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Shkollë e Mesme & Kolegji Komunitar
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ELECTRONICS DEPARTMENT

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Class	4-6	Group	G-7	Date	26/05/2023	Academic Year	22-23

# Project Topic	The supervising teachers	
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Work Group	Name of Student	Project (0-3)	Documentation (0-6)	Presentation (0-1)
Student 1	Darti Lila			
Student 2	Albion Spaho			
Student 3	Erlis Ciko			

Objectives	Nr.	Compleated (YES/ NO)	
Building a sustainable underwater structure	1		
Construction of an electronic circuit and management system	2		
Creation of a control system with a computer interface	3		
Implementation of artificial intelligence in the analysis of underwater fauna	4		

Key Words	Submarines, Marine Research, Marine Fauna, Artificial Intelligence
Literature	
Source 1	https://www.rcshipyard.com/tech/
Source 2	https://encounteredu.com/cpd/subject-updates/learn-more-how-are-submarines-used-for-deep-ocean-exploration
Source 3	https://www.youtube.com/watch?v=YDM7Ezb_vN0
Source 4	https://www.iso.org/home.html

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Class	Year	Member 1	Member 2	Member 3	Member 4	Member 5
4-6	2023	Darti Lila	Albion Spaho	Erlis Ciko		

	Date	

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4-6	2023	Darti Lila	Albion Spaho	Erlis Ciko		

1. Abstract:

SEAORB represents a unique effort that combines ingenuity, engineering skills and the spirit of adventure to build a functional submarine with the purpose of exploring Albanian marine fauna. The main objective of this project is to develop a functional and suitable submarine to improve marine fauna research capabilities and to better understand ecosystems and their dynamics. The submarine will provide a safe and controlled environment for researchers, supported by well-organized diving, hazard protection and lighting systems to observe and document these extraordinary organisms. The submarine has been specially designed to provide an endless sea experience through the implementation of artificial intelligence. The work methodology will include the research of the location of the marine fauna and the study of its behavior. SEAORB has great potential for new discoveries and contribution to knowledge on marine biodiversity. In addition to scientific research, this submarine can also be used for educational purposes, promoting awareness on the protection of the seas and sensitizing the public on the importance of preserving marine fauna and flora. In conclusion, SEAORB is a project that aims to make a significant contribution to the field of marine biodiversity research and education. Using technology and passion for the sea, the project aims to pave the way for new discoveries and highlight the importance of preserving and protecting the marine environment for future generations.

2. Introduction

Nature has always pushed man to explore the environments that surround him, no matter how harsh or scary, no matter how mysterious or intriguing. The Cold War (1947 - 1991) motivated the most powerful states to explore precisely the unknown, space, the front of the future. The greatest achievements, from the launch of the first LO satellite to the first step on the surface of the Moon have drawn our attention to the stars. Large bodies of water, although closer to us, have always been a great challenge for man.

Trieste[1], one of the most important steps in the exploration of maritime geography, clearly showed us how little we know about the world around us. The deepest point on Earth, Challenger Deep[2], about 3000m deeper than the highest point on the globe, presented us with a new horizon; gave us more questions than answers. One of the most fascinating aspects of this new world is undoubtedly the life that thrives under water, or rather, how the flora and fauna have found the best way to survive amidst the greatest challenges that the bottom of the ocean offers[3], just as man has always found a solution to his problems.

Many independent makers have taken on the challenge of building a device capable of withstanding the challenges posed by salt water, the sworn enemy of any electronic/electrical device. DIY Perks[4], a popular YouTuber in the DIY community, designed a simple submersible[5] for shallow depths using the BALLAST SYSTEM[6], based on pistons using simple medical syringes and water pumps to create the propulsive force to move the submarine forward. A solution that seems simple at first glance turns out to be compact and interesting. His submarine's lack of mobility, however, poses a problem in tight spaces or tight turns. PeterSripol[7] another youtuber known for his creative engineering projects, brings a new design, more compact and more mobile. His submarine[8] comes as a solution for magnet fishing enthusiasts[9]. A problem that comes with Peter's solution is the lack of modularity of the submarine as well as the lack of a variable diving system (without using preset weights).

The SEAORB submarine comes as a compact solution for seafront exploration by a small team with big dreams! Unlike DIY Perks, our sub includes an open pump based (no high pressure) ballast system. SEAORB also features a more mobile system for tight turns. On the other hand, unlike PeterSripol, our submarine is modular and more modifiable. By taking the most positive aspects of both projects and improving their problems, SEAORB comes as the best possible solution.

SEAORB comes to the aid of marine biologists by guaranteeing them a safe and simple way to conduct their field studies. The project guarantees several advantages, such as modularity, large usable space for installing additional modules, as well as stability and ease of use. Usable from any possible environment, SEAORB guarantees the best experience for every user and guarantees assistance in future discoveries in the fascinating underwater world.

3. **Division of the work:**

   Darti Lila - Design and construction of submarine electronic circuits, optimization of power usage and protection from potential circuit hazards.

   Albion Spaho - Designing the structure of the submarine, building the pressure control system and water chambers, managing the electrical cables, connecting them and the interior space efficiently.

   Erlis Ciko - Implementation of a remote control system by computer interface, implementation of artificial intelligence for the study of marine fauna.

4. Materials and Methods:

SEAORB consists of groups of chambers that cooperate with each other to create an optimized system. These rooms are divided respectively:

1) **Power Control** - Rooms responsible for controlling submarine power. This is where the batteries are located, divided into two groups connected in parallel to guarantee the necessary power for the submarine.

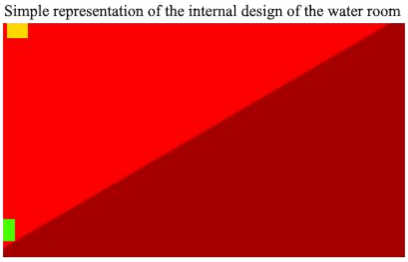
2) **Water Rooms** - Chambers which enable the creation of the necessary space to add the necessary weight which will allow the submarine to have a controllable dive with different depth levels. The pediment chambers guarantee the complete emptying of the submarine to bring the SEAORB back to the surface.

3) Control Room - The most important room which contains all the necessary elements for the control of the submarine. This is where the microcontroller and camera are located.

Water chambers:

The chambers that allow water to be filled to increase the submarine's weight are cylindrical in shape to match the submarine's exterior design. The chosen form allows the passage of cables along the inner perimeter of the submarine to facilitate the connections between the elements. The cavity created inside the chambers enables a uniform filling with water and eliminates air pockets that can be created during filling. Utilizing the largest possible space, the chambers can hold 1L of water adding the weight needed to break the balance created by buoyancy.

