



MATE ROV '26

TECHNICAL REPORT

Delta University for Science & Technology, Egypt



Team Leader

Shimaa Sherif

Electrical Team

Shimaa Sherif
Nada Mohamed
Abdrahman Osama
Mariam El-desoky

Mechanical Team

Abdullah Mohamed
Eslam foad

Software Team

Omar Abdelazim
Ali Mohamed

Non-Tech Team

Ahmed Elshafey
Yousef Omar

Team Advisor

Dr. Walied Raslan
Dr. Ahmed Abdelkader

Mentors

Eng. Khaled Elgayyar
Eng. Mohamed Yasser
Eng. Youssef Elgayyar



DELTA UNIVERSITY
FOR SCIENCE AND TECHNOLOGY

PREFACE

In mid-2025, our journey didn't begin in a lecture hall, but through the spark of a digital screen. While following the global echoes of underwater robotics competitions on social media, we were captivated by the stories of innovation, the breathtaking prototypes, and the relentless spirit of competitors from across the globe. Watching those videos and photos wasn't just scrolling through a feed; it was a profound moment of inspiration that ignited a shared passion within us. We realized then that we didn't want to just be spectators—we wanted to be the ones pushing the boundaries of what is possible beneath the waves.

Driven by this newfound ambition, team TITAN was forged at Delta University for Science and Technology. We came together with a singular vision: to transform that digital inspiration into a tangible reality. With the unwavering support of our university, we transitioned from admiring global innovators to becoming creators ourselves. After months of rigorous research, iterative design, and tireless dedication, we proudly present our latest achievement: the Titamarine ROV.

Our ultimate goal transcends the engineering of a robot; we strive to become a source of inspiration for others, just as we were inspired at the start of our path. At TITAN, we believe that passion is the true engine of innovation. The Titamarine is our message to the world—a testament that with grit and determination, we can penetrate the deepest waters and build a technological future that reflects our highest aspirations. This report is more than a technical document; it is the epic story of our transition from dreaming behind screens to leading in the depths.



Fig 1 : TITAN CREW after a session was presented.

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We would like to express our deepest gratitude and heartfelt appreciation to the organizations and individuals who have been the pillars of support for our team throughout this challenging yet rewarding journey. Their belief in our vision and their unwavering support were instrumental in bringing this project to life.

MATE ROV Competition: For providing an extraordinary platform that inspires innovation and challenges the next generation of engineers. We are grateful for their continuous support and for fostering a global community of STEM enthusiasts.

Delta University for science and technology: For providing the necessary academic environment, administrative facilities, and financial backing. Their commitment to student-led technical projects has been the foundation of our success.

Team Advisors & Mentors: We owe a great debt of gratitude to our advisors, "Dr Waleed Raslan & Dr Ahmed Abdelkader" and "Eng Mohamed Yasser & Eng Khaled Elgayyar & Eng Youssef Elgayyar", for their invaluable technical guidance, patience, and for pushing us to excel beyond our perceived limits. Their mentorship has been the compass that guided us through complex engineering hurdles.

University Leadership: We extend our thanks to [Dr Sayed Ward & Dr Mazen Selim] for their visionary leadership and for creating an atmosphere that encourages practical engineering and international competition.

Our Families and Friends: To our parents and friends, thank you for your endless patience, emotional support, and for being our primary source of motivation during the long nights and intensive work sessions.

Finally, we would like to thank every member of our team for their dedication, synergy, and hard work. This project is not just a machine; it is a testament to what we can achieve when we work together toward a common goal.



1. DESIGN RATIONALE

1.1 ROV OVERVIEW

As newcomers to the specialized field of underwater robotics, Team TITAN began this journey at Delta University with a steep learning curve. Our initial phase was dedicated to intensive research, analyzing previous MATE ROV competitions and studying marine engineering principles to bridge the gap between theoretical knowledge and practical application. After months of iterative design and prototyping, we developed our final competition vehicle: Titamarine.

Titamarine is engineered for the Pioneer Class with a focus on modularity and mission-specific efficiency. The vehicle features a robust mechanical frame designed to provide a stable platform for its propulsion and sensing systems. Drawing inspiration from industry-standard underwater systems, we implemented a sealing strategy that ensures the integrity of our core electronics while maintaining easy access for maintenance.

A standout feature of our architecture is the high-performance propulsion system, which utilizes six modified Bilge pump 1100GPH motors (12V, 3A) for superior underwater agility and precise 5-degrees-of-freedom movement. To ensure precise power management, we integrated two Buck Converters: the first steps down the voltage from 48V to 12V to power the motor drivers, while the second converts 12V to 5V to provide a stable and isolated power rail for the onboard electronics and sensors.

Despite being our debut project, the refined design of Titamarine has reached a high level of operational readiness, successfully completing initial buoyancy and navigation tests. This milestone marks our transition from a student-led initiative to a competitive engineering team ready for the MATE ROV Egypt Regional challenge.



Fig. 2: Titamarine after the internal parts have been installed

2. SYSTEM DESIGN

2.1 ROV STRUCTURE

2.1.1 CHASSIS

The chassis serves as the structural backbone of Titamarine, engineered for maximum durability and corrosion resistance. Our primary objective was to balance structural strength with a lightweight profile, targeting a density of approximately 95% that of water to achieve near-neutral buoyancy.

During the initial design phase, Aluminum was heavily considered for the frame due to its rigidity. However, it was ultimately rejected due to the high risk of galvanic corrosion in marine environments and its significantly higher manufacturing cost compared to HDPE.

We selected High-Density Polyethylene (HDPE) for two main reasons:

Engineering: It offers exceptional impact resistance and reliability in underwater environments.

Environmental: HDPE is fully recyclable, aligning with our commitment to sustainable engineering.

The chassis was fabricated by precision-machining 10 mm HDPE sheets into custom-designed components, resulting in a robust and modular frame that ensures easy maintenance



Fig. 3: 10mm HDPE Sheets



Fig. 4: Titamarine Initial Chassis Frame Fully Assembled

The chassis features a fully modular design, enabling easy disassembly for maintenance and portability. All components were precision-cut using a CNC Router and assembled with high-grade Screws, sized specifically for load requirements. By utilizing the best local materials and advanced manufacturing, our chassis represents a unique, flexible, and high-quality engineering solution.

2.1.2 ELECTRONIC COMPARTMENT

The waterproof electronics compartment follows the Blue Robotics ROV enclosure design—an acrylic cylinder sealed on both ends with 3 O-ring-fitted end caps. It offered the most reliable and adaptable solution.

