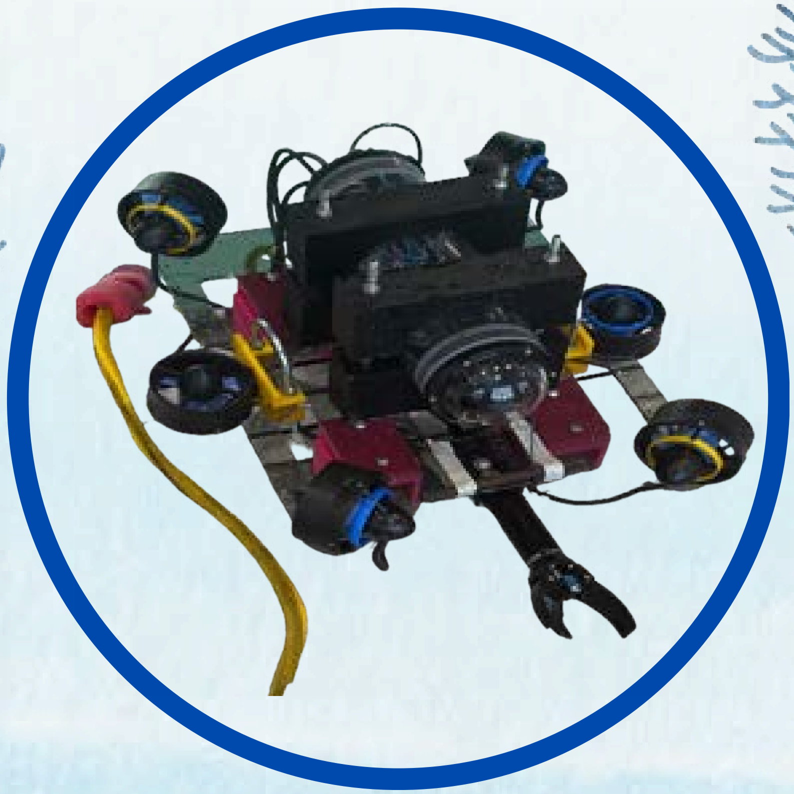
Technical Documentation

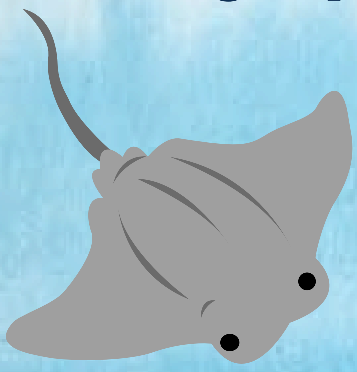
Aquabot Technicians



Corpus Christi TX, United States

Foy H. Moody High School

TR5-Stingray 2.0



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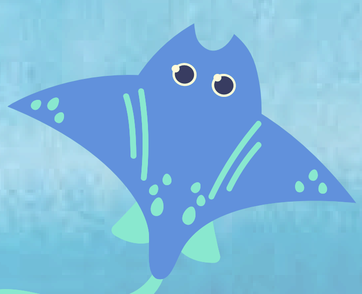


Abstract

The Aquabot Technicians is an underwater robotics company based in Corpus Christi, Texas. The company comprises 10 proficient engineers that are passionate about creating technology that addresses challenging global issues. The following advancements improve reliability and continuity within the ROV (Remote operated vehicle) with upgraded electronic capabilities and a buoyancy engine with data processing capacities. The TR5-Stingray 2.0 was engineered with precise designing and testing, resulting in our ROV being able to not only complete the tasks outlined by MATE (Marine Advanced Technology Education) but adaptable to complete almost any tasks you would need. This technical document details The TR5-Stingray 2.0's development process as well as the ROV's capabilities. The newly customized ROV is more than capable of completing tasks such as identifying shipwrecks, lake acidification and invasive carp task, and removing or installing pc02 sensors and thermistors.

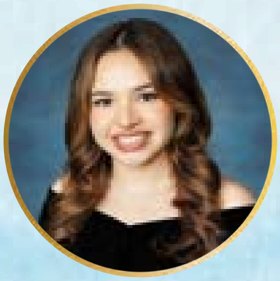
Figure 1: Aquabot technician Employees and Interns at MATE ROV's 2024 World Campionship

Project Managment

Team Members and Roles

Albert Mendoza (CEO): Senior, Majoring in Mechanical Engineering at Texas A&M Kingsville, hopes to be the CEO of his own company in the future

Emery Johnson (CFO): Senior, Majoring in Computer Science at Texas A&M Kingsville, Wishes to work for Google or Microsoft!

