Design and Development of Underwater Vehicle

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Introduction

Unmanned underwater vehicles (UUVs) are vehicles that can operate underwater without a human occupant. UUVs differ in sizes, they range from man portable lightweight vehicles to large and heavy vehicles. The ROV is connected to a command platform, which ensures energy supply and data communication between user and the ROV. How to design an Underwater Vehicles that is both fast and ultimately satisfying for any applications, which would be agile and stable, being able to be used also for civilian purposes? This duality would make it a major asset bringing together the two major areas of underwater activity. Therefore, designing and testing an UUV system will further highlight its importance and consider the different characteristics that are currently demand in the military industry and uprising commercial industries. By doing this project, a new method of designing the UUV could be established to make the process become more efficient/ effective.

Objective

This project aims to design a new AUV system, in accordance with the industry needs and to conduct a series of tests on the final prototype. The project will involve various research being done to completely understand the different types of submersible systems and to be able to distinguish between each of their different characteristics. The project must be based on requirements aimed at future real applications in the underwater environment. The project requirements are:

- The vehicle must have specific functionality for civlian tasks of inspection in the underwater environment.
- The vehicle must have a real possibility of being replicated in bigger dimensions.
- Easiness of construction, assembly, and maintenance

Mechanical architecture: The underwater robot designed had to respect the following rules: be simple and waterproof, stable in roll and pitch, resistant to a 20 m dive. be able to carry embedded electronic devices.

Design

The objective is to apply the typical design process and propose the optimum design solution for ROV compartments based on the functional analysis and identification of needs. The cylindrical hull-shaped is the optimum geometry as it offers great resistance against stress-induced from applied hydrodynamic and pressure forces during operation. There are also no stress concentrations for spherical shape. A slightly varying shape from perfectly spherical is estimated to have the best structural efficiency, however the drawback is that it is inefficient for usable internal space.

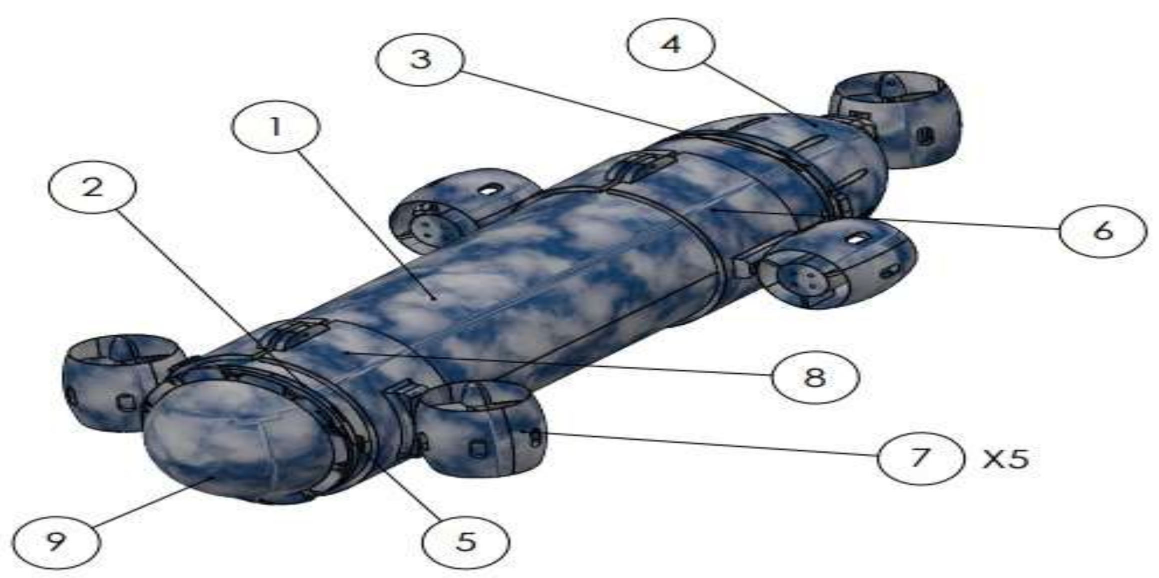

Figure 1: Optimum Design

Mechanical Parts:

