Project report

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"Seamoth"

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Summary

Introduction

As we embark on our first-year project in robotic engineering, the uncharted depths of the world's oceans beckon with mysteries yet to be unraveled. The underwater realm remains one of the last frontiers on our planet, largely undiscovered and enigmatic. Despite remarkable advancements in science and technology, the deep ocean's vastness and inaccessibility have limited our understanding of its hidden wonders.

In this context, Autonomous Underwater Vehicles (AUVs) emerge as indispensable instruments of exploration and discovery. Equipped with advanced sensors and cutting-edge technology, these autonomous vessels revolutionize our approach to the enigmatic depths. They are not mere tools; they are pioneers venturing into the unknown to unlock new places and phenomena concealed beneath the waves.

The mysteries that lie beneath the ocean's surface have captivated the imaginations of scientists and explorers for centuries. Now, with AUVs at our disposal, we are poised to unveil the secrets hidden beneath the watery expanse.

The subsequent sections of this work will delve into various categories of literature that underpin the development of our first-year project in robotic engineering. Each category represents a facet of knowledge that will guide the successful realization of our project and contribute to our ongoing quest to explore and understand the mysteries of the deep ocean.

Chapter I: State of the art

I.1. Project definition

I.1.a. Existing models

The first autonomous underwater vehicle (AUV) was developed in 1957 and was named the "Self-Propelled Underwater Research Vehicle", or SPURV, it was used to study diffusion, acoustic transmission, and submarine wakes. Since then, many AUV have seen the day.

A notable model of AUV is the SEMA MK-II which is an autonomous training target used by the military.

Another great example is the AUV developed by a Chinese university which was made to explore underside of arctic ice.

I.1.b. Project's extends, measures

Our project's goal is to make measures of the current sea state and cartography the underwater floor.

For now, we will only measure the water's temperature and pH to have info on the carbon dioxide rate and pollution.

In the future, we will consider making the unit able to make wildlife census.

I.2. The Seamoth

The robot must be able to move underwater, meaning it must be able to move in a straight line, to turn and to go up or down underwater.

It must be stable enough to be able to maneuver underwater on its own, it must be able to always return to the surface in case of a water leak.

When evolving in an area with seaweed or rocks, it would be better if it didn’t hurt himself on the obstacles. That’s why it would be great if it could avoid obstacles.

Furthermore, for the submarine to function properly we must protect the electronics and the motors.

Eventually, to accomplish its task the robot must be able to collect data of its surroundings.

I.2.a. Seamoth's motorization

The unit must be able to maneuver underwater, for this reason it must have a motorization that allows it to move freely in a 3-dimensional space. We will have propulsion based on the system of existing units because we thought that it will be hard to maintain stability otherwise. So, it will need a thrust propulsion. We studied two types of motor that we summarize in the following table.

Motor type	Pros	Cons	Cost estimation
Brushless DC motor	High speed range No voltage drops. Stable speed	electric control driver necessary	~20€ motor ~20€ ESC
Reversible DC motor	Easy to use	Low speed range High rotor inertia Brush change needed after a long use	€5

based on the submarine drone Qysea Fifish, we think that the use of 6 motors will help to easily control the Seamoth's movements.

We will need a lot of control over our motors to ensure the direction of the Seamoth, mainly to make sure the robot does not rotate on itself. Our choice went for the brushless DC motor because it can rotate faster and allow a more precise control over the motor.

With this one, we need a driver, and it's the ESC that allows us to regulate the current that comes from the battery. We also found how to reverse the motor only with an arduino.

We also need to make sure that the motors are properly protected against water to do that we will buy the motors already made waterproof as it will save us a lot of time and a lot of materials for 3d printing.

I.2.b. Seamoth's sensors

To explore its environment, the seamoth will be equipped with many sensors.

The main ones will be used to avoid obstacles, to do that sonars will be of great help. We thought about using a LIDAR however it was too expensive for the project and can't see trough water most of the time. Furthermore, to cartography the sea floor, the seamoth will be equipped with a stereo camera and a standard waterproof camera which will be used to film the diver during his diving sessions.

Eventually we need the robot to take measurement, to do that the robot will be equipped with a BME280 which is a sensor able make measurements for pression and temperature. We will also use a BNC electrode to read the pH of the water.

I.2.c. Seamoth energy

Speaking of energy, we will use a battery to supply our motor. We studied different batteries as it follows.

Battery type	Pros	Cons	Cost estimation
Lipo battery	Flat Highest energy density	Needs a management system (ESC)	~€50
Li-on battery	High energy density	Needs a management system (ESC) Needs a lot of space	~€60
Nickel-cadmium battery	High current	Low energy density (9V max) Toxic product	
Nickel-Metal battery	High current Decent density	Toxic product High discharge rate	

For that, we estimate the need of current from the battery at 6.5Amps and the voltage around 11V. In this case, because of the need for space on the boat, we thought about a Lipo battery 3S. The 3S means three Lipo cells in series with each cell having a voltage of 3.7V.

The advantage is that the management of the battery can be done by an ESC that we also need to regulate the motors. The last two batteries couldn't satisfy us either by the maximum output of voltage or by the rapidity of discharge.

I.2.d. Seamoth equilibrium

To maintain equilibrium underwater, the Seamoth will need a way to stabilize itself. Firstly, a way for it to know its orientation is needed, we will use a little inertial center. Then the seamoth needs to correct its position, we will need to configure motors to be able to respond to rotation changes.

