I-RIM

PhD Course in

ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Mobility and Autonomous Vehicles

Research Themes

1. LIFELONG AUTONOMY IN LEGGED-WHEELED ROBOTS THROUGH HYBRID MODEL-LEARNING AND CONTINUAL ADAPTATION, ITALIAN INSTITUTE OF TECHNOLOGY (IIT) 3

2. LEARNING-BASED PERCEPTION AND DECISION-MAKING FOR INTELLIGENT QUADRUPED ROBOTS IN SECURITY AND MONITORING MISSIONS - LEONARDO S.P.A., UNIVERSITY OF GENOA....5

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 by Italian Institute of Technology (IIT) 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. Lifelong Autonomy in Legged-wheeled Robots through Hybrid Model-Learning and Continual Adaptation, Italian Institute of Technology (IIT)

Curriculum:

Mobility and Autonomous Vehicles

Hosting Institution:

Italian Institute of Technology (Istituto Italiano di Tecnologia)

Department:

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

Tutor(s):

Dr. Nikos Tsagarakis

ISTITUTO ITALIANO DI TECNOLOGIA

Description:

Legged-wheeled robots are emerging as powerful platforms for navigating complex and unstructured environments, offering mobility advantages over only legged or wheeled systems. However, long-term autonomy in these platforms remains an open challenge due to the dynamic nature of real-world conditions and the robots' own physical evolution over time. This PhD project aims to develop a framework that enables legged-wheeled manipulation robots to continually refine their locomotion and manipulation capabilities, while dynamically updating their internal models to reflect environmental changes, wear, and reconfiguration.

The core idea is to combine model-based reasoning with data-driven learning in a hybrid architecture. Physics-informed models will be explored to provide structure and safety, while neural network components capture unmodeled dynamics and enable adaptive behaviors. The robot will maintain and update an internal representation of its own kinematic and dynamic properties allowing it to adapt to new environment challenges , payload shifts, or physical changes. A learning framework will support lifelong skill acquisition, enabling the robot to learn new behaviors without forgetting previously known ones. It is also expected that the robot will leverage on multi-modal perception, vision, force sensing, and proprioception to explore its learning in real-world context and adapt to terrain or manipulation task.

Real-world deployment and testing will be conducted using state-of-the-art quadruped legged-wheeled robots such as CENTAURO and the recenlty developed new CENTAURO robot of HHCM laboratory (https://hhcm.iit.it/robots), in different task missions. The result will be a self-adaptive robotic system capable of persistent, safe, and efficient operation, pushing the boundaries of long-term autonomy in mobile robotics.

The developments within this PhD topic are linked to research projects obtained from the European commicion and industry.

Requirements:

This topic lies in the intersection of Robot model-based control and learning. Ideal applicants should have excellent C++ and Python programming competences. Strong competences in robot control and learning are required while robotic vision skills will a plus. Knowledge of

motion planning tools and Robot Operating System (ROS/ROS2) is essential. The applicants should be fluent in English and team players.

References:

1. J. Lee et al, Learning Robust Autonomous Navigation and Locomotion for Wheeled-Legged Robots, Science Robotics Vol. 9, Issue 89, 2024

Number of positions available:

1

Main Research Site

Center for Robotics and Intelligent Systems (CRIS), Istituto Italiano di Tecnologia, via San Quirico 19D, 16163, Genova, Italy.

Contacts:

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Scholarship Amount:

- Fascia 4: 19,500 €/year

2. Learning-Based Perception and Decision-Making for Intelligent Quadruped Robots in Security and Monitoring Missions - Leonardo S.p.A., University of Genoa

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 https://dibris.unige.it/

Tutor(s):

Prof. Marco Baglietto, Dr. Chiara Piezzo

Description:

Leonardo, in collaboration with the Department of Informatics, Bioengineering, Robotics and Systems Engineering (DIBRIS) at the University of Genoa, is launching an industrial PhD program focused on AI algorithms for autonomous robotic intelligence.

The project supports the deployment of intelligent quadruped robots for patrolling and intervention tasks, where AI is expected to play a critical role in enabling real-time situational awareness, anomaly detection, and adaptive decision-making in complex, dynamic environments.

The core objective of the PhD is to **develop and integrate artificial intelligence methods for perception, understanding and autonomous behavior** of quadruped robots. These systems must learn from sensor data, adapt to evolving environments, and react to unstructured or unforeseen events without human supervision.

The research will focus on the following topics:

1. **Multimodal Perception and Sensor Fusion:**

   Development of AI models for real-time understanding of the environment using data from multiple sources (RGB/depth cameras, LiDAR, IMU). Techniques such as deep learning for semantic segmentation, scene classification, and multi-sensor fusion will be investigated to create rich and actionable representations of the environment.

2. **Anomaly Detection and Situation Assessment:**

   Exploration of both supervised and unsupervised learning methods to detect unusual events, behaviors or objects. The system must autonomously recognize deviations

from learned patterns and trigger security protocols or intervention behaviors when needed.

3. **Learning-Based Decision-Making and Policy Adaptation:**

   Design of **reinforcement learning** algorithms that enable the robot to select and adapt actions based on the current context. Emphasis will be placed on hierarchical policy learning, safety constraints, and generalization to unseen scenarios.

4. **Sim2Real Transfer and Domain Randomization:**

   Use of high-fidelity simulation and domain adaptation techniques to train AI models in virtual environments before deploying them in real-world conditions. Research will focus on improving the robustness and transferability of perception and control policies trained in simulation.

5. **Continual Learning and Onboard AI:**

   Integration of techniques for on-device inference and continual learning, enabling the robot to incrementally improve its behavior from experience during long-term deployments, without compromising safety or reliability.

This PhD will contribute to Leonardo's vision of **deploying intelligent autonomous systems** for persistent surveillance, threat detection, and infrastructure protection. The research outcomes will help advance the state of the art in **robotic AI**, with applications that go beyond security, including industrial inspection, disaster response, and smart mobility.

Requirements:

- Strong background in AI/ML, computer vision, or robotics
- Solid programming skills (Python, C++, ROS/ROS2)
- Experience with perception algorithms, deep learning or reinforcement learning
- Familiarity with simulation platforms and sensor data processing
- Creative thinking, autonomy, and interest in applied research

References:

[1] Jadoon, N. A. K., & Ekpanyapong, M. (2025). Quadruped robot simulation using deep reinforcement learning – a step towards locomotion policy. Simulation Modelling Practice and Theory, 139

[2] Hoeller, D., Omotuyi, O., & Burnham, T. (2024, June 17). Closing the sim-to-real gap: Training Spot quadruped locomotion with NVIDIA Isaac Lab. NVIDIA Developer Blog.

Company name and link (for industrial projects):

Leonardo S.p.A., https://www.leonardo.com

Number of positions available:

1

Main Research Site

Leonardo Cyber & Security Solutions Laboratory, Via Raffaele Pieragostini, 80, 16151 - Genova, Italy.

DIBRIS Department, DIBRIS Department, University of Genoa, Viale Francesco Causa, 16145, Genova, Italy.

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