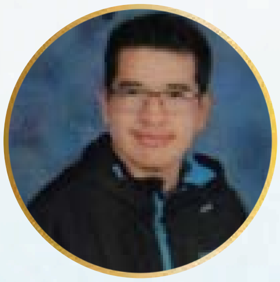


Audree Alvarado (Technical Documentation): Senior, Majoring in Architectural Engineering at Texas A&M Kingsville, Hopes to be the CEO of her own firm

Jonah Morales (Buoyancy Specialist): Senior, Plans to attend University of Texas Austin, plans to be a Marine Engineer and work for MTS.

Layla Chapa (Safety Officer): Senior, plans to attend University of Texas San Antonio, hopes to become a safety engineer and make ROV's safer for Marine Life

Project Managment



Jonathan Larado (Electrical Engineer): Junior, planes to major in Electrical Engineering at A&M College Station, hopes to become an engineer at Oceaneering

Exavier Rodarte (Mechanical Engineer): Senior , Majoring in Mechanical Engineering at Texas A&M Kingsville, hopes to become an engineer at Oceaneering

Christian Estrada (Pilot): Senior, Plans to pursue his welding career, Wishes to come back and volunteer with MATE!

Zane Hosey (Electrical Engineer): Junior, plans to major in Biomedical or Nuclear Engineering at Texas A&M , hopes to work for NASA!

Julia Perales (First Year Intern): Junior, Plans to attend Texas A&M University and major in Aerospace engineering, wants to work as an Aeronautical engineer.

Project Managment

Company Overview & Team Structure

The Aquabot Technicians is a company run by high school students with the goal of transforming the Global Ocean Observing System to protect and restore ecosystems and biodiversity.

Team Structure

Company Evaluation

As a fairly large team, this year we prioritized three main skills as a company such as critical thinking, communication, and intellectual development.

Critical thinking- in the earlier building stages of the TR5-STINGRAY2.0 we kept having issues with disconnection in the ROV. So we created a rotating team called the “Sting Team” where three employees had a specific job in finding the root cause of the disconnection. They break down each system in detail, evaluating each system and asking the Five Whys. The team then experiments using different parts and materials. After many different rotating teams, we were able to have a stable and longer connection, and in addition we were able to apply this method of critical thinking to other systems.

Communication- As a larger team there was a lot of miscommunication, for example if there was a dimension change in the frame, the buoyancy would be miscalculated, because both teams did not communicate clearly with each other. Therefore we created weekly team meetings which included each subteam giving a three minute update and added to a change log where all employees can view. After many meetings, the miscommunication was lessened and our employees were able to understand everyone's systems, how they were doing and what has changed.

Intellectual Development- After our recent regional MATE competition, the team struggled with some retrieval task, we would complete the mission but barely. Instead of moving past it we decided to dig deeper. After each practice with our ROV we held a reflection session, employees asked questions, such as “What caused the difficulties?” “Were the design trade-offs w[illegible]de worth it?” “If we had more time What would we do differently? We came out of [illegible]hese sessions with more knowledge, and a better mindset as engineers.

Monthly Team Schedule

Week

Meeting 1 – Early Week

Meeting 2 – Late Week

Week 1

Kickoff: Introductions, assign roles, overview of mission tasks, and club expectations.

Brainstorm & Planning: Generate design ideas, sketch concepts, assign research tasks.

Week 2

Design Finalization: Finalize ROV concept, compile materials list, assign build roles.

Begin Building: Assemble frame, prep workspace, organize tools, order components.

Week 3

Hardware & Software Integration: Mount electronics, begin basic coding, test circuits.

Dry Testing: Power up systems, troubleshoot wiring, test motors/sensors on land.

Week 4

Pool Testing: First in-water test, evaluate buoyancy, mobility, and camera feed.

Final Practice & Wrap-Up: Run timed mission practice, finalize documents, celebrate.

Design Rational

When our team first began production of our ROV in fall of 2024, the 2025 MATE ROV Ranger Competition Manual had not been released. However, we knew we needed a huge improvement in design based on results in the previous 2024 competition. Looking back at last year's competition we realized we had to be more precise and careful with our designing process. We looked to our predecessors' designs for inspiration as well as brainstorming everyday and planned to adjust once we knew the constraints set by the manual. We set out to create a frame design which improved upon the design of TR5-Stingray2.0. We created several cardboard prototype designs. The ROV will be designed to operate efficiently in aquatic environments, capable of maneuvering in various directions with precision and stability. The addition of a claw enables it to perform tasks such as object retrieval, manipulation, and lake acidification and invasive carp task .

Figure 2: Xavier R. and Albert M. Brainstorming frame measurement- Taken by Layla C

The TR5-Stingray2.0 is a meticulously design ROV capable of gliding through the water with ease. The frame is constructed of Lexan Plastic which is a lightweight and durable material, able to withstand underwater environments. After Several cardboard and plywood prototype, the Lexan Plastic frame was done by creating a carve (a program which programs cutting paths for our CNC machine) and cutting the frame using our CNC machine. In addition the ROV consists of 6 reused T200 Blue Robotics Thrusters, by placing each thruster on the outside of the frame, it allows the ROV to glide through the water efficiently and safely. One trade off that we made when using our thruster system was, putting the thruster on the outside of the ROV, we traded the risk of getting caught in rope/wires for the ability to flow through the water more proficiently .

