

MATE ROV Competition 2026

AQUA Masters

Technical Report

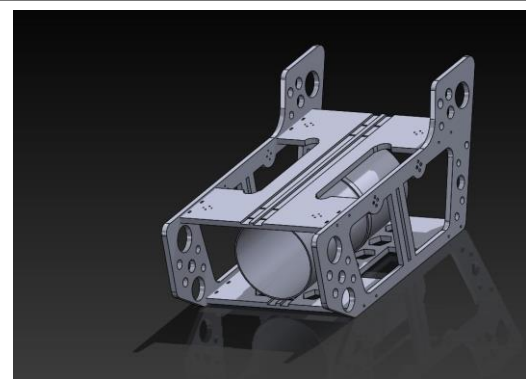
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At AQUA Masters, we're a team of passionate students driven by our love for underwater exploration. Our creation, the 'POSEIDON-X' ROV, is more than just a robot – it's our dedication to innovation and sustainability. Built to navigate the depths with precision and care for the environment. With advanced sensors and mechanical arm, we're ready to dive into new challenges and make waves in underwater robotics.



Team Members

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Abstract:

This technical documentation presents the design and development of an advanced Remotely Operated Vehicle (ROV) by Aqua Masters, a student team from the Marine and Offshore Engineering Department at the Arab Academy for Science, Technology and Maritime Transport (AASTMT), Alexandria, Egypt. The ROV is designed to perform underwater inspection and intervention tasks efficiently within a controlled aquatic environment.

The system features a robust mechanical structure, a reliable electrical architecture, and a software-based control system. It is equipped with eight strategically positioned thrusters, enabling full six-degree-of-freedom (6-DOF) maneuverability and precise control while maintaining a balance between performance and power consumption. A modular design approach was adopted to enhance maintainability and scalability.

To ensure operational stability, a carefully designed buoyancy and ballast system was implemented. The ROV also integrates a payload system including cameras, a temperature sensor for environmental monitoring, and a leak detection sensor to improve safety and system reliability.

Engineering trade-offs were systematically evaluated throughout the design process to optimize cost, efficiency, and functionality. Extensive testing and iterative development ensured that the system meets performance requirements and safety standards.

This project demonstrates the effective application of engineering principles, teamwork, and problem-solving in developing a reliable and competitive underwater robotic system.

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Design Rationale

Define Requirements

The design process began with a comprehensive definition of system requirements to ensure that the Remotely Operated Vehicle (ROV) meets all mission objectives effectively. The team gathered and analyzed detailed information about the competition tasks, constraints, and evaluation criteria to clearly understand the intended purpose and operational goals of the system.

This phase involved:

- Studying mission scenarios to identify required functionalities and performance expectations
- Analyzing environmental conditions such as water depth, visibility, and operational space
- Identifying constraints related to size, weight, power consumption, and maneuverability

Based on this analysis, key technical specifications were established, including:

- Depth rating appropriate for the competition environment
- Payload capacity sufficient to support cameras, sensors, and task-specific tools
- Operational endurance to complete all mission tasks within the allocated time
- High maneuverability enabled by an 8-thruster configuration for precise control

In addition, regulatory and safety requirements were carefully considered to ensure safe and compliant operation. These included electrical safety measures, waterproofing standards, and operator safety protocols. A leak detection sensor was also incorporated as a preventive safety feature to monitor system integrity during operation.

These defined requirements formed the foundation for all subsequent design decisions, ensuring that the final ROV system is efficient, reliable, and aligned with competition expectation

Conceptual Design

The conceptual design phase focused on exploring a wide range of possible solutions to meet the defined system requirements. The team conducted structured brainstorming sessions, supported by preliminary sketches and conceptual diagrams, to visualize different configurations and system architectures.

During this phase, multiple design concepts were evaluated, including:

- Various propulsion configurations, considering different numbers and arrangements of thrusters to achieve optimal maneuverability and control
- Alternative control system approaches, including different microcontrollers and communication methods
- Multiple frame and hull designs, focusing on structural strength, weight reduction, and hydrodynamic performance
- Different sensor and payload configurations to ensure effective task execution and system monitoring

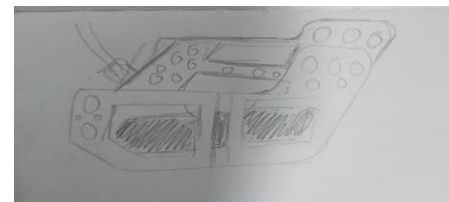


Figure 1 First hand sketch of Poseidon-x

Special attention was given to propulsion system concepts, where several configurations were explored before selecting the 8-thruster layout. This configuration was chosen for its ability to provide full six-degree-of-freedom (6-DOF) control, enabling precise navigation and stability in complex underwater operations.

