Aquajacks Robotics Company

Alpena Community College
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Technical Documentation 2025

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Aquajacks Robotics Company

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1. Company Abstract

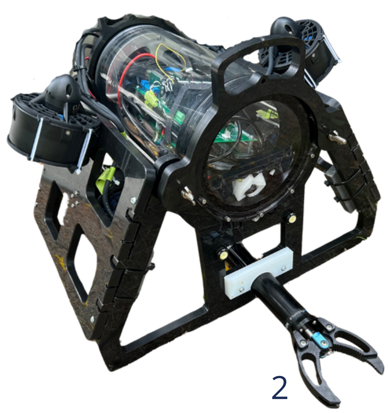
Aquajacks is an underwater robotics company based in Alpena, Michigan. While we are new to the industry, this company is dedicated to preserving ecosystems and shipwrecks in the Great Lakes along with monitoring climate change in both fresh and salt waters.

We are a company that consists of six hard-working qualified college engineers that formed in January of 2025. We have engineered the *Jack I* to successfully complete the challenges profiled by the 2025 Marine Advanced Technology Education (MATE) mission including analyse shipwrecks, complete underwater maintenance, and monitor ecosystems and the effects of climate change. The *Jack I* has many features that are designed to assist with navigation and performance of tasks. The robot's claw is manually adjustable for the convenience of interaction and retrieval of targets such as floats, underwater cables, and both removal and retrieval of items. The *Jack I* comes with four mounted Blue Robotics thrusters that allow for efficient movement, and a camera for visual aid to the pilot that is displayed on a computer monitor connected by Ethernet. Aguajacks has engineered the *Jack I* to be an optimal-performing robot and this company can handle the tasks provided by MATE.

Thomas Bruning
CEO & Electric Engineer

Clayton Thomson
Pilot, Mission Stategist,
& Safety Officer

Zachary Orr
CFO & Research Coodinator

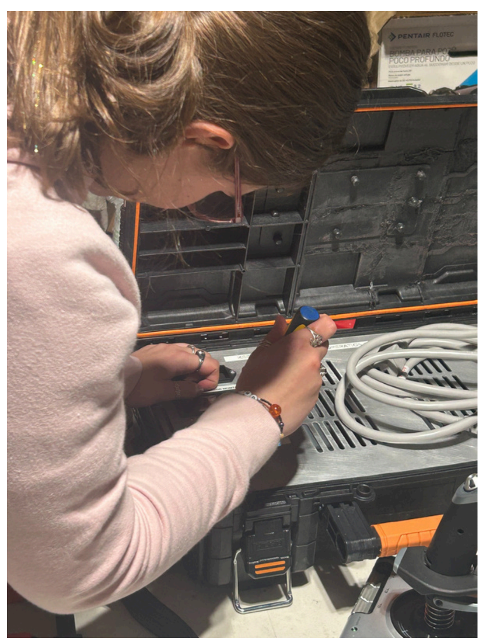


Emily Samp
Design Engineer & Tether Specialist

2. Team work and project management

A. Company Profile

Aquajacks are a new submersible robotic company based out of Alpena, Michigan: the Great Lakes state. We engineer ROVs to study the impact of marine ecosystems and climate change in both fresh and salt water. Our six engineers have experience in CAD, 3D printing, manufacturing in CNC machining, and coding software. Clayton, a team member, has 12 years experience performing in the MATE industry. With this experience he was able to mentor and train the other three new members to understand MATE's expectations to set the team up of success. The team members have worked hard to build, wire, and prepare every part of the *Jack I*. With such a short amount of time from our start date of January 2025, the team worked tirelessly to design and assemble the *Jack I* ROV robot from the ground up. Meanwhile our Planning and Research Coordinators, analyzed and documented everything required for MATE. Once the ROV was fully operational, the Aquajacks pilots, practiced maneuvering the robot and optimizing strategy for completing the mission with the rest of the team. The Aquajacks members designed and developed the robot and mission tools by choosing their area of interest and expertise. The working environment located at Alpena Community College campus was positive and supportive with the availability of a mentor's support as needed.



