itü auv team.

Master Catalog
2024

presents.

content.

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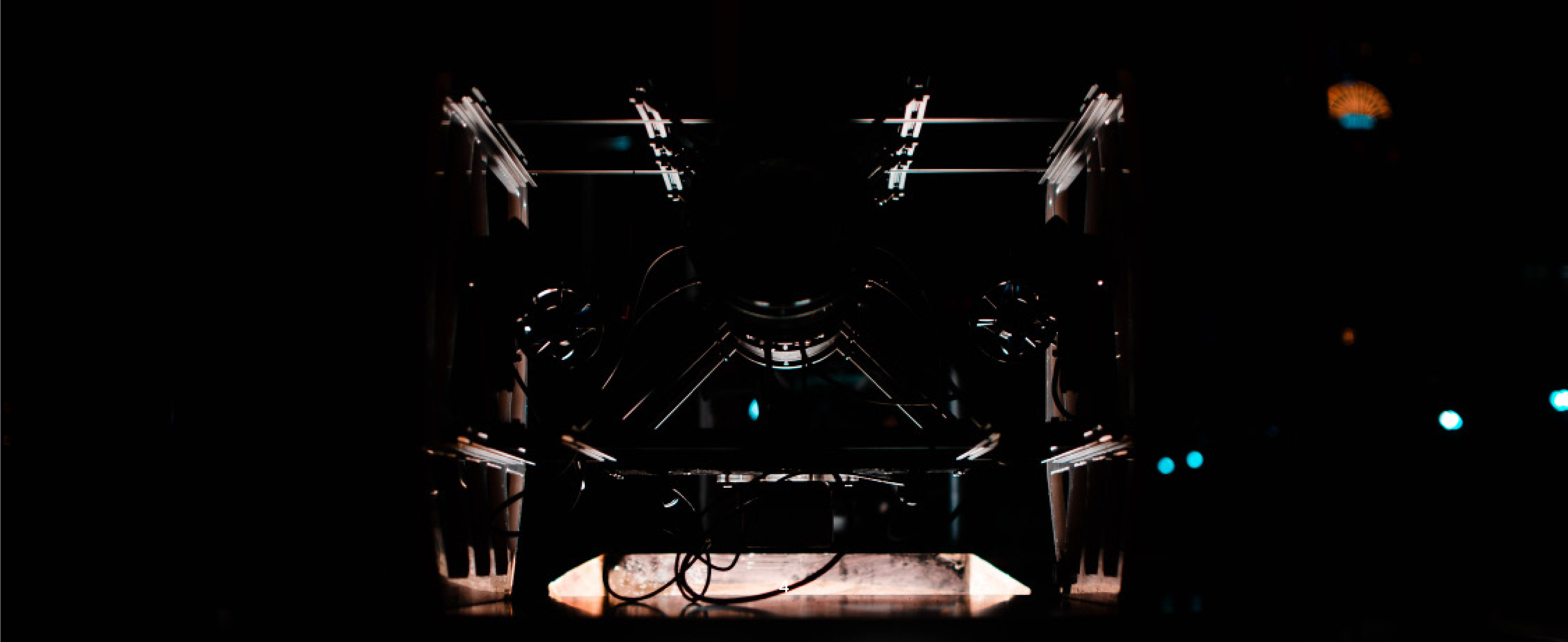
autonomous underwater vehicle.

An autonomous underwater vehicle (AUV) is a type of autonomous underwater robot equipped with various sensors to perceive environmental conditions. It operates by making appropriate decisions based on the detected conditions according to a predefined mission plan. AUVs are capable of capturing images, processing these images, performing object recognition, and interacting with surrounding objects using manipulators.



us.

The ITU AUV Team, established in 2018, was founded by members who began their studies in 2016, aiming to merge their two years of underwater robotics experience with autonomous technologies. Operating within Istanbul Technical University, the team is one of the few representing Turkey in international competitions such as RoboSub, SAUVC, and RAMI, as well as domestic events like Teknofest. They continue their efforts to excel in these competitions and showcase the capabilities of autonomous underwater vehicles (AUVs).

team structure.

Mechanic

The team is responsible for designing all the physical aspects of the vehicle, simulating the vehicle, simulating the designed components, and manufacturing them.

Creative

The team is responsible for creating the necessary visual and physical elements such as digital presentations, catalogs, and brochures for the team's introduction, and overall design.

Organization

The team oversees the general management of sponsorships, media relations, finances, and team strategies.

Software

The team is responsible for the development of relevant software modules for the flow of tasks within the vehicle.

Electronic

The team designs and develops electronic components that facilitate communication between all sensors on the vehicle and meet the power requirements of the

Team Leader

Batuhan Özer

Technical Mentors

Sencer Yazıcı
Ege Saygılı
İsmetcan Saraç
Berke Bozoklu
Süeda Korkmaz
Dinçer Öykünç

Academic Advisor

Doç.Dr. Bilge Tutak

turkuaz.

From 2018 to 2022, Turkuaz, developed, became the world champion.

#SAUVC2022

Champion

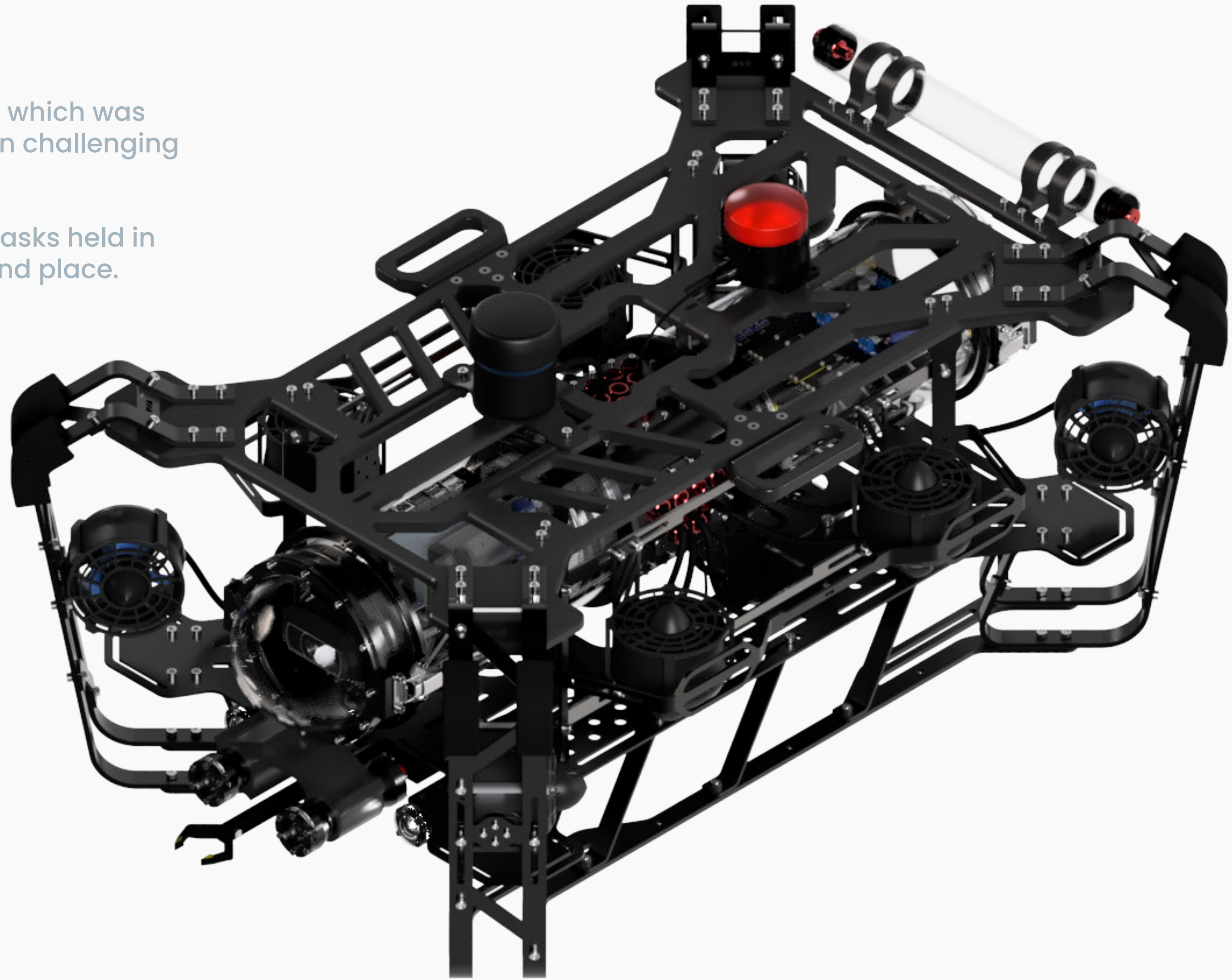
#RoboSub2021

FINALIST

taluy.

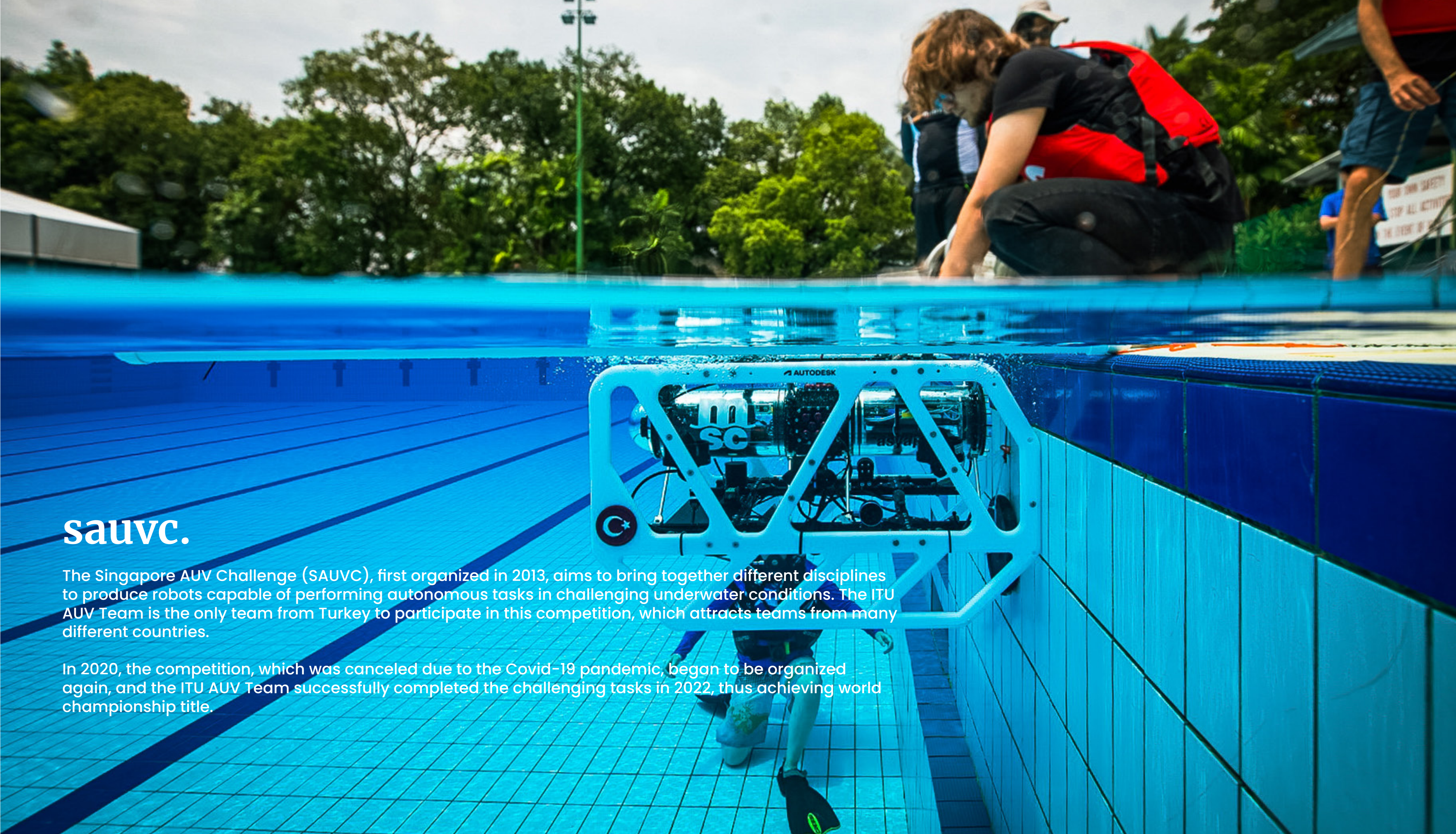
In 2022, the design process started and Taluy, which was completed in 2023, was designed to be used in challenging environments.