Part NO.	Parts	Function	QTY.
1	LOCKING-TUBE	Main Tube.	1
2	LOCKING-FLANGE	For reliable high-pressure sealing, a locking cord gland, and an anti-rotation feature.	2
3	END-CAP	The M10 and M14 holes are typically used for wiring or cable pass-throughs	1
4	RARE FRAME	enhancing the balance of the ROV by providing an additional vertical thrust	1
5	RETAINING-RING	to provide support to the dome	1
6	HORIZONTAL FRAME	Carries horizontal thruster	1
7	THRUSTERS	Provide a control over the movement and maneuverability	5
8	VERTICAL FRAME	Carries Vertical thruster	1
9	DOME	Provide a transparent view into the outside	1

SolidWorks Drawing

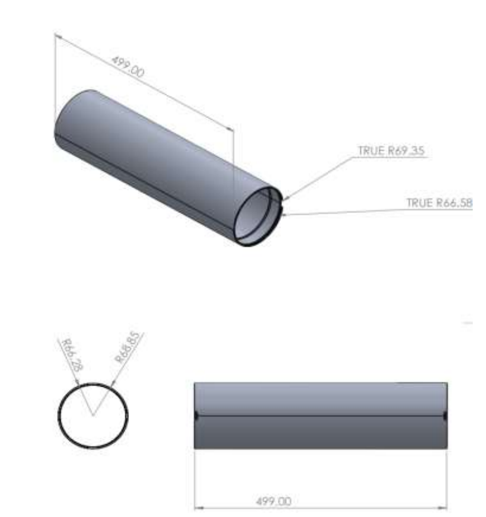

Figure 2: Main Tube (Part 1)

Figure 3: Flange (Part 2)

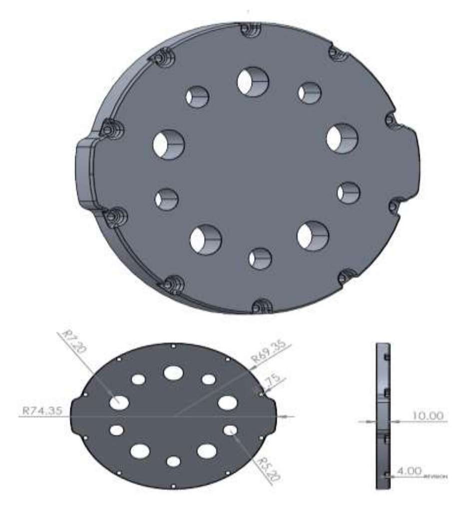

Figure 4: End Cap (Part 3)

Figure 5: Rare Frame (Part 4)

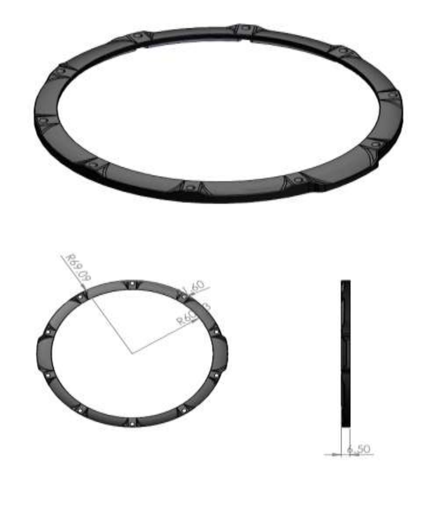

Figure 6: Retaining Ring (Part 5)

Figure 7: Horizontal Frame (Part 6)

Figure 8: Thruster (Part 7)

Figure 9: Vertical Frame (Part 8)

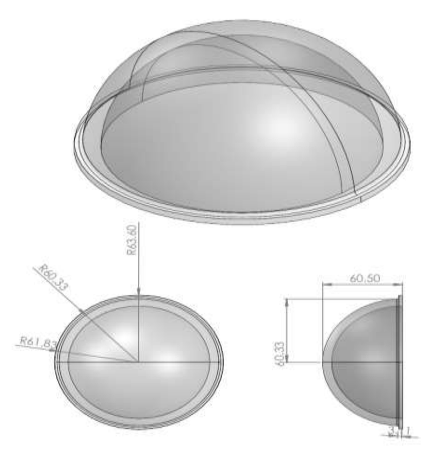

Figure 10: Dome (Part 9)

Simulation Results

The goal of this simulation is to examine the hydrodynamic performance of the ROV, emphasizing critical factors such as drag forces, and flow velocity. This analysis will be using ANSYS.

