

# **Development of the Scarborough Autonomous Underwater Vehicle Platform**

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**Abstract:** San Diego City Robotics is a long participating member of the *Association for Unmanned Vehicle Systems International Foundations* and the *U.S. Office of Naval Research International Robosub Competition*. We will be presenting the latest version of our AUV, the *Scarborough*. She was constructed in an eleven-month period, where she was improved from the last year's version. In the process, the team improved on our utilization of our Robot Operating System (ROS), custom 3D printed hardware, custom built Printed Circuit Boards (PCBs), and further developed our PID system. The *Scarborough* was manufactured almost entirely in-house, as it was in previous versions, and it features improvements over its predecessors. Additionally, she features software and hardware additions that raise the bar on its mechanical, electrical, and software design.

## Introduction

San Diego City Robotics is a community college based robotics organization dedicated to the development and implementation of an Autonomous Underwater Vehicle platform. We are proud to reintroduce the *Scarborough*, who was constructed by a team of about 15-20 students and community members. We were broken into 3 main sub-teams: Mechanical, Electrical, and Software design. Team leaders conducted community outreach efforts. Efforts for development were primarily spent on improving upon our already modular design for an underwater robotic platform. A part of the focus was to utilize a low-cost, open source innovation.

Most of our parts were designed, manufactured, and tested in-house by our own team members. This year's competition will require us to complete buoy and gate tasks, while still striving for a modular system that the team can grow on and learn with in the future. This mission required a development and push for inter-team communications, community networks, resilient and low-cost mechanical design, accurate visual processing of the vehicle's environment, and custom built PCB developments.

## Design Strategy

This year's AUV was designed and constructed within the build period as a continuation from the previous design. The modular mounting system from last year's system were heavily considered during construction to ensure an optimum and ideal operation. The team had access to manufacturing tools and equipment via a facilities sponsorship we had acquired in the previous year. 3D printed parts were heavily utilized in the design of the vehicle, in response to the ever-growing nature of technology, and it allowed for a more case-specific design of our AUV.

## Mechanical Design

Since *Scarborough's* maiden voyage last season, she has gone through a considerable amount of phases throughout her mechanical construction. Each phase focused on water-proofing and maintaining the structural integrity of *Scarborough*. One of the main concerns is maintaining pressure in her housing. In the previous year, the first phase featured a galvanized steel keg as the main pressure housing. The design was scrapped due to problems

arising in the uneven cast of the caps. The second phase featured an acrylic tube as the main pressure housing. This provided a more stable surface, less prone to warping, and it is the design that we have continued with.

This year, we have entered a new phase in the mechanical design of the *Scarborough*. As we have noticed, in the previous competition, the end caps of her hull leaked while in operation. This year, we have tested the housing twice, and twice it has failed. The test consisted of keeping the housing underwater for about 15 minutes. Each time, about a cup of water was found inside the housing after each test. Again, we suspect that the end caps were the problem. [ADD HOW WE SOLVED THE PROBLEM]

### Electrical Design

The electrical design of *Scarborough* underwent through one phase last year. Custom built PCBs were created for wire management and we utilized a Jetson Tk-1, as a sponsorship from NVIDIA. However, this year, we replaced the Jetson TK-1 with the more advanced Jetson TX1. The Jetson TX1 features a more advanced vision system than its predecessor, which will greatly improve our object recognition goal on the *Scarborough*.

### Software Design and Development

### Experimental Results

### Acknowledgements