Additionally, modular design concepts were considered to allow flexibility in component placement, ease of maintenance, and future upgrades. Trade-offs between complexity, cost, and performance were continuously evaluated throughout this stage to guide the selection of the most effective design approach.

The outcome of this phase was a set of well-defined conceptual designs that were further analyzed and refined in the subsequent design stages.

Detailed Design

Develop detailed engineering drawings and specifications for each component and subsystem of the ROV. Select appropriate materials, considering factors such as strength, buoyancy, corrosion, and weight. Perform all necessary measurements to reverse engineer bought components. Create the component as a part in SolidWorks and add it to the ROV assembly for checking fitment and overall design.

Fabrication

Fabricate prototype components using rapid prototyping techniques or traditional manufacturing methods.

Assemble the prototype according to the detailed design specifications.

Conduct initial tests to verify basic functionality and identify any design flaws or performance limitations

Analyze test results and feedback to identify areas for improvement or optimization.

Modify the design as necessary to address deficiencies or enhance performance.

Repeat prototype development and testing cycles iteratively until the ROV meets all requirements and performance criteria

Document the finalized design specifications, including any revisions made during the iteration process.

Ensure compliance with relevant standards and regulations

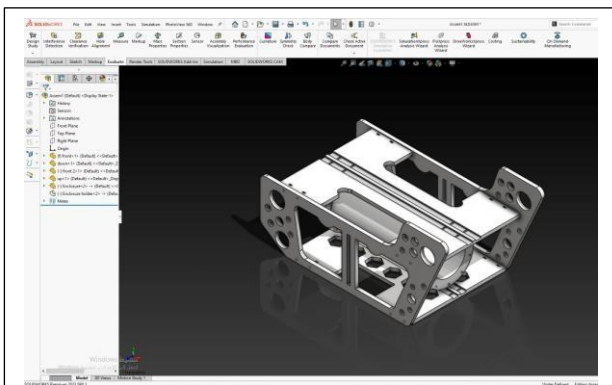


Figure 2 3d modeling the ROV on Solidworks



Figure 3 Poseidon-X

Propulsion System

Thruster Configuration & 6-DOF Analysis

To achieve high agility and precise station-keeping required for the MATE missions, the ROV is equipped with a high-power propulsion system consisting of **eight customized Bilge Pump thrusters**. These are strategically arranged to provide full **6 Degrees of Freedom (6-DOF)**:

- **Vertical Propulsion (4 Thrusters):** Mounted in a **dual-per-side configuration** (2 on each side). This symmetric arrangement ensures balanced heavy-lift capability and stable depth control. By utilizing differential thrust, this setup allows for precise **Pitch** and **Roll** adjustments, essential for stabilizing the ROV during heavy payload manipulation.
- **Horizontal Propulsion (4 Thrusters):** Positioned on the vehicle's base in a **45° vectored layout**. This geometry enables seamless **omnidirectional movement**, including forward, backward, lateral strafing (sideways), and high-speed **Yaw** rotation, allowing the pilot to navigate tight underwater environments with superior maneuverability.

Actuation & Motor Control Architecture

The transition from raw pump hardware to precision underwater thrusters is managed through a dedicated electronic control layer designed for high current stability:

- **Independent Motor Drivers:** Each thruster is paired with an independent **MD10C Cytron 10Amp High-Current Motor Driver**. This 1:1 driver-to-motor ratio ensures dedicated thermal management and prevents a single point of failure from disabling the entire propulsion line.
- **Precision Control:** These drivers facilitate bidirectional control and smooth speed ramping via **PWM (Pulse Width Modulation)** signals sent from the **ESP32** low-level controller.

- **Power Stability:** This modular architecture ensures that the high current draw of the 8 pumps is distributed effectively, preventing voltage drops and protecting sensitive logic units like the **Raspberry Pi 5** from electrical noise or power surges during rapid thrust changes.

MD10C Cytron Motor Driver

The ROV utilizes eight independent **MD10C Cytron Motor Drivers** to interface the high-power propulsion system with the control logic. This driver was selected for its high current handling and seamless integration with low-level microcontrollers.

Technical Specifications:

- **Voltage Range:** Supports a wide DC input from **5V to 30V**, accommodating various marine battery configurations.
- **Current Capacity:** Capable of **10A continuous** output and **30A peak** current (up to 10 seconds), meeting the high-torque demands of the bilge pump thrusters.
- **Logic Compatibility:** Fully compatible with **3.3V and 5V logic**, allowing direct control from the **ESP32** and **Raspberry Pi 5**.
- **Control Mechanism:** Employs **PWM (Pulse Width Modulation)** for bidirectional speed control and smooth acceleration/deceleration ramping.