Innovation

The Aquabot Technicians places a strong emphasis on innovation. The team defines innovation as a relentless pursuit of incremental modifications that enhance functionality while driving down costs. In order to keep costs low the team created a shop inventory system that would help sort out items that we already had or can make, this helped cut down on our cost effectively. In addition the TR5- Stingrays frame is placed beneath the electronic closure, rather than being placed on both sides of the closure as seen on the TR4-Stingray. By make this new change our engineers were able to retrieve or fix things in our electronic closure without having to deconstruct the entire frame. In addition as a team we innovated our 3D printed thruster shrouds, in order to protect marine ecosystems.

TR4-Stingray

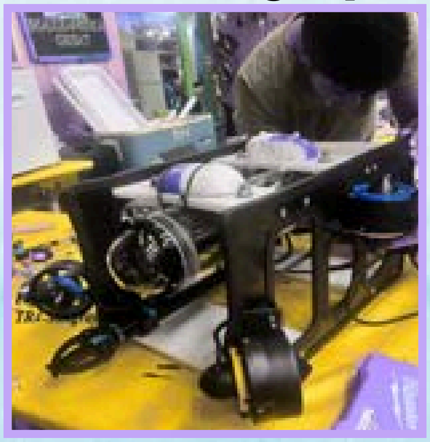
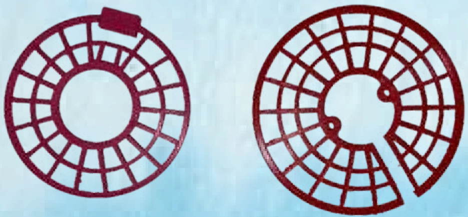


Figure 3 : TR4-Stingray- taken by Jonah Morales

TR5-Stingray2.0

Figure 4; TR5-STINGRAY 2.0- Taken By Layla Chapa



TR5- Stingray 2.0 Thruster Shrouds

Problem Solving

As a team were facing problems almost everyday, it could be technical or problems with teamwork. This year in order maximize brainstorming, technical advancements, and practice time, The company made it known we will take all ideas no matter how hard and silly which with the ideas we made pros and cons list comparing and contrasting our design rationale at that moment against the alternatives. The goal when choosing ideas was never how long or hard the process would be, but is it doable, and in budget.

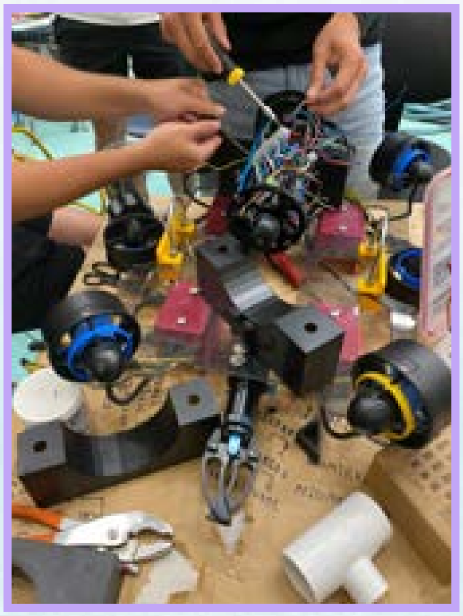


Figure 5: Electrical Engineers trouble shooting connection- Taken by Zane Hosey

Team Protocols and procedures:

Throughout the years the Aquabot Technicians have developed a protocol for problem solving called the 15 minute rule. When a problem occurs the person will brainstorm for 15 minutes and if the problem is not solved they will ask other people. This has helped increase our problem solving skills immensely, and helped us increase our time to meet our everyday mission objectives.

Innovation: The Aquabot Technicians places a strong emphasis on innovation. The team defines innovation as a relentless pursuit of incremental modifications that enhance

Figure 6 : Members having group meeting- Taken by Layla Chapa

Systems Approach

This year the TR5-Stingray 2.0 has a much different look then it did last year. We have constructed a frame that can move quickly through the water and lets us turn at much faster speeds than before. This new frame allows us to attached all of our payloads and other parts to the top of the frame so they are sitting there rather than hanging off. Last year we faced issues with having to access our electronics and with this new frame we are able to easily access all of our electronics.

Vehicle Structure and systems

This year, the Aquabot Technicians innovated a significant change in the TR5-Stingray2.0 , this new design reduced cost and made the Electronic closure easier to access and fix problems. The ROV's frame is rectangular and measures to 530mmx380mm and weighs 12.25 KG. The Frame is constructed from Lexan Plastic, using Carve Software to later cut on our CNC Machine.

