Industrial PhD Position: Underwater critical infrastructure surveillance and intrusion detection

Summary

Underwater critical infrastructure, such as sub-sea cables and pipelines, plays an essential role in global communications, energy transmission, and maritime operations. This infrastructure spans long distances, yet is highly vulnerable, as demonstrated by recent incidents. These incidents pose significant risks to economic stability, environmental safety, and national security. The inherent complexity of underwater environments, combined with the vast, often inaccessible nature of these infrastructures, makes real-time tracking, surveillance, and protection a formidable challenge. The underwater environment presents numerous challenges due to harsh conditions and limited access to energy, communication, and maintenance.

Research field:	Information and communication technology
Supervisors:	Prof. Dr. Maarja Kruusmaa
	Dr. Asko Ristolainen
	Lauri Vihman
Availability:	This position is available.
Offered by:	School of Information Technologies
	Department of Computer Systems
Application deadline:	Applications are accepted between October 01, 2024 00:00 and October 25, 2024 23:59 (Europe/Zurich)

Description

Research

This research focuses on developing a robust surveillance solution for protecting underwater critical infrastructure. This solution will employ modern multi-modal underwater sensor technologies. Various sensors will be considered depending on the use case and environment.

The solution will utilize novel signal processing methods to extend the range, reliability and coverage of both sensors and communications. In conjunction with Unmanned Surface Vessels (USV-s) and Unmanned Underwater Vehicles (UUV-s), the monitoring and communication range will be increased to cover the vast distances required for comprehensive surveillance. This research will explore how a suite of heterogeneous sensors and communication relays can work collaboratively to provide early warnings, detect potential threats, and deliver real-time situational awareness and structural health monitoring in an automated, cost-effective, and scalable solution to monitor both man-made and natural threats.

The outcomes of this research are expected to help to improve the resilience, monitoring, and protection of underwater critical infrastructure. The outcomes should be usable by Defsecintel to develop products and services for increasing national security.

Responsibilities and (foreseen) tasks

- Investigate various sensor and USV and UUV solutions for underwater monitoring and quantify their uncertainty and limitations
- Propose possible solutions for underwater critical infrastructure surveillance.
- Apply the proposed solutions in simulations for protecting critical infrastructure and in a real-world scenario.

Applicants should fulfil the following requirements:

- M.Sc. degree or equivalent in Computer Science, Mathematics, or a related field.
- Clear interest in the research topic of the position, based on their previous experience.
- Excellent English communication skills.
- Strong software development, writing and analytical skills.
- Ability to work as an independent researcher and part of an international team.

(The following experience is beneficial:)

- Programming in Python
- Code documentation, use of shared repositories
- Basic understanding on digital signal processing (filters, Fourier etc)

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical lenses to be used.

We offer:

- 4-year industrial PhD position combined in the leading underwater robotics research center and a rapidly growing Estonian deep-tech company.
- The chance of high-level research in an international group of researchers.
- Opportunities for visiting conferences, research stays and networking with globally leading universities and research centers.

About the company

The Centre for Biorobotics specializes in research and development of underwater robotics and sensing. On the robotics side, we are focusing on development of locomotion and control in underwater and multiphase environments, where conventional land and underwater platforms are underperforming. In connection with robotics, we are focusing on using bioinspired sensing methods in combination with conventional tools to improve situational awareness and navigation performance of our robots. Apart from robotics, we are also applying the bioinspired sensing methods in water flow sensing in natural environments (rivers, coast etc.).

Our core competences are as follows:

- Development and manufacturing of underwater robotic platforms
- Robot locomotion and control in multiphase environments
- Underwater sensing with applications in natural environments
- Mapping and navigation of unstructured environments

Some of our research activities include:

- Developing new principles of locomotion using soft and compliant actuators
- Control and navigation of underwater robots in flow, surges, and waves
- Robot sensing in underwater environments
- Distributed sensor networks for measuring and characterizing flow and turbulence
- Development of underwater sensor systems for safe navigation in harbors
- Measuring extreme flows including sub-glacial flows, rivers etc.
- Environmental sensors for monitoring and protection of critical infrastructure.

DefSecIntel Solutions (DSI) is freedom defenders' partner in surveillance and control, focused on developing and manufacturing world-class mobile autonomous and automated surveillance systems with AI-assisted technology. Our solutions are playing an important role for defence and homeland security in rapidly changing security environment by ensuring cost efficiency for customers and offering new capabilities.
Our systems are designed for different landscapes, terrains and weather conditions and are combat proven.

DefSecIntel main products are:

- Mobile and integrated autonomous situational awareness system SurveilSPIRE;
- Mobile surveillance and sensors system CAIMAN;
- Cutting edge AI-powered C2ISR software;
- ultra-short-range air defence system EIRSHIELD.
- Defsecintel Solutions are also well-known partner for security and defence R&D programmes such as the European Defence Fund, and we are validated by the European Commission.

(Additional information)

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