Operational Implementation:

By pairing each thruster with a dedicated MD10C unit, the system achieves a modular actuation layer. This 1:1 ratio ensures efficient power distribution, prevents total system failure in case of a single-channel malfunction, and protects the central processing units from significant voltage drops during high-load maneuvers.



Engineering Rationale: Value Engineering Approach

The decision to utilize modified Bilge Pumps with Cytron drivers instead of commercial ROV thrusters was a deliberate **Value Engineering** choice, balancing high performance with cost-effectiveness:

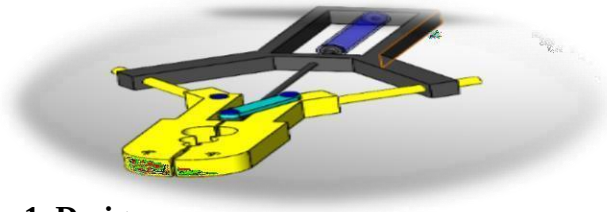
Metric	DIY Bilge System	Commercial Thrusters	Rationale
Thrust-to-Cost	Optimal	Low	8-thruster redundancy at 15% of the commercial cost.
Durability	Native Marine-Grade	High	Designed for continuous operation in harsh environments.
Serviceability	High	Low	Modular parts allow for rapid on-site field replacement.

- Customization:** By integrating our own motor drivers and ESP32 firmware, we achieved a level of **control responsiveness** comparable to professional-grade equipment, tailored specifically to the ROV's hydrodynamic drag.
- Maintainability:** The 8-thruster setup allows for individual motor troubleshooting without affecting the entire system integrity, ensuring zero downtime during competition runs.



Pneumatic Gripper

The need for robust and reliable manipulation tools for underwater operations is crucial for ROVs. Pneumatic systems offer advantages in underwater environments due to their relative simplicity, high power-to-weight ratio, and inherent safety compared to hydraulic or electric alternatives. This project focuses on designing and building a pneumatic gripper system suitable for ROV integration, utilizing commercially available components.

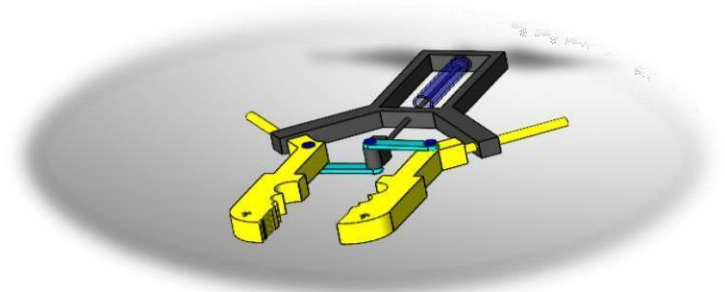


1. Design:

The gripper design is centered on a parallel jaw mechanism actuated by a double-acting pneumatic cylinder. A 3D model was created in SolidWorks to visualize and refine the design before fabrication. Gripper Jaw the jaws are designed with a curved profile to securely grasp objects of varying shapes and sizes. 20 cm length, one arm width 4 cm. The pneumatic cylinder's linear motion is translated into jaw rotation through a lever system. This mechanism amplifies the force applied by the cylinder, resulting in a strong gripping force. The opening distance is 7.5cm, the pneumatic cylinder is securely mounted to the gripper frame. The gripper frame provides structural support and houses the components. It is designed to be compact and lightweight while maintaining rigidity. **All printed components material PLA**

Gripper Components

1. **Compressor:** Shenyang eg compressor 25 liter ,6 bar pressure , single stage This compressor will be located on the surface and supply compressed air to the gripper via a hose.
2. **Pneumatic Cylinder:** 100mm stroke, 25mm bore double-acting cylinder. sidyen model
3. **Solenoid Valve:** 5/2 way pneumatic solenoid valve, 48V DC. This valve controls the direction of airflow to the cylinder, enabling opening and closing of the gripper.
4. **FRL System:** A combined filter, regulator, and lubricator (FRL) unit is employed to condition the compressed air before it reaches the cylinder. This protects the cylinder from contaminants, regulates the operating pressure, and provides lubrication for optimal performance.



