ALEV ROBOTICS

erAR19

Technical Report - 2019

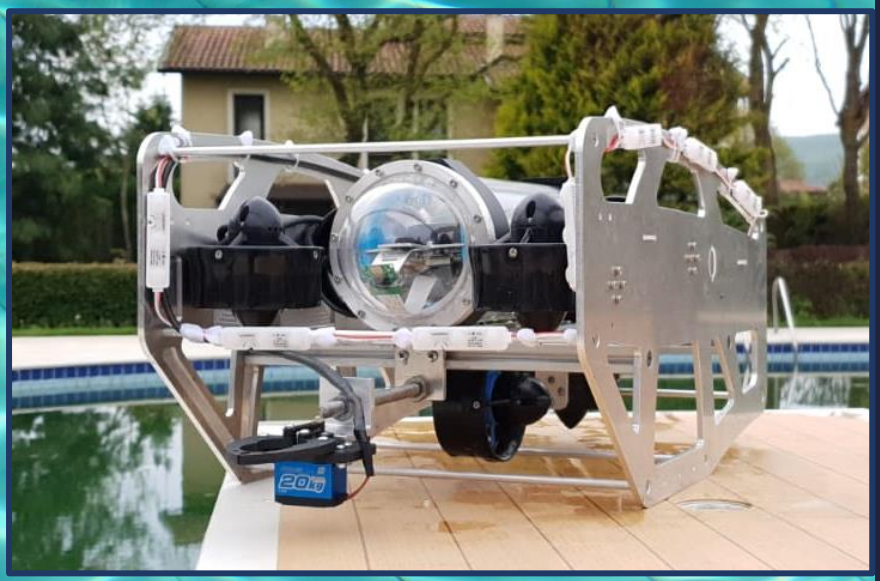


Table of Contents

I. Introduction

Abstract

Alev Robotics Club;

is a club that includes 9 students from 11th grade along with a mentor from Private ALEV Highschool.

Since the Alev Robotics Club was founded in 2016, the students have been working with Remotely Operated Underwater Vehicles that can successfully participate in emergency rescue missions and make discoveries underwater.

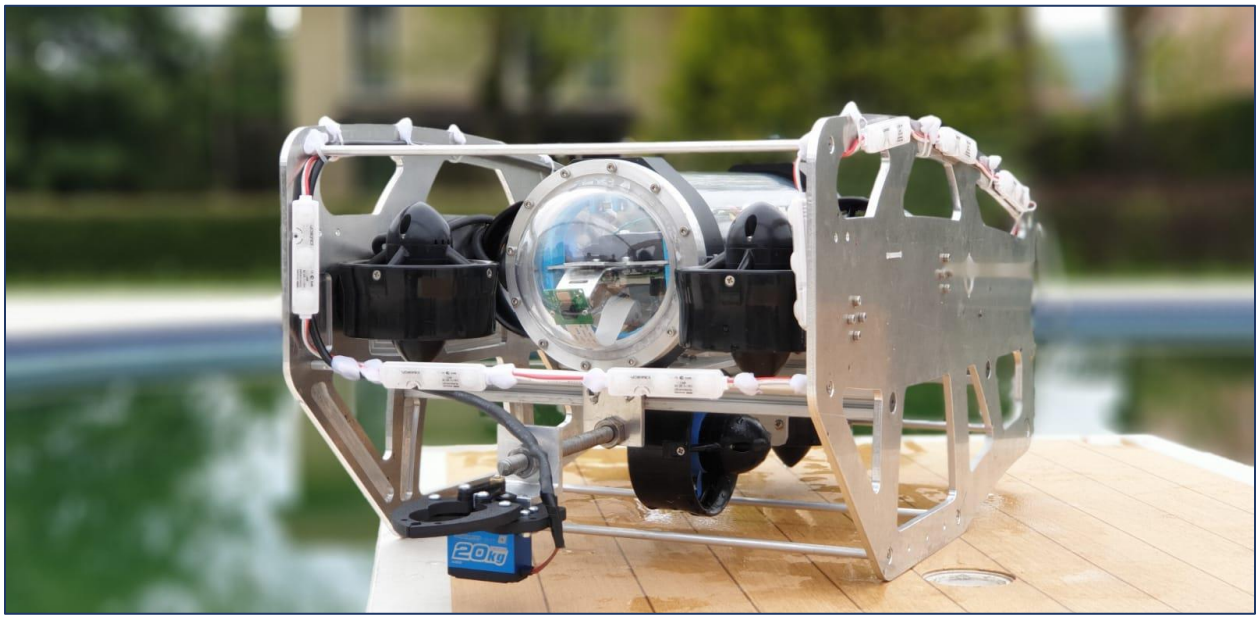
As a team, we have participated in many events and competitions, and crowned our hard work with the successful outcomes.

