Company: Bangalore BullSharks

Organization: YoLabs

Schools: National Public School, Inventure Academy, Greenwood High, Primus Public School and The International School Bangalore

Location: Bangalore, Karnataka, India

Team Members and their Roles:

- ✓ Anvay Varshney: Chief Executive Officer
- ✓ Udbhav Vasudevan: Chief Operating Officer
- ✓ Rishi Patchigolla: Head of Hardware
- ✓ Daksh Singh: Head of Software
- ✓ Pranav Vinayakam: Head of Safety and Support
- ✓ Saividyut Ashok: Head of Finance
- ✓ Ayansh Paliwal: Head of Technical Writing
- ✓ Mayank Mundra: Head of Marketing and PR
- ✓ Dhyan Murthy: Head of Product Test
- ✓ Hridank Bhagath: Head of Design

Mentors:

- ✓ Nitesh Varshney: Coach
- ✓ Piyush Kore: Additional Mentor

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Introduction (Abstract)

The **Bangalore Bullsharks** proudly present the **Leviathan ROV Mark I** for the 2025 MATE ROV Competition. Designed for speed, stability, and mission versatility, the Leviathan features a modular, heavy-duty PVC frame and is controlled via the SeaMATE Barracuda system. Four brushed DC thrusters in a diagonal configuration enable precise, multi-axis navigation.

Neutral buoyancy is maintained with adjustable PVC pipes and a ballast system for fine trim control. Electronics are aligned with the ROV's center of mass to ensure stability and minimize unwanted motion. The vehicle includes front and downward-facing and third person view cameras and is configured to accommodate a mechanical arm.

Power is supplied via a surface tether with a quick-connect waterproof connector for ease of use and reduced drag. Pool testing demonstrated over 95% stability and manoeuvring accuracy.

This document outlines the Leviathan's construction and control systems. Future enhancements include onboard sensors for advanced missions, extra mechanical arm for efficient tasks execution.

Company Overview

Bangalore BullSharks is a student-led engineering company operating under the umbrella of **YoLabs**, an innovation-focused organization based in Bangalore, India. Our team is a collaboration of young minds from five schools—National Public School, Inventure Academy, Greenwood High, Primus Public School, and The International School Bangalore—who share a passion for robotics, engineering, and underwater exploration.

Guided by our company motto: "**Engineered for Precision + Tested for Performance**", we have structured our organization like a professional engineering firm. Each member holds a defined leadership role, including CEO, COO, and heads of key departments. This structure has allowed us to manage the complexity of ROV development with clarity, accountability, and real-world discipline.

For the 2025 MATE ROV Competition, our mission is to deliver a reliable, modular, and mission-ready underwater vehicle—the **Leviathan ROV Mark I**. Built upon the SeaMATE Barracuda ROV system, our design emphasizes precision control, structural stability, and adaptability to a range of underwater tasks. Through detailed planning, hands-on testing, and teamwork, we exemplify the spirit of innovation and systems engineering.

Personnel

This information is captured in Title page of this document including individual members and their roles and responsibilities.

Project Management:

a. Project Overview:

- The project began on 15th April 2025 with a tight timeline to meet the competition date on 17th May 2025. Tasks were mapped out with assigned internal deadlines.
- This structured timeline ensured that sufficient buffer time was available before the May 17th competition for final calibration and unexpected adjustments, if any.

b. Resources and Operations Management:

Our primary hardware foundation was the:

- Barracuda ROV kit, which provided us with a tested, reliable base.
- The frame was constructed using durable PVC pipes, chosen for their density, availability, price and ease of manipulation.
- Additional components, including thrusters, tether systems, and the control board, were sourced from the kit and were bought locally if needed.

c. Procedures:

- Each phase of the project was divided between team members.
- Tasks such as design, construction, wiring, and coding were broken into manageable units.
- Each unit was assigned to a specific team member based on their specialization and skills e.g. hardware, software, design, etc.
- Clear internal deadlines were set to align with our overall project timeline.
- Regular reviews ensured that progress was consistent and aligned with competition requirements as well as team goals.

d. Communication Protocols:

To manage day-to-day operations and challenges:

- A supervisory protocol was put in place, with domain experts e.g. Software, Hardware, Design taking care of their task execution and reporting on whatsapp group including our Team Captain (CEO) periodically.
- Daily team huddles helped identify issues, redistribute tasks if needed, and maintain productivity.
- In case of technical blocks, the Troubleshooting Head was responsible for quick diagnosis and collaboration with relevant team leads to implement fixes.
- By maintaining role clarity, open communication, and feedback-driven workflow, we were able to adapt to evolving needs and ensure that our ROV was fully mission-ready by the competition deadline.

e. Schedule:

Task	Start Date	End Date	Notes
Designing	Apr-15	Apr-18	Complete CAD models and simulations
Frame building	Apr-19	Apr-23	Cutting of pipes, fitting with exact measurements, motor placements
Controller assembly	Apr-24	Apr-29	Soldering PCBs, making connections and soldering power and output cable:
Wiring and Tethering	Apr-30	May-01	Connecting wires and soldering, wrapping with the tether
Claw design & making	May-02	May-04	Designing claw mechanism, 3d printing and assembly
Coding	May-05	May-07	Coding movement and claw mechanisms
Buoy installations	May-08	May-10	Making right sized buoys for balance and proper flotation
Testing & finetuning	May-11	May-16	Testing in pool and making changes in accordance to the problem
National Competition	May-17	May-18	
Rest Days	May-19	May-22	Rest days after hectic month
Claw redesign	May-23	May-26	Redesigning and remaking vital claw system since the old one was unreliat
Frame remake	May-27	May-31	Enhancing material of frame and strengthening
Camera system change	Jun-01	Jun-03	Upgrading cameras and waterproofing them
Re-tethering	Jun-04	Jun-05	Re tethering all new wires since many componets have been added
Testing	Jun-06	Jun-09	Testing in pool
Finetuning	Jun-10	Jun-12	Making changes based on what we see in testing
Final preparation	Jun-13	Jun-15	Final prep work before shipping and travel