The simulation model consists of:

- 1,357,812 nodes
- 939,650 elements

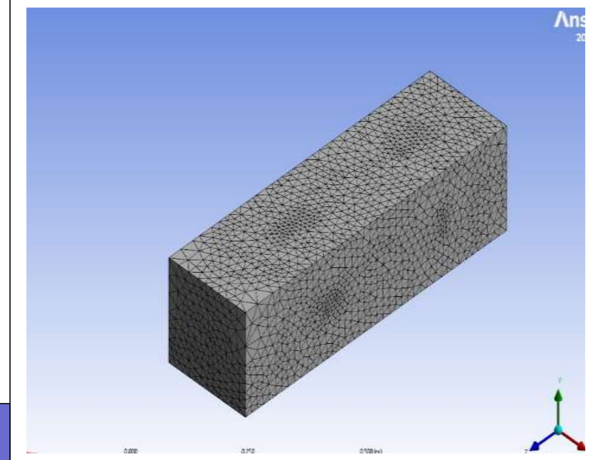

Figure 11:Domain mesh

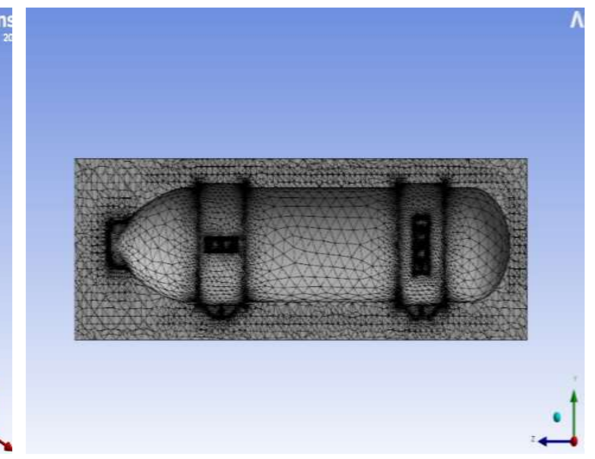

Figure 12:ROV mesh

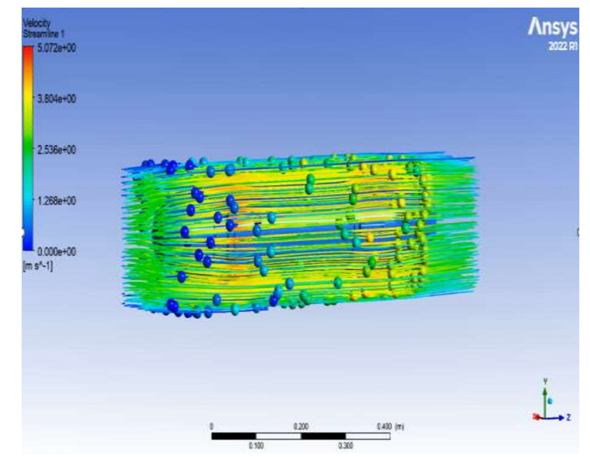

Figure 13:Velocity simulation

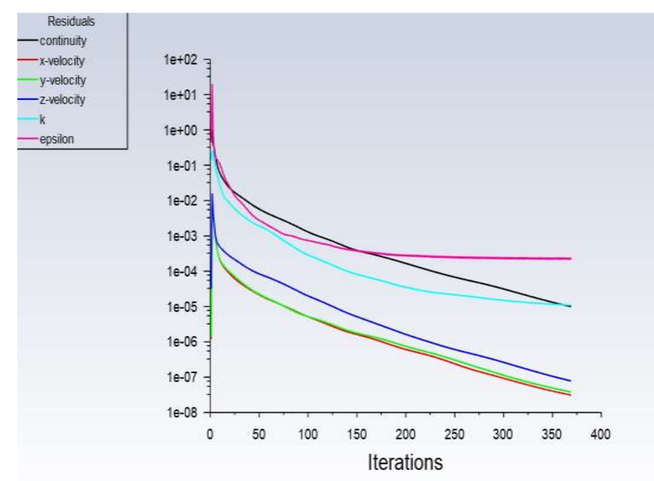

Figure 14: Residuals vs. Iteration

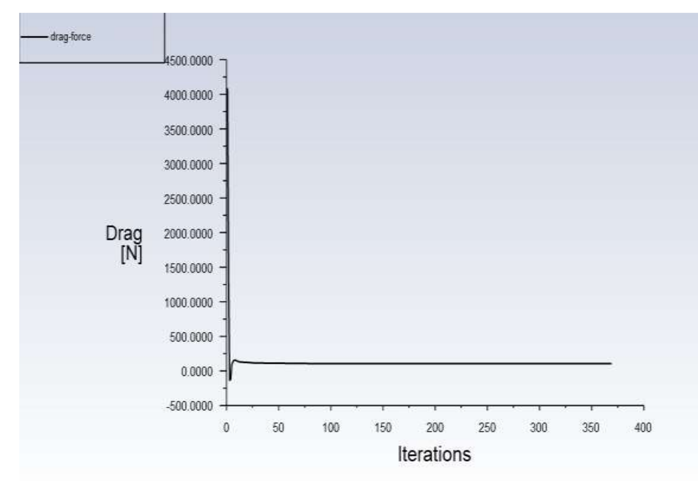

Figure 15: Drag vs. Iterations

Conclusion