Our goal as a team;

is to experience new things and improve ourselves in the field of science and technology while engaging in different communities and programmes to expand our vision, and we would be happy to help and share our knowledge in the future.

THE TEAM	
Berk Kaytancı	CEO/Mechanical Engineer
Ata Ağaoğlu	Mechanical Engineer
Batuhan Çakır	Mechanical Engineer
Kaan Taştepe	Mechanical Engineer
Ege Akbaba	Pilot/Software Engineer
Barış Uzel	Software Engineer
Paşan Sancak	Software Engineer
Nihan Koç	CFO/Manager
Zeynep Sueda Metinkale	CFO/Manager
Aziz Özdemir Keskinöz	Mentor

erAR19;
is a Remotely Operated Underwater Vehicle (ROV) manufactured by the members of the ALEV Robotics Club. The robot is equipped with six brushless motors, an aluminium frame, transparent housing, LED lights, a 720p 60fps camera and a multifunctional robotic arm.



With these features, the erAR19 is fully equipped to demonstrate tasks such as grabbing and carrying random items and obtaining views using the camera underwater.

The robot is a result of a months' worth of process. Alev Robotics has carefully planned, manufactured and tested said vehicle in order to complete it. During this process, the team has also taken safety into account. These not only include workshop safety, but also several safety features on the robot. (The safety practices of our team can be found in this document)

This document will be explaining the project of Alev Robotics; erAR19 in detail.

II. Design Rationale

Design Philosophy

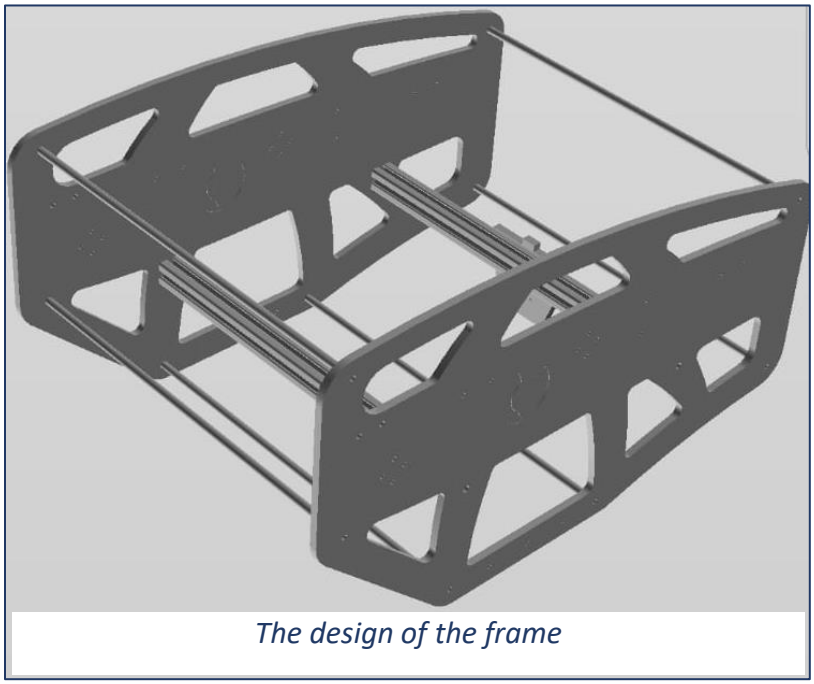
This project was the fourth remotely operated underwater vehicle (ROV) Alev Robotics has made and worked on. We learned a lot from our previous experiences and used those lessons, information gathered from our researches and brainstorming to form our new and improved project: erAR19