In 2023, at the 10th edition of the demanding tasks held in Italy, RAMI Competition, Taluy was awarded 2nd place.



#RAMI2023

SECOND PLACE



sauvc.

The Singapore AUV Challenge (SAUVC), first organized in 2013, aims to bring together different disciplines to produce robots capable of performing autonomous tasks in challenging underwater conditions. The ITU AUV Team is the only team from Turkey to participate in this competition, which attracts teams from many different countries.

In 2020, the competition, which was canceled due to the Covid-19 pandemic, began to be organized again, and the ITU AUV Team successfully completed the challenging tasks in 2022, thus achieving world championship title.

robosub.

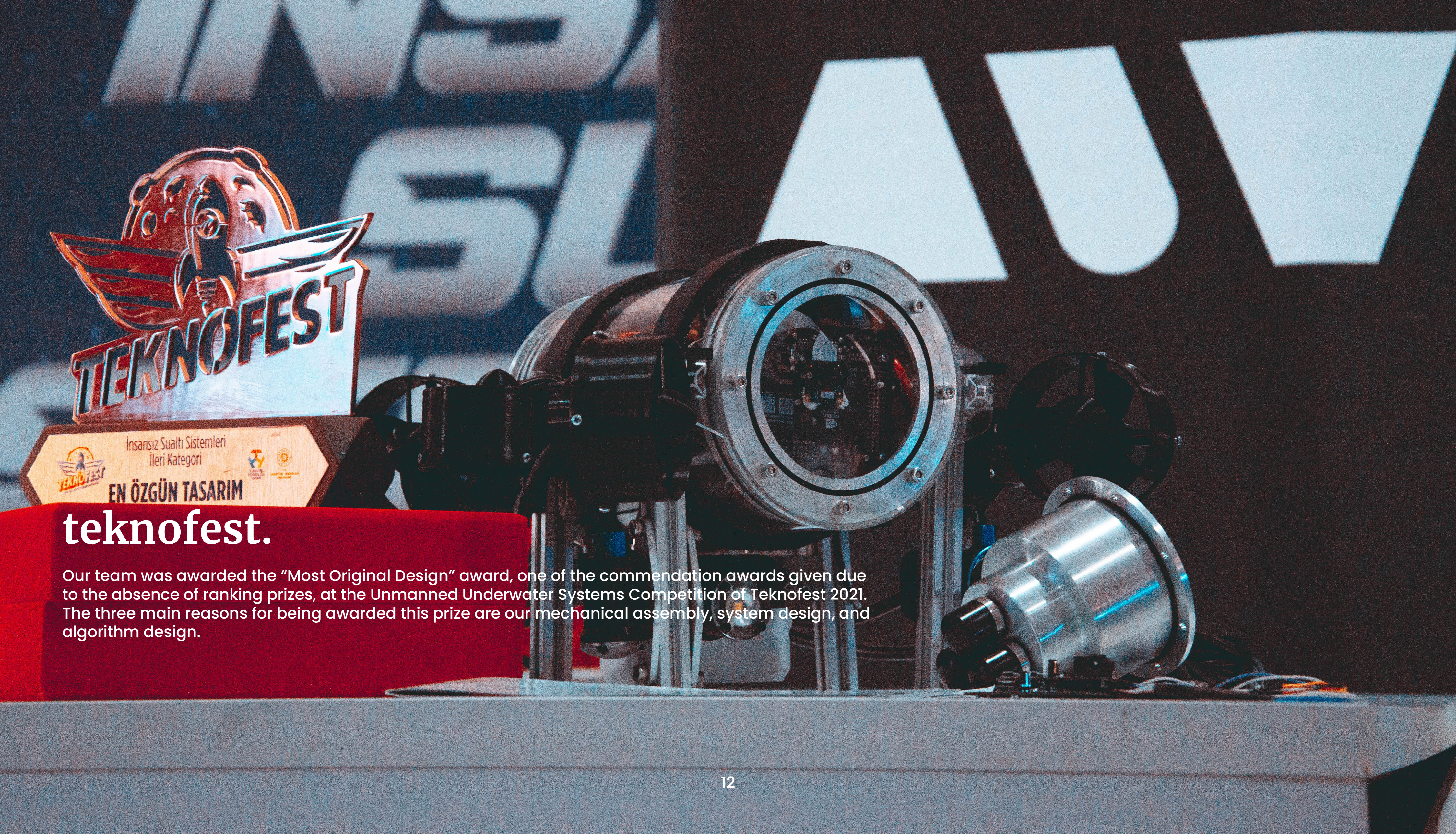
Since 1997, the competition held at TRANSDEC, owned by the US Navy, in San Diego, California, has been a prestigious event in the field of autonomous underwater vehicles. The competition is organized by the AUVSI association and Robonation.

The ITU AUV Team represented Turkey and Istanbul Technical University (ITU) as the only team from Turkey participating in RoboSub2021, thus making its mark on the international underwater robotics community. In 2024, we continue our efforts with the aim of participating in RoboSub, our biggest goal.

rami competition.

The RAMI Competition, held for the first time in 2022 in the city of La Spezia, Italy, is a competition consisting entirely of autonomous tasks that contain missions difficult to perform by operators. The competition takes place in open sea conditions in La Spezia, featuring challenging tasks such as variable depths, currents, and murky waters. One of the tasks involves observing a leaking pipe and then expecting underwater vehicles to autonomously repair it.

Hosting mostly postgraduate-level teams from European countries, the ITU AUV Team participated in this competition in 2023 and completed it in 2nd place, being awarded the Best Technical Presentation Award.



teknofest.

Our team was awarded the “Most Original Design” award, one of the commendation awards given due to the absence of ranking prizes, at the Unmanned Underwater Systems Competition of Teknofest 2021. The three main reasons for being awarded this prize are our mechanical assembly, system design, and algorithm design.

mechanic.