Engineering Design Rationale:

a. Overall Vehicle Design:

- Inspired by the SeaMATE Barracuda ROV framework which is in the of a cuboid.
- Compact, box-shaped PVC frame (500mm × 450mm × 400mm) for the main body.
- Two motors at the center to allow the bot to move front, back, and turn, one motor to allow for vertical movements, and one motor to allow for crab-like movements sideways.
- Buoyancy tubes securely fastened above center of mass and other places to help achieve stability and neutral buoyancy for the bot. Small pieces of pool noodle foam attached to the boat for adjusting buoyancy during testing, allowing for more effective testing.
- Joint of the tether connected at the back of the bot to allow all the wires for various control signals to be sent.
- Camera mounted at the front at a large height to allow for optimal vision during missions, as well as a second camera showing the status of the arms.
- Strong hook at the front, left position of the bot to allow for heavy-lifting purposes in missions.
- Versatile clamp arm at the front right of the bot to allow for accurate control of objects underwater.
- Large yellow tether along with black and white cables carrying signals for the motors, clamp, and camera starting from the control box and ending at the desired locations.
- Control box with fuses for safety and the host for the microprocessor. It also allows for user input to determine the actions of the bot. The control box is purchased from MateROV themselves as part of the Barracuda ROV kit.
- Joysticks are the main control for movement while a small button and switch mechanism controls the clamp on the bot.

b. Planning and Design Process:

- Conducted initial research using Barracuda reference materials.
- Created a CAD model in Fusion 360 for structure planning.
- Made a sketch of the design on paper without electrical connections to give a vague overall idea of what our ROV should look like.
- Tested each component in water individually to ensure its functional and waterproofed, and noting down significant difference in output power of the motors which occur naturally.
- Electrical connections mapped after initial hardware structure was created.
- Built and tested prototype in pool environment repeatedly and applied changes after continuously until the competition date.
- Identified instability in early thruster layout and adjusted based on our testing results.
- Repositioned vertical thrusters diagonally and rebalanced buoyancy in attempt to reach neutral buoyancy.

c. Trade-Offs:

- Used the extra fourth motor to help boost the forward and backward movements as moving across the pool will be more useful than moving up and down or crab movements, the latter which are only used for accurate positioning during missions.
- Chose diagonal vertical thruster mounting to enhance stability without using extra hardware.
- Used a tether to eradicate any risk for wireless connections going bad, however the bot is at risk of being tangled in its own tether. This was mitigated by placing the tether mount at the top and back of the bot.
- Used m-seal to hold the clamp mechanism to the bot, however further modifications will be tough to make during field testing.
- Used PVC connectors to hold the PVC pipe structure together which improves the structure's ability to be modified, however there is a risk of joints coming loose which is why we thoroughly hammer each joint into place before any test run.

Innovation

The company followed a process when it came to ideation and innovation:

- Each person had a voice and was allowed to share ideas.
- Each idea was analysed thoroughly by the group and voted on in case of disagreements.
- Any disagreements with ideas must be supported with logical or technical evidence to ensure no good ideas were scrapped due to personal interests within the team.
- Once an idea was selected, each member was asked if they agree, if not, further evidence was given for every team member to agree with the idea. This allowed maximum efficiency with each team member giving it their all to implement ideas.

Our team applied this process of innovation for the following features of our bot:

- Developed a simple, yet extremely effective PVC pipe hook which was capable of completing most of the tasks given.
- Plenty of zip ties were used as they offered an amazing combo of strength, low cost, and adjustability. They proved crucial in the rapid implementation of changes after testing.

- Invented a backup clamp arm using a motor and screw mechanism from scratch which allowed for precise object control underwater during missions. This is cheaper and met the requirements in initial testing. This was a good decision compared to developing an expensive, jointed arm.

Problem Solving

Our team followed a structured and collaborative problem-solving approach throughout the ROV design and development process:

- Used sketches and videos from testing to isolate and identify a problem faced.
- With the problem identified, we then went into the theory and tried to understand scientifically what the problem was.
- We checked each component in the related process to check if it has gone bad, due to the fact it's common for components to go bad.
- If a component has gone bad, we try to identify the cause. For example, if water has entered the system or if a short circuit has occurred.
- For logical problems, we ideate as a group on possible solutions. If we are unable to think of something, we turn to our mentor for guidance and clues or research into past competitions and how other teams tackled their problems.

Many times, during the initial planning, there were alternate ways to tackle a given problem. In such cases, we simply went back chose the alternative.

Systems Approach:

- Our team aimed to create a balanced system between functionality and control. We did this through minimizing the unique features of our bot, aiming for quality over quantity to complete the tasks. Higher quality allows each part of our bot to be able to retrieve more points during the missions.
- The first aspect of our system which we implemented was our control system. Guaranteed high quality was purchased from the SeaMate store to absolutely guarantee no issues with the entire connection of the various systems.
- The next system was a PVC hook installed on our bot. We ensured the size of the hook was compatible with the mission tasks. Furthermore, we also tested the durability of this hook to increase its versatility to act as a backup for our clamp.
- Another crucial system was our propulsion system. This consisted of four motors placed in various positions to ensure proper mobility.
- Another key system was our three-camera visual system. This is extremely important as it's required for every mission task underwater, which is why we purchased expensive cameras to guarantee top quality.
- The final system was our mechanical arm. This was created to allow the Leviathan to perform mission tasks which require careful manipulation of objects underwater using a combination of servo motors.