Our goal was to eliminate as many flaws in our design as possible. We made sure to not make the mistakes we made during our previous projects. (These are stated in the *Challenges and Improvements* part of this document.) Other than eliminating those specific problems, our main goal for this project was stability and control. We aimed to design a robot that was stable underwater, so that we could have maximum efficiency and control over the vehicle.

We designed and executed the erAR19 with this philosophy. (The process will be explained in detail throughout the *Fabrication* part of this document.)

Frame

The choice of material was critical for our frame. After using several different materials such as plastic tubes or PFTE (Polytetrafluoroethylene), we decided to opt for aliminum for this project. The reason we chose aliminium is because it's a very durable and light material. Although that characteristic of the material was advantageous, aliminium also has a disadvantage. Aliminium has a high density, which causes it to sink easily. This required us to use more thrust power. Overall, the advantages outweighed the disadvantages and we settled on aliminium.



The design of the frame

After choosing the material, we designed our frame digitally. As shown in the picture, the desin of our frame has two main side parts and connecting parts in between.

We used our design and got the framing for our robot prepared at an industry.

Housing

Alev Robotics team always preferred transparent housing, for it makes it easier to see any problems that may occur inside the housing.

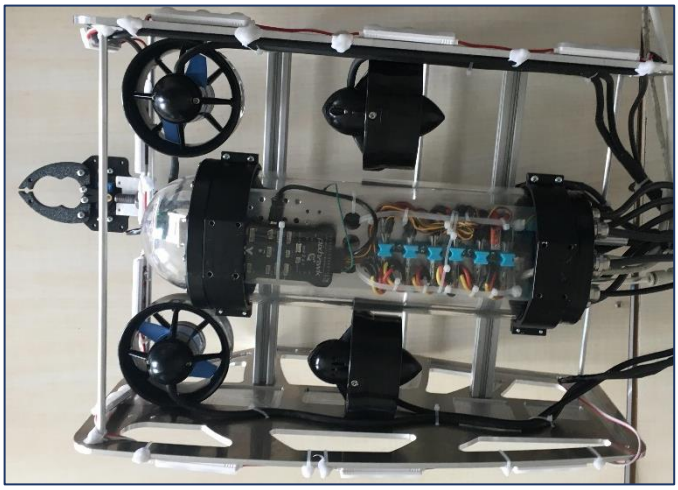
erAR19's housing is a reused housing from ALEV Robotics' third project, Legacy. But before using the housing in our newest project, it went through cold cutting using abrasive, which renovated the surface of the housing and eliminated the damage that was caused by epoxy.

Transparent housing is the most sufficient housing, with only one disadvantage. If not careful, the housing may get scratched, but that wont effect the water-resistance of the housing.

Thrusters

The erAR19 is equipped with a total of 6 thrusters. 4 of them located on the sides – 2 at the right and 2 at the left – and the other 2 are located at the middle, under the ROV.

For this project, we decided to reuse the thrusters we had used in our previous projects because we were satisfied with their performance. We have 6 brushless thrusters. They have high efficiency, which means they have high performance and need low energy to run at full speed. They don't have any disadvantages that we have found, which is why we chose to use them in erAR19.



