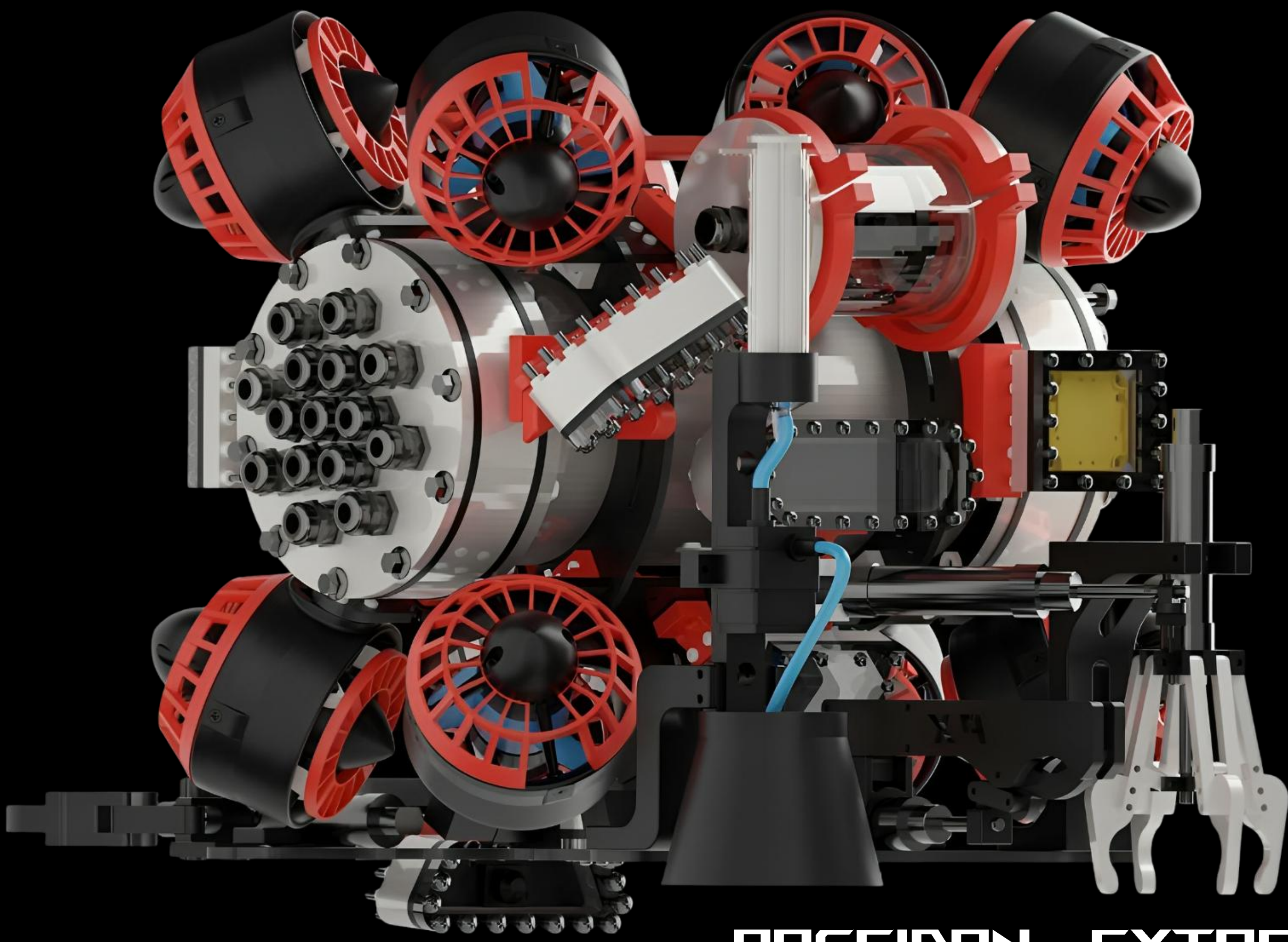
OVERFLOW ROBOTICS

ALEXANDRIA, EGYPT EST. 2021



POSEIDON - EXTREMUS

- 26" Albaraa gomaa II CEO
- 25 Hamza Taha II CTO
- 25 Ezz Eldin II CFO
- 26 Ahmed Amr II 3D visualizer / mechanical CTO
- 25 Eyad Ahmed II Hardware CTO
- 26 Youssef Karim II Software CTO
- 26 Shady Mohamed II Electrical Engineer
- 25 Omar shahin II Electrical Engineer
- 25 Ibrahim Mohammed II Software Engineer
- 25 Mohammed Adel II Electrical Engineer
- 26 Marwan Ashraf II Software engineer
- 26 Mohammed Waleed II Software engineer
- 25 Ahmed Fathy II Mechanical Engineer
- 27 Fagr El-hawary II Mechanical Engineer
- 25" Rokia EIkady II Mechanical Engineer
- 26" Eyad Mohammed II Mechanical Engineer
- 27 Barthinia Hany II Mechanical Engineer
- 27" Youlus Hany II Mechanical Engineer
- 26 Yehia Mohammed II Mechanical Engineer
- 26" Kirolos Khatas II Mechanical Engineer
- 27" Moustafa Elshenawy II Mechanical Engineer
- 25" Mohammed Seddik II Media / Mechanical Eng.
- 26 Ahmed Salah II Software Engineer
- 27 Yassin Karim II Software Engineer
- 27' Abdelrahman saad II Mechanical Engineer
- 27" Moez El-din II Mechanical Engineer

1.0 Abstract

Overflow Robotics is proud to present Poseidon-X, our newest underwater ROV created in response to the 2025 Marine Advanced Technology Education (MATE) challenge. With the experience of our championship-winning Poseidon 2.0 as a stepping stone, our group of 25 team members comprised of experienced ROV engineers and students has leaned on four years of cumulative experience to create this vehicle. Poseidon-X is structured for high maneuverability in diverse underwater environments, with compact size and a striking red and black color scheme to enhance visibility. It features state-of-the-art technology, including a durable isolation box, 3D-printed components, custom carbon fiber parts, eight high-speed cameras, four adaptive grippers, an Inertial Measurement Unit (IMU), a thermometer, and eight advanced T200 thrusters. This diverse array of features allows Poseidon-X to effectively cover a wide range of underwater operations, from complex exploration missions to environmental monitoring. Our design effort involved extended brainstorming periods and cross-functional interaction between mechanical and electrical groups, solving issues faced with Poseidon 2.0 in depth. Extensive testing stages, including dry and pool testing, verified our innovations and validated the dependability and resilience of Poseidon-X under actual conditions. Dedicated to writing exclusively for the 2025 MATE RFP, Poseidon-X goes beyond all mandatory requirements and best represents our commitment to innovation, excellence, and environmental stewardship. We look forward to helping make significant impacts in the area of underwater robotics with this groundbreaking ROV.

Figure 1 Team Photo

2.0 Planning and scheduling

Scheduling and planning were some of the biggest issues that Overflow Robotics experienced in the 2025 season. The team was very ambitious, and accordingly, they needed a lot of time from everybody. Therefore, efficient communication among members was instrumental to ensuring orderly attendance and work output in meetings. In order to implement this, reminders and updates were constantly posted on WhatsApp, our main messaging service, and via email, promoting ongoing communication and teamwork among the members. The most essential organizational tool the Overflow Robotics team used was the communal Google Drive, which was a sort of company documents hub. These were carefully divided into folders named Design Documents, Photos, Competition Documents, Safety, Code, etc. Keeping detailed records continued to be vital to the team's success. Developing a well-organized project schedule was an early challenge in the season. Our CEO anticipated this by implementing an Early Timeline to kick-start and direct the activities of the season. This schedule gave a clear guideline to Sub-team leaders, giving them the important task of keeping the timeline intact so that the right completion of the task and milestones could be achieved. In the first half of the season, Overflow Robotics sought to make workflow more efficient by implementing an electronic workspace tool. The team used "Trello" in task delegation, with specific deadlines for each task. Via this portal, all members were provided with detailed announcements and technical alerts, aligning with project schedules and continuous improvements.

Figure 2 Trello Dashboard

3.0 Project Management

Overflow Robotics is a progressive company that specializes in underwater robotics, founded by a group of committed high school students with the vision of propagating eco-friendly technology through innovative means. Located in Alexandria, Egypt, we are determined to create advanced robotics to solve environmental issues. We have doubled our team size this year from 14 to 25 members, with 20 passionate new members joining us, all committed to realizing our vision for 2025.

3.1 Team Structure and Roles

The team is organized into five specialized departments, each led by a department head who ensures effective communication and project management:

1. **Mechanical Engineering**: Responsible for designing ROV CAD models, constructing frames, developing manipulation systems, and creating enclosures.
2. **Software Development**: Focused on developing the ROV's graphical user interface (GUI), implementing image processing techniques, and utilizing the Robot Operating System (ROS) for seamless integration.
3. **Hardware Engineering**: Tasked with creating printed circuit boards (PCBs) and wiring systems to ensure robust performance.
4. **Marketing**: Handles social media outreach, community engagement, and promotional activities for our programs and events.
5. **Documentation**: Maintains all MATE competition documentation and ensures proper record-keeping of our processes and findings.

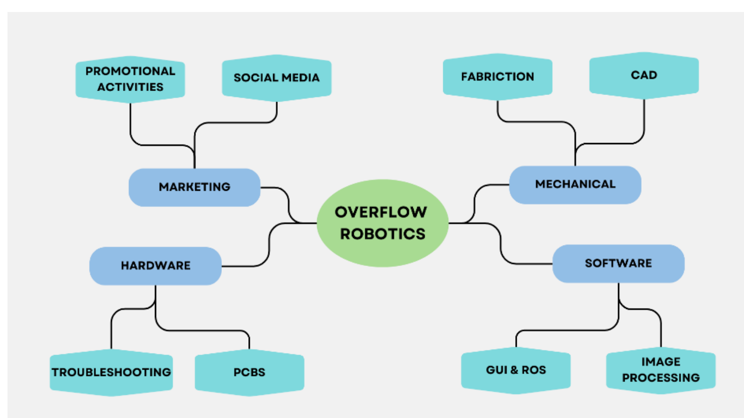


Figure 3 Sub-Teams layout

Each department sets specific objectives aligned with the overall mission, fostering a collaborative environment where skills and creativity thrive. Each company member took apart in a department based on personal desires and skills (see homepage for personal).

