition so every idea put forward has been introduced,articulated and created by our team for this particular 2024 competition. However, doing research into previous years, our team was able to gain knowledge in how to best pick materials and what design choices might work better for this set of tasks.

Learning from the past while also brainstorming amongst the team, we were able to avoid compatibility issues between different materials as well as create an ROV designated for this particular competition..



ROV CAD

Engineering Design (electrical)

Electronic Design and Cabling

Included in the vehicle’s overall electronic design are a beagle board, four bidirectional escs, four thrusters, two servos, a camera, bus bar, and a 12v to 5v buck converter. Likewise, the vehicle is operated by a tether which contains a data cable and 12v power supply cables (with anderson connectors). The Power line connects to the bus bar in order to provide power with single point unsoldered connections for all different systems.

Control System Design

The vehicle's control system utilizes a BeagleBone Black (BBB) which is connected to our main computer (laptop) via a CAT6 ethernet tether to a router, which our main computer connects to wirelessly. The connection allows the creation of an SSH through putTY software, providing direct communication to the ROV computer (BBB).

The ROV is controlled via the keyboard of our laptop (WASD layout) which allows for it to move forward/backwards, and ascend/descend in the water. This communication is managed via a Python script, which reads input from the SSH console and sends it to the required motors for activation.

> Demonstrated understanding of tether design and requirements

> Developed and described a tether management protocol

Propulsion

After careful thought and collaboration, our team chose to use four T60 thrusters mounted around the ROV for propulsion and movement. Our vertical movement thrusters are placed on the upper portion of the PVC frame to allow the ROV to raise and lower without interfering with the two horizontal thrusters. They are also placed on the front and back to allow for pitch control. This was done to counteract any pitch forward while the vehicle is carrying an item.

The horizontal thrusters are placed throughout, including the right and left side of the ROV to allow control while turning the vehicle. This was decided since it allows the thrusters free range of motion left to right and forwards and backwards. Likewise, only four thrusters were chosen to reduce costs, this will be balanced out with the other materials added to the ROV.

Engineering Design (electrical)

Trade-Offs

We kept in mind the power the ROV would draw and how much we would have access back at the control station. Our main ideals were keeping design simple and costs down. The mission requirements often could have overlapping tools to work for different tasks. We made sure to read manuals thoroughly and watch the videos trying to come up with what would draw the least amount of power and allow up to do tasks as quickly as we could.

Payload and Tools

After weighing the pros and cons, our team chose to use one camera located at the front of the ROV for a first person perspective. We chose this placement for the advantages ikt give to see our claws movements and to get a better perspective of what the ROV sees when its moving and accomplishing tasks. For payloads we thought of the most simple solutions that would require the least kinetic parts. The more moving parts more often mean the more problems. In the words of past mentors we remember “KISS” keep it simple stupid.

Sensors

For this competition, we opted for no sensors in order to cut costs. We trust the capabilities of the vehicle to meet the mission requirements using only the camera at the front.

Testing and Troubleshooting

Vehicle testing methodology

Our main cycle of testing for the vehicle was to create a rough draft of both the ROV and the code. Our team did this to create a baseline for our current progress. After this setup, our team was able to improve upon designs, add more features to the code, and further optimize the vehicle and its capabilities.

