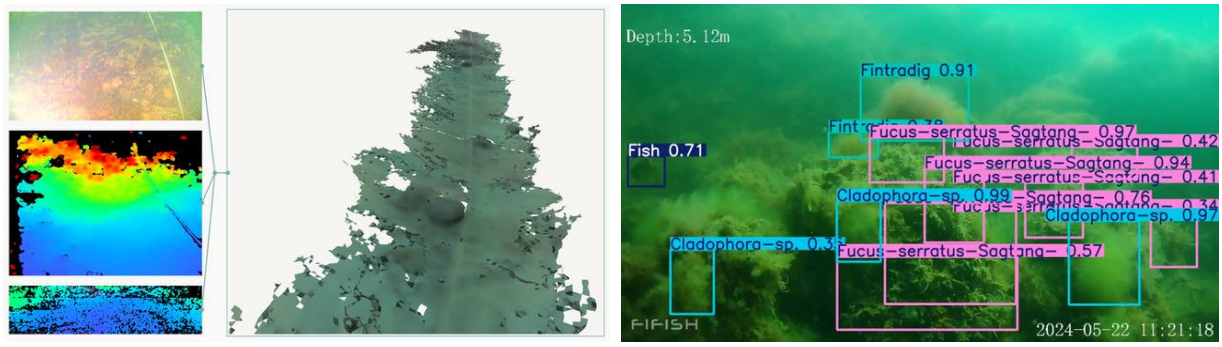
Automated ROV Transects for Benthic Algae Monitoring in the Baltic Sea



Hard-substrate algae such as *Fucus* and red algae are key indicators of the state of the Baltic Sea, and today they are monitored mostly by dive teams. The divers follow a transect line, typically 100 m long, and record species and **percentage cover per 1 m depth interval** on either side of it. The method is well established, but it needs several divers per site and is slow and costly, which limits how often each site can be revisited. Small, low-cost remotely operated vehicles (ROVs) could survey the same transects more often, but they are usually piloted by hand, so successive surveys do not follow the same path and are hard to compare. Repeat robotic surveys of benthic habitats have been demonstrated with large AUVs [1], low-cost ROVs have followed visual references autonomously in aquaculture [2], and deep learning has estimated benthic cover from Baltic underwater imagery with errors close to expert annotation [3], supported by growing collections of annotated seafloor images [4]. However, **autonomous and repeatable transects with a low-cost ROV, whose results can be compared directly with those of divers**, remain largely unexplored.

The goal of this project is to **make a small ROV perform a benthic transect autonomously and repeatably, and to turn the imagery it collects into cover and species estimates comparable with a dive team's results**. The student will start by developing **navigation and control for following a transect line while holding a constant altitude** above the seabed, using only the sensors available on a BlueROV2-class vehicle (camera, IMU, pressure sensor and, depending on the configuration, a DVL or sonar), together with a mission layer that defines a transect and re-runs it. The repeatability of the system will be **measured against motion-capture ground truth in the KTH Marinarium test tank** over repeated runs. In parallel, the student will build a pipeline that estimates algae cover and species from the vehicle's imagery and **compare it, interval by interval, with a dive team's results on a real Baltic transect** for which an ROV recording already exists. Depending on the student's interests, the project can lean towards the control or the data side, and can be extended with **a mosaic or 3D reconstruction of the transect** from camera and sonar data, an annotation tool through which divers label images to train learning-based models, or field trials of the autonomous survey around Askö.

Required qualifications: proficiency in Robotics and in Computer Vision or Machine Learning. This project targets students in Robotics, Systems and Control, Computer Science or Machine Learning. Applicants are expected to have passed KTH courses such as DD2410 Introduction to Robotics, EL2320 Applied Estimation, DD2423 Image Analysis and Computer Vision, DD2421 Machine Learning or equivalent. Confidence in Python and C++ is required. Experience with ROS, deep learning frameworks like PyTorch, and previous hands-on work with real robotic platforms, including field or pool trials, is a strong merit. An interest in marine ecology and environmental monitoring is welcome.

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References:

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- [2] – Akram, Waseem, et al. “A visual servoing scheme for autonomous aquaculture net pens inspection using ROV.” Sensors 22.9 (2022): 3525.
- [3] – Šiaulys, Andrius, et al. “Coverage estimation of benthic habitat features by semantic segmentation of underwater imagery from South-eastern Baltic reefs using deep learning models.” Oceanologia 66.2 (2024): 286–298.
- [4] – Lowe, Scott C., et al. “BenthicNet: A global compilation of seafloor images for deep learning applications.” Scientific Data 12 (2025): 230.