Compressed air from the surface compressor is fed through the umbilical to the ROV. The onboard FRL unit conditions the air before it reaches the solenoid valve. The 48V DC solenoid valve is controlled by the ROV's control system. Energizing the valve directs airflow to one side of the cylinder, causing the gripper to close. De-energizing the valve and switching its state redirects airflow to the other side, opening the gripper. Finally it can apply a **Force $\approx 275,790 \text{ Pa} * 0.000491 \text{ m}^2 \approx 135.4$**

Electrical Design

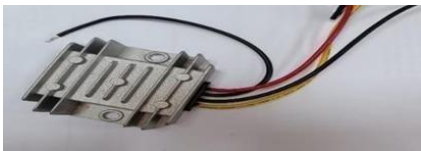
Power Distribution

The ROV functions with a 48VDC and a 40 A power supply.

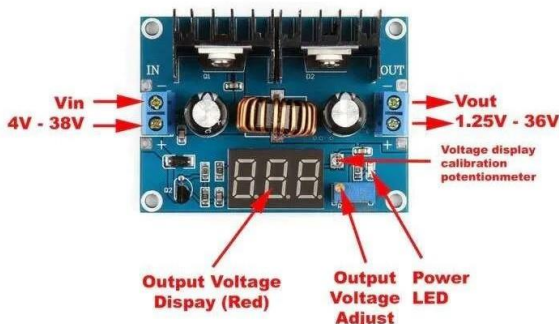


There is no voltage conversion in the tether from the surface source until the waterproof 48VDC to 12VDC regulators power converters which are powering the following:

- 1- Motor Drivers
- 2- Eight thrusters
- 3- LEDs



There is 12 VDC to 5VDC regulators that supply energy through the main chamber to the control section and communication systems. These systems include servomotors, a microcomputer Raspberry Pi 5, sensors, and ESP32 microcontroller.



Waterproof DC-DC Converter

To enhance the ROV's reliability during long-duration dives and protect the internal electronics from humidity or potential minor condensation, the power system utilizes a specialized **IP67-rated Waterproof Buck Converter**.

Technical Specifications & Resilience:

- **Ruggedized Enclosure:** The converter is housed in a high-quality, die-cast aluminum shell that acts as an integrated heatsink, providing superior thermal dissipation even in restricted airflow environments.
- **Fully Encapsulated:** The internal circuitry is fully potted with thermally conductive epoxy resin, offering **IP67 protection** against water ingress, dust, and mechanical vibrations.
- **Stable Output:** It is designed to step down the main battery voltage to a steady **12V or 5V rail**, ensuring that the **independent motor drivers** and **Raspberry Pi 5** receive a clean power supply without interference from the high-current thruster system.

System Implementation:

This converter serves as the primary power regulator for the ROV's logic and auxiliary systems. Its robust design ensures that even in the event of high humidity or mechanical stress within the main enclosure, the core processing units (Raspberry Pi 5 and ESP32) remain isolated and operational. By utilizing a waterproof-rated module, we have added an extra layer of **redundant safety**, aligning with our engineering philosophy of minimizing critical points of failure.



Power Regulation: DC-DC Buck Converter

The ROV's power architecture integrates high-efficiency **Adjustable DC-DC Step-Down (Buck) Converters** to provide regulated power to sensitive logic components. This module ensures a stable voltage supply, isolating the control electronics from the high-current fluctuations caused by the 8-propulsion motor system.

Technical Specifications:

- **Voltage Range:** Supports an input of **4V–38V DC** and provides a precision-adjustable output of **1.25V–36V DC**.
- **Current Capacity:** Delivers up to **5A** of continuous current, supported by integrated aluminum heatsinks for thermal stability.
- **Efficiency:** Achieves up to **96% conversion efficiency**, minimizing heat buildup within the electronic enclosure.
- **Monitoring:** Features an onboard **3-digit LED display** for real-time input/output voltage verification during pre-dive diagnostics.

System Role:

These converters serve as a critical buffer, stepping down the main battery voltage to power the **Raspberry Pi 5 (5V)** and **ESP32** controllers. By decoupling the logic rail from the propulsion rail, the system prevents "brown-outs" and protects the processors from back-EMF spikes.



Electronics Enclosure

Material Selection: Ertalyte (PET-P)

The primary electronics enclosure is manufactured from **Ertalyte (PET-P)**, a high-performance thermoplastic chosen for its exceptional dimensional stability and high mechanical strength. Unlike standard polymers, Ertalyte provides:

- **Low Moisture Absorption:** Ensuring the enclosure maintains its geometry and sealing integrity during long-duration submersions.
- **Superior Chemical Resistance:** Protecting the vessel against the corrosive nature of aquatic environments.
- **Thermal Reliability:** Supporting passive heat transfer from internal high-tech components to the surrounding water.