The project has successfully demonstrated the feasibility and functionality of a standard Remotely Operated Vehicle (ROV) for various applications. The final design not only meets the required specifications but also demonstrates scalability for future use. Future developments could include integrating AI for autonomous navigation and incorporating advanced sensors for enhanced operational capabilities.

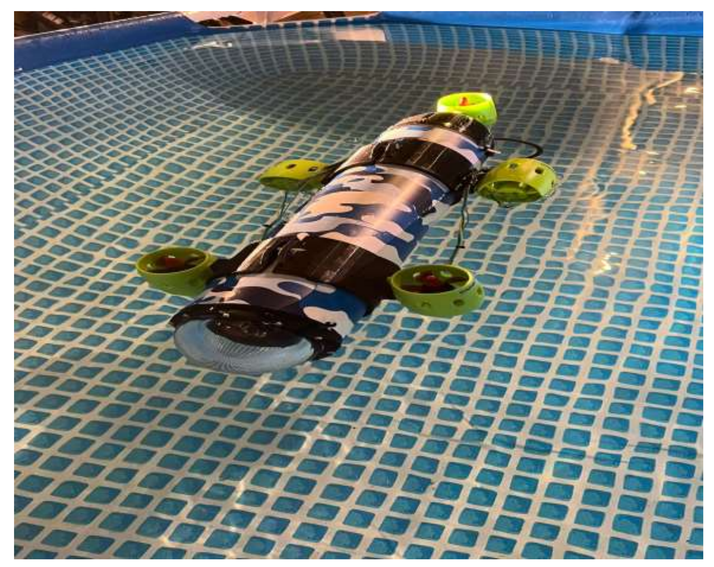

Figure 16: Testing ROV on Surface of The Water

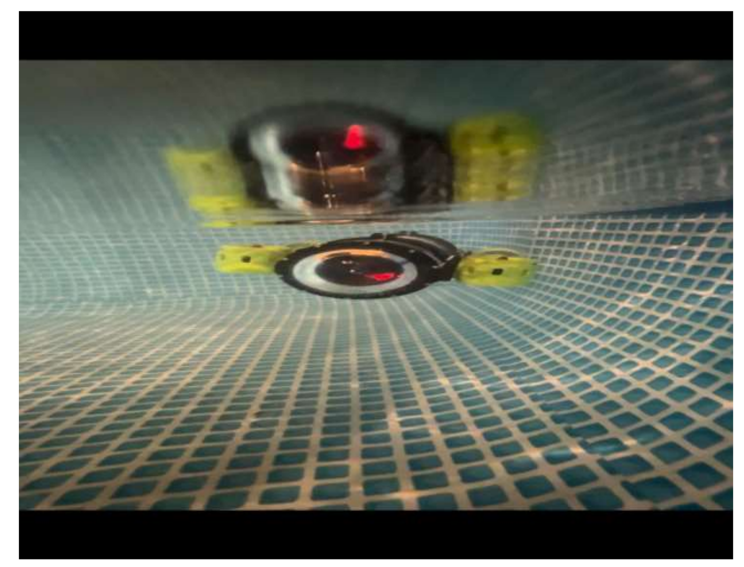

Figure 17: Testing ROV Deep in Water