Aquajacks working on *Jack I*

B. Project Management

This structured timeline presents the Aquajacks' schedule and what important work needed to be accomplished leading up to the competition. The team met two days of the week in the evenings for 2 hours or more each meeting. It was important that the team kept a flexible time schedule so it could easily integrate into all the team members' college schedules for maximum efficiency. Effective communication is essential to our team's success. In addition to our regular in-person meetings, we maintain consistent contact through iMessage group chats (quick team updates and coordination), Canva (collaborative documentation), Google Docs (team documentation and research notes) and Microsoft Teams (team schedule and deadlines). These digital tools allowed Aquajacks to have access to the information at all times and to collaborate outside of scheduled practices, organize key documents, and ensure that everyone remains informed and knowledgeable. In addition to this huge commitment, the team also met on Saturdays and on weekday evenings for the months of May and June.

Timeline Overview

January – Learning basics

- Following the start of the Spring semester of the Alpena Community College, the team assembled for the first time and began designing a plan for the MATE competition, researching the requirements and gathering the proper components to engineer a successful underwater robot. Part of the team also reviewed the rules and safety requirements of the competition. Team roles were chosen.

February to March – Assembly and research

- The electrical systems were assembled and placed into the enclosure. The frame was designed in the 3D modeling software of Solid Works as we waited for the ordered materials to arrive. The tether and simulated power supply was assembled. The team continued the necessary research and planning for potential hazards or challenges during competition.

April – Testing and integration

- All mechanical components such as the thrusters, camera, and tether were attached to the main electrical components of the robot. These components were then successfully tested and proven operational. The team began documentation of required competition documents. Tools were created to use in competition.

May – Final Preparations and Assembly

- The main frame was successfully assembled and necessary modifications were made. The claw was attached and controls for the robot were coded into the components. The robot was fully assembled and prepped for competition. A filmed product demonstration video for the competition was completed and submitted for qualification.

June – Final Preparations and Documentation

- The team held practice time in the tank and local pool to test the *Jack I*'s capabilities for the competition. The Aquajacks perfected their knowledge and delivery for product presentation of the *Jack I*.

3. Design Rationale

Aquajacks formed in January 2025 with the second semester of college courses at Alpena Community College. The primary goals were to develop an underwater ROV to successfully complete the mission set by MATE. Our focus was to design a robot that demonstrated excellent communication with the pilot, reliability in completing necessary tasks, customized for specific conditions, efficiency and safety as a priority. An additional challenge was to provide all these features on the ROV, yet cost effective. The building process for engineering the *Jack I* on paper was more complex when put into practice. While all the parts were sourced from the components provided from MATE in the EagleRay ROV kit with the exception of the claw, the process proved to be more challenging than expected.

3.1 Design Evolution

ROV Frame (front close up)

The frame of the *Jack I* ROV was engineered with efficiency in mind. Using a triangular shape allows for the ROV to move quickly easily. However, the specifically designed flat base allows for slower and safer descent which minimizes any potential damage the ROV could endure over multiple mission runs. Another future that was in our design is a set of handles which assist in transporting the ROV more safely and securely. After the ROV was assembled the testing process began. Many modifications and changes the the *Jack I* were made. It was tested thoroughly by the pilots and found it to demonstrate good communication, ease for task completion, efficient, and safe for the operator and ecosystems it was operating in.

A. Innovation

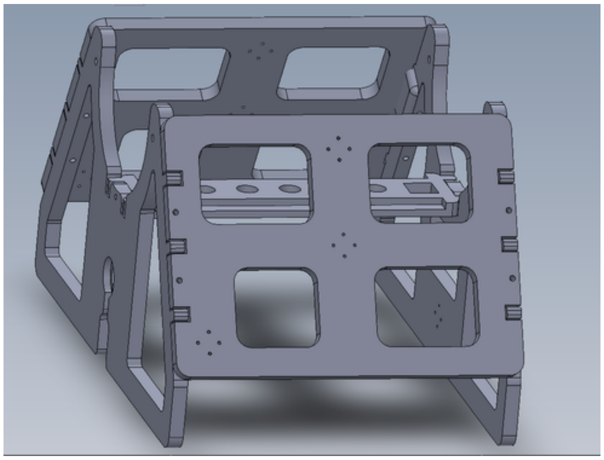
Medusa jellyfish capture device

In order for the *Jack I* to capture the medusa jellyfish, the team used CAD to prototype a collection devise to secure them without injuring any. Unfortunately, the prototype failed as it was too buoyant for the ROV to use effectively and it was not transparent in order to see through it. So instead, the team engineered a large (203mm) transparent funnel for the claw to hold that can capture the jellyfish without harm. During testing this proved to be an effective way to complete this task.

