SeaGuardians Robotics

TRI-CITIES EDUCATION ASSOCIATION FOR CHRISTIAN HOMESCHOOLERS

Johnson City, TN, USA

PROVERBS 27:17

ROV Overview, Ian Crews

Mentors: Amy Crews, Kimberley Willard, Kristin Cobble

- Ian Crews (12th)- CEO, CFO, Head Of ROV, Marketing Team
- Lucas Hiebert (12th)- Head of Design
- Jaron Cobble (11th)- Chief Safety Officer, Documentation Coordinator
- Nathan Willard (10th)- Head Of Non-ROV Devices
- Jacob Rawson (12th)- Mechanical Engineer
- Abigail Kelly (11th)- Mechanical Engineer
- Ethan Bunch (9th)- Electrical Engineer, Deputy Safety Officer
- Connor Kelly (9th)- Web Administrator, Marketing/Writing Team, Props Manager
- Annabell Wilhite (9th)- Deputy Safety Officer

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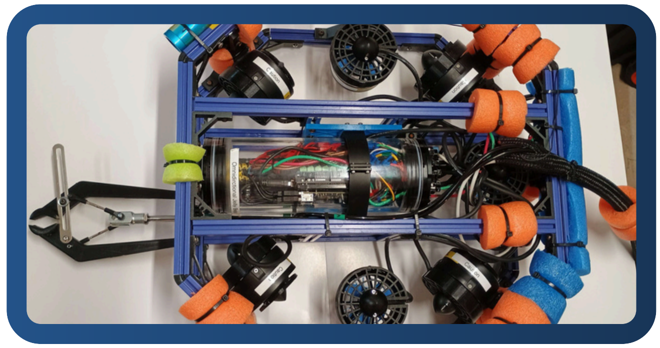

Fig. 1.1 - Overhead View of ROV, Ian Crews

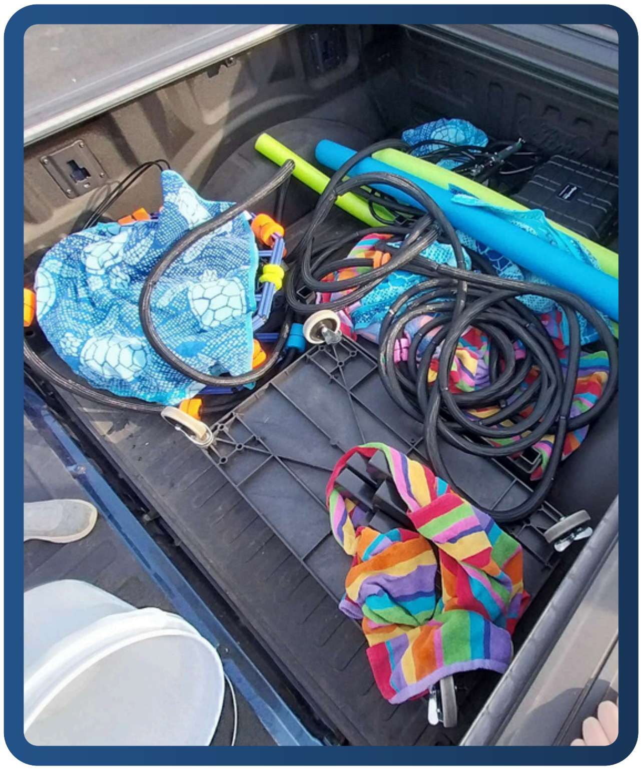

Fig 1.2 - ROV Loaded for Transport, Jaron Cobble

Fig 1.3 - First water test, Annabell Wilhite

Abstract

SeaGuardians Robotics is an up-and-coming underwater robotics company based in Johnson City, Tennessee. Our mission is to use technological resources to learn and grow together, and better the world through it. Our newest model, Big Octagonal Bot (BOB), is a practical and efficient design created in response to the MATE ROV Competition's 2025 Request for Proposal. This Remotely Operated Vehicle (ROV) is designed to withstand almost any environment, from warm lakes and rivers to the icy depths. BOB is equipped with the best thrusters on the market for reliable maneuvering, accompanied by highly rated cameras and the company's brand new, custom pneumatic claw. With this ROV, people of all skill levels will be capable of easily completing a variety of tasks, such as deploying and recovering complex ocean observing systems, installing sensors, marine life restoration, and much more. This document details the technical specifications of SeaGuardians Robotics' 2025 ROV, BOB, as well as the company's processes used in order to bring this build to life.

Teamwork

Company Overview

SeaGuardians Robotics is an underwater robotics team based in Johnson City, Tennessee. This year, the team has only nine members. This opened up a few new challenges, namely the amount of roles each member holds due to limited manpower. However, safety remains a top priority.

Our team verse, "As iron sharpens iron, so one man sharpens another." (Proverbs 27:17), constantly reminds us that no matter what, we are here to grow and learn. This helps our team achieve the goal of becoming "the company we need for the ocean we want." This is the team's fifth year competing in the MATE ROV Competition. With three members graduating, it is essential to focus on passing on knowledge from past years to the years to come.

Fig. 2.4-5 - Team photos, Amy Crews

Project Management

This season, SeaGuardians Robotics reinvented itself to continue to improve the structure of our team. Several SeaGuardians leaders left last year, leaving key roles to be filled. In addition, we overhauled our safety standards to ensure maximum safety. The largest change, however, was the change in leadership; thanks to the diligence of the exiting members, the new leaders were more than ready to take on their roles.

The team has three main divisions, which are as follows: ROV Team, Float Team, and Props Team. In each division there is one head; CEO Ian Crews is the head of the ROV Team, Nathan Willard leads the Float Team, and Connor Kelly leads the Props Team.

From the beginning of the season, the team followed a rigid schedule, keeping tight deadlines and working in stages. This schedule proved itself effective, as the team has been performing water tests since February 27, 2025.

SeaGuardians Robotics finds communication and collaboration extremely important. The team uses the communication app Discord to communicate outside of meetings due to its ease of use and helpful features. For important files, a Google Drive is used. Everyone on the team has access to both of these platforms. The Google Drive stores important documents that are needed later in the year and backs up important files to prevent them from being lost.