Vehicle Overview and Systems

The *Leviathan ROV Mark I* is based on the ORTHO ROV supplied by MATE ROV. Its frame is a symmetrical cuboidal structure measuring 500 mm (L) × 450 mm (W) × 400 mm (H) and constructed entirely of ¾-inch PVC piping and respective connectors.

The advantage of the cubical design is its durability and stability, ease of build, and modular capacity to add mission-specific attachments. There are four vertical connectors that connect the top and bottom boxes, and the rounded edges and glued joints create an enclosed box that resists the torsional and bending stresses typically applied during fieldwork.

a. Key Functional Components:

Buoyancy System

- Two large cylindrical buoyancy elements are mounted longitudinally along the top of the ROV, spanning the front and rear cross beams.
- These elements are constructed from 40 mm PVC pipes, sealed with end caps for water-tight integrity.
- Positioned above the center of mass, they generate a restoring moment that enhances stability by naturally correcting pitch and roll deviations.
- We also added an extra smaller buoy to counterbalance the ROV as the arm added extra weight
- Additionally, during field testing, we add small pieces of pool noodle for temporary usage in buoyancy

Thruster Configuration

The ROV employs four 150 W brushed DC thrusters, included in the SeaMATE Barracuda ROV and tether kit. These are strategically positioned in accordance with the ORTHO ROV design to enable full 3D manoeuvrability:

- **Two thrusters** angled at 45° for **forward/reverse motion and yaw control**
- **One downward-facing thruster** for **vertical (heave) movement**
- **One side-mounted thruster**, oriented perpendicularly, to facilitate **lateral (sway or crabbing) movement**

Sensor & Electronics Pod

- Equipped with **two camera modules**:
    - **One forward-facing camera** for navigation and for a first-person view.
    - **One in the back** for situational awareness third person view
    - **One downward-facing camera** providing visual feedback for arm operation and object manipulation
- A **mechanical arm** is installed, capable of **vertical motion and rotation**, actuated by multiple waterproof servos, enabling precise handling of mission tools and payloads.

b. Rationale for MATE ORTHO Design:

a. **Lower Cost:**
It uses standard parts, fewer angled mounts, and simpler frame geometry - reducing overall build cost.

b. **Reduced Weight:**
Efficient use of PVC and minimal structural overlap keeps the ROV lightweight and balanced.

c. **Better Mechanical Reliability:**
Straight mounting of thrusters reduces torsional stress and potential wear, improving durability.

d. **Easy to Modify After Testing:**
Modular frame allows quick repositioning of components and structural adjustments based on testing outcomes.

e. **Attachment-Friendly Design:**
Multiple flat surfaces and open sections make it easy to mount tools like arms, cameras, and sensors.

c. Disadvantages Compared to Vector Design:

a. **Reduced Manoeuvrability:**
Cannot perform diagonal or combined movements, less agile in dynamic or tight scenarios.

b. **Less Efficient Use of Space:**
Requires clear separation between thrusters, increasing the frame footprint slightly.

c. **Lower Thrust Force per Axis:**
Since fewer thrusters contribute to each motion axis, the total thrust per direction is lower. Vector designs often have multiple thrusters working together per movement vector, resulting in greater directional force.

Despite the manoeuvrability benefits of the vector layout, we chose the **Ortho ROV** for our project because it offered:

- Better control and stability during precise mission tasks
- Lower cost and simpler construction
- Higher reliability and easier maintenance
- Flexible mounting for tools and mission-specific equipment

Feature	Ortho Design	Vector Design
Cost	Lower – fewer parts, standard mounts, and simpler frame	Higher – angled mounts and more complex fabrication
Mechanical Reliability	High – straight mounting reduces wear and misalignment	Angled thrusters are more vulnerable to vibration or stress
Maneuverability	Limited – only linear or rotational motion along single axes	High – enables diagonal movement and combined axis control
Thrust Force per Axis	Lower – each thruster serves only one axis, fewer contribute to any motion	Higher – multiple thrusters contribute to each movement vector
Attachment Flexibility	Easy – flat frame surfaces support simple addition of tools or manipulators	Limited – less space and more interference risk
Build Complexity	Simple – ideal for testing, rapid assembly, and repairs	Complex – requires vector math, more tuning, and precise builds

Vehicle Structure

a. Our ROV:

We based our Design on the ORTHO ROV design given by the MATE ROV however we have a few key differences:

1. Increased Stability:
   - We added extra support beams especially for the vertical and sway motors as there was only 1 point of connection from the bot and caused a lot of instability
2. Thruster Configuration:
   - In the original design the vertical motor was not placed in the center of the ROV and thus did not properly go up and down
3. Buoy Positioning:
   - The ROV contains two 45 cm PVC 40 mm buoys and a smaller 15 cm buoy 4PVC 40 mm buoy near the arm to counteract the weight of the servos.