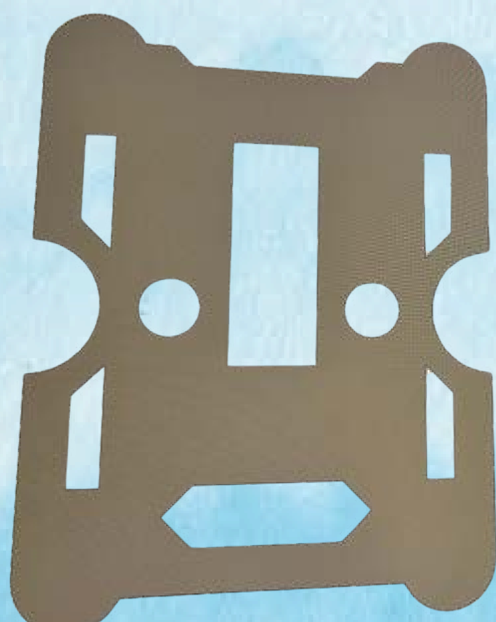


Figure 7: Fusion 360 3D model- Drawn and Taken by Zane Hosey

Control/Electrical System

The electronic design was chosen with the mindset of having the most efficient parts we could afford. We used a raspberry pi 4 and a navigator because we are more knowledgeable and understanding of their capabilities. In addition, the fathom x in the capsule transfers data wirelessly to its recipient in the control box which is displayed on our laptop. The T-200 thrusters are significantly faster then T-100s, which increases overall mobility in the water. Our tether consists of power wires for the ROV and hydraulics for the extractor.

We use a raspberry pi 4 and a navigator as our control system allowing us to have better continuity resulting in an improved display of the ROV.

The tether is lightweight allowing the robot to not get dragged down and the shell is big enough to hold our hydraulic, power, and signal wires.

Albert Mendoza working on Electronic Capsule

Figure 8 : CEO working on capsule- Taken by Emery Johnson

Figure 9: Electronics Enclosure and Electronics Tray- Photo from BlueRobotics

Figure 10: Raspberry Pi- photo from RaspberryPi.com

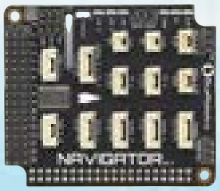


Figure 11: Navigator - Photo from Blue Robotics

Figure 12: Fathom X - Photo from Aquabot

Figure 13: PS5 Controller - Photo from Amazon

Figure 14: Low-Light HD USB Camera

Figure 15:Newton Sea Gripper- photo from Blue Robotics

Propulsion

TR5-Stingray 2.0 makes use of six Blue Robotics T200 Thrusters (Figures 3-4). These thrusters are a vital component of our ROV, as they facilitate all system-wide movement, including thrust, yaw, and sway. Two thrusters are located forward and at the back of our ROV and facilitate heave and pitch. Four corner thrusters are located port-side forward and at the starboard-side forward and aft, each at an angle of 45˚. Speed and polarity of the thrusters are regulated by ESCs (electronic speed controllers). When running at 12V, RPM of the T200 are as follows: with an ESC PWM (pulse-width modulation) value of 1900 µs, a T200 operates with a maximum forward speed of 2995 RPM; with an ESC PWM value of 1200 µs, a T200 operates with a maximum reverse speed of 2975 RPM.

