Scottie Subs: Modified Underwater Autonomous Vehicle

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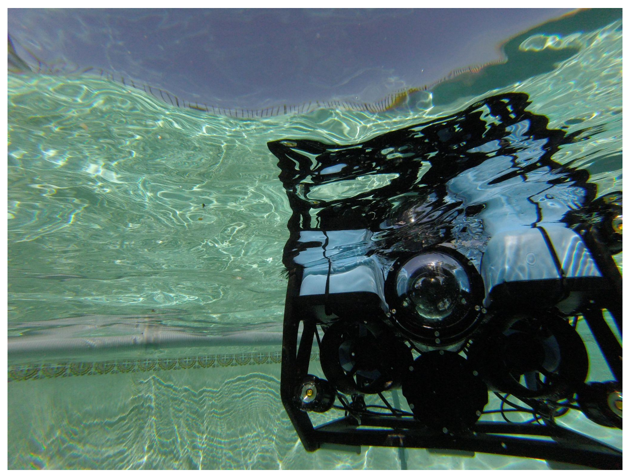
I. Abstract

Helix Charter High School Robosub, also known as Scottie Subs, is using a modified BlueROV2 and its software to convert this off-the-shelf underwater robot into our own AUV (autonomous underwater vehicle) that can be programmed to complete tasks given to us. This paper will highlight our process, experience, and designs as we will compete in the 2023 international Robosub competition. This year our team focused on simple computer vision in order to have a solid foundation.

II. Competition Goals

When we began the BlueROV2 construction, we had no experience with underwater autonomous robotics, so our primary goal was to complete the simple tasks and ensure that our basics were strong. We plan to approach the course with an emphasis on computer vision; as we don't have sonar. As a result of this, we will be attempting simple vision-based tasks. In the beginning, the team was having a hard time deciding whether to make the robot complex even though it was our first time competing, or whether to purchase a simple robot and modify it. In the end, we determined the most reasonable option was to buy the BlueROV2. This decision emphasizes reliability for our robot as we have fewer difficulties to face over complexity which would include designing new electronics and parts. Our main focus was hands-on learning with a spotlight on understanding the basics and fundamentals of device navigation and computer vision in various scenarios, which includes object and color recognition. The BlueROV2 uses a Raspberry Pi 4, which is currently ideal for the team due to our limited experience; however, it is limited in the long term as this platform makes it harder to upload more complex programs, including machine learning programs.



III. Design Strategy

In the beginning, we had a variety of different design ideas that, in the end, would prove to be too challenging for this upcoming competition. The BlueROV2 already has the most optimal design features with an easily accessible electronics enclosure and an easy-to-use frame. All of the tasks that we decided to do were version based which is why we did not incorporate any new advanced systems. One of the goals of the competition is to design a kill switch. We designed and 3d printed a kill switch that would be easily accessible and reliable. Using inspiration from the internet, we used a linear snap action lever which would make the switch more reliable and keep the switch more stable. The kill switch works by having a magnet on the end of the lever and a magnetic limit switch which is connected to an anti-spark switch. When the magnet is pushed into the range of the sensor by the 3D linear lever, the battery is disconnected from all of our electronics and thrusters.

IV. Testing Strategy and Results

Before testing our robot in water, we first ensured all the electronics worked. One of the team's main values is to establish a strong foundation before proceeding to do any new expansions. This is why before doing any water testing, we tested our robot outside of water with as much of the electronics as we could. After this, our testing strategy was to first make sure it was water-tight and that it doesn't have loose connections that could come off easily if a collision were to occur. We then moved on to controlling the robot manually. This was an important step in the process because we were able to visualize how the robot would move conceptually in a program. For example, we would control the thrusters individually and manually. By observing this, we would properly understand how our computer vision code could move the robot. Then the next step came, which we are still currently working on; autonomy. We have been working on using Ardusub and Pymavlink in order to program the robot and use computer vision code using openCV. The programming for this has been difficult because of the large learning curve that comes with it.

V. Acknowledgments

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VI. References

- Gzumwalt, A 100% 3D Printed Linear Snap Action Mechanism Cutaway Model. (Nov 13, 2020). Accessed: May 25, 2023. [Online Video]. https://www.youtube.com/watch?v=X6JtrShQIwo&t=78s

- Rusty, Kevin, Daniel *BlueROV2 Assembly*. Accessed: Jan. 16, 2023. [Online]. Available: https://bluerobotics.com/learn/bluerov2-assembly/

Component	Vendor	Model/Type	Specs	Custom/purchased	Cost	Year of Purchase
ASV Hull Form/Platform	Blue Robotics	BlueROV2	N/A	Purchased	$5,980.00	2023
Waterproof connectors	Blue Robotics	Penetrators	https://bluerobotics.com/store/cables-connectors/penetrators/wlp-vp/	Purchased	Included with BlueROV2	2023
Propulsion	Blue Robotics	T200	https://bluerobotics.com/store/thrusters/t100-t200-thrusters/t200-thruster-r2-rp/	Purchased	Included with BlueROV2	2023
Power System	Blue Robotics	(3) Lithium-Ion Battery	14.8V, 10Ah	Purchased	$492	2023

Motor Controls	Blue Robotics	(6) Basic ESC	https://bluerobotics.com/store/thrusters/speed-controllers/besc30-r3/	Purchased	Included with BlueROV2	2023
CPU	Blue Robotics	Raspberry Pi 4 Model B	16 GB	Purchased	Included with BlueROV2	2023
Teleoperation	Blue Robotics	Fathom-X Tether Interface (FXTI)	https://bluerobotics.com/store/rov/bluerov2-accessories/fxti-asm-r1-rp/	Purchased	Included with BlueROV2	2023
Compass	Blue Robotics	Navigator Flight Controller	https://bluerobotics.com/store/comm-control-power/control/navigator/	Purchased	Included with BlueROV2	2023
Intertial Measurement Unit (IMU)	Blue Robotics	Navigator Flight Controller	https://bluerobotics.com/store/comm-control-power/control/navigator/	Purchased	Included with BlueROV2	2023

Doppler Velocity Logger (DVL)						
Camera(s)	Blue Robotics	Low-Light HD USB Camera	https://bluerobotics.com/store/sensors-sonars-cameras/cameras/cam-usb-low-light-r1/	Purchased	Included with BlueROV2	2023
Hydrophones						
Algorithms		Pymavlink, openCV				
Vision		openCV				

Localization and Mapping						
Autonomy		Ardusub Pymavlink, and openCV				
Open-Source Software		Ardusub, Python, Pymavlink, and openCV,				