Zotquatic Engineering – Underwater ROV

Team 15B: Jefferson Ng, Tyler Quilici, Thomas Vaughan, Christopher Ramirez, Tyler Furukawa, Oscar De Jesus
Sponsor: Prof. Sherif Hassaan
Department of Mechanical and Aerospace Engineering, University of California, Irvine

Executive Summary

The increasing presence of small metal debris in underwater ecosystems poses a significant environmental threat on seabed fauna and flora, necessitating the development of a low-cost, open source, submersible ROV capable of efficiently locating and retrieving these objects to mitigate pollution and safeguard aquatic biodiversity. In order to meet this need, our team has begun to research and design such an ROV that is capable of 4 degrees of freedom, controlled by a joystick, and provides live camera footage. While we are not aiming to deploy our ROV in deep waters, we will be simulating such a mission in the ARC pool to retrieve crushed metal cans.

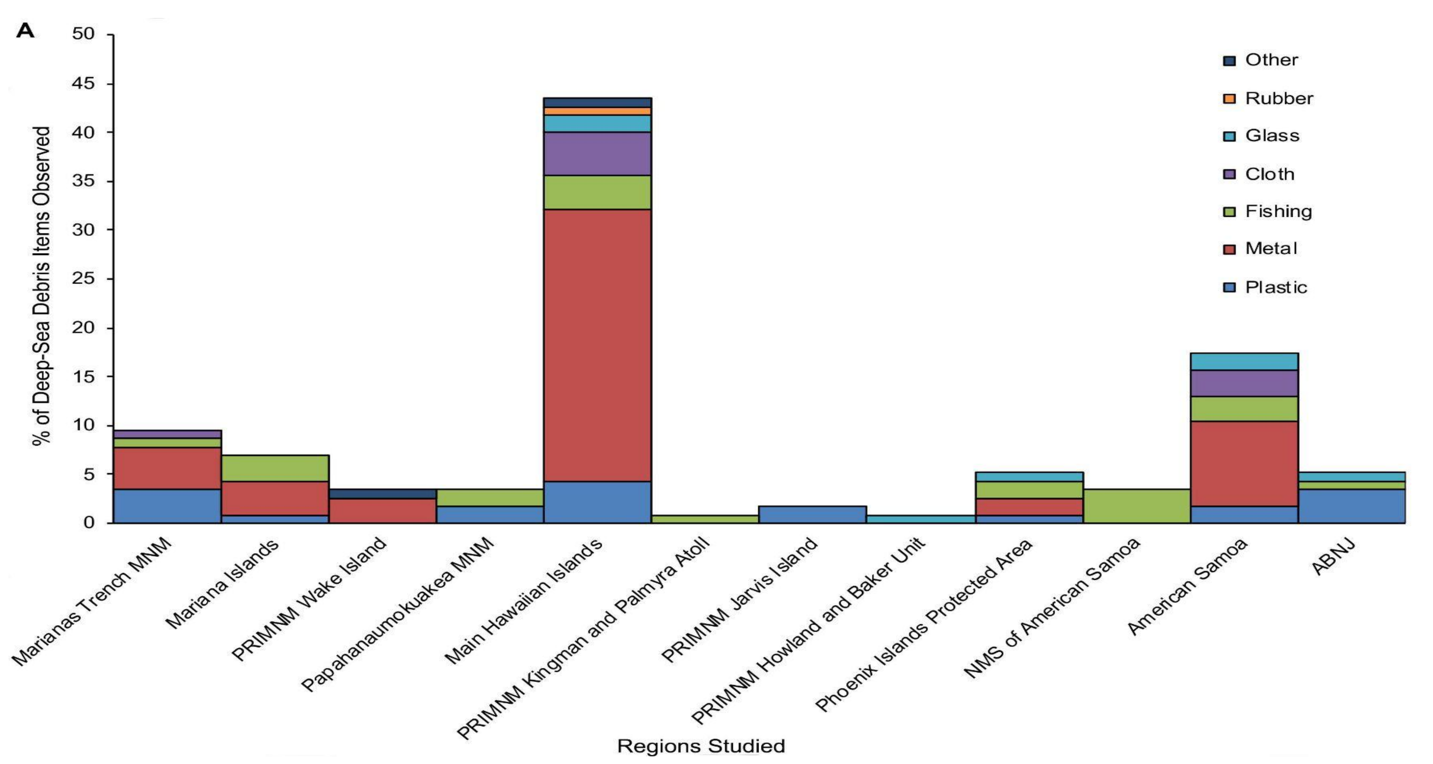

Figure 1: Amount of Deep-Sea Debris Items in Various Regions. Diva Amon et. al, 2020. [1]

Goals and Objectives

Early Concepts

Our team generated our concepts after reading through MATE's underwater ROV textbook and analyzing technical documentation from the MATE competition [2]. After weeks of discussion, we decided on a PVC-based frame constructed around a centered enclosure. We plan to use high buoyancy materials at the top of the frame and weight at the bottom to increase stability. Some forms of bio-inspired elements were considered, as shown in the crab legs in the figure on the right. We did not have a clear vision for manipulator early on in the design process.

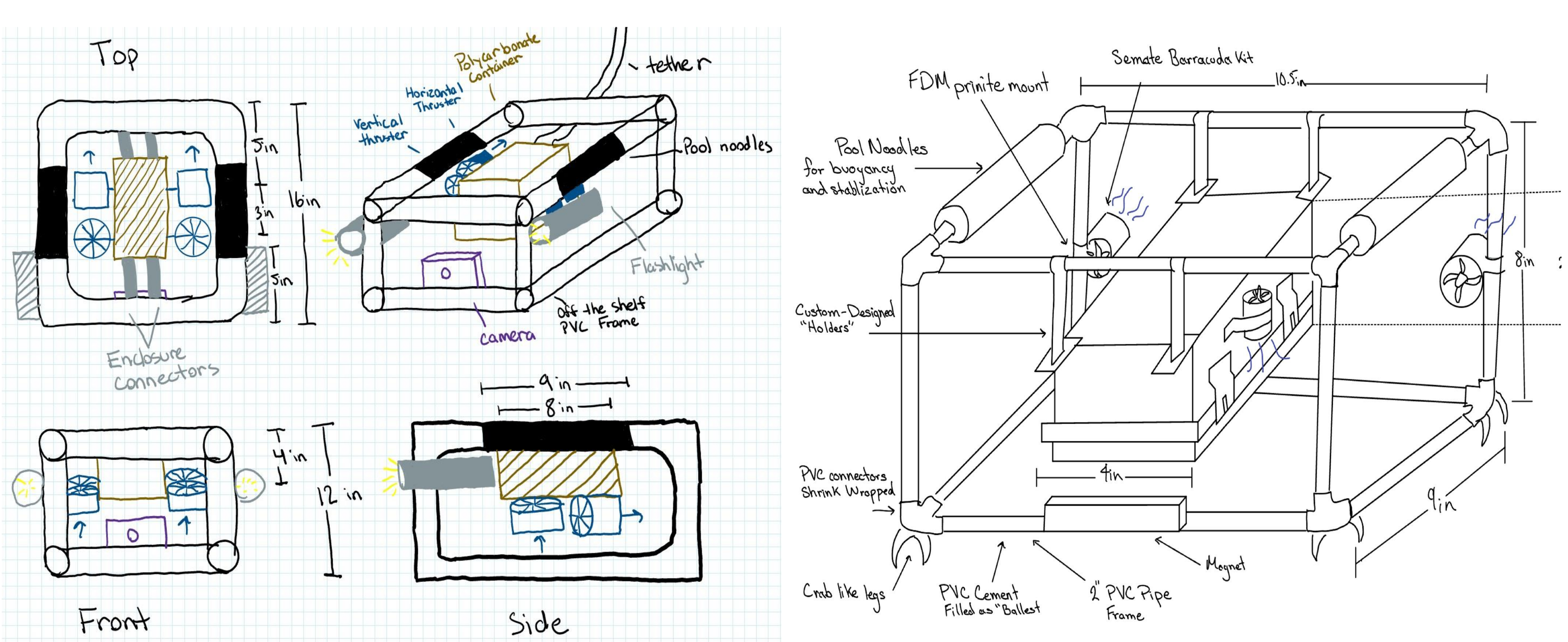

Figure 2: Early Concept Engineering Sketches Generated by Our Team.