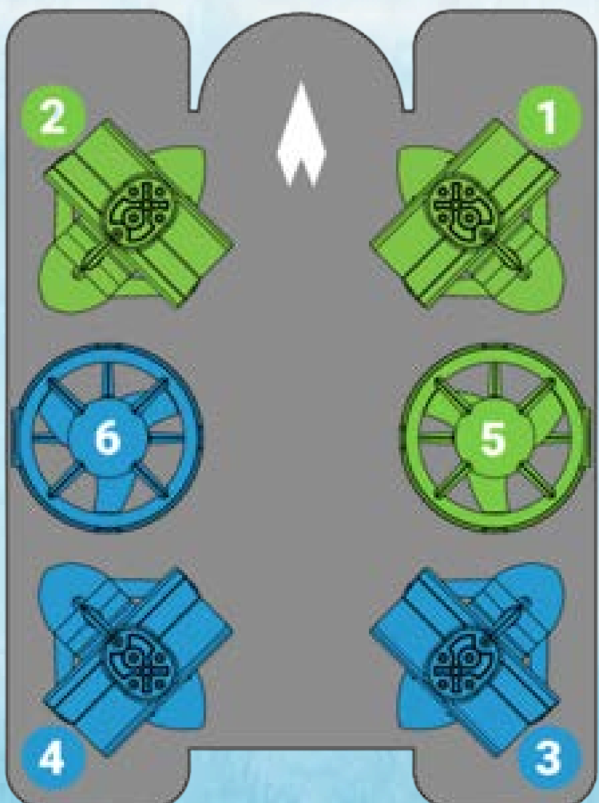


Figure 17: T200 Thruster with 3D printed Shrouds- Photo taken by Audree Alvarado

Figure 16: Thruster Placement- Made by Audree Alvarado

Buoyancy and Ballast

In addition to the TR5-Stingray2.0 , our company created an underwater glider that will complete vertical profiles and transmit data back to mission control. The teams came to an agreement to name the vertical float (OSUG). The (Open System Underwater Glider) demonstrates the compartments of the float. This compartment consists of the actuator as well as the electrical enclosure that holds all components that run the float. The main idea of the vertical float is to simulate a real world task that consists of measuring information such as temperature, pressure, salinity of water, as well as depth data. In order to accomplish this, the vertical float must complete two vertical profiles. The way the float operates is through a closed communication between a forward/reverse timer relay and actuator. The actuator is attached to 10 10ml syringes that are pulled and pushed to add and remove water. To complete the communication, the Bar 30 sensor will communicate with the Raspberry Pi to communicate how much pressure is being applied and how deep the engine stays. During this process our float will communicate to our mission station through a raspberry pi and a sensor collecting data about pressure, temperature and depth information during the descent of the float and then release that data to the mission station to process.

Figure 18: Bouancy Engine- Photo taken Albert Mendoza

Payloads and Tools

One of the payloads that we have attached to the robot is a two way syringe that uses water hydraulics to extract EDNA from a specific area that we bring up and test for the PH level. This payload is attachable and detachable to the ROV, a hose attached to the syringe, this hose is in the tether, where on deck is connected to the other syringe. On deck when the syringe is pulled, underwater the EDNA is able to be successfully extracted

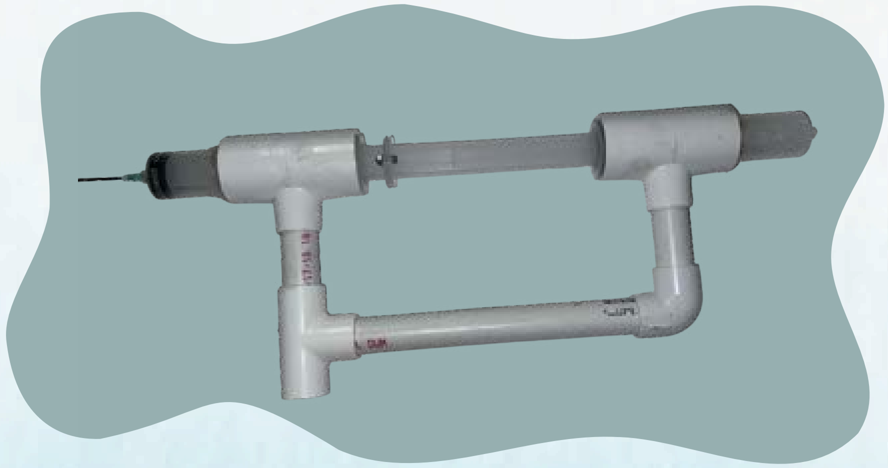


Figure 19 : Payload - Taken by Audree Alvardo

Camera

Using a backup camera from a vehicle onto an underwater robot offers enhanced navigation in murky and dark underwater environments. It's also officiant because it only takes up to 1 to 5 volts which is crucial because we need to minimize the amount of power distributed in the robot so we manage the power along with the thrusters and claws. With its high-resolution imaging , the camera provides real-time clarity, improving situational awareness for safer maneuvering and obstacle avoidance. Getting this leverage of this existing technology, this combination is cost effective and streamlines development, enhancing the robots functionality for underwater exploration and expectation tasks show in

