I-RIM

PhD Course in

ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Mobility and Autonomous Vehicles

Research Themes

1. TERRAIN-AWARE MAPPING AND AUTONOMOUS EXPLORATION OF MOBILE ROBOTS – PLACE RESERVED FOR LEONARDO S.P.A. EMPLOYEE 2

The main goal of the Mobility and Autonomous Vehicles curriculum is to train scientists and researchers capable of working in multidisciplinary teams on topics related to state-of-the-art solutions for mobility and intelligent vehicles operating on land, water, or in the air. Specific areas of research may include:

1. Development of control algorithms that, starting from sensory data, enable planning and control of vehicle dynamics, including the assignment of vehicles to transport service requests.
2. Development of sensors and sensor data processing algorithms to ensure accurate perception of the vehicle's surrounding environment, both static and dynamic.
3. Integration and coordination of human and artificial intelligence to facilitate coexistence between driverless and human-operated vehicles, as well as between driverless vehicles and other users in shared environments.
4. Development of a regulatory framework addressing objectives to be optimized in emergency situations where a fully harm-free solution for people, animals, or property is not achievable.
5. Study of methods to ensure the safety of the vehicle, its passengers (if any), and people, animals, or property around it, under all conditions.
6. Development of technologies for autonomous freight transport, off-highway vehicles, unmanned vehicles for last-mile delivery, and agricultural applications.

The research theme offered will be awarded to the top applicants selected for this theme.

Ideal candidates are students holding a Master's degree (or equivalent/higher) in STEM (Science, Technology, Engineering, and Mathematics) disciplines, preferably with a background in Robotics.

Students will conduct their research project at the hosting institution (as described in the research project sheet). Interested applicants are encouraged to contact the tutors and/or the Unit's Principal Investigator (PI) for further information prior to submitting their application.

International applications are welcome, and applicants will receive logistical support with visa processing, relocation, and related matters.

1. Terrain-aware Mapping and Autonomous Exploration of Mobile robots – place reserved for Leonardo S.p.a. employee

Curriculum: Mobility and autonomous vehicles

Hosting Institution:

Leonardo S.p.A.

University of Genoa (Università degli Studi di Genova)

Department:

Robotics Laboratory, Innovation Hub & Intellectual Property

DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering

Tutor(s):

Navvab Kashiri, Gianni Vercelli

Description:

Autonomous exploration of unstructured environments plays a crucial role in applications such as search and rescue, planetary exploration, and environmental monitoring, but enabling mobile robots to navigate and map complex terrains remains a significant open challenge. This PhD project aims to advance the field of autonomous robot navigation by developing terrain-aware mapping, traversability analysis, and exploration planning methods optimized for mobile robotic platforms operating in unstructured, real-world environments. Terrain variability, including slopes, deformable surfaces, vegetation, and obstacles, poses fundamental difficulties for reliable locomotion and safe autonomous decision-making.

This research seeks to address these challenges through the design of perception-driven and learning-based algorithms capable of real-time terrain characterization and adaptive exploration on resource-constrained robotic systems. The work will focus on three key components:

- Terrain characterization and traversability estimation, leveraging geometric and semantic cues from onboard sensors to classify surface properties and assess locomotion risk.
- Terrain-aware 3D mapping, integrating elevation models, surface type information, and uncertainty representations to build rich environmental maps that support safe navigation.
- Autonomous exploration planning, combining frontier-based and learning-driven strategies to maximize coverage efficiency while respecting terrain-induced mobility constraints.

The goal is to enable mobile robots to autonomously explore and map previously unknown environments in a safe, efficient, and terrain-adaptive manner, without requiring human supervision or pre-existing environmental knowledge. The proposed research will combine algorithmic innovation, simulation-based prototyping, and experimental validation on real-world robotic platforms across a range of challenging outdoor and indoor terrain conditions.

Requirements:

Candidates should have a degree in Robotics Engineering, Computer Engineering, or related study programs. Applicants are expected to be proficient in software design and development (software architectures for robots, C/C++, Python), artificial intelligence techniques for robots, perception, reasoning, and motion planning and execution. The ideal candidate is proficient in SLAM and machine learning.

References:

- Rollo, Federico, Valentina Pericu, Marco Roveri, Arash Ajoudani, and Navvab Kashiri. "LEO-SLAM: A Multi-Level Scan Matching Approach with Submap-based Loop Closure Detection." In *2025 European Conference on Mobile Robots (ECMR)*, pp. 1-7. IEEE, 2025.

Company name and link (for industrial projects):

Leonardo S.p.A.,

https://www.leonardo.com/en/innovation-technology/leonardo-labs/robotics

Number of positions available:

1

Main Research Site

Robotics Lab, Leonardo SpA, Via Raffaele Pieragostini, 80, 16151 - Genova, Italy.

Contacts:

Email: navvab.kashiri@leonardo.com, gianni.vercelli@unige.it

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