3.2 Project Management and Operations

To facilitate efficient operations, Overflow Robotics employs a comprehensive project management framework known as the **4M (4 Meetings) Method**, designed to enhance communication and ensure project alignment:

- **Weekly Main Meeting**: Every Friday, the entire team gathers to review progress, address challenges, and set goals for the upcoming week.
- **Board Meeting**: Every Thursday, the executive board meets to outline objectives and key tasks for the weekly main meeting.
- **Progress & Goals Meeting**: Each Tuesday, an online meeting is held to evaluate current progress and set new goals based on team feedback.
- **Department Meetings**: Department heads conduct regular meetings throughout the week, either online or in person, to ensure tasks are on track and to brainstorm solutions to emerging challenges.

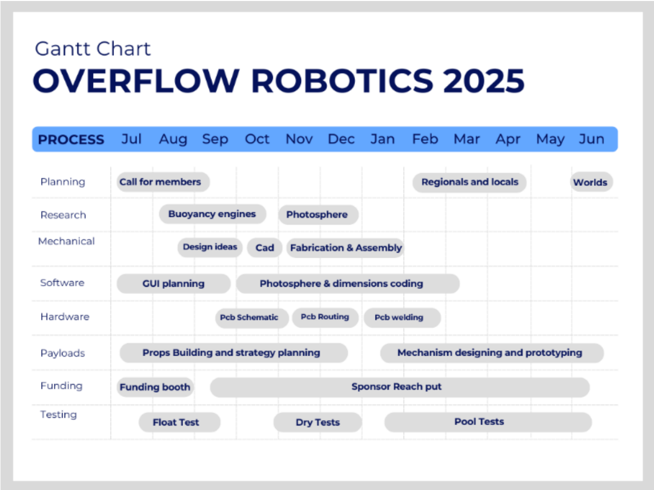


Figure 4 Gantt chart

Our two-tier administrative structure enhances communication and accountability:

- **High-Level Administration**: The CEO, CTO, and department heads meet weekly to discuss strategic goals and assess project outcomes.
- **Low-Level Administration**: Team members are organized into smaller groups, each with a designated leader responsible for completing specific tasks and meeting deadlines.

This technique gave us an edge on completing specified tasks on time.

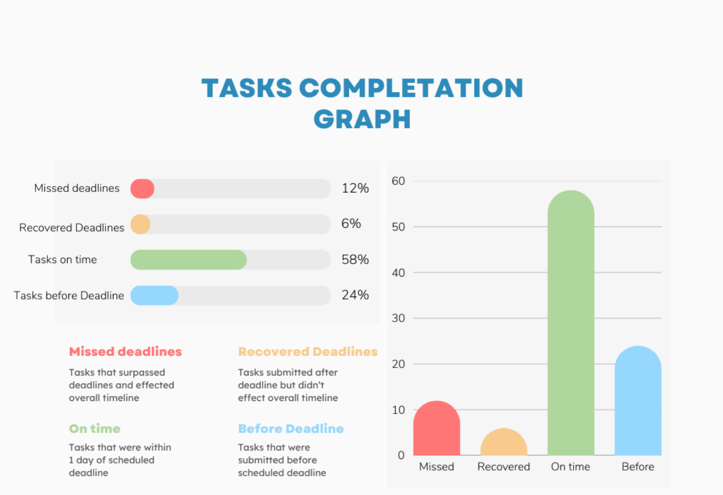


Figure 5 Task completation graph

3.3 Day-to-Day Problem Solving

At Overflow Robotics, effective problem-solving is integral to our daily operations and project success. Our approach emphasizes proactive communication, collaboration, and a structured framework that empowers team members to tackle challenges as they arise.

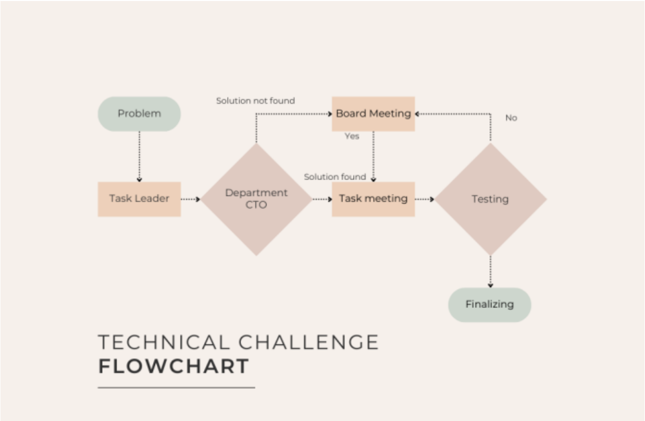


Figure 6 Problems Flow Chart

Open Communication Channels: We ensure a setting in which members can easily report issues and challenges. Frequent reminders in our weekly Main Meetings enable all members to speak out against challenges, so no problem falls through the cracks. Furthermore, leveraging tools such as WhatsApp and Trello makes real-time discourse possible, allowing for quick resolution of urgent matters.

Collaborative Brainstorming Sessions: When faced with difficulties, we have a series of brainstorming sessions. The sessions include people from various departments-bringing different perspectives and inventive solutions. For example, if a technical problem arises during the designing process, the mechanical and software engineers sit together to identify the cause of the problem and come up with an effective solution to address it.

Designated Problem-Solving Teams:

Small group teams are organized to address specific issues. These groups, guided by a designated team member, examine the issue at hand, generate potential solutions, and uphold their findings during our Progress & Goals Meetings. This rather inclines toward delegate technocracy, which stimulates a greater degree of accountability and allows for more detailed exploration of complex problems.

3.4 Training and Development

In this season, 20 new members have joined, and we introduced an elaborate training program. The training included workshops instructed in very rudimentary but important areas, such as CAD modeling, coding, and circuit design. New recruits went through hands-on activities that encouraged

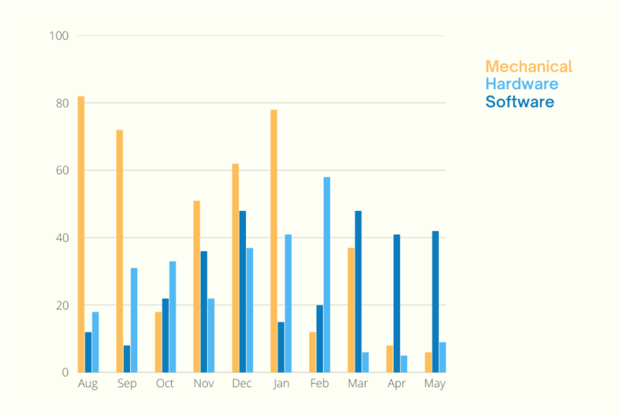


Figure 7 Sub-Team man hour spent

teamwork and project management skills, culminating in a building contest simulation to prepare them for real-life scenarios.

3.5 Resource Management and Communication

Effective communication is crucial to our success. We have a common Google Drive for organized documentation work so that all team members can access design documents and safety protocols. We use various communication tools: WhatsApp, Zoom, and Google Meet to enjoin and coordinate all our members. Furthermore, we also implemented Trello as our project management tool for task assignments, due date tracking, and progress monitoring. This simplified our workflow such that we could focus on our main objective: to build the Poseidon-X ROV, which must satisfy all the requirements from the MATE RFP and excel in competition. Overflow Robotics aims at innovating collaboration and ongoing improvement. Our structured approach to project management coupled with our drive for training and development poise us to success in addressing concerning environmental challenges facing our time.

Figure 8 Training phase

3.6 Administrative Challenges Faced

Throughout the season, Overflow Robotics encountered both major and minor challenges that required significant effort from multiple team members.

Challenge:

Managing a team of 25 members proved daunting within the 2024 administrative framework. Effectively assigning tasks, monitoring progress across various projects, and maintaining a supportive and welcoming work environment for all members while ensuring productivity was a considerable undertaking.

Solution:

To address these challenges, several project management tools were integrated into the 2025 administrative system, including Trello, Google Drive, and a dedicated WhatsApp community. The executive board assumed primary responsibilities, while group task leaders managed specific duties, leading to a remarkable improvement in overall team productivity.

4.0 Testing and troubleshooting

Veichle testing methodolgy. This is a comprehensive and iterative testing methodology that Overflow Robotics employs for Poseidon-X in regard to assurance to reliability and performance. The program basically starts from component testing, where each element of the ROV is tested individually. For example, the thrusters are tested in an environment closely simulating the controlled environment in order to gather thrust and efficiency outputs and data. Afterward, an integrated test consists of submerging the ROV in a test pool, which simulates realistic conditions. The Poseidon-X performs various pre-defined maneuvers for obstacle avoidance and depth navigation, collecting data which is then used for refinements to optimize performance.

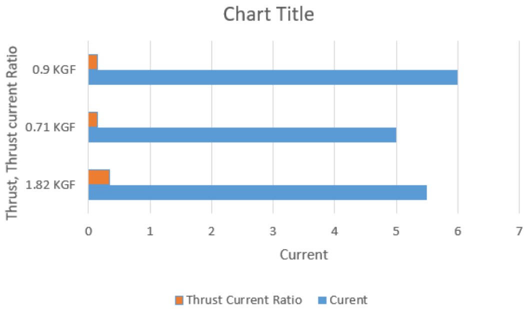


Figure 9 Power cable test results

4.1 Troubleshooting Strategies and Techniques

Overflow Robotics tackles testing challenges with a robust troubleshooting strategy that emphasizes analytical skills and teamwork. When issues arise, such as intermittent power failures or sensor malfunctions, our team utilizes a **systematic diagnostic approach**. For example, if a thruster fails to respond, we first isolate the issue by checking power connections and then run diagnostic commands to test the thruster's functionality. The team uses a detailed troubleshooting checklist, developed specifically for Poseidon-X, which guides us through identifying and resolving issues methodically. This checklist includes steps for monitoring sensor outputs and verifying component interactions, ensuring no aspect is overlooked.