Figure 20 : Digital Camera - Photo from Blue Robotics

Float Systems Integration Diagram

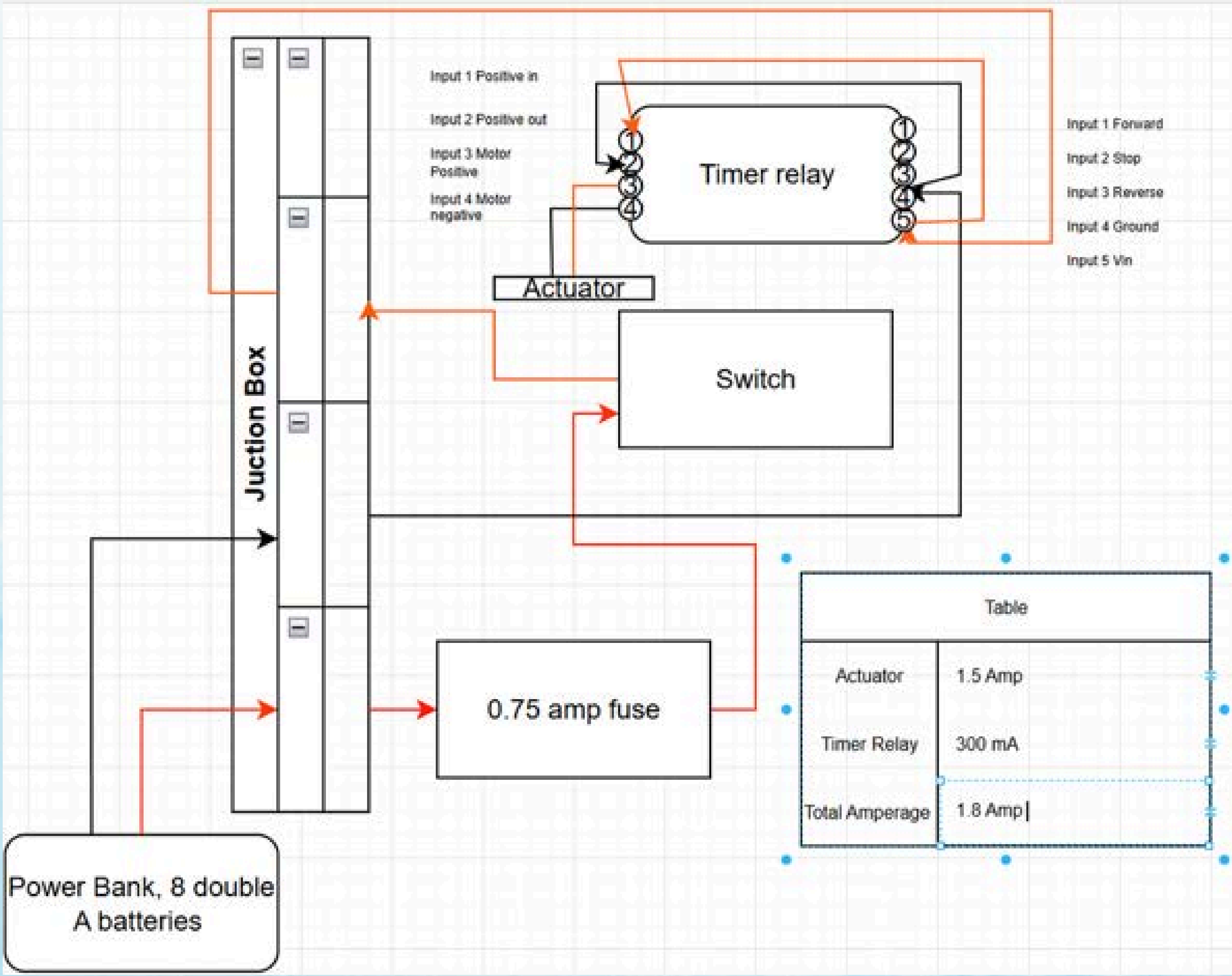
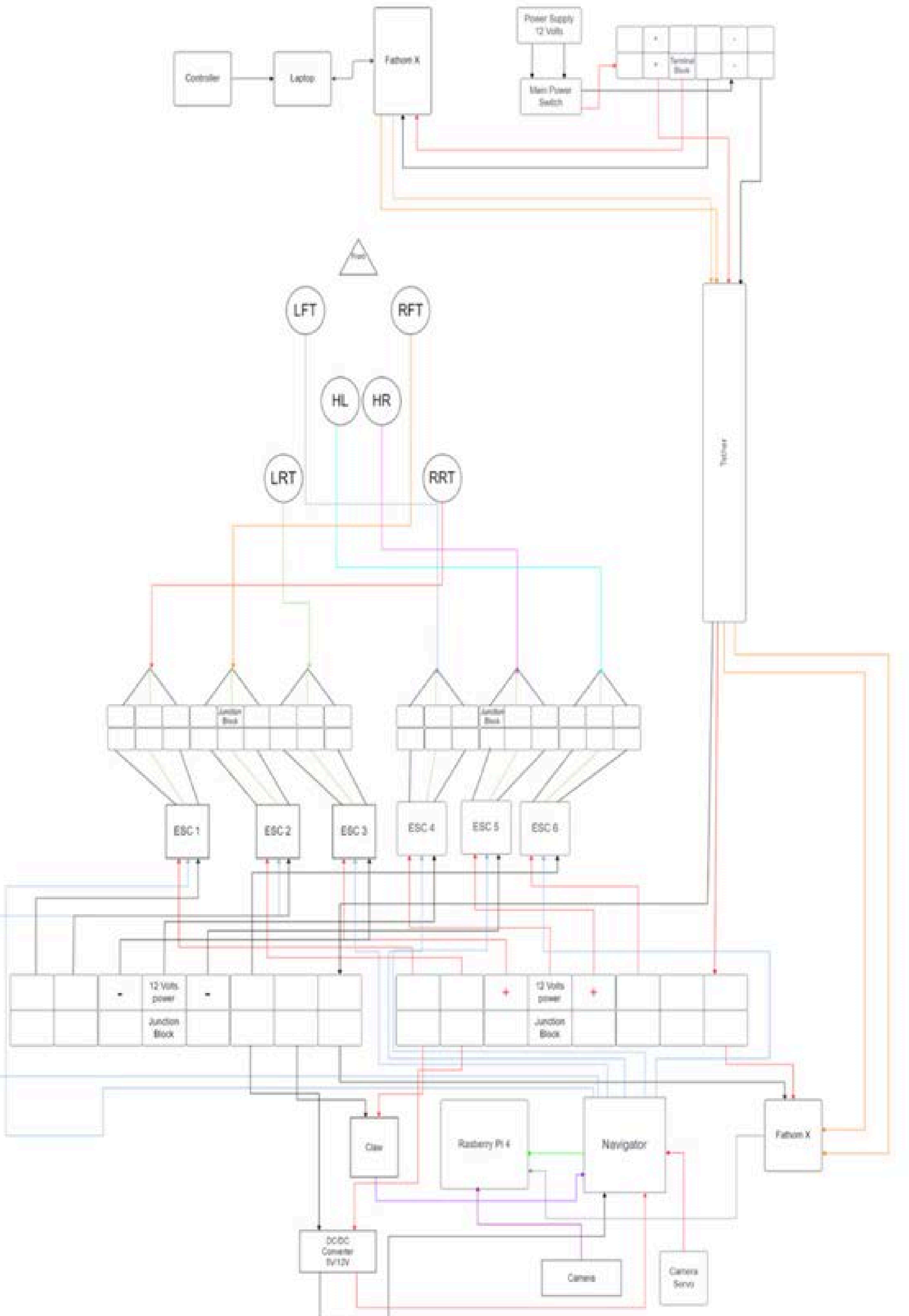