Simple representation of the internal design of the water room



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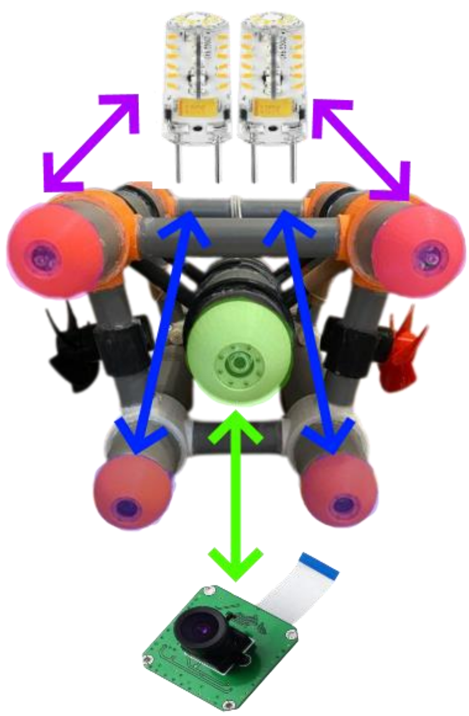


Front View:

To create the ability to see under water, the submarine uses two systems closely connected to each other. Separated and analyzed individually they are:

1) Camera: The "eye" of our submarine is precisely the camera located in the center of the control room. The 1Mpxl camera enables real-time visuals and the ability to capture images without creating a delay.

2) The lights enable illumination of the environment and the object in front of the submarine. Lights are divided into corresponding pairs as follows:

a) Focusing lights (highlighted in purple) enable focusing on a distant object.

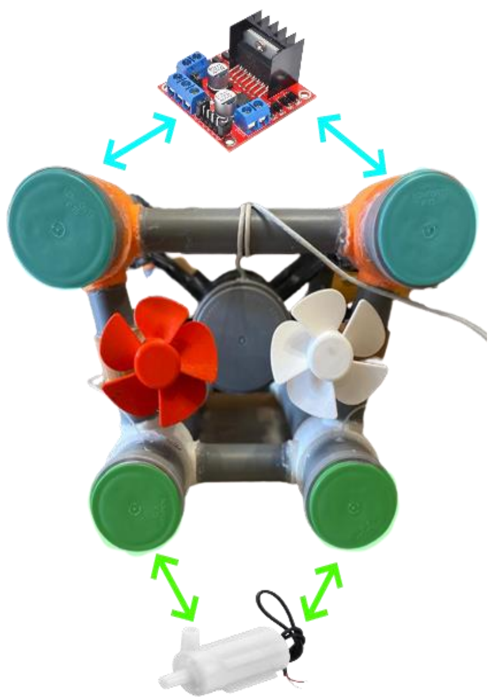
b) Ambient lights (highlighted in blue) enable the illumination of nearby objects and the environment near the submarine.

Back View:

To enable the submarine to move in all three dimensions, the SEAORB uses two control systems. These systems are divided as follows:

1) Motor system: The motors are controlled by means of motor drivers which are located at the end of the power chambers. The contact they have with the chassis of the submarine enables the cooling of this element during long-term uses.

2) Pump system: The pumps responsible for extracting water are located near the water chambers. Together with the external pumps, the pump system enables uniform filling of both chambers to create balance in the submarine's center of gravity.



Connecting the submarine to the laptop:

SEAORB uses a combination of USB and Ethernet interfaces. USB is used to have a simpler way of data transmission while Ethernet is used to reduce the possibility of losing information over distance. This combination is realized by means of two adapters, USB-Ethernet and Ethernet-USB, which carry out the transmission of all information on both sides of the communication.

5. Theoretical Part

5.1. Clarification regarding the theoretical part.

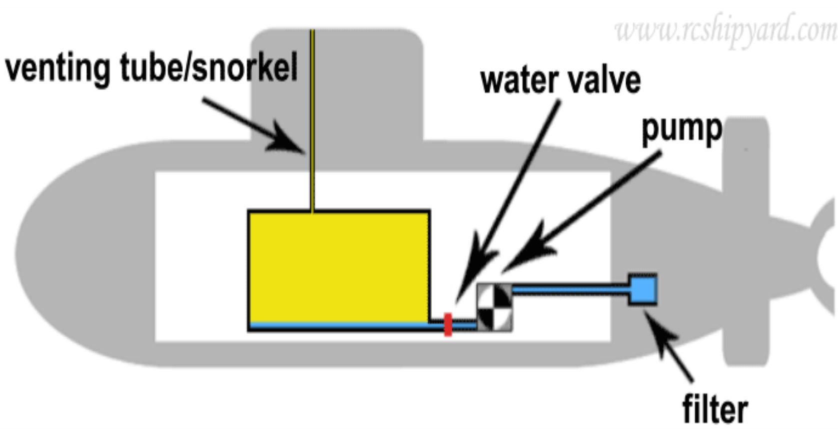
The submarine is divided into five different rooms for its operation. Here is a breakdown and explanation for each of them:

Upper rooms for placing batteries and electrical elements:

- The upper rooms are responsible for the placement of batteries and electrical elements of the submarine.

- These rooms provide the necessary space for the installation and connection of batteries, charging systems, electrical interfaces and other important equipment.

Lower chambers for water tanks and pumps:



- Lower rooms are dedicated to hold the pump and the water chambers.

- These chambers hold the water necessary for the operation of the submarine and are connected to pumping systems for the supply and removal of water as needed.

3. Central room for electronic parts of the project (main room):

- The central room consists of the main room of the submarine and contains the electronic parts of the project. This room is where the equipment and related electronic components are located, such as the command systems, control interfaces, sensors and general monitoring equipment of the submarine.

- This division into rooms allows the organization of the various components of the submarine in a convenient way and facilitates their access and maintenance. Through this structuring, each room has a specific function and is responsible for the specific part of the submarine for which it is designed.

