KELPIE ROBOTICS

MAY 2025

TECHNICAL REPORT

KELPIE ROBOTICS '25

University of Ottawa, Ottawa, ON, Canada

PRESENTED TO

MATE ROV COMPETITION 2025 - EXPLORER CLASS

MANAGEMENT TEAM

CEO - Juan Hiedra Primera
COO - Carolina González G.
CTO Software - Rafal Rytwinski
CTO Mechanical - Dakota Squires
CTO Electrical - Adam Dia
CTO Float - Ethan Bowering
Jr. Logistics - Mathis H. Barrette
Jr. Electrical - Isaiah Kwapisz
Jr. Float - Abdullah Ramadan
Mentor - Jason Demers

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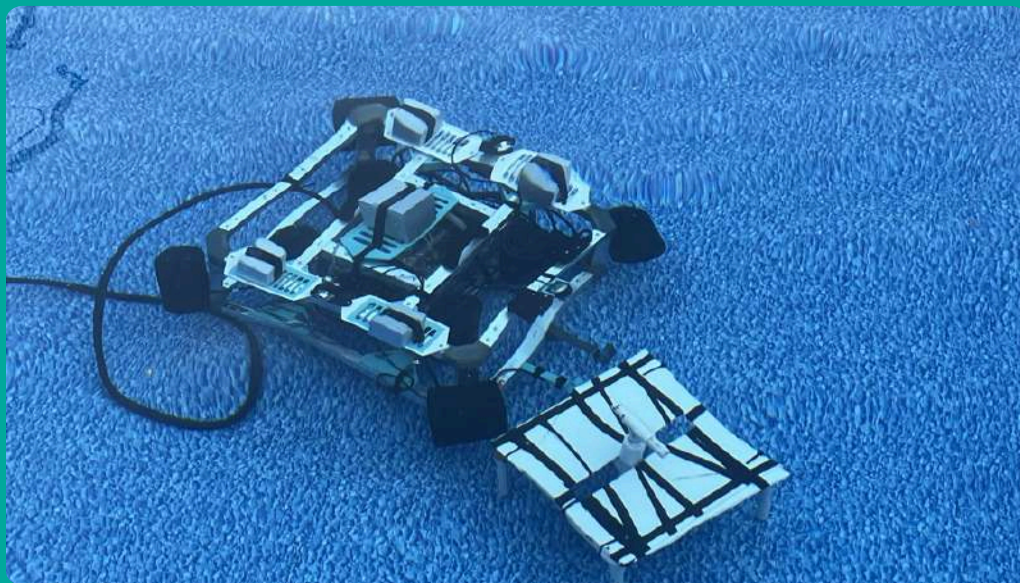


Figure 1: SELK-I

ABSTRACT

Kelpie Robotics is proud to represent the University of Ottawa in the 2025 MATE ROV Competition under the EXPLORER class. This international competition challenges student teams to design, build, and operate remotely operated vehicles (ROVs) to complete real-world underwater missions.

Our entry, SELK-I, is a high-performance ROV engineered for agility, stability, and versatility. This year’s design emphasizes modularity, reuse of proven components, and improvements in underwater maneuverability and control. SELK-I is equipped to perform tasks such as object manipulation, navigation through complex environments, and real-time environmental sensing.

Beyond the vehicle itself, this project reflects a year of coordinated work by a large and diverse team. Students from electrical, mechanical, software, and management backgrounds collaborated in Agile-inspired cycles of development and testing. With dedicated access to the John McEntyre Team Space and Brunsfield Centre at the University of Ottawa, our team iterated on every subsystem—from our 3D-printed attachments to the temperature sensor stack.

In this report, we present the rationale, design, and testing of SELK-I’s subsystems. We also document the challenges encountered and overcome, the innovations developed, and the teamwork that brought SELK-I to life. Through this effort, Kelpie Robotics continues its mission: to empower students with hands-on engineering experience while building systems that perform with purpose.

Kelpie Robotics has also designed a non-ROV Device (Float) and is actively involved in Corporate Responsibility efforts. Please refer to the respective documentations.

COMPANY OVERVIEW & PROJECT MANAGEMENT

TEAM HISTORY & GROWTH

Kelpie Robotics was founded in 2022 by a group of passionate engineering students at the University of Ottawa. At the forefront of this initiative was our current CEO, Juan Hiedra Primera, who sought to create a hands-on environment where students could apply their technical knowledge to real-world ocean challenges through robotics.

What began as a small exploratory project quickly evolved into a structured organization committed to innovation, sustainability, and technical excellence. Since its founding, the team has grown to include approximately 50 active members, spanning multiple engineering disciplines and academic years.

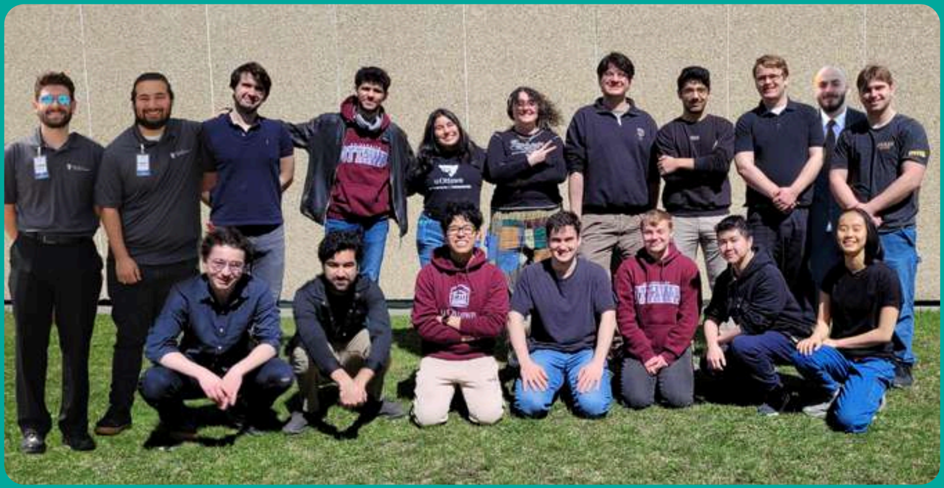


Figure 2: Kelpie Robotics Team Leads joined by several core and general members

Now entering our third competitive season, Kelpie Robotics is proud to present our newest vehicle, SELK-I, as part of the Explorer class of the MATE ROV Competition.

ORGANIZATIONAL STRUCTURE

To maintain efficiency and specialization, the team is divided into five sub-teams, each focusing on a core area of the project:

- **Mechanical Team** - Designs the vehicle frame, buoyancy system, enclosure mounts, and payload tools.
- **Electrical Team** - Manages ESC carrier boards, power distribution, tether integration, and sensor connectivity.
- **Software Team** - Implements control logic, telemetry, ROS2 communication, and onboard sensor processing.
- **Float Team** - Develops and deploys a separate float system for environmental monitoring and sensor testing.
- **Logistics Team** - Oversees procurement, documentation, competition deliverables, and travel coordination.

Each sub-team is led by a Team Lead, typically a senior student with relevant experience. Supporting each lead is a Junior Lead, who is mentored throughout the year to eventually assume the lead role. This mentorship model ensures sustainability, knowledge retention, and long-term team continuity.

To balance high performance with member engagement, Kelpie Robotics operates under a two-tier structure: the Core Team (~20-25 members) focuses on building and operating SELK-I, while the Outer Team (~25 members) engages in exploratory projects—offering a flexible, hands-on experience for students with limited availability.

PROJECT SCHEDULING AND AGILE WORKFLOW

The team uses a hybrid Agile methodology to manage progress throughout the year:

Macro Planning - At the start of the season, the executive team establishes a roadmap that includes key milestones: concept generation, subsystem prototyping, vehicle assembly, system integration, validation, and competition readiness.

Micro Execution - Day-to-day task tracking is handled through Kanban boards on Agile project management platforms. Each sub-team manages their own Kanban board with columns such as Backlog, In Progress, Testing, and Done. Weekly sub-team check-ins and monthly all-hands scrums help synchronize tasks and resolve cross-team dependencies.

