RoboSub 2026 Technical Design Report

Olympic College (Olympic College Engineering Club)

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Abstract: 2026 is the second year that the Olympic College Engineering Club (OCEC) has entered the RoboSub competition. The AUV designed this year, Ranger-02, is a completely new design based on lessons learned from Ranger-01. This new design is focused on being able to effectively and reliably maneuver in six degrees of freedom, use computer vision to identify and locate objects of interest, and then navigate to that object. Our other goal with Ranger-02 is to create an autonomous underwater vehicle (AUV) that can be easily modified and built upon, incorporating new capabilities in future competitions.

I. INTRODUCTION

Ranger-02, the second vehicle put forth by the Olympic College Engineering Club (OCEC), is a clean slate design that is intended to serve as a base vehicle that can evolve and grow in future years. Ranger-01 proved to be unsuitable for continued development for several reasons. The large number of custom electronics components and custom designed thrusters would have made it prohibitive to make any of the necessary upgrades to ensure Ranger-01's viability for future competitions. Considering that Ranger-01 was no longer viable, the OCEC decided to start fresh with Ranger-02.

II. COMPETITION STRATEGY

The primary goal for Ranger-02 in this year's competition is to be able to head out using the Coin Flip start and to complete Task 1, navigating through the gate. We determined that the key capabilities needed for Ranger-02 to complete these tasks are as follows. Stability: Ranger-02 must be capable of maintaining the desired depth, attitude, and heading while stationary or moving. Sensing: Ranger-02 must be able to determine where it is in the pool and be able to identify the gate. Navigation: Ranger-02 must be able to determine its starting state and successfully route itself through the gate.

III. DESIGN STRATEGY

The core design philosophy for Ranger-02 is to create a base AUV capable of reliably performing the fundamental navigational tasks needed to complete our competition goals. It also must be adaptable enough to accommodate future growth and added functionality such as grabber arms or torpedo launchers. This philosophy led to the decision to use modular off-the-shelf frame and hull components as well as some computer systems that are overpowered for the functions they are currently tasked with.

A. System

All systems on the AUV need to be capable of being easily modified, replaced, and upgraded should the need arise. The use of off-the-shelf components is an important part of meeting this goal. In contrast to the Ranger-01 of 2025, where 90% of the components were designed and machined on campus, this year we have tried to use off-the-shelf solutions as much as possible while still being able to meet our goal of making an adaptable platform.

B. Mechanical

The team decided to use goBILDA aluminum components for the primary frame of Ranger-02. Several mockup designs made in SolidWorks using goBILDA CAD models proved that many different vehicle layouts could be achieved with only a few common structural components. The material choice of components was also a favorable factor with respect to weight, drag, and corrosion resistance, all of which were issues from 2025. Using goBILDA components also provided a vast number of mounting points that could use standard sized M4 mounting hardware. These mount points gave us options for mounting our pressure vessels and thrusters in as well as any future hardware such as manipulators, projectile launchers, or advanced sensors like a DVL.

The second decision that drove the structural design of Ranger-02 was the choice of pressure vessels. In 2025 we used a custom designed pressure vessel with seals and fitting that were made in-house. While there were no leaks or major failures, accessibility was limited and hazardous for electronics integrity due to friction, fit, and arrangement. Considering this, we pivoted to using Blue Robotics cylindrical locking enclosures, tried and true professional solutions.

The design of the frame underwent several different iterations during preliminary design. Originally, two designs were considered: a box frame and an H-shaped or I-shaped frame was considered for maximum structural integrity and number of mounting points for other components. After testing the strength of frame members, it was decided that the extra strength from the enclosed box design was not necessary.

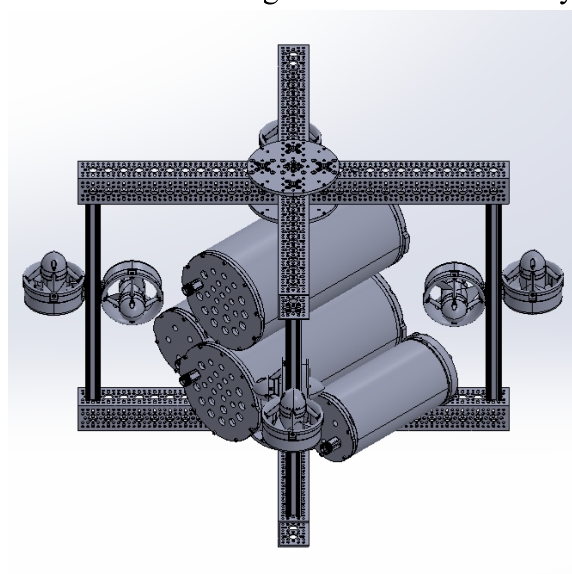


Figure 1. A preliminary design for Ranger-02 showing a version of the box frame design.

