Martech 2023.
Marine Technology Workshop
19,20th June. Castellón de la Plana, València, Spain

Underwater Autonomous Event-Driven Profiler and Data Retrieval System

J. Pereira[1], J. Galante[1], J. Neiva[1], M. Ribeiro[1], R. Mendes[12]

[1] *Laboratório de Sistemas e Tecnologia Subaquática da Faculdade de Engenharia da Universidade do Porto, R. Dr. Roberto Frias, 4200-465 Porto Portugal, +351220413200, jlp, galante, jneiva, maribeiro @lsts.pt)*
[2] *+ATLANTIC CoLab, Rua do Conhecimento 4 2520-614 Peniche Portugal, renato.mendes@colabatlantic.com)*

***Abstract* – Understanding Ocean variability, particularly in the productive upper water column, requires understanding ocean processes. Numerous physical and bio-geochemical processes in the water column must be studied at different spatial and temporal scales that still need to be fully understood. Current fixed-point observatory structures are one of the principal methods to collect data from the Oceans due to their endurance and capability to observe oceanic phenomena at a high rate. In this work, we present a new conceptual approach and design for an oceanic profiler which intends to overcome the most common logistical hurdle when deploying those kinds of platforms at sea.**

***Keywords* –** *Ocean; Observatory; Autonomous; Profiler.*

I. INTRODUCTION

Current fixed-point observatory structures are one of the principal methods to collect ocean data due to their endurance and capability to observe phenomena. That potential capability is especially true for oceanic phenomena that suffer rapid modifications in time and must be monitored at high-rate frequency. Complementary means such as Biogeochemical-Argo (BGC-Argo) floats, profilers like the Wirewalker, and robots such as Gliders and AUVs are now one of the main tools in the observational capacity of the ocean on a global scale [1]. State-of-the-art Autonomous vehicles can play a crucial role in data collection for newly envisioned concepts of underwater observatories by adding portability, economic sustainability and the capability to operate as a node in a network [2]. The prime objective of this work was to create a new concept of autonomous profiler to overcome the logistical hurdle of deploying equipment to sample the water column.

II. APPROACH AND IMPLEMENTATION

The system in development had to be simple and lightweight enough to be deployable and recoverable by a single person. The water column sampling characteristics required the system to be somehow “stationary” concerning the X and Y axis (considering cartesian coordinates) but moving along the Z axis. The system had to endure between one and four days comprising a minimum set of sensors mandatory for oceanographic studies, such as Conductivity, Temperature and Depth. The system development targeted sampling the top 200-meter depth water column, which corresponds roughly to the limit of the continental shelves. To fit within the project budget, it had to be designed to be low-cost (less than 10k€ without payload) without compromising the data collection quality. Finally, it needed to be compatible with the LSTS toolchain [3] to enable direct interaction with other systems qualifying to be part of a heterogeneous network and discard the need to develop more software to be commanded and controlled.

To be able to vertically profile the water column, the system (APDR) needs to either have buoyancy variation or have vertical thrusters to navigate along the Z axis. Taking advantage of developed technology for the LAUV in terms of drag efficiency and the existing propulsion system, it was decided to use the same tail as in the LAUVs which has proved to be robust and proficient in controlling cylindrical format underwater vehicles. This choice conditioned thus the system shape, payload capacity and components selection and placement inside the system. Since it had a similar shape and shared the same hotel and payload as in the LAUV, the battery design had as a reference the LAUV used in the River Plume Front experiments [4]. That specific configuration figures a power consumption of less than 90Wh and is equipped with batteries totalling 2.5kWh capable of operating (at 1m/s) for roughly 24 hours. To keep a slightly buoyant cylinder vertical in the water, most of the mass had to be distributed at the bottom of the cylinder. The top of the system was populated with the computational system and the payload. The APDR can rely on a GPS device installed to provide global position at the surface. The interaction with the APDR can be done either wirelessly or acoustically.

A customized Globalstar satellite SPOT device is used to ascertain the current position of the vehicle at the surface, aiding in the recovery of the system. A standalone acoustic pinger marker will help locate the system if trapped underwater.

III. RESULTS

Figure 1 displays the subsystems inline before and from assembly perspective. As can be realized, there is a huge space between the batteries and the computational subsystem purposely designed to keep the APDR in a vertical position.