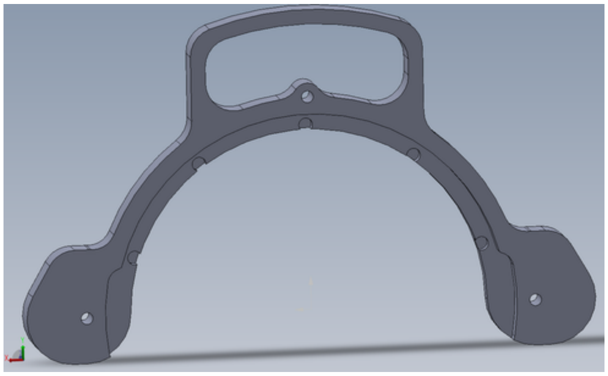
3.2 Vehicle Structure and Systems

A. Vehicle Structure and Frame

The frame of the *Jack I* ROV was engineered with efficiency in mind. The ROV measures 31mm x 46mm x 35mm. Using a triangular shape allows for the ROV to move hydro-dynamically. However, the specifically designed flat base allows for a slower and safer descent which minimizes any potential damage the ROV could endure over multiple mission runs. The frame is constructed from CNC plastic, which allows for the perfect positioning for attachments like the camera, tools, and thrusters. Another future that was in our design is a set of handles which assist in transporting the ROV more safely and securely. After the ROV was assembled the testing process began. Many modifications and changes the the *Jack I* were made. It was tested thoroughly by the pilots and found it to demonstrate good communication, ease for task completion, efficient, and safe for the operator and ecosystems it was operating in.



CAD Model of Frame



CAD Model of Frame Hatch

B. Propulsion

There are four Blue Robotics brushless thrusters that are strategically designed on the *Jack I*. Two thrusters are mounted back to back with one inside the frame and the other located on the outside of the frame. One set is on the left mid back of the frame and the remaining set is on the right of the frame. It is very important that the robot remains upright at all times while in the water. The thrusters are housed both on the inside and outside of the frame at a 45 degree angle which insures optimal operation and safety from all controls.

Brushless Thruster

C. Buoyancy and Ballast

For our company's buoyancy system, we use the trapped air in the enclosure that houses our electronics underwater. The team first used pool noodles as well but found them to be ineffective to assist the buoyancy system. Pool noodles have a crush point around 2.13m and struggle to function in deeper water, which is problematic with the required water depth for MATE. The tank being utilized is 5.49m both for our regional and world events. The air trapped in the enclosure is a more reliable buoyancy system allowing the Jack I to perform with precision. Overall, our robot is light enough that it does not require any additional buoyancy systems. However, the tether does use two small (12.7cm) sections of pool noodle for its buoyancy.

3.3 Electrical and Control Systems

At the surface, the operator's station consists of a laptop running LabVIEW software. LabVIEW serves as the comprehensive control interface, processing incoming sensor data from the ROV and translating operator commands into signals that control the vehicle's movements and functions. The software provides real-time feedback about the ROV's status, depth, orientation, and environmental conditions.

Control input comes through dual Saitek X52 joystick controllers, professional-grade flight control systems repurposed for underwater navigation. These controllers offer precision input with multiple axes of movement—allowing the operator to control forward/backward motion, lateral movement, vertical ascent/descent, and rotational yaw simultaneously. Additional buttons and controls on the joysticks can be programmed to operate auxiliary functions such as lights, manipulator arms, or sampling equipment.

When the operator moves the joysticks, the LabVIEW software interprets these commands and converts them into digital signals that travel back down the tether to the ROV's control system. The onboard controller then distributes appropriate power levels to the various thrusters, creating differential thrust that results in the desired movement through the water column.

A. ROV Electronics

The communications system within the enclosure converts the digital signals from the surface controllers—the dual Saitek X52 joysticks—into precise thruster commands. When an operator moves a joystick, the motion is translated through LabVIEW into digital instructions that travel down the tether to the Jack I's control board, which then sends appropriate power levels to the thrusters. The electronics enclosure also houses sensors that provide critical operational data. This sensor data is continuously sent back to the surface through the same tether, appearing on the LabVIEW interface to provide the operator with real-time situational awareness of the ROV's position.