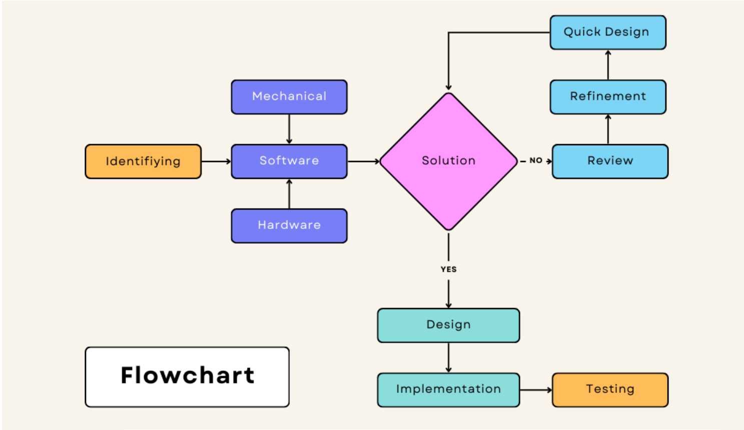


Figure 10 Troubleshooting flowchart

4.2 Prototyping and Testing to Evaluate Design Options

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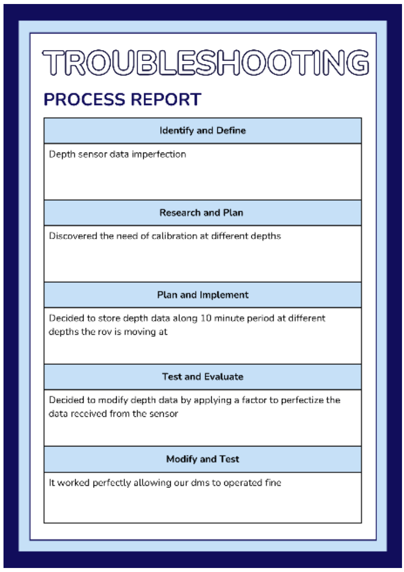

Figure 11 Depth sensor process report

5.0 Safety

5.1 Safety Rationale

The safety of all team members comes first on Robotics. Because of the delicate and often hazardous nature of this work, we go beyond MATE safety standards; it is our culture. To make sure that all team members, especially newcomers, are properly informed, we designed a detailed orientation program in-line with our EHS policy and JSA. It consists of a strong emphasis on device safety training and what precautions to take before the start of any manufacturing or testing process. Staff works within pairs or small groups; no one operates machinery alone. Senior team members and advisors are present, supervising the work until a new member is pronounced competent. Safety meetings held periodically focus on such topics as hand safety, eye safety, electrical safety, and power tool safety. Upon violation of any such protocol, the member is instantaneously informed on the risks they have engineering into their actions, retrained on the procedures and our teams discuss it in the subsequent meeting. This keeps all members focused and continued with vigilance in keeping the standard of safety in the field high.

5.2 Vehicle-Specific Safety Features

Some payload tools represent potential dangers for divers and other personnel; thus, we have added many specific safety features in our ROV design. Each thruster has custom-fit shrouds in compliance with MATE specifications (MECH006) to lessen the likelihood of injuries. In addition, Poseidon-X is designed with rounded edges and clearly indicated warning labels to reinforce awareness of safety. Mixing practical safety tips is a great idea: the red claw fingers indicate potential pinch points, and all sharp edges are either most effectively eliminated or well covered. The electronics are enclosed in a watertight HDPE enclosure with double O-ring seals to stop any water ingress. An in-line fuse rated 25 amperes should be included in between the power supply and the control box to avoid overcurrent situations. Other safety measures include the regular checking in-house for exercising devices for malfunction and making sure, as much as possible, that the components are sturdy materials such as carbon fiber, to eliminate weak points. Warning labels have been placed around the ROV so that users can be warned about required precautions.

Figure 12 Thruster shrouds

5.3 Safety Procedures and Checklists

For the purpose of ensuring a common approach to safety, the team employs the use of detailed safety checklists during ROV operations. These checklists consist of such things as pre-operational inspections, equipment checks, and emergency or evacuation procedures. All team members are required to wear the necessary safety gear when working around, or in areas adjacent to, the ROV: e.g., safety glasses, gloves, and closed-toe shoes. When operations are taking place around water, there are strict protocols to be enforced: electrical cords and any other devices should not be kept near moisture, and a dry, elevated area is established for the placement of vehicles and tools to avoid all contacts with water. The communication of important parts of the operation is vital: such as entering the water or activating the thrusters to avoid anything between team members. Before submersible entry takes place, an evaluation of critical components is carried out for proper function, and any visible damage is assessed. If problems surface during the operation, the ROV is taken out of the water immediately for fixes. Periodic drills provide an opportunity for all the personnel to work on scenarios, thereby building upon our proactive approach to safety. Therefore, due to the confluence of all these practices, the safety features, and the operation of continuous improvement, Overflow Robotics demonstrates a deep commitment to the safety of personnel and the commissioning of services by our ROV.

6.0 Design Rationale

Figure 13 Poseidon - Extremus

Overflow robotics main goal for 2025 is enhancing all setbacks from Poseidon 2.0 in Poseidon-X, The high board assembled in July to identify all design problems in Poseidon 2.0 and came out with the next decision chart; As demonstrated, maneuverability was the main development point for 2025 as the new challenge came with a new 5.5 meter deep pool that needed enhanced buoyancy and maneuverability, along with a lot of other key development points demonstrated in the decision chart.

DECISION CHART

IMPORTANCE SCALE	1-3	3-5	5-8	8-10
MANUEVARIBLITY				✓
WEIGHT		✓		
SIZE		✓		
MODULARITY				✓
ACCESIBLITY			✓	

Figure 14 decision chart

6.05 Design evolution

Overflow Robotics' newest ROV, Poseidon-X brings significant improvementsacross all critical systems with core capabilities in safety, agility,reliability, and customization. Building on the insights of Poseidon 2.0and listening to the most critical augmentations, our team has assembled toconform Poseidon-X to MATE expectations in RFP. There is focus in thisdevelopment phase, and design leaders of Overflow Robotics have made theirkey decisions on what could be tackled this season. This includedcommunication improvements, electronics refinements, and cameraserviceability improvements. The result is Poseidon-X, expertly crafted ROV toassist in the restoration, conservation, and protection of the aquaticecosystems based on a diversity of environments. Poseidon-X is not merelyan upgrade, but a bona fide leap into the unknown. Moreover, the team haskept on iterating to maximize the efficiency and practicality of the device:earlier design methodologies were based on iterations, and we came to realize that the one thing we should concentrate on at every stage in developmentwas reliability, which enabled us to design special mission-oriented ROVs to be tailored for several distinct challenges. Quality testing and pilot inputs enabled multiple refinements on Poseidon-X's assorted tools,electronics subsystems, software, and its end effector, assuring us maximal in-field performance.

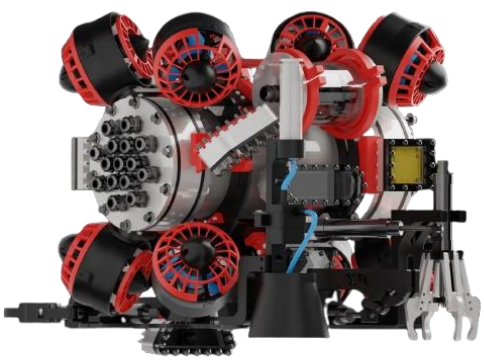

Figure 15 Poseidon-X Render

6.1 Design process

Over the course of our review of prior builds of Poseidon, we put together a list of the main areas that need improvement speed and design. Poseidon 2.0 was functional, but not to the expectation we had set up at the beginning, so we began building Poseidon 2.0. This version handles these issues with a new modular, functional, and compact design that lets us address a variety of jobs with great efficiency. This design process follows the six-step methodology: Define, Brainstorm, CAD, Prototype, Develop, and Finalize. It emphasizes endless collaboration and innovation from the Company staff, ensuring a clean understanding of the problems facing marine ecology. The Define phase encompassed thorough research into those aspects of life, which in turn laid the foundation on which our design objectives were to be built. During this phase, we brainstormed and some many different approaches were suggested with a focus on modularity that would allow the vehicle to adapt to future mismatches. Concepts were then developed into detailed CAD models in SolidWorks. After having determined specific tasks for the 2025 contest, the focus then shifted to looking for mechanisms to incorporate into the final design, making sure to leverage lessons learned to guarantee success. The prototype stage consisted of the testing process, including Computational Fluid Dynamics (CFD) analysis and stress testing methods. Historical feedback from those evaluations lent themselves towards iterations and turning towards improving our design to optimize our performance. Feedback, step-by-step it would be each week at the design reviews, became part of the critical feedback to make sure each advancement was still in line with the mission. Poseidon-X is not merely an upgrade; it is truly a testament to the collaboration and understandings of marine woes that Overflow Robotics defines in its acts. And so the stage is set for there now to be waterproof commercial-grade equipment ready for excellence at the 2025 MATE. Competition, reflecting our commitment to innovation, functionality, and environmental stewardship.

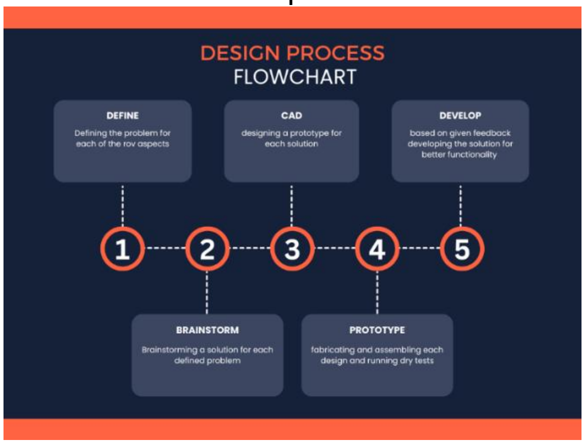

Figure 16 Design Process

6.1.5 Frame

Material Selection

In the last two seasons, Overflow Robotics used HDPE as the main material for the ROV frame. A thorough analysis for alternatives proved that HDPE was a weak candidate to meet the design objectives for 2022. In the evaluation of materials, acrylic and aluminum alloys were examined in conjunction with carbon fiber. Eventually, carbon fiber was selected as the main material for the Poseidon-X frame due to its special features. The peculiar merit of carbon fiber was the great strength-to-weight ratio, corrosion resistance, and design flexibility which would help to realize the objectives. Acrylic, while lightweight and economical, is no match for this material for strength and durability.

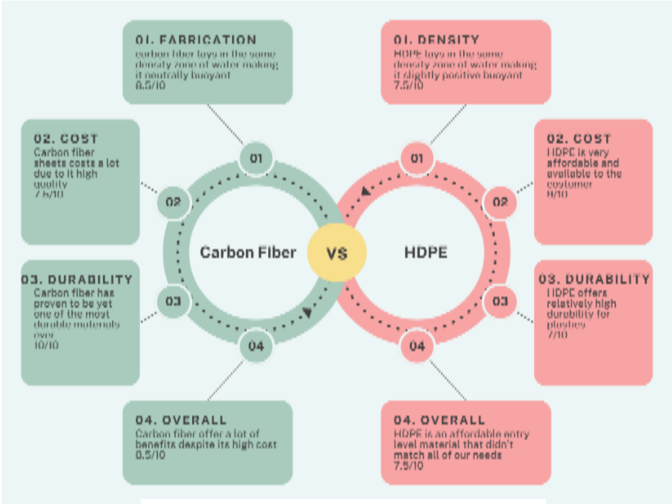

Figure 17 Materials comparison

Aluminum, while strong, neither lightweight nor resistant to corrosion and does not afford the same flexibility with nifty designs. (Comparative analyses are displayed in a chart below) Hereby, the frame for the Poseidon-X shall be entirely manufactured from carbon fiber and this frame would be assembled using 3D-printed joints, thus resulting in a very lightweight structure with a great strength-to-weight ratio. While the carbon fiber comes at a high cost, this investment was definitely well worth it for the performance and durability achieved.

