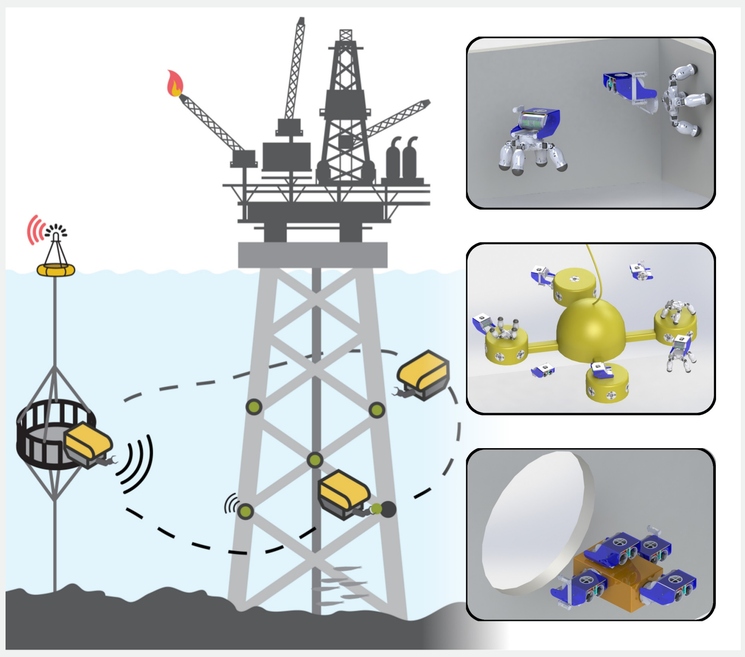
DTU Electrical Engineering
Department of Electrical Engineering

The REMORA Project

Collaborative Modular Underwater Robotic System for Long-term Autonomous Operations

Investigators: D. J. Christensen, R. Galeazzi, A. G. Özkil, U. D. Nielsen, A. Visser, P. Mariani and B. Stage

Developers: A. G. Zsurzsan, C. Witting, F. J. Hansen, H. M. Bastiaan



REMORA Vision – Concept illustrations of the system during an offshore inspection operation. Multiple robots with different capabilities are deployed to inspect the structure, deliver sensor nodes or retrieve data from previously installed sensors. In between missions, the robots reside at the subsea docking station, where they can recharge batteries, transfer mission data, communicate with on-shore monitoring centre or be repaired.

Abstract — *REMORA aims at bootstrapping new high-impact underwater robotic activities at DTU. The project will develop the necessary infrastructure, i.e. underwater robotic system and test facilities to perform world-class research, innovation and education in the area of offshore underwater robotic technology. The ultimate objective is to strengthen the Danish maritime sector within inspections and maintenance of offshore installations.*

REMORA: REconfigurable MOdular Robotic system for Aquatic environment

The REMORA project proposes to develop an underwater robotic system for autonomous inspection in confined waters of marine structures and environments, such as offshore renewable energy farms, oil & gas platforms, mariculture infrastructures, mapping of archaeological sites, surveillance of coastal waters, exploration of natural marine environments.

REMORA envisages a robotic system consisting of heterogeneous modular robots able to physically dock and communicate with other robots, transport tools and robots, and recharge their batteries while underwater. These properties give rise to a system with unique capabilities such as

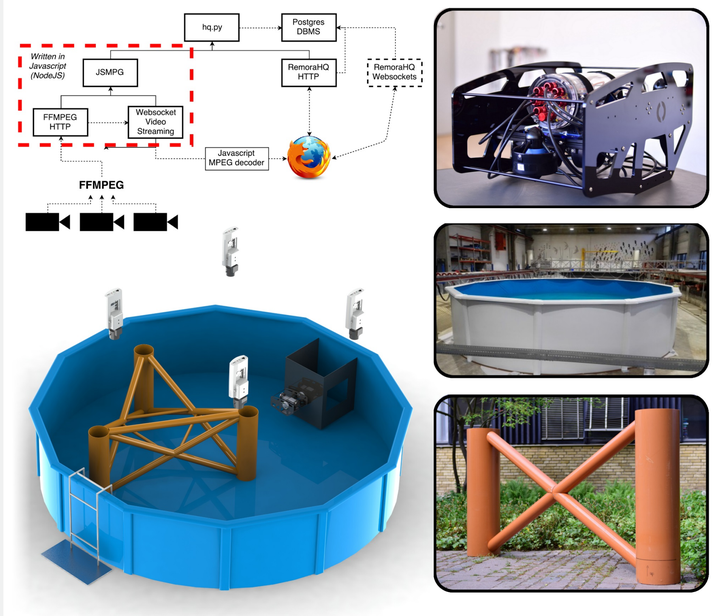
- *Functional* and *morphological reconfiguration* to adapt the robotic system to the current task
- *Dependability* of the robotic system towards single agent fault or failure
- *Increased endurance* leading to long-term autonomous operations