Even though the SeaGuardians team is divided into different divisions, everyone's input is important and valued. At the start of the season, all team members worked together and crafted the design of the ROV. Later in the season, the team was sorted into different divisions that suited the abilities of each member to make things as efficient as possible. This being said, everyone still works together as a team, especially when making key decisions. In this way, the team can function as one unit, even though each division has its own focus.

Fig. 2.3 - Construction Day, Lacey Berry

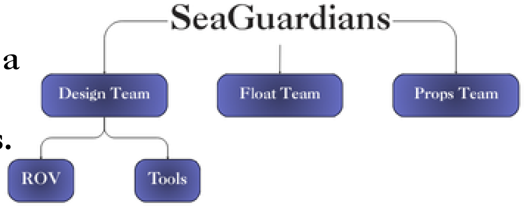

Fig. 2.4 - Project Divisions, Jaron Cobble

Design

Innovation

This year, the SeaGuardians team has made an effort to strike a delicate balance between innovation and affordability. To reduce cost, materials such as T200 thrusters, wiring, and other electrical components have been recycled from previous seasons. Rather than utilizing 3D printing, the frame is constructed from 20x20mm aluminum extrusions to allow modularity. A custom-built pneumatic claw manipulator allows for any necessary interactions with the ROV's environment. Above all, visibility is better than ever before with the utilization of one high-resolution USB camera for the forward-facing perspective. In addition, an Adalov fishing camera has been recycled from last season to view the claw manipulator, along with an Eyoyo fishing camera as a backup. Given all of these innovations, this year's ROV can be considered the best and most controllable one yet designed by the SeaGuardians.

The preservation of our natural hydrosphere and its ecosystems is very important to the SeaGuardians. To do this, it is essential to maintain these ecosystems with ease and precision. As such, SeaGuardians Robotics designed the product to be easy to control, while also having a high range of mobility. The rugged frame makes the ROV durable enough to be deployed in a wide range of environments from rivers to the ocean.

The frame is constructed from 20X20 aluminum extrusions, allowing for easy modifications and additions to the frame. aluminum extrusions also allow for easy mass production and a safe working environment. For manipulators, the ROV has been equipped with a custom-designed claw powered by a hand valve-operated pneumatic piston. Four T200 thrusters arranged in a vectored configuration, in addition to three vertical T200s mounted in a triangle, allow for all eight degrees of freedom.

With the video system, considerable upgrades have been made compared to the previous season. This year, one USB camera was used to provide high-resolution visuals with minimal latency. In addition, an Eyoyo fishing camera was added in case camera signals are lost One Adalov fishing camera was recycled from last year and was mounted to provide a clear view of the manipulator claw. The USB camera is mounted to a custom electronics backboard and are sealed inside a clear tube with the rest of the onboard electronics. The Adalov and Eyoyo cameras are designed to be waterproof and their cables are attached to the tether. To view the camera outputs, two TFT monitors and a laptop are used to allow the pilot to see all available viewpoints quickly and with ease.

Fig 3.1 - ROV's First Swim, Annabell Wilhite

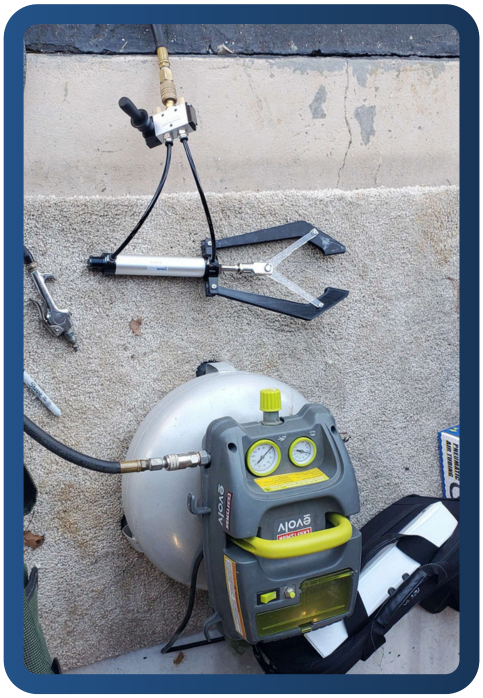

Fig 3.2 - Claw Testing, Annabell Wilhite,

This year's tether is greatly improved over last season's tether. In total, there are six cables/wires and two pneumatic lines, allowing for a lightweight and compact tether. For the 2025 season, SeaGuardians Robotics designed, 3d printed, and built a custom pneumatic claw. This was decided because a pneumatic system is more reliable, more robust, and is stronger than the VEX Robotics V1 claw that was utilized in previous seasons.

Engineering Rationale

For the SeaGuardians, finding accessible and innovative ways to maintain aquatic ecosystems is of utmost importance. As such, we hold in high priority the easy operation of our ROV, leading to a highly maneuverable, affordable, and completely safe ROV.

The frame of the ROV is constructed from 2020 aluminum extrusions, allowing for higher strength and modularity and low weight compared to previous seasons. The ROV is equipped with seven T200 thrusters arranged in a vectored configuration, allowing for more powerful and easy maneuvering than ever. This was done because a vectored thrust configuration allows for an extremely wide range of motion. For manipulation, a custom pneumatic claw has been fitted to the ROV to prepare it for any sort of tasks it may face, as well as being exponentially more reliable than an electric claw. Furthermore, three cameras are mounted on the ROV and connected to a laptop and two TFT monitors on the surface to allow the pilot easy viewing of crucial angles. one USB camera, allow clear visuals for forward views. The second and third cameras are a recycled Adalov fishing camera and an Eyoyo fishing camera, which provide wide viewing angles of the custom pneumatic claw and what lies ahead. The tether is considerably more compact than the previous season, consisting of two 10-gauge power wires, one analog cable, two camera cables, one signal wire, and two pneumatic lines.

Frame

For 2025, Sea Guardians Robotics chose to go with a frame made up of 33 aluminum t-slot extrusions. This primarily makes the frame inexpensive. In addition, it is also easy to replace parts if need be. Learning from previous years, the design team decided to go with an octagonal frame due to its simplicity and ease of production. In addition, it would be easy to implement a vectored thruster configuration with this frame shape. The frame is designed to be easily modified; this allows for the claw, underwater enclosure, and thrusters to be mounted easily and efficiently. Each piece of aluminum extrusion is mounted to at least 2 others using t-slot nuts and bolts attached to corner brackets. This ensures that the frame is sturdy and can withstand significant force. The team decided to use aluminum extrusions because they are non-buoyant and easy to work with. All crucial electronics are housed in an enclosure on the ROV. Signals are sent through a tether approximately 23 meters in length to the ROV to control it.

