

# Soft robot locomotion and manipulation in confined multi-phase environments

## Summary

This PhD project will leverage soft, variable stiffness, and variable impedance actuators to achieve robust robot locomotion as well as simple manipulation tasks, for the exploration of confined unstructured environments with yielding and unpredictable terrains. The proposed project will contribute towards the research performed at the Centre for Biorobotics on the development of robot prototypes for the upcoming EU-funded project PIPEON, which will investigate methods for performing inspection and maintenance tasks in sewer pipes.

Information and communication technology
Prof. Dr. Maarja Kruusmaa
Roza Gkliva
This position is available.
School of Information Technologies
Department of Computer Systems
Applications are accepted between October 01, 2024 00:00 and October 25, 2024 23:59 (Europe/Zurich)

## Description

#### The research

Performing tasks that are dangerous for humans in places difficult to reach is one of the main reasons for the rapid development of robotics in recent years. However, robot locomotion in unstructured and dirty environments is still a challenging task that can greatly reduce the range of robots and impede their performance. Also, the ability to interact with the environment is traditionally addressed as a separate task from locomotion, and requires additional mechanisms and control methods.

The proposed PhD project aims at developing and testing actuation methods that can achieve both locomotion in multi-phase environments as well as simple manipulation tasks in confined environments. To address this goal, the project will explore soft, variable stiffness, and variable impedance actuation, from the conceptualization and design phase, to the fabrication and control. Given the corrosive and abrasive nature of these environments, a "rugged-by-design" philosophy should be applied to the prototypes from the design stage, in order to achieve reliability and robustness.

During this PhD project, the candidate will work in an international team, and will develop and test prototypes and methods in a fully equipped lab at the Centre for Biorobotics and other TalTech facilities. We strongly support field work and experimentation in natural settings to accelerate the development and bring the solutions closer to real-life applications.

#### Responsibilities and (foreseen) tasks

- Design and development of locomotion methods for unstructured multiphase environments
- Development of soft actuator prototypes with variable morphology (geometry, material properties, etc.)
- Development / implementation of control methods for the actuators, incorporating sensing where appropriate
- · Publishing achieved results in (Q1) journals and top conferences of the robotics field

#### Applicants should fulfill the following requirements:

- A master's degree in robotics-related engineering discipline with mechanics training (e.g., mechanical engineering)
- A clear interest in the topic of the position
- Excellent command of the English language



- Strong and demonstrable writing and analytical skills
- Capacity to work both as an independent researcher and as part of an international team
- Capacity and willingness to aid in organizational tasks relevant to the project

### (The following experience is beneficial: )

- Background in robot locomotion, and/or soft robotics
- · Experience with experimental and/or theoretical robotics concepts
- Programming in C, C++, python
- Working knowledge of ROS or ROS 2, MATLAB
- Working knowledge of CAD and FEA software

#### We offer:

- 4-year PhD position in one of the only bioinspired robotics groups in Estonia with 15+ years' experience in international and national funded projects
- The chance to do high-level research and collaborate with experts in one of the most challenging robotics fields, in the context of an upcoming EU funded project
- Opportunities for conference visits, research stays, and networking with various cooperation partners
- The university employs the Early Stage Researcher with a salary meeting or exceeding 2300€ gross.

#### About the department

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 terrestrial and underwater platforms are underperforming. In connection with robotics, we are focusing on developing 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, coasts 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 in 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

#### (Additional information)

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