Components

The Poseidon-X features a unique and highly functional design, equipped with 8 thrusters, 5 manipulators, 8 cameras, 6 light casings, and an electronic housing. Its frame is primarily composed of four main components:

1. Upper Plate: Used to mount cameras and the handle.
2. Lower Plate: Provides mounting points for manipulators and additional cameras.
3. Thruster Fixation Plates: Secure the thrusters and light casings in place.
4. Electronic Housing Fixation Plates: Connect all frame parts and securely hold the electronic housing. All views of the frame design are shown below.

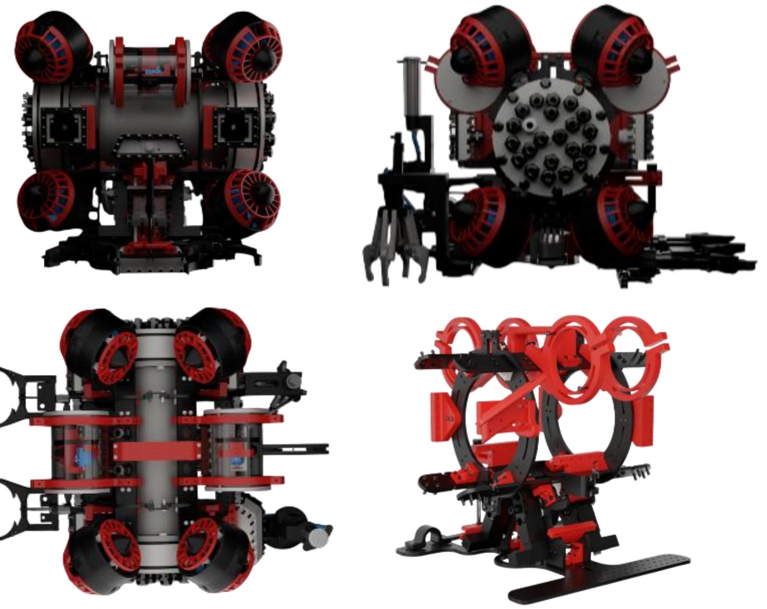

Figure 18 Front – Top – Isometric – Right views of the vehicle frame

6.2 Fluid Dynamics

With speed being a critical factor for the 2025 ROV, Overflow Robotics implemented several strategies to enhance Poseidon-X's performance:

- Streamlined Body Design: A streamlined frame was prioritized to reduce drag and enable higher speeds underwater.
- Carbon Fiber Frame: The use of carbon fiber for the main frame significantly reduced the ROV's overall weight, contributing to faster movement.
- 3D-Vectored Thruster Configuration: This configuration increased speed by 60% compared to the previous model, Poseidon 2.0.
- CFD Analysis and Drag Reduction: Computational Fluid Dynamics (CFD) analysis identified areas of high drag, allowing the team to implement more streamlined solutions to minimize resistance.

Figure 19 Streamlined frame demonstration

Housing

The Poseidon-X is equipped with a cylindrical electronic housing made of HDPE, positioned sideways at the center of the vehicle to minimize drag. HDPE plates with stainless steel glands are mounted on both sides to securely seal the cables. Gaskets are fitted on both sides and fastened with screws to ensure a watertight seal for the HDPE plates. Our housing was designed to withstand pressure up to 1 bar = 10 meter deep.

Figure 20 Electronic housing

6.2.5 Buoyancy and ballast

The Poseidon-X is demonstrates buoyancy; which is the ability of an object to stay afloat. Buoyant force is the one that decides whether an object will sink or float based on its weight and surface area in contact with fluid. When an object floats, it pushes away that mass of water equal to its own weight. Conversely, if the weight of the object is greater than that of the displaced fluid, the object will sink. This principle is influenced by the density or weight of the fluid; denser fluids can prop up heavier bodies. In a divided fluid pressure. increases with depth due to the weight of the overlying fluid. Therefore, the pressure at the bottom of a submerged object is greater than at the top, creating an upward buoyant force. Using this concept, a spreadsheet was developed to calculate the volume, buoyant force, and weight of each component in water (refer to Figure). The analysis revealed that Poseidon-X was slightly negatively buoyant, requiring additional foam to achieve neutral buoyancy. Reducing excess material helped decrease Poseidon-X's weight to 9.7 N, with a displacement volume of 10,890 cm³. Archimedes' principle, expressed as F_buoyancy = V × ρ × g, was applied to determine neutral buoyancy. The buoyant force was calculated at 8.7 N, which was less than Poseidon-X's weight, resulting in a 1 kg negative buoyant force. To counteract this, floating foam was added, ensuring the vehicle became neutrally buoyant as a key design consideration.

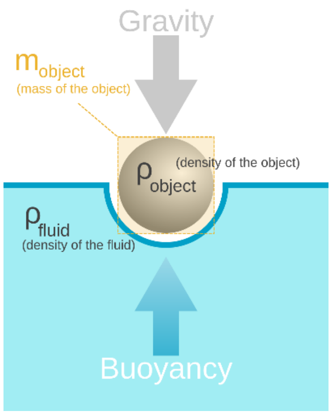

Figure 21 Buoyancy principal

6.3 Thrusters and Propulsion

In past years, Overflow Robotics has relied on the Blue Robotics T-200 thrusters for their extremely superior thrust-to-current ratio, ensuring reliable and efficient operation. This year, the team re-examined the configuration of the thrusters in the ROV to optimize for the requirements specified in the 2025 MATE ROV RFP, which will require operations in a 5.5-meter-deep pool. Although capable of providing horizontal maneuverability, the previous 6-thruster vectored design fell short concerning required efficiency for vertical travel. This led to a major redesign after extensive testing and analysis, finally settling on a new 8-thruster three-dimensional configuration. The advantages of this new arrangement are that all eight thrusters combine to assist the vehicle in every motion, allowing for precise and efficient motion in all six degrees of freedom. The thrusters are set at strategic angles of 30 and 60 degrees within the XY and YZ planes to facilitate forward motion, while allowing for outstanding vertical and lateral stability and agility. A spreadsheet comparison showed that this configuration would do much better in even thrust distribution and could hence achieve much higher speeds and improved responsiveness. Trade-offs were carefully weighed to find a happy medium between power consumption, cost to manufacture, and actual performance. Though the 8-thruster design consumed more power and pushed material costs slightly higher, the ability to service mission-critical items such as quicker vertical travel and smoother navigation made it a worthwhile investment. The Blue Robotics T-200 thrusters were, therefore, chosen for their excellent energy efficiency, drawing less power but providing more thrust output. This ensured a manageable energy budget while overall improving performance. The team also performed extensive simulations and physical testing to compare the alternative configurations. The new design mitigates induced drag and has the added benefit that the thrusters don't conflict with other systems on the vehicle. Also, their modular arrangement facilitates the ease of maintenance and upgrades in the future while improving the long-term adaptability of the ROV. By addressing both the functional and economic challenges, Overflow Robotics achieved an optimized thruster design that balances cost-efficiency, power consumption, and mission performance, ensuring the ROV is prepared for the demanding tasks of the competition.

Figure 22 T200 Thruster

Figure 23 Thruster layout

6.3.5 Innovation

Poseidon-X exploits advanced innovations to achieve higher functionality and efficiency while maintaining cost-effectiveness. The incorporation of ROS stood out by allowing the construction of a sophisticated PID controller integrating IMU and depth sensor data. It works to provide accurate positioning and stabilization across all XYZ axes, allowing for better maneuverability-even in a challenging underwater environment. ROS also serves as a modular and expandable software platform that helps to cut down on development costs in the long run while allowing new features to be incorporated without any difficulties down the road.

The DMS will allow the ROV to change its orientation on the fly in response to the operational preferences of the pilot. It provides the ability to reverse the orientation of a vehicle about its forward and backward faces on demand, thus allowing for the adaptation of the Poseidon-X to mission-specific requirements without any changes in physical hardware.

Carbon fiber has been chosen as the main frame material due to its high strength-to-weight ratio. This base material leads to the formation of structures that are lightweight yet highly durable, minimizing energy consumption while increasing speed and agility without compromising reliability.

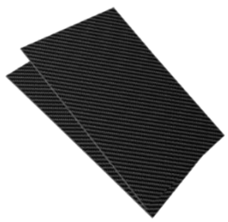

Figure 24 Carbon fiber sheets

The Jetson Nano microcontroller provided considerable computing benefits. With its significantly better processing capacity and performance compared to the previous Arduino Nano, the Jetson Nano allowed for faster data handling, real-time decision-making capabilities, and minimizing the latency on all vehicle systems. This added not only provides Poseidon-X with a much improved response time but also makes it such that the system can incorporate complex algorithms and multi-threaded tasks which should lead to further technological upgrades.

Figure 25 Nividia Jetson Nano

In conclusion, the designs span a customized thruster calibration interface optimized for aft thrust load distribution, thus encouraging smooth and efficient transitions. Optimization minimizes the inefficiency via energy consumption, with operation times scaling significantly upward for the Poseidon-X.

6.4 Payloads

Cameras

To meet the stringent vision requirements outlined in the MATE RFP 2025, Overflow Robotics equipped Poseidon-X with a robust and versatile 7-camera system tailored for operations in a 5.5-meter-deep pool and tasks requiring precise manipulation. A thorough analysis of mission objectives demonstrated the need for comprehensive 360-degree visibility and multi-angle monitoring of manipulators for successful task execution.

Figure 26 Hikvision usb cam

The 6 Hikvision 1080p USB cameras offer great refresh rates, image quality, and a wide 110° field of view (FOV). This combination makes for low-latency, high-resolution video streams that are suitable for navigation, object detection, and task-specific precision. Camera placement was meticulously planned to provide unparalleled visibility.

- Two cameras were mounted inside acrylic tubes, controlled by servos, offering a 180° rotational view. These cameras monitor both the manipulators and the ROV's top view, providing critical flexibility for dynamic tasks.