Fig. 3.3 - Frame With Thrusters, Lucas Hiebert

The design of the frame was chosen due to its minimal drag as well as its strength. The frame is durable enough to survive impacts from foreign objects in a work environment such as sticks, rocks, or other debris. The previous season's 3D printed frame design was abandoned due to waterproofing issues in addition to its excessive buoyancy. The frame and its components are very heavy, causing the ROV to sink; to counteract this, the SeaGuardians have decided to use polyethylene foam to neutralize the weight of the ROV. This foam is mounted to the frame using zip-ties to keep it in a secure position.

Systems Approach

As in previous seasons, the Bible verse Proverbs 27:17 has been kept in mind among the SeaGuardians. The ROV's reliance on different components interacting with and assisting one another bears a strong resemblance to the way the team members rely on and work with one another. The control box on the surface houses the means to control the ROV, containing a hand-operated pneumatic valve that actuates the manipulator claw and an analog PS2-style controller that is used to control the ROV's movement. The control box adapts the signals from the controller into an RS232 analog cable, which runs down the tether with two 10-gauge wires, one other signal cable, two camera cables, and two pneumatic lines. The signal from the surface is processed by an Arduino housed onboard the ROV. From here, the signal is sent to ESCs, where it is then sent to the thrusters as an electronic signal. The USB camera sends footage through the Arduino, where it is processed and sent through the tether to the TFT monitors on the surface. Adalov and Eyoyo fishing cameras send video footage through the camera cables, where the signals are processed by circuit boards within the control box and viewed on two TFT monitors.

Buoyancy & Ballast

The SeaGuardians' 2025 ROV is equipped with an underwater enclosure. The purpose of this enclosure is two-fold. Firstly, it holds the ROV's electronics and prevents water damage. Second, the enclosure works to counteract the weight of the ROV. Since the enclosure is sealed, the air within adds buoyancy to the robot. In addition to the enclosure, team members determined that polyethylene foam would provide the necessary buoyancy needed. Because this foam displaces so much water relative to its volume, it is extremely effective in creating positive buoyancy. During water testing, team members determined the amount of foam that would be necessary for the ROV. The polyethylene foam works together with the underwater enclosure and the weight of the ROV to achieve neutral buoyancy. During water testing, the team encountered three main issues with buoyancy. During early trials, syntactic foam was tested and was unable to effectively counteract the weight of the ROV. The team then decided to switch to the aforementioned polyethylene foam. After some testing, the team was able to adjust the amount of foam needed to stabilize the ROV. With the correct amount of buoyancy BOB can operate in any aquatic area. Finally the team decided to go with a mixture of Polyethylene and Polystyrene foam to maximize floatation at different depths.

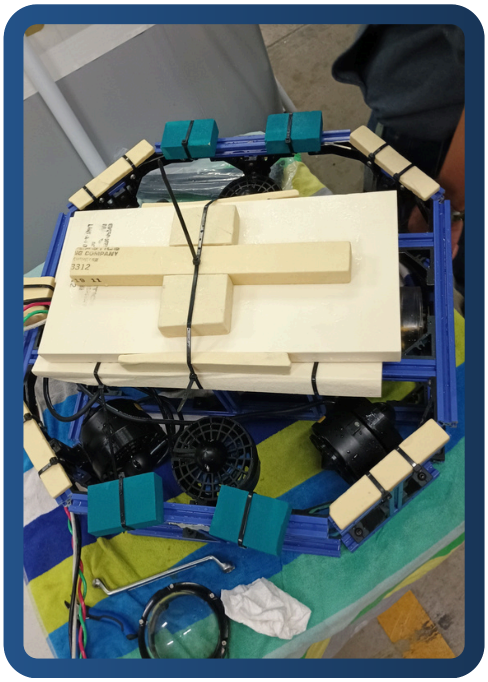

Fig 3.4 - Floatation Testing, Ian Crews

One other problem was that the ROV was stern-heavy and consistently tipping backwards. However, when the team added the claw onto the front of the ROV, this issue was resolved. Finally, the team was experiencing water leakage within the underwater enclosure. This was a major concern due to the risk of harming the electronics. The added water was also reducing the buoyant force. Members worked to reinforce the seals of the enclosure to prevent any further problems. Careful water testing was continued to ensure that this was no longer an issue.

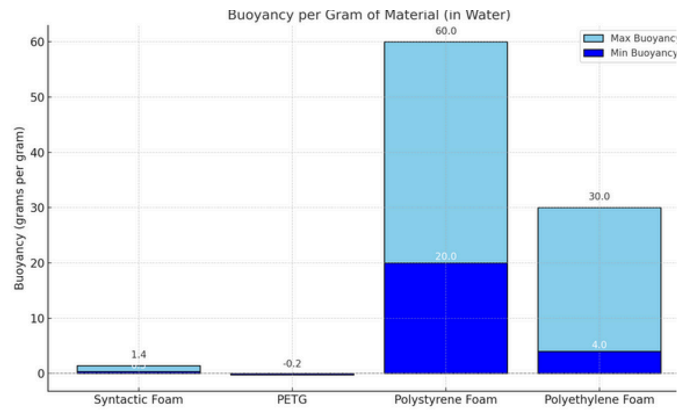

Fig. 3.5 - Buoyancy Graph, Ethan Bunch

Propulsion

This year, SeaGuardians Robotics decided to upgrade the propulsion system by adding an additional three T200 thrusters compared to the previous season. This choice was made in order to improve the ROV's maneuverability. When equipped with only four thrusters, steering required a lot of unnecessary movement. By adding the extra thrusters, piloting has become more precise and enables all eight degrees of movement. The T200s have been placed in a vectored formation to allow for easy X, Y, and Z plane movement. In order to keep costs down, the thrusters from last year were kept in good condition and recycled this year. By reusing this resource, the team was able to invest the saved money into other necessities. While the supplementary T200s increase precision, they inflate power consumption as well. By throttling down the 12 volt thrusters, the team was able to maintain an acceptable level of power at 25 amps. Reducing the power means that all seven thrusters are able to operate without causing a blown fuse. With these enhancements, the team was able to improve the precision of the ROV's movement without significantly impacting power consumption or cost. Precise handling will be critical to ensure successful mission outcomes.

