I-RIM

PhD Course in ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Robotics and Intelligent Machines for Hostile and unstructured environments

Research themes

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2. OPTIMIZATION OF DISTRIBUTED ACOUSTIC SENSING AND MULTISENSOR DATA FUSION – FINCANTIERI S.P.A. 5
3. INTELLIGENT AND SAFE ROBOTIC SYSTEMS FOR COMPLEX AND UNSTRUCTURED ENVIRONMENTS – THE ITALIAN INSTITUTE OF ARTIFICIAL INTELLIGENCE (AI4I) 8
4. LEARNING, REASONING, AND DECISION-MAKING IN HUMANS AND SOCIAL ARTIFICIAL SYSTEMS – UNIVERSITY OF MILANO-BICOCCA 10
5. HIERARCHICAL MULTI-AGENT REASONING AND SAFE MANIPULATION FOR MODULAR LUNAR ROBOTIC SYSTEMS – UNIVERSITY OF GENOA-ASI 12
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The main goal of the curriculum “Robotics and Intelligent Machines for Hostile and Unstructured Environments” is to address challenges related to the study and development of enabling technologies and complex systems that will allow robots and intelligent machines to operate in environments that are dynamic, partially or completely unknown, difficult to predict, and potentially very challenging.

The general objective of the curriculum is to train scientists and research technologists capable of working in multidisciplinary teams on projects where interaction with a complex environment plays a crucial role in technological development and design.

The research theme offered 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. 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. Underwater Foundation Model for Autonomous Marine Systems – Fincantieri S.p.A.

Curriculum: Hostile and unstructured environments	FINCANTIERI ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA Università di Genova
Hosting Institution: University of Bologna, Bologna	
Department: Department of Physics and Astronomy "Augusto Righi" (DIFA), University of Bologna **Laboratory:**	
Tutor(s): Prof. Paolo Oddo (University of Bologna) Scientific referents of the agreement: Prof. Giovanni Indiveri (University of Genoa – ISME); Mirko Stifani (Fincantieri S.p.A.)	

Description:

The research line aims at developing a first environmental Underwater Foundation Model, intended as a reference model to consistently describe and update the marine and underwater environment in support of the deployment of marine autonomous systems.

The main goal of the PhD is to combine data from environmental modelling services, such as CMEMS/Copernicus and similar sources, with observations and measurements collected in the field, also through dedicated campaigns, in order to produce a three-dimensional estimate of the main environmental variables of operational interest at the relevant spatio-temporal scales. The variables considered include, in particular, temperature, salinity, currents and sound speed in water, since these parameters affect navigation, mission planning, sensor behaviour and, more generally, the quality of operational performance.

In this perspective, the foundation model is not intended as the set of all final applications, but as a reusable foundational core, able to learn an up-to-date three-dimensional representation of the underwater environment from model data and real observations, and to progressively refine it as new measurements become available.

The expected result is a model able to provide, quickly and with limited computational resources, environmental analyses useful at tactical scale in a specific area of interest, supporting preliminary assessments, the choice of deployment time windows and the definition of mission profiles.

The PhD does not aim at developing all the subsequent applications of the foundation model, such as advanced mission optimisation, digital twin, synthetic environment, imaging or ATR, which may be addressed in subsequent activities. The scholarship is instead aimed at building the first foundational block, namely a reliable, updatable and reusable 3D environmental model, conceived as the basis for future environment-aware developments.

The reference system for the activities is DEEP (Dynamic Ecosystem for Enhanced Performance), orchestrated by the Underwater Management System (UMS) Toolbox, for which the developed model may constitute the supporting environmental layer.

Research plan

Year 1

- Identification of the environmental variables relevant to underwater missions.
- Analysis of the available data sources, including CMEMS/Copernicus, other environmental services and existing observational data.
- Definition of the reference areas, scenarios and spatial and temporal scales for operational and tactical applications.
- Set-up of the methodology for integrating model data and real measurements.
- Definition of the criteria for verifying and assessing the quality of the estimates produced.

Year 2

- Development of the first prototype of the environmental foundation model.
- Integration of model data with available or ad hoc collected observations.
- Production of the first three-dimensional estimates of temperature, salinity, currents and sound speed.
- Verification of the model's ability to update and refine itself on the basis of new measurements.
- Assessment of computing times and of compatibility with use in operational contexts.
- First experimental integration with a simulation environment or with the DEEP / UMS Toolbox framework.

Year 3

- Validation of the model on representative scenarios and, where possible, on data collected during dedicated campaigns.
- Optimisation of the quality, robustness and updatability of the environmental estimates.
- Demonstration of the model's ability to rapidly produce environmental analyses useful at tactical scale.
- Preparation of the outputs in a form usable by mission planning, simulation or operational support systems.
- Definition of possible subsequent evolutions towards advanced applications.