Finite Element Analysis (FEA) & Depth Rating

To validate the structural integrity of the **Ertalyte** vessel, a rigorous **Static Stress Analysis** was conducted using SolidWorks Simulation under maximum expected hydrostatic pressure:

- **Maximum Stress Level:** The simulation recorded a maximum Von Mises stress of **1.475×10^0 MPa** ($1,475,000 \text{ N/m}^2$), which is well within the elastic limit of the material.
- **Displacement Analysis:** The maximum resultant displacement was calculated at **1.475×10^{-3} mm**, indicating negligible deformation under operational loads, which ensures the O-ring seals remain uncompromised.
- **Factor of Safety (FOS):** The design maintains a high **Safety Factor (Factuality)**, ensuring the enclosure can withstand pressures at depths exceeding the competition requirements without structural failure.

Sealing & Stability Integration

The enclosure is integrated into the ROV using a **dual-flange O-ring system**, providing a self-sealing mechanism that improves as external pressure increases. According to our **Naval Architecture Report**, this configuration contributes to a **Metacentric Height (GM) of 0.168 m**, guaranteeing a stable and upright orientation for the vehicle during mission tasks.

Lighting System

To ensure high-visibility operations in turbid underwater environments, a custom lighting system was engineered by adapting and modifying a high-intensity car lamp. The lighting unit is integrated into the ROV chassis using a 3D-printed mounting bracket, specifically designed to optimize the illumination angle. Optical Optimization for Webcam Integration Unlike standard configurations, this lighting system is positioned directly above the Webcam to maximize the clarity of the visual feed:

- **Reflection Minimization:** The strategic mounting offset reduces "backscatter" (light reflecting off suspended particles in the water) back into the webcam lens, which is crucial for maintaining a sharp image with standard sensors.
- **Enhanced Observation:** The modified car lamp provides a broad, high-lumen beam that compensates for the webcam's dynamic range, ensuring consistent video quality during deep-water tasks.

Control Architecture

The lighting system is fully integrated into the ROV's power distribution and control network:

- **Relay Logic:** The lights are interfaced with a relay module via a customized connector, allowing the pilot to toggle the illumination remotely through the control station.
- **Modular Connectivity:** The use of dedicated connectors facilitates easy maintenance and ensures a waterproof seal at the electrical entry points.



Vision System

The ROV utilizes a multi-layered vision system designed for real-time pilot feedback and advanced spatial analysis.

Primary Navigation: Internal HD Webcam

The core navigation is handled by an **HD Webcam** integrated within the main electronic enclosure for maximum protection.

- **Enclosure Integration:** Internal mounting shields the camera from the marine environment, eliminating external cabling and reducing potential leak points.
- **Optical Clarity:** The camera operates through a transparent **Polycarbonate head cap**, selected for its impact resistance and undistorted high-resolution video at depth.
- **Technical Advantage:** This setup ensures a stable USB link to the **Raspberry Pi 5**, providing a low-latency feed while minimizing "backscatter" from suspended particles.

Tether

The tether serves to supply power and Ethernet communication to the ROV through three cables. Two of these cables, each extending 40 meters, fulfill the power supply requirements by providing positive and negative connections. Additionally, a CAT-6 Ethernet cable, also 40 meters in length, facilitates communication between the ROV and its control system.

Software-Based Systems

Architecture & Code Structure

The ROV utilizes a **decentralized processing architecture** designed to balance high-level computational tasks with low-level hardware reliability. The software stack is categorized into two primary tiers:

- **High-Level Processing (High-Tech):** Executed on a **Raspberry Pi 5** using **Python**. This layer manages mission logic, data routing, and complex telemetry processing. Leveraging the Pi 5's 2.4GHz quad-core power allows for high-speed data handling and rapid development through extensive Python libraries.
- **Low-Level Execution (High-Tech):** Managed by an **ESP32** microcontroller programmed in **C++**. The ESP32 was selected for its dual-core capability, ensuring deterministic, real-time performance for PWM signal generation and direct sensor interfacing while simultaneously handling communication tasks.

Communication Protocols

To ensure high-speed data exchange and minimal latency, a dual-protocol communication framework was implemented:

- **Internal Interfacing (UART):** The Raspberry Pi 5 and ESP32 communicate via **UART**. This point-to-point protocol ensures a dedicated and stable hardware-level link for command execution within the electronics enclosure
- **Surface-to-Vehicle Link (UDP via Ethernet):** Communication with the Topside Station is established using **UDP** over a dedicated Ethernet tether. UDP was prioritized over TCP to eliminate head-of-line blocking, providing the real-time responsiveness essential for precise underwater piloting.