Fig. 3.6 - T200 Thruster Mounted to ROV, Jaron Cobble

Payload & Tools

Claw

At the beginning of this season, it was recognized that a manipulator claw would be essential for the ROV to interact with its surroundings. During the 2024 regional competition, a critical flaw was recognized when the main shaft on a Vex Robotics V1 claw sheared during the SeaGuardians' second product demonstration. As a result, it was suggested that a pneumatic claw be used. Not only do pneumatic claws provide more grip strength, they are also more reliable and easier to operate.

After some research, the design team concluded that purchasing a premade system would not be cost-effective. Instead, a custom claw was designed. This claw utilizes a pneumatic cylinder with two 6.35mm OD air lines connected to a three position hand-operated valve to actuate the cylinder at the surface. Air pressure is provided by an air compressor with the output regulated to 40 PSI. The custom claw arms and mount were 3D printed from PETG plastic. The tips of the claw arms are coated in silicone to provide grip. (See Appendix B for Pneumatic SID.) The claw allows the ROV to carry heavy loads in any environment and is easy to use, allowing pilots of all skill levels to operate the ROV.

Fig. 3.7 - Pneumatic Claw, Ian Crews

Cameras

This year, considerable upgrades have been made to the camera system. Utilization of an onboard Arduino Mega allows for easy integration of various electronics. One USB camera has been connected with a laptop to provide crystal-clear imagery with minimal latency. The USB camera is mounted facing forwards on the front of a 3D-printed two-piece electronics tray, allowing the pilot to clearly see what is in front of the ROV. This tray is housed within a Blue Robotics Subsea Watertight Enclosure. In addition, an Adalov fishing camera has been reused from the previous year and faces the custom manipulator claw. A new fishing camera has also been added to the frame to further increase viewing angles, as well as acting as a backup in the event that the USB cameras lose signal.

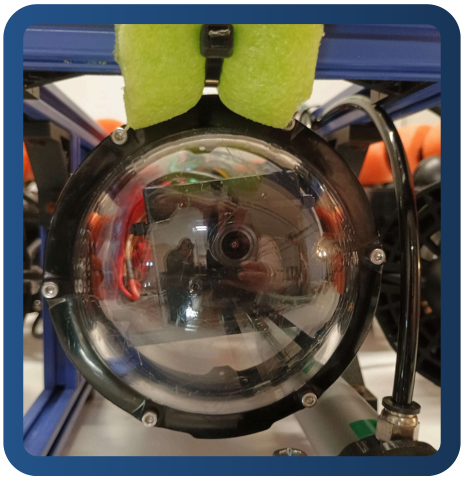

Fig. 3.8 - Front Camera, Ian Crews

Polyp Collector

In order to collect Polyp stage jellies attached to solar farms, SeaGuardians Robotics has developed a custom collection rake. The collector consists of two large-toothed combs attached to two hairbrushes, allowing the pilot to easily remove a polyp jellyfish by hooking it in the prongs of the comb or bristles of the hairbrush.

Water Sample Collection Syringe

Although the collection of a water sample presented numerous challenges for SeaGuardians Robotics, several prototypes were designed before a useable tool was discovered. The water sample collector is constructed from 3 syringes and a 3D printed mount. Two syringes mounted on a plate actuate a third syringe via hand-powered pneumatics, which will then be used to extract a 50 mL water sample.

Control & Electrical

Software

The ROV's program started its life in C++, which is the primary language used with Arduinos. In the code, one ESC is assigned to each thruster. On the side of the pool, the pilot makes analog inputs using a wireless PlayStation 2 controller. These inputs are sent through the tether to an Arduino Mega onboard the ROV. The code then sends these inputs to the proper ESCs, where the pilot's input becomes movement.

SeaGuardians Robotics needed a much more complex code to operate the ROV this year. The S.E.A.L. team, a former MATE ROV team, gave SeaGuardians special permission to recycle their code. However, some modifications needed to be made in order to have the code suit our needs. Utilizing this code has been a learning experience that has, most importantly, expanded the team's coding knowledge.

Fig. 3. 9-12 - ROV Code, Ian Crews

Control System

This year, SeaGuardians Robotics took a different approach to designing the control system by incorporating underwater electronics. The control system is split between above and below the water. Above the water, a poolside control box houses the controller receiver, a pneumatic claw valve, a USB to ethernet converter, and a Retrofighters Defender PlayStation 2 controller. A watertight onboard electronics housing contains an Arduino Mega, an ethernet to USB converter, power supply bars, a buck converter, and one Blue Robotics Electronic Speed Controller per thruster. All of this is mounted on a custom 3D printed mounting plate. (See Appendix A for SID.) The simplicity of the design allows for easy maintenance by one of any skill level.

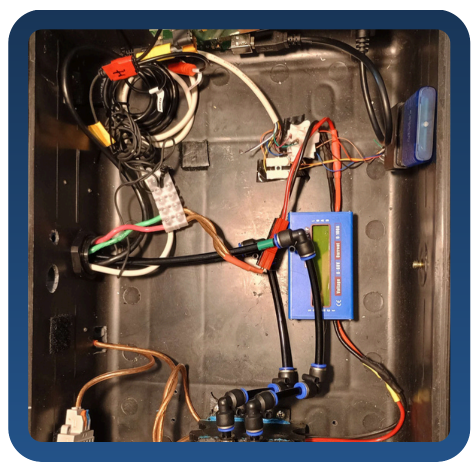

Fig. 3.13 - Poolside Control Box, Ian Crews

Tether

The tether is a key part in the creation of the SeaGuardians' ROV, allowing for power and communication between the control box and the submerged unit. The tether is 75 feet (22.86 meters) long. The team decided to use two 10 gauge wires, one RS232 cable, one ethernet cable, two pneumatic lines, and two camera cables. These wires and cables make up the core of the tether. The 10 gauge wires are used to provide power to the ROV and its thrusters.