For visual operations, the Jack I enclosure contains video processing circuits that handle camera signals before sending them up the tether to the operator's display. The camera is mounted on the front of the electronic tray.

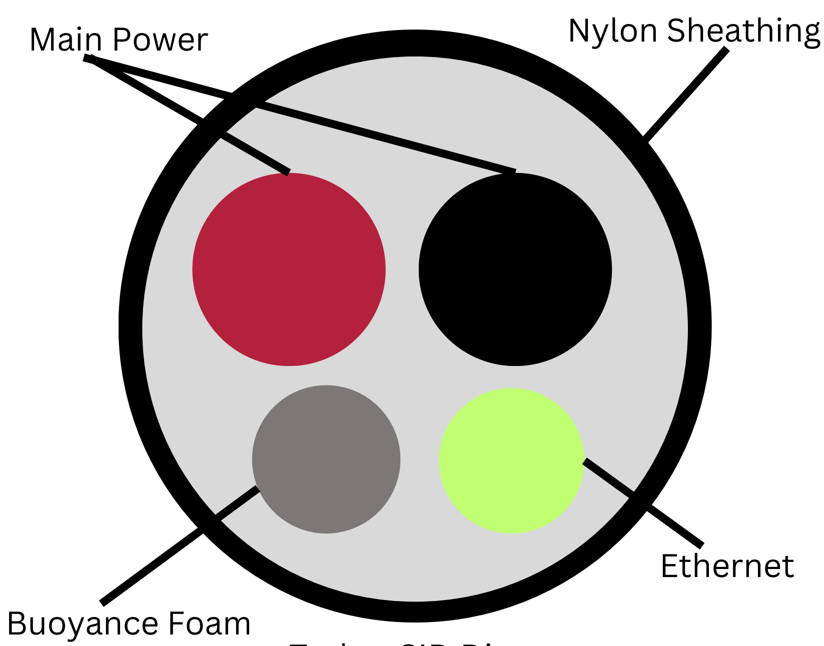
All of these components are strategically arranged inside the Jack I's enclosure to maintain proper balance, maximize space efficiency, and ensure adequate heat dissipation. The electronics tray is built from aluminum to help dispute heat from the electronics. The clear acrylic housing allows for visual inspection of the electronics while operating, providing operators with immediate feedback if any issues arise with internal components.

This integrated electronic system enables the Jack I to perform a wide range of underwater tasks while maintaining reliable communication with its surface operators through the LabVIEW control interface and Saitek X52 joystick controllers.

B. Tether

The Jack I uses a 15-meter tether that is neutrally buoyant. The main power conductors are copper wires 10 AWG that deliver 48 volts to the ROV. The tether includes an Ethernet cable that runs the length of the tether, connecting the surface computer with the ROV's onboard computer.

To enhance buoyancy and prevent the tether from controlling the ROV, we incorporated a solid foam tube within the tether. This added buoyancy helps prevent the tether from tangling at the bottom, thereby protecting the shipwreck while the ROV collects information to help identify it. All conductors are sheathed in a nylon web to ensure safety and prevent snagging during normal operations.



Tether SID Diagram

C. Control System

The *Jack I* ROV utilizes a comprehensive control system to provide precise underwater operation. At the surface station, the primary interface is a laptop running LabVIEW software. LabVIEW serves as the command center, providing a graphic interface where operators can monitor all ROV systems and view real-time data from onboard sensors. This software processes all control inputs and handles the bidirectional communication between the operator and the underwater vehicle.

Dual Saitek X25 Joysticks

The physical control inputs come from dual Saitek X52 joystick controllers. These professional-grade controllers offer multiple degrees of freedom and precision handling. Typically, one joystick manages forward/backward thrust and lateral movement, while the second handles vertical movement and yaw rotation. The various buttons and switches on these controllers can be programmed through LabVIEW to activate auxiliary functions such as lights, camera controls, or manipulator operations.