This structure supports adaptability and transparency, making it easier to track tasks, reprioritize quickly, and ensure consistent momentum.

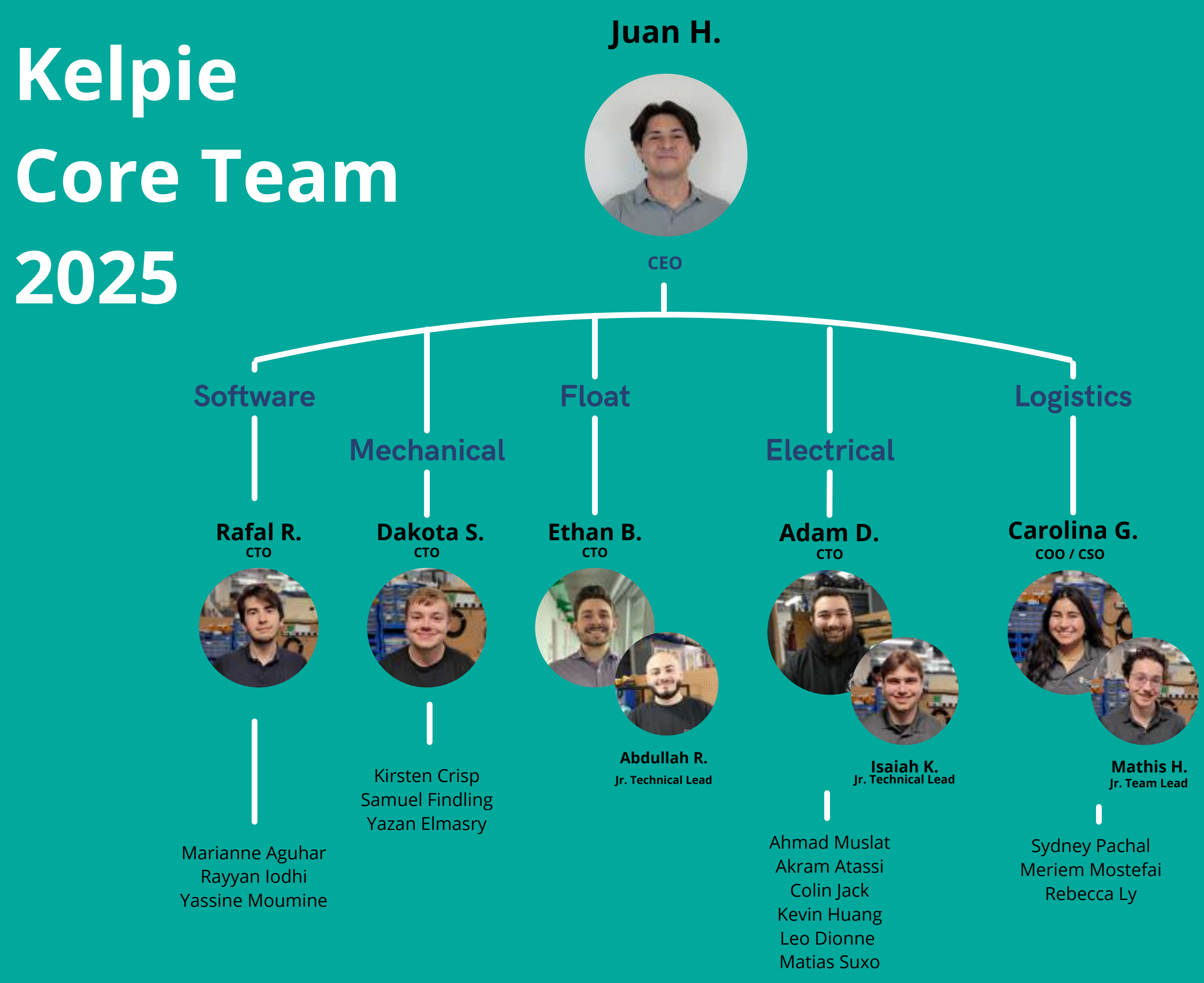


Figure 3: Kelpie Robotics Core Team organizational chart

FACILITIES & RESOURCE MANAGEMENT

Kelpie Robotics operates out of the **John McEntyre Team Space (JMTS)**, located in the STEM Complex at the University of Ottawa. This collaborative engineering hub — offered through the **Faculty of Engineering's Centre for Entrepreneurship and Engineering Design (CEED)** — provides competitive teams with the infrastructure and support needed to prototype, iterate, and compete on an international scale.

Figure 4 (top) and 5 (bottom): Bandsaw and mill at Brunsfield Center being used to prepare the frame's aluminum channels.

Day-to-day collaboration takes place in JMTS, where team members coordinate tasks, test assemblies, and host integration sessions. The environment fosters hands-on learning while emphasizing safety, accountability, and respect for shared resources.

The **Brunsfield Centre** in the STEM Complex allows team members to use advanced manufacturing tools for precise fabrication and custom parts assembly. To ensure safety, access to tools is granted only after completing training and safety certifications, ensuring that all operations comply with CEED protocols.

Our mentor, Jason Demers, is CEED's Competitive Teams Manager and Manufacturing Advisor, playing a key role in supporting our team's work. Whether for troubleshooting manufacturing issues or advising on material selection, his expertise is a vital resource throughout the build process.

The CEED environment and spaces, with their vibrant community of students, faculty, and industry advisors, enable Kelpie Robotics to turn ideas into competition-ready systems.

VEHICLE DESIGN

ENGINEERING DESIGN RATIONALE

Our 2025 ROV aimed to be more lightweight, achieve greater maneuverability, and simplify assembly further than previous models. Previous versions used a hollow, rectangular prism-shaped frame for modularity and accessibility. This year, we retained the overall shape but refined its dimensions to reduce material use and optimize for modularity and maneuverability.

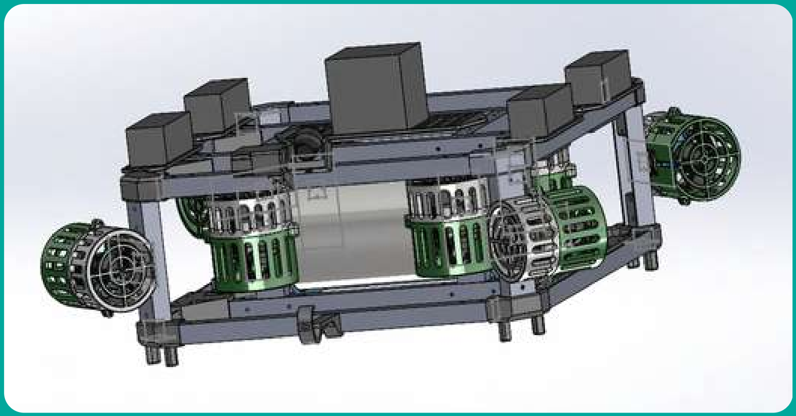


Figure 6: SELK-I CAD model

The design process was iterative, driven by practical testing and strategic trade-offs. We evaluated multiple frame concepts, including plate- and extrusion-based options, but ultimately chose to adapt our existing extrusion-based frame format to reduce manufacturing complexity and cost. Every major design decision was guided by mission requirements, cost efficiency, and reuse of proven components.

VEHICLE STRUCTURE

The redesigned frame measures 24.5 cm in height, 61.5 cm in length, and 54.0 cm in width, with a total dry mass of 6.75 kg. Compared to the 2023 frame, which stood at 60 cm in height and weighed over 10 kg, this redesign represents a significant improvement in weight and size without compromising structural integrity.

The ROV frame consists of two key components: an **outer frame** that defines the shape and houses external modules, and an **inner frame** that secures the enclosure.