Through the RS232 cable, input signals are transmitted to the ROV to be converted into thrust by the onboard electronics.

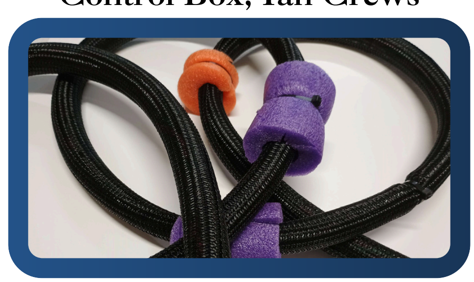

Fig. 3.14 - Coil of Tether, Ian Crews

The ethernet cable carries video signals from the ROV to the surface, in addition to the dedicated camera cables. To protect it from the underwater environment, the tether is protected by a flexible plastic sheath. This also helps the tether withstand numerous handling maneuvers while maintaining a strong signal. To ensure that the ROV does not incur drag while submerged, the team made sure that the ROV and tether were properly buoyant by using a continuous length of low-density polyethylene foam to minimize drag.

	Tether Management Checklist
1	Uncoil tether to prevent tangles
2	Feed tether through the entry hole
3	Prevent slack from the ROV
4	Pull tether out of the entry hole
5	Recoil tether to prevent tangles

Problem Solving

Problem-solving is a big part of building an ROV. This year, SeaGuardians Robotics encountered several issues that needed to be fixed.

The signal for the controller was too weak to travel through the 75-foot (22.86 meters) tether, so the Arduino was receiving poor or incorrect signals. The team decided to fix this problem by obtaining a new controller with a stronger signal.

One of our team's biggest problems was waterproofing the underwater enclosure. At first, it was assumed that the enclosure was just leaking from one bolt. After applying silicon grease to that bolt, the leak persisted. With much research and troubleshooting, the problem was finally determined to be the incorrect assembly of a few Wetlink Penetrators on the enclosure. After properly assembling the leaking Penetrators, the enclosure was watertight.

The pneumatic claw was the cause of other minor problems. Early on, there were problems with the claw's actuation. When operated by the hand valve, the cylinder would open and close with violent force and speed. To remedy this, adjustable dampers were installed on the exhaust ports of the valve to restrict flow without reducing strength.

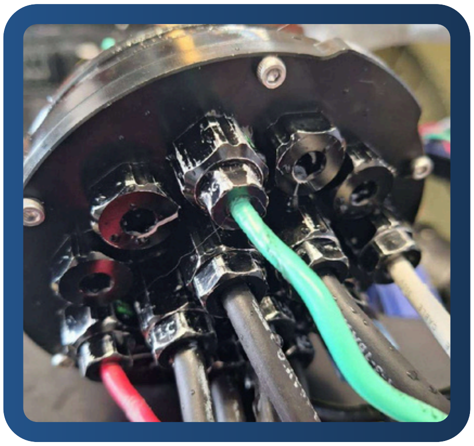

Fig. 3.15 - Testing Leaking Penetrators, Kristin Cobble

Testing & Troubleshooting

This year, SeaGuardians Robotics has overcome several challenges. The PS2 controller chosen for the ROV sent a signal that was too weak to carry down the 75 foot (22.86 meters) tether to the Arduino Mega. However, after switching to the Retrofighter's Defender controller, which has a much stronger signal strength, the issue was fixed. The largest problem area was the underwater enclosure. The first issue was finding out how to mount all necessary electronics inside the enclosure. Due to the limited space and the abundance of needed equipment inside the enclosure, space was by far the biggest concern. After all components were mounted and ready to be installed, the team quickly found out that it did not fit inside the enclosure. In order to fix this, the team installed more compact connector plugs for the ESCs to both the thruster and Arduino.

With this change, as well as routing some wires differently, everything managed to fit. At the start of underwater testing, leaks were soon discovered. After reapplying grease and adding new O-rings to the Blue Robotics Wetlink Penetrators, the issue persisted. Finally, the leakage was resolved after changing two worn seals and properly assembling some Wetlink Penetrators that were installed incorrectly. When designing the custom pneumatic claw, countless setbacks and problems arose. Premade claw systems were initially considered, but these proved to be uneconomical. Soon thereafter, Design Team member Jaron Cobble began researching in order to design a claw. After designing and printing the first set of claw arms, clearance issues were present; the pneumatic cylinder was impacting the arms when retracting, preventing the claw from closing. To remedy this, Cobble lengthened the claw arms and moved their pivot points away from the cylinder. After assembly, more problems arose during the first test. During actuation, the cylinder extended and retracted with explosive force, damaging the claw. After reinforcing the broken pieces, dampers were installed on the exhaust ports to restrict flow without affecting clamping force. In its final iteration for the 2025 competition season, the pneumatic claw's grip surface has been expanded, angled, and coated with silicone to provide as much grip as possible.

Safety

Safety Philosophy

This year, Seaguardians Robotics took a slightly altered approach to safety. The wellbeing of all members is still of utmost importance to Seaguardians Robotics, and all safety protocols are in compliance with MATE standards. However, some rules and procedures have been altered, removed, or added to keep employees safe while they gain knowledge and experience.

Procedures & Protocol

In an effort to maintain maximum safety and simplicity, Seaguardians Robotics made minor revisions to the safety protocol and procedures in place. The season began with the same safety policies as last season, and all members were required to read and digitally sign a document containing these policies. During construction, flaws within the safety procedures were found, particularly concerning soldering. As such, a revision was made that requires proper ventilation and removes the need for latex or vinyl gloves, as they could melt in the event of an accident. In addition, the structure of safety officers was revamped.