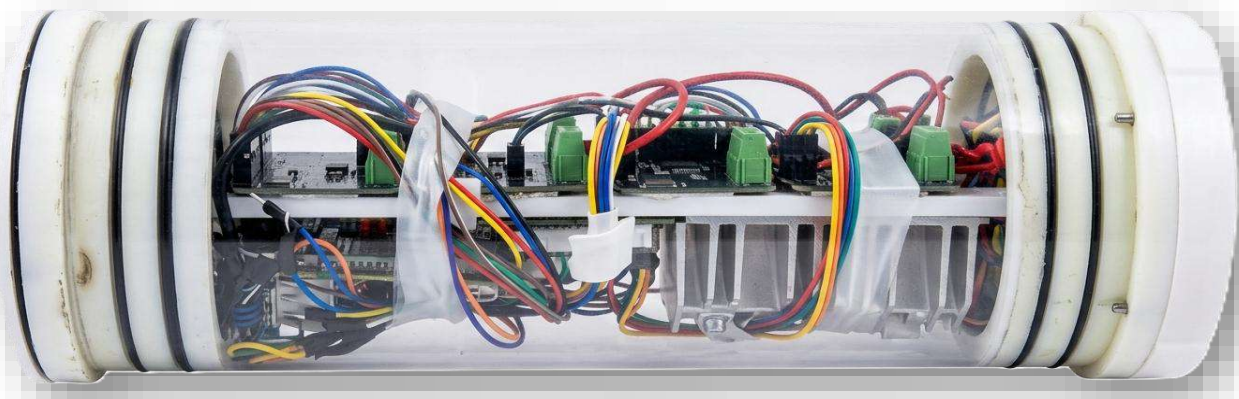


Fig. 5: Titamarine Electronics Holding Tray (3D Printed)

Due to international shipping constraints and budget optimization, we developed a high-quality, locally fabricated enclosure for Titamarine. The core of our electronics housing is a 3mm thick transparent acrylic cylinder, providing both structural integrity and clear internal visibility.

Key Technical Specifications:

Sealing Mechanism: To maximize the integrity of the O-rings and improve the overall seal, white silicone grease was generously applied to all mating surfaces. We engineered two 5cm flanges, each featuring three O-rings to ensure a redundant, high-pressure seal against water ingress.

Camera Integration: A precision-cut circular acrylic faceplate was integrated into the front end-cap to provide an undistorted field of view for the mission camera.

Internal Architecture: To maximize space efficiency, all internal mounting racks for the electronics and drivers were custom-designed and 3D-printed, allowing for a secure and organized electronics layout.

Our in-house enclosure achieved a reliable depth rating of 35–45 meters, which fully complies with MATE Pioneer Class requirements. This successful local fabrication allowed us to bypass the size limitations of imported samples, resulting in a custom-sized, fully functional housing built entirely by our team.

2.1.3 MANIPULATOR ARM

To execute complex underwater tasks with precision, we developed a specialized manipulator system fabricated from High-Density Polyethylene (HDPE). This modular construction was selected for its exceptional durability and rigidity in aquatic environments.

Actuation & Motion Control:

The manipulator is driven by two independent DC motors, providing superior control over mission objectives:

Rotational Motion: The first motor is dedicated to achieving a full 360-degree rotation of the entire gripper assembly. This specific design was chosen because it provides maximum freedom of movement at a highly cost-effective price point, which was critical for successfully completing Task 2 and Task 3. We use the current sensing pin in the bts controlling the gripper as a feedback for not closing the gripper too much on the object or closing the gripper while it is already close .

Gripping Action: The second motor powers a sophisticated internal Gearbox. This system utilizes a Worm Gear paired with two standard gears to provide a powerful, self-locking mechanism for the precise opening and closing of the jaws.

Structural Configuration:

The robust HDPE assembly is strategically divided into six primary sections:

Four specialized components engineered for the mechanical "Open/Close" gripping action.

Two structural housing components designed to enclose and protect the internal gear system and motors.

This combination of 360-degree rotation and high-torque worm-gear gripping provides Titamarine with a versatile and robust tool capable of handling diverse mission-specific payloads with ease.

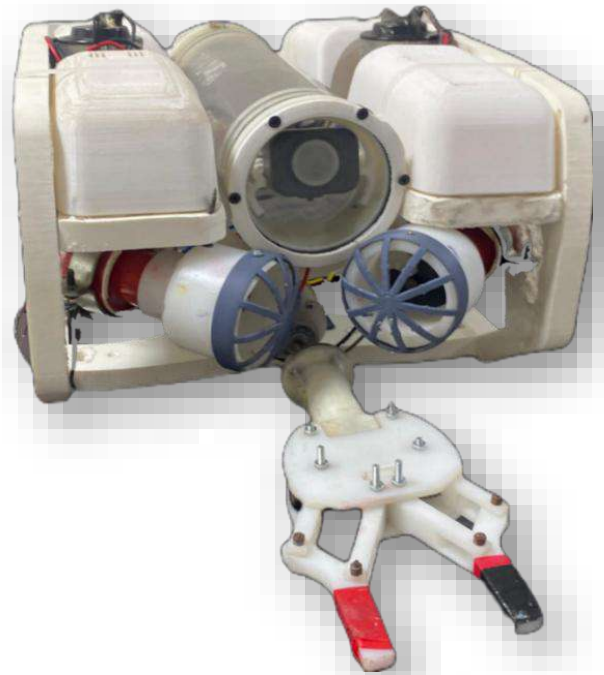


Fig 5: The arm and the gripper after being installed

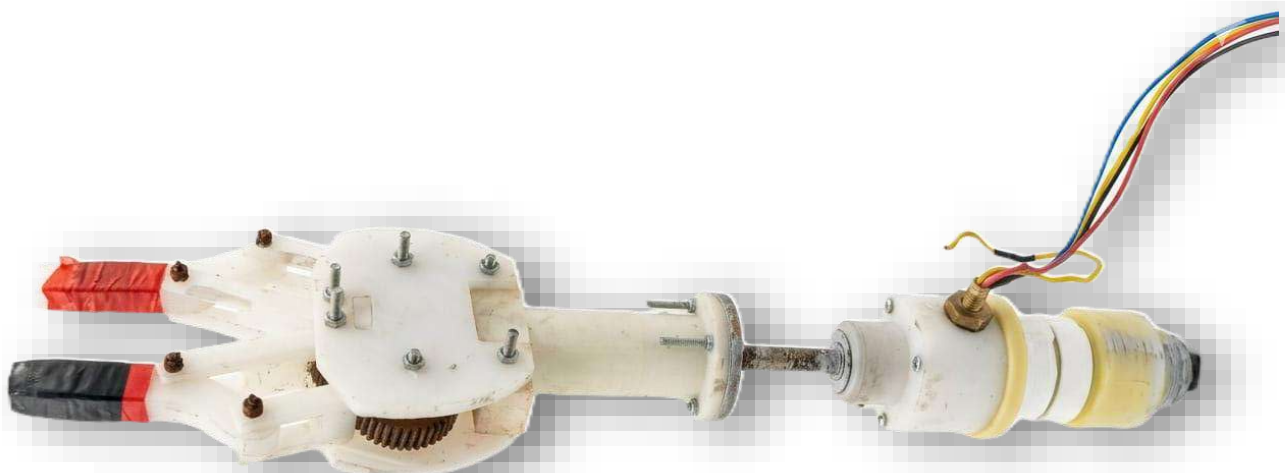


Fig 6: The arm and the gripper before being installed in Titamarine

2.1.5 TETHER

The tether for **Titamarine** is a custom-engineered umbilical designed to provide reliable power and high-speed data transmission. The system integrates three primary cables into a single, streamlined bundle:

Power Delivery: Two 10 AWG cables (Red and Black) are used for the main power supply, ensuring high current capacity and minimal voltage drop across the tether length.