Troubleshooting strategies and Techniques

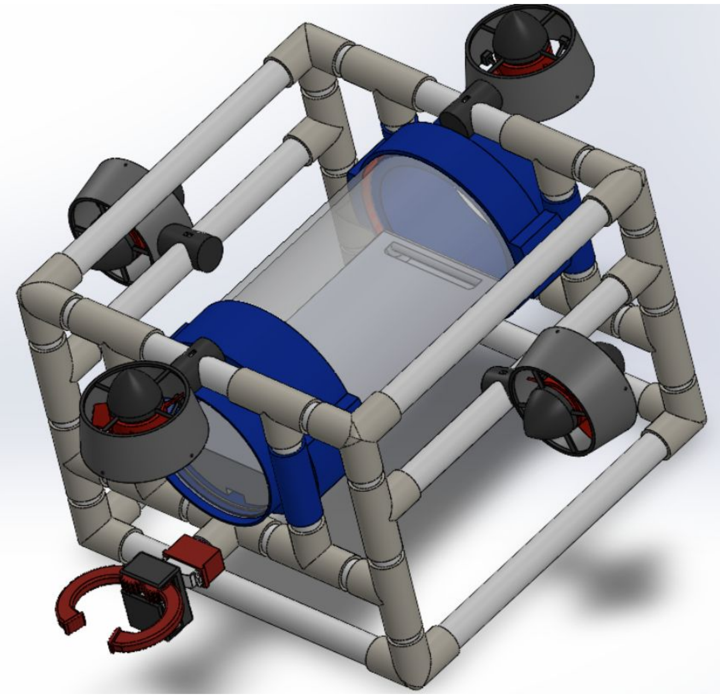
Troubleshooting the code of our vehicle was a consistent event in order to move forward in facilitating the actions necessary to complete the tasks. To troubleshoot, the code was deployed while under monitor from the team, which helped to understand and build upon the issues and successes encountered. When presented with a failed deployment of the current code, we re-evaluated our methods before sending them back in for another test. Our troubleshooting focused on rampant physical tests rather than any conceptual or ideological attempts.

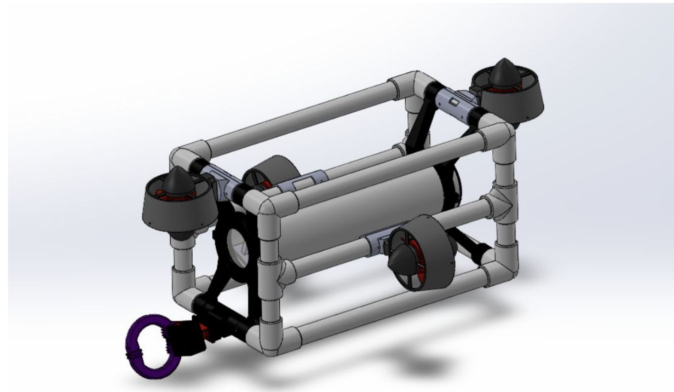
Prototyping and Testing to Evaluate Design Options

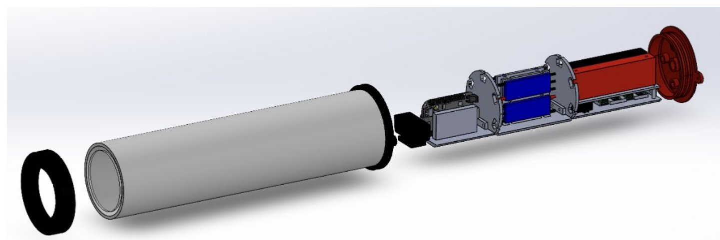
To design our ROV, the team met for design meetings that were centered around researching different parts, past-competing vehicles, and general brainstorming. The majority of our design process took place in CAD, where we could change out motors, claws, and materials to get a better understanding of how the vehicle could perform.