Safety Checklist	
1	Ensure the table is dry
2	Check the control box for loose wire
3	Place the control box on the table
4	Remove tether from transport
5	Remove ROV from cart and place it on the ground
6	Plug PSU in and plug PSU into control box
7	Connect pneumatic hose into hand valve
8	Connect USB cable between control box and computer
9	Power on PSU and control box
10	Open OBS
11	Test controls and claw

Now, three deputy safety officers report to one head safety officer, allowing for much closer monitoring of the workspace. With these changes, the safety guidelines provide safe handling of any and all situations, including but not limited to attire, conduct, first aid, poolside behavior, electrical safety, and proper use of tools. If a member breaks one of the safety guidelines, the member in question will be issued a safety strike. If three strikes are issued to the same member during one meeting, he or she will not be allowed to work on the ROV for the rest of the meeting. In addition to revisions in safety guidelines, minor changes in the proper training of tools have been made. This year, members were trained formally on the most commonly used tools; further training is done as needed if a member needs to use a tool that he or she has not been trained to use. The team safety box is always accessible. Included in the safety box are basic PPE such as disposable gloves and safety glasses, as well as basic first aid items such as Neosporin, antibacterial spray, burn cream, and bandages. Furthermore, at least two adults are present at all times to further monitor the workspace. (See Appendix C for JSEA.)

ROV Safety

The ROV has had key safety features implemented. All thrusters have shrouds over both sides to prevent injury or damage. In addition, all thrusters are marked in yellow and have caution labels. The claw has caution markings as well. Extra care has been taken with the wiring on the back of the onboard electronics housing, affectionately referred to as the Omnidirectional Jelly Bean (OJB). Where the wires enter the rear cap, all Wetlink Penetrators have been carefully checked to ensure absolutely no leakage around wire entry points. Adequate strain relief has been fitted onto the ROV and the control box to prevent damage of wires. On the power supply, a fuse has been added to prevent an abundance of current from being drawn. All connections within the control box have been labeled, and an acrylic faceplate protects operators from electrical currents. In the event that drastic measures are needed, a power switch has been installed on the side of the control box as a failsafe for a quick and easy shutoff.

Fig. 4.1 - T200 Thruster with Shroud, Jaron Cobble

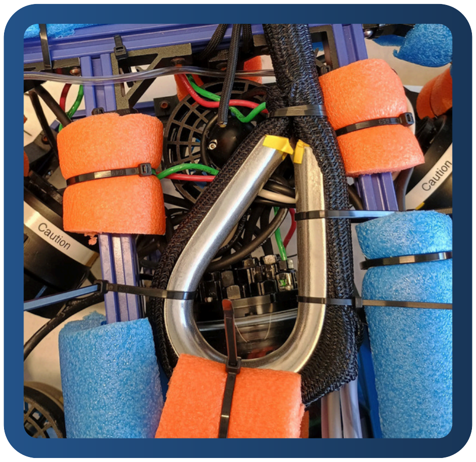

Fig. 4.2 - Tether Strain Relief, Ian Crews

Build vs. Buy, New vs. Used

Considering the team's resources this year, SeaGuardians Robotics sought to make the best decisions for their product, keeping in mind development time as well as the goal of making an affordable, quality ROV. As previously mentioned, the entire frame was constructed of aluminum extrusions. The team also purchased PETG to print custom designed camera mounts and claw mounts, as well as custom pneumatic claw arms. The team decided to create and print each of these pieces with PETG because it is extremely cost-efficient. Materials purchased new include the following: USB and fishing cameras, select 10 AWG tether cables, PETG filament, metal brackets, an ethernet cable, pneumatic tubing, cylinder, hand valve, and aluminum extrusions. The team chose to purchase these items to ensure quality and ease of use.

The materials bought new also significantly cut down production time compared to creating these components from scratch. Most reused materials were recycled from previous seasons. The SeaGuardians chose to recycle components from past vehicles in order to employ all their available resources. These include seven thrusters and the underwater enclosure. One of the team members also donated an Arduino Mega to act as the "brain" of the ROV. Repurposing these materials eliminated much uncertainty because of the history and familiarity of the products. Despite the amount of reused parts, BOB is still affordable and easy to mass produce.

Accounting

Fundraising

Since the SeaGuardians Robotics team is a homeschool team, it is more challenging to gather the necessary funds. Therefore, fundraising is an important part of our team. We capitalize heavily on the support of our local community for help with our funding. This helps us build strong connections with our local community. The SeaGuardians undertook two main fundraisers this year. The first was a Cash Calendar. This fundraiser sought financial help from friends and family. The SeaGuardians also hosted our third annual semi-formal dance. This fundraiser helps us create a connective experience for the teenagers in our homeschool community.

Fig 4.3 - Team Fundraiser Dance,
Amy Crews

Budgeting

At the beginning of the 2024-25 season, the CEO of SeaGuardians asked every member to work on the budget. Needed items were found, priced, and placed into a Google spreadsheet. From there, the total estimated budget was set. The total budget at the beginning of the year was set at $2,266.99. In total, the team as a whole worked on the budget for 16 hours. SeaGuardians Robotics prioritized re-using trusted items from previous competition years. Because of the care taken by past members to protect expensive components such as thrusters, this year's team was able to use budget funds to improve other elements. In addition, the team hosted fundraisers in order to counteract the necessary costs. At the beginning of the year, a total of $2,266.99 was set for the budget (see Appendix C for ROV Budget). The team wanted to prioritize being cost effective without compromising the quality of the ROV. In order to achieve this goal, members searched for the best prices available. If an item was used and in good condition, it was purchased instead of buying a brand new version. Another benefit the team received was donated pool time provided by STREAMWORKS STEM Gym, Johnson City Parks and Recreation, and private pools.

Due to its homeschooling background, SeaGuardians Robotics has placed more responsibility in the hands of each team member's family, although funds are allotted based on family size and financial ability. Each team member will provide their own transportation and meals on competition day. Because of generous donations, the reusing of past items, travel savings, and overall awareness of cost, the team spent only $2,437.39 on the ROV (see Appendix D for ROV Cost).

Acknowledgements

SeaGuardians Robotics would like to thank all who mentored them through this process: Issachar Wine, Rylee McDaniel, Jay Wilhite, Cody Tipton, Samuel Funderburk, and any others who may not be mentioned. We wouldn't be where we are without your support and encouragement.

The company would also like to thank Hosanna Fellowship Church, Johnson City Memorial Park Community Center, Johnson City Freedom Hall Pool, and STREAMWORKS for allowing the team to meet at your facilities. In addition, the team would also like to thank any who contributed to the SeaGuardians GoFundMe page for their financial support. Lastly, thank you to STREAMWORKS for hosting the MATE ROV Competition Appalachian Highlands Regional. The team wouldn't be competing without you either.