Data Communication: A shielded CAT6 Ethernet cable was selected to facilitate communication between the surface station and the onboard Raspberry Pi 4.

We strategically opted for CAT6 because it fully supports the Gigabit Ethernet bandwidth required by the Raspberry Pi 4. This choice is more cost-effective and provides better local availability without compromising performance. To protect data integrity from electromagnetic interference (EMI) generated by the high-current motors, we utilized the shielded (S/FTP) version of the CAT6 cable. This ensures a stable, low-latency 1080p video feed and precise control signals, representing an optimal balance between affordability and high-performance reliability.



Fig. 7: cable CAT 6

2.2 BUOYANCY & PROPULSION

2.2.1 BUOYANCY

Titamarine was designed to be near-neutral buoyant, with its buoyancy being slightly bounced. The slightly buoyancy makes the ROV float naturally when deployed in water without thrusters on, and the ROV behaves like a floating object. This allows its **2 vertical/Z-axis thrusters** to maneuver the ROV in any direction at any height, as a quadcopter drone behaves in the air. The additional thrusters at the front and back allow the ROV to move freely in any direction at a fixed height, and they are used to maneuver the ROV, especially when the ROV is at the bottom of the pool performing tasks.

This design allows us to easily adjust the buoyancy of the system by modifying the amount of foam housed under the four white covers on the top of the ROV. Furthermore, we can easily fine-tune the center of mass and the center of gravity by strategically placing adjustable weights along the lower chassis. This design lowers the center of gravity relative to the center of buoyancy, enhancing passive stability and reducing unwanted roll and pitch during operation.

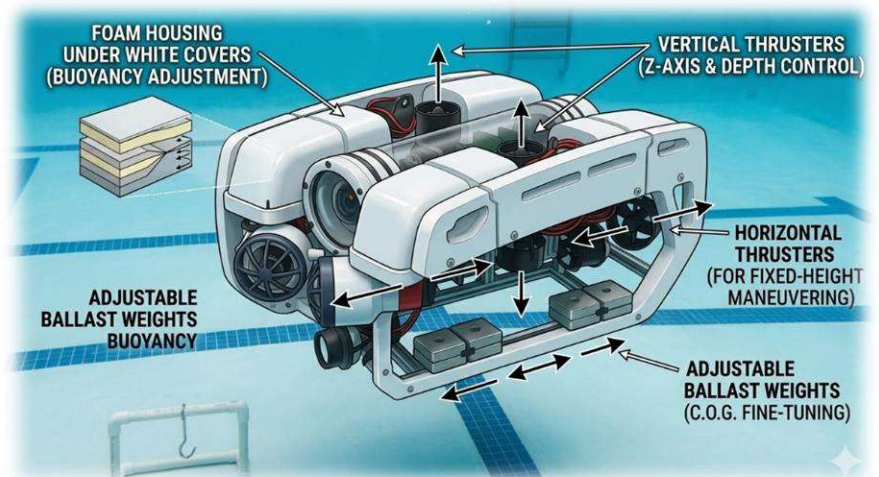


Fig.8: An expressive image generated by AI showing the vehicle's buoyancy

2.2.2 THRUSTER ORIENTATION

Titamarine uses an six-thruster configuration with BILGE PUMP 1100GPH thrusters, each controlled by a dedicated BTS for independent operation. Two thrusters are mounted at the upper corners, all aligned along the positive Z-axis. The bottom front pair is angled at 45° between the positive X and Y axes, while the rear pair is angled at 45° between the positive X and negative Y axes. This configuration enables full 5-DoF control, allowing precise movements, rapid 360° spins, and omnidirectional maneuverability using one or more thrusters as needed. This entire orientation of six thrusters allows **Titamarine** five Degree of Freedom (**5-DoF**) Movement Orientation. To ensure both hydro-dynamic efficiency and absolute diver safety, all six thrusters are equipped with custom-fitted propeller shrouds, preventing accidental contact and debris entanglement.

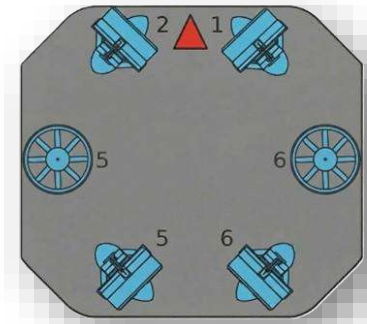


Fig. 9: Thruster

2.2.3 CONTROL

Titamarine is controlled by a gaming joystick from playstation. The joystick keys are calibrated and configured to suit **Titamarine's** needs. The pilot can control thrusters individually or change mode to use preset control of UP, DOWN, LEFT, RIGHT, and STOP. The pilot can also toggle Constant Thrust Mode or Incremental Thrust Mode depending on the scenario. Constant Thrust Mode makes the ROV move at a constant speed in any direction, while the Incremental Thrust Mode allows the ROV to slowly gain speed till it reaches maximum velocity while moving in a direction, as long as the pilot is keeping the button pressed. This control system, although slightly complex, allows the pilot to do versatile maneuvering with enough training.



Fig. 10: Joysticks Used For Control

2.3 ELECTRONIC SYSTEM

2.3.1 ELECTRONIC SYSTEM OVERVIEW

The Titamarine ROV operates on a robust power system, starting from the surface power supply protected by a 25A fuse. Power is delivered via the tether at 48V, then stepped down using high-efficiency converters: a 48V to 12V converter for the thruster system and a 12V to 5V converter to power the onboard logic.

Core Processing & Control:

The vehicle's intelligence is centered around a Raspberry Pi Model 4, which handles high-level data processing and communication with the surface station (Laptop & Monitor) via the joystick interface. For low-level hardware execution, the system utilizes an Arduino Mega as the primary microcontroller, interfacing directly with all sensors and motor drivers.



Figure 11: Raspberry Pi Model 4

Propulsion & Actuation:

The ROV features a sophisticated propulsion and manipulation system consisting of six thrusters and 2 motors for the arm. Each motor is driven by a dedicated BTS7960 high-power motor driver, all of which are controlled by the Arduino Mega to ensure precise movement and task execution.

Sensing & Environmental Awareness:

To monitor both the internal environment and external conditions, the Arduino Mega integrates a diverse suite of sensors:

MS5540: Since the depth sensor must be directly exposed to water to read pressure, its delicate surface electronics were carefully isolated and potted with waterproof epoxy to prevent short circuits. Furthermore, the epoxy will be coated with a layer of wax to ensure it is environmentally safe and non-toxic to the aquatic environment. This setup is designed for high-precision pressure and altitude measurements.

MPU6050 (Inertial Measurement Unit): Used to track the ROV's orientation, tilt, and motion. because of this sensor, the ROV can maintain a stable, fixed position, height, and orientation automatically after the pilot releases the controls.

BMP280: For monitoring internal barometric pressure and temperature.

Rain Sensor: Utilized as a specialized leak detection system to sense any water ingress within the electronics enclosure.

Vision & Communication:

Real-time visual feedback is provided by a Camera module connected directly to the Raspberry Pi 4. The communication link is maintained through a dedicated Tether, ensuring a stable data flow between the ROV's internal processors and the surface control unit.



