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ROBOTICS CLUB, IITK

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[HULL AND TORPEDO DESIGN AUV-IITK]

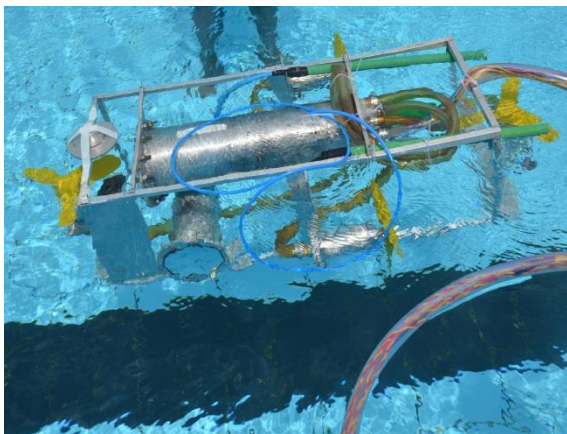
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ABSTRACT

The purpose behind making the Autonomous Underwater Vehicle was to do certain tasks under water without any human intervention. Presently, the mechanical body of the vehicle has been integrated with torpedo launching capability. In addition to it, the four custom made thrusters provide it 4 Degrees of freedom. The body of the hull made up of aluminum provides excellent heat sink facility. The overall design of the hull favors optimization of weight and space in the vehicle. However the hull is still not completely autonomous, the plans being ready, would be implemented in the near future. This paper is an overview of the design and concepts of the underwater vehicle.

KEYWORDS

Autonomous Underwater Vehicle, hull, design, torpedo, launching mechanism, AUVSI, RoboSub, thrusters, pneumatic system, center of buoyancy, aluminium hull, acrylic rack, propellers, degrees of freedom, CAD, Solidworks, PVC pipe, solenoid valve, water-proofing, silicone sealant, O-rings, Lithium-Polymer batteries, Inertial Measurement Unit, Sensory system



INTRODUCTION

The Autonomous Underwater Vehicle was made in a period of 40 days with a mission to develop a vehicle for the AUVSI RoboSub competition. The tasks of the competition include simulation of real world missions like object detection and torpedo firing, etc.

The present mechanical design is robust, and is apt for incorporating all the electronic equipments into it in the future. The degrees of freedom include forward-backward, up-down and yaw and pitch motion with the help of 4 custom made thrusters.

The paper is broadly divided into following categories:

1. Design overview
2. Hull design
3. Torpedo launching
4. Water proofing
5. Power source
6. Vehicle status and testing
7. Future prospects

1. DESIGN OVERVIEW

The entire body of the vehicle is made up of aluminum which makes it water resistance and facilitates heat sink. It consists of a cylindrical hull with a rectangular outer frame with an overall length of 1 meter.

The vehicle features separate enclosures for the electronics part and the battery thus making it more convenience to replace them when discharged.

With the 4 thrusters the vehicle has 4 degrees of freedom and has attained a top speed of 0.5 m/s. Further, the pneumatic system includes a gas tank and a solenoid

valve which triggers the launch of the torpedo.

Overall, the vehicle is neutrally buoyant so, we can take our vehicle under the water to a certain height with the help of the thrusters and then turn them off while performing any task at that particular height. This eliminates the unnecessary wastage of energy in running the thrusters.

2. HULL DESIGNING

2.1. FRAME

The vehicle consists of a rectangular frame of dimensions 30cm x 30cm x 80cm to which most of the components has been attached. Apart from it the frame also defines the overall shape of the vehicle and also provides rigidity to it.

While screwing the components to the frame, very possible effort has been made to maintain symmetry so that the center of mass is close to the geometric center of the vehicle to minimize weight trimming.

2.2. MAIN HULL

The main hull is the brain of the vehicle. It is cylindrical in shape and is proposed to incorporate all the electronic components of the vehicle. The material used is aluminum which being a good conductor of heat facilitates heat sink for the electronics in it.

The main hull is equipped with a 3 stage



acrylic rack which can slide over its inner surface and a clear acrylic lid. The acrylic



rack is designed to house the majority of microcontrollers on it.

The main hull acts as an interface between the battery and the entire electronics of the vehicle. The entire vehicle receives power through battery via the main hull. To perform this task it is equipped with nine openings through which wires emerge. Above all the hull is completely water proof and is a perfect chamber for the electronic racks.

2.3. THRUSTERS

All four thrusters in the vehicle are custom made. Each thruster consists of a 100rpm High torque motor and propellers. The propellers have about 10 cm long blades which provides enough thrust to take our vehicle to a top speed of 0.5m/s.

Presently, we are not having opposite handed thrusters. So the counter torque generated by them is balanced by putting extra weight on the vehicle. These thrusters provide 4 degrees of freedom to the vehicle.



3. TORPEDO DESIGNING

3.1. BASIC STRUCTURE

The torpedo is also custom designed by 3D printing. The CAD model of the torpedo has been made on Solid works.

The material used is ABS plastic whose specific gravity is 1.03(close to water) thus making it possible to make accurate trajectories. The center of buoyancy is quite behind the center of mass of the torpedo thus helping it to retain its path when slightly deviated.

The maximum range of the torpedo is 3 meters.

3.2. LAUNCHING MECHANISM



The torpedo is propelled by a pneumatic system. A torpedo is contained within a PVC pipe which is connected to a 1000psi CO2 tank via a solenoid valve.



4. WATER PROOFING

Water Proofing was one of the major problems faced by us while designing the bot as we had to ensure proper movement of parts without too much friction but on the same hand also ensure that water does not get in. For water proofing purposes we relied on-

- a) *Aluminium Welding*- It was our primary method for water proofing. It was basically used for joining different parts and ensuring water does not enter from between parts.
- b) *O-rings*- O-rings were used to prevent water to go inside the acrylic lid and the thruster casings. They proved to be very effective.
- c) *Silicone sealant*- It was used as a tertiary agent for final waterproofing.

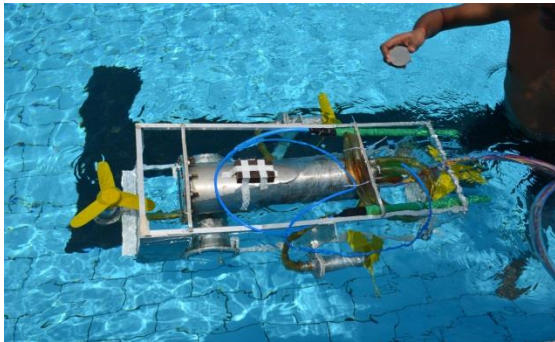
Apart from these we also used M-seal for preventing the water to enter the hull.

POWER SOURCE

We used 12 volt-lithium polymer batteries for our vehicle and are thinking of continuing its use in our future prospects.

VEHICLE STATUS AND TESTING

We tested our vehicle in swimming pool for 2 hours on the last day and found that our torpedo firing was quite accurate and torpedo travelled a distance of approx. 3 meters. Also our vehicle was exhibiting all DOFs and a depth of about 4 feet and there were no problems whatever.



FUTURE PROSPECTS

- Integrating it with Image processing team to make it autonomous at the basic level.
- Including robust sensory system such as IMU, Doppler velocity log, hydrophones etc.
- Designing a new vehicle to perfectly fit the requirements for the competition.
- Increasing the speed of our vehicle.

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