Robotic Arm

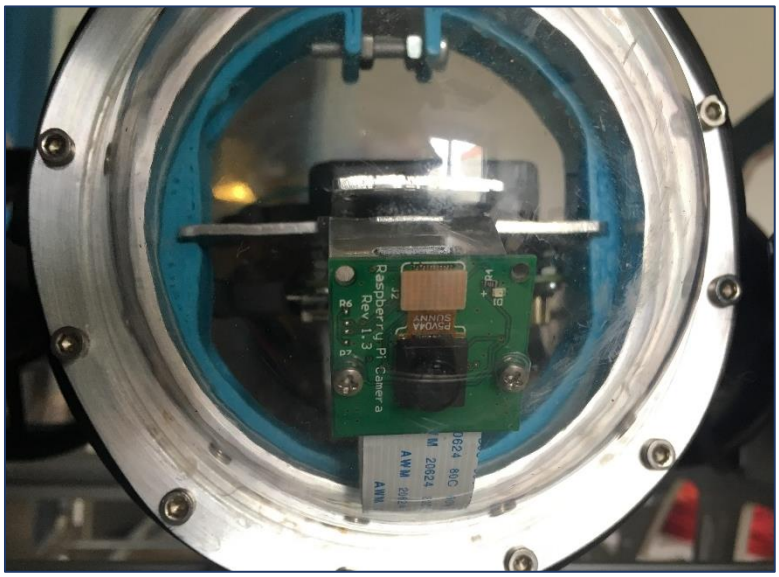
The robotic arm is currently located at the front of the ROV, where it is in the field of vision of the camera.

The characteristics of the robotic arm include portability. It can be reassembled in order to fit to suitable parts of erAR19. It can move to any direction and is extremely mobile.

The robotic arm was designed to achieve specific tasks for the MATE ROV tasks.

Camera System

The erAR19 ROV is equipped with a raspberry version 1.3 camera. The 720p and 60fps camera produces high quality images which makes operating the vehicle easier.



The reason we chose Raspberry is because it has an easy connection and produces images without delays. The instantaneity helps with the accuracy of our decisions and actions.

The camera is located at the front of the robot. It is safely protected inside the waterproof housing.

Electrical System

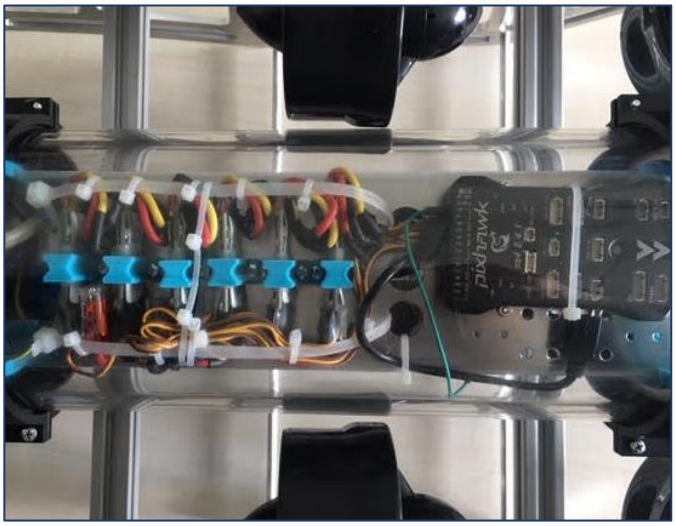
For our cables, we use the Wago connectors. After researching, we found out that The Wago clap technology makes for faster installation and eliminates maintenance. These connectors all use clamps to terminate fine stranded and solid stranded conductors. Once the wire is inserted into the connector, the Wago clamp secures the conductor and encloses its insulation.

The advantage of these connectors was that we eliminated the need for solders. The problem was that they took up too much space, but we managed to fit them into our system.

Software and Programming

For our ROV, we used Raspberry Pi and the ArduSub Software. ArduSub is a well-developed ground control station software for piloting and configuration.

We also have a flight controller. The purpose of a flight controller is to receive commands and control the motors in order to keep the quadcopter in the air. In our system, we used Pixhawk.



