Biohybrid Robotic Mussel-Nest for Ecological Control and Co-Regulation of Invasive Species

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

Description

Invasive quagga mussels are rapidly colonizing Swiss lakes, damaging hydropower infrastructure, clogging underwater sensors, and threatening long-term ecological monitoring systems. This project proposes the development of a novel **biohybrid robotic platform** capable of monitoring and *modulating* mussel attachment through real-time sensing and actuation. Instead of using destructive removal methods, the system aims to **co-regulate** mussel colonization as a controllable ecological interaction.

The work integrates underwater sensing, soft robotic actuation, ecological modeling, and closed-loop control. The robotic platform will be designed for deployment on **LéXPLORE**, EPFL's large-scale floating observatory on Lake Leman—one of the most mussel-impacted scientific infrastructures in Switzerland.

The project contributes to emerging research in sustainable and ecological robotics and is intended for publication at top conferences and journals in biohybrid and environmental robotics.

Work packages

WP1 Research mussel settlement dynamics and identify key measurable signals (biofilm onset, impedance, microcurrents).

WP2 Design and prototype an underwater robotic substrate integrating waterproof sensors and actuation modules (vibration, microcurrents, electrostatic fields).

WP3 Develop closed-loop control strategies for real-time modulation of mussel colonization based on sensor feedback.

WP4 Conduct controlled tank experiments to evaluate behavioral responses and refine prototypes.

WP5 Deploy and validate the system in Lake Leman via the LéXPLORE platform, assessing long-term stability, ecological impact, and co-regulation effectiveness.

Figure 1: Quagga mussels colonizing underwater surfaces, obstructing sensors and infrastructures.

About us

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

- Background in robotics, mechanical engineering, environmental engineering, or related fields.
- Experience with mechanical design, embedded systems, materials, or underwater devices.
- Knowledge of sensors, actuation systems, or ecological data is beneficial.
- Interest in biohybrid robotics, ecological sensing, or environmental sustainability.

Application

- CV and motivational letter.
- Transcript of records.
- Portfolio or examples of previous projects.
- Short statement about your interests and relevant experience.

Timeframe

Start date flexible; earliest start possible immediately.