Mobile Sensing Systems for Urban Infrastructure and Environment Monitoring

Summary

The PhD candidate will participate (together with the supervisors and project team) in the research and design of a prototype of a next-generation mobile sensing platform tailored for environmental monitoring in urban areas. The platform will integrate multi-modal sensors, on-device signal processing, and lightweight anomaly detection algorithms for real-time operation on mobile assets (e.g., public transport vehicles or garbage trucks). The final system will seamlessly integrate into the digital infrastructure supporting smart city data governance.

Research field:	Information and communication technology
Supervisors:	Olev Märtens
	Jaanus Kaugerand
Availability:	This position is available.
Offered by:	School of Information Technologies
	Department of Software Science
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

Background and Motivation

This doctoral project is supported by the CitySense project. A modular, mobile urban sensing network deployed on public service vehicle fleets. The sensor platform supports real-time monitoring of road surface conditions, traffic infrastructure, and urban environmental parameters such as air quality, city noise or thermal (heat islands) anomalies. The system emphasizes sensor modularity, data- and AI-driven analytics, and interoperability to create actionable insights for urban planning.

Cities across Europe are implementing digital twin systems and smart infrastructures to improve urban resilience. Mobile sensing provides high-resolution, real-time data that complements static infrastructure sensors, enabling dynamic monitoring of pollution, noise or environmental events.

Research Tasks

Edge computing platform:

- Research and design of the modular, mobile sensing platform suited for deployment on moving platforms under real-world urban conditions.
- Integrate multi-modal sensor suites (e.g., CO, temperature, sound, vibration, GNSS, camera, IMU).
- Address environmental resilience, power optimization, and sensor calibration procedures.

Edge level Signal Processing and Anomaly detection:

- Develop embedded software for real-time data acquisition, preprocessing, and compression.
- Implement signal processing routines (e.g., FFT, STFT, filtering, noise reduction) optimized for edge hardware.
- Fuse multi-modal sensor data from both local and distributed sensors (e.g., CO, temperature, sound, vibration, GNSS, camera, IMU) to enhance detection of events like road damage, pollution spikes, abnormal noise levels or heat islands.
- Important research and development challenge could be providing all sensor data with accurate time and location stamps also at the high speed of the mobile platform.
- Compare and optimize edge-based anomaly detection against cloud-based processing approaches.

Field Testing and Validation

- Collaborate with the City of Tallinn for real-world deployment and system testing.
- Benchmark the mobile system's outputs against static infrastructure and manual ground truth datasets.

- Perform validation studies in Tallinn city with a focus on robustness, usability, and operational effectiveness.

Applicants should fulfil the following requirements:

- A master's degree in computer science, data science or engineering, with a focus on edge computing.
- Interest in Edge computing hardware, electronics and sensors.
- Interest in sensor data analysis and computational modelling.
- Very good proficiency in spoken and written English language.
- Basic skills or willingness to learn Estonian language.
- Willingness to travel to international and domestic project meetings.

The following experience is beneficial:

- Proficiency in Python, MATLAB, R, or other languages for data processing and statistical analysis.
- Basic knowledge of web/cloud platforms for sensor data visualization or dashboards
- Interest in sustainability, smart cities, and urban systems.
- Demonstrated ability to work independently and collaboratively in interdisciplinary environments.
- Proficiency in scientific communication and writing.

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