I-RIM

PhD Course in

ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Mobility and Autonomous Vehicles

Research Themes

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. Model-Based and Learning Control for Morphing Robotic Platforms in Autonomous Modular Construction – Italian Institute of Technology

Curriculum: Mobility and autonomous vehicles	
Hosting Institution: Istituto Italiano di Tecnologia	
Department: Humanoid and Human Centred Mechatronics Research line (https://hhcm.iit.it/)	
Tutor(s): Nikos Tsagarakis, nikos.tsagarakis@iit.it	

Description:

This PhD project will be carried out within BRICKS, a new EU research project aligned with the PhD period, aiming to revolutionize onsite construction through autonomous, collaborative, and modular robotic systems building on the foundations developed within the EU CONCERT project. Within this context, the PhD will focus on the development of motion planning and control tools for morphing robotic platforms capable of operating both from the ground and on vertical structures. Starting from a mobile manipulation base, the research will investigate how wall-climbing robotic arms can be mechanically and functionally integrated through docking and latching interfaces. These interfaces will allow the BRICKS robotic platform to be transported across the construction site, operate while mounted on the mobile platform, and morph/detach to latch onto interfaces embedded in the modular building blocks. The main objective will be the design of motion planning and control methods for wall approach, latching, climbing, and arm transfer. With these tools, the PhD will address the transition of robotic arms from the mobile base to the wall, stable attachment to structural modules, and climbing motion along vertical surfaces while carrying construction blocks or tools. Multi-arm coordination will also be investigated to support the manipulation of larger modules. The project will further develop capabilities for autonomous modular block handling and assembly, including block perception/recognition, grasping, transport, alignment, latching, and release. Overall, this PhD will contribute to a new generation of adaptive robotic construction systems that combine mobility, climbing, manipulation, and collaborative autonomy to enable scalable robotic assembly of modular buildings and infrastructure.

Requirements:

This PhD topic lies at the intersection of robot model-based control, motion planning, and learning-based autonomy for mobile manipulation, wall-climbing, and modular construction assembly. Ideal applicants should have excellent programming skills in C++ and Python, together with strong competences in robot control, robot dynamics, and learning-based methods for autonomous robotic systems. A solid background in motion planning, trajectory generation, force/impedance control, and multi-robot coordination will be highly valuable. The knowledge of Robot Operating System ROS/ROS2 is essential, as the research will involve the integration and validation of control, perception, and planning modules on complex modular robotic platforms. Any experience with mobile manipulation, legged or climbing robots, will be an advantage. Finally, given the role of perception and autonomy, experience in robotic vision, 3D perception, Vision-Language-Action models will be a plus.

References:

- Romiti et al., Minimum-Effort Task-based Design Optimization of Modular Reconfigurable Robots, IEEE ICRA 2021, **DOI:** 10.1109/ICRA48506.2021.9561273
- Lei et al., Task-Driven Computational Framework for Simultaneously Optimizing Design and Mounted Pose of Modular Reconfigurable Manipulators, IEEE IROS 2024, **DOI:** 10.1109/IROS58592.2024.10802089
- Rossini et al, Concert: a modular reconfigurable robot for construction, Journal of Field Robotics, 2026, **DOI:** 10.1002/rob.70092

Number of positions available:

1

Main Research Site

Humanoid and Human Centred Mechatronics Research line (https://hhcm.iit.it/)

Center for Robotics and Intelligent Systems (CRIS), IIT, Genova

Contacts: Email: nikos.tsagarakis@iit.it

Funding Scheme: This grant is partially funded by the Bricks project (Building Robotic Intelligence and Modular Construction Kit System). Please note that, pending the signing of GA 101307186, it is covered by internal IIT funds.

Scholarship Amount:

- Fascia 4: 19,500 €/year

2. 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:

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Funding Scheme: Place reserved for Leonardo S.p.a. employee