Emre Orkun Kayran

Bahadır Göktürk

Ege Sözütek

Hivşa Delal Şahin

Nehir Mamuk

Pelin Özmutlu

Taner Özpınar

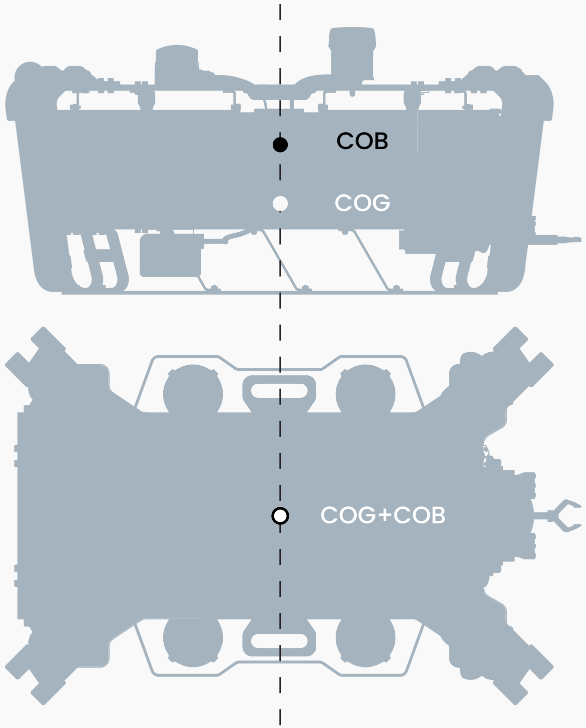
Maximum Weight
26 Kg

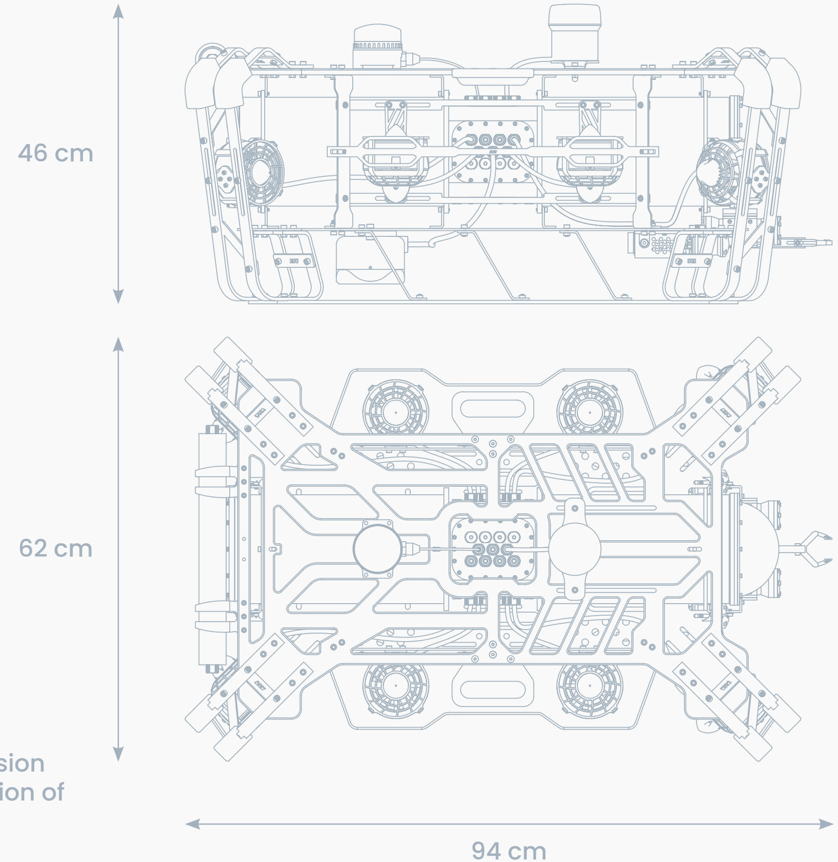
Maximum Speed
4 Kn

Diving Depth
300 m

Carrying Capacity
100 N

Mission Duration
4 Hour

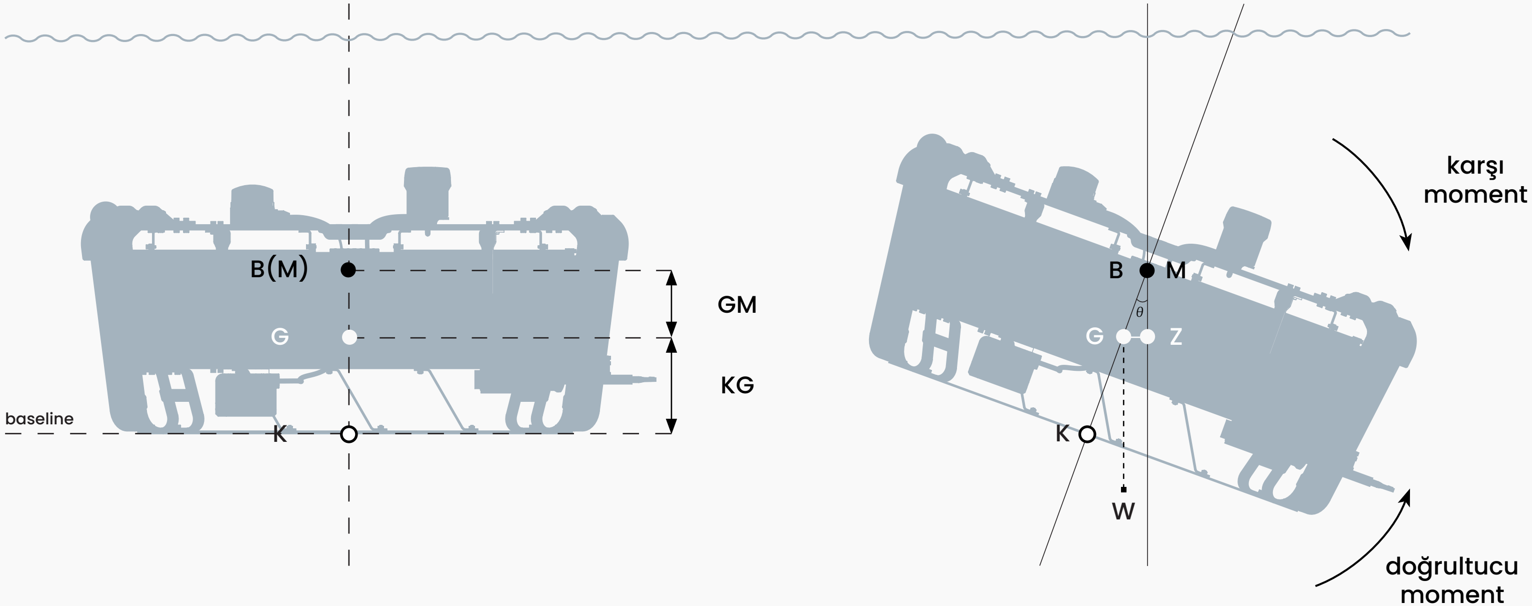




design.

Our vehicle consists of three main components structurally: chassis, electronic housing unit, and mission equipment. The positions of the components have been determined taking into account the distribution of the frame and the centers of gravity.

By aligning the VCG (Vertical Center of Gravity) and VCB (Vertical Center of Buoyancy) points, the vehicle is prevented from tilting in a static state, and by aligning the LCB (Longitudinal Center of Buoyancy) and LCG (Longitudinal Center of Gravity) points, trim is ensured in a static state. In this way, the vehicle remains stable in a static state. During design and modification, the positions of VCG, VCB, LCB, and LCG of the vehicle are calculated simultaneously with a MATLAB code. This allows the balance state of the vehicle to be observed mathematically.



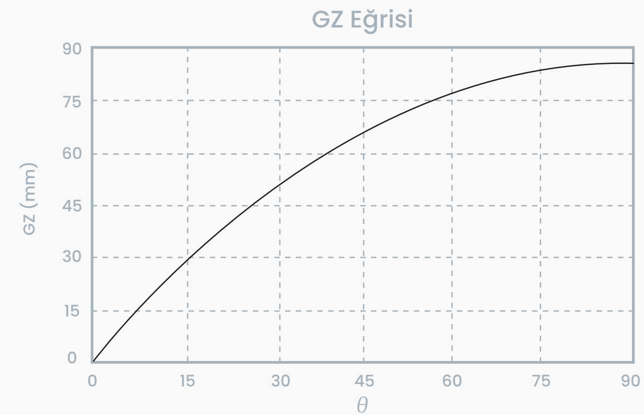
KM	288.5 mm
GM	84.6 mm
KB	288.5 mm
KG	203.9 mm

dynamic stability.

For autonomous underwater vehicles, dynamic stability emerges as a crucial design element. The stability analysis of Taluy was conducted by examining the GZ curve. The area under this curve represents the vehicle's capacity to stabilize itself. The metacentric center (M) coincides with point B since the volume remains constant. Unwanted forces encountered underwater are balanced by the vehicle's own righting moment. Dynamic stability is found by multiplying the area under the GZ curve within a specific angle range by the weight.

$$\mathbf{DS} = W \int_0^\theta GZ \, d\theta$$

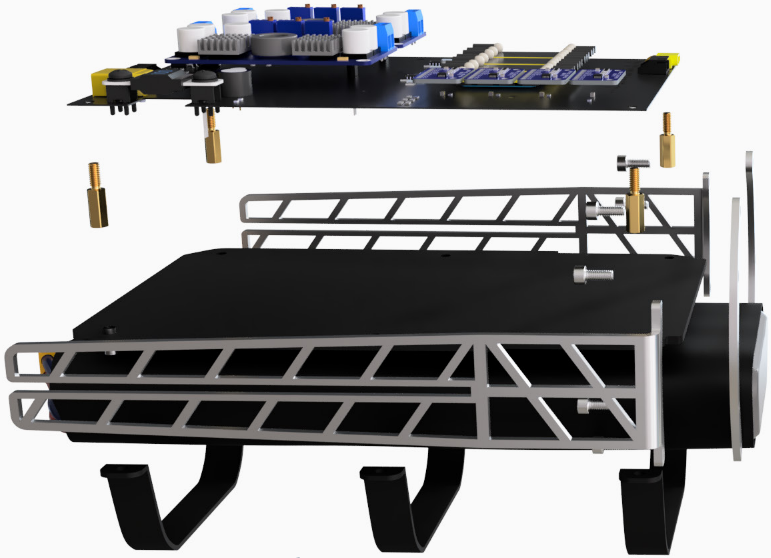
These assessments are of critical importance to measure the vehicle's stability performance and make necessary adjustments. The analyses revealed that the righting moment at critical angles was quite high.

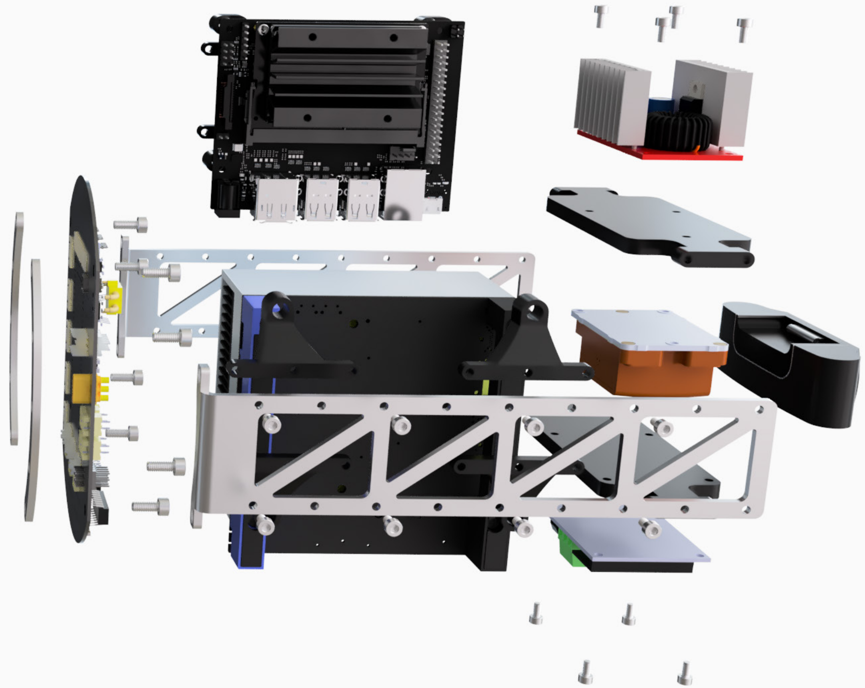


penetrator.

BlueRobotics brand Wetlink penetrators are used to ensure the waterproofing of electronic components underwater. These penetrators provide waterproofing without the use of epoxy.

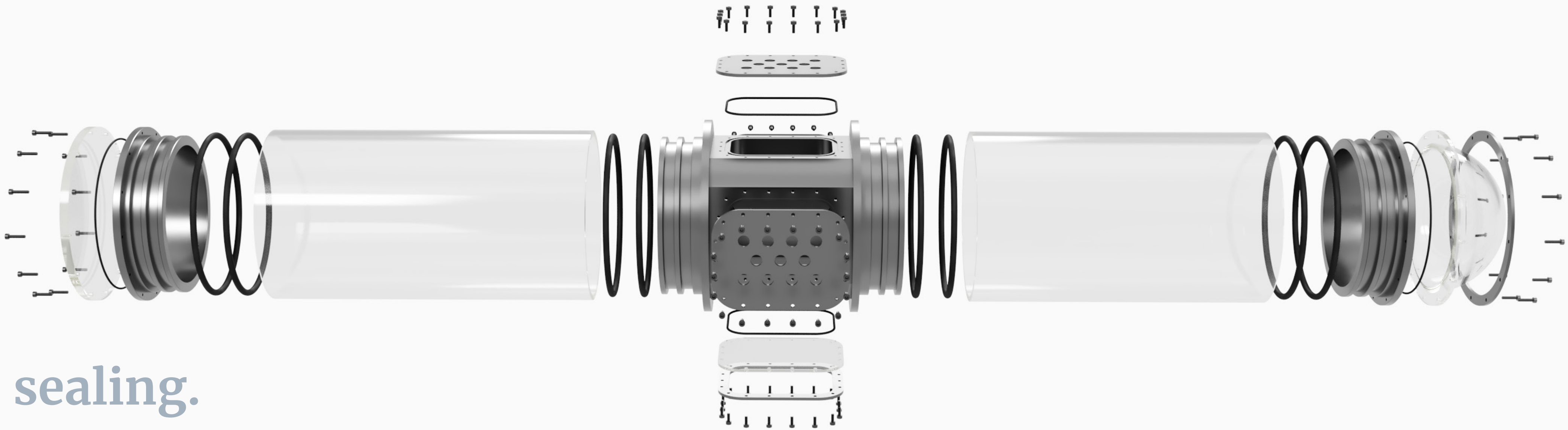
Consisting of 5 separate parts, the penetrator, when a cable passes through it, prevents electronics from coming into contact with water up to 950 meters underwater with the help of silicone seals and O-rings on it.