Methodology

Work Breakdown Structure, Trade Study, and FBD

The majority of the early portion of our project involves creating an organizational structure and defining the problem to formulate an organized list of requirements. The work breakdown structure shown below illustrates the tasks we are undertaking for this project rather than the products we produced. We used trade study tables to analyze different component selection. For engineering analysis, we drew FBD to validate our designs.

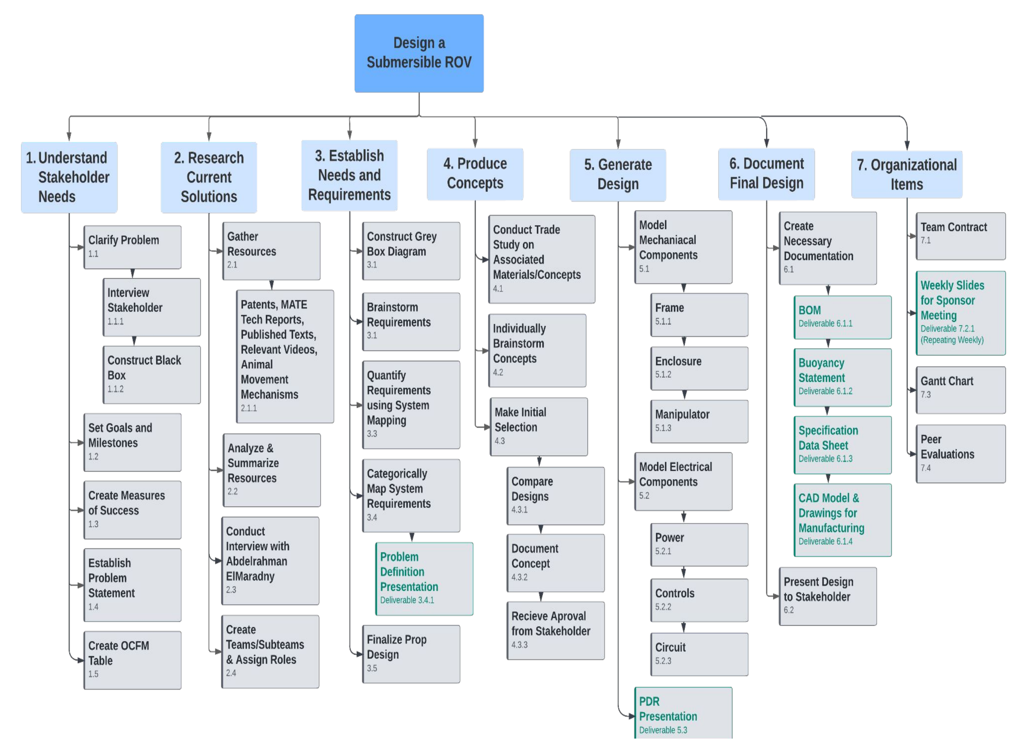

Figure 3: Work Breakdown Structure of ROV Design Process.

Criteria/Requirements	Weighting(%)	Plastic Tupperware	Polycarbonate Box	Scuba Diver Cylindrical Capsule	PVC Cylindrical Capsule
Cost	20	2	1	2	2
Availability/Replaceability	10	2	1	2	2
Customizability	10	1	2	1	1
Appearance	10	0	2	1	1
Transparency (for Camera)	5	2	2	0	0
Heat Dissipation	10	1	2	1	1
Waterproof Reliability	10	1	2	2	1
Drag	5	1	1	2	1
Ability to Store Electronics	15	2	2	0	0
Safety	5	1	2	1	1
Total	100	1.4	1.65	1.25	1.1