References

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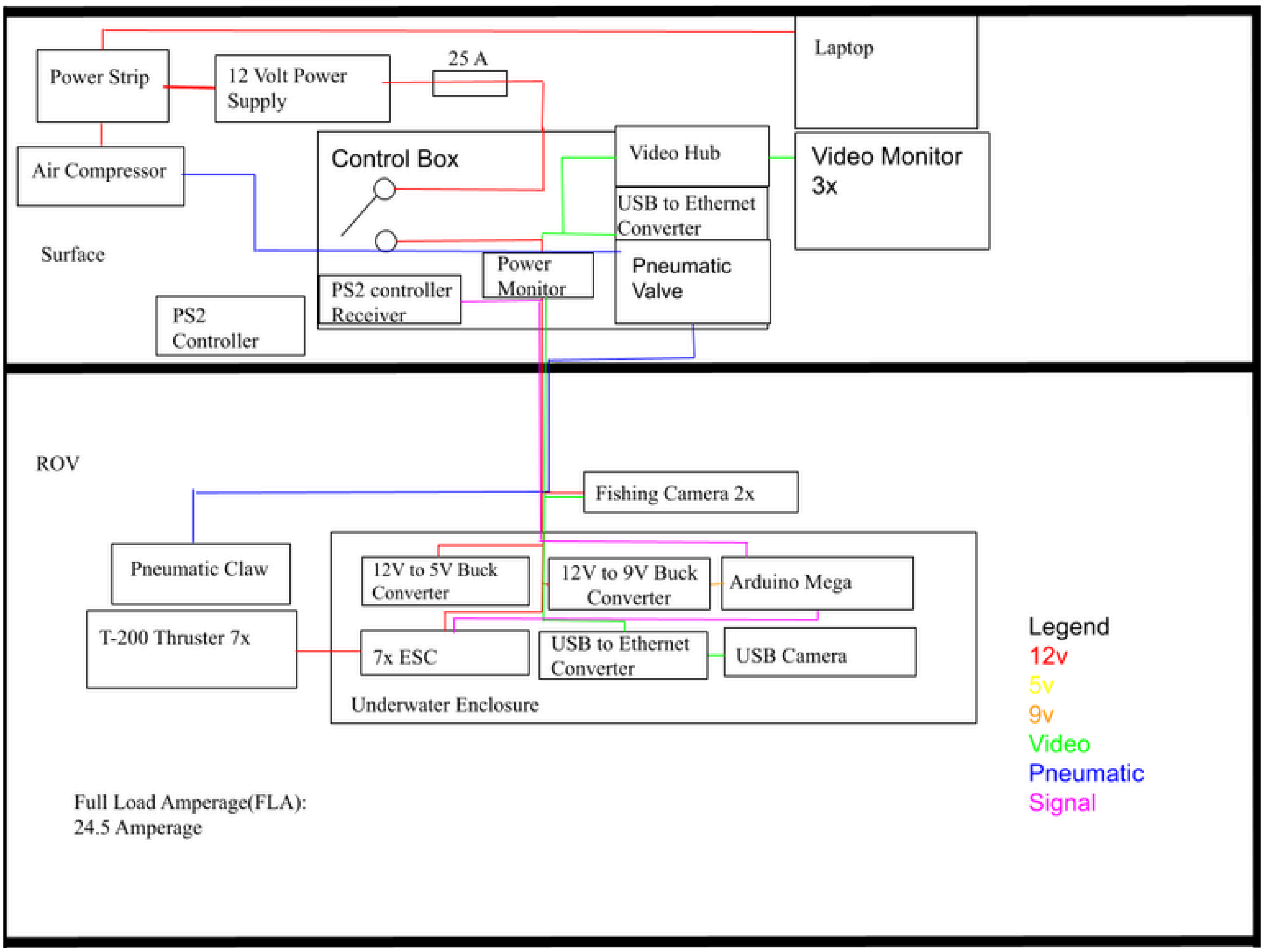
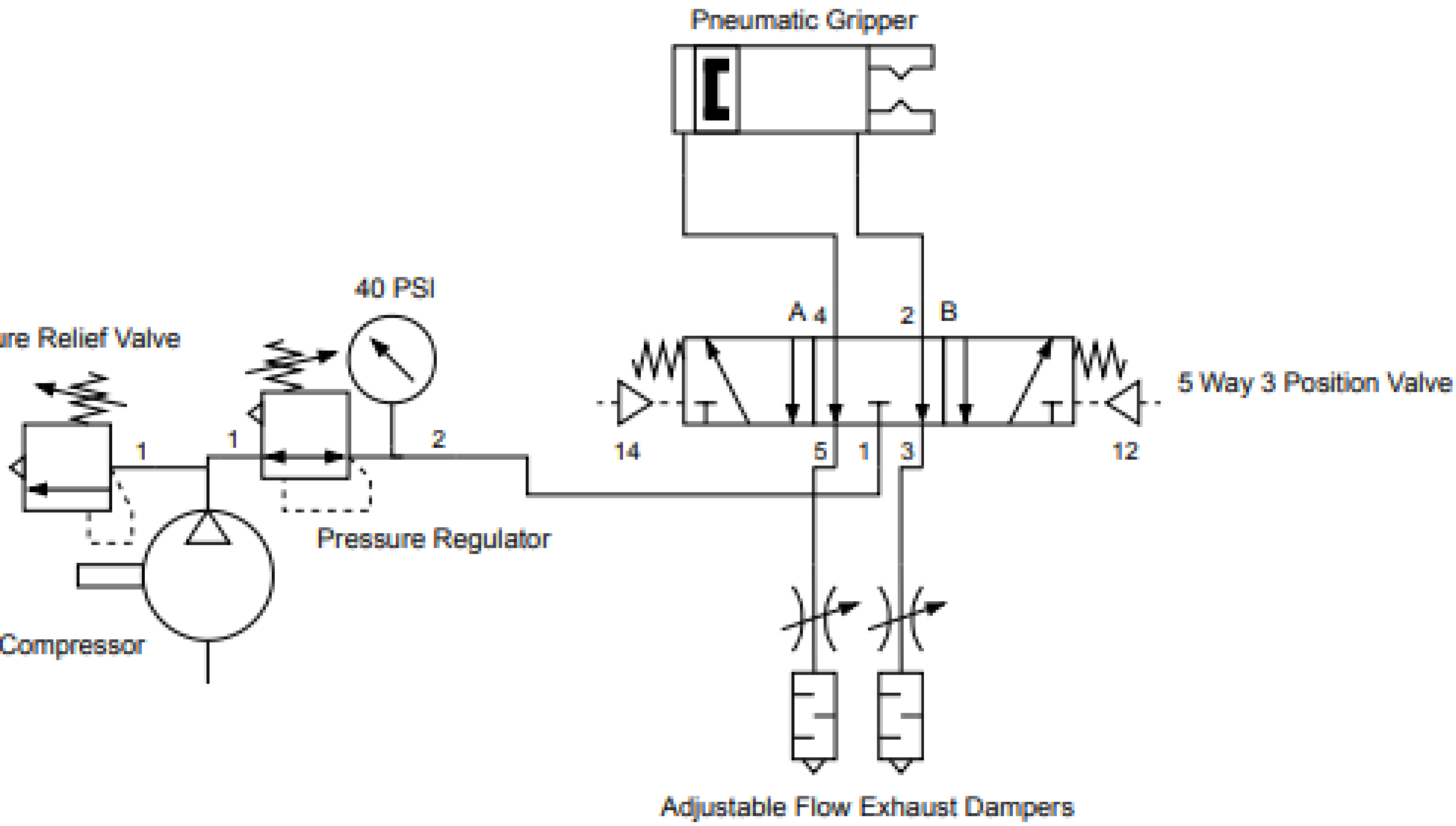
Appendices