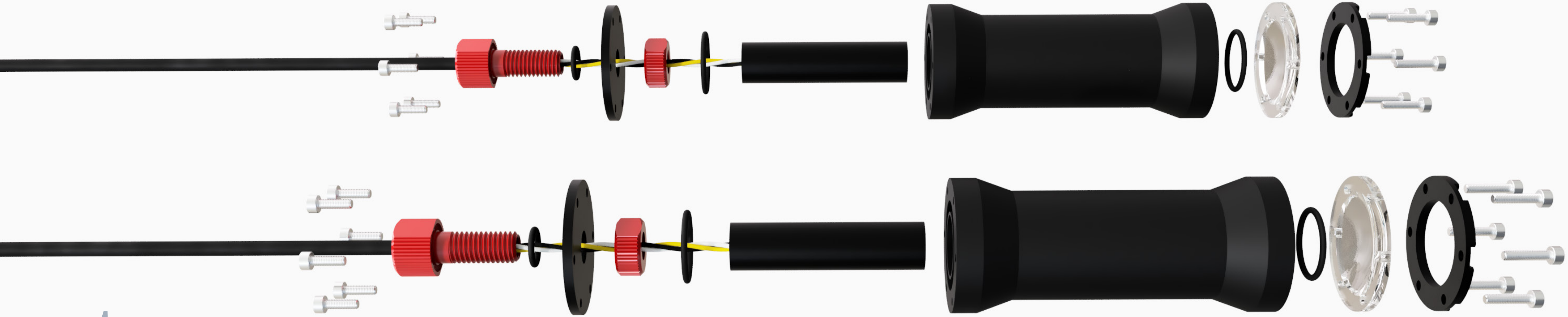
electronic enclosure.

This is the section where the motor controllers, cameras used for image processing, battery, electronic components, and parts that should not come into contact with water are located. This section consists of two cylindrical PMMA tubes, an Aluminum 6061 center flange located between these two tubes, PMMA front and rear covers, and Aluminum 6061 front and rear flanges. The purpose of selecting cylindrical tubes is to distribute water pressure to the surface in the best possible way, as the cross-section that circularly distributes water pressure. The selection of acrylic as the material for the tubes is based on factors such as the pressure resistance of the tube at the depth at which the vehicle will operate, the ability to visually inspect the electronics during the development stage of the vehicle, and cost considerations.



sealing.

For sealing, one rear and front flange and one middle flange to form the connection between these 2 tubes are used. The connections between the two cylinders, as well as between the front and rear covers and the cylinders, which will also provide sealing, have O-ring seal (O-ring) channels. The dimensions of the seal channels were designed using the channel design tool of Trelleborg, a company producing sealing products, to ensure production compliance with standards. The design of the seals was made considering the amounts of channel filling, compression ratios, and elongation ratios. The front cover is produced as a half-spherical dome head. By utilizing the principle of refraction of light underwater, a wider field of view is obtained. There are four square holes on the middle flange. These holes correspond to 11 penetrator passage holes in the covers. The cables of the equipment outside the vehicle that need to come into contact with water are provided through penetrator passages and connected to the electronic cards inside the tube.

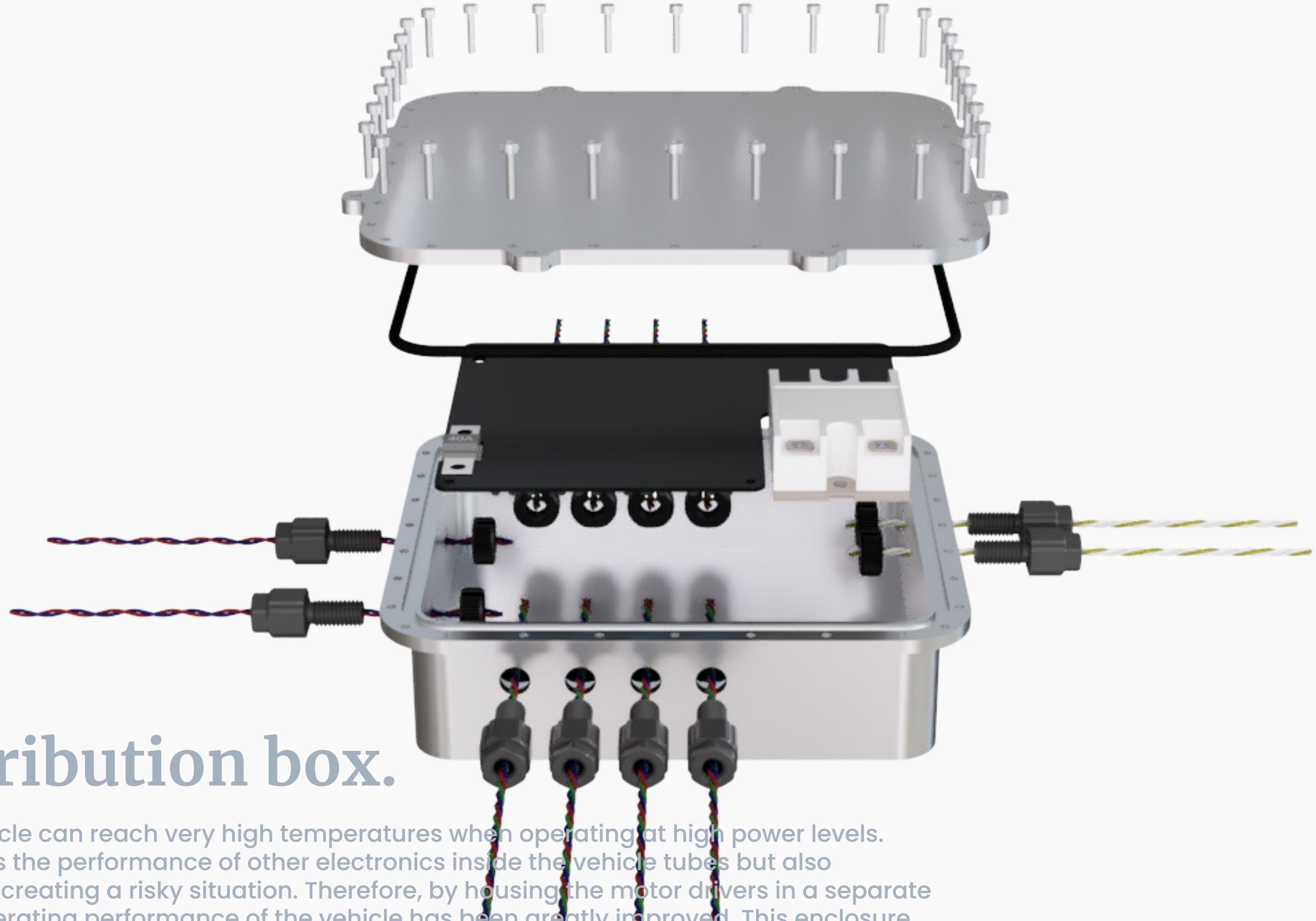


stereo camera.

A single camera is insufficient to estimate the depth of objects underwater. Therefore, our software and mechanical team has developed a camera unit that can mimic the human eye. The unit can perceive how far objects are from the vehicle in perspective.

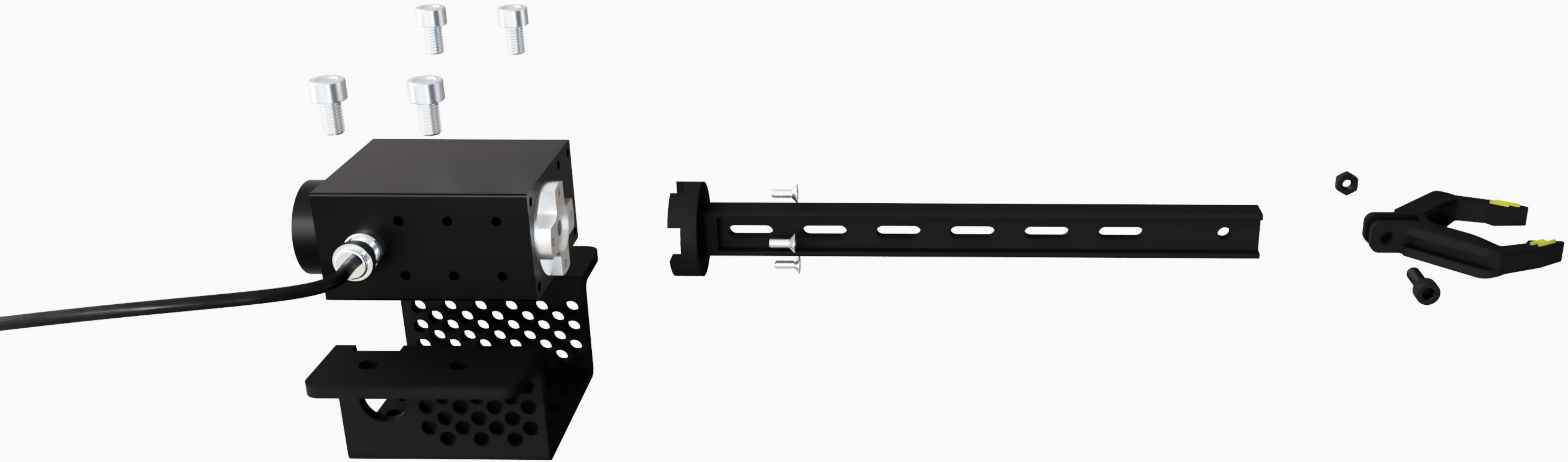
Thanks to the 2.8mm focal length and 155-degree field of view provided by the “bullet” cameras inside the housings, object detection has been facilitated.

Our mechanical team has opted for Aluminum 6061 to ensure that the housings can withstand hydrostatic pressure at great depths and facilitate heat transfer underwater for the cameras.



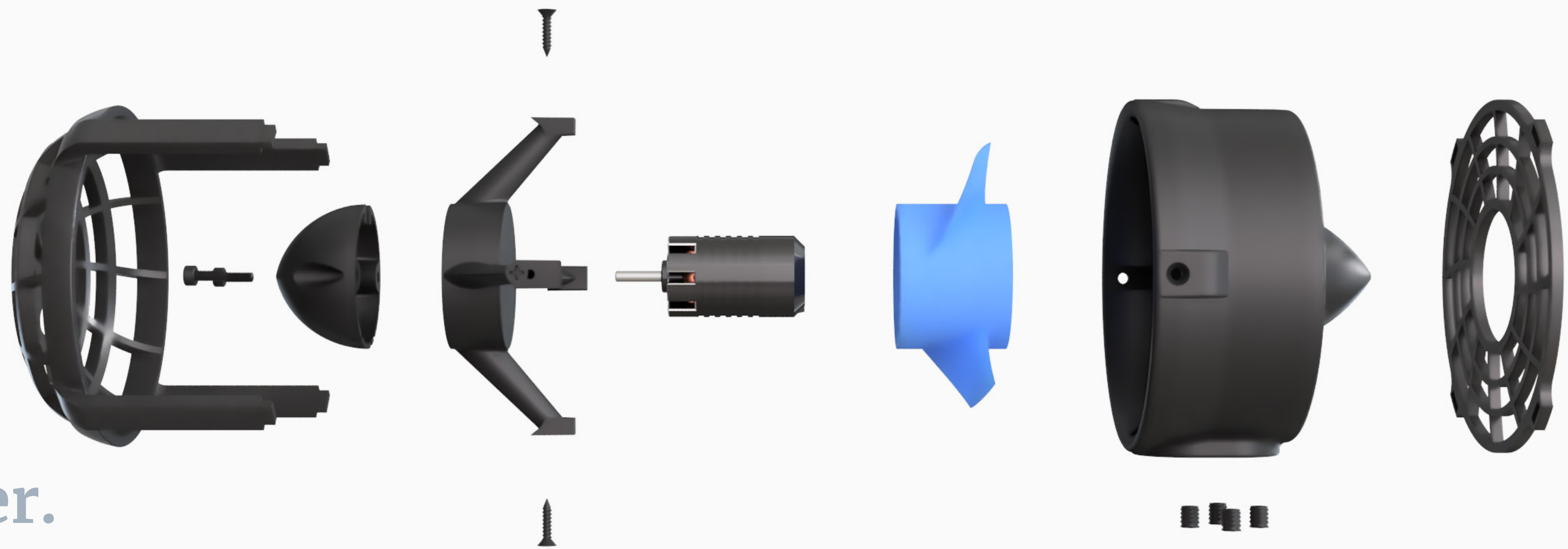
power distribution box.