We decided that we would also need to manufacture custom parts to mount the Blue Robotics enclosures to the frame regardless of the frame layout, thus making direct mounting of pressure hulls to the frame irrelevant to frame component orientation. With those considerations in mind, we determined that the extra weight and drag induced by having almost twice as many frame members would outweigh the positive attributes of that frame design.

These choices led us to the X-shaped frame concept, inspired by the ubiquitous standardization of X-shaped quadcopter frames. An additional benefit of this design was that the eight-thruster layout is common and already has support in the ArduSub software used for flight control. The thruster layout uses eight units, with four vertical thrusters and four horizontal vectored thrusters at 45-degree angles. All thrusters are mounted at the ends of the frame arms with custom designed 3D printed brackets.

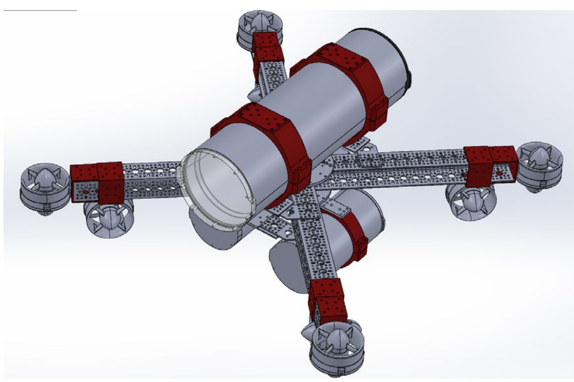


Figure 2. Final layout for Ranger-02 showing the X-frame and smaller hulls

The enclosures used are as follows: one-150mm diameter, 500mm long tube to house the camera system and all electronics except the batteries which are housed separately in 102mm diameter, 200mm long enclosures. The large enclosure was chosen to be aluminum to help with thermal management for electronics. The original design for the AUV layout called for a single enclosure to house both batteries, but after mockup testing it was decided that the extra wiring and difficulty of removing both batteries from the same tube would be more of an inconvenience than housing each battery in its own enclosure. Separating the batteries also increases the relative surface area of each battery's enclosure in contact with the water which will help reject heat compared to having both in the same enclosure.

Several components required custom design and manufacturing. Out of these parts, all but one was made with 3D printing. Most of these pieces were the mounting brackets to hold the pressure vessels to the frame and to mount the thrusters to the frame. Being able to rapidly design, print, and test new mounting brackets allowed for a lot of optimizations to happen quickly. Various bolt patterns, part geometries, and wall thicknesses were rapidly prototyped and tested before final prints were made using PET-G filament.

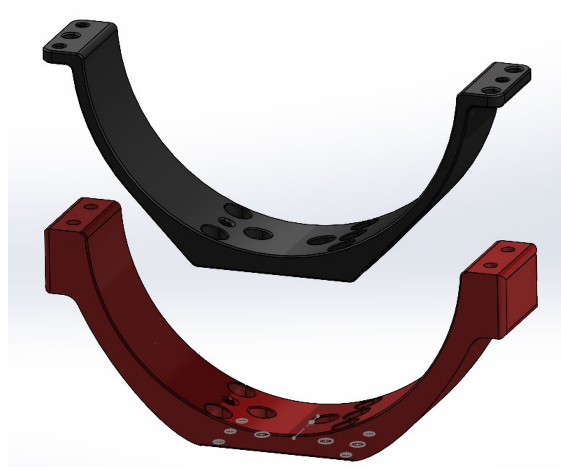


Figure 3. 2 different versions of the same 3D printed mounting bracket, the red design is the newer, strengthened version.

C. *Electrical*

The primary design concern for the electrical system on Ranger-02 is making sure the system will be able to handle its maximum power loads in a safe and predictable manner. The key points for this goal are making sure that fuses are properly sized and located to make sure that excessive power draw will not damage any components, will not cause other components to brown out and lose efficacy, and to make sure the power that is being delivered to components is clean and in the proper voltage range.

The power system has a high voltage side for powering the thrusters and a low voltage side for sensors and computing. Ranger-02's power comes from a pair of 14.8V 18Ah lithium-ion Blue Robotics batteries. The primary reason these batteries were chosen was their capacity and cylindrical shape designed to fit inside pressure hulls.

The high voltage system is designed to handle a worst-case scenario where all thrusters pull maximum load. We used documented max loads from the product specifications sheet because we could not perform enough testing to determine actual load values before the design needed to be finalized. The thruster voltage line is separated from the rest of the system by a contact relay kill switch, controlled by a reed switch and magnet. The full power schematic for Ranger-02 can be found in Appendix A.