***Figure 21: Float System Integration Diagram-
Made by Zane Hosey***

ROV System Intergration Diagrams
TR5-Stingray2.0



Parts	
Fathom X Tether Interface Board Topside	100mA
Fathom X Tether Interface Board Water Tight Enclosure	100mA
ESC LFT	100mA
ESC RFT	100mA
ESC HL	100mA
ESC HR	100mA
ESC LRT	100mA
ESC RRT	100mA
Camera	800mA
Servo Camera	100mA
Navigator	200mA
Raspberry Pi 4	500mA
Claw	1A
LFT Thruster Motor	3.1A
RFT Thruster Motor	3.1A
HL Thruster Motor	3.1A
HR Thruster Motor	3.1A
LRT Thruster Motor	3.1A
RFT Thruster Motor	3.1A
DC/DC Converter	60mA
Total 22.4 A.X 150%	33.6 A

Figure 22: ROV System Integration Diagram- Made by Jonathan Larado

Safety

Safety Philosophy

For the Aquabot Technicians, safety is not just a requirement it's a mindset shared by every member of our 9- person team. We are fully committed to protecting the well being of our crew and the environments we work in throughout every phase of development, testing, and operation

Aquabot upholds strict safety standards that meet and oftrn Exceed industry and MATE regulations . Our team follows comprehensive safety procedures and engages in thorough training that covers essential topics such as proper lifting techniques, electrical safety , tool handling,in, hazardous materials protocols , and workspace organization.

Figure 23: Albert Mendoza and Deondre Washington Cutting out the frame- Photo taken by Layla Chapa

Safety Procedures

Constructions:

- Go over the propper plan with all the employees to ensure everyone is one task
- While everyone is working, the safety officer goes around making sure everyone is following proper safety protocols
- When everyone is finished they make sure to unplug tools and put them back and clean whatever mess they made
- When completing each task and an employee is have trouble to prevent mistakes they are you get a second opinion is presented if needed

Lab Safety	• Hair must be up and out of face • No Jewelry • No Baggy/Open Clothing • Closed-toed shoes • No Horse Playing • Safety Goggles and / or safety gloves when needed
ROV Safety	• All sharp edges filed down • The Lexan frame is surrounded with rubber on the edges to round the sharp edges. • The thrusters have plastic shrouds above and below them to avoid any harm or injuries to marine life. • All wires and the control system are labeled