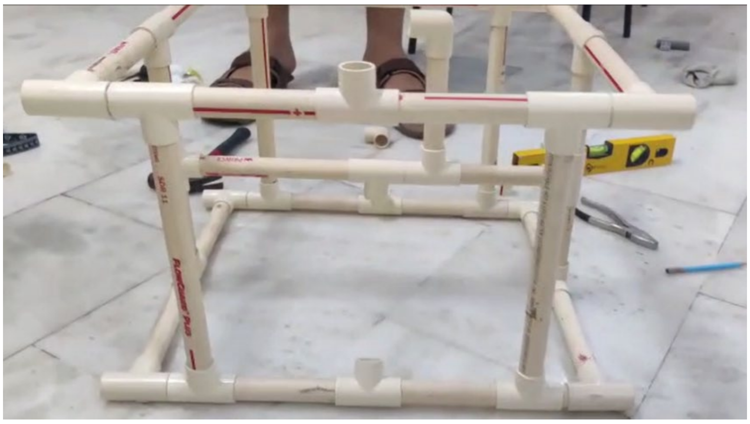


Diagram: ORTHO ROV design

b. Mechanical Arm:

- The Leviathan ROV Mark I's mission capabilities are extended with a forward-facing mount for a manipulator arm, seamlessly integrated into the lower front section of the frame.
- Three servos drive the arm's operations: one for vertical movement, another for claw manipulation, and a third for claw closing, enhancing versatility in competition tasks.
- A safety hook is included as a fail-safe measure, ensuring operational continuity in case of arm malfunction.

Note: there is a file containing the 3D design of the arm

Control/Electrical System:

a. Control System:

- The control box of our ROV is the Barracuda ROV with Thrusters and Tether.
- The kit is equipped with an Arduino Uno R3 which acts as the CPU.
- There are 7 fuses in the control box: 25 amp in the power cable, 15 amp in the control box and 5, 3-amp fuses which ensures there is plenty of coverage for short circuits and blowouts.
- The motors move from joystick feedback. Left joystick moves ROV forward/back and left/right while the right joystick moves the ROV up/down & yaw just like drone controller.
- The Arduino takes feedback from the joysticks to program two Saber tooth modules.
- One Saber tooth module operates one set of motors and the second operates the additional set; one is for forward/back and the other is for up/down, lateral, and yaw.
- There is also a mustimeter hardwired in to sense any change in power.

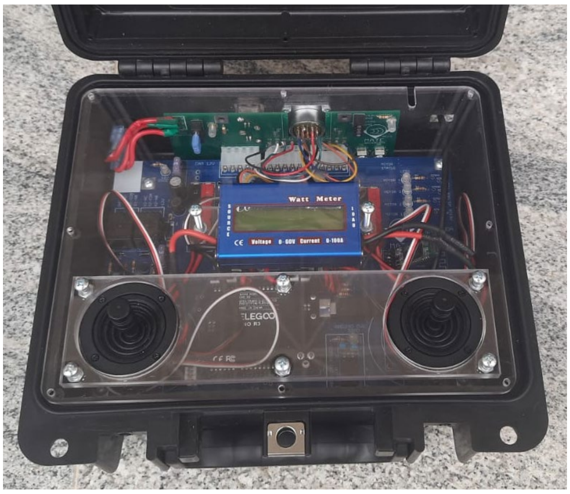
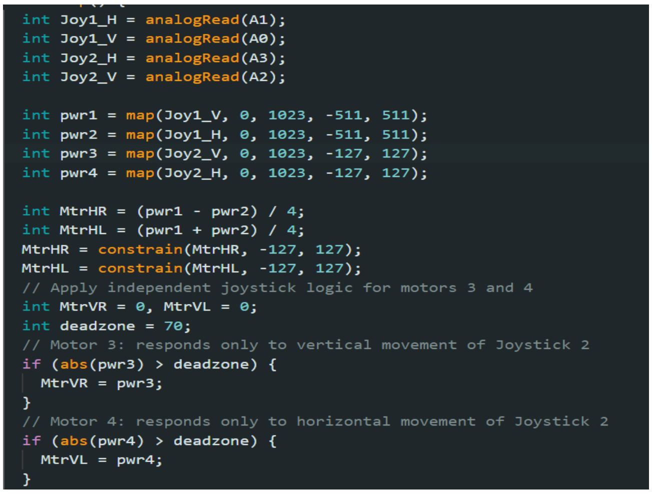


Diagram: Control Box



```
int Joy1_H = analogRead(A1);
int Joy1_V = analogRead(A0);
int Joy2_H = analogRead(A3);
int Joy2_V = analogRead(A2);

int pwr1 = map(Joy1_V, 0, 1023, -511, 511);
int pwr2 = map(Joy1_H, 0, 1023, -511, 511);
int pwr3 = map(Joy2_V, 0, 1023, -127, 127);
int pwr4 = map(Joy2_H, 0, 1023, -127, 127);

int MtrHR = (pwr1 - pwr2) / 4;
int MtrHL = (pwr1 + pwr2) / 4;
MtrHR = constrain(MtrHR, -127, 127);
MtrHL = constrain(MtrHL, -127, 127);
// Apply independent joystick logic for motors 3 and 4
int MtrVR = 0, MtrVL = 0;
int deadzone = 70;
// Motor 3: responds only to vertical movement of Joystick 2
if (abs(pwr3) > deadzone) {
  MtrVR = pwr3;
}
// Motor 4: responds only to horizontal movement of Joystick 2
if (abs(pwr4) > deadzone) {
  MtrVL = pwr4;
}
```

Diagram: Code

b. Tether:

- The Tether System components come from Barracuda ROV with Thrusters and Tether (Rev 2) and this construction details from MATE ROV provide a strong, trustworthy tether system.
- Tether sheath provides protection for all wiring necessary for cameras and servos.
- Pieces of pool noodles cut and evenly space 50 cm apart minimize tether strain so that the tether.

