BeaverAUV

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Anchovy

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BEAVER COUNTRY DAY SCHOOL

ABSTRACT - Anchovy is BeaverAUV's submission to the 2024 RoboSub Competition. The AUV was designed and built by a team of high school students from Beaver Country Day School. Anchovy was designed as an iterative improvement over last year's Tulomee AUV, making key improvements in the accessibility and functionality of the vehicle. Additionally, several logistical advancements were made, including sponsor relations, outreach, and collaboration post COVID-19 Pandemic. While we're still in the process of rebuilding the full BeaverAUV team, we're continuing to put our best foot forward to build towards the future, working for a vehicle capable of completing tasks using computer vision and torpedo launching.

COMPETITION STRATEGY

BeaverAUV's team includes students with different levels of robotics knowledge, with many different backgrounds in all aspects. As a result, BeaverAUV's competitive strategy has attempted to balance competition task performance with program management, aimed primarily towards the cultivation of members' talents. To this end, time is split between technical endeavors and the development of robust programming that encourages the pursuit of engineering. Coming out of the COVID-19 pandemic, the team has spent more time working through the typical pipeline of team members (i.e., learning rudimentary skills such as coding principles and circuit construction and progressing towards more advanced topics such as CAD and object detection) as well as collaborating across divisions. This progression has allowed for greater learning and

collaboration to help us reach a higher level of understanding for the submarine. All members have been able to shift focus throughout the process from technical endeavors to practicing leadership and mentorship while transferring knowledge to each other. With BeaverAUV on the rise, we're continuing to build towards the future, working towards a vehicle capable of completing tasks using computer vision and torpedo launching.

VEHICLE DESIGN

MECHANICAL DESIGN

1. THE FRAME

   Due to fabrication costs, the AUV's frame remains the same since its 2018 creation, all the while a new frame has been designed and adapted since 2020. The reused nature of the frame has not inhibited continued iteration. The frame, made of ¼ inch anodized aluminum and designed with modularity as a focus, has built in rails for "on-the-fly" weight adjustment and using 3D-printed clips, a series of attachments are fixed to the frame, such as a camera mount for the both forward and downward facing cameras. This year, the sub has an added layer of perpendicular cells for improved sturdiness in order to relieve excess pressure on the base.

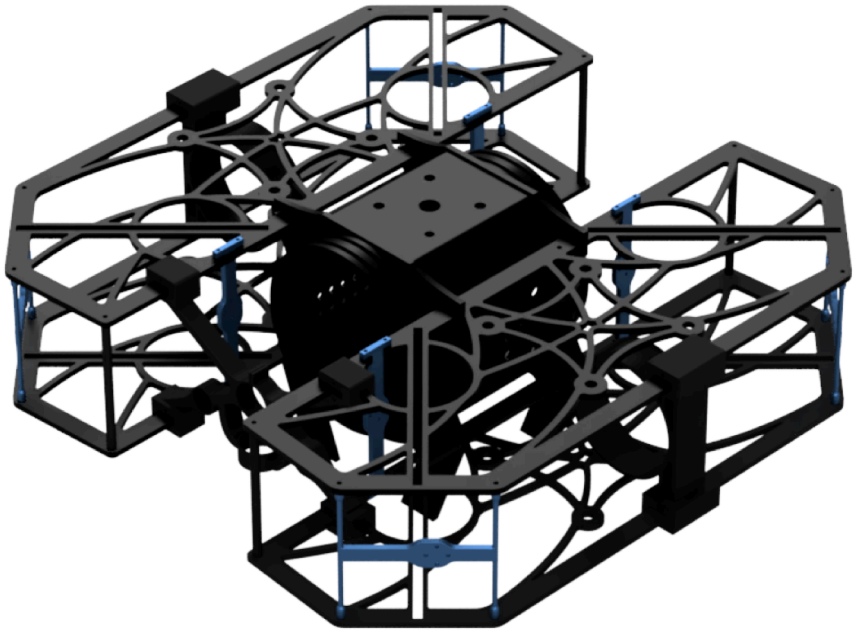

Fig. 1: Anchovy's frame with 3D-printed attachments.

2. HULL

Anchovy's main hull is made up of two 7.5" ID x 8" OD acrylic tubes. Forming axial O-ring seals in the center console as well as two custom aluminum end caps, the hull caps were designed to remain permanently on one side of each hull, within the submarine. The hull pressurizes when in use, to increase submarine safety and efficiency. Both the hull and end cap assemblies can be removed and replaced without disconnecting any electronics or removing any screws, which has proven to provide a drastic increase to usability.

Fig. 2: 7.5" ID x 8" OD acrylic tube and aluminum end cap assembled.

3. THE CENTRAL HUB

Anchovy revolves around a central hub, consisting of minimally-machined stock aluminum pipes and blocks. Because both the pipes and the blocks have been welded together, it ensures cost and manufacturing efficiency for the submarine. The use of several hole penetrators and a single wet connector for the tether

allows for all the data (i.e., thruster data) to flow in and out of the vehicle (i.e., sensor data and external computer input) from the central hub.

Fig. 3: The central hub with hole penetrators attached.

ELECTRICAL DESIGN

Anchovy's electrical system enhances efficiency and reliability of the submarine. Any external terminals were replaced with water proof "wet-sockets", not only for protection and longevity but also for efficiency. Other minor alterations to the AUV's pre-existing electrical system—made up of two primary modules: the power and computer—improves its overall allowed for greater accessibility and modularity. An in-house designed PCB drives the power module, and is attached to an Arduino Nano to drive 8 ESC's. These ESC's are placed on a custom, house-made acrylic rack for organization within the sub. Although there is thermal concern for the ESC's location, the aluminum hull it is placed next to acts as a heatsink to prevent any overheating. The computer module is centered around a network switch, which interlinks the on-board NVIDIA Jetson TX2, on-board Raspberry Pi,

and any external computer. The power and the computer modules are both connected and tethered with a skeleton-like compartment to essentially sandwich the parts together while still allowing heat and airflow to and from the hull.

SOFTWARE DESIGN

The AUV's software uses ROS for interprocess communications to center around two core processes: mission and thruster control. Using OpenCV, the mission control filters all the collected images (focusing on those from the R and G channels) to create a state of task management for the machine. As the images filter, geometrics are recognized and analyzed until the desired objective is detected, which then leads the state machine to determine which actions must be taken based on the object's location. The state machine's response to these determined actions sends the thruster control into efficient movements to achieve the desired state. As this is happening, the date is transferred to the motors in the Arduino Nano, telling the ESC what percentage to run the motors. The data is also transmitted to the PID management system. This PID manager is used to update these data and maintain the desired movement and position, as well as, the data from the waterflow sensors gives an indication of the velocity of the AUV.

EXPERIMENTAL RESULTS

The BeaverAUV team built a hovercraft from scratch that mimics the movements, specs, code, and actions of the submarine in order to test the code live without the possibility of water damage or accidents to any part of the sub. The hovercraft is coded using github and is programmed with arduino, mimicking the code of the submarine. The hovercraft is designed to take into consideration the design of the submarine. For example, the Shrouds are designed for aerodynamic performance, and also for safety of both propellers and people, imitating the propellers of the sub. Building the hovercraft not only allowed for the team to get a better understanding of Anchovy, it also allowed for more in depth analysis of what needed to be done in order for sub to function in the best possible way. Finally, successful experimentation of the hovercraft gave additional knowledge which then segwayed into improving the code that controls Anchovy.

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