Figure 12 : Arduino MEGA

2.3.2 POWER SUPPLY & MANAGEMENT

The **Titamarine** utilizes a high-efficiency 48V DC power architecture, selected to minimize voltage drop over the tether and bypass the 25A limits of standard 12V systems.

1. Power Input & Safety:

Surface power enters via an Anderson Powerpole SBS50 connector. For maximum safety, a 25A fuse is installed within 30 cm of the entry point, providing immediate overcurrent protection against electrical faults.

2. Multi-Stage Voltage Conversion:

Power is managed through a two-stage step-down process:

48V to 12V"30A – waterproof": High-efficiency Buck Converters power the eight (8) BTS7960 motor drivers, providing the necessary power for propulsion.

12V to 5V: LM2596HVS step down buck converter, provide a stable 5V supply for logic components.

3. Control & Sensing Integration:

The regulated 5V line powers the vehicle's "intelligence":

Processing: Provides stable power to the Raspberry Pi 4 and Arduino Mega.

Sensing: Supports the onboard sensor suite, including the MS5540, MPU, BMP280, and the Rain Sensor (utilized as a leak detection probe) to monitor the electronics enclosure's integrity.



Figure 13: Buck Converter

2.3.3 POWER CONSUMPTION

Components	Power Per unit	Quantity	Total Power
horizontal Thrusters	36W (12V × 3A)	4	144W
Raspberry Pi	10W (5V × 2A)	1	10W
Arduino Mega	2.5W (5V × 0.5A)	1	2.5W
Vertical Thrusters	45w(12Vx 3.75A)	2	90W
Gripper Motors	14.4w(12Vx1.2A)	2	28.8W
Total Consumed			275.3W
Base Current: $(275.3W / 48V) = 5.7A$ With 1.5 × Safety Factor: $5.73A \times 1.5 = 8.60A$ Fuse Installed on each motor: 5A			

2.4 SURFACE CONTROL STATION

2.4.1 CONTROL STATION SETUP

The surface control station consists of a laptop, one controller, and a monitor. AC power is marked separately for the surface station. The station is set up on a single table, allowing the Pilot and Co-pilot to focus on their respective roles. The Pilot controls ROV movement via the joystick while the Co-pilot manages camera orientation via the laptop.

2.4.2 SOFTWARE & PILOT INTERFACE

Our ROV software enables full vehicle control, navigation, and live video streaming for species identification and underwater scene reconstruction. Developed in Python, it uses OpenCV for live frame streaming, models for image processing& detection, and Pygame for joystick input handling.

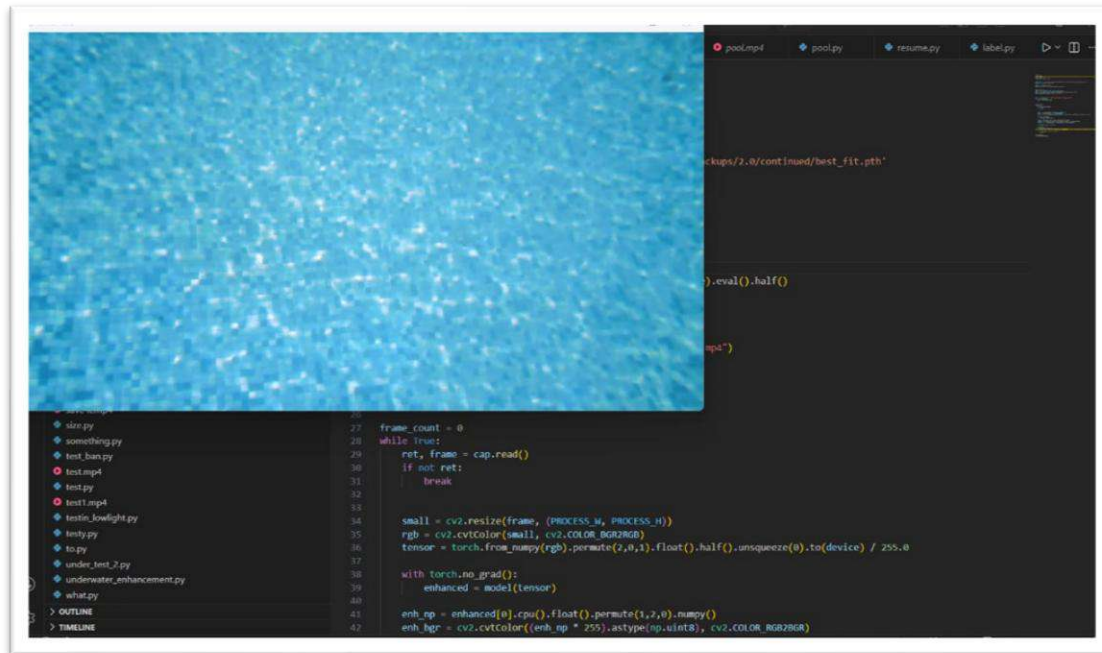


Fig. 14: Pilot Interface.

The Pilot Interface is built using OpenCV windowing with an interactive floating overlay panel, providing real-time video and toggable AI model activation via keyboard hotkeys. Communication follows a three-tier architecture — the laptop reads joystick states, encodes them as commands, and transmits them to the Raspberry Pi over Ethernet. The Pi forwards these commands to the Arduino via USB serial, which drives the ROV thrusters and actuators. The camera feed travels in reverse — raw frames are captured on the Pi and streamed to the laptop where all AI processing occurs on the GPU.

2.4.3 CAMERA VIEWS & MONITORING

The live camera feed is streamed from the Raspberry Pi to the laptop over Ethernet at native resolution. The pilot can toggle between raw, enhanced, and detection-annotated views at any time using keyboard hotkeys without interrupting the stream or joystick control loop.

2.5 ROV VISION 2.5.1 UNDERWATER VISIBILITY

The ROV uses a USB camera connected to the Raspberry Pi, which acts as a bidirectional relay — forwarding raw frames to the laptop over Ethernet and receiving joystick commands to forward to the Arduino. All image processing is handled on the laptop GPU, decoupling control latency from vision processing.



Fig. 15: Kisonli HD

2.5.2 CAMERA CALIBRATION & NOISE REDUCTION

Computer Vision Features include:

- Underwater Image Enhancement — MIRNet restores color, contrast, and fine detail in real time. Toggled with “U” key.

- European Green Crab Detection — YOLOv8s fine-tuned on 819 green crab and 698 other crab images across multiple training phases, with nuanced learning rates at each phase. The model detects and classifies crabs with bounding boxes and confidence scores. Toggled with “O” key. Confidence threshold (0.0-1.0) and inference size (500-2000) adjustable via control panel.

- 3D Scene Reconstruction — Press “S” to start intelligent frame capture using Laplacian blur detection and frame difference filtering, capturing only sharp, non-redundant frames to rapid_3d_frames/ (max 200 frames). Press “E” to stop. Frames are processed with COLMAP to produce dense 3D point clouds and meshes for spatial analysis— We can see the mesh-result using MeshLab. Single frame capture with “C” key includes perspective correction.

- Perspective Transformation— After single capture (“C”), option 1 allows interactive corner dragging with opacity preview, enabling precise correction of underwater distortion before saving.