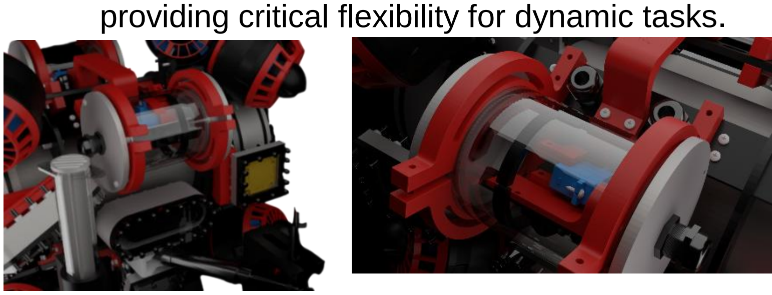

Figure 27 Tube Cameras

- One rear-facing camera was strategically positioned for clear back navigation ensuring full situational awareness during reverse maneuvers

- One downward-facing camera, positioned centrally, was optimized for capturing the surrounding environment and contributing to the ROV's 360° photosphere generation system.

- One camera mounted on the top right provided additional perspective on manipulator operations, minimizing blind spots.
- One camera below the manipulators, mounted on a piston, moved vertically to provide precise views of objects below, enhancing the pilot's ability to perform intricate tasks.

Figure 28 Piston fixed camera

This comprehensive arrangement ensures maximum pilot awareness and efficiency while maintaining modularity for quick servicing. The servo-controlled and piston-mounted cameras were innovations designed specifically to overcome challenges in dynamic mission scenarios. An Intel RealSense D435i camera was selected as the primary forward-facing camera for Poseidon-X. This camera was chosen specifically for its stereo vision capability, enabling accurate underwater measurement.

Figure 29 Intel RealSense D453i

6.4.5 Sensors

To enhance Poseidon-X's operational capabilities, four mission-critical sensors were carefully selected and integrated:

- **IMU (Adafruit BNO055):** Provides precise orientation and position data, enabling Overflow Robotics to develop and fine-tune the PID (Proportional-Integral-Derivative) controller and Adaptive Motion System (AMS). These systems allow for precise navigation and stabilization, especially critical for tasks requiring fine manipulator control.

Figure 30 IMU sensor

- **Depth Sensor (Blue Robotics BAR010):** This sensor enables the ROV to accurately measure depth and maintain precise vertical positioning through the Depth Maintaining System (DMS). Its integration with the 360° photosphere system allows for detailed environmental mapping, a key mission task.

Figure 31 Depth sensor

- **pH Sensor:** Measures the dissolved CO_2 levels in water, critical for assessing environmental conditions. The sensor's integration into the ROV's systems allowed for efficient data acquisition and transmission, ensuring mission objectives related to water quality analysis were met.

Figure 32 PH Sensor

- **Leakage Sensor:** Monitors all electronic housings for potential water ingress. Upon detecting a leak, the system triggers an immediate shutdown, protecting the ROV from catastrophic failure. This robust safety mechanism aligns with Overflow Robotics' focus on reliability during underwater operations.

6.5 Manipulators

The Poseidon-X is equipped with three manipulators: a vertical dual fin, a horizontal dual fin, and a down 4 fin. Each manipulator is designed for specific tasks and operates pneumatically using double-acting pistons controlled by 5/2 solenoid valves.

Horizontal Dual Fin:

- Constructed from a combination of 3D-printed components and other fabricated materials.
- Operated by a double-acting pneumatic piston.
- Functions: Removing the lid, installing the power connector, and connecting the pCO_2 sensor.

Figure 33 Horizontal manipulators

Vertical Dual Fin:

- Constructed from a combination of 3D-printed components and other fabricated materials.
- Operated by a double-acting pneumatic piston.
- Functions: Replacing the lid, installing the hydrophone, and removing the power connector cover.

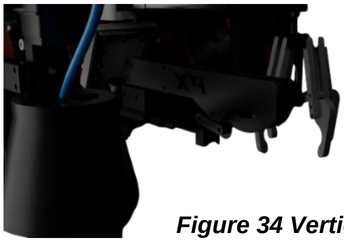

Figure 34 Vertical manipulator

Down 4 Fin:

- Constructed from a combination of 3D-printed components and other fabricated materials.
- Operated by two double-acting pneumatic pistons: one to open and close the manipulator and another to rotate it 90 degrees.
- Functions: Removing and installing the anode.

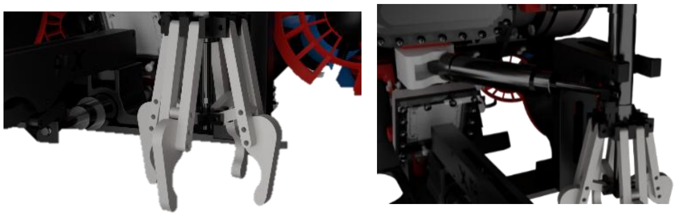

Figure 35 Rotating 4-fin

6.5.5 Mission-Specific Tools

Besides having 4 manipulators the vehicle is equipped with 4 tools each one assigned for specific mission

Fish Collection Net:

- A net is mounted on the vehicle to collect floating fish species.
- Designed to retain ping-pong balls as long as the ROV remains stationary on the water surface.

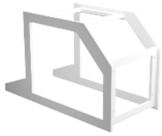

Figure 36 fish collection net

Epoxy Application Mechanism:

- A mechanism designed to install the epoxy patch.
- The patch is attached to the vehicle using two small weak Velcro strips, allowing it to detach and adhere to the disease site when applied.

Water Sampling Mechanism:

- Utilizes a cone, syringe, and water pump to collect water samples.
- A 3D-printed cone is fixed facing downward and connected to a pump via a hose.
- When the ROV penetrates the lid, the pump activates, transferring water from the container to the syringe.

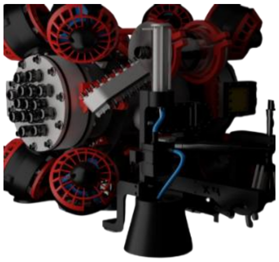

Figure 37 Water sampler mechanism

6.6 Thermometer replacing mechanism

- Fabricated from 3d printed parts and acrylic
- It operates using 4 double acting pistons

An entire attachment system has been specifically designed to address the task of replacing the thermometer. The ROV delivers this attachment to the designated task site, where a dual manipulator system engages. This system securely grips both end caps of the thermometer, while a hook mechanism catches the old thermometer. The dual manipulators then move apart, effectively disconnecting the

Figure 38 Thermistor replacing mechanism

old thermometer. At this point, a piston is activated to position the new thermometer in place. Finally, the dual manipulators close again to securely connect the new thermometer, completing the replacement process efficiently.

6.6.5 Tether & Tether management

The tether is a vital component of ROVs. After finalizing the electrical system, our team determined that the ROV required two power cables and a single Cat6 cable for data. To optimize reuse, we tested all Poseidon 2.0 tether cables. For the power cables, we connected them to a power supply and used an ammeter to measure the voltage drop under varying current loads. The results showed that both power cables were in excellent condition, with minimal voltage drop. The Cat6 cable was tested by verifying that all eight wires could transmit data. RJ-45 connectors were attached to both ends, and signal messages were sent through the cable. However, the communication was unstable, leading us to purchase a new Cat6 cable. One significant change to this year's tether was its length. With the pool depth now at 5.5 meters, the team increased the tether length from 20 meters to 30 meters to ensure unrestricted underwater maneuverability. Additionally, since the vehicle utilized pneumatics, a single pneumatic cable was included to supply air. To simplify tether management, all the cables were bundled into a single lightweight coating. Tether management Three general categories were provided: buoyancy, flexibility, and strain relief. To prevent the tether from going under, foam pieces were added to ensure that the tether would remain buoyant. Cables were deliberately designed to remain flexible for good maneuverability and with a 360-degree revolving strain relief at the termination for anything that might restrict the freedom of movement of the vehicle.

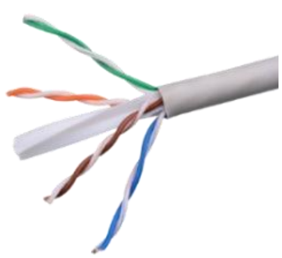

Figure 39 Cat6 cable

6.7 ROV Software Architecture

1. Overview

The Remotely Operated Vehicle (ROV) system comprises two primary components: Control Station: Equipped with a laptop and an external monitor. ROV Unit: Contains an NVIDIA Jetson Nano and a Raspberry Pi Pico. These components communicate over an Ethernet connection, facilitating real-time control and monitoring.

Control Station Hardware Components Laptop: Acts as the primary interface for the operator, handling user inputs and displaying feedback. External Monitor: Provides an extended display for enhanced monitoring and control.

Software Components Joystick Interface: Captures operator commands and transmits them to the Jetson Nano via Python sockets over Ethernet. Graphical User Interface (GUI): Developed using Svelte, the GUI displays real-time video feeds, IMU data, depth readings, and system status indicators. The combination between Jetson nano and a raspberry pi pico was utilized to easily control the thrusters and manipulators through the pico while receive the cameras feed through the jetson nano.

2. Operating System

Ubuntu Bionic (18.04): Provides a stable environment for running control algorithms and processing sensor data.

Communication with Control Station Utilizes Python's socket library to receive joystick inputs from the control station over Ethernet.

Motor Command Processing Interprets joystick inputs to generate movement commands. Sends these commands to the Raspberry Pi Pico via serial communication using Python's pyserial library.

Video Streaming Captures video feeds from onboard cameras. Streams video to the control station using MJPEG-Streamer over HTTP, enabling real-time monitoring.

3. Image Processing

Executes custom Python scripts for tasks such as: Photosphere Creation: Stitching multiple images to create a 360-degree view.

For the shipwreck Distance Measurement: Utilizing data from the Intel RealSense D435i stereo camera to calculate distances between points in the environment using the built in library provided by intel.

4. Raspberry Pi Pico

Firmware MicroPython: A lightweight implementation of Python optimized for microcontrollers, facilitating rapid development and deployment.

Serial Communication Receives movement commands from the Jetson Nano via serial interface.

PID & DMS (Depth maintaining system) Implements a PID (Proportional-Integral-Derivative) control system to regulate motor speeds, ensuring stable ROV movement and orientation. Utilizes feedback from the Inertial Measurement Unit (IMU) and depth sensor to maintain desired pitch, yaw, roll, and depth. While the DMS stabilizes the vehicle at the desired depth while doing the mission tasks by regulating the motor speeds.