Custom PCBs were designed and used for low power applications on Ranger-01, but they proved to be poorly designed and unable to handle the power loads they experienced in operation. The PCBs were also not expandable or future proof. By using more off-the-shelf computing hardware, the low voltage wiring was significantly more simplified, and it was decided that PCBs were not needed for Ranger-02. For the new vehicle, a Cube Orange and ADS-B flight controller control the thrusters, instead of a Raspberry Pi 5 in conjunction with various Arduino components to achieve the same goal. The primary CPU is an Nvidia Jetson Orin Nano, and a ZedX stereo camera provides vision. Both components were donated to the team before the design process began, so they were incorporated from day one. The final key components are a Teensy 4.1 to manage the temperature and moisture sensors monitoring conditions in all three pressure hulls.

D. Software

We decided to use a Cube Orange as our primary control system, running ArduSub, as we determined that using it would be a far easier solution than writing controls software. The Cube will execute maneuvers that are passed to it from the Jetson Orin Nano and will collect data from IMUs and sensors. The Jetson will be running Ubuntu and ROS 2. Ultralytics YOLO library will be used to identify the gate. 3D depth data from the ZedX will be used to determine the distance to the gate.

We will be using a Sense-Plan-Act (SPA) architecture to navigate. The combination of IMU, depth sensor, and visual data will allow the AUV to be able to determine its orientation, position, and motion. The AUV will execute a “start box procedure” to determine its orientation then move out of the box. After this maneuver it will locate the gate, if necessary, through a very simple search maneuver to scan the area around it. Next, the AUV will maneuver towards the gate, translating the gates position in pixel space into maneuvers for the cube orange.

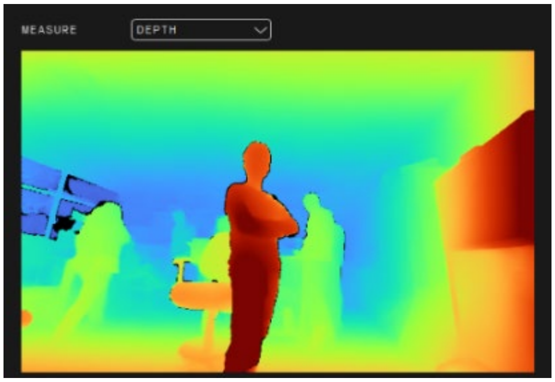


Figure 4. A view from the ZedX showing the depth mapping feature used to determine the range to the gate.

IV. TESTING STRATEGY

The testing strategy for Ranger-02 is centered around safety and reliability, and will ensure components are protected from mutual damage, and the AUV is safe for crew to work on. Our secondary goal in testing was to make sure that components and subsystems function reliably and communicate properly. The majority of the testing process is done on the bench and without access to a pool large enough to submerge Ranger-02 we are mostly limited to component and subsystem level testing. There are only three wet tests scheduled: The first test being performed in the water will be a preliminary weight and balance test to validate center of mass and center of buoyancy calculations. The second will be a full-up test of the entire AUV and all of its systems in a pool where it will be able to maneuver freely. The third test will be a repeat of the second test after addressing any problems faced in the previous test.

A. Component Testing

Major components will be bench tested to determine their functionality before implementation into their respective subsystems. Samples of minor components may be representatively tested with a multimeter before use to ensure function as expected.

The most critical components that are bench tested are the 3D printed parts, Thrusters/ESCs, and batteries. The 3D printed components were stress tested, and materials were chosen based on material properties as required by application. The thrusters will be tested individually to check ESC connection and current draw. Thrust values are derived from Blue Robotics technical data sheets as opposed to experimental data collection.

B. Subsystem Testing

Three sub-systems comprise the vehicle: structural, propulsion, and electronics. Structural includes frame components and pressure vessels, propulsion consists of the thrusters, batteries, ESCs and the kill switch assembly, and the electronics system contains all processing components and electronics not encompassed by the propulsion subsystem.

The subsystem testing focuses primarily on electronics. Because the system is low power, it can be tested using a tabletop power supply. It is also the most complex subsystem, containing all sensing functions, computing, and propulsion controls. Hardware-in-the-loop tests will be critical for software verification given our limited capacity for full-system tests. The propulsion system cannot be tested on the frame except during pool sessions, so thorough component-level testing is essential.

C. Software Testing

The YOLO algorithm will be tested with a validation data set. Once trained, fresh images and physical gates will be used to validate its accuracy. ROS nodes can be tested with Python scripts to test error management and edge case behavior.

Once individual software components have been tested, we will do hardware in the loop testing to attempt to simulate portions of the mission on the bench. We will not be able to simulate depth readings or properly tune the PID until we can get the whole AUV in the water, but we will be able to test its ability to determine its orientation, and the software can properly respond to heat and moisture alarms.