Propulsion System

The ROV moves with **four 150 W brushed DC thrusters** included within the SeaMATE Barracuda ROV and tether package. They are positioned according to the ORTHO ROV design to enable 3D mobility:

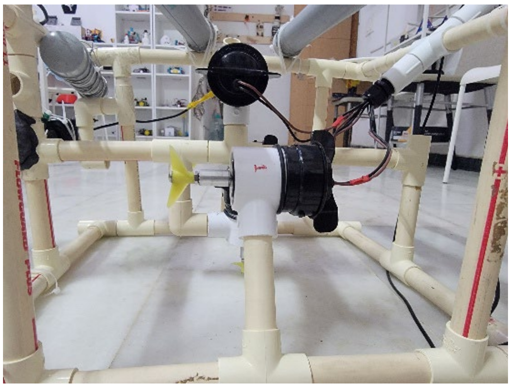
- **Two thrusters** angled at 45° for **forward/reverse motion and yaw control.**
- **One downward-facing thruster** for **vertical (heave) movement.**
- **One side-mounted thruster**, oriented perpendicularly, to facilitate **lateral (sway or crabbing) movement.**

a. Control actions and control capabilities:

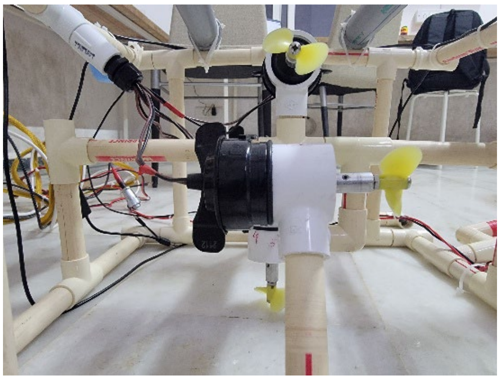
- The two horizontal thrusters allow for differential thrust, comprehensive turning and spinning is easy.
- The vertical thruster makes lift and power use constant while it allows for a slow descent without spinning.
- Therefore, the ROV can station keep and hover and make slight adjustments for the hovering precision needed for object retrieval.

b. Trade-offs made:

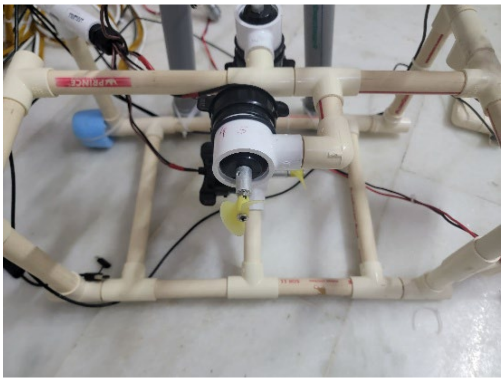
- More thrusters would enable better spinning but would cost more with more wiring and power usage.
- Diagonal or vectored thrusters would allow for better roll/pitch control but would complicate operator interface and add unwanted build weight.



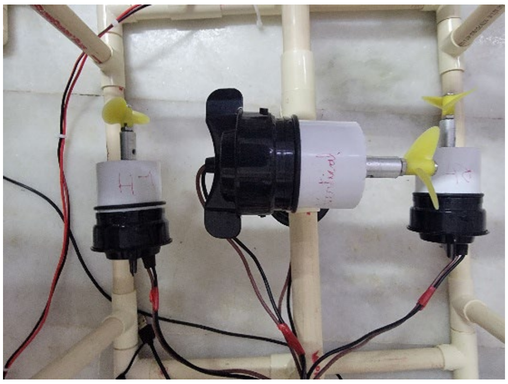
Left Motor



Right Motor



Vertical Motor



Crab Motor

Buoyancy and Ballast System

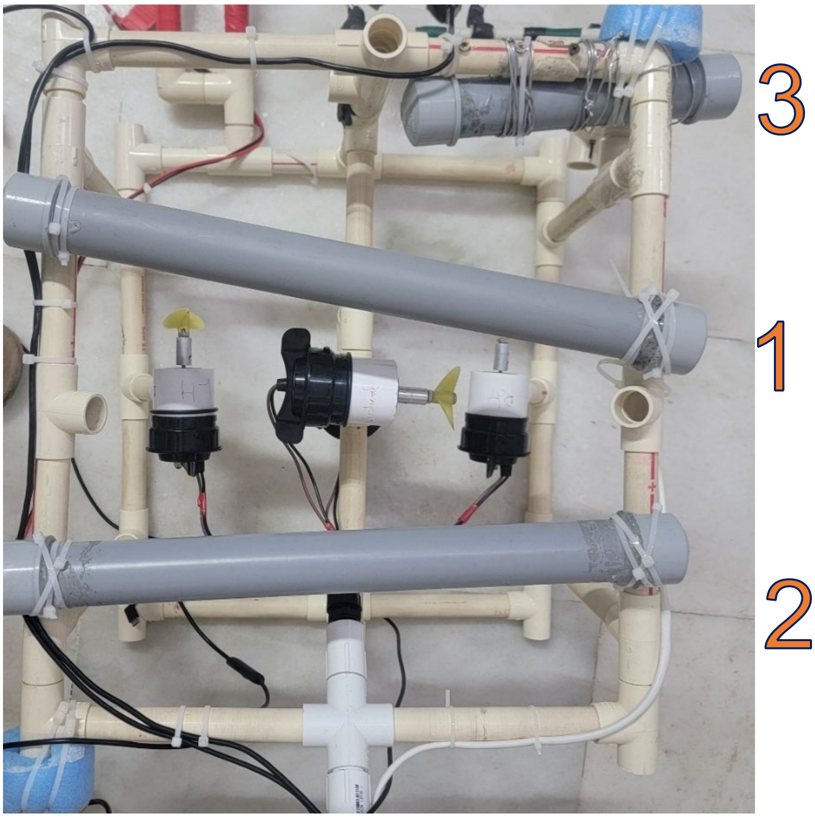
The ROV is neutrally buoyant as it has two cylindrical 40 mm PVC pipes mounted on top of the frame. These are positioned above the center of mass so that the vehicle will naturally right itself in the water, along with the additional 15 cm buoy for the arm to create a stable orientation.

a. Description of Buoyancy System:

- Placement was chosen to balance the total dry weight of the vehicle, achieving neutral buoyancy within ±50 g.

b. Buoyancy Principles Applied:

- The vertical distance between the center of buoyancy and center of mass introduces a stabilizing moment that resists unwanted rotation.
- This configuration contributes to passive righting behavior essential for hands-free stability.
- Fine ballast adjustments are made using small steel plates mounted beneath the frame.
- These can be shifted forward/backward and side-to-side to trim pitch and roll, buoyancy within ±50 g.