Reverse Mode Functionality Incorporates a software-based reverse mode to simplify control when the ROV's orientation is reversed, ensuring intuitive operation for the pilot.

5. Communication Protocols

Ethernet Communication Protocol: TCP/IP

Data Transmission: Joystick commands, video streams, and telemetry data between the control station and Jetson Nano.

Serial Communication Protocol UART Baud Rate: Configured based on system requirements to ensure reliable data transfer between the Jetson Nano and Raspberry Pi Pico.

Sensors IMU, Depth Sensor. This architecture ensures efficient and reliable operation of the ROV, providing real-time control, stabilization, and monitoring capabilities.

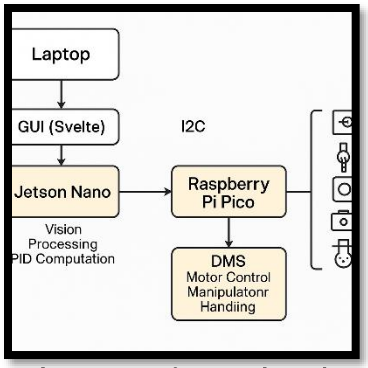

Figure 40 Software Flow chart

6.8 Trade-offs

Various component choices influenced the vehicle's overall cost, dimensions, weight, and performance.

- Jetson Nano vs. Raspberry Pi 5: Both microcomputers were evaluated as potential main controllers for the vehicle. The Jetson Nano was ultimately chosen due to its superior computing power, built-in GPU, and additional ports.

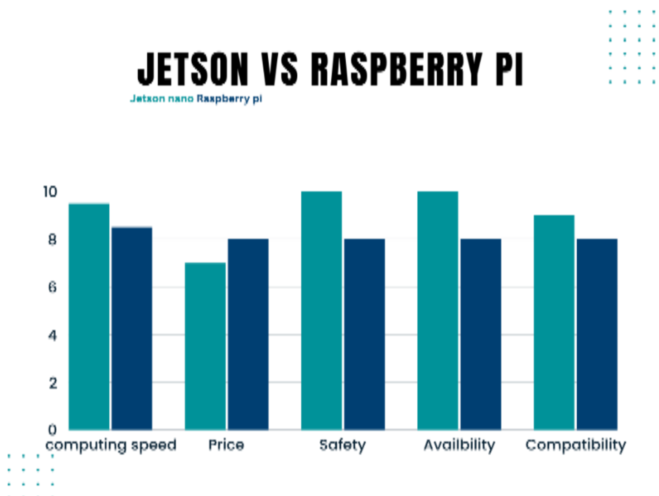

Figure 41 Jetson nano vs raspberry pi comparison

- Carbon Fiber vs. HDPE: While both materials demonstrated excellent suitability for ROVs, carbon fiber was selected for its exceptional durability and lightweight properties, despite it’s higher cost.

- Thruster Configuration: A comparison between a 3D-configuration and a vectored configuration was made when increasing the number of thrusters to 8. Although the vectored configuration provided 4 thrusters for each direction, it resulted in a larger vehicle and reduced speed. Instead, the 3D-configuration was adopted, leveraging all 8 thrusters for every direction, improving speed and minimizing size.

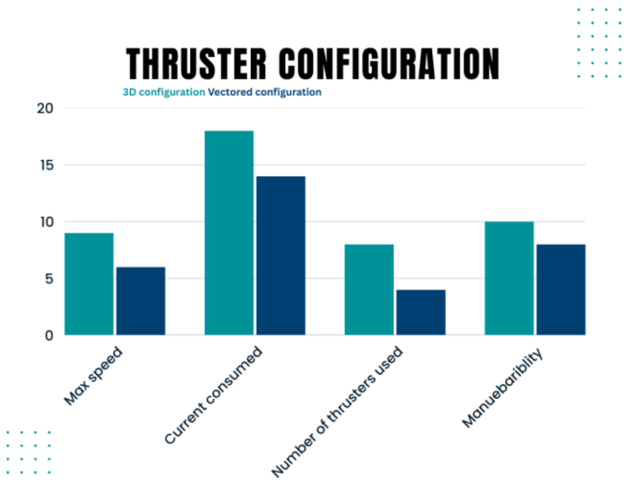

Figure 42 Configuration trade off

6.9 Buy VS Build & New VS Reused

A critical factor influencing the selection of reused and in-house built components was the overall team budget. To optimize resource allocation, the High-Level Administration convened to prioritize which components should be built in-house or purchased:

- Pressure Sensor: The team decided to purchase the Blue Robotics Bar010 pressure sensor, despite its relatively high cost. The hardware team determined that developing an in-house pressure sensor would require extensive trial and error,
- significantly increasing the overall expense.
- Electronic Enclosure: Designing and building an in-house electronic enclosure provided complete flexibility in terms of dimensions, materials, and modularity. Additionally, it reduced costs by 70% compared to commercially available enclosures.
- Electronic System: While designing custom PCBs demanded considerable effort, creating an in-house electronic system proved more cost-effective and allowed for greater flexibility in future upgrades.
- Waterproof Thrusters: The decision to purchase ready-made waterproof thrusters, specifically the Blue Robotics T200, was straightforward. Sealing brushless thrusters would have required substantial R&D, making the off-the-shelf option more practical.

Reusing components proved to be highly beneficial in reducing unnecessary costs. However, all reused components were subjected to a rigorous testing phase to ensure they maintained optimal performance:

- Thrusters: Each thruster underwent a current-to-thrust ratio test to confirm they delivered the required performance.
- Power Cable: The vehicle's power cable was tested for voltage drop, and Overflow Robotics decided it was suitable for reuse.
- Pneumatic Components: Various pneumatic parts underwent performance and pressure tests to ensure they were safe and functional.

All tested components successfully met performance standards and were approved for reuse in this year's vehicle successfully saving us 1,528 USD if we were to buy them new.

Systems Approach

Overflow Robotics' Poseidon-X has been designed by keeping modular and compact body designs at the core of its functionality, flexibility, and maintenance ease. One of the team's early goals was to create a type of modular structure that would allow fast inspection, quick replacement, and easy redesign of malfunctioning components. This philosophy dictated the use of both the chassis and electronic tray.

6.10 Chassis Design

The chassis structure of Poseidon-X was designed to be highly modular, allowing it to adapt easily to different tasks. This flexibility was very crucial for mission-oriented tasks, enabling the team to reconfigure the chassis without major redesigns. Such modularity also enabled the vehicle to be transported quickly and allowed for a reduced assembly time during testing and deployment. Importantly, the chassis is made out of lightweight yet tough carbon fiber, underlying its capability to withstand underwater operations without compromising its compactness.

Electronics Integration

The electronics tray was designed to be both modular and compact, which allowed the use of a smaller, efficient electronics tube. This optimization significantly reduced the size of Poseidon-X without sacrificing functionality or accessibility. The modular electronics tray facilitated organized cable management, quick access for debugging, and the flexibility to incorporate additional components if needed. This approach not only enhanced the ROV's compactness but also made it easier to perform maintenance and future upgrades.

Figure 43 Raspberry pi pico

Compact System Design

Designing a compact ROV like Poseidon-X required a holistic approach, considering how each subsystem interacted with others. The integration of thrusters, sensors, and electronic systems was meticulously planned to avoid overcrowding while maintaining peak performance. Careful planning, system mapping, and iterative prototyping ensured that the design maintained a balance between compactness and functionality. The team's ability to achieve a small footprint without compromising on core features like stability, performance, and accessibility highlighted their attention to detail.

Electrical and Control Systems

The Poseidon 2.0 electrical system represents a significant leap forward in design and functionality, addressing the limitations of its predecessor while introducing innovations to improve performance and reliability. This year, Overflow Robotics adopted a modular architecture, integrating cutting-edge components and designing a versatile PCB system to optimize power distribution, data processing, and signal management.

6.11 System Overview

The heart of the system is a Jetson Nano microcontroller, paired with a Raspberry Pi Pico, replacing the legacy Arduino Nano. This configuration enhances computational capacity and facilitates seamless integration of advanced vision processing. The vehicle's vision system was upgraded from CCTV cameras to Hikvision webcams, delivering higher frame rates, improved clarity, and superior reliablity in underwater conditions.

The redesigned PCB system features four specialized boards that streamline operations:

Power PCB: Equipped with nine outputs, this board distributes power to eight thrusters and a single 12V output for the rest of the system. It incorporates three diodes and nine 30A fuses to ensure protection against back currents and overloading, enhancing safety and durability.

Figure 44 Power PCB

Cameras PCB: Facilitates the connection of seven USB cameras through two USB hubs, enabling efficient data transfer to the Jetson Nano for real-time vision processing.

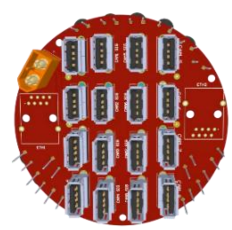
Figure 45 Camera PCB

Payload PCB: Supplies precise power to mission-critical attachments, such as grippers, lights, and mechanisms, ensuring stable and efficient operation through its 12V outputs.

Figure 46 Payload PCB

Signal PCB: Bridges the Raspberry Pi Pico with all ROV

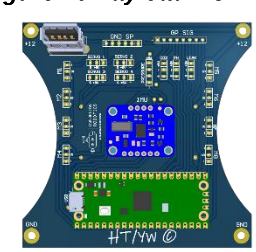

Figure 47 Signal PCB

components, efficiently managing signal transmission for optimal responsiveness.

Innovative Dual-System Design

Overflow Robotics boasts a pioneering dual system to allow adaptability in full. The primary system includes a Jetson Nano and Raspberry Pi Pico, while the backup system would rely on an Arduino Nano and CCTV cameras. It was ensured that all PCBs were designed to be universally compatible so that the systems can switch with no modification of the other system hardware. While the main system worked well, the backup system is ready to fulfill its purpose in case something unforeseen takes place.

Data Flow and Power Management

Data is transferred from the team station to the Jetson Nano via a Cat6 cable, enabling fast and reliable communication. The Jetson Nano processes commands and relays them to the Raspberry Pi Pico, which distributes signals to all connected components, ensuring precise control over the vehicle's operations.