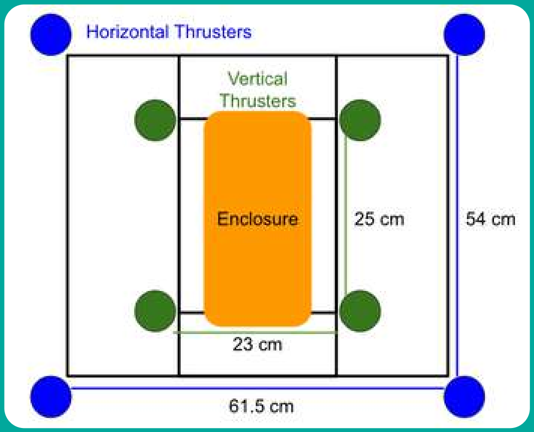


Figure 7: Dimensional frame diagram

BUOYANCY AND STABILIZATION

Neutral buoyancy of the ROV was achieved through a combination of air encapsulated in the enclosure and high-rigidity foam to create lift. There are five foam mounting surfaces on top of the ROV; one located in the center, and two along the left and right sides. Each mount has an adjustable ladder-like structure which allows for the adjustable positioning of the foam via a Velcro strap.

Stability was a key design goal for SELK-I. To achieve this, geometric symmetry was at the forefront of the design by utilizing a rectangular shape and positioning all heavy components evenly across the shape.

Figure 8 (left): Foam mounting platform modeled in Fusion 360.
Figure 9 (right): SELK-I floating on surface during pool testing.

MATERIAL: ALUMINUM U-CHANNEL

6061 aluminum U-channels were selected for their excellent balance of strength, low weight, corrosion resistance, and affordability, making them ideal for continuous underwater exposure. Compared to hollow square or cross-channel designs, U-channels reduced material cost and total mass while maintaining structural stability and allowing for easy assembly. The channel geometry also serves as cable routing and improves water drainage.

3D-PRINTED JOINTS

All U-channels are connected via custom 3D-printed joints made from PETG (polyethylene terephthalate glycol) filament, for its high strength, impact resistance, and ease of printing. All prints were done in-house using high-quality 3D printers, enabling rapid iteration, precise dimensions, and significant cost savings compared to outsourcing complex geometries.

Based on expected load and stress distribution, the joints were designed to be roughly twice the width of the channel, ensuring sufficient surface area without excessive bulk and improving force distribution under load. All major frame intersections are connected at 90° angles, providing key structural reinforcement.

The inner vertical bars are connected using a unique angled joint structure that adds wall thickness where needed, helping to manage stress concentrations caused by abrupt geometry changes. These joints are also filled internally, contributing to the vehicle's passive buoyancy without increasing external drag.

Outer corners of the frame use 90/45° joints so that horizontal thrusters could be angled for better maneuverability. Lower corner joints are equipped with flexible TPU (thermoplastic polyurethane) covers to provide a softer interfacing surface.

Joints feature M4 screw holes in symmetrical layouts for flexible configurations and universal mounting, as well as chamfered edges for easier printing and assembly.

Figure 10: Different joints used on the frame.

ENCLOSURE

The ROV's electrical components are housed in a 6 in transparent acrylic tube sourced from Blue Robotics. Its cylindrical design promotes buoyancy by enclosing air and avoiding additional padding, which also reduces weight. The enclosure is centrally mounted within the frame to optimize center of gravity and vehicle stability.

A square metal enclosure was originally considered but was discarded after failing leak-proofing tests. Leveraging prior experience and testing, the team reverted to the proven acrylic design. Reusing the existing enclosure not only reduced integration challenges but provided a cost-effective and reliable solution without compromising structural integrity.

A custom 3D-printed mount was designed by the team to secure the tube. It rests in a semi-circular cup with an extended lip to lock the end cap, preventing rotation. It is fastened using Velcro straps and zip ties—allowing for quick access while ensuring secure fastening during operation.

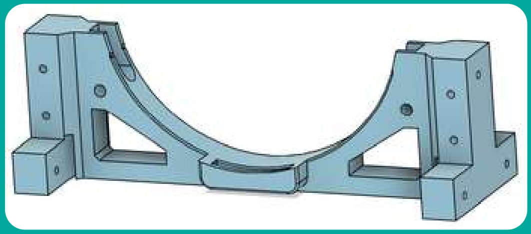


Figure 11: Enclosure mount modeled in Fusion 360

Thrusters
The propulsion system includes eight Blue Robotics T200 thrusters—four mounted horizontally and four vertically.

The vertical thrusters are installed at the inner square corners, directly on the inner frame's vertical bars. For enhanced maneuverability, the horizontal thrusters are angled at 45° on each exterior corner, enabling precise:

- Obstacle navigation
- Object approach and manipulation
- Stable hovering (with vertical control)
- Tether-aware rotation using yaw

This layout ensures complete 6-degree-of-freedom control while preserving internal space and cable routing efficiency. Safety shrouds cover all blades to protect handlers and prevent entanglement.

Cameras
To enhance operational awareness, the ROV features up to four cameras, both servo-mounted and static. One servo-mounted camera monitors the manipulator during manipulation, while the other provides a pan view of the ROV to prevent entanglement. The static cameras offer fixed perspectives, including one focused directly on the manipulator to improve depth judgment during object interaction.

This configuration not only improves mission task execution but also adds redundancy: if a servo camera fails, a static backup ensures continued operation.

Manipulator System - CLAW
The CLAW manipulator was designed for versatility and simplicity. Constructed from multiple layers of laser-cut ¼-inch acrylic, it can be rapidly fabricated in-house, minimizing outsourcing costs. The design includes two interchangeable arms:

- A curved arm for lifting larger objects like pipes.
- A straight arm for smaller or precision tasks such as pin retrieval.

These arms are mounted on either side of a fixed bar driven by a servo motor. The shaft enabling end effector rotation is 3D printed to match the layered geometry of the CLAW.

To allow CLAW to rotate freely while resisting water exposure, a plain thrust bearing was selected. A water-resistant ball bearing was originally considered, but due to higher costs and implementation challenges, the team opted for the thrust bearing—a simpler and more cost-effective solution that still performs well underwater.

Mechanical Design "Build VS Buy VS Reuse" Summary

Build	Buy	Reuse
JOINTS: Custom modular 3D-printed joints allow for specific channel connections that balance strength with weight minimization.	**CLAW SERVOS:** Using existing waterproof servo casings rather than making our own provides reliability and functionality.	**THRUSTERS:** The Blue Robotics T200 Thrusters seen on our previous ROVs remain the primary method of movement for SELK-I.
END EFFECTORS: To ensure our manipulators best adhere to mission requirements, we decided to design and manufacture our own end effectors.		**ENCLOSURE:** The Blue Robotics 6" Enclosure used in previous iterations of our ROV continues to provide a reliable waterproof housing to our electronic systems.

ELECTRICAL & CONTROL SYSTEMS

ENGINEERING DESIGN RATIONALE

The electrical system of SELK-I was engineered to be modular, compact, and robust, balancing power distribution, space constraints, and control requirements within a watertight enclosure. Key decisions were driven by previous testing experience and the need to maximize reliability while minimizing cost and integration complexity. A stackable ESC board design was chosen to reduce the space used in the enclosure. A custom power board architecture enabled safe and efficient power delivery across systems, while the single-board computer (SBC) processing unit provided a flexible platform for sensor integration, control logic, and telemetry.

Trade-offs such as building a custom Pi HAT versus purchasing a commercial solution, and reusing existing converters and cameras, were made to reduce cost and increase system familiarity. This approach reflects a deliberate effort to reuse proven components while integrating custom in-house solutions that allow for rapid iteration, diagnostics, and precise control of the ROV in mission-critical scenarios.

SYSTEM OVERVIEW

SELK-I's electrical architecture is divided into three core modules:

1. **Central Processing Module** - Manages sensors, cameras, telemetry, and control inputs.
2. **ESC Carrier Boards** - Host the motor controllers for all propulsion units.
3. **Power Distribution Board** - Regulates and distributes voltage and current to each subsystem.