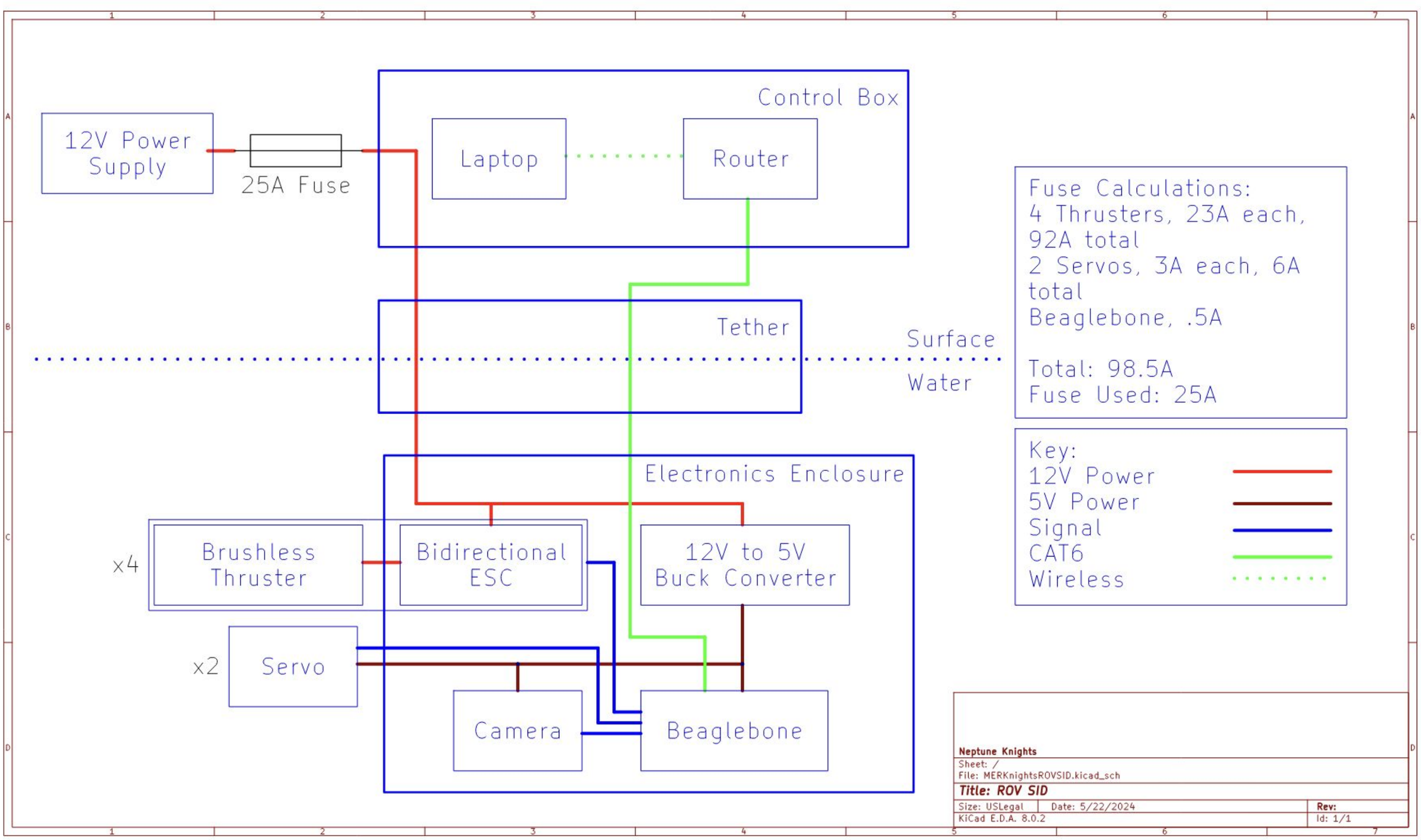
Making these designs physical for prototyping was aided by use of a 3D printer; the printer was used to create parts such as guards, mock-ups of claw designs, and end-caps for the electronics tube. This process allowed us to quickly create and test options with large, or minute, changes in order to see their effect and optimize accordingly.