Figure 4: Example of Trade Study used for ROV Enclosure Selection

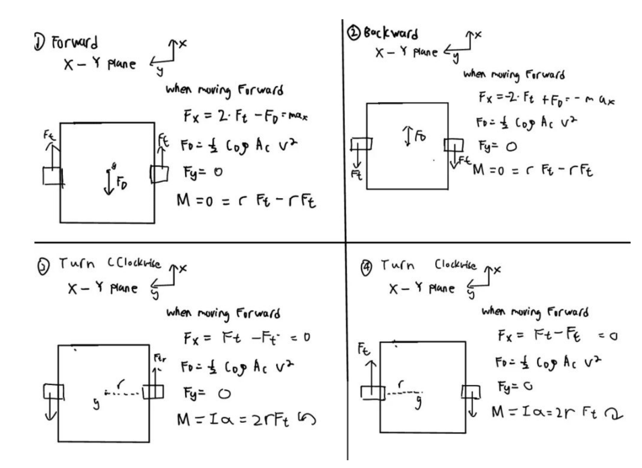

Figure 5: Engineering analysis for motor placement

Final Design & Hardware

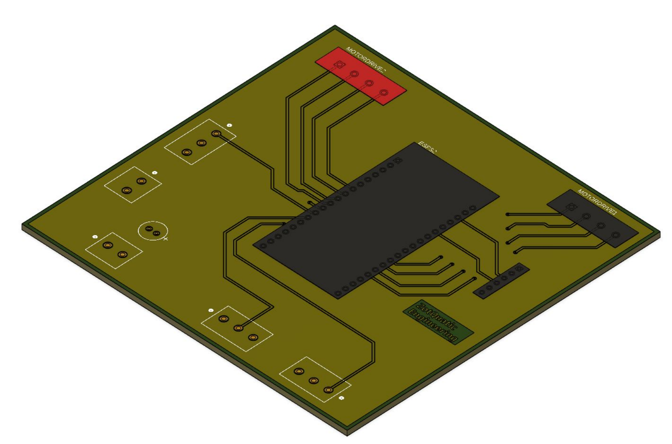

Figure 6: PCB Design

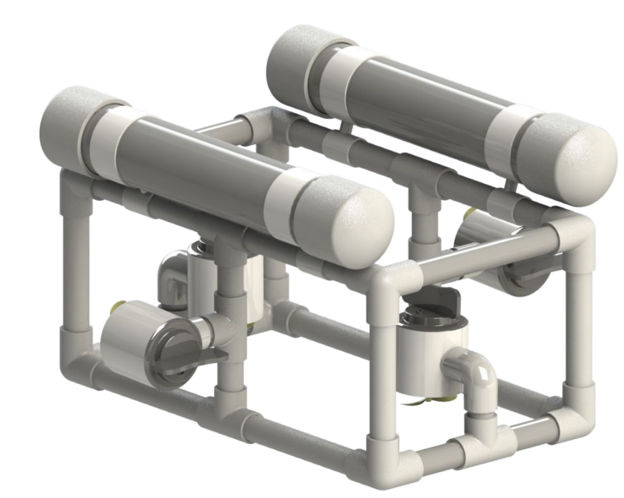

Figure 7: Isometric View

Figure 8: Section View

Figure 9: Top View

Gray Box Diagram

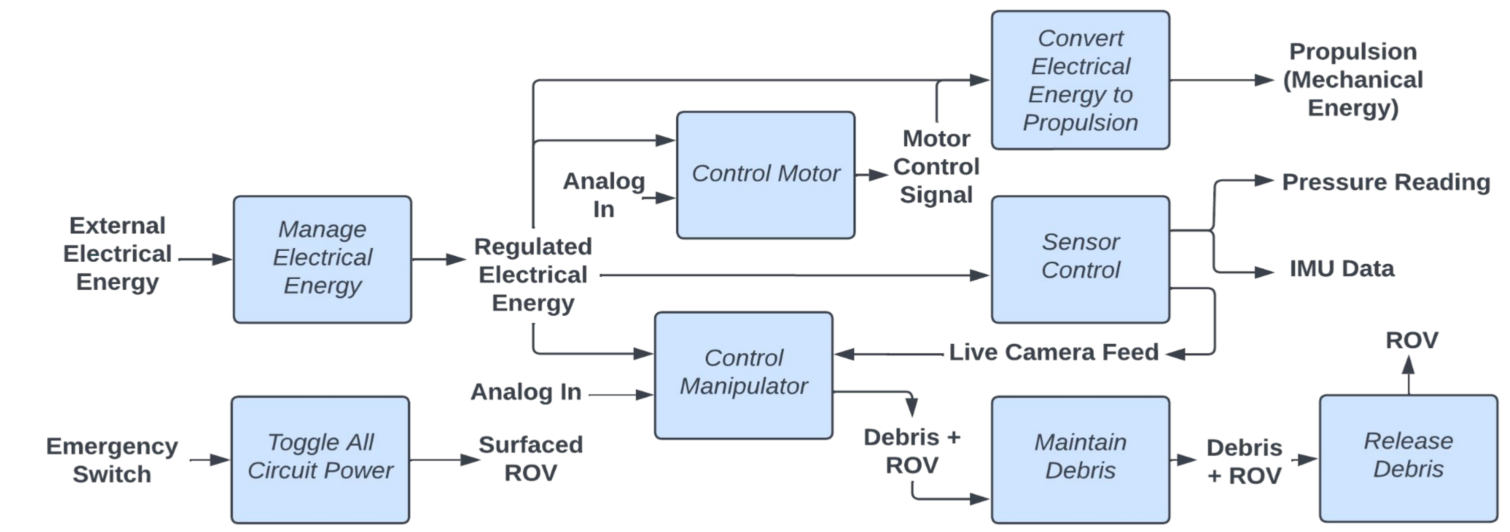

Figure 10: A Gray Box Diagram Displaying All Functions of ROV.

Bill of Materials

Current Design

We have currently created our Bill of Materials (BOM) with all of the chosen electronics. Alongside the electronics selection, we have constructed our power budget table, schematic diagram, and designed a PCB to transmit signals to multiple onboard devices.

	Bill of Materials					
	Product Name	Underwater ROV				
	Description					
	Team Number	15B				
	Team Member Names	Tyler Furukawa, Oscar De Jesus, Thomas Vaughan, Chris Ramirez, Tyler Quilici. Jefferson Zi Hao Ng				
	Part Count	34				
MAE 151	Total Cost	425.12				