Buoy 1 and 2 are the main Buoys and Buoy 3 Is the Extra buoy for the arm

Payload and Tools

- The Leviathan ROV Mark I is designed for mission flexibility in situations that require it, like underwater missions such as the MATE ROV competition.
- It comes with three video input channels enabling us to attach the front-facing camera, downwards facing camera, and third person view camera.
- This setup provides great situational awareness, facing where we're going to see where we're going and what we're doing, and downwards to better assess where we are working.
- The number, type and location of cameras were chosen to create the best viewing experience and operational effectiveness while driving in the complicated underwater world. For example, we decided to have 3 cameras for our ROV.
- One that is facing front, the one that's positioned at the top facing downwards, and one that is at the back giving us a view of what's behind us.
- As for our payload, we have an arm and a hook that are custom made.
- The arm is designed to grasp certain things, and the hook is made to provide lifting or repositioning power from beneath.
- These are used for more specific mission requirements such as turning valves or pulling items off or putting items back on.
- Finally, to improve operations, the ROV has sensor input ports and a programmable Arduino board.
- This is for predetermined or custom-selected sensors for technical required uses during the mission.

Choices Made: Build vs. Buy, New vs. Used

- We had to make considerate decisions about building in-house versus buying off the shelf, weighing performance, customization, and cost.
- We decided to build in-house a few components, most notably the custom manipulator arm and hook.
- Additionally, our ability to construct these tools in-house provided control over material choice, size, and actuation so those aspects matched our mission needs.
- However, we decided to buy components such as the thrusters, the tether, and the power distribution board from reputable sources (e.g., SeaMATE Barracuda Kit) since they are reliable, pre-waterproofed, and purchased from companies with years of experience operating underwater.
- This decreased risk and saved time for other developments.
- As for New vs. Used components, we made the conscious decision to use components from previous builds such as, the video system, and parts of the frame. Each was tested for performance and compatibility with this year's design.
- We are driven by sustainability goals, reusing these components showed good engineering adaptability, able to reconstruct visual evidence met with new environmental needs.
- Collectively, our Build vs. Buy and New vs. Used decisions indicate conscientious efforts that promote optimum reliability, resource efficiencies, and mission effectiveness.

System Integration Workflow for Leviathan ROV Mark I

Step 1: Data Collection:

- All camera angles are stitched together in real-time on multiple screens.

Step 2: Data Interpretation:

- Movement Control:
  - Controlled by joystick steering.
  - The left joystick connects to two motors giving forward, reverse, left turn, and right turn functionality.
  - The right joystick connects to two motors allowing for upward, downward, left, and right crab/sway movements.
- Arm Control:
  - Controlled by joystick steering.
  - The joystick can manoeuvre the arm, allowing it to pick up and drop objects.
  - Each direction pressed on the controller will allow the servo to turn that predictable way.

Step 3: Determination:

- Movement Control:
  - Joysticks are wired to an Arduino Uno R3 that sends the information relevant to Sabertooth modules.
  - The left joystick is wired to the first Sabertooth module, which governs motors 1 & 2.
  - The right joystick is wired to the 2nd Sabertooth module, which governs motors 3 & 4.

- Arm Control:

  - By using an ESP32, the button information from the controller is sent via Wi-Fi to trigger the corresponding servos to turn as users desire.

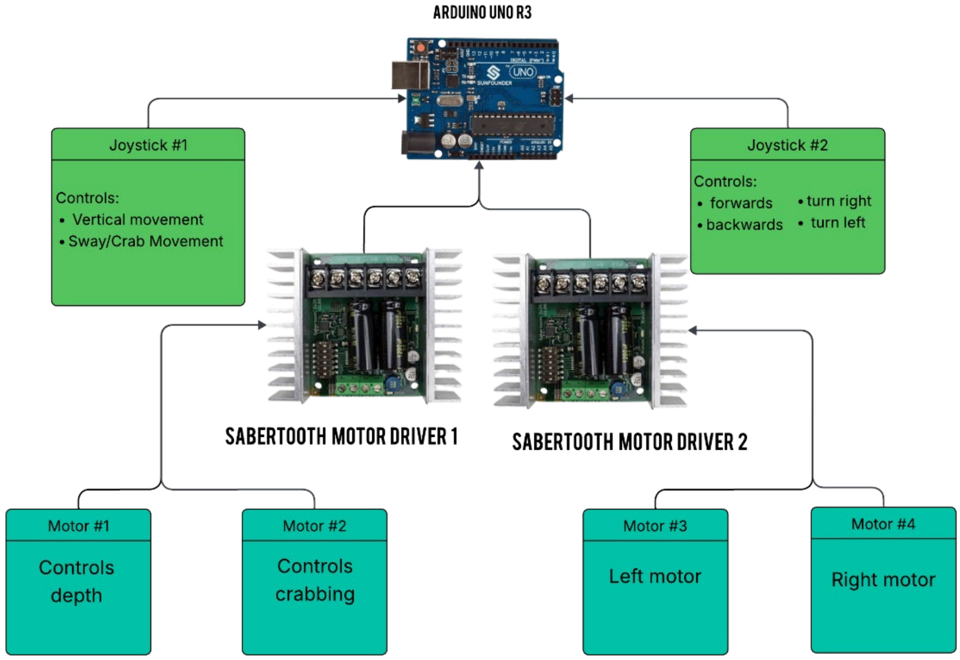
Step 4: Active Control:

- The motors and servos move as decided by the controller input per motor/servo designation.