- Dynamic Parameter Control — Confidence threshold, inference size, and enhancement resolution are adjustable in real time through a floating overlay panel with immediate adjustments.

- Data Analysis Tools — Frequency analysis extracts species count tables from PDFs and computes proportional frequencies. Threat assessment extracts iceberg and platform data from PDFs to evaluate surface and subsea threats.

- Joystick Control Pipeline — Pygame reads joystick states continuously, encodes commands as compact packets, and transmits them to the Raspberry Pi over Ethernet. The Pi forwards each packet to the Arduino over USB serial, where the Arduino decodes and executes thruster and actuator commands. The round-trip latency is only due to Ethernet and serial transmission speed, keeping response immediate and independent of vision processing load.

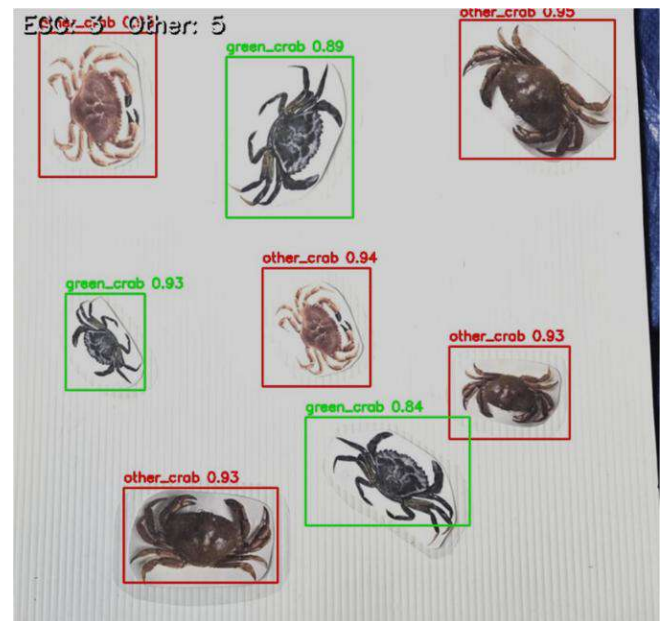


Fig. 16: example of green crab detection.

2.6 ROV SPECIALIZATION

Titamarine specializes in:

- **Underwater Computer Vision:** Object detection and identification, color detection, correction, and identification, size and distance measurement, low-light visibility and automatic 3d modeling.
- **Underwater Maneuvering:** Accessing underwater regions physically inaccessible to human divers (narrow caves, coral reefs, etc.).
- **Underwater Intervention (Repair, Removal, Replacement):** Repairing underwater devices, removing debris, replacing worn-out underwater components like sacrificial anode, hydrophone, etc.



Fig. 17: tasks and requirements

3. CRITICAL ANALYSIS

3.1.1 Software Optimization & Debugging (The Control Logic)

Our software architecture is designed for modularity and ease of troubleshooting: Environment Stability: We utilize a stable distribution of Raspberry Pi OS optimized for the Raspberry Pi 4, ensuring seamless hardware-software integration and low-latency communication.

Testing Protocols: Our workflow incorporates Unit Testing and Q&A models to isolate and debug code segments independently.

Version Control: We maintain a rigorous GitHub workflow where all new code is verified in a simulation environment before deployment. Stable versions are properly backed up to prevent any disruption during mission updates.

3.1.2 Electrical Diagnostics & Power Validation (The Energy Core)

To ensure electrical stability and protect sensitive components, we use a suite of diagnostic tools:

Power Regulation: Our Buck Converters and voltage regulators undergo periodic performance audits using oscilloscopes and multimeters to monitor ripple voltage and efficiency.

Sensor Calibration: Components such as the MS5540 and MPU6050 are calibrated against known standards to guarantee data accuracy during underwater tasks.

Connectivity: All wiring harnesses are tested for continuity and proper insulation before the ROV is powered up.

3.1.3 Mechanical Reliability & Resilience (The Structural Frame)

Mechanical tests focus on the durability of the chassis and the integrity of moving parts:

Vibration & Impact Analysis: We conduct stress tests to simulate the effects of thruster vibration and potential underwater collisions, ensuring the frame remains rigid.

Fastener Audit: A comprehensive inspection of all joints, nuts, and bolts is performed before every mission to prevent any mechanical failures caused by loosening during operation.

3.1.4 Waterproofing & Pressure Integrity (The Protective Shell)

During simulation, we found this final barrier for the ROV's electronics, verified through a two-stage process:

Pneumatic Leak Detection: A handheld vacuum kit is used to subject the seals to a pressure of 4 bars. This ensures the ROV is depth-rated for 42 meters, exceeding the competition's requirements by a safety factor of four.

Static Submersion: The enclosure is submerged for several hours to confirm that no micro-leaks or moisture ingress occur under realistic conditions.

3.1.5 Integrated Full-System Validation (The Final Mission Readiness)

The final phase is the "Full System Test," a step-by-step verification following a strict algorithm. This test confirms that the software commands translate correctly into mechanical actions while the system is fully sealed and powered.

4. SAFETY

4.1 PHILOSOPHY

For our team, safety is the bedrock of our engineering process. We firmly believe that an ROV is only as effective as it is secure, and every design iteration is made with this principle at the forefront. We lead a culture of "Proactive Prevention," where every team member is empowered to identify and mitigate risks during the design phase. For us, safety is not merely a checklist; it is a core value that ensures the well-being of our personnel, the integrity of the competition environment, and the sustainability of our technical assets.

4.2 AWARENESS & TRAINING

Safety begins with education. All team members undergo rigorous safety briefing and drilling sessions every two weeks. These sessions provide hands-on experience in handling electrical emergencies, water ingress protocols, and the proper use of specialized industrial tools. We ensure that every member—from software developers to mechanical technicians—is fully prepared to respond to unforeseen situations with precision and calm.

4.3 SAFETY STANDARDS

Our team and the ROV we have built strictly adhere to industrial safety regulations and align perfectly with the MATE ROV Competition Safety Requirements. We follow these standards not only to ensure professional presentation but to guarantee that our vehicle operates safely under the specific environmental constraints of the competition pool.

4.4 SAFETY FEATURES

Since our ROV operates on a 48V System, the safety features include:

- Anderson Powerpole SBS50 Connectors
- Properly crimped power cables with the connector using Anderson's recommended crimpers.
- Fuse installed within 30 cm of the Anderson Powerpole Connectors.
- No power conversion before the ROV. Single attachment point to the power source.
- ALL propellers are completely shrouded to IP-20 standards. Mesh size < 12.5 mm.
- All items securely attached to ROVs using industry grade screws, bolts, and fasteners.
- No exposed copper or bare wire. All wiring is securely fastened and properly sealed.
- Tether is properly strain relieved on both ends. All wires entering and leaving the surface control station have adequate strain relief and wire abrasion protection.
- No exposed motors. All components using electric power are properly sealed and waterproofed.
- All connectors utilized are properly rated for their application.
- No sharp edges or elements of the ROV design that could cause injury to personnel or damage the pool surface.
- Redundant Electronic Sealing & Isolation: To safeguard sensitive components, including the Raspberry Pi 4, all electronics are housed within a dedicated, pressure-rated enclosure. This chamber is engineered to be the furthest point from water-entry risks, utilizing high-grade seals and internal desiccants to prevent moisture accumulation or condensation.
- Adjusted Buoyancy (Fail-Safe): The ROV's weight and displacement are meticulously balanced to be slightly bounced. In the event of a total power failure or thruster shutdown, the vehicle will naturally float to the surface, preventing collisions with the pool floor and ensuring easy recovery.