The motor drivers of the vehicle can reach very high temperatures when operating at high power levels. This situation not only affects the performance of other electronics inside the vehicle tubes but also increases the tube pressure, creating a risky situation. Therefore, by housing the motor drivers in a separate aluminum enclosure, the operating performance of the vehicle has been greatly improved. This enclosure, produced in a 3-axis CNC, is specially designed for the positioning of the PCB designed by the electronic team. All thrusters are gathered in a single enclosure, and the necessary power distribution is supplied from the battery inside the vehicle. In this way, the heat generated inside is transferred to the water through thermal pads.



robotic arm.

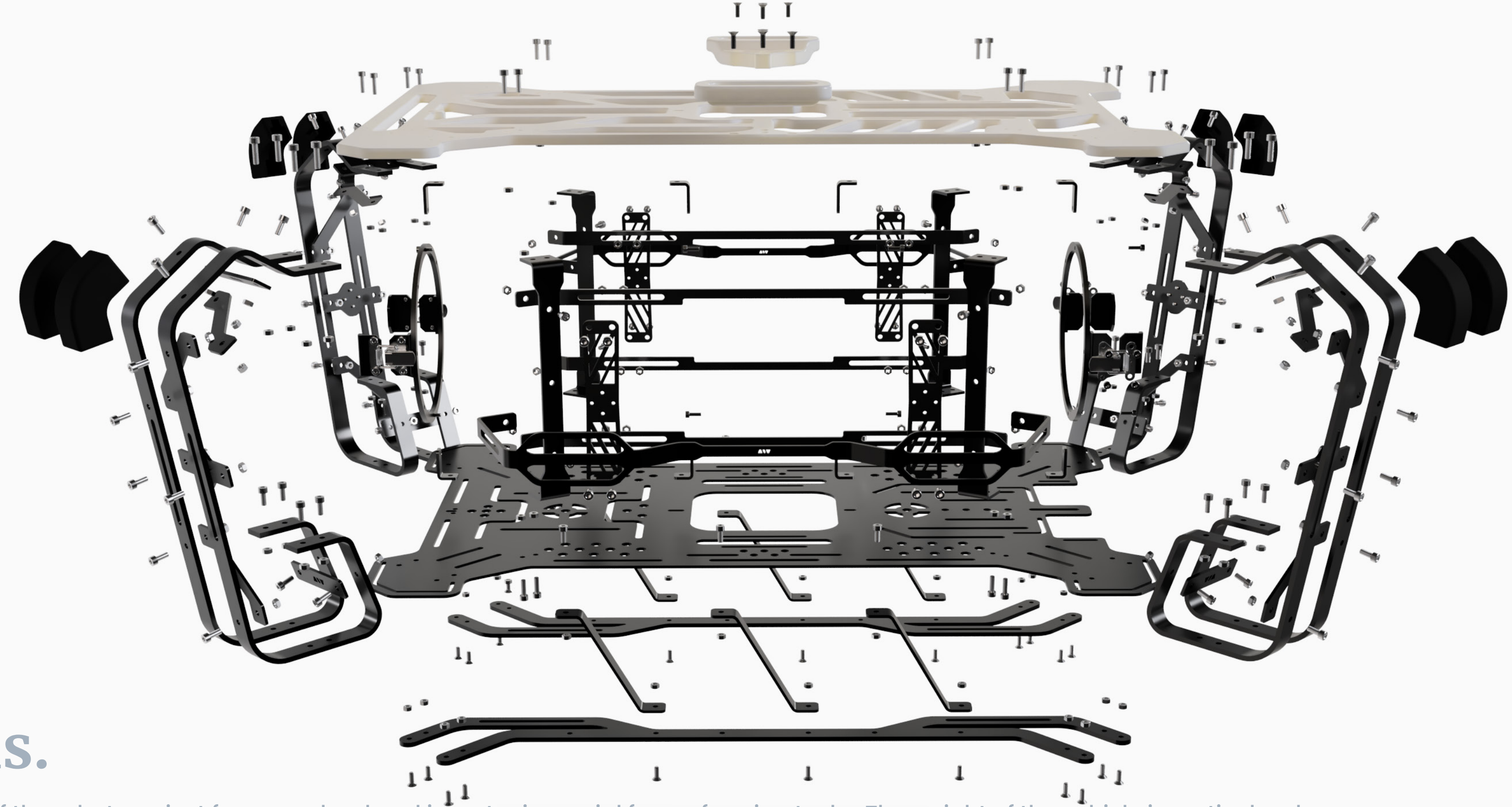
The design of the gripper mechanism aims to be simple and functional. The mechanism can move with the help of a single servo motor. The servo motor is attached to an aluminum plate located under the vehicle with four bolts through a part produced by 3D printing. The part connected to the rotor of the motor is designed according to the “I-beam” theory. This allows the motor to operate smoothly at torques of up to 3.5 Ncm. The gripping arm at the end is designed to allow the part to perform roll movements. This part can be replaced according to the environment in which the vehicle operates. Produced and simulated by the mechanical team, this mechanism can work flawlessly up to 150 meters.



thruster.

In our vehicle, 8 Blue Robotics T200 model brushless DC motor thrusters have been chosen. These motors are positioned to provide movement along 4 z-axes, 2 x-axes, and 2 y-axes, thereby providing mobility in 6 degrees of freedom.

These motors were chosen for their high thrust and efficiency underwater. The analysis conducted indicated that the chosen motor model and quantity would provide sufficient speed and maneuverability for the vehicle. The positions of the motors have been determined in this way to facilitate the autonomous movement of the vehicle.



chassis.

The resistance of the robot against forces on land and in water is crucial for performing tasks. The weight of the vehicle is meticulously calculated to balance the volume inside the tubes. The components of the vehicle are primarily divided into three parts: corner cage systems, bottom and top plates, and side cage systems. 5mm Aluminum 6061, individually manufactured using the press brake bending method, is used at four corners. The corner cage systems have grooved channels for the positioning of thrusters that provide movement along the X-Y axes of the vehicle. In case of a change in the vehicle's center of gravity, the height of the thrusters can be adjusted. The top plate is made of HDPE, and the bottom plate is made of 5mm Aluminum 6061 flat plate. The side cage systems accommodate the thrusters that provide movement along the Z-axis of the vehicle. Due to the high moment the cage system is exposed to, it is made of stainless steel. The bottom cage of the vehicle is supported by aluminum strips bent in a Z-shape using the press brake bending method, carrying the mission equipment and the weight on land. This increases the vehicle's payload capacity.

electronic.

İsmail Furkan Mutlu

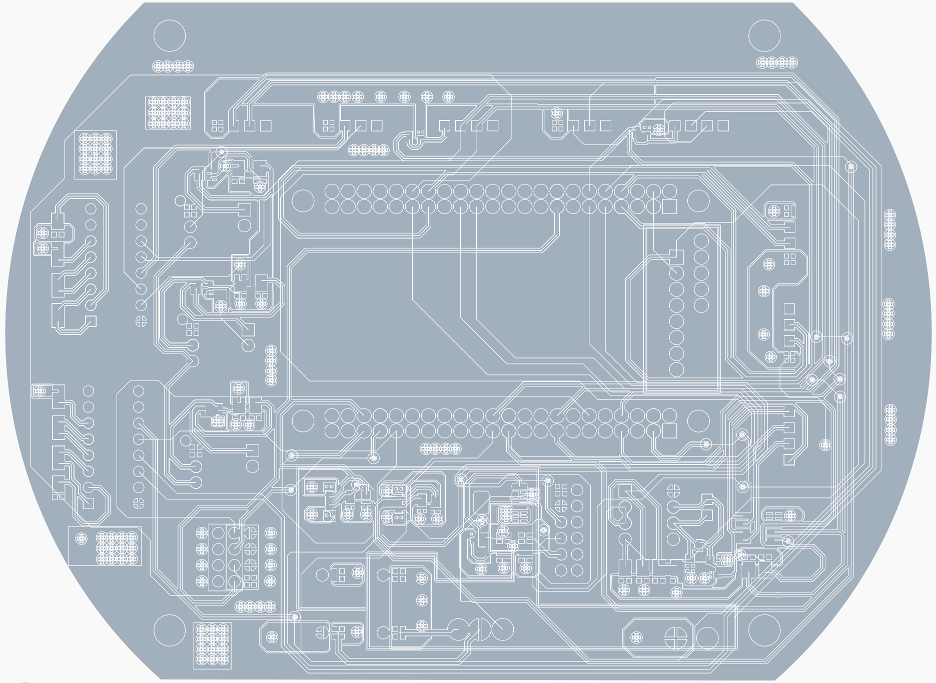
Elif Türkmen

Nihat Memduh Arslan

Ömer Eren Bay

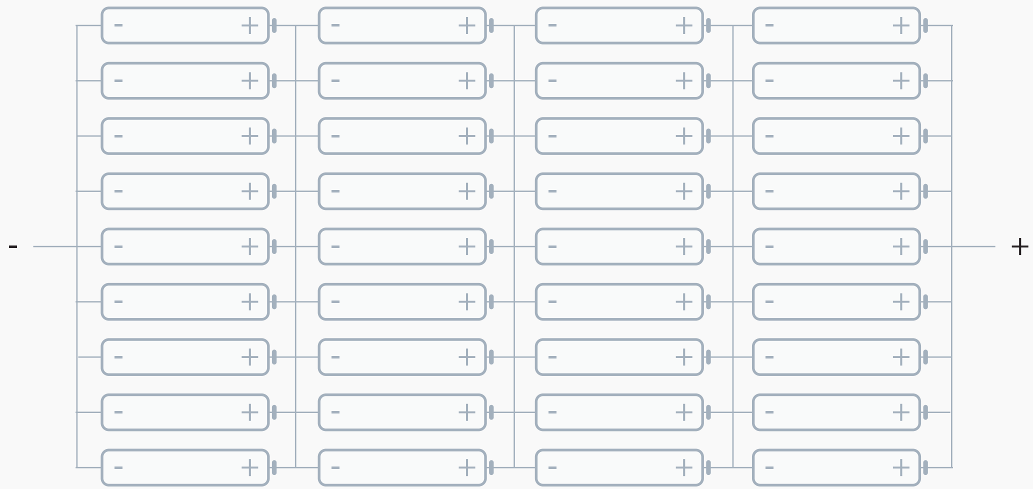
Seren Sıla Uysal

Yusuf Çalışkan



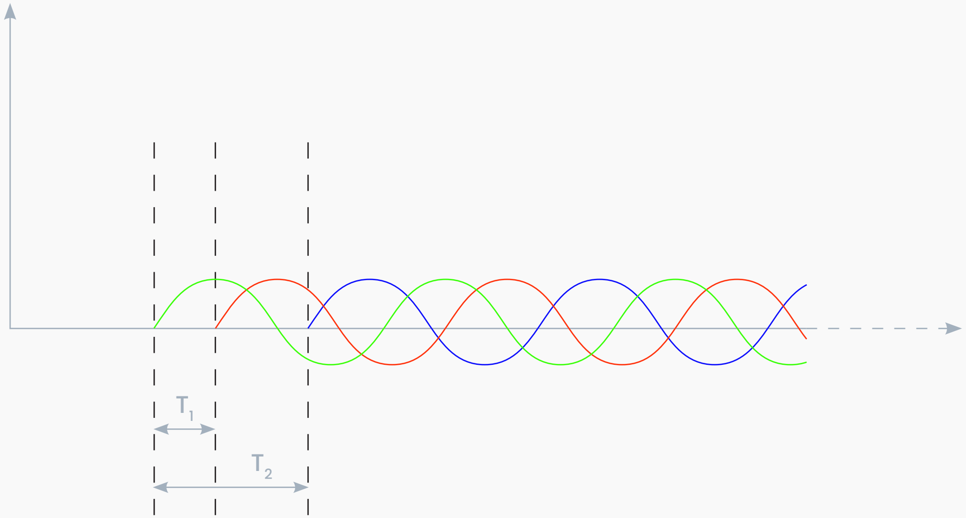
vehicle electronics.