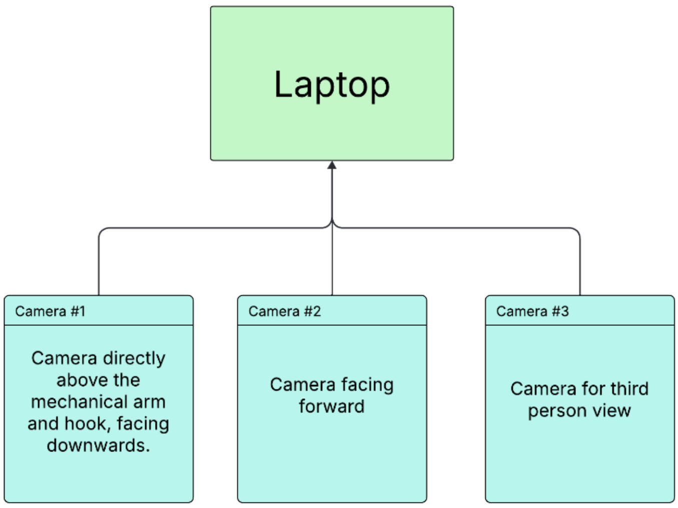
Step 5: Feedback Loop:

- The system is in a feedback loop to ensure proper control, activity, and scoring based on arena conditions.

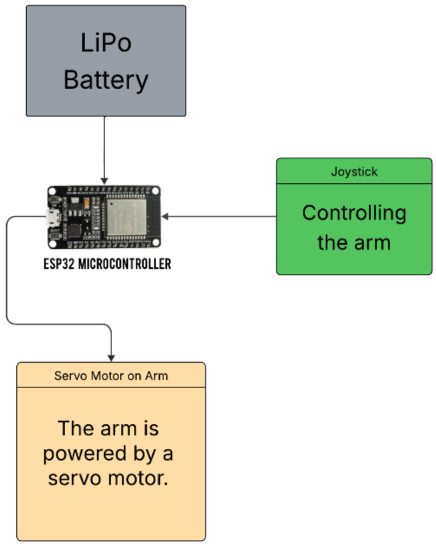
Main Vehicle Control



Camera Inputs



Arm Control



Safety and Risk Mitigation

- Safety was a top priority throughout the design, construction, and operation phases of the **Leviathan ROV Mark I** .
- Our team implemented a safety strategy to protect personnel, ensure durability of the used materials, and maintain reliability of the ROV.
- We enforced use of PPE including gloves and goggles while soldering, cutting and wiring.
- The usage of four fuses was implemented due to its complete prevention of damaging electrical components in case of a short circuit.
- A multimeter was used to monitor the current and voltage going through the unit.
- Many components, such as the control unit and tether, were sourced directly from MATE as they are tried-and-tested over multiple years and have a proven track record for reliability, thus removing much risk of component failures and short circuits.
- Team members were briefed on safe tool usage and proper handling of electronic components.
- All high-current wires were securely insulated and labeled, and fuse protection was installed on power lines to prevent short circuits.
- The ROV frame was designed with rounded edges and shielded propellers to minimize physical risk during handling.
- Electrical components were housed in waterproof enclosures, and strain reliefs were used on tether and cables to avoid stress and disconnections due to pulling of the wire.
- Subsystems such as thrusters and cameras were tested independently before integration, ensuring early detection of issues. Before each mission, we followed a detailed pre-dive checklist covering:
    - Battery and fuse status
    - Functional checks for thrusters, cameras, and tools
    - Tether integrity and connection test
    - Emergency shut off and communication test
- The checklist was printed and physically verified before testing. Post-test reviews were conducted to check issues and improve on the ROV.
- This safety-first approach ensured accident-free working of the team and highlighted our commitment to responsible engineering.

Gloves and Goggles used while soldering

Safety checklist for construction and operation

This checklist was developed and followed by the Bangalore BullSharks team to ensure safety and quality during the design, construction, and operation of the Leviathan ROV Mark I.

Construction Phase Safety Checklist		
SN	Safety Item Description	Y/N
1	PPE (gloves and goggles) worn while soldering, cutting, or drilling	
2	Mentor supervision ensured for all high-risk tool use	
3	All power tools handled with insulated gloves and proper grip	
4	High-current wires properly insulated and labeled	
5	Fuses (15A and 3A) installed in control box to prevent overcurrent damage	
6	All electrical components sealed in waterproof enclosures	
7	Strain relief applied to all external cables, especially the tether	
8	Control box tested with multimeter before integration	
9	Visual inspection of sharp edges and shielding of propellers	
10	Proper ventilation ensured during soldering and adhesive use	

Pre-Operation Phase Safety Checklist		
SN	Safety Item Description	Y/N
1	Battery fully charged and voltage verified	
2	Fuses checked for continuity	
3	All thrusters tested for direction and responsiveness	
4	Cameras (front, down, back) confirmed operational	
5	Hook and arm servos tested for range and control	
6	Tether inspected for wear, twists, or loose connectors	
7	Emergency shut-off mechanism functional	
8	Joystick control interface tested with Arduino + Sabertooth modules	
9	Waterproof seals on electronics verified	
10	Printed pre-dive checklist marked off before each test or mission	