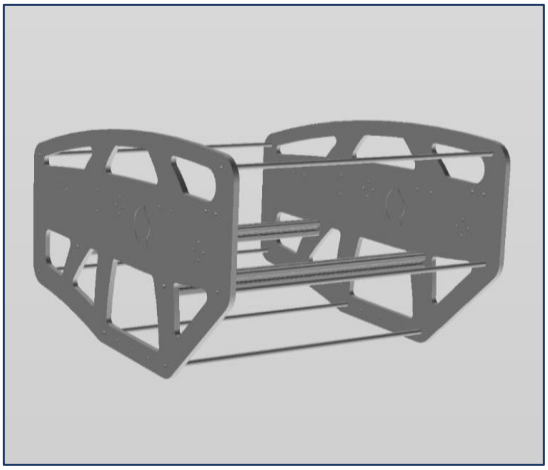
Control System

Alev Robotics has experienced both keyboard and controller techniques, and has decided to use the controller technique which requires a controller that has a wired connection to our control box (Computer).

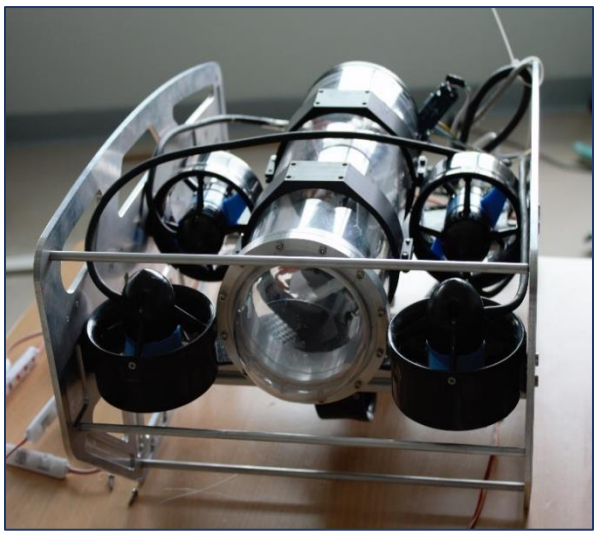
Designing our underwater ROV erAR19, our priority was to make it as stable as possible. In this case, a controller allows us to make precise and small movements with erAR19, unlike the keyboard technique, which does the exact opposite.

Fabrication

After all the parts were ready for constructing the erAR19, ALEV Robotics started with the frame. As explained before, during the *Frame* part of the document, the design was made digitally by us and then sent to an industry located in İstanbul, Tuzla for production. Afterwards, the transparent housing was immobilized to the frame.



The designing process of the frame



The ROV before the instalment of the electronics

The electronics were put inside according to our electronic design.

Some small compartments were designed and then made by a 3D printer.

After inserting everything and making sure that everything was waterproof, the housing was sealed with screws.

During the whole process, we faced some challenges; which will be mentioned in the *Challenges and Improvement* part of the document.