Appendix A: ROV Systems Integration Diagram



Appendix B: Pneumatic Systems Integration Diagram



Appendix C: Job Safety Environmental Analysis

No	Job	Hazard	Potential Consequences	Correction Measures	Responsible
1	Demonstration setup and takedown	• Wet Floor • Heavy Objects • Unsteady Objects • Electrical Currents • Pressurized Air	• Falling • Crushed Appendages • Pinching • Short Circuit • Air Embolism	• Extreme Caution • Spatial Awareness • Proper Handling of Pneumatic System	• Pilot • Co-Pilot • Tether Manager • Props Manager • Float Manager • Mathematician • Technician
2	ROV Deployment	• Wet Floor • Heavy Objects • Unsteady Objects • Electrical Currents • Pressurized Air	• Falling • Crushed Appendages • Pinching • Short Circuit • Air Embolism	• Extreme Caution • Spatial Awareness • Proper Handling of Pneumatic System	• Pilot • Co-Pilot • Tether Manager • Props Manager • Float Manager • Mathematician • Technician
3	ROV Operation	• Wet Floor • Underwater Electronics • Pressurized Air	• Falling • Electrocution • Air Embolism	• Extreme Caution • Spatial Awareness • Proper Handling of Pneumatic System	• Pilot • Co-Pilot • Tether Manager • Props Manager • Float Manager • Mathematician • Technician
4	ROV Retriveal	• Wet Floor • Heavy Objects • Unsteady Objects • Electrical Currents • Pressurized Air	• Falling • Crushed Appendages • Pinching • Short Circuit • Air Embolism	• Extreme Caution • Spatial Awareness • Proper Handling of Pneumatic System	• Pilot • Co-Pilot • Tether Manager • Props Manager • Float Manager • Mathematician • Technician

Appendix D: ROV Budget

Type	Item	Quantity	Price New
New	USB Camera	2	$18.99
New	USB to Ethernet Converter	2	$49.99
Used	T-200 Thrusters	6	$200
New	150mm 2020 Extrusions, 4 pack	6	$11.99
New	300mm 2020 Extrusions, 4 pack	2	$17.99
New	500mm 2020 Extrusions, 4 pack	1	$30.99
New	2020 Extrusion Corner Bracket, 10 pack	7	$21.66
New	2020 Extrusion 135 degree bracket, 8 pack	2	$15.99
Used	T-200 ESC	6	$38.00
New	Arduino Mega(elegoo)	1	$20.99
Used	Underwater Enclosure	1	$230.00
Used	underwater Enclosure Dome	1	$40.00
Used	underwater Enclosure endcap	1	$55.00
Used	Underwater Enclosure End cap flanges	2	$45
Used	Underwater Enclosure Clamps	1	$50
New	Buck Converter	1	$12.15
New	Screw Terminal Block Breakout Shield Module for Arduino MEGA-2560 R3	1	$32
Projected Cost:			$2,266.99

Appendix E: ROV Cost

Type	Item	Quantity	Price New
New	USB Camera	2	$18.9
New	USB to Ethernet Converter	2	$49.9
Used	T-200 Thrusters	6	$20
New	150mm 2020 Extrusions, 4 pack	6	$11.9
New	300mm 2020 Extrusions, 4 pack	2	$17.9
New	500mm 2020 Extrusions, 4 pack	1	$30.9
New	2020 Extrusion Corner Bracket, 10 pack	7	$21.6
New	2020 Extrusion 135 degree bracket, 8 pack	2	$15.9
Used	T-200 ESC	6	$38.0
New	Arduino Mega(elegoo)	1	$20.9
Used	Underwater Enclosure	1	$230.0
Used	Underwater Enclosure Dome	1	$40.0
Used	Underwater Enclosure endcap	1	$55.0
Used	Underwater Enclosure End cap flanges	2	$4
Used	Underwater Enclosure Clamps	1	$5
New	Buck Converter	1	$12.1
New	Screw Terminal Block Breakout Shield Module for Arduino MEGA-2560 R3	1	$3
New	25mm Bore 100mm Stroke Pneumatic Cylinder	1	$17.9
New	Nylon 1/4 in Pneumatic Tubing, 60m	1	$50.9
New	Automatic Drain Air Filter Pressure Regulator	1	$23.4
New	1/4 in Push to Connect 90 Degree Elbows, 10 Pack	1	$6.9
New	5 Way 3 Position Pneumatic Hand Valve	1	$20.9
New	Retrofighters Defender Wireless PS2 Controller	1	$49.9
ROV Cost:			$2,437.3