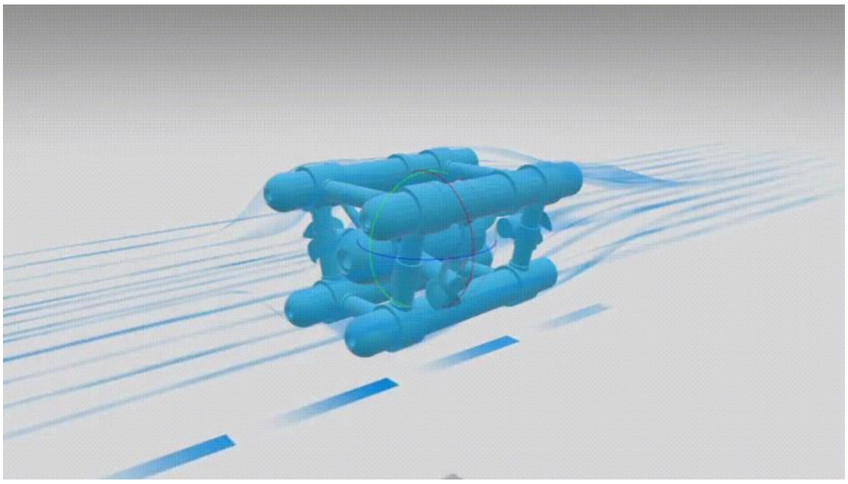
- Separated in this way, the rooms of the submarine (for the placement of batteries and electrical elements, water tanks and pumps, as well as the main room for the electronic parts of the project) make it easier to balance and find the point of stability (buoyancy) of the submarine.

- By dividing the submarine into separate compartments, it is easier to organize the batteries, water tanks, pumps and electronic components in order to ensure adequate weight and stability. The compartmentalization allows the development of different balancing strategies and helps to find the most suitable place for the stability of the submarine in the water.

- This compartmentalization of the submarine helps improve the overall performance and safety of a submarine by simplifying the way components are organized and making it easier to balance and find the point of stability underwater.

5.2. Building the model in the simulator briefly explaining the simulator. Clarifications in operation and expectations of the scheme/ circuit /programming.

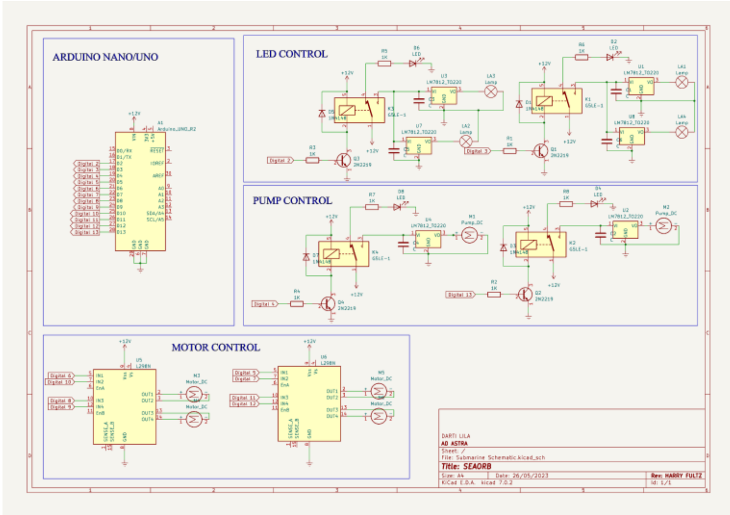
Hidrodinamika:



The analysis of SEAORB's structure begins with its hydrodynamics, where by means of the **AirShaper** simulator, we created a model that simulates the dynamics that the submarine will have during movement and how the fluid around it will react to the changes that the submarine will make in environment.

Electronic Circuit:

The electronic circuit is divided into 4 seperate circuits as follows:



1) **Arduino Nano/Uno:**

   The microcontroller which enables communication with the computer and commands the circuit.

2) **LED Control:**
   The controllable circuit that sends power to the LED and controls them.
3) **Pump Control:**
   The controllable circuit that sends power to the pumps and controls them.
4) **Motor Control:**

   The controllable circuit that sends power to the pumps and controls them.

Camera:

The camera has an individual connection to the computer, connected to the BUS in parallel with the Arduino, it sends and receives signals via the USB-Ethernet cable. The power for the camera is taken directly from the computer 5V power over Ethernet [10].

5.2. Analytical analysis of the scheme/circuit/program, mentioning how the theoretical knowledge obtained at school was applied in the different subjects.

Power Requirements:

1. **Arduino:** To operate the Arduino, of 12V and 0.1A need to be provided.
2. **Motors:** Each motor needs 12V and 0.8A. Therefore, the total power consumption for four motors is given by the formula:

$$Power\ (Motors) = Voltage\ (Motor) \times Current\ (Motor) \times Number\ of\ Motors$$

$$Power\ (Motors) = 12V \times 0.8A \times 4 = 38.4\,W$$

3. **Pumps:** Each pump needs 9V and 0.5A. Therefore, the total power consumption for two pumps is given by the formula:

Power (Pumps) = Voltage (Pump) × Current (Pump) × Number of Pumps

$$Power\ (Pumps) = 9V \times 0.5A \times 2 = 9\,W$$

4. **LEDs:** Each LED needs 12V. One set of LEDs consumes 25W (Ambient Lights) and the other consumes 35W (Focus Lights). Since the LEDs are divided into two parallel groups, the total current requirement for the LEDs can be calculated as follows:

Current (LED ambient) = Total Power (LED ambient) / Total Voltage (LED ambient)

$$Current\ (LED\ ambient) = \frac{25W}{12V} = 2.08A$$

Current (LED focused) = Total Power (LED fokusuar) / Total Voltage (LED fokusuar)

$$Current\ (LED\ focused) = \frac{35W}{12V} = 2.91A$$

All four LEDs together will require a total of 10.18 A.

Component Selection:

a. Motor Drivers: L298N Motor Drivers are selected based on the voltage and current requirements of the motors. The selected Motor Driver are able to handle at least 12V and 0.8A per motor, with a higher value for the electric current to ensure a safety range.

b. Relays: Relays are selected based on the voltage and flow requirements of the pumps and LEDs (MAX 16V). The relays are able to handle 9V and 12V, with a maximum current of 1A. The selection provides a certain higher value for the electric current as a safety range.

c. Arduino: The Arduino should be selected based on the number of digital caps needed to control motors, relays, and LEDs. Make sure the Arduino model has enough digital caps to accept the necessary signals!

Circuit Design:

- **Battery (Power source):**

The power source must guarantee a voltage of 12V and 5A throughout the circuit. Safety systems such as built-in capacitor filters are used to avoid sudden voltage drops and smooth out ripples that can be created by various noises from the circuit elements.

- **Arduino:**

Arduino connects to motor drivers, relays and LEDs according to their control requirements. Each motor driver must be connected to two motors and the relay must control the pump. The LEDs are connected in parallel, with resistors limiting the electrical flow to provide the required voltage and current.

- **Pump Control:**

The pumps draw power directly from the battery and use a relay and BJT transistor current control circuit. The voltage before entering the pump is limited by the LM7809 voltage regulator which guarantees 9V at the pump input and filters which minimize the noise generated by the electronic elements.

- **LED Control:**

The LEDs, as well as the pumps, draw power directly from the battery and use a relay and BJT transistor current control circuitry. The voltage before entering the pump is limited by the LM7812 voltage regulator which guarantees 12V at the pump input and filters which minimize the noise generated by the electronic elements.