Level	Description	Quantity	Source (shop distributor)	Distributor Part Number	Cost $ (each)	Cost $ (total
2	5V Reg	1	Pololu	D24V90F5	32.95	32.9
2	12V Buck Converter	1	Amazon	B08KZPXK63	49.99	49.9
1	IMU(MPU6050)	1	Amazon	B00LP25V1A	9.99	9.9
2	Female header20	1	Amazon	B0741FXGGW	4.56	4.5
2	ESP32	1	Amazon	B0718T232Z	10	1
2	2terminal blocks	10	Digikey	1935161	0.5	5
2	3terminal	3	Digikey	1935174	0.69	2.0

Figure 11: Bill of Materials for all Components of our ROV.

Conclusions and Future Work

We have now completed documentation for our designs and tested our electronics. In the spring, we will shift gears to constructing the mechanical systems, governing the electronics through smarter algorithms and control systems, and rapidly testing in appropropriate facilities.

References

[1] Diva J. Amon, Brian R. C. Kennedy, Kasey Cantwell, Kelley Suhre, Deborah Glickson, Timothy M. Shank and Randi D. Rotjan. Deep-Sea Debris in the Central and Western Pacific Ocean
[2] Marine Technology Society. *2024 Competition Manual Explore Class.*

Acknowledgements

Professor Sherif Hassaan, Professor Mark Walter, Professor David Copp, TA Shorbagy Mohamed