Resource & Fail-safe Management

To ensure the stability of the Raspberry Pi 5 during intensive processing, the system utilizes **SystemD service management** to handle telemetry and data routing daemons, allowing for automatic recovery in the event of a software crash. A critical **Fail-safe logic** is also implemented: if the UDP heartbeat is lost for more than 500ms, the system automatically neutralizes all PWM signals to stop the thrusters, preventing vehicle drifting.

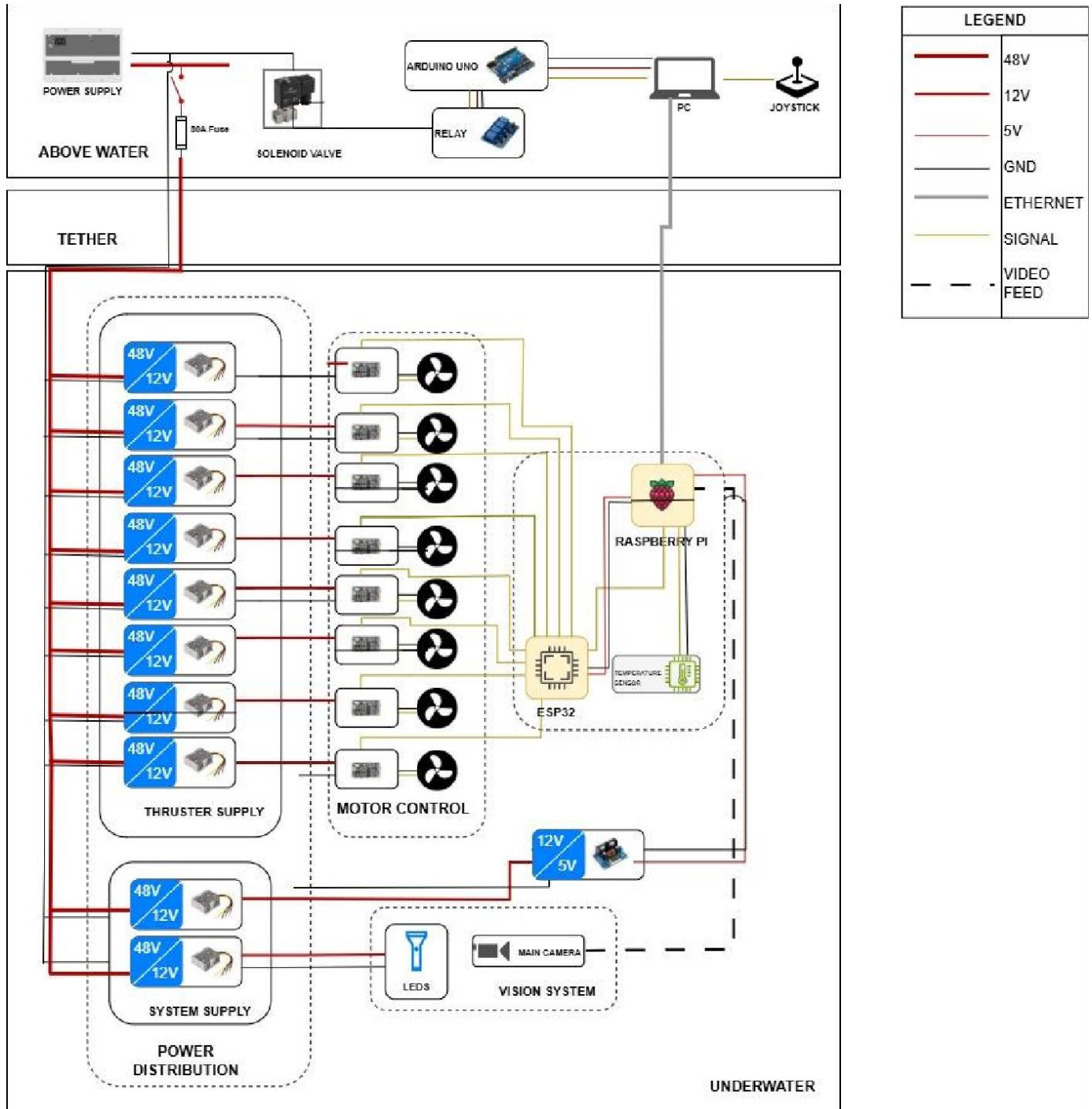
Topside Interface (GCS)

The surface control is facilitated through a **Custom Graphical User Interface (GUI)** [e.g., developed via PyQt/Tkinter]. This interface decodes the incoming UDP stream into a real-time telemetry dashboard, displaying vital signs such as internal temperature, voltage levels, and leak sensor status to provide the pilot with full situational awareness.