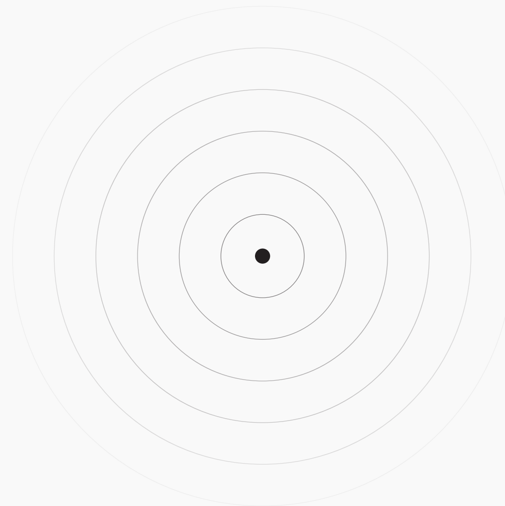
To accomplish challenging tasks in demanding environments, the vehicle is equipped with various sensors. Our mainboard essentially serves as the main low-level processing unit, utilizing a Real-Time Operating System (RTOS) to control safety features, communication with all sensors, control algorithms, and Input/Output (IO) operations. Among the sensors on the vehicle are active sonars, passive sonars, an Inertial Measurement Unit (IMU), Doppler Velocity Log (DVL), pressure sensor, temperature sensor, and a range of monocular and stereo cameras. Additionally, the mainboard is responsible for communicating with our other circuit boards. These include providing data representing the status of the onboard main battery, such as temperature, current, voltage, and State of Charge (SoC).



battery.

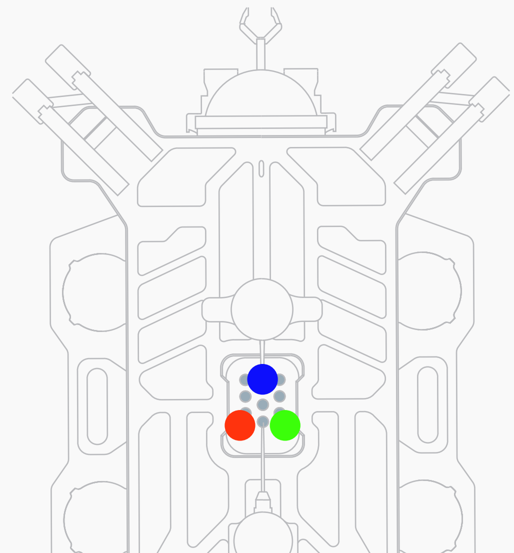
The vehicle operates with a custom-designed Li-ion battery pack consisting of 4 series and 9 parallel cells. Inside the battery pack, there is a fuse to prevent short circuits, and a Battery Management System (BMS) is included to balance and charge the series cells. The battery pack utilizes Sony's US18650VTC6 Li-ion cells as individual cells. With a 4S9P configuration, the battery pack has a total energy capacity of 400Wh and can provide 5300W peak and 2000W continuous power. The inclusion of 4 series cells, compared to our previous 3 series battery packs, has reduced power losses by providing a higher voltage along with the current drawn.

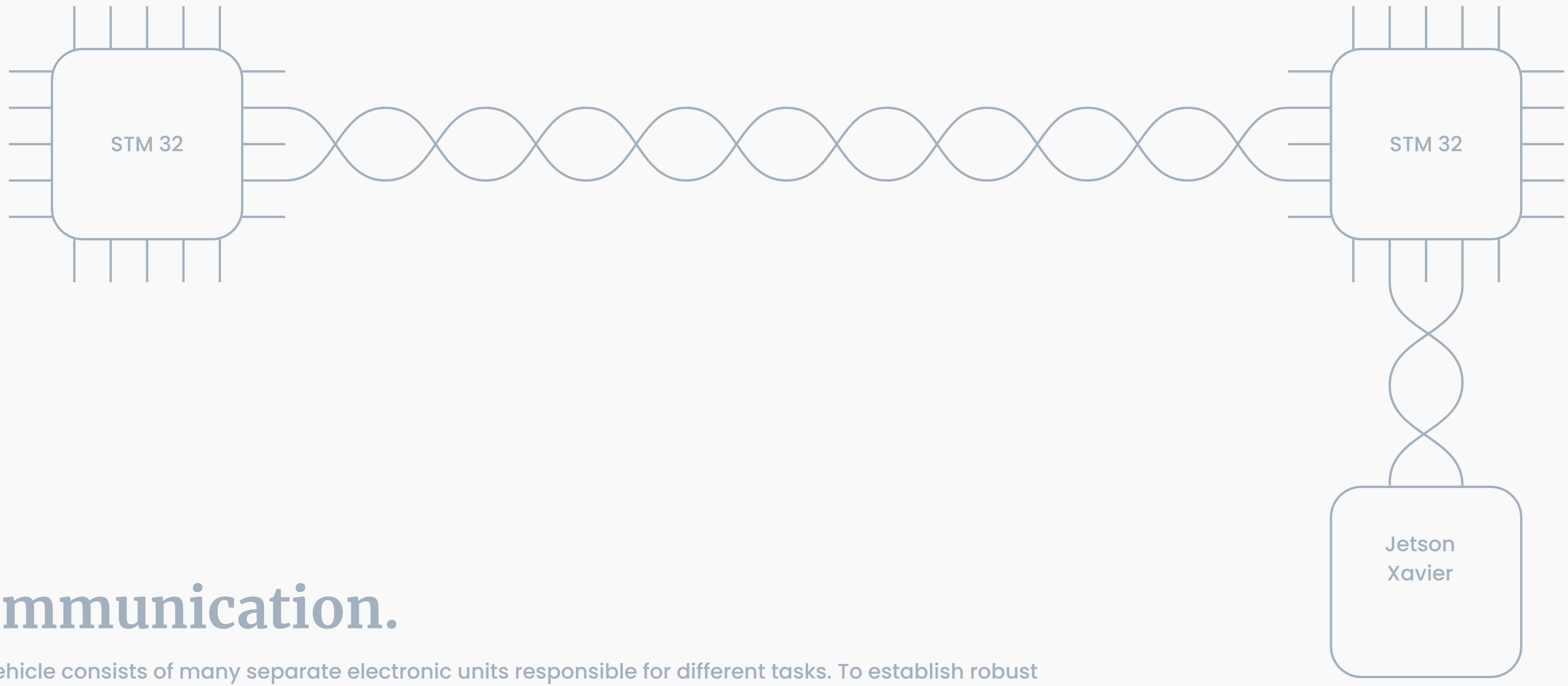




acoustic.

Underwater acoustics is a significant field covering solutions for various challenges such as communication, navigation, and range estimation. The vehicle is equipped with both passive and active SONARs to overcome these challenges. Along with our Acoustic Processing Board (APB), the vehicle's Passive SONARs (Hydrophones) can detect underwater sounds in the range of 25kHz to 50kHz with high sensitivity. The board provides comprehensive solutions for signal processing with a specially developed Acquisition Protocol (ACQ). The sampling frequency can be increased up to 2 MHz, and real-time processing of 16-bit captured data is performed using Short-Time Fourier Transform (STFT). Direction of Arrival (DOA) algorithms such as MUSIC and WAVES can calculate the arrival angle of the sound with extremely low error levels.





communication.

The vehicle consists of many separate electronic units responsible for different tasks. To establish robust communication, RS-485 is used among the internal units of the vehicle. For faster communication, USB High Speed is employed, keeping the communication line under as low Electromagnetic Interference (EMI) as possible. The design of the vehicle allows for reducing EMI by placing sensitive digital/analog components in the front enclosure and high-power-consuming components in the rear enclosure. During tests, a main communication cable exits the vehicle to the surface with twisted pair cables driven by Fathom-X modules at both ends, carrying Ethernet packets. Since the vehicle operates with ROS, access to the entire ROS network is available via the Ethernet connection, allowing the surface computer to monitor sensor data or send commands to the vehicle. The software also comprises safety components that will shut down thruster operation in case of a communication failure to prevent emergencies.

software.