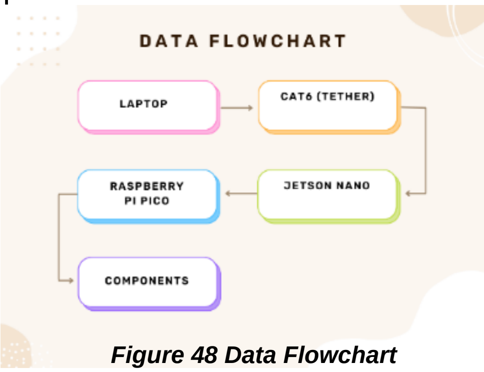

Figure 48 Data Flowchart

For power management, two 6mm copper cables supply power from the station to the vehicle through an XT60 connector. The Power PCB handles power distribution, featuring robust protection mechanisms such as three diodes and nine 30A fuses. This configuration ensures consistent and reliable power delivery to the eight thrusters and other subsystems, minimizing the risk of failures during operation.

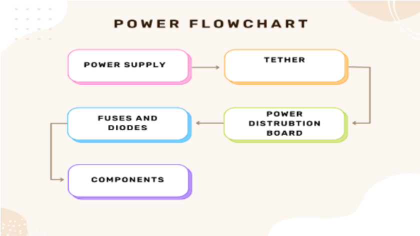

Figure 49 Power Flowchart

6.12 Conclusion

The Poseidon 2.0 electrical system exemplifies innovation and reliability through its modular PCB design, advanced microcontrollers, and dual-system adaptability. The upgrades in vision processing, signal management, and power distribution collectively elevate the performance of the ROV, making it a state-of-the-art solution for underwater exploration.

6.13 Float Rationale

Buoyancy engine

Operated by a buoyancy engine, floating and sinking is achieved by adjusting the volume of water inside the float. So for a negative buoyancy effect, water taken inside makes the float sink and to float, the same water is pushed outside becoming positively buoyant letting it rise. This is done using a motor driver and a power screw mechanism that rotates to extend two 50-millilitre syringes and take in water. This process is controlled by a limit switch mounted such that its action prevents overextension of the syringes, which would otherwise cause separation and leaking of water to the inside of the float. Tao return to the surface, the motor driver rotates in the opposite direction, closing the syringes to expel water until stopped by another limit switch. This setup allows for cautious and safe movement.

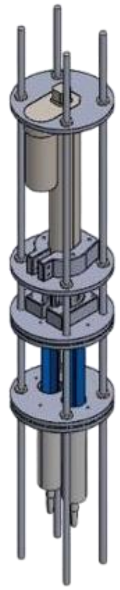

Figure 50 Float buoyancy Engine

Frame

The internal frame consists of six iron rings, machined precisely with suitable holes to accommodate mission-specific components within the float. The structure is packaged in a cylindrical acrylic shell, allowing maximum visibility into the float interior. The entire assembly is 90 cm tall and has a diameter of 17 cm, compact but functional.

Sealing and pressure relief

The float is sealed with two pop-off designed to release if excessive internal pressure is built up that can cause structural damage or small explosions in worst cases. Each cap is lined with two rubber O-rings ensuring a watertight seal even under high pressure at depths of six meters. The top cap featuring two cable glands securely housing two open pneumatic cables, which are sealed and connected directly to the syringes to allow water movement.

Electrical components

The float system is operated using a esp32 that works as a microcontroller while providing a wide range of communication, a motor driver is utilized to operate the linear actuator in both direction.

7.0 Budget, Costs & Expenses

7.1 Budget

At the beginning of the season, Overflow Robotics exercised a responsible and active approach to budgeting, using insights from the previous year's financials combined with investigation into area suppliers for reasonable pricing on main components. Each sub-team played a major role by presenting very role by presenting very detailed information with assessed costs. Once these proposals were cleared and accepted by the CEO and CFO, teams were free to continue with their technical work, making sure that every decision was in line with the financial plan.

Estimated Expenses				
General	Thrusters	2	400	Reused-New / T200 thrusters
	TCU	1	300	New / TCU Case
	Registration	1	400	New / Mate Registration
	Tools	1	180	New / Drill and mechanical tools
	Travel	--	--	Employee Paid expense
	Tether	4	185	New / Singal and power tether
	Fluid power quiz	1	25	New / Mate fluid power quiz
Mechanical	Frame	1	180	New / Frame materials
	Machining	1	220	New / Mechanical vehicle machining
	3D printing	1	120	New / Shrouds and Manipulators parts
	Nuts, Bolts, Screws	1	160	New / Nuts, Bolts, Screws
	Electronics housings	1	120	New / Vehicle Electronic housings
Electrical	ESCs	3	108	Reused-New / Blue robotics ESCs
	Cameras	9	490	New / USB Cameras
	Jetson Nano	1	250	New / Microcontroller for the system
	Joystick	1	40	Reused / 3D extreme pro Logitech
	Tubes	2	120	New / Acrylic Tubes for cameras
	PCBs	4	90	New / Electric system PCBs
	Electric Components	1	440	New / Raspberry pi, Mosfet modules, etc...
Total Estimated Budget = 3828				

Figure 51 Estimated Expenses

To better structure a suitable budget, many dollars were allocated that did not even directly contribute to the technical portion of the project, like t-shirts, marketing, and social media initiatives, which speak to the brand and team identity.When it came to travel, a well-thought-out and explicit budget directed to each employee enabled them to be responsible for individual travel expenses. This decentralized structure inspired personal accountability and development of a real accountability culture in the team. The budgeting process facilitated proper resource allocation while at the same time ensuring continued success and sustainability of Overflow Robotics' initiatives; thus, assuring monetary health that advanced truly innovative progress.

OVERFLOW ROBOTICS				
Travel Finacial Plan				
Item	**Description**	**QTY**	**PRICE**	**TOTAL**
Ticket	Plane Tickets	9	USD 935	USD 8,415
Hotel	Air bnb rental	1	USD 2,400	USD 2,400
Transportation	Van rental for 9 passengers	1	USD 1,750	USD 1,750
Accommodation	Meals and snacks for the team	9	USD 75	USD 675
	Total			USD 13,240
Notes	Some Visas have been issued for team members the last year			

Figure 52 Estimated travel Expenses

7.2 Costs

Except for fluctuations in price and economic stability in Egypt, our budget has faced many crises, making it veer off the paths of the original financing plan. But, we found innovative strategies to trim the expenses, causing overall savings. Most of our costs were primarily spent on electrical components and tools; nevertheless, because of the exorbitant international import tariff, their prices showed irritating spells of a rise. To counter these challenges, Overflow Robotics adopted budgeting strategies to secure donations, ensure resource equity, and carefully consider whether procurement, fabrication, or recycling of materials was most suitable. The design of unique in-house components and the preparations for charging high standards against the term is virtually, if not entirely compromised. These pro-active designs paved the way for an iteration of the ROV that is nicely engineered, highly specialized, and economically frugal.

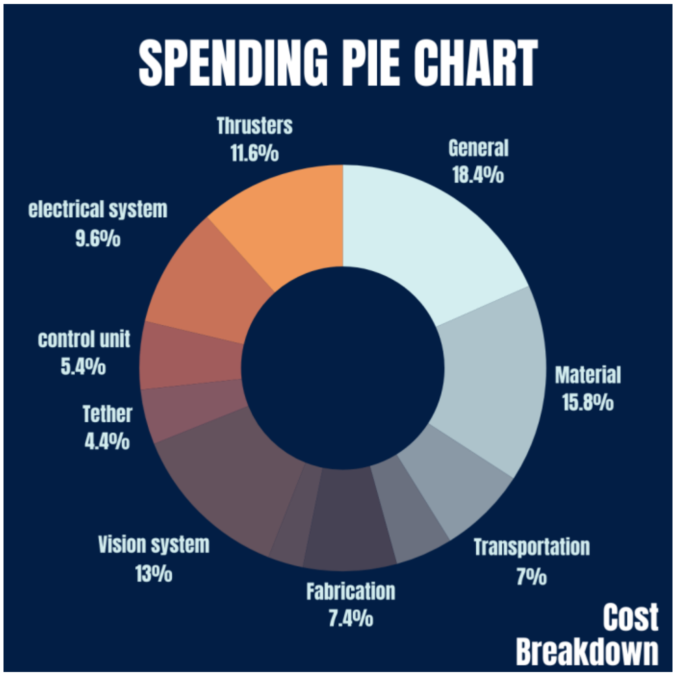

Figure 53 Spending pie chart

7.3 Accounting

Overflow Robotics were rounded up to kick off their season on a good note by making efforts to secure funding by putting two personnel full-time for the task. They were actively contacting people and companies for potential financial support. While they initially had minimal responses, they soon landed a huge sponsorship from PCB Way that allowed them to clear not just the PCB cost, but partly for electrical parts as well. With an acknowledgment of the necessity for a little internal support, Overflow Robotics decided to implement an employee dues payment mechanism. Each of the learners paid a fine of about $190, thus contributing to the team and innovatively gaining an array of experiences, tools, and parts. Apart from this, the team on its behalf generated income by organizing some series of robotics courses during an entire season; through effective social media marketing, they were able to raise additional funding of about $94.By diversifying its revenue streams by external sponsorship, internal contributions, and educational activities, Overflow Robotics was in a position to sustain its mandate. The approach insured not only the acquisition of required resources but also reaffirmed the team's commitment to being innovative, collaborative, and financially resilient, thus paving the way for growth and sustainability.

Budget per Month

	Income ($)				Expenses ($)
	Source	Amount	Income	Accumalative Income	Actual Expenses
November	Employee Dues Fund from last year	$560.00 $100.00	USD 660	USD 660	$655.00
December	Employee Dues	$560.00	USD 560	USD 1,220	$556.00
JANUARY	Employee Dues Afiz Makers space	$560.00 $200.00	USD 760	USD 1,980	$755.00
MARCH	Employee Dues	$560.00	USD 560	USD 2,540	$554.00
April	Employee Dues	$560.00	USD 560	USD 3,100	$556.00
Total				USD 3,100	$3,076.00

Figure 54 Monthly income and expenses

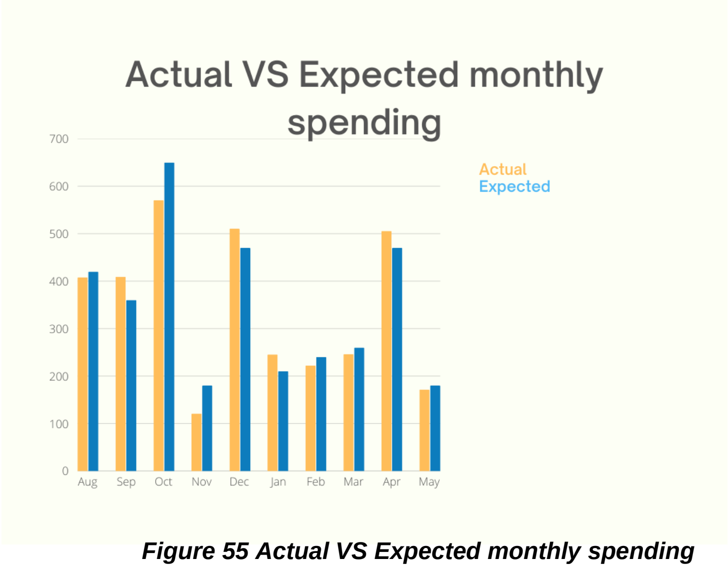

Figure 55 Actual VS Expected monthly spending

8.0 Akcnowdgments

- The assistance from Mate ROV Egypt and MATE center was invaluable in addressing any issues we encountered
- . Mate ROV Egypt played a crucial role in guiding us through the entire registration The Mechanism Fabrication Center not only assisted us throughout the fabrication process but also provided all necessary machinery.
- Our mentors, including Moazz Mahmoud, Abdelwahab Adam, Ehab Abdel Rahman, Ahmed Amin, and Abobakr Mohamed, continuously supported and motivated us to reach new heights within our field.
- PCB Way and Blue Robotics deserve recognition for generously providing their services at discounted rates, allowing us to utilize them effectively at minimal cost.