- **Motor Control:**

The motors get direct power from the battery and use the motor driver to control the power and signals received from the Arduino. The voltage of the motors does not need a filter or voltage regulator, since 12V is guaranteed by the power source.

Supplying the necessary energy:

The circuit is supplied with a suitable lithium ion power source that can supply the total power requirements calculated above. The power source is able to provide 38.4W for the motors, 9W for the pump and 60W for the LEDs. The current received from the power source is ensured that there is no fluctuation before entering each component that needs it by means of the corresponding filters. The power source is portable and rechargeable.

Arduion Code:

The Arduino code is built to control the motors, pump and LEDs according to the desired functionality. The code uses the appropriate digital capabilities to send signals to the motor drivers, relays and LEDs. A pseudo code would look like this:

- [Establishing a serial connection with the computer according to a COM port]
- [Declaration of corresponding pins]
- {Creating functions that define the signals that are sent by the Arduino to control the elements}
- {Building the conditions that call the above functions based on the inputs coming from the computer}

5.3. Norms and standards that will have to be taken into account.

1**. ISO 19673: Remote Controlled Watercraft - Terminology and Basic Definitions:**

This standard defines basic terminology and definitions for remotely operated watercraft. This document helps to develop a common language and understanding of concepts related to this field.

2. **ISO 19674: Remote Controlled Watercraft - Safety and Performance Requirements:**

This standard defines the safety and performance requirements of remotely operated watercraft. It includes aspects such as design, construction, operation of electrical and electronic systems, as well as tests and verifications to guarantee proper operation of the vehicle.

3. **ISO 19675: Remote Controlled Watercraft - Requirements for Remote Control Systems:**

This standard regulates the requirements for remote control systems in remotely operated watercraft. Includes specifications for remote control system elements, signal transmission, receivers, and control interfaces.

4. **ISO 19676: Remote Controlled Watercraft - Use and Management of Received Data:**

This standard regulates the use and management of data received from remotely operated watercraft. It includes aspects of data recording, their storage, as well as methods for their analysis and distribution.

5. **ISO 19677: Remote Controlled Watercraft - Requirements for Resistance to Operating Conditions:**

This standard defines the requirements for the resistance of remote-controlled watercraft to the conditions of exploitation. Includes testing for memorial resistance, water resistance, temperature, solar radiation impact, as well as rough sea impact.

6. **ISO 19678: Remote Controlled Watercraft - Environmental Protection Tools:**

This standard regulates the use of remote-controlled watercraft for the protection of the aquatic environment. It includes requirements for minimizing the vehicle's impact on the aquatic environment, such as the implementation of cleaning and monitoring technologies.

5.4. Design structure and material to be used, why was this material chosen?

The materials used are PLA (Polylactic Acid) and PP (Polypropylene) plastics as important materials. These plastic materials have different characteristics and offer special benefits in submarine construction and use.

PLA is a bio-based polymer that is produced from plant-based materials such as corn and shrubs. This makes it a good choice for applications that need a more environmentally friendly interface. PLA has other benefits such as lightness, rigidity and thermal stability. However, it is more sensitive to high temperatures and is not as resistant to chemical products as PP.

PP is a common polymer used to make plastic products. It has a good combination of strength, high temperature resistance, chemical resistance and stability. PP is also relatively light and flexible. These characteristics make PP a good choice for submarine use, for components that must be resistant to water, chemicals and high temperatures.

By combining PLA and PP plastics in the construction of the submarine, the benefits of each material can be taken advantage of. PLA offers an environmentally friendly solution and good thermal characteristics, while PP provides resistance and stability in conditions of exposure to water and chemical products. Their combination can improve the performance and durability of the submarine in its conditions of use in the water.

5.5. Summary table of the theoretical part which will be referred to the practical and final part.

System/Element	Voltage	Current	Power
Power Supply	12V	5A	60W
Arduino	12V	0.186A	2.23W
LED (Ambient)	12V	2.08A	25W
LED (Focus)	12V	2.91A	35W
Pumps	9V	0.5A	4.5W
Motors	12V	0.8A	9.6W

Communication cable	Length	Loss in m
RJ45	10 m	Loss after 100m
USB	0.2 m	Loss after 5m

6. Practical Part

6.1. Clarifications for the practical part, implementation, schema/circuit/program, measurements and comparisons with the theoretical and simulated model.

Implementation of the circuit:

The electrical circuits are realized in PERFBOARDS [11], where the electrical elements are connected with tin to create the necessary contacts between them. To facilitate debugging, the elements are placed on female pin headers, which enable the modularity needed for future improvements to the circuit.

LEDs are used in the circuit to indicate the state of the elements (ON/OFF). Using several LM78XX helps distribute the current and eliminates the possibility of the element overheating, a problem that would cause unnecessary noise in the signal as well as damage to nearby circuits and connections. The ceramic capacitors located at the input of the LM78XX enable the elimination of external noises as well as soften the instantaneous drop that can be caused by the disconnection of the signal.

Realising the Arduino Code:

```
#define ledHigh 3
#define ledLow  2
#define motorLS 6
#define motorLS1 10
#define motorLB 8
#define motorLB1 9
#define motorRS 5
#define motorRS1 7
#define motorRB 11
#define motorRB1 12
#define divePump 4
#define surfacePump 13
```

Declaring the variables:

In the following code we declare each pin based on the digital outputs of the Arduino. These pins can be interchanged, but in our case the particular configuration was chosen to make the internal connections of the submarine simpler. Each pin is named according to the function it performs, where LEDs are divided into ambient (ledLow) and focus (ledHigh). Motors to operate must have one positive signal and the other phased by 90° (negative). These two signals determine the direction of rotation. The extensions behind the engine determine the location of the engine (LS - Left Side; LB - Left Back; RS - Right Side; RB - Right Back). For pumps the only values are dive and surface.

The setup() function serves to declare the serial connection of the Arduino to the computer and to declare the working method of the pins (OUTPUT/INPUT).

```
void setup() {

  Serial.begin(9600);   pinMode(ledHigh, OUTPUT);   pinMode(ledLow, OUTPUT);
  pinMode(motorLS, OUTPUT);   pinMode(motorLS1, OUTPUT);  pinMode(motorLB, OUTPUT);
  pinMode(motorLB1, OUTPUT);  pinMode(motorRS, OUTPUT);   pinMode(motorRS1, OUTPUT);
  pinMode(divePump, OUTPUT);  pinMode(surfacePump, OUTPUT);

}
```

```
void loop() {
  if (Serial.available()) {
    char receivedChar = Serial.read();
    if (receivedChar == 'W') {forward();}   else if (receivedChar == 'A') { left();}
    else if (receivedChar == 'S') { reverse();}   else if (receivedChar == 'D') {right();}
    else if (receivedChar == 'I') {enableHighBeams();}  else if (receivedChar == 'K') {disableHighBeams();}
    else if (receivedChar == 'U') {enableLowBeams();}   else if (receivedChar == 'J') {disableLowBeams();}
    else if (receivedChar == 'P') {halt();}   else if(receivedChar == '.'){dive();}
    else if(receivedChar == ','){surface();}}
}
```

In the loop() function we read the serial port when it is connected and based on the received information we call one of the possible functions.