Mustafa Yunus Diler

Batuhan Özer

Alperen Can

Caner Aslan

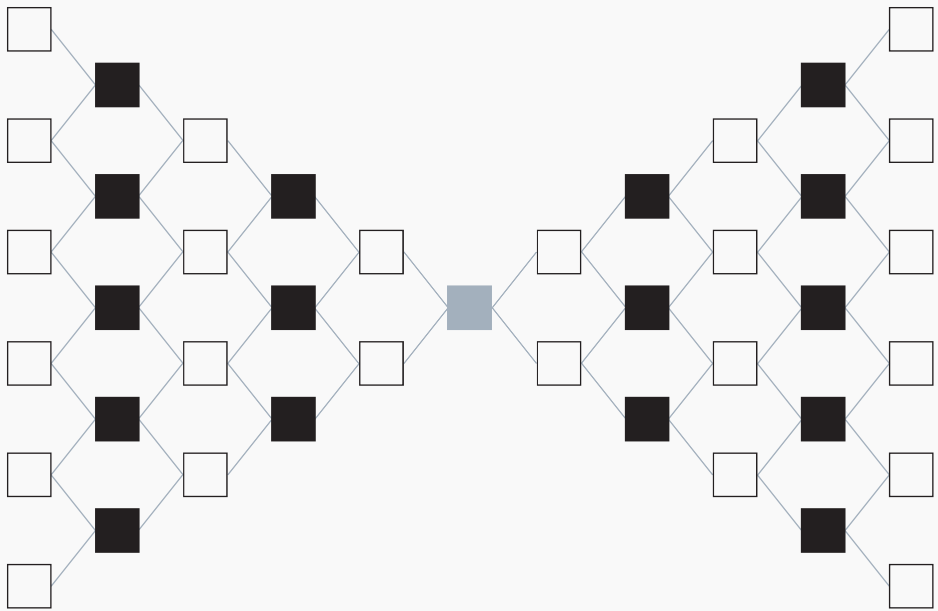
Emre Tezel

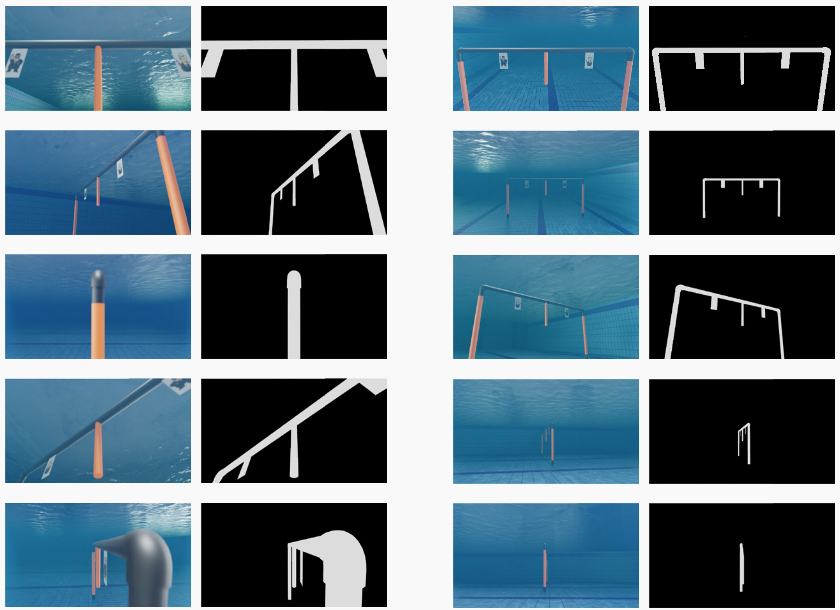
Kayra Pamukçu

Ozan Hakan Tunca

Ozan İnal

Seren Sıla Uysal

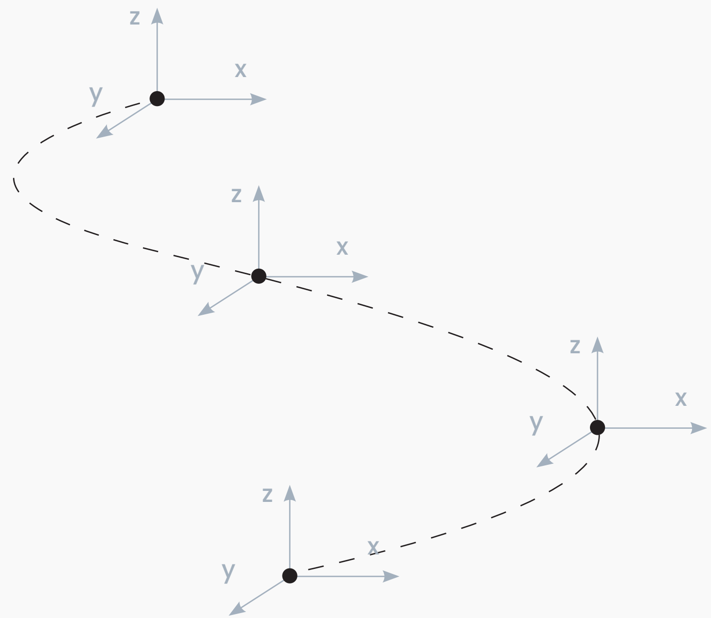


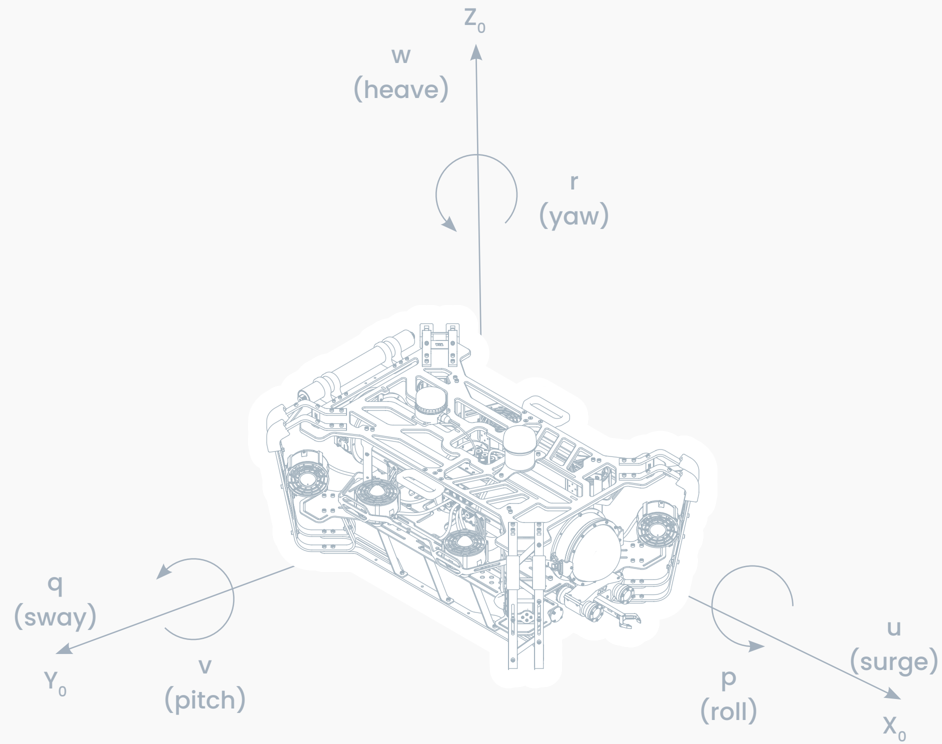


computer vision.

Detecting and identifying mission objects is a crucial capability that an autonomous underwater vehicle (AUV) must possess. Therefore, an object recognition algorithm based on machine learning has been developed using datasets specifically prepared for these tasks.

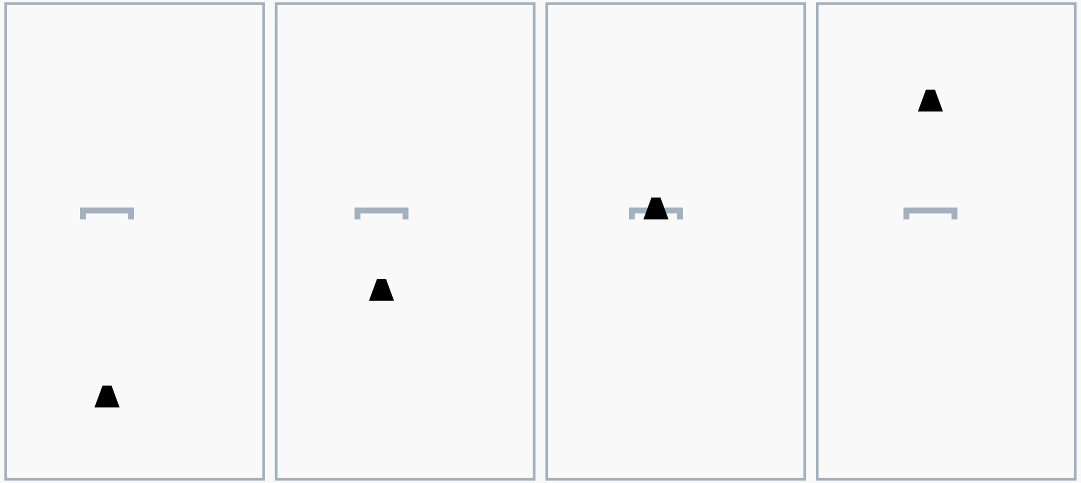
The large dataset necessary for training this algorithm was created and labeled using Blender 3D software and custom automation scripts written specifically for this program.

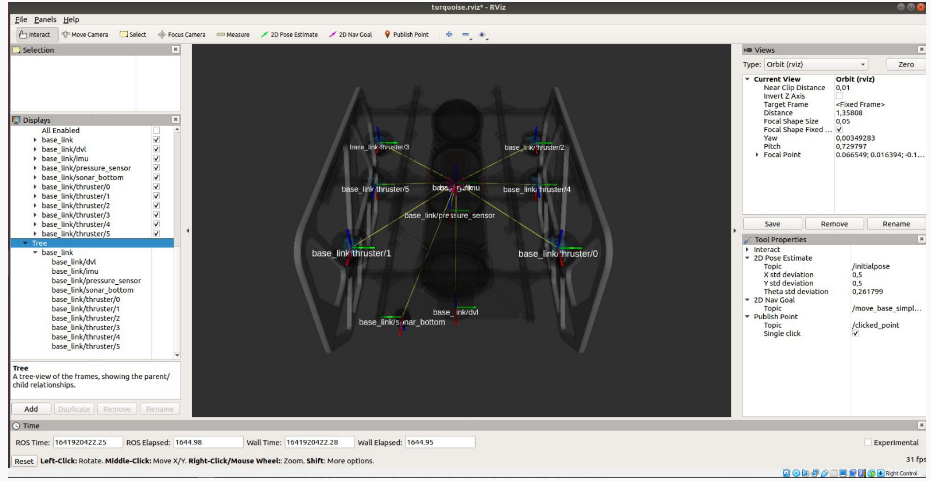




localization & navigation.

Localization provides the function of determining the position and orientation of the vehicle, enabling safe movement, mapping, and environmental interaction. The vehicle's localization is performed using data from sensors such as IMU (Inertial Measurement Unit), DVL (Doppler Velocity Log), and a barometer, as well as images from onboard cameras. These cameras track ground markers and use simultaneous localization and mapping (SLAM) algorithms like ORB-SLAM. This data is combined using an Extended Kalman Filter (EKF) with acceleration, velocity, and position data from the IMU, DVL, and barometer to provide estimates of speed and position in all Cartesian and polar coordinates.

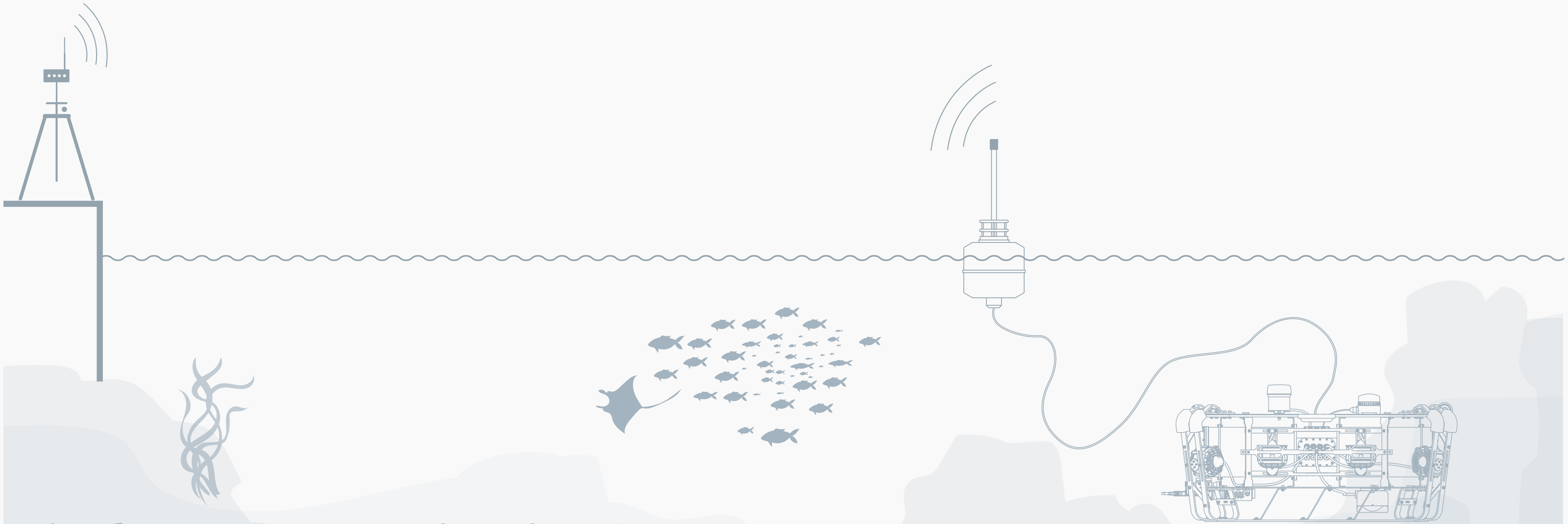




simulation & ros.

