Vertical Control of Biologically-Inspired Underwater Robot

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Introduction

- Underwater lateral robotic manipulation is used for multidimensional maneuverability for underwater vehicles [1].
- Ballasts displace water between the surrounding water and a containment chamber inside the robot to allowing vertical maneuverability [2].
- The goal for this underwater robot is to clear plant life from a canal.

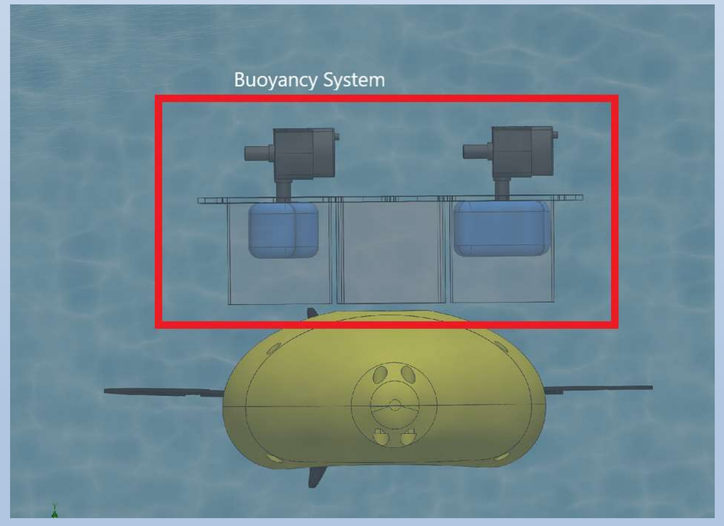

Figure 1: Ballast prototype

Model

- Submerged object's buoyancy depends on the relative mass of the object, m_s, density of the water, ρ_w, and the volume of water that is displaced, V_{shell} (2). F_G is the force of gravity of the object and F_B is the buoyancy force.
- When relative weight (RW) of the object is equal to the buoyant force (1), the object is neutrally buoyant.
- Position control of the object by changing the volume of water in the system (4), which describes the sum of forces.
- Equation (6) describes the relationship between pressure and volume.

(1) $F_G = F_B$

(2) $mg = \rho g V(t)$

(3) RW $+\rho_w V_w = \rho_w V_{shell}$

(4) ma = RW $+\rho_w V_w - \rho_w V_{shell}$

(5) $h = \iint \frac{m_s + \rho_w V_w - \rho_w V_{shell}}{m_{sys}} dh$ (6) P V_{shell} =nRT

Design Process

- The first prototype has a fixed volume with variable amount of water input using a one-way pump (Figure 1).
- Flexible air bladders are contained in 3D-printed rigid boxes. Water is pumped into the flexible air bladder to compress the air in the rigid structure.

Data Collection

- Height will be measured with visual recognition software and is plotted against time
- Pressure has an effect of the performance of underwater robotic components

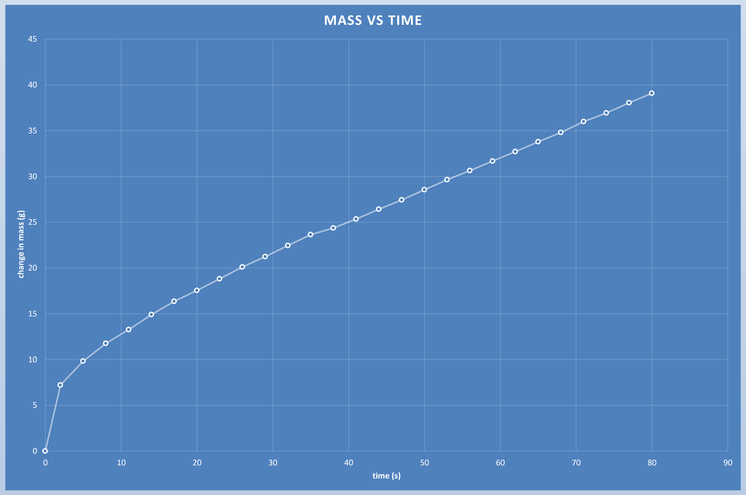

Figure 2: Experimental limit of flowrate given pressure variation

References

[1] Børseth, S. (2018). *Low Energy Buoyancy Actuator for Vertical Underwater Motion*. [online] Brage.bibsys.no. Available at: https://brage.bibsys.no/xmlui/handle/11250/2461343 [Accessed 26 Oct. 2018].
[2] Woods, S., Bauer, R. and Seto, M. (2012). Automated Ballast Tank Control System for Autonomous Underwater Vehicles. *IEEE Journal of Oceanic Engineering*, 37(4), pp.727-739.

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