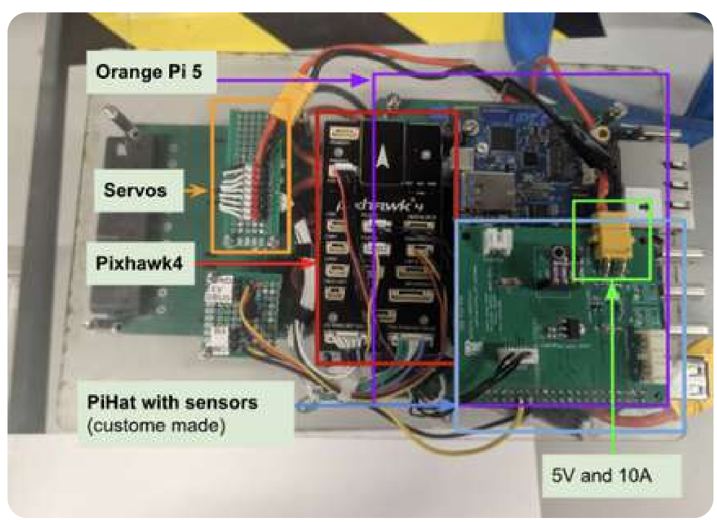
CENTRAL PROCESSING UNIT

The brain of the system is an Orange Pi SBC running the Ubuntu 24.04 LTS Linux distribution. It interfaces with the Pixhawk 4 flight controller via a serial connection, and connects to the topside computer via Ethernet. The SBC relays control inputs, handles video streams from the three cameras and logs sensor data from:

- SHT30 (internal temperature sensor, via I2C)
- DS18B20 (external temperature sensor, via 1-Wire)
- Bar30 (pressure sensor, connected to Pixhawk)
- Internal leak sensor

Two cameras are used for active navigation, while the third performs mission-specific tasks and can be moved to provide alternative perspectives.

Figure 12: Central Electronics Module of SELK-I



ESC CARRIER BOARDS

SELK-I uses eight motors for full 6-DOF movement. Each motor is paired with an **Electronic Speed Controller (ESC)**. To **ensure redundancy**, a ninth ESC is integrated as a live spare.

Each carrier board holds three ESCs that share a 12V power rail. The boards are stacked vertically with standoffs, conserving enclosure space while maintaining thermal separation. Individual data harnesses ensure that each ESC receives a unique signal from the Pixhawk flight controller.

POWER DISTRIBUTION

Incoming power from the topside unit arrives as 48V DC. This is stepped down as follows:

- 3 × 12V 30A rails for the ESC carrier boards via three high-efficiency power converters
- A 5V 10A rail for low-power systems, including the SBC, sensors, and cameras

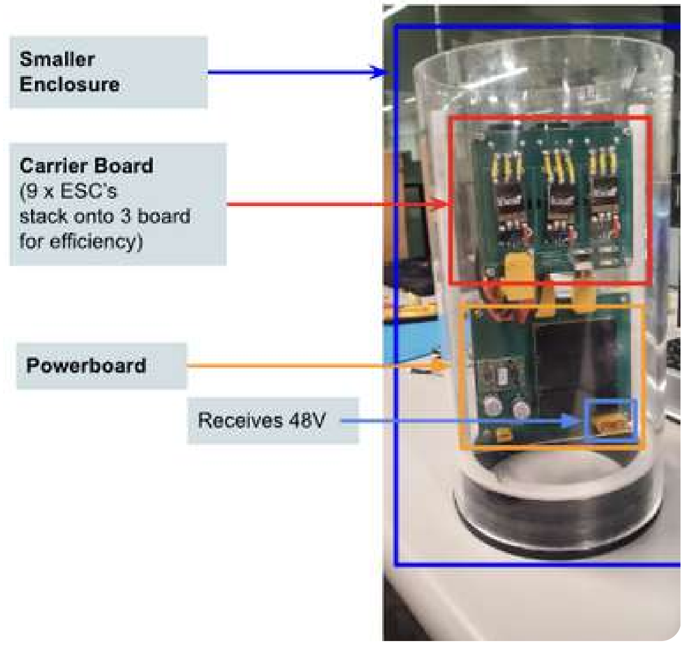
Two 5V 5A UBECs (Universal Battery Eliminator Circuits) convert 12 V to 5 V. This power is then distributed among the peripherals via the Pi-HAT.

Under full load, SELK-I draws approximately 1238W, staying safely under the 1440W competition maximum

DESIGN TOOLS AND FABRICATION

KiCAD was used to design PCB schematics for the custom Pi HAT, ESC carrier boards, and power board. The compact ESC stacking design allowed for a smaller enclosure. Power converters were chosen from existing off-the-shelf components, lowering integration cost while improving familiarity.

Figure 13: Internal Power and Motor Control System Inside SELK-I's Enclosure



COMMUNICATION AND TETHER MANAGEMENT

The tether includes:

- Ethernet for video and data transfer
- Power lines delivering 48V DC

SELK-I uses the following data protocols:

- I2C for internal sensors
- 1-Wire for external temperature
- UART for control signals and telemetry
- Ethernet (TCP/UDP) for camera feeds and topside data exchange

A tether management protocol prevents tangling and strain. Tether strain reliefs are installed at cable entry points. Tether length is adjusted manually based on task and pool dimensions.

Electrical Design "Build VS Buy VS Reuse" Summary

Build

Pi HAT: Our custom Pi HAT solution allows us to incorporate sensors and servos that may not directly or easily interface with our flight controller or SBC, while providing a clean and modular solution.

Buy

FLIGHT CONTROLLER: Using an off-the-shelf flight controller allows SELK-I to benefit from existing flight stabilization functionality, and provides reliability and functionality.

Reuse

DC-DC CONVERTERS: Our previously-used 48-12V DC-DC and 12-5V DC-DC converters continue to provide a reliable, effective, and efficient source of power delivery and conversion.