The functions located to the right enable all the mobility and vision that the submarine requires to work in the best possible way. Each motor uses two pins to select the direction it will take. LED lights and pumps are controlled by two dedicated functions to turn on and off as well as surface and submerge respectively. Finally, a function is built in which stops any possible movement to stabilize the submarine and focus it on a temporary stationary point.

```
void forward(){
  digitalWrite(motorRB, HIGH);  digitalWrite(motorRB1, LOW);
  digitalWrite(motorLB, LOW);   digitalWrite(motorLB1, HIGH);}
void left(){
  digitalWrite(motorLS, HIGH);  digitalWrite(motorLS1, LOW);
  digitalWrite(motorRS, LOW);   digitalWrite(motorRS1, HIGH);}
void right(){
  digitalWrite(motorRS, HIGH);  digitalWrite(motorRS1, LOW);
  digitalWrite(motorLS, LOW);   digitalWrite(motorLS1, HIGH);}
void reverse(){
  digitalWrite(motorRB, LOW);   digitalWrite(motorRB1, HIGH);
  digitalWrite(motorLB, HIGH);  digitalWrite(motorLB1, LOW);}
void enableHighBeams(){digitalWrite(ledHigh, HIGH);}
void disableHighBeams(){digitalWrite(ledHigh, LOW);}
void enableLowBeams(){digitalWrite(ledLow, HIGH);}
void disableLowBeams(){digitalWrite(ledLow, LOW);}
void dive(){digitalWrite(divePump, HIGH);}
void stopDive(){digitalWrite(divePump, LOW);}
void surface(){digitalWrite(surfacePump, HIGH);}
void stopSurface(){digitalWrite(surfacePump, LOW);}
void halt(){
  digitalWrite(motorRB, LOW);   digitalWrite(motorRB1, LOW);
  digitalWrite(motorLB, LOW);   digitalWrite(motorLB1, LOW);
  digitalWrite(motorRS, LOW);   digitalWrite(motorRS1, LOW);
  digitalWrite(motorLS, LOW);   digitalWrite(motorLS1, LOW);
  stopSurface();                stopDive();}
```

6.2. Instrumental measurements of electrical/electronic quantities compared to theoretical and simulated ones. Analysis and evaluation errors from theoretical modeling and practical implementation.

Requirements for Power:

Battery (Power Source): The power source guarantees 13.16V and 4.98A after a full charge. The power that this power supply unit guarantees is 65W in total.

Arduino: The microcontroller when operated individually, can be measured in parallel and series with multi-meter to identify voltages and currents in positive and negative poles of motors. The following values represent the measured values:

Measurement	Measured Value
Voltage	11.92V
Current	0.168A
Power	2.08W

Motors: After powering only the motors (all four simultaneously), we can measure in parallel and series with the multi-meter to identify the voltages and currents in the positive and negative poles of the motors. The following values represent the measured values:

Measurement	Measured Value
Individual Voltage	11.82V
Total Voltage	11.82V
Individual Current	0.84A
Total Current	3.36A
Individual Power	9.93W
Total Power	39.8W

Pumps: After powering only the pumps (both simultaneously), we can measure in parallel and series with the multi-meter to identify the voltages and currents on the positive and negative poles of the pumps. The following values represent the measured values:

Measurement	Measured Value
Individual Voltage	8.95V
Total Voltage	8.95V
Individual Current	0.56A
Total Current	1.13A
Individual Power	5.012W
Total Power	20.049W

LEDs: Once only the LEDs are powered on (all four simultaneously), we can measure in parallel and series with a multi-meter to identify the voltages and currents on the positive and negative poles of the LEDs. The following values represent the measured values:

Measurement	Measured Value
Individual Voltage	11.98V
Total Voltage	11.98V
Individual Current (LED Ambient)	1.05A

Total Current (LED Ambient)	2.13A
Individual Current (LED Focus)	1.42A
Total Current (LED Focus)	2.85A
Individual Power (LED Ambient)	12.57W
Total Power (LED Ambient)	25.94W
Individual Power (LED Focus)	17.01W
Total Power (LED Focus)	34.02W
Total Power	59.69W

Communication cable: Using a USB - Ethernet adapter comes with a disadvantage; compression of transmitted information. This does not pose a problem for the Arduino control, but the same cannot be said for the camera. The camera's transmission has small packet loss, but is noticeable to a well-trained eye.

Communication cable	Length	Loss/m
RJ45	10m	Small loss of packages
USB	0.2m	No Loss

Comparison between the theoretical and measured values:

Element	Theoretical Voltage Value	Theoretical Current Value	Theoretical Power Value	Measured Voltage Value	Measured Current Value	Measured Power Value	Margin of Error
Arduino	12V	0.1A	1.2W	11.92V	0.168A	2.08W	27.89%
LED (Ambient)	12V	2.08A	25W	11.98V	1.05A	12.57W	65%
LED (Focus)	12V	2.91A	35W	11.98V	1.42A	17.01W	69.72%
Pump	9V	0.5A	4.5W	8.95V	0.56A	5.012W	7.06%
Motor	12V	0.8A	9.6W	11.82V	0.84A	9.93W	3.39%

*** Calculating the error with the formula:**

Percentage Error =| ((Estimated Number – Actual Number)/ Actual number)| x 100.

**** Percentage of error comes as a result of an average of three errors.**

***** Marzhet e larta të gabimit janë të pritshme pasi nuk është llogaritur momenti ku të gjithë elementet punojnë së bashku.**

The large margins of error are expected because we havent taken into account the moment when all the elements work simultaniously.

Analysis of errors during measurements and use:

Human error: During measurements the main error is human error. In the reading of the instrument, there are small fluctuations in current and voltage, which can be read incorrectly by humans. This can turn into a problem for several consecutive measurements as the average of the values read by the human eye over this time can pose a problem for the accuracy of the measurements.

Rounding to two digits after the comma: Rounding to two digits after the comma: Rounding of values is done to avoid the long time that exact calculation would require. Although effective in small measurements made in a short time, this error can prove fatal in the case of measurements at a smaller degree of accuracy.