SID

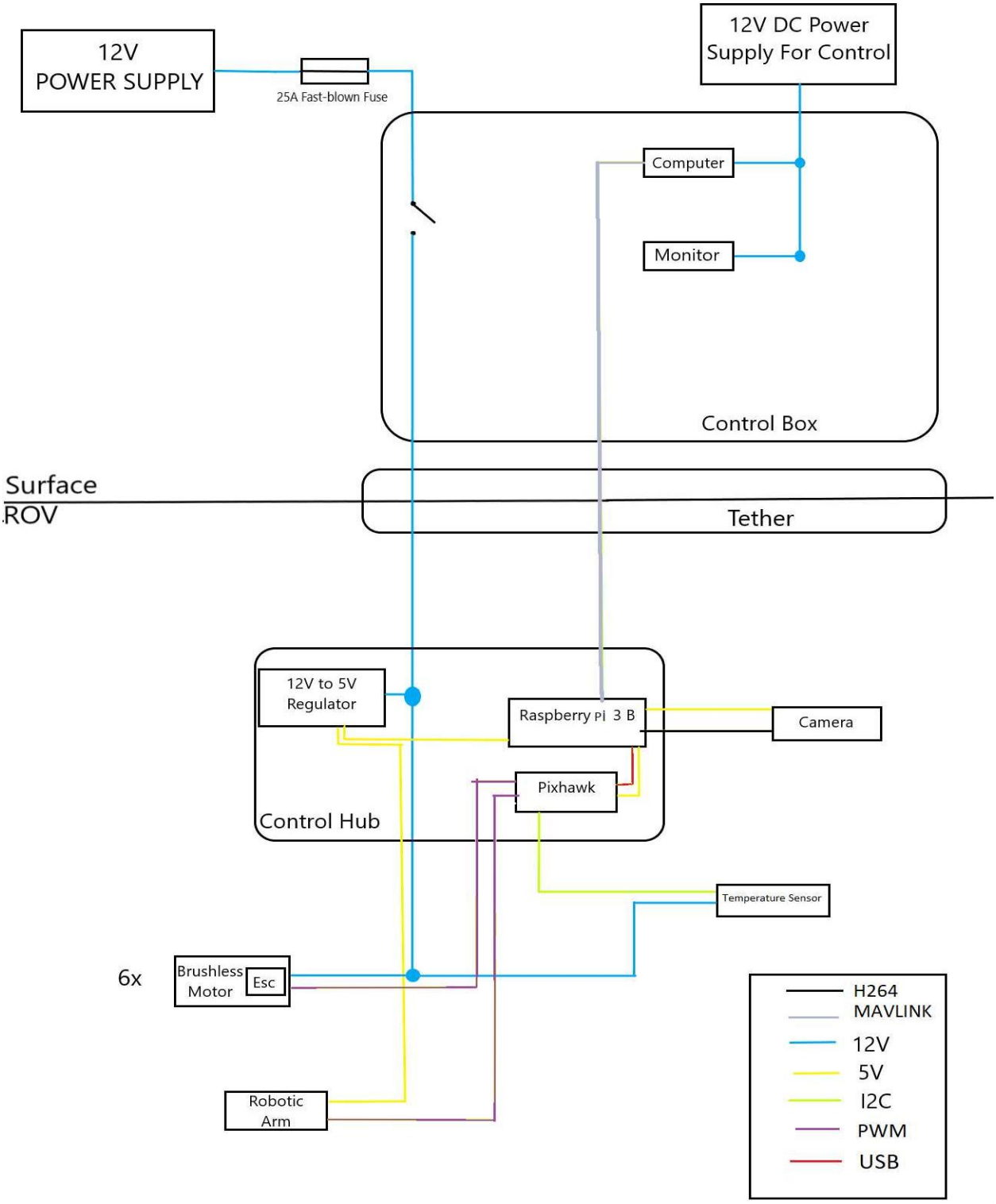


Figure: System Integrated Diagram (SID)

III. Safety

Safety Philosophy

Aside from the learning experience, a very important thing we value is safety in our company. We, as Alev Robotics, make sure to provide the team with a safe work environment.

We value not only our safety, but for others as well. Which is why we do our best to make sure that our ROV or any of our materials/systems cause any kind of severe damage to the people or places around us, especially during competitions where a lot of people are gathered together.

We have done, and will continue doing our best to put safety first.

Workshop Safety

As the members of this project, we spend a lot of time in our workshop. Which is why it's so crucial for us that we have a safe work environment. We always try to keep the cables and everything organized and we make sure not to work on our projects while the power is on.

One very important aspect about workshop safety is that; since the participants spend so much time at the workshops, they will continue doing what they have learned at their workshops everywhere. Which is why we believe that ensuring some safety rules in the workshop means that the members will be careful about those rules everywhere they go, because that's how they have learned it.

Safety Features

✓ LED Lights

The lights are incredibly important for guidance, especially in a case of low lighting. But it also ensures the safety of others and us. We have LED lights located all around the frame of our ROV, which will notify the other vehicles or living beings of our location, and prevent possible crashes or accidents.