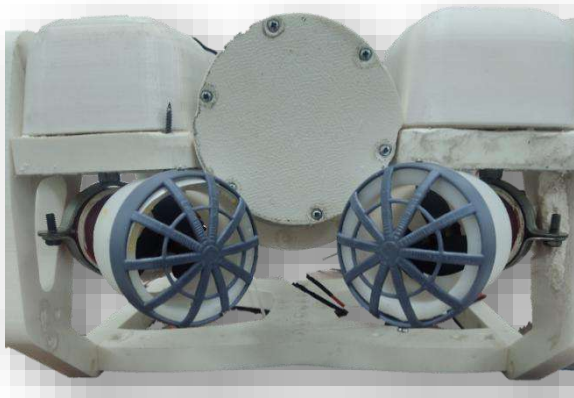


Fig. 18: 3D printed covers for safety

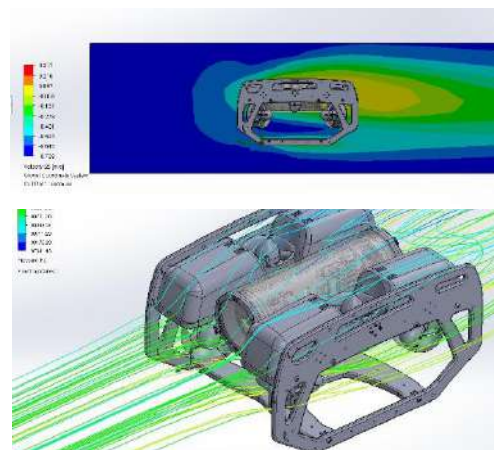


Fig. 19: First simulation to Titamarine

5. PROJECT MANAGEMENT

5.1 TEAMWORK & ORGANIZATION

TITAN represents the specialized underwater robotics division at Delta University, Egypt. As a dedicated team of undergraduate students, we are driven by a passion for advancing marine technology through innovation, interdisciplinary collaboration, and competitive excellence. Our primary mission is to design, engineer, and deploy high-performance Remotely Operated Vehicles (ROVs) for the prestigious International MATE ROV Competition.

For the TITAN team, efficient project management is the backbone of our technical success. To develop our ROV, Titamarine, we implement a structured strategy of Iterative Reviews and clear accountability. We follow an Agile Framework, organizing our development cycle into 2-3 week sprints. At the conclusion of each sprint, the team conducts thorough reviews to assess technical progress, resolve integration challenges, and adapt our milestones to ensure the project remains on schedule. This iterative process fosters continuous improvement and allows us to respond effectively to unexpected engineering hurdles.

To maintain high standards and motivation, we utilize an internal performance tracking system. This allows us to recognize outstanding contributions within each sprint, promoting a culture of excellence and healthy competition among our members.

5.2 PROJECT SCHEDULING AND TIMELINE

We establish rigorous milestones and deadlines for every phase of the Titamarine development cycle, including:

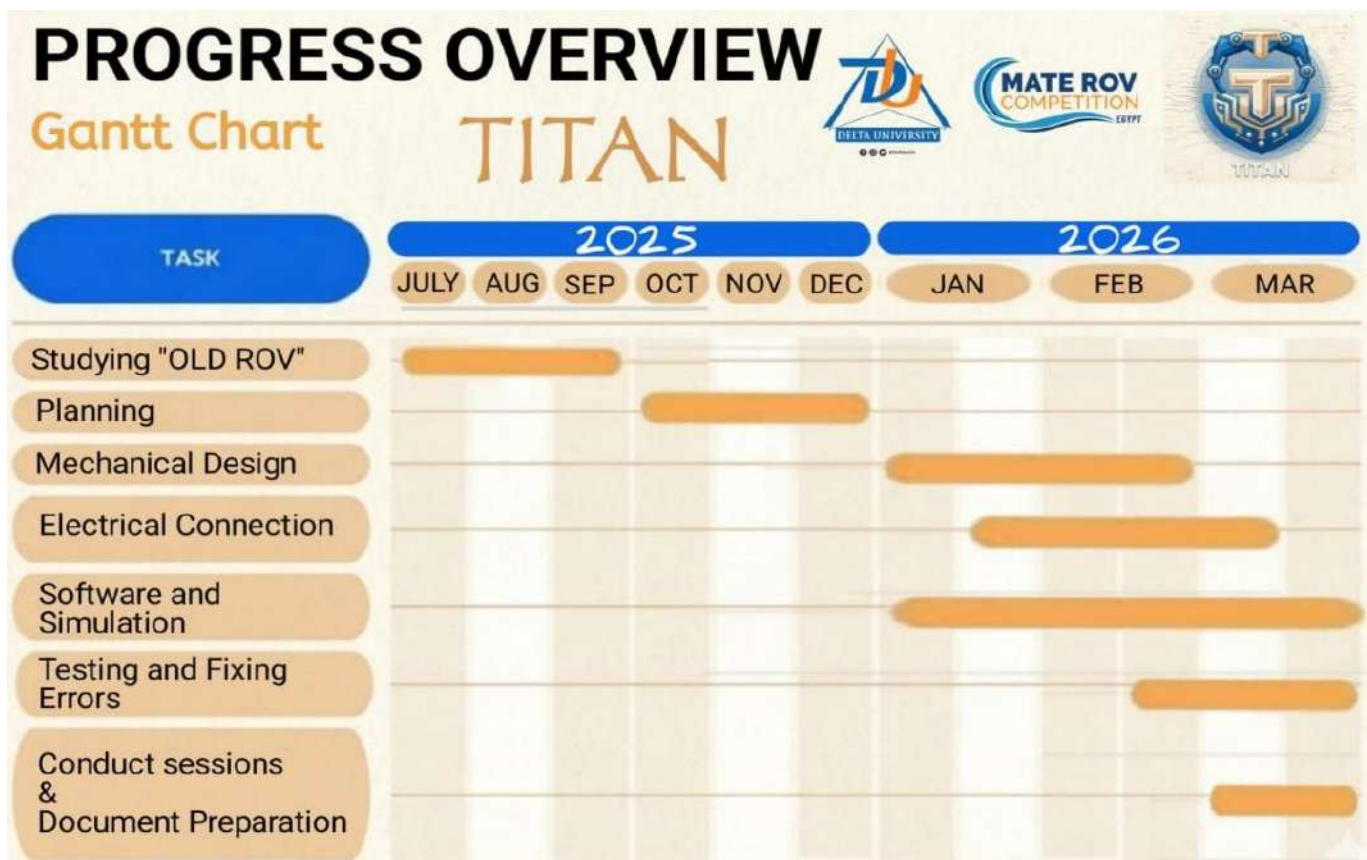


Fig. 20: Progress Overview (Gantt Chart)

5.3 ACCOUNTING

Financial transparency and resource optimization have been central to TITAN's success. Our budget, approved by Delta University, was meticulously managed by the Team Lead and Logistics Lead to ensure project sustainability.