Software Testing Methods

Reliability is verified through rigorous **Modular Unit Testing**. Each module—including motor driver logic, communication handlers, and sensor parsing—is isolated and validated independently. This facilitates early-stage debugging and ensures components meet specifications before global system integration

SID



Safety

Philosophy

Aqua Master places a high priority on the safety of our students, attendees, and the marine ecosystem. In all aspects of our work, we perform strict safety procedures and adhere to industry standards. Our ROV is built with several levels of safety protection, such as emergency shutdown systems, fail- safe for navigation, and robust building materials resistant to pressure. In order to guarantee peak performance and reduce any possible dangers, we also carry out comprehensive pre- deployment inspections and checks.

Checklist

Pre-deployment

- All members wear the proper safety gear.
- Clear communication amongst the team.
- Check electrical connection, cables, and connectors for any signs of wear or corrosion or exposed cables.
- Verify the integrity of the waterproof housing and watertight connectors.
- Make sure the tether is untangled.
- Verify the area around the ROV is clear and free from obstructions.
- Power-up
- Test power systems for proper functioning and voltage levels.
- Check tethered communication systems for clear signals and proper operation.
- Test the camera, throttle, and steering functions with the remote control.

Launching

- Look for underwater dangers or obstructions that might interfere with ROV navigation.
- Visually inspect for any leaks into the waterproof housing and look for any large bubbles.
- One member is in a position holding the tether in case of a leak.

Retrieving

- The operator calls for a pull-up after piloting the ROV up.
- One team member cuts off the power to the ROV.
- Two team members pull out the ROV.
- Visually check for any damage or leaks in the waterproof housing.

Emergency Cases

Loss of Communication

- In case of loss of communication reboot the system.
- If no reconnection is established turn off the ROV and pull it out using the tether.

Leak Detection

- In case of a leak hit the emergency stop button.
- Use the tether to pull out the ROV.
- Check the waterproof housing for any damage.
- Pull out all electronic equipment and dry them.
- After drying, test the system to ensure it is operational.

Bill of Materials (BOM) - USD

Category	Component	Qty	Unit (USD)	Total (USD)	New	Used	Recycled
Electric Power System	Voltage Converter 48V to 12V	10	12.54	125.40		✓	
Electric Power System	Current Sensor ACS712	1	2.18	2.18	✓		
Electric Power System	Voltage Sensor 0–25V	1	27.55	27.55	✓		
Control System	Raspberry Pi 5	1	161.5	161.5	✓		
Control System	Raspberry pi cooler	1	47.5	47.5	✓		
Control System	Raspberry Case	1	1.33	1.33	✓		
Control System	ESC BLHeli 40A	9	19.00	171.00		✓	
Control System	ESP32	1	9.50	9.50	✓		

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Control System	Web Camera	1	16.15	16.15	✓		
ROV Attachments	Pneumatic Arm	1	111.12	111.12		✓	
ROV Attachments	Shaft Coupler	1	1.43	1.43		✓	
ROV Attachments	Stepper Driver	2	2.56	5.12		✓	
ROV Attachments	Stepper Motor	2	9.02	18.04		✓	
Thrusters	Front Guard	9	0.82	7.38		✓	
Thrusters	Back Guard	9	0.49	4.41		✓	
Thrusters	Propeller	9	1.31	11.79		✓	
Thrusters	Holder	2	8.07	16.14		✓	
Thrusters	M3 Insert	10	0.10	1.00		✓	
Thrusters	M4 Insert	30	0.10	3.00		✓	
Thrusters	M3 Screws	100	0.03	3.00		✓	
Thrusters	Brushless Motor	9	5.70	51.30		✓	
Thrusters	M4 Screws	50	0.04	2.00		✓	
Body	Half ROV Top	2	37.72	75.44		✓	
Body	Back Top	2	25.14	50.28		✓	
Body	Recycled Frame	1	0.00	0.00			✓
Body	New Hull Machining	1	40	40	✓		
Body	Artillion Sheets	2	109.23	218.46	✓		
Consumables	Glue	23	0.10	2.30	✓		
Consumables	M4 20mm	50	0.06	3.00	✓		
Consumables	M3 16mm	100	0.02	2.00	✓		
Consumables	Wire 6mm	6	0.86	5.16	✓		
Consumables	Soldering	10	0.15	1.50	✓		
Consumables	Screws	175	0.02	3.50	✓		
Consumables	Nuts	30	0.04	1.20	✓		
Consumables	Extra Wire	10	0.86	8.60	✓		
Consumables	Heat Sink	12	0.72	8.64	✓		