3.4 Payload and Tools

A. Digital Camera System

Digital Camera

The Jack I ROV incorporates a Blue Robotics Low Light HD USB camera that provides real-time visual feedback to operators on the surface, enabling precise navigation and inspection capabilities underwater. The camera is a Blue Robotics Low Light HD USB camera specifically designed for underwater ROV applications. This camera excels in challenging underwater lighting conditions and delivers high-definition video quality. The camera is housed directly within the Jack I's six-inch electronics enclosure, sharing the same waterproof, pressure-resistant acrylic housing that protects all the ROV's electronic components. Being housed within the main electronics enclosure eliminates the need for additional waterproof camera housings or external penetrations for camera cables. The camera connects via USB directly to the onboard control system within the enclosure. This USB connection is then interfaced through the ROV's communication system and transmitted up the tether cable to the surface. The digital USB signal provides high-quality video transmission with minimal signal degradation over the length of the tether.

B. Retrieval Claw

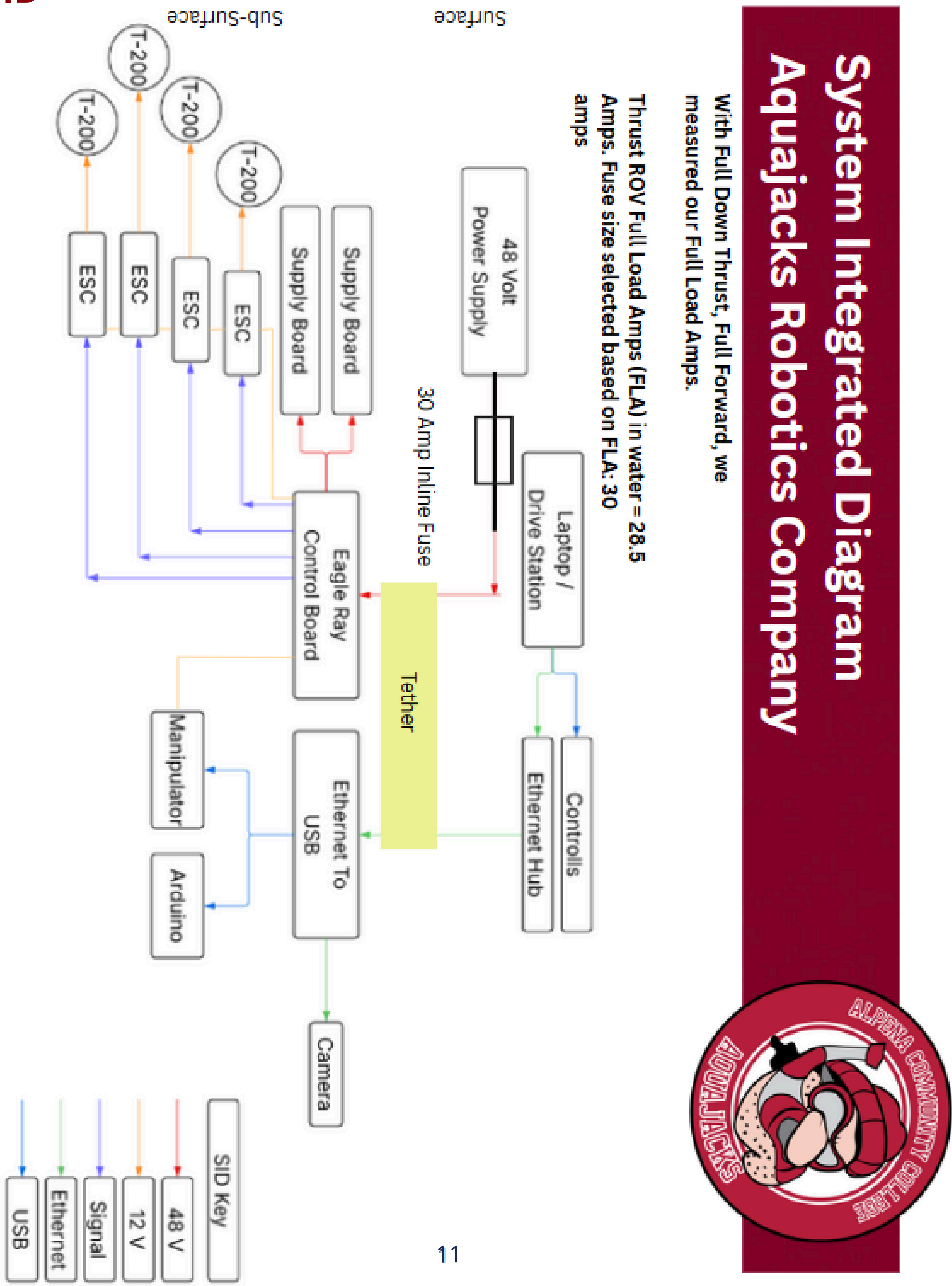
The *Jack I* ROV incorporates a Blue Robotics Newton Gripper as a manipulator tool, providing the capability to grasp, collect, and manipulate objects underwater. The Newton Gripper is a waterproof, pressure-rated robotic gripper specifically designed for underwater ROV applications. It features two opposing jaws that can open and close with precise control, allowing operators to pick up objects, manipulate samples, or perform delicate tasks underwater. The gripper is rated for significant depth and constructed with corrosion-resistant materials suitable for marine environments. Power for the Newton Gripper comes from the Jack I's 12V power system, drawing from the same converted power rail that supplies all onboard components. The gripper's motor system operates efficiently within this voltage range, providing sufficient force to handle a variety of objects and samples underwater.