Calibration of the instrument: The lack of calibration of the measuring instrument before the measurement will pose a problem in accurate measurements which will require high accuracy. The absence of a calibrator is expected for most instruments, but it is important to add the margin of error at the end of the measurements.

***The margin of error (± 0.5% in total) is also calculated in the electronic measurements above.**

6.3. Structure, production and assembly. Problems, solutions, dimensions and trials.

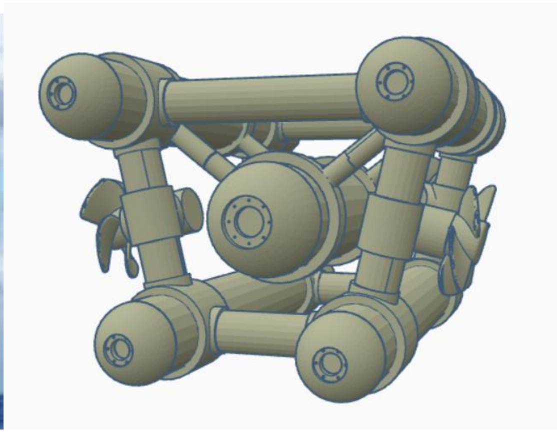
1. Adapting the shape of the structure: The SEAORB design adapts to the shape and characteristics of the structure that is necessary for the specific application. This may include the stability, mobility, internal construction and other aspects of a particular structure in water.

2. Use of suitable materials: To create the SEAORB, it is important to use materials that are available and suitable for underwater applications. These materials can be corrosion-resistant polymers, high-strength metals, or a combination thereof, depending on the particular project conditions.

3. Balance and stability in water: The design of the SEAORB aims to have a good balance to ensure that the structure stays stable under water and does not create unnecessary pressures on it. This includes recognizing and managing hydrodynamic forces, water pressure and other conditions in the water.

To achieve the goal of stability and good hydrodynamics, the SEAORB can include aspects such as aerodynamic shape, underwater placement, the choice of materials with high corrosion resistance, and other configurations that improve the performance and stability of the structure in water.

Overall, the purpose of SEAORB is to provide a stable structure suitable for the underwater environment, and to provide a functional platform for various applications such as scientific research, environmental monitoring, or other services in open water environments.



In the SEAORB design process, one of the main issues was the insulation part and finding the best insulation material to ensure the structure is suitable for underwater use. Insulation of the structure is important to protect the equipment and internal components from the impact of water, extreme temperatures, and other environmental changes. In this context, the insulation material with high resistance should also be determined, to ensure an efficient insulation and extend the life of the structure.

To solve this problem, several criteria were important to identify the best insulating material for SEAORB:

1. **Water resistance:** The insulation material should be suitable for use in water and have a high resistance to water infiltration and holes.

2. **Thermal resistance:** The insulation must have high resistance to different temperatures and be able to maintain a stable environment within the SEAORB structure.

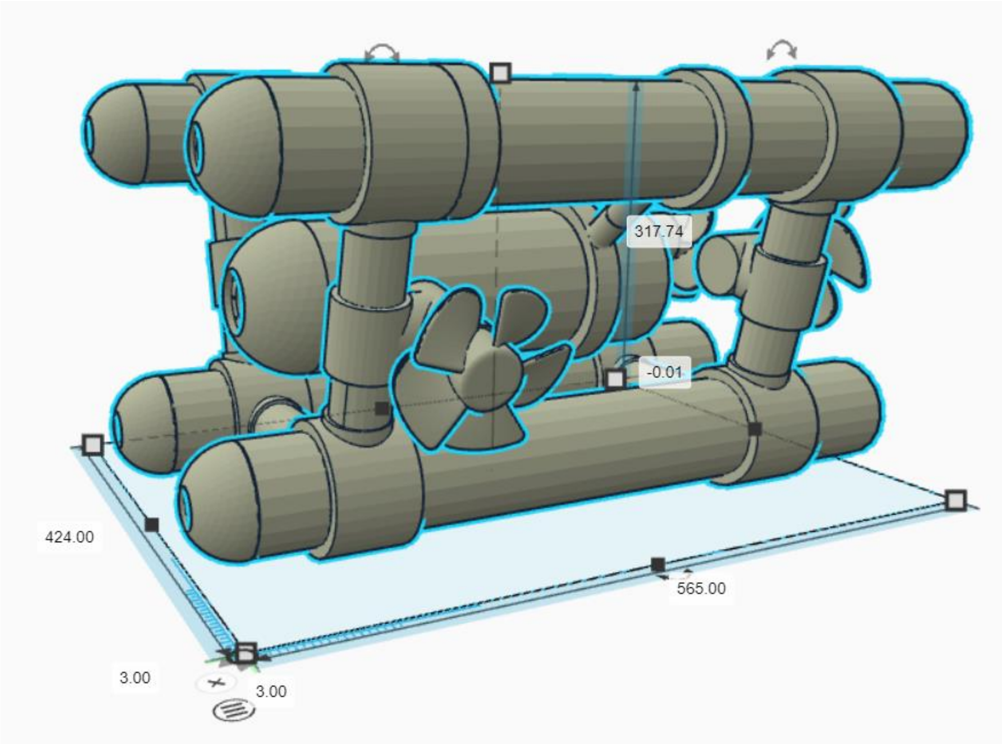
3. **Mechanical resistance:** The material must be resistant to water pressure and have good resistance to maintain structural integrity under water pressure.

4. **Compatibility with other materials:** The insulation material must be well compatible with other materials used in the construction of the SEAORB structure and have a good interaction with them.

A material often used for insulation in underwater applications is rigid polyurethane, which has a high water resistance, good thermal resistance, and good insulating ability. Combining rigid polyurethane with other suitable materials, such as fiberglass or plastic material, can provide a good solution for insulating the SEAORB structure.

However, the choice of insulation material is specific to the SEAORB project and should be based on application needs, aquatic environment conditions and budget constraints.

Dimensions of SEAORB:



6.4. The materials used, why they were chosen compared to others.

Polypropylene (PP) is a thermoplastic polymer widely used in the plastics industry. It has a simple molecular structure and is stable to most chemical products and high temperatures. PP has good corrosion resistance and mechanical strength characteristics, making it a preferred choice for various industrial and commercial applications.

Polylactic Acid (PLA) is a bio based polymer and is made from lactic acid that is produced from plant-based materials such as corn and sugar cane. PLA is an eco-sustainable and biodegradable material, which is also stable in contact with foods. Due to its organic origin, PLA is a preferred choice for other applications such as food packaging, biodegradable plastic films and other construction products used in unstable environmental conditions.