Testing and Trouble Shooting

When we started testing the robot we had lots of issues with connection specifically regarding the camera. He couldn't get camera feed yet we had connection to the thruster and so we started testing different camera's and camera wires to see what the problem was. We troubleshooted the camera and found it worked so we started testing other components connected to the camera such as the navigator. We tested our navigator with different raspberry pies to see if we could get connection and then we started changing the SD cards found inside the raspberry pies. Eventually at the end we learned that most of the pixhawk's didn't work with our raspberry pie so we went back to using the navigator. In the end we found the exact navigator, exact raspberry pie, and SD card and one day we were finally able to get connection to the camera and vizual feed underwater

Figure 24: Exavier R. and Jonah M. Trouble shooting the ROV Connection- Photo taken by Emery Johnson

Build VS Buy , New Vs Reused

In our project, we faced a crucial decision between building, buying, and reusing materials, ultimately relying heavily on reused items due to limited funding and broader financial constraints within our school. As reflected in the expense report, many of the core electronics—such as the Phathom X, ESCs, Navigator, T200 Thrusters, Electronic Enclosed Capsule, and a Logitech hand controller—were reused from previous years to keep costs manageable. Items like the gripper claw, power supply, and various cameras were also salvaged to avoid additional expenses. Budget restrictions meant we couldn't afford the latest equipment or upgrades, so we adapted by incorporating more reused components, including a monitor screen, servo motors, waterproof casing, and a frame structure from a previous build. While reusing parts required extra time for testing and modifications, it enabled us to move forward without compromising the overall functionality of our project. This reuse approach not only minimized costs but also encouraged resourcefulness and sustainability within our team.

Cost Accounting

School Name	Foy H. Moody High School	Sept 11 , 2024	4/26/2025		
Instructor	Madeline Martinez				
income	Citgo,CCISD, Marine Technical Society company , and A & B Plastics				
					Amount
Eletectronics	Dell laptop			Donated	349$
Material	lexan sheet			Donated	63.99$
Material	camera enclosure			Re-used	97.00$
Electronics	Power switch			Re-used	5.08$
Material	power wire			Re-used	40.24$
Material	Tether			Re-used	30.24$
Hardware	SD Micro Card			Re-used	8.94$
Hardware	Electronics tray			Re-used	55.00$
Electronics	120 RPM 12 Volt DC Motor			Re- used	12.67$
Electronics	Digital Camera Servo			Re-used	64.00$
Material	Control Box			Re-used	41.56$
Material	4" Acrylic Tube			Re-used	90.00$
Material	Penetrating Bolts			Re-used	31.75$
Material	Nuts/Bolts/Screws			Re-used	41.69$
Sealant	Marine Grade Epoxy			Re-used	43.21$
Electronics	SOS Leak Senor			Re-used	32.00$
Electronics	Thruster Commander			Re-used	60.00$
Material	Electronics Tray Terminal Blocks And Hardware			Re-used	45.00$
Material	Wet Link Penetrator			Re-used	95.00$
Hardware	Waterproof Adjustable NPT Cable Glad			Re-used	$17.30
Material	Double Sided Duct Tape			Re-used	$4.78
Material	Door Trim			Re-used	$7.17
Electronics	Dc/Dc Converter			Re-used	$11.99
Electronics	Timer Module DC			Re-used	$19.35
Material	Seal Wire Connections			Re-used	$39.99
Material	Switch			Re-used	$20.00
Material	M10 Enclosure Vent			Re-used	$9.00
Sealant	Molykote Glue			Re-used	$32.00
Material	Double A Batteries			Re-used	$18.10
Electronics	Fathom-X x2			Re-used	$392.00
Hardware	Power Box			Re-used	$68.99
Electronics	Low-Light HD USB Camera			Re-used	$99.00
Electronics	Gripper Claw x1			Re-used	$219.00
Electronics	Digital Camera			Re-used	$19.99
Electronics	ESC x6			Re-used	$216.00
Electronics	T200 Thrusters x6			Re-used	$833.94
Material	White HDPE			Re-used	$52.71
Material	Roller Transport Cart			Re-Used	$267.27
				Total cost	$3,554.95

Figure 25: Cost Accounting Spreadsheet- Created by Emery Johnson

Acknowledgements :

Our Company would like to express a special thanks towards all those who donated to The Aquabot Technicians development of the TR5-Stingray2.0 . This company would not have been successful without their generous support Aquabot Technicians would like to thank Corpus Christi Independent School District (CCISD) for providing us with the travel expenses and most of our funding. We would like to thank Foy. H Moody High School , our home campus for supplying us with intelligent and considerate mentors. Additionally , the company would like to thank Blue Robotics for providing us with most of our components for our ROV from their website. Finally we would like to thank MATE for hosting this competition as it supplies our company and others with exceptional opportunities and experiences that will benefit us for the rest of our lives. Aquabot Technicians would not have advanced as far as it is without the help.

The members of Aquabot Technicians would like to thank Citgo for making our innovation program possible as part of Project Lead The Way. For this wouldn't be possible without the creation of our program and the teachers and staff of the Citgo Innovation curriculum.