We designed the frame to include a mount for the claw. However, we encountered an issue we hadn't anticipated: the claw was not positioned in a way that allowed the camera to provide a full view for the pilots. As a result, the team had to modify the mounting system to extend the claw further out. This adjustment also altered the distribution of weight, requiring us to adjust the ballast weights.

Control of the gripper is integrated into the existing LabVIEW control interface. Operators can command the gripper to open and close using designated buttons or controls on the Saitek X52 joystick controllers. The LabVIEW software translates these button presses into digital commands that travel down the tether to the ROV's control system, which then sends the appropriate signals to the gripper's motor controller.

The gripper system provides force feedback and position sensing, allowing the control system to report the gripper's status back to the operators through the LabVIEW interface. This feedback lets operators know whether the gripper is fully open, closed, or holding an object, and can indicate if the gripper encounters resistance while closing.

4. SID



System Integrated Diagram
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With Full Down Thrust, Full Forward, we measured our Full Load Amps.
Thrust ROV Full Load Amps (FLA) in water = 28.5 Amps. Fuse size selected based on FLA: 30 amps
Surface
Sub-Surface
48 Volt Power Supply
30 Amp Inline Fuse
Laptop / Drive Station
Controlls
Ethernet Hub
Tether
Eagle Ray Control Board
Supply Board
Supply Board
ESC
ESC
ESC
ESC
T-200
T-200
T-200
T-200
Ethernet To USB
Manipulator
Arduino
Camera
SID Key
48 V
12 V
Signal
Ethernet
USB
ALPENA COMMUNITY COLLEGE
AQUAJACKS

5. Build vs. Buy and New vs. Reused

Our Eagle Ray kit was provided MATE as a grant to help Alpena Community College students participate in the MATE ROV Competition. Everything that came in the kits was new. The material we used for the frame came from the ACC machine workshop. It was leftover form another student project they we were able to use. The newton grabber was a used item from the local high school team UR2 that loaned it to us for this year. We did not have funds to purchase a new newton gripper. We chose the gripper because it is very reliable and was simple to integrated into our control system.

6. Safety

A. Safety Philosophy

Our Safety Officer has tested and made sure our ROV is up to code and is safe to use during competition. She ensured that the thruster caps were applied properly to all of the propellers. Furthermore, she confirmed that the tether had its mesh covering and was connected to the strain relief. All of these things help the ROV safely work underwater. It is crucial that it’s up to code inside and out. Observing and helping in the process of building, our Safety Officer made sure everyone had the correct safety gear and applied it when needed. This helps keep the entire team safe while working on and around the ROV.

B. Lab Protocols

At the ACC Robotics lab we consider safety be the most important factor. For this reason, we have a designated safety officer whose primary job is to make sure that all team members and employees are following the safety protocol that we as a company have put in place.

When working inside the lab, close-toed shoes, and long sleeves shirts and pants are required at all times. In addition, we require anyone with long hair to keep it tied up while working around electrical and heat based components.

Safety glasses are also kept around the lab and are required when soldering or if any machine cutting or drilling is required. Other protocols include: having at least one mentor or adult around when working with heat or electric units, and ensuring the lab is closed off from any non-Aquajack employs or Team members to prevent accidents involving other people.

C. Vehicle Safety Features

Our ROV complies with all required safety features. This includes a strain relief located at both ends of the tether. All thruster have guards placed on the comply to the IP-20 guide lines. The frame is built with no sharp edges or point that could potentially hard anyone handling the ROV.