SID

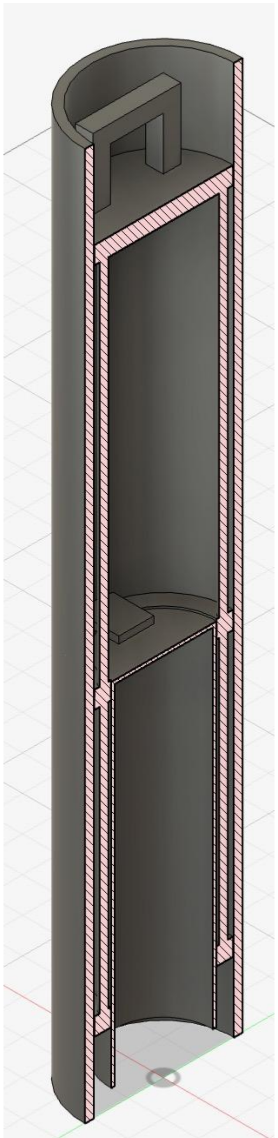


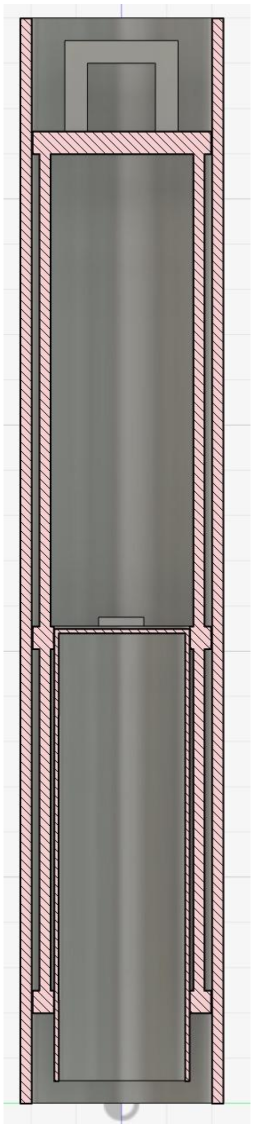





12V Power Supply
25A Fuse
Control Box
Laptop
Router
Tether
Surface
Water
Electronics Enclosure
x4
Brushless Thruster
Bidirectional ESC
12V to 5V Buck Converter
x2
Servo
Camera
Beaglebone
Fuse Calculations:
4 Thrusters, 23A each, 92A total
2 Servos, 3A each, 6A total
Beaglebone, .5A
Total: 98.5A
Fuse Used: 25A
Key:
12V Power
5V Power
Signal
CAT6
Wireless
Neptune Knights
Sheet: /
File: MERKnightsROVSID.kicad_sch
Title: ROV SID
Size: USLegal
Date: 5/22/2024
KiCad E.D.A. 8.0.2
Rev:
Id: 1/1

Vertical Profiler Non-ROV Device





Our Non-ROV device is based on the idea of a syringe to control the buoyancy engine. Including sensors and onboard batteries. In the interest of keeping our devices cost effective and mass producible we created the shell of the float of PVC and create a 3D printed cage to hold parts ranging from sensors, batteries, etc.