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Lighting	Laser Lights	2	7.60	15.20	✓		
Waterproof Housing	Enclosure Top	1	19.53	19.53		✓	
Waterproof Housing	Enclosure Mid	1	13.62	13.62		✓	
Waterproof Housing	Enclosure Bottom	1	15.88	15.88		✓	
Waterproof Housing	Camera Enclosure	1	35.57	35.57	✓		
Waterproof Housing	Fan	2	0.66	1.32	✓		
Waterproof Housing	Artillion Tube	1	114	114	✓		
Waterproof Housing	Glands	20	1.24	24.69	✓		
Electric Power System	Ethernet Cable	1	15.2	15.2	✓		
Electric Power System	Wire 3 mm 10m	1	3.8	3.8	✓		
Electric Power System	Buck converter 8 am	1	4.2	4.2	✓		
New Thrusters	Bilge Pumps 2000gph	8	33.25	266	✓		
New Thrusters	Cytron MD10C DC motor driver	8	16.15	129.18	✓		
Vertical Tube	Acrylic Tube	1	47.5	47.5	✓		

Total: 1911.82 \$

Project Timeline

The development of the ROV was carried out over a structured timeline to ensure efficient progress and timely completion of all project phases.

- **Week 1–2:** Requirement definition and analysis of mission tasks
- **Week 3–4:** Conceptual design and brainstorming of system configurations
- **Week 5–6:** Detailed design of mechanical, electrical, and control systems
- **Week 7–8:** Procurement of components and initial prototyping
- **Week 9–10:** Assembly of the ROV structure and integration of subsystems
- **Week 11–12:** Development and testing of the control system
- **Week 13–14:** System integration and debugging
- **Week 15:** Pool testing and performance evaluation
- **Week 16:** Final modifications, optimization, and documentation preparation

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Conclusion

The development and testing of DIY thrusters for our ROV proved to be a successful endeavor, offering a cost-effective alternative to commercially available options. Through meticulous design, fabrication, and experimentation, we optimized the performance of the thrusters, achieving greater thrust output and efficiency. The insights gained from this project not only contribute to our participation in the MATE competition but also demonstrate the potential for affordable, high-performance thruster solutions in regions with limited access to specialized equipment.

Acknowledgments

We extend our heartfelt gratitude to the marine and offshore engineering department, encompassing esteemed professors, dedicated staff members, and invaluable mentors, whose unwavering guidance and constructive feedback have been instrumental throughout our project journey. Their collective expertise and encouragement have not only enriched our learning experience but have also played a pivotal role in shaping the success of our endeavors. We are profoundly grateful for their generous support, without which our team would not

have been able to navigate the challenges and opportunities inherent in competitive environments.

Additionally, we would like to express our



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deepest appreciation to MATE and all their staff and volunteers for affording us the invaluable opportunity to showcase our work. Their commitment to fostering innovation and excellence within the maritime community is commendable, and we are honored to have been a part of such a prestigious platform.

As we reflect on our journey, we recognize and cherish the profound impact that the guidance and support of both our academic institution and MATE have had on our growth and development as aspiring engineers. Their unwavering belief in our capabilities has inspired us to strive for excellence and pursue our passion for marine engineering with dedication and determination.

In conclusion, we offer our sincerest gratitude to all those who have contributed to our journey, enriching it with their wisdom, encouragement, and support. It is through their collective efforts that we stand poised to

make meaningful contributions to the field of marine engineering and beyond. Thank you.

Future Developments

One significant challenge we encountered this season was the shortage of crucial components like ESCs and delayed material deliveries, hindering our progress. Despite the potential increase in costs, the advantages far outweigh the expenses. Additional parts not only facilitate ongoing development but also serve for future research endeavors.

AQUA Masters is committed to continuous advancement, adapting designs to embrace modern technologies. Innovation is at the core of our ethos, as we explore novel methods to enhance our ROV designs. Our primary objective is integrating a localization system into our ROV, marking a significant stride towards achieving full autonomy without the need for manual piloting.

In tandem with the deployment of Tiny Shark, several custom modules have been devised and will be incorporated into next year's system. While we've made significant strides within a short timeframe, AQUA Masters remains dedicated to ongoing educational enhancement and refinement. Tiny Shark stands as our most impressive prototype to date, embodying both our achievements and the challenges we've overcome. However, our commitment to pushing boundaries and embarking on ambitious projects remains unwavering.