Post Operations Phase Safety Checklist		
SN	Safety Item Description	Y/N
1	Visual inspection of ROV for leaks, damage, or loose joints	
2	All moving parts lubricated if needed	
3	Any faults or irregularities logged in troubleshooting document	
4	ROV dried and stored in a safe, dry location	
5	All tools cleaned and returned to storage	
6	Team debrief conducted to share observations and learning	

Testing and Troubleshooting

- We began with unit testing individual components such as thrusters, motor drivers and the controller—before integrating them into subsystems.
- Each thruster was tested in water to confirm directionality and balance. Similarly, the camera system was tested under both dry and submerged conditions.
- During integration testing, we checked for electrical conflicts, loose connections, and communication delays between components, as well as short circuits.
- The custom arm and hook were repeatedly tested with simulated mission tasks to assess stability, strength, and operator control.
- Troubleshooting involved a combination of visual inspections, multimeter, code debugging (serial monitor), and substitution of suspected malfunctioning components.
- In cases of unexpected behavior, we isolated subsystems and replaced them with working backups to find out faults quickly.
- We 3D printed parts where needed, to ensure that we were able to test quickly and fix all problems.
- This allowed us to iterate quickly and choose the right designs.
- Every major change or fix was logged in a shared troubleshooting document, which served as a data bank for all team members and helped prevent repeated issues.
- These thorough testing and troubleshooting strategies gave us confidence in the ROV's readiness for competition scenarios.

Budget and Cost Accounting

- Our budget planning was thorough and closely aligned with project goals. We started with a detailed cost estimation spreadsheet that included parts, spares and safety materials—all recorded in USD.
- We factored local rates for parts that were sourced nearby, included itemized expenses.
- This transparency and control ensured responsible financial management and proper use of available resources.
- We received $2000 from the parents of team members collectively and reused certain materials from the previous round. We also received guidance and financial support from YoLabs, who also let us use tools and items from the lab.

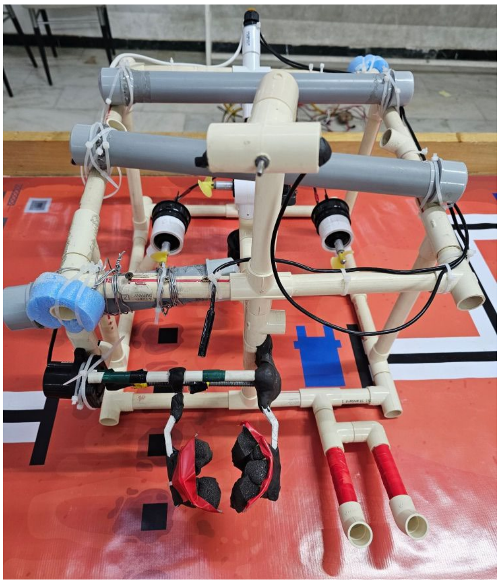
Budgeting

School Name:	Bangalore Bullsharks	Reporting period:	From:	01-05-2025
			To:	17-06-2025
Instructor:	Nitesh Varshney			
Income				
Source				**Amount**
Parent Sponsored				$2000
Expenses				
Category	**Type**	**Description/Examples**	**Projected Cost**	**Budgeted Value**
Hardware	Re-used	PVC pipes,tees,servo etc	$1200	-
Electronics	Purchased	Control Box, wires	$1260	$1260
Travel	Purchased	1 round trip to Alpena,USA	$1600	$1600
General	Purchased	Marketing material, transportation packaging	$100	$100
Hardware	Purchased	Arm	$100	$100
Sensor	Re-used	3 Techno View Cameras,displays	$100	-
			Total Income:	$2000
			Total Expense	$4360
			Total Expense-Re-use/Donations	$3060
			Total Fundraising Needed	$1460

Costing

School Name:	Bangalore Bullsharks	Reporting period:	From:	01-05-2025			
			To:	17-06-2025			
Instructor:	Nitesh Varshney						
Date	**Type**	**Category**	**Expense**	**Description**	**Sources/ Notes**	**Amount**	**Running Balance**
01-05-2025	Parts Donation	General		Tools Donated by Yolabs	Tools used throughout the construction of the ROV	$500	$-500
02-05-2025	Re-used	Hardware	PVC	PVC pipe tees	Used for Vehicle	$289	$-211
04-05-2025	Purchased	Electronics	Control Box	Barracuda ROV with Thrusters and Tether	Used for Controlling Vehicle	$1260	$1049
08-05-2025	Re-used	Sensors	Camera	Re-used in previous competition	Necessary for Navigation	$100	$1149
010-05-2025	Purchased	Hardware	Arm	Servos,3D printed materials, Screws	Necessary for completion of tasks	$100	$1249
01-06-2025	Purchased	Travel	Airfare	1 round trip to Alpena,USA	International Economy Tickets	$1600	$2849
						Total Raised:	$500
						Total Spent:	$3349
						Final Balance:	$2849

Leviathan ROV Mark I – Vehicle Photo



References and Acknowledgement:

a. Acknowledgement to:

- The Parents of Bangalore Bullsharks Team for Sponsoring Our Team
- Yolabs Organization for providing Valuable Equipment and Resources

b. References:

1. Barracuda ROV with Thrusters and Tether: Barracuda ROV with Thrusters and Tether
2. ROV Design : Ortho ROV Bot Design
3. Guide for Building the ROV: Guide for ROV Building
4. Guide to Help Us Understand Buoyant Force: Buoyant Force Explained
5. Base Design for Our Arm: Arm Design
6. Movement Code: Movement Code
7. Arm STL Files: Arm STL files
8. Control Box Testing: Control Box Testing
9. 1st time Testing: 1st Testing
10. Float Testing: Float Testing