Both Polypropylene (PP) and Polylactic Acid (PLA) have their advantages in building a project, while each has specific applications. Here are some of the advantages of PP and PLA in construction:

Advantages of PP:

1. Chemical resistance: PP is resistant to most chemicals, making it a good choice for industrial applications that come into contact with chemicals.

2. Mechanical resistance: PP has good resistance to tension and deformation, making it suitable for applications that require a durable and strong material.

3. Corrosion resistance: PP is resistant to corrosion, making it a good choice for applications in wet or water environments.

4. Food compatibility: PP is suitable for food packaging applications and others related to the food industry, as it is safe for food contact and has good resistance to holes and microorganisms.

Advantages of PLA:

1. **Ecological:** PLA is a bio-based and biodegradable material, which is suitable for environmentally sustainable applications and building zero waste products.

2. **Suitability for 3D printing:** PLA has good compatibility for 3D printing and can be used to create custom parts in construction projects.

3. **Food compatibility:** PLA is safe for contact with food, making it suitable for food packaging and takeout applications.

4. **Aesthetic coating:** PLA offers a wide range of colors and visual effects, making it a preferred choice for projects that require a distinctive look or artistic designs.

For each construction project, it is important to consider the specific requirements and factors related to performance, sustainability, ecology and cost-effectiveness.

Advantages of PP and PLA compared to aluminum:

1. **Light weight**: PP and PLA are lighter weight materials compared to aluminum. This makes them more suitable for applications where the weight of the structure is important, such as in the automotive industry or shipbuilding.

2. **Lower cost**: PP and PLA are usually cheaper than aluminum, offering a more economical solution for projects with budget constraints.

3. **3D Printing**: PLA is a suitable material for 3D printing, making it useful for creating customized and complex parts in construction projects. This can reduce costs and production time in some cases.

6.5. Instrumental measurement of mechanical quantities compared to theoretical designed ones. Analysis and evaluation of errors from theoretical modeling and practical implementation.

The measurement of mechanical quantities in the marine context includes calculations for water supply from pumps and propeller characteristics.

For the pump:

Data available:

- Time needed to fill a room with water: 40 seconds

- Chamber volume: 500 milliliters

To calculate how many milliliters of water the pump supplies in one second, the percentage formula can be used:

Volume of water per second = Volume of the chamber / Time required to fill the chamber

Volume of water per second = 500 ml / 40 seconds = 12.5ml/s

For the slope part inside the rooms, this is designed to make their download easier. Accordingly, the materials and design of the slope and pediment ensure a free path for water to exit the room with as little resistance and obstruction as possible.

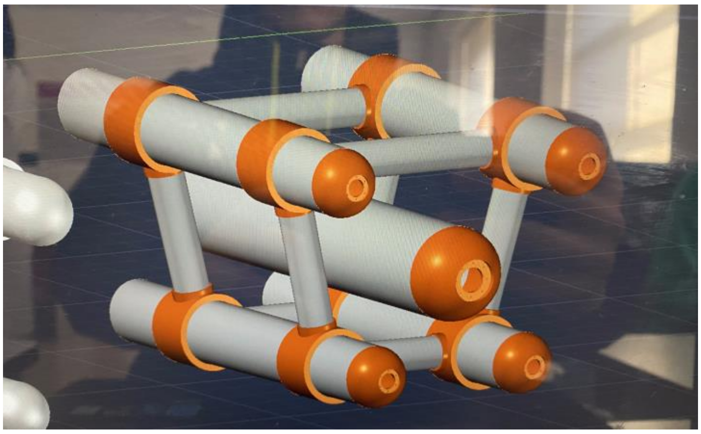
For propellers:

The propellers used are taken as a model of the propellers used for watercraft which also perform towing and displacement of various marine machines by having a small number of revolutions of the propeller, using as little energy as possible and without creating turbulence in the structure, increased life expectancy. 5-blade propellers are used and have an angle of 30 degrees. These propellers are used to create a greater displacement of the amount of water at low speeds. The submarine has about 500 revolutions per minute.

For the part of the propeller installation, on one side of the submarine, propellers with clockwise rotation are placed, while on the other side, propellers with counterclockwise rotation are placed. This placement is done to minimize the rotational forces in the water that are generated by the propellers and to reduce the vibrations of the structure.

These characteristics of the propellers and their placement help to optimize the submarine's performance, ensuring that water displacement is as efficient as possible and with as little vibration as possible.

6.6. Foto/ video reale gjatë punës.



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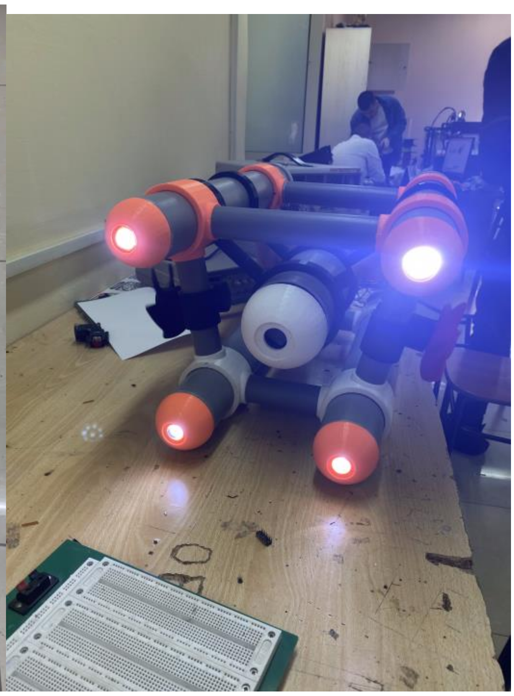

7. **List of materials, cost and time spent in tabular form.**

   7.1. List of materials used with reference prices and stores.

Element	Code	Quantity	Price (Albanian Lek)
Tub PP D45	-	2	240
Tub PP D75	-	4	1000
Tub PP D110	-	1	275
Pipe Cork	-	5	215
DC Motor	-	4	2000
Motor Driver	L298N	2	800
Arduino Nano	-	1	1000
Camera	-	1	800
Voltage Regulator	L7812cv	4	400
Voltage Regulator	L7809cv	3	300
Transistor	BC546B	4	400
Diodes	-	10	100
LED Diodes	-	10	100
LED Lamps	-	4	800
Relay	HK3FF-DC5V-	4	200

	SHG		
Pumpa	-	4	1200
Connector	-	2	200
Silicon	BISON 6306986	2	1200
Adhesive	S665	2	1000
Conductors (Cables)	-	10m	1000
USB-RJ45 Adapter	-	2	1200
USB HUB	-	1	600
Ethernet Cable	U/UTP	10m	1000
-	-	-	16030