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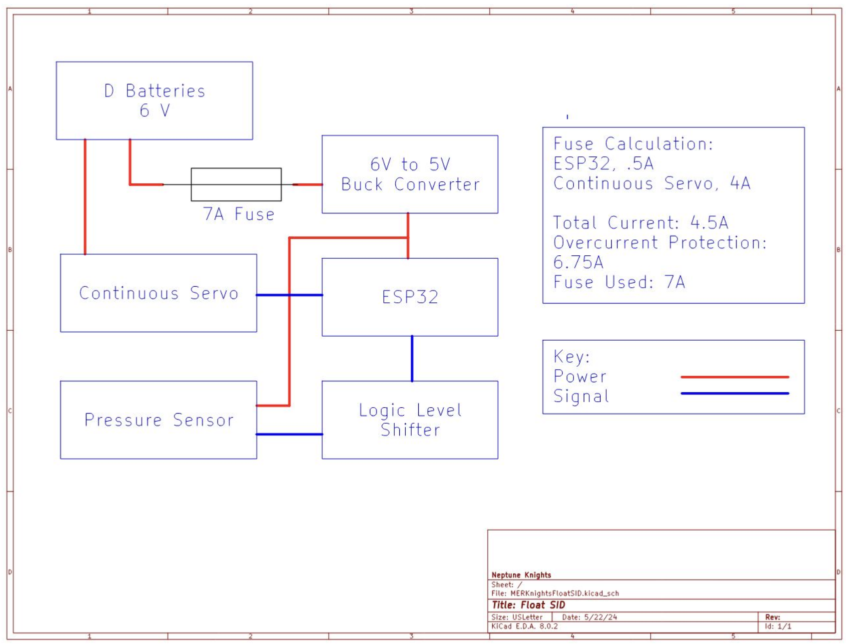
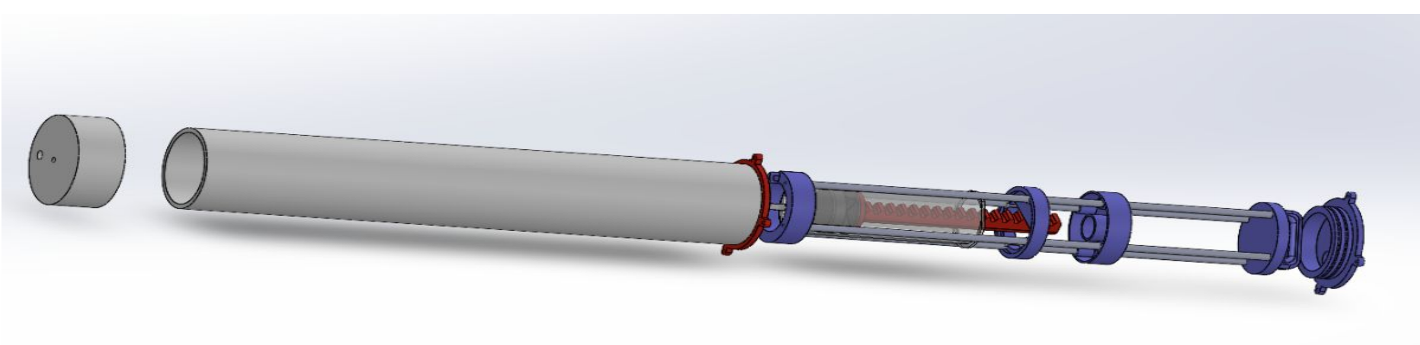
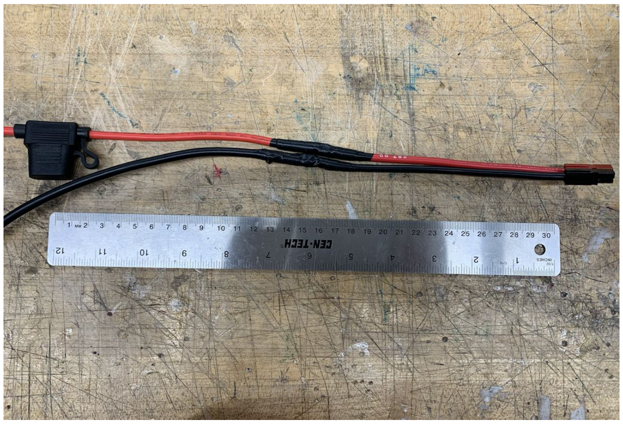


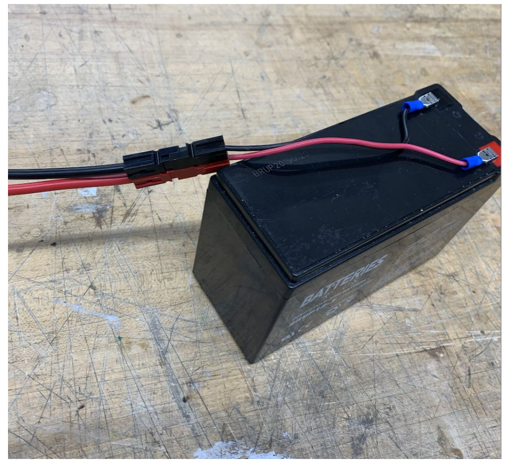
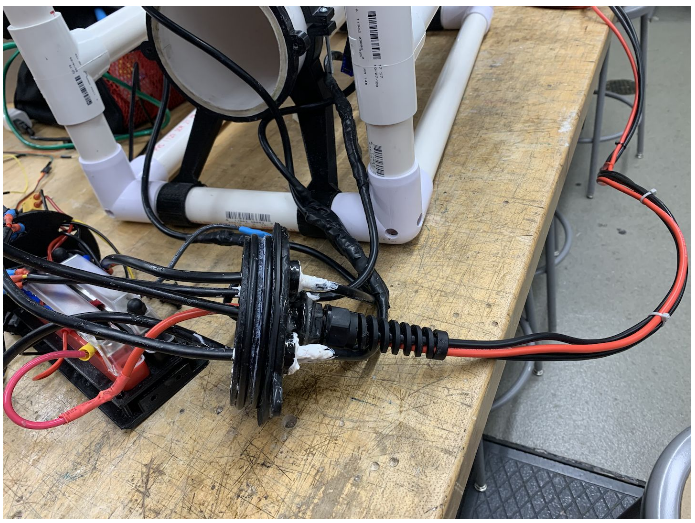
CAD of Float