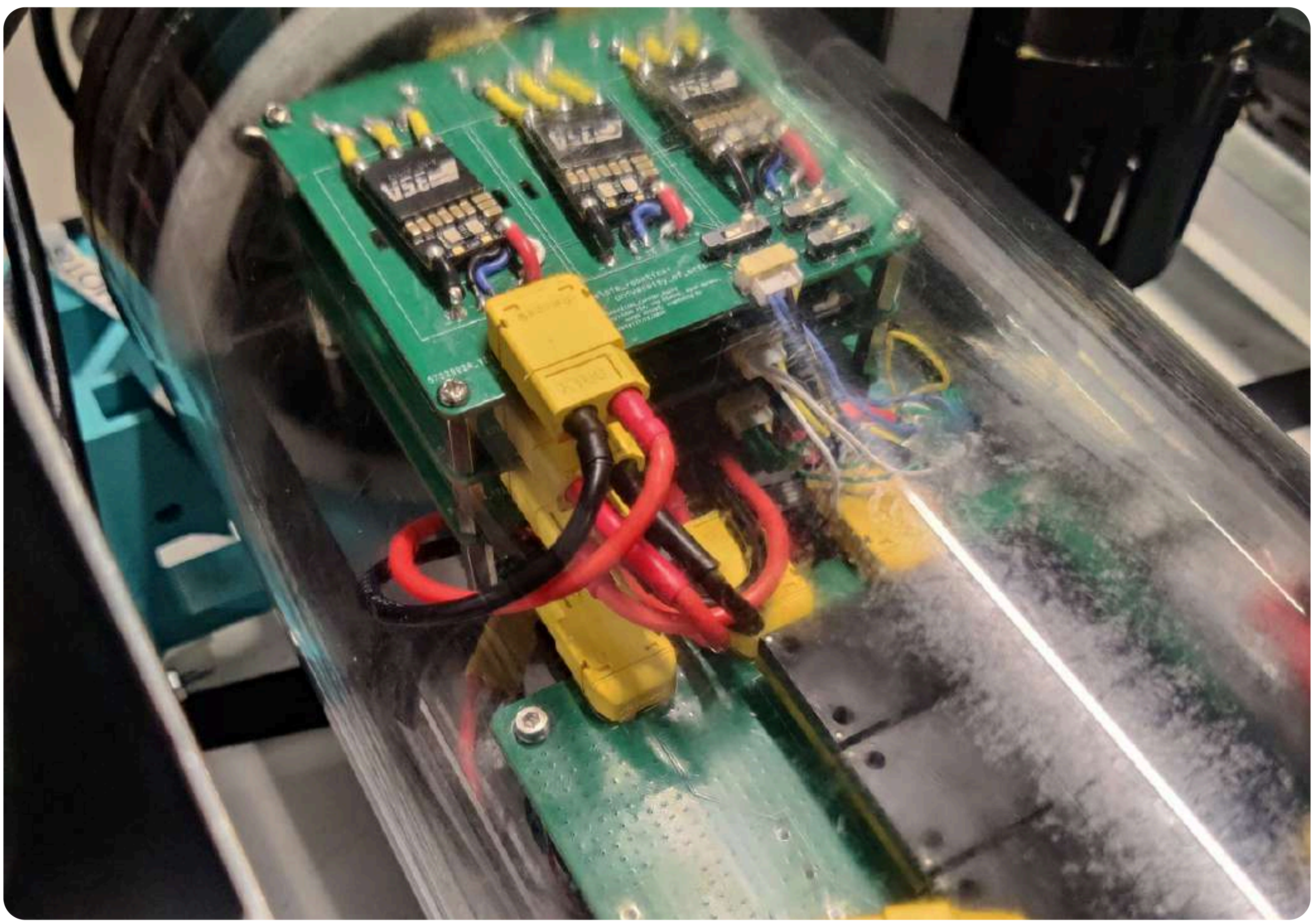


Figure 14: Motor Control System Inside SELK's Enclosure and Frame

SOFTWARE ARCHITECTURE

ENGINEERING DESIGN RATIONALE

The SELK-I control system was designed to balance **mission-ready reliability** with **forward-looking modularity**. Two architectures were developed: Scope 1, the deployed system for the MATE 2025 competition, and Scope 2, a ROS2-based system under development. Both scopes leverage ArduSub as a fully-featured open-source solution; but while Scope 1 uses individual software modules, Scope 2 explored extensibility for future capabilities such as a unified communication layer, and autonomous navigation.

SCOPE 1 - DEPLOYED CONTROL STACK

Pixhawk 4 - Primary Flight Controller

The Pixhawk 4 runs the ArduSub firmware, responsible for PID stabilization, reverse kinematics for 6-DOF movement, and autonomous control modes such as 'depth hold' and 'stabilize'. It directly interfaces with the Bar30 pressure sensor for real-time depth feedback, and a power module that monitors total voltage and current draw.

SBC - Companion Computer

The SBC communicates with the Pixhawk over UART and runs several critical processes such as:

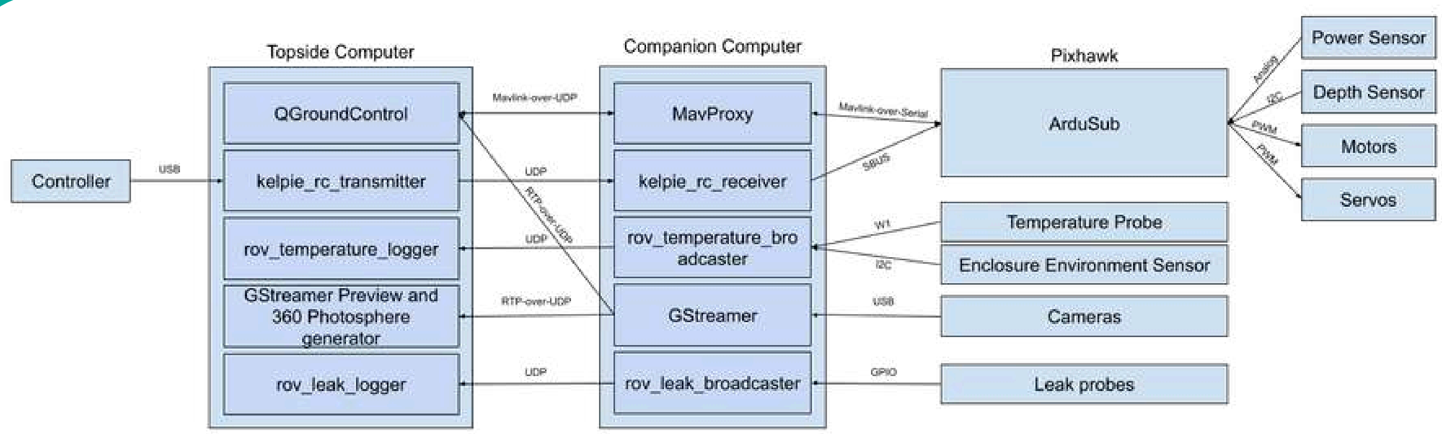
- **MAVProxy:** Facilitates MAVLink message forwarding between the Pixhawk and the topside computer.
- **GStreamer:** Streams USB camera feeds over UDP to topside.
- **ROV-Temperature-Broadcaster:** A custom UDP broadcaster written in C++ that gathers and transmits data from two sensors:
  - DS18B20 (external, 1-Wire)
  - SHT30 (internal, I^2C)
- **Remote Contol Receiver:** A UDP controller that receives inputs and sends them to the Pixhawk via SBUS Protocol.
- **Leak Broadcaster:** A transmitter for the leak sensor's reading.

These drivers were developed in-house in C++ due to the lack of existing low-level libraries suitable for performance-critical use.

Topside Computer - Ubuntu 24.04 LTS

The surface system runs QGroundControl to interpret controller inputs and display the feed from one of the cameras. Additional previews are displayed via separate GStreamer pipelines. It also receives temperature data over UDP for diagnostics.

Figure 15 : Scope 1 - SID



Communication & Protocol Stack

- UART: Between Pixhawk and SBC
- I^2C: Internal temperature sensor (SHT30)
- 1-Wire: External temperature sensor (DS18B20)
- Ethernet: Used for MAVLink (via TCP), sensor data (via TCP), and video (via UDP)

SCOPE 2 – ROS2 ARCHITECTURE (IN DEVELOPMENT)

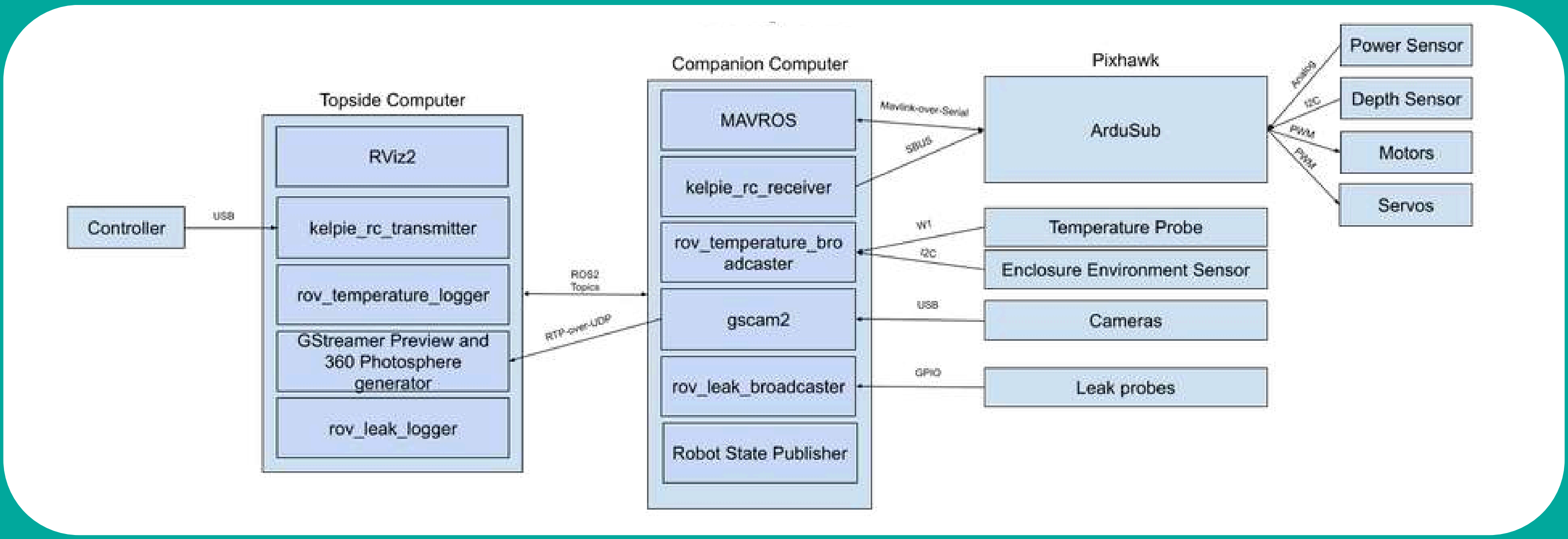
Scope 2 represents SELK-I's future control direction by leveraging ROS2. Its core components include:

- mavros: Replaces MAVProxy to integrate Pixhawk into the ROS2 ecosystem
- gscam2: Native ROS2 camera node replacing GStreamer, with potential to unify all camera streams
- Custom ROS2 Nodes: Replace all current UDP implementations with ROS2-based ones.
- Robot State Publisher: Broadcasts SELK-I's URDF model for spatial awareness and future SLAM integration
- ROS-based visualization: A planned Python interface to plot historical data from pressure and temperature sensors

This system uses ROS2 nodes to improve fault isolation and testing and lays the foundation for future capabilities like autonomous navigation, sensor fusion, and integration with additional sensors.

Though development was progressing, integration challenges prevented deployment for the 2025 competition season. Future work will build on this system for post-competition development and data analysis.

Figure 16 : Planned Scope 2 - SID



TESTING & VALIDATION

TESTING METHODOLOGY

To validate SELK-I's mechanical stability, buoyancy behavior, and control system performance, a series of pool tests were conducted at various stages of development. These tests were designed to iteratively verify system readiness for mission tasks and to isolate electrical and control issues in a low-risk environment.

Figure 17: Buoyancy testing of SELK-I

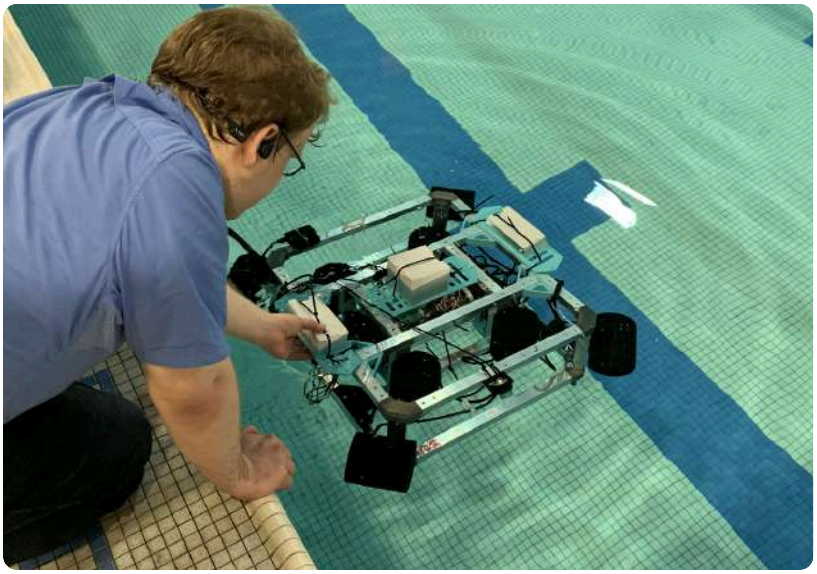


Table 1 - Pool Test Results

#	Test Focus	Outcome	Lessons Learned / Adjustments
Pool Test 1	Initial power-up and connection	Failed — Ethernet issue prevented connection	Switched tether connector design; improved cable strain relief
Pool Test 2	Buoyancy check, passive stability	Power issue at tether prevented drive testing, but buoyancy testing and calibrating was done	Confirmed more buoyancy needed; added foam; fixed connector issues
Pool Test 3	First drive + claw & camera hardware	Thruster mapping had some issues, but the system connected	Identified mapping error
Pool Test 4	Full functionality, manipulator tuning	Success — Thruster mapping was fixed, depth hold and attachments worked fully	Verified stability modes; improved end effectors

TROUBLESHOOTING TECHNIQUES

- **Power Path Debugging:** Electrical failures traced to a faulty power connector; resolved by redoing the tether head and re-terminating all connections.
- **Ethernet Link Issues:** Early connection failures were resolved by isolating crosstalk interference and shielding key pairs in the tether.
- **Thruster Mapping Errors:** Movement irregularities were traced to incorrect channel assignments in ArduSub. This was resolved through systematic motor testing and remapping via QGroundControl.
- **Manipulator Tuning:** The CLAW's servo angle and arm profiles were iterated between tests to improve its grip on cylindrical and narrow objects.

ITERATIVE PROTOTYPING

Between tests, mechanical and electrical sub-teams collaborated to:

- Install foam blocks incrementally for buoyancy tuning
- Add thruster spacers and reposition motors
- Modify static and servo camera mounts
- Design and attach TPU covers
- Refactor the servo control logic for better CLAW responsiveness

Each mechanical change was tested in water, and logging from the Orange Pi helped monitor sensor behavior in real time. Testing under real-world pool conditions was essential to achieving system stability, confirming depth hold accuracy, and validating CLAW functionality.

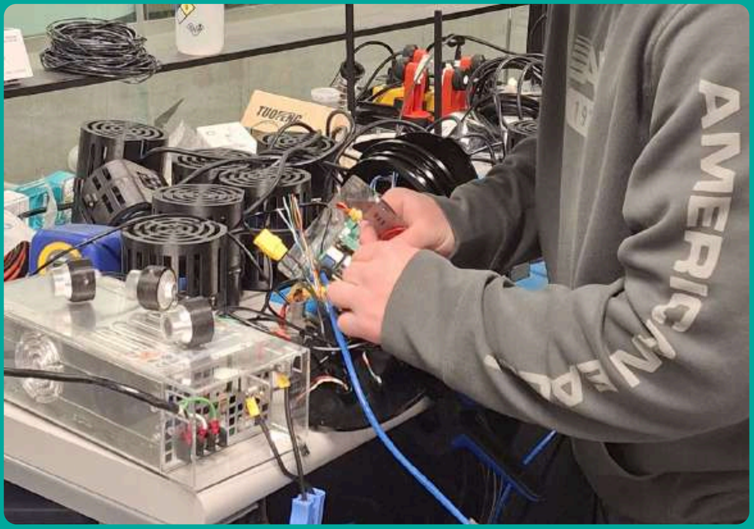


Figure 18: Re-crimping failed ethernet cable

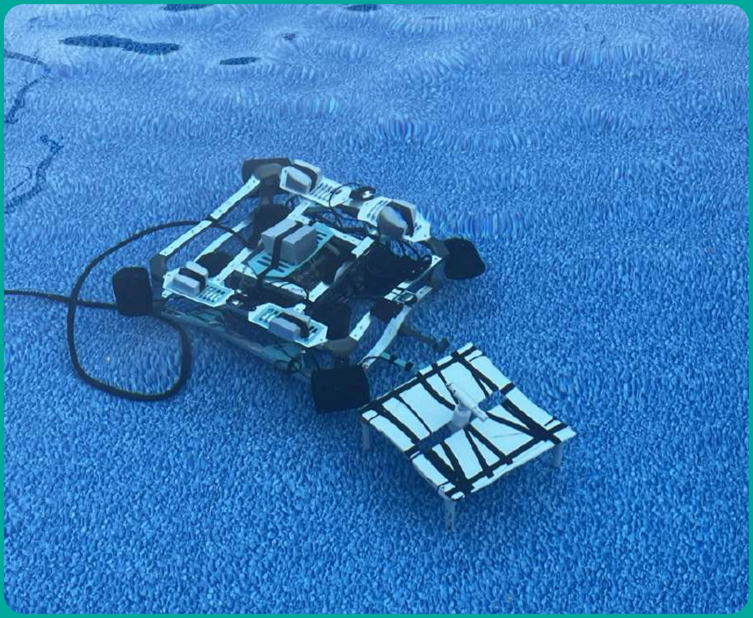


Figure 19: SELK-I performing missions

SAFETY CONSIDERATIONS

GENERAL SAFETY RATIONALE

The SELK-I ROV was developed with a safety-first mindset, prioritizing the protection of team members, equipment, and testing environments. Throughout the design and build process, safety protocols were integrated into electrical, mechanical, and operational decisions. The SELK-I team took proactive steps to prevent hazards such as electrical shorts, overheating, water ingress, sharp edges, and unintentional thruster activation.