REMORA infrastructure development

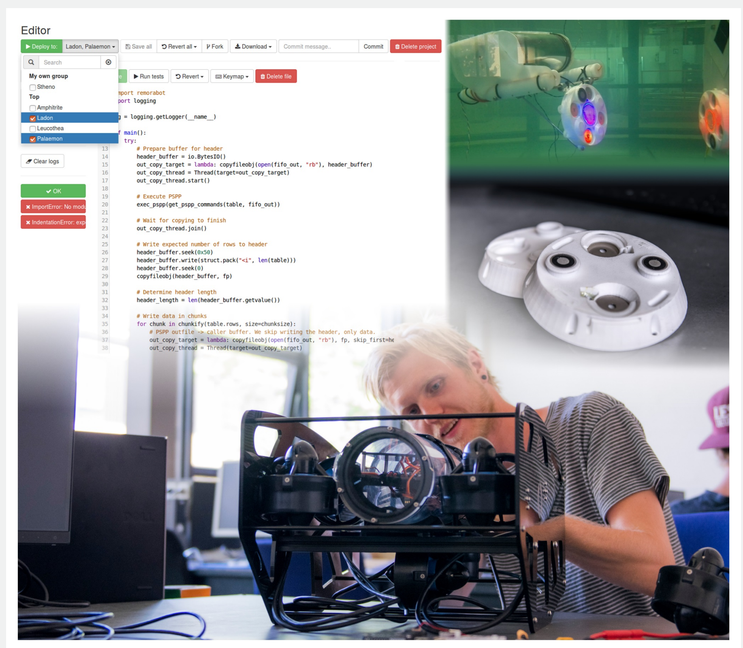
The REMORA project features the implementation of lab facilities (both software and hardware) to enable the development and experimental testing of a collective reconfigurable modular robotic system. The REMORA lab currently consists of:

- Cylindrical pool (DxH: 5x1 m)
- Scaled model of a jacket structure
- 8 remotely operated vehicles (ROVs)
- Mission monitoring centre and functionality development environment both based on Python.

Further, a 3D motion tracking system will be implemented to allow closed-loop robot and mission control.



REMORA Infrastructure – Software and hardware experimental facilities are currently under implementation. A Python based development environment was implemented to enable rapid deployment of new control and perception functionalities into the individual robots. Further, a scaled model of an offshore platform leg was built to enable experimental validation in quasi-realistic scenario. 8 ROVs are ready for testing ground-breaking ideas in the area of reconfigurable modular robotics.



REMORA Platform – The robotic system development requires competences spanning across different areas of engineering and opens research and educational possibilities in the fileds of robotics, control technology, mechanical design, artificial intelligence, product development and more.

Research, innovation and education for Det Blå Danmark

The REMORA project aims at establishing a research, innovation and educational platform to develop knowledge, technology and prospective engineers in support to the Danish maritime sector. Existing research activities in the areas of modular robotics and collaborative systems have been linked to the REMORA project, and new ones are set up with European partners within the H2020 framework. The REMORA platform will develop an educational framework in the form of a pilot *Blue Dot project* at Maritime DTU. Activities to promote the robotic platform towards specific segments of the Danish offshore industry will be carried out to investigate potential innovation actions.

DTU Mechanical Engineering
Department of Mechanical Engineering

DTU Aqua
National Institute of Aquatic Resources