University Support & Facilities:

The university provided critical institutional support, which significantly empowered our development process:

Infrastructure: Access to engineering labs and the university swimming pool for buoyancy and maneuverability testing.

Prototyping: Full utilization of 3D printing facilities and mechanical workshops.

Expenditure & Technical Evolution:

As this was our first build of the Titamarine, our accounting reflects an iterative engineering approach. We accounted for "learning costs," where some initial components failed during high-pressure testing or due to electrical spikes. These were replaced with superior alternatives—such as our high-efficiency 1100GPH Bilge Pumps—to ensure mission reliability.

All expenditures shown in the following reports represent newly purchased hardware and the necessary budget for regional and international participation.

	A	B	C	D	E	F	G	H	I
	Component Name	Quantity	Category	Type	Date	Basic cost in (EGP)	Price in (USD)	Amount in (EGP)	Price in (USD)
1	BODY	1	Mechanical	Purchased	24/12/2026	12000 L.E.	220 \$	12000 L.E.	220 \$
2	BILGE PUMP	6	Hardware	Reused	-	4,680 L.E.	\$89.59	-	-
3	ACKLYRIC TUPE	1	Mechanical	Purchased	27/12/2026	800 L.E.	\$15.31	800 L.E.	\$15.31
4	FLANGE	2	Mechanical	Purchased	29/12/2026	600 L.E.	\$11.49	600 L.E.	\$11.49
5	SCREW	64	Mechanical	Purchased	29/12/2026	64 L.E.	\$1.23	64 L.E.	\$1.23
6	O RING	6	Hardware	Purchased	29/12/2026	180 L.E.	\$3.45	180 L.E.	\$3.45
7	FUME	1	Mechanical	Purchased	29/12/2026	600 L.E.	\$11.49	600 L.E.	\$11.49
8	WATER HOSE	1	Mechanical	Purchased	3/12/2026	500 L.E.	\$9.57	500 L.E.	\$9.57
9	ARM BODY	1	Mechanical	Reused	-	800 L.E.	\$15.31	-	-
10	ARM MOTOR	2	Hardware	Purchased	15/3/2026	600 L.E.	\$11.49	600 L.E.	\$11.49
11	MACHINING CHASSIS ON ROUTER	-	Service	Purchased	25/12/2026	1,000 L.E.	\$19.14	1,000 L.E.	\$19.14
12	3D PRINTING	-	Service	Donated	12/2026 to 15/3/2026	-	-	-	-
13	3D PRINTED PARTS	15	Mechanical	Donated	12/2026 to 15/3/2026	2,200 L.E.	\$42.11	-	-
14	CAMERA	1	Hardware	Purchased	5/2/2026	750 L.E.	\$14.36	750 L.E.	\$14.36
15	ETHERNET	1	Electrical	Purchased	5/2/2026	400 L.E.	\$7.66	400 L.E.	\$7.66
16	ARDUINO MEGA	1	Electronic	Purchased	3/12/2026	1,500 L.E.	\$28.71	1,500 L.E.	\$28.71
17	RASSBERRY PI 4	1	Electronic	Donated	6/2/2026	9,000 L.E.	\$172.28	-	-
18	MICRO SD CARD 32GB	1	Electronic	Purchased	7/2/2026	500 L.E.	\$9.57	500 L.E.	\$9.57
19	ELECTRIC WIRES	1	Electrical	Purchased	15/2/2026	1,650 L.E.	\$31.58	1,650 L.E.	\$31.58
20	BLOTS	12	Mechanical	Purchased	15/2/2026	270 L.E.	\$5.17	270 L.E.	\$5.17
21	COPPER CONNECTOR	55	Electrical	Purchased	15/2/2026	60 L.E.	\$1.15	60 L.E.	\$1.15
22	SCREEN	1	Hardware	Purchased	15/3/2026	1,300 L.E.	\$24.89	1,300 L.E.	\$24.89
23	JOY STICK	1	Hardware	Purchased	6/2/2026	500 L.E.	\$9.57	500 L.E.	\$9.57
24	LEDS	2	Electrical	Purchased	15/3/2026	1,252 L.E.	\$23.97	1,252 L.E.	\$23.97
25	PCB	1	Electronic	Purchased	15/3/2026	1,000 L.E.	\$19.14	1,000 L.E.	\$19.14
26	BTS7960 MOTOR DRIVER	8	Electronic	Purchased	3/12/2026	4,400 L.E.	\$84.23	4,400 L.E.	\$84.23
27	MS5540	1	Sensor	Purchased	5/3/2026	995 L.E.	\$19.05	995 L.E.	\$19.05
28	BMP280	1	Sensor	Purchased	5/3/2026	65 L.E.	\$1.24	65 L.E.	\$1.24
29	MPU6050	1	Sensor	Purchased	5/3/2026	175 L.E.	\$3.35	175 L.E.	\$3.35
30	RAIN SENSOR	1	Sensor	Purchased	5/3/2026	88 L.E.	\$1.68	88 L.E.	\$1.68
31	STEP DOWN CONVERTER 48V TO 12V	1	Electrical	Purchased	15/2/2026	2,900 L.E.	\$55.51	2,900 L.E.	\$55.51
32	STEP DOWN CONVERTER 12V TO 5V	1	Electrical	Purchased	15/2/2026	65 L.E.	\$1.24	65 L.E.	\$1.24
33	EMERGENCY SWITCH	1	Electrical	Purchased	15/3/2026	100 L.E.	\$1.91	100 L.E.	\$1.91
34	FUSE 5A	10	Electrical	Purchased	15/3/2026	10 L.E.	\$0.19	10 L.E.	\$0.19
35	CERAMIC FUSE 25A	1	Electrical	Purchased	15/3/2026	7 L.E.	\$0.13	7 L.E.	\$0.13
36	HEAT SHRINK	1	Hardware	Purchased	15/3/2026	40 L.E.	\$0.77	40 L.E.	\$0.77
37	ELECTRICAL TAPE	1	Hardware	Purchased	15/3/2026	20 L.E.	\$0.38	20 L.E.	\$0.38
38	TERMINAL BLOCK	4	Hardware	Purchased	2/12/2026	120 L.E.	\$2.30	120 L.E.	\$2.30
39	SPRAY OIL BOX	1	Hardware	Purchased	27/12/2026	40 L.E.	\$0.77	40 L.E.	\$0.77
40	SPRAY AKAI BOX	1	Hardware	Purchased	2/12/2026	55 L.E.	\$1.05	55 L.E.	\$1.05
41	TOTAL					39,286 L.E.	\$752.03	22,606 L.E.	\$432.73

Fig. 21: Initial Estimated Budget

*The price columns F and G represent the vehicle's manufacturing cost, while columns H and I represent the cost we paid at Titamarine.