The software architecture of our vehicle is built on the Robot Operating System (ROS). ROS provides an open-source platform with a modular and extensible structure, making it easier to integrate different robot components. This platform offers hardware independence, allowing various sensors, cameras, and other components to be compatible with the system. Additionally, ROS's standardized communication structure facilitates data sharing between different modules.

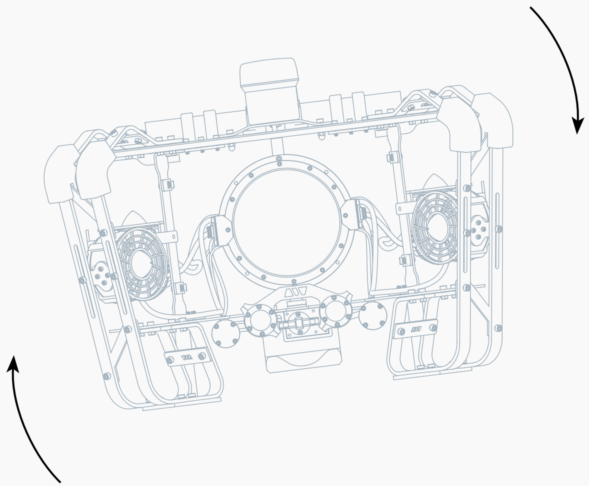
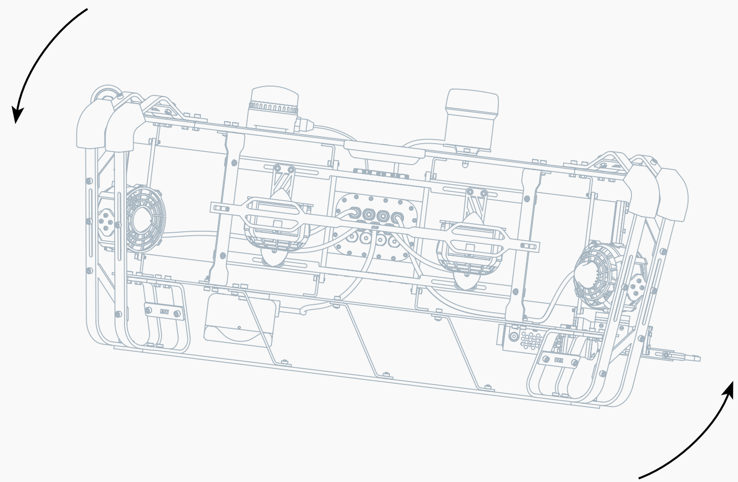
The mathematical model of our vehicle is thoroughly tested in a Gazebo-based underwater physics simulation that runs on ROS. This integrated approach optimizes the processes from sensor data processing to motion control and continuously improves our vehicle's performance.



wireless communication.

To maintain communication with the ground station, a buoy connected to the vehicle via a tether cable has been designed. There is wired communication between the computer inside the vehicle and the buoy's computer, while wireless communication is established between the buoy's computer and the ground station's modem. This setup ensures data flow between the vehicle and the ground station.

Additionally, the buoy tracks the guide light mounted on top of the vehicle using a camera placed underneath it, and follows it using attached motors. This guide light provides relative position information of the vehicle with respect to the buoy, and, combined with the GPS sensor on the buoy, enables precise localization of the vehicle. This makes the localization process easier and more accurate.

auto-leveling.

An automatic leveling algorithm has been developed to maintain the vehicle's stability and maneuverability. This system continuously measures the vehicle's orientation and makes real-time adjustments using four upward-facing thrusters and a PID (Proportional-Integral-Derivative) controller. It effectively minimizes roll and pitch movements. This approach ensures that the vehicle maintains its stability even in rough sea conditions, allowing it to perform its tasks with high accuracy and precision.

creative.

Ozan Hakan Tunca

vision.

The creative team is the unit responsible for the formation of the team's project presentation and promotional content. Utilizing all available resources, they ensure the team's visibility and attract support from investors. Comprised of unsung heroes, the team focuses on memorable visual design, curiosity, and all things good.

action.

The team is responsible for creating graphic content during the production process and defining the team’s visual communication direction by incorporating video and photo shoots. They handle the design and printing of posters, catalogs, business cards, logos, and team uniforms. Additionally, they capture team performance footage and ensure it is edited and produced for suitable social media content.

organization.

Selen Cansun Kırgöz

Alperen Can

team.

The team takes on important responsibilities to ensure the effective and successful operation of the team. Among their duties are organizing team activities and coordinating test processes. They also communicate with university and faculty administration and keep track of content related to competitions.

sponsorship.

Developing autonomous underwater vehicles is made possible through the valuable contributions of sponsors. In this context, the team aims to establish sponsorship relationships that align with its goals and coordinate production and competition processes financially by utilizing these supports effectively.

guidance.

As the ITU AUV Team, we prioritize future generations. We share our knowledge and experiences with students working in this field, such as teams from Cağaloğlu Anatolian High School, Adana Science High School, and Beşiktaş Anatolian High School AUV teams. Additionally, we introduce our vehicle to younger students to spark their curiosity.

our sponsors.

T.M.M.O.B. GEMİ MAKİNELERİ İŞLETME MUH ODASI
1960

INCE SHIPPING GROUP
ISTANBUL • SINGAPORE • DUBAI • PANAMA

INCE SHIPPING GROUP

KUZEY STAR
SHIPYARD

GİMAS

İ.T.Ü.
1993
GELİŞTİRME VAKFI

1971

TÜRKİYE GEMİ İNŞA SANAYİCİLERİ BİRLİĞİ

AUTODESK

our previous sponsors.

our material suppliers.

our needs.

Mechanic

- Production Cost
- Hardware Requirements
- Maintenance Fee

Creative

- Printing Expenses
- Rental Services
- Software Licenses

Organization

- Logistics Support
- Accommodation Expenses
- Competition Application Fee

Software

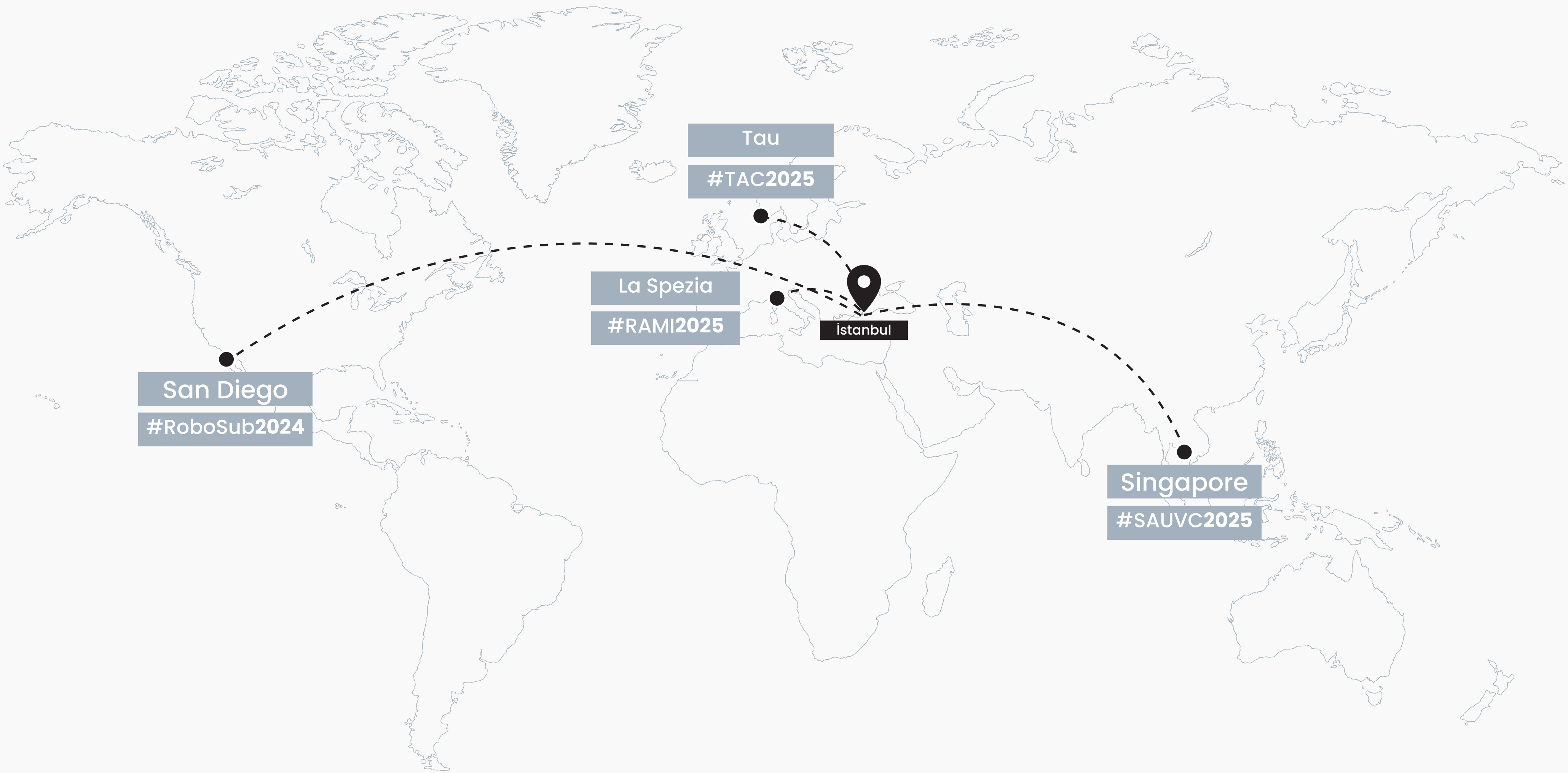
- Server Setup
- Hardware Components
- License Payments

Electronic

- PCB Production
- Sensor Taxation
- Component Support

packages.

	main sponsorship	diamond 500k	platinum 250k	gold 150k	silver 70k	bronze 30k
Thank you post on social media	●	●	●	●	●	●
Adding the company logo to the team portfolio	●	●	●	●	●	●
Sharing the company name and logo on the website.	●	●	●	●	●	●
Tax exemption	●	●	●	●	●	●
Newsletter	●	●	●	●	●	●
Competition jersey back sponsorship	●	●	●	●	●	●
Adding the logo to the competition roll-up	●	●	●	●	●	
Adding the logo to the RoboSub vehicle	●	●	●	●	●	
Organization of corporate social responsibility projects	●	●	●	●		
Organization of joint media and advertising campaigns	●	●	●			
Making the company's introduction on the YouTube channel	●	●				
Granting chest sponsorship on the team jersey.	●	●				
Naming the RoboSub vehicle	●					
Decision on the color scheme for the RoboSub vehicle	●					
Team name	●					


Tau
#TAC2025
La Spezia
#RAMI2025
İstanbul
San Diego
#RoboSub2024
Singapore
#SAUVC2025

flight packages.

	Thank you post on social media	Adding the company logo to the team portfolio	Sharing the company name and logo on the website	Tax exemption	Newsletter	Competition jersey Back sponsorship	Adding the logo to the competition roll-up	Adding the logo to the RoboSub vehicle	Organization of corporate social responsibility projects	Organization of joint media and advertising campaigns
1-2	●	●	●	●	●	●	●	●		
3-4	●	●	●	●	●	●	●	●	●	
5+	●	●	●	●	●	●	●	●	●	●

communication.

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