✓ Kill Switch

In an emergency situation when the robot can not be shut down in a usual manner, kill switches (or emergency stops) are used to switch the machine off abruptly and prevent any possible accidents.

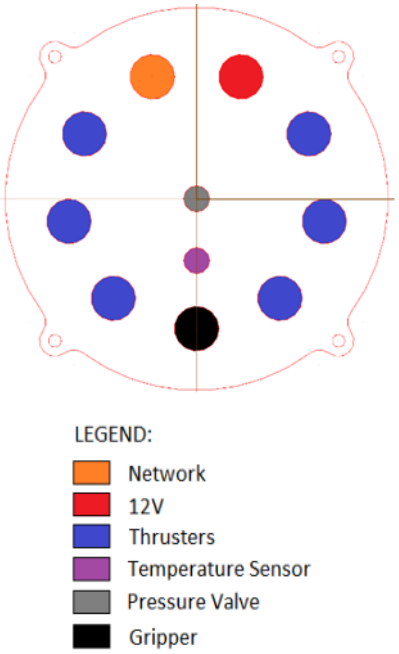
✓ No Sharp Edges

Sharp edges on a ROV can cause possible damaging to the location and injure the members while working on the robot. Which is why we made sure to cover any sharp edges on our ROV.

✓ Thruster Shrouds

The shrouds located on the thrusters prevent any body parts from coming near the thrusters and getting injured.

✓ Connectors and Waterproofing



Making the ROV waterproof is the most important and hardest challenge we faced as a team. On our previous projects, we used epoxy to make our vehicle waterproof. But after we realized epoxy was not the best option to make the ROV waterproof, we used near to zero epoxy on erAR19, which differentiates it from our previous projects. (For further information go to *Challenges and Improvements*) To make erAR19 waterproof, we used connectors which not also guarantees the safety of the robot, also keeps the cables from tangling. We have a total of 8 connectors on the back of the housing.

Troubleshooting

Based on our experience from last year, our team has understood the importance of establishing a systematic troubleshooting process in order to save time during development, and especially the product demonstration.

These steps also allow for non-electrical or software engineers to troubleshoot themselves. The following are potential problems and solutions.

Thruster and tooling -

1. Check if the fuse is blown
2. Check if the ESC's are online
3. Check if the Raspberry Pi is on and blinking properly
4. Check if the connection between Raspberry and Pixhawk is secure
5. Check if the connection between the computer and Raspberry Pi is secure
6. Check if the servo motors/thrusters are somehow stuck
7. Open the housing and make sure all connections are secure

IV. Conclusion

Challenges and Improvements

Making underwater ROV's is always a challenge itself, because it is very hard to make the housing waterproof. In the past we have used epoxy to make our ROV's water-resistant, like many underwater ROV makers do. As much as epoxy makes the ROV completely waterproof, it is not the best choice, since it is very hard to work with.

Epoxy has many disadvantages. First of all, it takes a lot of time to dry, and doesn't easily come off. If a problem occurs within the ROV's housing, epoxy will make it very hard to fix that problem, because epoxy only comes off by scraping it off with a hard, sharp object, which does not only violate our safety philosophy, also damaging the housings surface, and may even cause permanent damage that cannot be fixed in a short period of time. For that, we minimized our usage of epoxy.

Another subject that has challenged our team was the little detailed parts of the ROV that were created with 3D-printer. (These parts were mentioned in the *Fabrication* part of the document.) The little parts didn't always match to our reused parts, for that we had to make extra parts which taught us that we should have made extra parts for back-up from the beginning.

Overall, we overcame the challenges we faced; learned a lot and improved while working as Alev Robotics to make erAR19. We hope to accomplish many more improvements in the future.

Acknowledgements

ALEV Highschool

MATE Centre

Avusturya Liseliler Eğitim Vakfı

MATE ROV Turkey