5.4 CHALLENGES

Throughout our journey in the MATE ROV competition, the TITAN team encountered several critical hurdles that tested our resilience and engineering capabilities:

- **Economic & Logistical Constraints:** Operating within the Egyptian local market presented significant challenges in sourcing specialized underwater components. We faced high customs duties, fluctuating exchange rates, and long shipping lead times for essential parts like the Pixhawk controllers and specialized sensors. To overcome this, we adopted a "Local Adaptation" strategy, modifying available components—such as the 1100GPH Bilge Pumps—to serve as high-performance thrusters, ensuring the project stayed within budget without compromising functionality. While modifying the 1100GPH Bilge Pumps provided a highly cost-effective propulsion solution, critical analysis revealed that these brushed bilge thrusters are inherently less efficient than standard brushless marine thrusters, drawing more power for the equivalent thrust.
- **Technical Integration:** Transitioning to a 48V DC architecture required rigorous testing to ensure the safety of our logic-level electronics. Ensuring waterproof integrity for the Titamarine enclosure under pressure were constant technical battles that required multiple design iterations.
- **Testing Facilities:** Finding suitable underwater testing environments was a logistical challenge. We had to coordinate extensively to secure pool access that met the depth and water clarity requirements for our sensor calibration (like the MS5540 depth sensor) and for filming the technical qualifier video. Moving heavy equipment and the ROV system between the university labs and testing sites required precise coordination and specialized transport handling.

5.5 LESSONS LEARNED

Developing the Titamarine and participating in the MATE ROV regional qualifiers has been a transformative educational leap for our team:

Marine Engineering: We gained profound insights into waterproofing techniques, material science for high-pressure environments.

Technical Mastery: The project enhanced our expertise in CAD Design, PCB Fabrication, and 3D Printing.

Software & Vision: We learned to implement Computer Vision algorithms for underwater tasks, including color correction for distorted environments and real-time object detection for mission-specific markers.

Professional Skills: Beyond the technical scope, we sharpened our skills in Project Management (Agile/Sprints), Technical Documentation, and Safety Leadership, which are crucial for our future careers as Mechatronics Engineers.

5.6 FUTURE PLANS

The TITAN team views the Titamarine project as the first step in a long-term roadmap:

Scaling Up: Based on our performance in the regional qualifiers, we aim to transition from the current class to the Explorer Class next year, incorporating more advanced autonomous features and robotic manipulation.

Knowledge Transfer: We plan to establish a "Junior TITAN" program to train underclassmen at Delta University, ensuring the sustainability of the team's expertise.

Regional Impact: Our long-term vision is to develop affordable ROV solutions tailored for the Mediterranean and Red Sea environments, supporting local marine research, underwater inspection, and environmental monitoring in Egypt.

- **Haptic/Visual Feedback:** Adding a sensor feedback system to the gripper to measure grip force and prevent crushing delicate objects.
- **Propulsion Upgrade:** Replacing the current modified bilge pumps with dedicated Blue Robotics T200 thrusters to drastically improve power efficiency and thrust-to-weight ratio.
- **Enclosure Redesign:** Enlarging the main electronic tube (e-rod) diameter to allow for easier cable management, better heat dissipation, and more organized internal component arrangement.
- **Custom Electronics:** Designing and fabricating a custom Printed Circuit Board (PCB) for Electronic Speed Controllers(ESCs) to replace off-the-shelf motor drivers, reducing internal footprint and weight.

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APPENDIX A: COMPANY STRUCTURE

TITAN

— ROV TEAM —



DELTA UNIVERSITY
FOR SCIENCE AND TECHNOLOGY

Location: Delta University, Egypt
First year competing in MATE



TITAN TEAM

2nd to 4th year Engineering students

TEAM MEMBERS

- Dr. Waleed Raslan - Team Advisor
- Dr. Ahmed Abdelkader - Team Advisor
- Eng. Khaled Elgayyar- Mentor
- Eng. Mohamed Yasser - Mentor
- Eng. Yousef Elgayyar - Mentor
- Shimaa Sherif - Electrical Eng
- Nada Mohamed - Electrical Eng
- Abdrahman Osama - Electrical Eng
- Abdullah Mohamed - Mechanical Eng
- Eslam foad - Mechanical Eng
- Mariam El-desoky - Mechanical Eng
- Omar Abdelazim - Software Eng
- Ali Mohamed - Software Eng
- Ahmed Elshafey - Marketing Director
- Yousef Omar - Safety officer

APPENDIX B: SAFETY CHECKLIST

TITAN team follows a rigorous safety protocol to ensure secure operations. Before every operation, the safety checklist printouts are handed to the responsible team members to carry out a safety check and verify.

TITAN CHECK LIST

Pre-Deployment Checks:

- ☐ Ensure that the Power Supply is off.
- ☐ Inspect all power connections and ensure all electronics are functional.
- ☐ Verify waterproof seals
- ☐ Ensure the tether is secured with strain reliefs to prevent damage.
- ☐ If Necessary, run **Full System Test**.

Operational Safety Measures:

- ☐ Use personal protective equipment (PPE) during assembly and testing.
- ☐ Maintain clear communication among team members during deployment.
- ☐ Monitor electrical connections to prevent overheating or short circuits.

In-water Safety Measures:

- ☐ Continuously monitor ROV from poolside by assigning responsibility to a member.
- ☐ Monitor Tether Excessive Strain or Entanglement.
- ☐ If leak detected/monitoring member gives an alert, proceed with **Emergency Procedures**.

Emergency Procedures:

- ☐ Identify emergency shutoff points.
- ☐ Co-pilot Turns Off Power.
- ☐ Have designated personnel for rapid intervention in case of failures
- ☐ Deployment Members Recover ROV after receiving "Turned Off" call from Co-pilot.
- ☐ Swiftly dry the ROV and check for damage or failure points.
- ☐ Document and report any safety incidents for process improvements.

APPENDIX C: FULL SYSTEM TEST PROCEDURE

TITAN TEST LIST

Date:

Time:

Checked By:

Verified By:

Full System Test Procedure Checklist:

Pre-Deployment Test:

- ☐ Turn On Control Station AC Power
- ☐ Check Control Station Functionality
- ☐ Turn On 48V DC Power Supply
- ☐ Check Power Supply Voltage Output with Multimeter
- ☐ Turn Off 48V DC Power Supply
- ☐ Properly Connect the Tether Anderson Powerpole to Power Supply Anderson Powerpole
- ☐ Power On the 48V DC Power Supply
- ☐ Connect Ethernet to the Control Station Laptop
- ☐ Verify Camera Feeding
- ☐ Confirm Communication
- ☐ Confirm Software GUI Readings
- ☐ Check Thrusters at Low Speed
- ☐ Test Main Manipulator Functionality
- ☐ Test Mini Gripper Functionality
- ☐ Verify Everything Above is Checked
- ☐ Properly Deploy the ROV in water
- ☐ Proceed to Underwater Test

Underwater Test:

- ☐ Adjust Orientation
- ☐ Adjust Flotation
- ☐ Test Motion & Control
- ☐ Test ROV Balance
- ☐ Check for SOS Leak Alert
- ☐ Test PID and Calibrate if necessary
- ☐ Test ROV Surfacing
- ☐ Return ROV to Shore
- ☐ Turn Off ROV through Software
- ☐ Power Off 48V DC Power Supply
- ☐ Disconnect Ethernet from Laptop
- ☐ Retrieve the ROV

Notes/Comments:

