I-RIM

PhD Course in

ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Inspection and Maintenance of Infrastructure (CODE 11661)

Research Themes

1. COMPUTER VISION AND AI APPLICATIONS FOR REMOTE SENSING OF PHOTOVOLTAIC PLANTS – WESII S.R.L., UNIVERSITY OF GENOA 2
2. COOPERATIVE MODELS AND CONTROL IN HUMAN-ROBOT COLLABORATION SCENARIOS – UNIVERSITÀ DI GENOVA 4

The main goal of the Robotics and Intelligent Machines for Inspection and Maintenance of Infrastructures curriculum is to train scientists and researchers capable of working in multidisciplinary teams on topics related to state-of-the-art solutions for infrastructure inspection and maintenance tasks. Robotics holds significant potential to drive technological innovation in inspection and maintenance processes by reducing costs, improving service quality, and enhancing safety while minimizing environmental impact.

The inability to adapt existing plants and infrastructures to the capabilities of standard industrial robots—combined with the increasing autonomy of cutting-edge technological solutions—has created favorable conditions for the development of specialized service robotics designed for civil and industrial inspection and maintenance applications.

The research theme offered by Wesii S.r.l will be awarded to the top applicants selected for this theme.

Ideal candidates are students with a strong background in robotics and intelligent machines, from various perspectives including control and artificial intelligence. Please consult the individual requirements for each research theme.

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

International applications are welcome, and participants will receive logistical support for visa issues, relocation, and related matters.

1. Computer Vision and AI Applications for Remote Sensing of Photovoltaic Plants – Wesii S.r.l., University of Genoa

Curriculum: Inspection and maintenance of infrastructures	
Hosting Institution: Wesii S.r.l, University of Genoa (Università degli Studi di Genova)	
Department: Wesii S.r.l R&D Department DIBRIS, Department of Informatics, Bioengineering, Robotics, and Systems Engineeering	
Tutor(s): Dr. Mauro Migliazzi (Wesii), Prof. Luca Oneto (UNIGE)	

Description:

Remote sensing technologies, empowered by computer vision and artificial intelligence (AI), are revolutionizing the way we monitor, inspect, and optimize photovoltaic (PV) plants. Wesii S.r.l., a global leader in multispectral aerial inspection, is at the forefront of this transformation by integrating information coming from drones, aircrafts, multispectral sensors, satellite data, and proprietary AI/ML algorithms to provide high-accuracy insights for asset management in the renewable energy sector. This PhD project focuses on the development of next-generation vision-based algorithms and analytics for PV plants through advanced advanced image processing, deep learning-based approaches (e.g. SAR image super-resolution), and sensor fusion techniques.

The research will explore how multispectral and thermal imaging data acquired by drones, aircrafts, and satellites can be automatically interpreted to identify mechanical anomalies, monitor thermal behaviour, and assess degradation of PV plants over time.

Scientific activities will be addressed in a high-level industrial application context, as addressed by Terna and Duferco, companies that are partners in Wesii

Requirements:

Applicants are expected to have strong programming skills in Python. Experience with computer vision frameworks (e.g., OpenCV, PyTorch), a solid background in AI/ML techniques, and familiarity with geospatial data, will be positively evaluated.

References:

1. Tanda G., Migliazzi M. Infrared thermography monitoring of solar photovoltaic systems: A comparison between UAV and aircraft remote sensing platforms (2024) Thermal Science and Engineering Progress, 48

2. Madeti S.R., Singh S.N. Monitoring system for photovoltaic plants: A review (2017) Renewable and Sustainable Energy Reviews, 67, pp. 1180 - 120
Company name and link (for industrial projects): Wesii S.r.l. (https://www.wesii.com/)
Number of positions available: 1
Main Research Site Wesii S.r.l., P.zza Nostra Signora dell'Orto, 8, 16043 Chiavari (GE), Italy.
Contacts: Email: Mauro Migliazzi: mauro.migliazzi@wesii.com
Funding Scheme: This doctorate grant is funded by Wesii S.r.l.
Scholarship Amount: Fascia 1: 16,500 €/year

2. Cooperative models and control in human-robot collaboration scenarios – Università di Genova

Curriculum:

Industry 4.0

Hosting Institution:

University of Genoa (Università degli Studi di Genova)

Department:

DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering (https://dibris.unige.it/)

Tutor(s):

Prof. Enrico Simetti, Prof. Fulvio Mastrogiovanni

Description:

Effective human-robot collaboration requires the development of sophisticated models that enable robots to understand and predict human behavior, facilitating seamless and safe interaction. While humans utilize adaptable cognitive models to collaborate with each other, replicating such models in robotic systems remains an evolving research challenge. This research proposal focuses on creating integrated cognitive models that merge human behavior analysis, motion perception, and task-priority management. These models will equip robots with the ability to adapt dynamically to the changing conditions of collaboration and different operational contexts.

The research is developed along two main directions. In the first, the aim is to design integrated cognitive models for task recognition and behavior prediction using machine learning techniques, such as convolutional neural networks for processing video data and recurrent neural networks for time-series sensor data. This will allow robots to perceive human actions, infer intentions, and predict potential future states of the collaboration. Additionally, leveraging in-the-loop simulations and digital twin technology will enable real-time assessment of ergonomics and interaction patterns, enhancing the robot's capacity to anticipate complex scenarios and respond with appropriate adjustments. This research will start from previous work [1].

In the second, task-priority-based control will be implemented to manage complex multi-robot scenarios, balancing safety, ergonomic considerations, and task objectives. This involves optimizing the robot's real-time response to concurrent demands, enabling it to maintain a balance between various goals and constraints. In particular, the idea is to work on optimization and reinforcement learning algorithms to tune the gains and priority of such control frameworks [2,3].

Requirements:

Applicants are expected to have strong programming skills (including Python, C/C++), a good background in control, software development and machine learning.

References:

1. Darvish, K., Wanderlingh, F., Bruno, B., Simetti, E., Mastrogiovanni, F., & Casalino, G. (2018). Flexible human–robot cooperation models for assisted shop-floor tasks. Mechatronics, 51, 97-114.
2. Karimi, M., & Ahmadi, M. (2021). A reinforcement learning approach in assignment of task priorities in kinematic control of redundant robots. IEEE Robotics and Automation Letters, 7(2), 850-857.
3. Penco, L., Hoffman, E. M., Modugno, V., Gomes, W., Mouret, J. B., & Ivaldi, S. (2020). Learning robust task priorities and gains for control of redundant robots. IEEE Robotics and Automation Letters, 5(2), 2626-2633.

Number of positions available: 1

Main Research Sites

GRAAL (https://graal.dibris.unige.it/) and TheEngineRoom (https://theengineroom.dibris.unige.it/), DIBRIS Department, University of Genoa, Via all'Opera Pia 13, 16145, Genova, Italy.

Contacts:

Email: enrico.simetti@unige.it, fulvio.mastrogiovanni@unige.it

Funding Scheme: This doctorate grant is funded by the DIBRIS Department (Project PRIN 2022 CONCERTO – A COgNitive arChitecture for sEamless human-Robot inTeractiOn)

Scholarship Amount:

- Fascia 4: 19,500 €/year