turBOT - Mini Autonomous Underwater Vehicle

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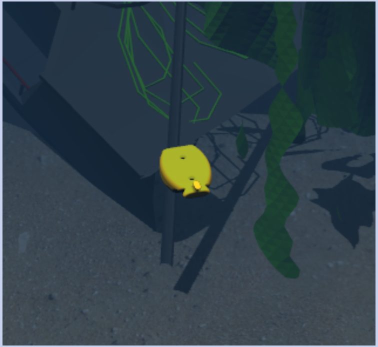
Introduction

The main objective of this research is to propose an AUV model with small dimensions, capable of carrying missions on sea coastal and shallow waters with 50 meters deep. For this project, is expected:

1. A navigation system able to navigate in indoor and outdoor environments
2. Identify and avoid objects
3. Perform all activities with minimal intervention



Main requirements

Customer

- Indoor/outdoor navigation
- Obstacle avoidance
- Autonomous navigation
- Small dimensions
- Energetic efficiency
- Lighting system

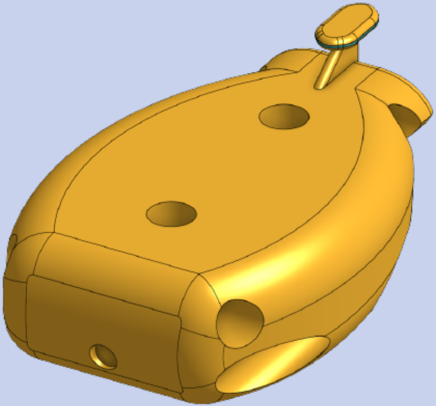
System

- 5 DOF and 6 Thrusters composition
- Perceive dynamic environments
- Max 0,8 x 0,5 x 0,5 m dimentions
- Max 20 kg weight
- 2 h of battery autonomy
- Positive buoyancy

Working environments

turBOT is capable to navigate in indoor or outdoor environments but is being developed for coastal sea 50 m deep.

Vehicle's design



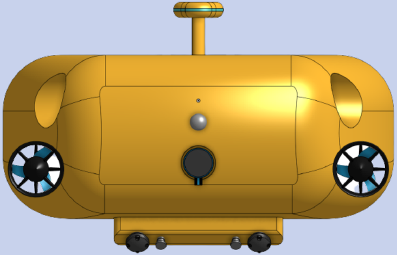
The first vehicle's design was made using OnShape software,based on real-life Turbot Fish.
After CFD analysis, an optimized design a will be developed by the team.

Vehicle's dimensions

Sensors and peripherals

In order for the AUV to act autonomously, these sensors and general peripherals were chosen:

1. Low-light HD USB camera
2. Minteye standard stereo camera
3. Ping sonar altimeter and echosounder
4. Red laser diode module
5. MPU6050 IMU
6. Venus638FIpx GPS
7. Lumen Subsea Light



Resultant force between weight x buoyancy

Values such as weight, volume and center of mass are reported by OnShape. The resulting force between the weight and the buoyancy found through this formula:

$$F_r = a_g(\rho_f V_s - m_v) \tag{1}$$

- a_g = Gravity acceleration
- ρ_f = Fluid density
- V_s = Submerged volume
- m_v = Vehicle's mass

turBOT data calc:

$F_r = a_g(\rho_f V_s - m_v)$
$F_r = 9.8\frac{m}{s^2}(1028\frac{kg}{m^3} * 0.016m^3 - 16.7kg)$
$F_r = -2.47N$

It is ideal if the buoyancy is slightly positive so that the vehicle floats and at the same time can dive without much effort from the thrusters.

Drag force

In order to minimize thruster effort, it is important to develop a structure that results in a minimal drag force. This force can be calculated through this formula:

$$D = -\frac{1}{2} C_d \rho_f A v^2 \tag{2}$$

- C_d = Drag coefficient
- ρ_f = Fluid density
- A = Transversal area or cross sectional area
- v = Relative velocity

turBOT data calc:

$D = -\frac{1}{2} C_d \rho_f A v^2$

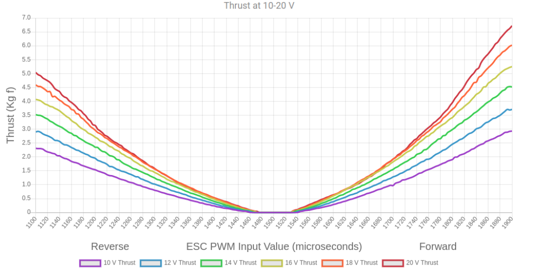
$D = -\frac{1}{2} * 0,42 * 1028 \frac{kg}{m^3} * 0,088 m^2 * 1 \frac{m}{s}$

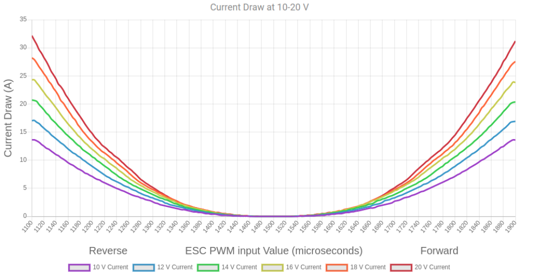
$D = -22.63 N$

Battery autonomy

For the calculation of the battery autonomy, it was considered that the vehicle:

- Stays stable at the same depth
- Moves forward at a speed of 1.0 m/s
- Moves laterally at a speed of 0.5 m/s

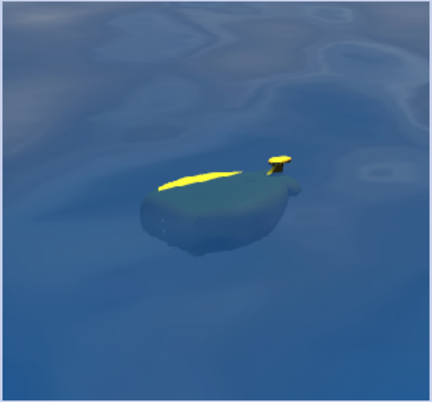




The current that each thruster will require for them to exert the necessary force was obtained. A battery life of X hours could be estimated.

Simulation conditions

Simulation is being made with parameters that simulate the real world constructed on Gazebo with UUV Simulator.



- Fluid density $= 1028\ Kg/m^3$
- Fluid speed $= 0$
- Depth $= 60$ m

Questions?

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