V. CONCLUSION

The design for Ranger-02 has several significant improvements over Ranger-01 and also has the ability to incorporate new design elements in the future. Ranger-02 has more capable thrusters, a lighter structure, more powerful computing and new sensor capabilities using machine vision. These improvements will allow us to make it farther in the competition this year and will enable us to grow Ranger-02's capabilities in years to come without requiring a total redesign of the AUV.

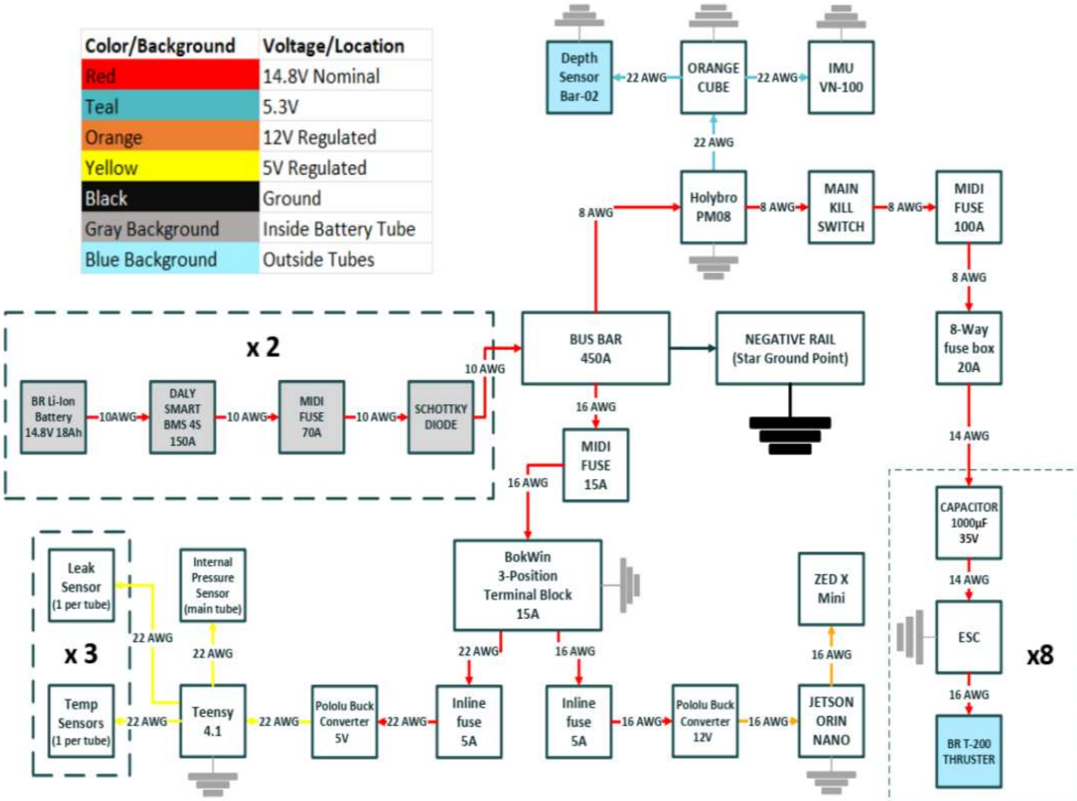
VI. ACKNOWLEDGEMENTS

Our team is forever grateful for the generous support we received from the people and institutions in our community. They not only gave us the material support we needed but also kindly shared with us their technical knowledge and emotional support. VectorNav, Blue Robotics, SolidWorks and USA Metal Online all donated products to OCEC. Keyport NUWC was kind enough to not only offer us material support but also connect us with professionals who helped mentor us on our journey. Last, and most importantly, are the individuals in our community that came out to support us materially and intellectually: Scot Groulik, Lee Barras, Andrew Doerr, Dion Moses, and Jennifer Hedegaard. Without these kind and patient individuals, we would not have made it as far as we have.

A full list of donated components is available in Appendix B.

APPENDIX A

Power Diagram



The documentation for the T200 lists the load when using 12, 16 and 20 volts, making 16 volts the best choice based on the nominal 14.8V, actual 16V discharge of the batteries. An 8-way fuse box with 20A fuses splits power to each ESC and T200 thruster. Fuses are used to cap max potential current draws on components, providing a safety buffer for operation to protect components and wires.

APPENDIX B

Donated parts list

Donor Name	Material Support Donated
Andrew Doerr	Electronics components
Blue Robotics	4x T200 thrusters with ESCs
Jennifer Hedegaard	Structure components and electronics
Keyport NUWC	Cube Orange+, T-200 thrusters
Lee Barras	Electronics components
Scot Groulik	ZedX, Nvidia Jetson Orin Nano
Solidworks	Full commercial licenses
USA Metal Online	Aluminum plate stock
Vectornav	VN-100 IMU

THANK YOU!