Design of a Aerial-Deployed Fin-Powered Underwater Module for Quagga Mussel Monitoring

Laboratory of Sustainability Robotics (LSR) — Dr. Luca Romanello

Description

Invasive mussel species such as quagga and zebra mussels pose significant ecological and infrastructural challenges in freshwater systems. Monitoring their spread, density, and impact remains difficult due to limited accessibility, visibility, and spatial variability.

This project explores the design of a **biomimetic fin-powered underwater sensing module** inspired by flapping hydrofoils and energy-efficient aquatic locomotion. The system is intended to operate as part of a coupled aerial–aquatic platform, where a drone handles deployment while the submerged unit exploits hydrodynamic interaction with currents for low-energy positioning and observation.

The work targets both robotic system development and environmental monitoring applications.

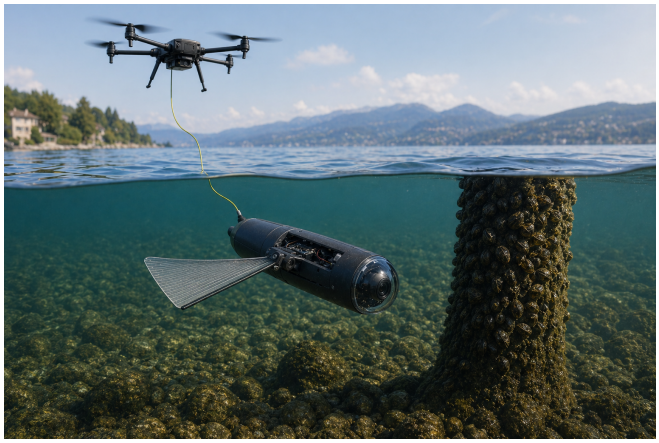

Figure 1: Placeholder: biomimetic fin-powered underwater module integrated in a coupled aerial–aquatic system.

Work packages

WP1 Literature review: Review hydrofoils, biomimetic propulsion, underwater sensing systems, and existing approaches for underwater monitoring (vision and eDNA).

WP2 Design and development: Design and prototype the underwater module, including biomimetic fin, mechanical structure (CAD), and integration of electronics and actuation.

WP3 Optimization and analysis: Analyze hydrodynamic performance through simulations and/or experiments (e.g., water tunnel), evaluating efficiency, thrust, and stability.

WP4 Camera integration: Integrate an underwater vision system for mussel detection and counting, and collect data for initial dataset development.

WP5 Field testing and validation: Conduct experiments in real environments, with optional integration of eDNA sampling for complementary species detection.

About us

The Laboratory of Sustainability Robotics (LSR) at EPFL and EMPA.

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Requirements

- Background in robotics, mechanical engineering, or related fields.
- Experience in CAD, hydrodynamics, or control systems is beneficial.
- Interest in bioinspired robotics and environmental applications.

Application

- CV and motivational letter.
- Transcript of records.
- Portfolio or project examples (if available).

Timeframe

Start date flexible.