Shops:

Physical:

MEGATEK:https://www.google.com/maps/place/Megatek/@41.3684082,19.7066001,15z/data=!4m6!3m5!1s0x13502e866dc0b0af:0xe4f1e550fd725efa!8m2!3d41.3684082!4d19.7066001!16s%2Fg%2F1tf04ys6?entry=ttu

ATILAELECTRONICS:https://www.google.com/maps/place/Atila+Electronics/@41.3240132,19.8041104,17z/data=!3m1!4b1!4m6!3m5!1s0x135031aa099612f5:0x86fbdcb2296cb85!8m2!3d41.3240092!4d19.8066907!16s%2Fg%2F11fzz6ztyp?entry=ttu

ONLINE:

Amazon:https://www.amazon.com/

7.2. Cost.

Extra Cost	Cost (Albanian Lek)
Transport + Costums	10320

Cost covered by the school	Cost (Albanian Lek)
Filament 3x 1kg	12000
3D Printing 120 Hours	24000
-	36000

Total Cost	Cost (Albanian Lek)
Elements	16030
Extra Cost	10320
Cost covered by the school	36000

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-	62350

7.3. Time spent on the project:

The time spent on this project is around 5 muaj (Janar 2023 - Maj 2023)

8. Results:

8.1. Present the results of your work in tabular form:

Expectations	Realization
The construction of a stable structure which enables the necessary space for keeping the elements and creating the necessary balance for a stabilized navigation.	Realization of the unique sustainable structure which creates the possibility of physical and thermal balancing, separating the different structures in specific rooms and creating space for communication between them.
Creating an electronic control system for modules and motors using a microcontroller.	Construction of a controllable electronic control system, which guarantees the safety of the elements from electrical and thermal hazards.
Building a computer interface that enables communication between SEAORB and the outside world.	Creation of a web interface, which connects to the submarine and enables its control through the keyboard panel and the possibility to access the submarine's camera.
Isolation and testing in a controlled environment to test the various functionalities and see how the submarine reacts during various tests	Isolation is the biggest problem of the submarine as the tools available to us are not enough. Testing of various modules and motors performed in a controlled dry environment.

9. Discussions and conclusions

In conclusion, SEAORB has shown tremendous potential for innovation and exploration in the field of electronic circuit design, construction of sustainable underwater structures and interactive interfaces. What distinguishes this project from similar attempts is the focus on ease of use, easy construction approach and perfect integration of different design phases. The unique balanced structure brings many advantages in using the device. The software we have built not only provides strong control capabilities, but also provides continuous real-time project monitoring capabilities.

There are several areas where we can further improve this project. First, expanding the component universe to include a wider range of devices and modules would provide users with more options and flexibility in their measurements and monitoring. Furthermore, the structure has the potential to become more compact and smaller, providing mobility even in tight spaces such as underwater caves. The control program can be extended to provide other monitoring services such as GPS location, graphic monitoring of internal as well as external systems.

In an optimistic light, this project is just the beginning of an amazing journey in naval engineering and submarine design of the future. With each improvement and refinement, we are getting closer and closer to a future where the design of electronic circuits becomes more intuitive and efficient. By cultivating a collaborative and innovative mindset, we can pave the way for revolutionary progress in research in Albania, shaping a world where technology and creativity come together to push the boundaries of what is possible.

Together, let's embrace the endless possibilities and continue to innovate, explore and inspire the next generation of research project designers in every walk of life. Let's make the world a better place to live in by learning more about it.

10. Sources used in this project.

Source 1 : Use of submarines for exploration

https://encounteredu.com/cpd/subject-updates/learn-more-how-are-submarines-used-for-deep-ocean-exploration

Source 2 : Finding norms and standards

https://www.iso.org/home.html

Source 3 : The technology used

https://www.rcshipyard.com/tech/

Source 4 : Model Reference

https://www.youtube.com/watch?v=YDM7Ezb_vN0

Links to specific segments during documentation:

[1] - The research submarine which has reached the deepest point of the ocean for the purpose of its study. https://en.wikipedia.org/wiki/Trieste_(bathyscaphe)

[2] - The deepest point in the ocean discovered so far (2023). https://en.wikipedia.org/wiki/Challenger_Deep

[3] - Online single-article journal from 2022 with the latest sea creature discoveries. https://mashable.com/article/deep-sea-ocean-discoveries-2022

[4] - DIYPerks YouTube channel.https://www.youtube.com/@DIYPerks

[5] - Submarine created by DIYPerks. https://www.youtube.com/watch?v=pUba126uzvU

[6] - Explanation of the Ballast system and how ships use it. https://www.marineinsight.com/guidelines/a-detailed-explanation-on-how-to-operate-a-ships-ballast-system/

[7] - PeterSripol's youtube channel. https://www.youtube.com/@PeterSripol

[8] - The submarine created by PeterSripol. https://www.youtube.com/watch?v=YDM7Ezb_vN0

[9] - Magnet fishing, a hobby where the fisherman uses a magnet to pull metal objects from the bottom of a body of water. https://en.wikipedia.org/wiki/Magnet_fishing

[10] - Power over Ethernet, method of passing power through an Ethernet cable. https://en.wikipedia.org/wiki/Power_over_Ethernet

[11] - Perfboard, a tool used in the construction of electronic circuits. https://en.wikipedia.org/wiki/Perfboard

11. Acknowledgments:

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https://al.linkedin.com/in/jurgen-metalla-1960b062

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https://al.linkedin.com/in/arban-uka-ba3335196

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https://al.linkedin.com/in/ilir-capuni-20108a83

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https://al.linkedin.com/in/klarens-hoxha-807366149

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https://al.linkedin.com/in/eni-%C3%A7oku

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https://al.linkedin.com/in/arbra-pasha-a3b3251a8

We thank Professor Andi Gjeta (Harry Fultz Institute) for the contribution of knowledge during the school year in the subject of Professional Practice applied to the project.

https://al.linkedin.com/in/andi-gjeta-26b212140

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https://al.linkedin.com/in/devis-merdini-88694b90

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https://www.linkedin.com/in/eugenhoxha

Last, but not least, we want to thank our parents and all our friends who have given us the courage to get up again after every fall. We feel lucky to have been surrounded and surrounded by a group of Engineers, Professors, both professional and educational.

12. Self evaluation.

Rate your paper from 1 (poor/poor) to 10 (very good)		
How much do you rate your work on this project?	Dobët / Mirë / Sh.mirë	Grading: 10
What evaluation criteria did you use?		
Building the project structure. Construction of electrical circuit and noise protection. Construction of a computer interface for submarine control. Testing the project and its functionalities.		