Autonomous Marine Navigation in GNSS-Denied Environment

Summary

This PhD position focuses on advancing the field of autonomous marine navigation in GNSS-denied environments. During the PhD, the candidate will investigate methods to localize autonomous vessels in areas where GNSS is either unavailable or unreliable. The research will explore localization techniques such as visual odometry using sea bottom images acquired from side-scan sonar, as well as sensor fusion involving visual odometry data, water flow sensors, and inertial measurement units (IMUs). The project will also involve addressing challenges related to noise reduction from environmental factors such as waves and other disturbances. The outcomes aim to enhance precise navigation of autonomous vessels in GNSS-degraded conditions.

Research field:	Information and communication technology
Supervisors:	Kristjan Tabri Dr. Uljana Reinsalu
Availability:	This position is available.
Offered by:	School of Information Technologies Department of Computer Systems
Application deadline:	Applications are accepted between January 01, 2025 00:00 and January 24, 2025 23:59 (Europe/Zurich)

Description

Advancements in artificial intelligence (AI) have brought significant attention to autonomous surface vessels (ASVs) due to their potential in applications where human presence may be risky or costly. These vessels are commonly used for tasks like seafloor scanning, offshore wind park mapping, harbor monitoring, and inspecting underwater infrastructure. ASVs operate autonomously on regular schedules, enabling a single operator to manage multiple vessels, thereby reducing costs.

Accurate navigation and mapping are critical for ASVs, relying heavily on precise localization. While GNSS (Global Navigation Satellite System) is generally reliable, it is not always available or stable. For instance, recent GNSS jamming incidents in the Baltic region and signal obstructions near large ships in harbors highlight its limitations. Consequently, ASVs require alternative localization methods to ensure accurate odometry and navigation.

This PhD research focuses on developing advanced methods for ASV localization and navigation in GNSS-degraded environments. One approach involves utilizing side-scan sonar to capture seafloor images, enabling visual odometry to track vessel movements relative to the seabed. Additionally, sensors such as water flow sensors and IMUs provide supplementary motion data, including speed and orientation. However, sensor data is often noisy due to environmental factors such as waves, currents, and wind. Addressing these challenges will involve designing techniques for noise reduction and data fusion from multiple sensors.

The research aims to enhance ASV autonomy and operational effectiveness, enabling precise navigation even in complex marine environments.

Responsibilities and Foreseen Tasks

1. Conduct a comprehensive literature review on ASV localization and navigation methods, focusing on visual odometry and sensor fusion techniques.
2. Develop algorithms for utilizing side-scan sonar data for visual odometry.
3. Research and create techniques for fusing data from sensors such as IMUs and water flow sensors to improve odometry accuracy.
4. Address noise challenges in sensor data caused by environmental factors like waves, currents, and wind.
5. Propose and conduct real-world data collection experiments.
6. Test and validate methods in simulated environments and real-world scenarios.
7. Collaborate with researchers and companies to align research with practical marine technology applications.

8. Document and publish research findings in peer-reviewed journals and present at conferences.

Requirements

Mandatory:

- A master’s degree in computer engineering or computer science.
- Strong interest in the research topic.
- Excellent command of English (written and verbal).
- Demonstrable writing and analytical skills.
- Proficiency in programming, especially in Python and C++.
- Ability to work both independently and within an international team.
- Willingness to aid in organizational tasks relevant to the project.

Preferred Experience:

- Machine vision, visual odometry, or related AI and signal processing fields.
- Working with the Robot Operating System (ROS).
- Autonomous driving or robotics.

We Offer

- Collaboration on developing autonomous technologies using real field data and testing algorithms on autonomous platforms.
- Access to advanced research infrastructure, including test basins, sensors, and autonomous platforms.
- Opportunities for conference attendance, research stays, and networking with leading universities and research centers.
- A stimulating research environment within the School of Information Technology at Tallinn University of Technology.
- A 4-year PhD position with full-time paid employment, competitive salary, and benefits.
- Support for professional development and research dissemination.

Employment

The position is based at the School of Information Technology, Tallinn University of Technology. The expected duration of doctoral studies is four years. Following the standard practice, the initial contract will be for one year, with extensions based on successful progress reviews.

The position will be filled as soon as a suitable candidate is found. TalTech reserves the right to leave the position open or extend the application period for justified reasons.

How to Apply

Please refer to the admission guidelines at TalTech PhD Admission.

For further information, contact:

- Kristjan Tabri (email: kristjan.tabri@taltech.ee)
- Uljana Reinsalu (email: uljana.reinsalu@taltech.ee)

Job Locations: Tallinn & Kuressaare, Estonia

To get more information or to apply online, visit https://taltech.glowbase.com/positions/896 or scan the the code on the left with your smartphone.