The APDR propulsion operation principles allow for three different types of operation: It can lock a position and keep profiling the water column vertically at that very same position; it can be released at a location and perform vertical profiles without locking an X and Y coordinates (thus drifting); or it can work as a data carrier by downloading data from a moored underwater observatory and uploading it once at the surface.

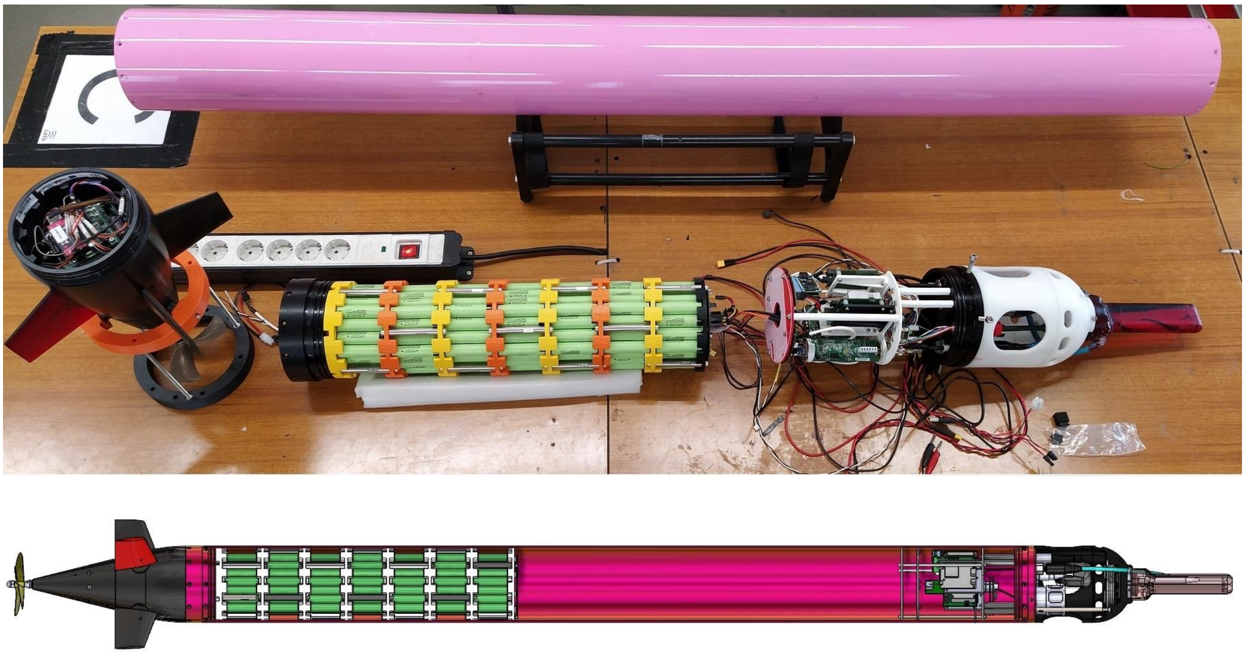

Figure 1 - Preassembled subsystems on the top and projected assembly on the bottom

IV. CONCLUSIONS

An Underwater Autonomous Event-Driven Profiler and Data Retrieval system was projected, considering the specific requirements of fast and easy profiling of the underwater column. The prototype is assembled and currently in technology readiness level 4. Water trials will ultimately validate the platform reliability when profiling the water column up to 200m and assess its usefulness in real conditions.

REFERENCES

[1] Chai, F., Johnson, K. S., Claustre, H., Xing, X., Wang, Y., Boss, E., ... & Sutton, “This Chai, Fei, et al. "Monitoring ocean biogeochemistry with autonomous platforms”, *Nature Reviews Earth & Environment 1.6*, 2020.

[2] Carapuço, Mafalda Marques, et al), “Portuguese European Multidisciplinary Seafloor and Water Column Observatory Initiative”, *Frontiers in Marine Science*, 2022

[3] Pinto, José, Paulo Sousa Dias, and Joao Borges de Sousa, “Coordinated Operation of Multiple AUVs using the LSTS Toolchain”, *2018 IEEE/OES Autonomous Underwater Vehicle Workshop (AUV)*, 2018

[4] Mendes, R., Da Silva, J. C. B., Magalhaes, J. M., St-Denis, B., Bourgault, D., Pinto, J., & Dias, J. M, "On the generation of internal waves by river plumes in subcritical initial conditions", *Scientific Reports 11.1*, 2021