D. Operations and Safety Checklist

When operating during a mission or practice all Aquajacks personal must follow these general safety guidelines:

1. Closed-toe shoes must be worn at all times.
2. Long hair must be tied back.
3. Follow the correct protocols for operating the ROV.
4. No running near the poolside.
5. Safety glasses must be warn during maintenance operations.

Team Safety Check-off Sheet

Checklist Items	YES	NO	Action Required
Electrical schematics & power distribution diagrams	☐	☐	☐
Technical report	☐	☐	☐
Navigator CLASS SAFETY CHECKLIST (safety inspection)	☐	☐	☐

Part 2: Physical F

Checklist Items	YES	NO	Action Required
All items are secured to the ROV and will not fall off	☐	☐	☐
Hazardous items are identified, and protection is provided	☐	☐	☐
Propellers are enclosed inside the frame or shielded so that they will not contact items outside the ROV.	☐	☐	☐
No sharp edges or elements on the ROV that could cause injury to personnel or damage to the pool surface	☐	☐	☐

Part 3: Electrical

Checklist Items	YES	NO	Action Required
Single attachment point to the power source	☐	☐	☐
25 amp single inline fuse, no frays in tether or conductors.	☐	☐	☐

7. Testing and Troubleshooting

This is the Aquajacks' first year competing in the MATE ROV competition, and there were several obstacles to overcome. We have made many changes and improvements to the *Jack I* over the past five months since we entered the competition. The first major issue was scheduling. The Aquajacks began with six college students, all of whom also hold jobs. This means we needed to schedule meeting times around everyone's ACC courses and work schedules. Over time, this grew into a series of issues that all of our team members needed to discuss. Finally, a solid schedule that at least the majority of our team could follow was developed, and the use of online resources became vital. However, when classes ended, two team members realized that they would not be in the area for the competition and left the team in May.

The second major issue was assembling the circuit boards. Despite some of our team members' backgrounds in robotics, we lacked experience soldering and assembling surface mounts and being delicate with the soldering. The Aquajacks practiced on old or unused circuit boards to get proficient at it and then worked on the ROV's actual parts.

One of the significant challenges during the building process was building the frame. It was mapped out through Solid Works, a computer program designed to create 3D models. Unfortunately, the 3D model wasn't entirely accurate. Once the frame was cut out using the Solid Works model as a reference, we had to make some modifications to the frame so all the pieces would fit properly together. This included slight modifications so parts such as the claw, the camera, and thrusters could be mounted adequately into place.

An Electrical check starts with checking the connections of the tether; if the tether has been severed from the ROV (as unlikely as that is), a team member will switch off the power and attempt to reattach the tether. If the tether is fine check the fuse near the end of the surface side of the tether, if the fuse is broken then it should be replaced with a spare fuse that our team is required to have on hand, incase of the fuse blows. If there is no issue with the fuse then both the power supply and the robot should be investigated In the event that a part or wire in the enclosure is severed or damaged in some way, we also have spare parts for the enclosure on hand if the enclosure requires repairs. If it does require repairs, the team safely removes the enclosure from the ROV's frame and opens the enclosure in a dry and clean environment and begin the repair process.

8. Budget and Cost Accounting

Types	Category	Description	Cost
Donated Parts	Eagle Ray ROV Kit	48V Power Supply, Enclosure	$2,355.18
Purchased	Joystick Controllers	Saitek x52	$76.25
Purchased	Spare Case Penetrator	Blue Robotics Penetrator	$41.88
Purchased	Circuit Boards	Arduino Mega R3 Board	$23.05
Donated Parts	Claw	48V Power Supply, Enclosure	$0
		Total	$2,496.36

9. Conclusion

A. Acknowledgements

Though this is the first time in several years that Alpena Community College has been involved in Underwater Robotics, but this has only caused our team to be more determined to see this through. We would like to thank the Alpena Community College school board for letting us meet there after school and for the grant money that helped to fund our team. In addition, we would like to thank out mentor David Cummins for his help with starting the team and coaching us through confusing moments. We would also like to give appreciation to MATE for granting us our ROV kit. A special thanks to the UR2 team for gifting us a claw for our robot. Without these parties help, our team would not be where it is now.

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All pictures of team members used in this technical documentation were taken by Clayton Thomson.