- Additionally, the unwavering support from our friends and family members has been instrumental in our journey. They have stood by us through thick and thin, offering encouragement and understanding whenever needed. Their belief in our endeavors has fueled our determination to succeed, and we are grateful for their love and support every step of the way.

9.0 References

Pressure sensor

Buoyancy principle

Drag force principle

Jetson nano

Raspberry pi pico

Mate rov ranger

Pid controller

Blue Robotics T200s

10.0 Appendices

Tether Checklist:

Setup:

- ✓ Straighten and eliminate any kinks in the tether.
- ✓ Safely plug the tether into the control box.
- ✓ Secure strain relief to prevent accidental disconnection from the control box.
- ✓ Inform other employees about the deployed tether to prevent accidental stepping.
- ✓ Attach the strain relief to the ROV.
- ✓ Connect the tether to the ROV.

Post-Run:

- ✓ Safely disconnect the tether from the control box.
- ✓ Safely disconnect the tether from the ROV.
- ✓ Neatly roll up the tether on the hose reel.

On-Deck Checklist:

- ✓ Follow the tether setup protocol.
- ✓ Connect the power supply and set it to 12v.
- ✓ Power up the ROV.
- ✓ Test the thrusters and claws.
- ✓ Verify camera views on the designated deck screens.
- ✓ Carefully lower the ROV into the water.
- ✓ Release any trapped air bubbles.
- ✓ Await the "ready" signal from deck crew.
- ✓ Initiate launch with a countdown.

Pre-Run Checklist:

- ✓ Inspect electrical power connections.
- ✓ Perform a dry run to ensure unobstructed and functional cameras.
- ✓ Confirm the security of all waterproof seals.
- ✓ Check thrusters for proper function and clearance.
- ✓ Verify proper functioning of the claw.

Post-Run Checklist:

- ✓ Power off the Control Box.
- ✓ Turn off the power supply.
- ✓ Follow the tether disconnect procedure.
- ✓ Dry the ROV and place it safely on the cart.

Clean the work area, removing all materials, props, supplies, and debris.

Figure 56 Safety Checklist

Cost Analysis								
item		Description	quantity	status	Estimated Budget (USD)	Budgeted Value (USD)	Difference (USD)	Running Total
General	Thrusters	T200	2	New	400	400	0	4592
		ESC	3	New	108	108	0	4484
	Registration	Registration	1	New	400	400	0	4084
Mechanical	Material	Carbon Fiber	1	New	180	205.5	-25.5	3878.45
		3D printing	1	New	120	165.42	-45.42	3713.03
		Rubber silicon (ROV)	1	New	80	65.2	14.8	3647.83
		HDPE (ROV)	1	New	15	28.1	-13.1	3619.73
		Acrylic (Float)	1	New	35	38.2	-3.2	3581.53
		Silicon spray	3	New	18	22.4	-4.4	3559.13
		Magnets	7	New	29	29	0	3530.13
		Epoxy	4	New	25	30.88	-5.088	3499.25
	Fabrication	Machining	1	New	220	185.6	34.4	3313.65
	Fasteners	Screws	450	New Reused	80	65.8	14.2	3247.85
		Nuts	450	New Reused	80	50.1	29.9	3197.75
	Pneumatic System	pistons	7	New Reused	180	150.8	29.2	3046.95
		Valves	7	New	120	138.4	-18.4	2908.55
		Compressor	1	Donated	--	--	--	2908.55
	Miscellaneous	Zip ties	12	Donated	--	--	--	2908.55
		Heat shrinks	35	New	10	7.2	2.8	2901.35
		Weights	8	New	50	38.4	12.6	2862.95
		Floatation	20	New	70	28.5	41.5	2834.45
Electrical	Electrical System	PCBs	4	New	90	102.7	-12.7	2731.75
		PCB Components	4	New	85	70.8	14.2	2660.95
		Jetson nano	1	Donated	--	--	--	2660.95
	Vision System	Cameras	9	New	490	550.2	-60.2	2110.75
		Raspberry pi	2	New	200	200	0	1910.75
		Tubes	2	New	120	115.2	4.8	1795.55
		Monitor	1	New	60	60	0	1735.55
	Sensors	Depth Sensor	1	New	75	75	0	1660.55
		Linear Actuator	1	New	55	40.7	14.3	1619.85
		Temperature sensor	2	New	15	20.8	-5.8	1599.05
	Tether	Ethernet Cable	5	New	35	18.7	6.3	1580.35
		CAT-6	1	New	25	25	0	1555.35
		Pneumatic Cable	1	New	80	80	0	1475.35
		Power Cable	2	New	80	52.7	27.3	1422.65
	Control Unit	Control Box	1	New	120	138.8	-18.8	1283.85
		TV	1	New	180	210	30	1073.85

Figure 57 Total Cost

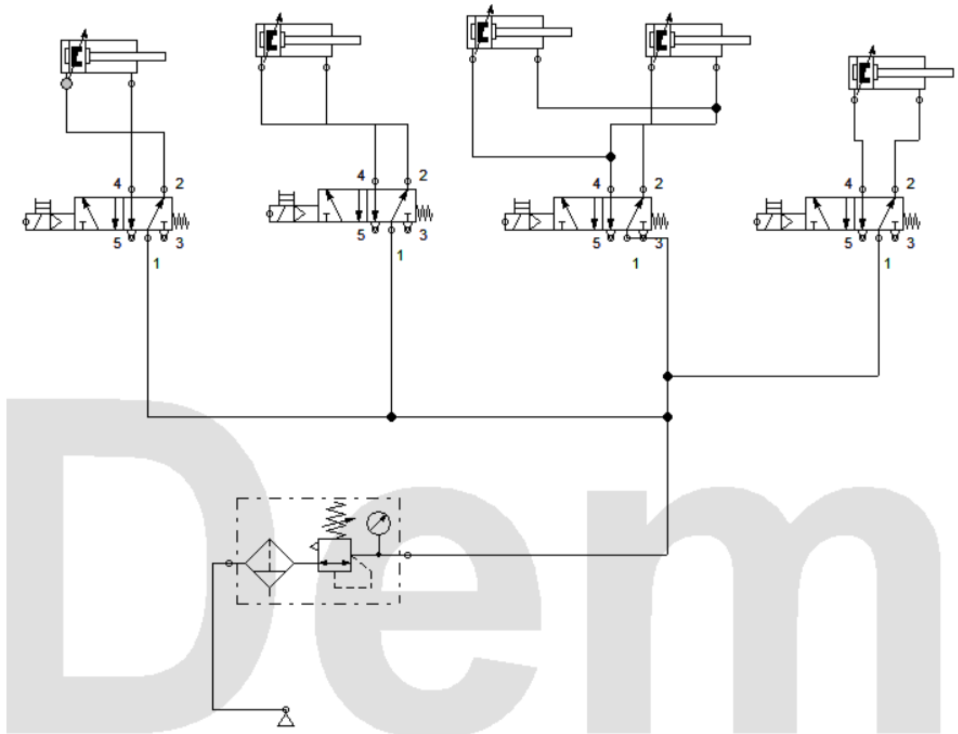

Figure 58 Pneumatic Sid

Fuse calculations:

Fuse used 25 Amps

- 5 Usb cameras 5*0.5 = 2.5 Amps
- Jetson nano 2 Amps
- 8 T200 Thrusters 8*1.5 = 12 Amps
- 6 electric selnoids 6*0.25 = 1.25 Amps

Total 17.75 Amps * 150% = 26.625 Amps

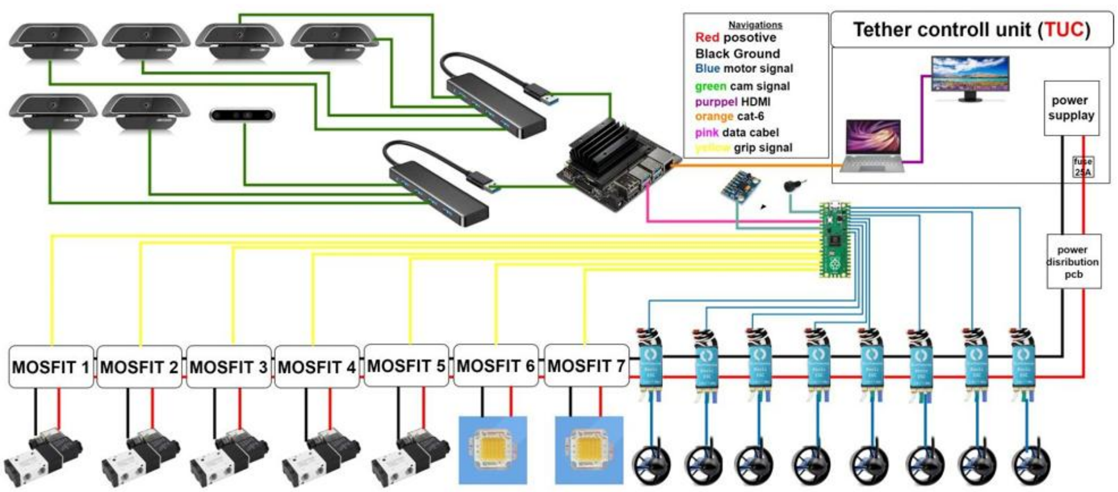

Figure 59 Electrical Sid