Number of motors	Pros	Cons
2		Movement control: -
3		
4	Movement control: +	Costly: +
5	Movement control: ++	Costly: ++
7	Movement control: +++	Costly: +++
8	Movement control: ++++	Costly: ++++

I.2.e. Protecting the circuits from water

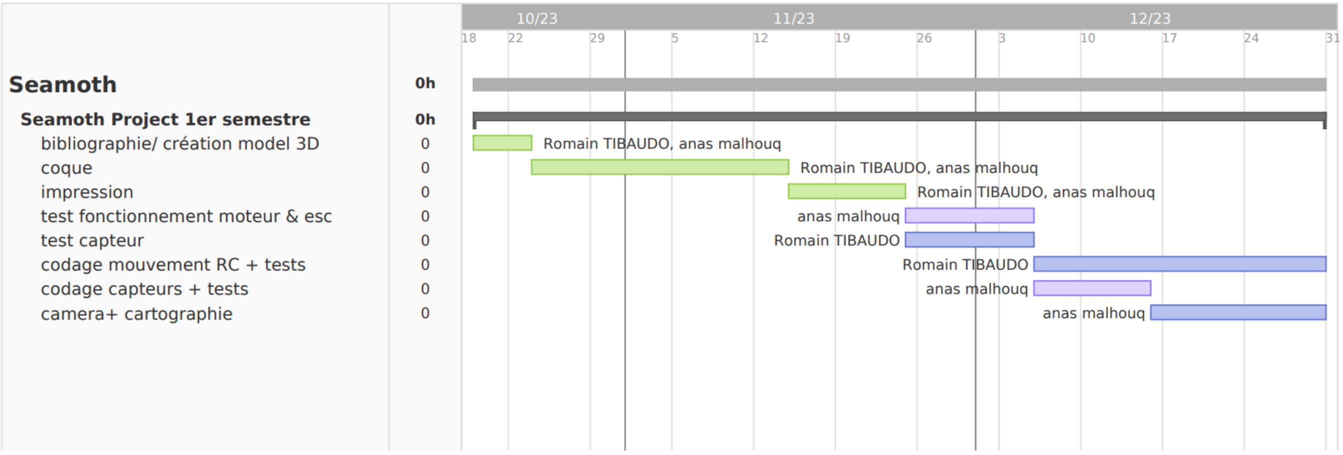
To protect the circuits, we will not make a waterproof hull as making a waterproof hull by 3d printing is hard, and a leak could force us to change the circuits altogether. Furthermore, making a hull like that will use much 3d printing materials, making the process expensive.

Instead, we chose to buy a waterproof box which is inexpensive in comparison, it will allow us to protect the circuits with much more ease while letting us make the robot the shape we want by building around it.

Chapter II. Organization

To make this project come to an end, we must organize ourselves properly.

This is why we have realized a Gantt chart as follows.



[Gantt Chart on Excel]

We also have a [Github repository].

Conclusion

In conclusion, the compilation of this bibliography has provided a comprehensive overview of the existing body of knowledge and research related to submarine robots, specifically Autonomous Underwater Vehicles (AUVs). The diverse range of sources, highlights the significance and relevance of this field. The wealth of information available underscores the extensive research conducted to advance the capabilities and applications of AUVs. As an engineering student embarking on a project involving submarine robots, this bibliography serves as the cornerstone for our work. The resources referenced here provide valuable insights into the design, technology, control systems, applications, and challenges associated with AUVs. These sources will guide us in understanding the state of the art, identifying potential areas for innovation, and developing a strong foundation for our project. Moving forward, we will use this bibliography as a reference point to delve deeper into specific aspects of AUVs and to ensure that our project is well-informed and innovative. By leveraging the knowledge gathered from these sources, we aim to contribute to the advancement of AUV technology, enabling its continued impact in fields such as oceanography, environmental monitoring, marine exploration, and more. Our journey in engineering and research is just beginning, and this bibliography marks the commencement of our exploration into the world of underwater robotics. With these resources as our guide, we are well-equipped to navigate the depths of this exciting field and ultimately make valuable contributions to the future of autonomous underwater vehicles.

Bibliography

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Reversing BLDC motor standard rotation.

Le robot inspiré des méduses se déplace comme le nageur le plus efficace de la nature

jellyfish propulsion

How do jellyfish swim? | Earth | EarthSky forces

applied by swimming jellyfish Drag coefficient -

Wikipedia profiles aerodynamics / hydrodynamics

profiles NACA

Intergovernmental Panel on Climate Change - Wikipedia

AR6 Synthesis Report: Climate Change 2022 — IPCC

Carbon dioxide - Wikipedia Arduino

based hovercraft aircraft propellers

and how they work

Annex A. Needed materials

- Fisher wire
- Turbidity sensor
- Small battery for the recon unit
- Batterie Lipo 3s 6500mAh 80C 11.1V
- ESC 30A Lynxmotion Multirotor BEC 1A (Avec Connecteurs) - RobotShop
- Kyrio A2212 Brushless Motor 2200KV Outrunner Brushless Motor
- Waterproof servomotor
- induction Qi coil
- AZDelivery ESP8266X ESP-01S WLAN Module WiFi Compatible avec Arduino et Raspberry Pi