PERSONNEL SAFETY MEASURES

- **Leak Detection Sensors:** Multiple leak sensors were installed in the main electronics enclosure to immediately alert the operator to potential water ingress during operation.
- **Thruster Shrouds:** All thrusters are equipped with protective shrouds to prevent accidental contact during handling and poolside work.
- **Power Isolation:** Main power is disconnected during maintenance using accessible inline connectors and circuit isolation, reducing the risk of accidental startup.
- **Landing Covers:** The frame's base features TPU landing pads, minimizing the risk of damage or sharp contact when placing the robot on surfaces.

EQUIPMENT & ELECTRICAL SAFETY

- **Short Circuit Protection:** All major power rails are protected using power converters with integrated short-circuit and overcurrent protection.
- **Thermal Monitoring:** The internal temperature of the main enclosure is constantly monitored via the SHT30 sensor. Threshold alerts are used to prevent overheating.
- **Cable Management:** The tether and internal wiring use heat-shrink, zip ties, and shielding to prevent short circuits, entanglement, and signal interference.
- **ESC Thermal Separation:** ESCs are mounted in a stacked configuration using standoffs, which allows for airflow between units and prevents heat buildup via direct contact.

OPERATIONAL SAFETY PROTOCOLS

- **Pre-Deployment Checklist:** Before each test or mission, the team follows a checklist that includes tether inspection, battery checks, leak sensor verification, and software diagnostics.
- **Dry Power-On Testing:** All subsystems are tested out of water prior to deployment to ensure stable software communication and electrical connections.
- **Surface Operator Lock-In:** The joystick and command software remain disabled until verbal confirmation is given that the area is clear and all systems are verified.

BUDGET & COST ANALYSIS

Revenue			
Crowdfunding (donations and sponsors)	USD 3,782.17		
uOttawa Engineering Endowment Fund	USD 8,644.96		
JMTS Donor Fund Faculty Match	USD 3,241.86		
TOTAL	**USD 15668.99**		
BOM and Manufacturing Costs	**PREDICTED**	**COST**	**SPENT '24-25**
Aluminum U-Channel	USD 540.31	USD 297.71	USD 297.71
PETG Filament	USD 144.08	USD 117.05	USD 117.05
Fasteners	USD 72.04	USD 60.20	USD 60.20
PCB Manufacturing	USD 1,080.62	USD 520.94	USD 520.94
Electronic Components/Connectors + Tether	USD 1,440.83	USD 1,550.42	USD 1,550.42
Cameras	USD 0.00	USD 1172.18	USD 0.00
Thrusters	USD 0.00	USD 1041.30	USD 0.00
Manipulators	USD 720.41	USD 1326.19	USD 665.34
Non-ROV Device	USD 360.21	USD 301.62	USD 301.62
TOTAL	**USD 6050.00**	**USD 6387.61**	**USD 3513.28**
Operational Costs	**PREDICTED**		**SPENT**
Pool Rental	USD 360.21		USD 441.70
Transportation and Lodging	USD 7,168.11		**SEE NOTE 2**
Prop Construction	USD 72.04		USD 81.80
Marketing and Apparel	USD 792.45		USD 791.09
TOTAL	**USD 8392.81**		**USD 1314.59***
NET	**USD 1226.18**		**USD 10841.12***

NOTE 1: All costs converted from CAD

NOTE 2: Travel costs not yet finalized; we project a **USD 3673.01** surplus

TIMELINE

PLANNING	DUE DATE
• TEAM RECRUITMENT • KICKOFF BRIEFING • PRELIMINARY DESIGN REVIEW	• SEPT 20TH 2024 • SEPT 27TH 2024 • OCT 11TH 2024
DESIGN	**DUE DATE**
• INTERNAL DESIGN REVIEWS • CRITICAL DESIGN REVIEW (WITH EXTERNAL MENTORS)	• OCT 18TH 2024 • OCT 29TH 2024
MANUFACTURING	**DUE DATE**

• CORE SYSTEMS IMPLEMENTATION
    ◦ ENCLOSURE
    ◦ FRAME
    ◦ SOFTWARE STACK
	• JAN 20TH 2025

TESTING	**DUE DATE**
• PASSED ALL COMPREHENSIVE TESTING • PRE-COMPETITION SUBMISSIONS	• MAR 15TH 2025 • MAY 15TH 2025
TRAVEL	**DUE DATE**
• PACKAGE ALL TOOLS AND ROV PARTS • LEAVE TO ALPENA, MI • TRAVEL BACK TO OTTAWA, ON	• JUN 13TH 2025 • JUN 15TH 2025 • JUN 22ND 2025

Conclusion

Kelpie Robotics’ journey through the MATE ROV competition has been a transformative experience. We've grown our skills in mechanical design, electronics, and software by building a vehicle that responds to real marine challenges.

Along the way, we learned practical lessons—like the importance of ordering components early, allowing for iteration and failure in 3D prints, and always measuring twice before cutting. These setbacks were not roadblocks but stepping stones that taught us how to think like engineers.

Moving forward, we plan to apply these lessons with greater foresight—streamlining our prototyping process, improving our design cycles, and continuing to innovate with both care and curiosity. As we refine our technical skills, we remain mindful of why we compete: to better understand and protect our oceans. Each improvement we make to our ROV is also a step toward improving how we interact with and preserve marine life.

ACKNOWLEDGEMENTS & REFERENCES

We would like to sincerely thank the JMTS, as part of the Centre for Entrepreneurship and Engineering Design (CEED), and the University of Ottawa, including the Engineering Endowment Fund (EEF) from the Faculty of Engineering for their generous support.

Additionally, we extend our gratitude to all our financial contributors, whose donations have played a vital role in the success of this project.

Lastly, and most importantly, we would like to thank MATE for providing us the opportunity to apply our learning in exciting new directions!

REFERENCES

Marine Advanced Technology Education (MATE) Center. (2024). *2025 COMPETITION MANUAL EXPLORER CLASS*. https://20693798.fs1.hubspotusercontent-na1.net/hubfs/20693798/2025%20EXPLORER%20Manual_FINAL_1_6_withCover.pdf

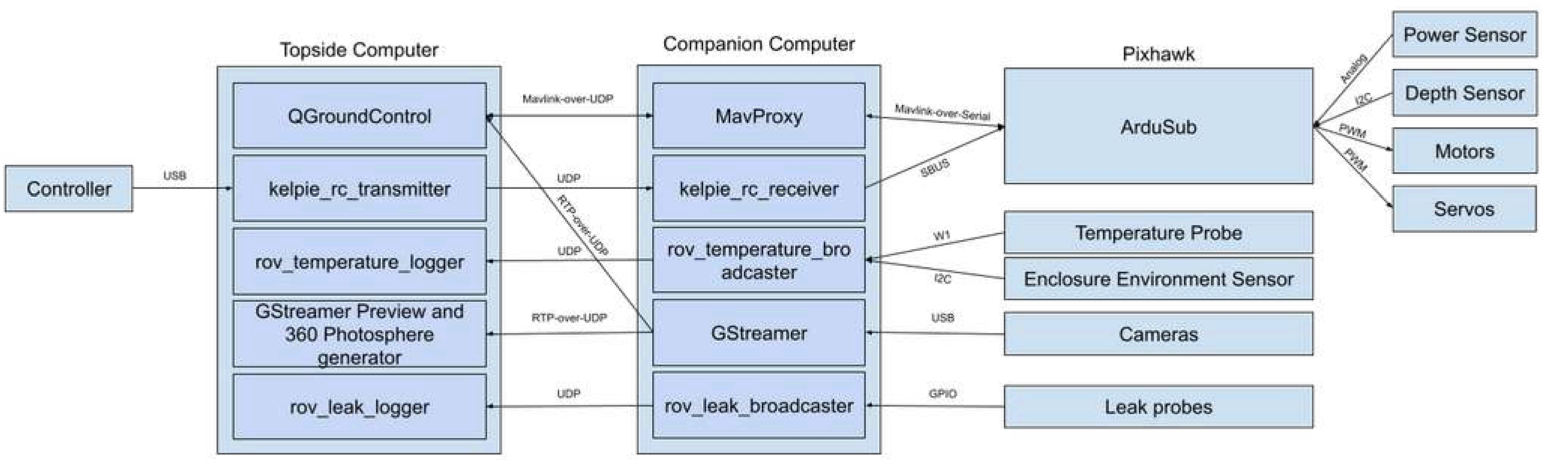
University of Ottawa. (n.d.). *John McEntyre Team Space (JMTS). Centre for Entrepreneurship and Engineering Design.* https://www.uottawa.ca/faculty-engineering/centre-entrepreneurship-engineering-design/facilities/john-mcentrye-team-space