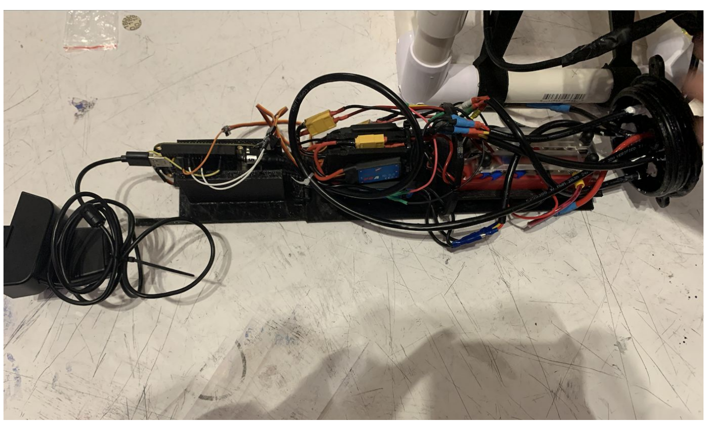
Safety

We will be using a laptop and keyboard for controls. We will not be using fluid power or pneumatics.







Accounting

Budget:					
Income:	**Type**			**Expected Amount**	**Notes:**
GoFundMe	Donation			$1,500	
Expenses	**Type:**			**Expected Cost**	**Notes:**
Hardware	Purchased			$300.00	
Hardware	Reused*			$80	*Market Value
Electronics/Sensors	Purchased			$240	
Travel	Purchased			$500	
Total Expected Income:				$1,500	
Total Expected Expenses:				$1,120.00	
Expected Final Balance:				$380	

Project Costing				
Total Raised:				
Source:	**Type**		**Amount:**	**Notes:**
GoFundMe 4/18	Donation		$579.90	
GoFundMe 4/22	Donation		$582.30	
GoFundMe 4/23	Donation		$203.31	
GoFundMe 5/14	Donation		$48.25	
Dues Payments:	Dues		$220.00	11 members worth
Total Funds Raised:			$1,633.76	
Project Costing				
Category:	**Item**	**Type:**	**Actual Cost:**	**Notes:**
Electronics/Sensors	Case Box	Purchased	$8.34	
	Servo/Motor	Purchased	$37.40	
	Servo + Batteries + Receiver	Purchased	$84.64	
	Main Cables	Purchased	$24.47	
	Distribution Terminal	Purchased	$17.99	
	Gauge Wire	Purchased	$26.98	
	Extension Cable	Purchased	$10.39	
	Pressure Sensor	Purchased	$18.79	
	Fuse Holders	Purchased	$7.49	
Hardware	Main Pipes	Purchased	$28.23	
	Filament + Other Materials	Purchased	$46.28	
	Epoxy and Plugs	Purchased	$12.20	
	Waterproofing Gaskets	Purchased	$9.79	
	Elbow Connectors	Purchased	$16.99	
	Thrusters	Reused*	$80	Market Value, borrowed from Roboboat
Travel:	Hotel Room	Pending	$500	*see expected cost
*reused in this case means borrowed from another club				
Total Income			$1,633.76	
Total Expenses			$929.98	
Final Balance:			$703.78	