APPENDIX A: SAFETY CHECKLIST

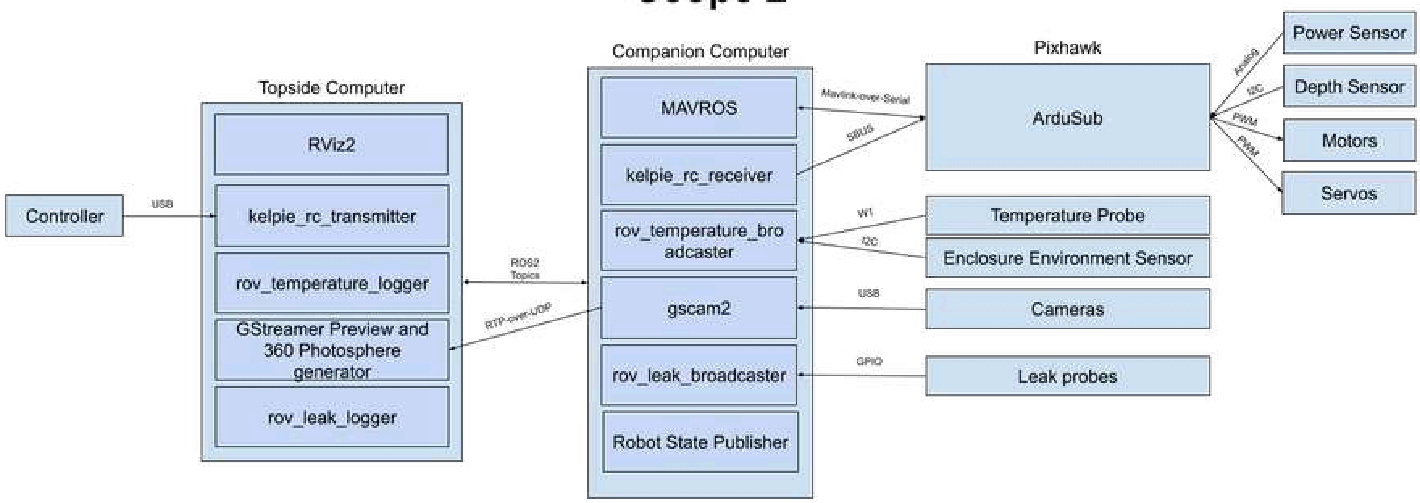
Check Item	Completed?
PREFLIGHT	
Inspect tether for frays, cuts, and secure ends; ensure strain relief is in use	◻
Verify enclosure seals are intact, including face, radial, and vent seals	◻
Ensure all attachments (cameras, manipulators, buoyancy) are properly, safely, and firmly attached	◻
DEPLOYMENT	
Connect tether to data and power ports on ground station	◻
Test joystick and control interface (QGroundControl) responsiveness	◻
Verify all thrusters respond correctly to input	◻
Confirm video streams are active and in position	◻
Ensure ESC telemetry is visible (RPM, voltage)	◻
CLEANUP	
Disconnect tether from data and power ports on ground station	◻
Visually inspect ROV for any damages, leaks, or other issues	◻
Ensure tether is properly coiled and prepared for storage or transit	◻

APPENDIX B: SOFTWARE SID

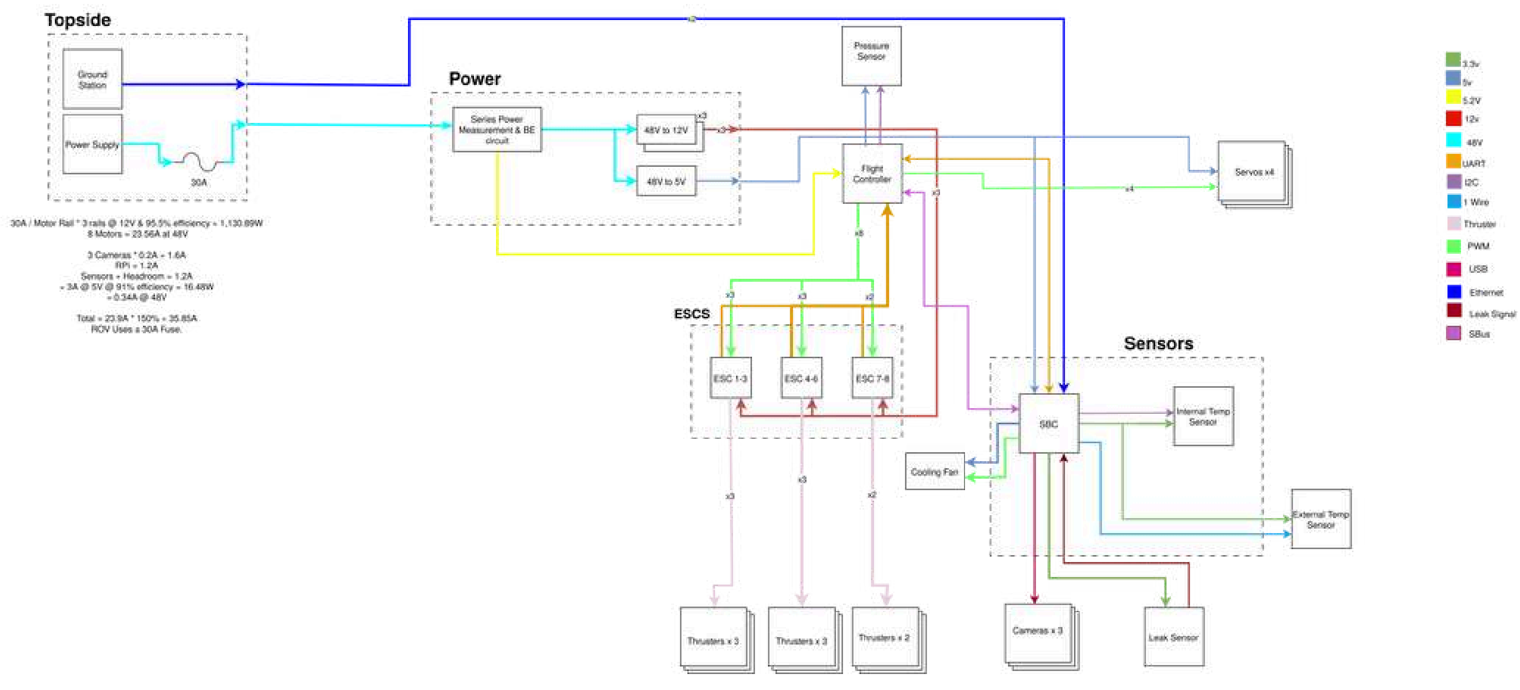
Scope 1



Scope 2



APPENDIX B: ELECTRICAL SID



APPENDIX C: FULL CAD MODEL