Requirements:

The ideal candidate would have a Master's degree in Physics, Physical Oceanography, Environmental Engineering, Applied Mathematics, Computer Science, Data Science, Artificial Intelligence, or a closely related discipline. Knowledge of ocean modelling, data assimilation and/or machine learning, together with good programming skills (e.g., Python), is appreciated.

References:

- A. Storto, G. De Magistris, S. Falchetti, P. Oddo, "A Neural Network-Based Observation Operator for Coupled Ocean-Acoustic Variational Data Assimilation," in *Monthly Weather Review*, 2021.
- A. Storto, S. Falchetti, P. Oddo, Y.-M. Jiang, A. Tesei, "Assessing the Impact of Different Ocean Analysis Schemes on Oceanic and Underwater Acoustic Predictions," in *Journal of Geophysical Research: Oceans*, 2020.

- P. Oddo, S. Falchetti, S. Viola, G. Pennucci, A. Storto, I. Borrione, G. Giorli, E. Cozzani, A. Russo, C. Tollefsen, "Evaluation of Different Maritime Rapid Environmental Assessment Procedures with a Focus on Acoustic Performance," in *The Journal of the Acoustical Society of America*, 2022.

Company name and link (for industrial projects):

Fincantieri S.p.A., Trieste – https://www.fincantieri.com

Number of positions available: 1

Main Research Site

The research activities will be carried out at:

- University of Bologna – Department of Physics and Astronomy "Augusto Righi" (DIFA), Bologna (hosting institution);
- University of Genoa – ISME (Interuniversity Research Center on Integrated Systems for the Marine Environment), c/o DIBRIS, Genoa – administrative seat of the PhD programme;
- Fincantieri S.p.A. – company sites, according to the research programme agreed between the scientific referents.

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Funding Scheme: This doctorate grant is funded by Fincantieri S.p.A. under the agreement with the University of Genoa – ISME (Interuniversity Research Center on Integrated Systems for the Marine Environment) for the National PhD Programme in Robotics and Intelligent Machines (DRIM), XLII cycle.

Scholarship Amount:

- Fascia 4: 19,500 €/year

2. Optimization of Distributed Acoustic Sensing and Multisensor Data Fusion – Fincantieri S.p.A.

Curriculum: Hostile and unstructured environments	FINCANTIERI UNIVERSITÀ DI PISA Università di Genova
Hosting Institution: University of Pisa, Pisa	
Department: Department of Information Engineering (DII), University of Pisa **Laboratory:**	
Tutor(s): Prof. Riccardo Costanzi (University of Pisa) **Scientific referents of the agreement:** Prof. Giovanni Indiveri (University of Genoa – ISME); Mirko Stifani (Fincantieri S.p.A.)	

Description:

The research line aims at developing advanced methodologies and tools for the management and optimisation of distributed underwater sensing systems, based on electro-acoustic and non-acoustic sensors integrated on fixed and mobile platforms operating in a coordinated manner.

In this context, the research aims to go beyond the development of individual signal processing techniques, focusing on the definition of a system-level approach to underwater sensing. The objective is to study models and methods to predict, configure and dynamically adapt the system according to the operational scenario, the environment and the required performance.

Particular attention is paid to the optimal positioning and configuration of fixed and mobile sensing nodes, also in cooperative mode, in order to improve coverage, detection and information quality while complying with the main operational, energy and communication constraints. In this perspective, the sensing system is treated as a dynamic entity, whose effectiveness depends not only on the performance of the individual sensors, but also on their arrangement, coordination and integration.

In parallel, the research investigates data fusion methodologies for tracks originating from heterogeneous sensors with different resolutions, uncertainties and update rates (multimodal approach). The goal is to correlate information from different sources in order to build a coherent representation of the operational context, supporting decision-making and planning processes.

The ultimate goal of the research is therefore a scalable and transferable framework, able to support the design and management of distributed sensing architectures, improving the overall effectiveness of the system in terms of coverage, detection, information quality and integration with autonomous and mission systems. The reference system supporting the activities is DEEP (Dynamic Ecosystem for Enhanced Performance), a complex system for the monitoring and protection of critical underwater infrastructures and environments.

Research plan

Year 1

- Definition of the methodological framework for the management and optimisation of distributed sensing systems, including fixed and mobile nodes with heterogeneous characteristics.
- Analysis of the main deployment configurations of sensors and platforms, identifying the parameters affecting coverage, detection and information quality.
- Preliminary study of sensor performance as a function of configuration, geometry, environmental conditions and operational scenario.
- Definition of the scope of the predictive models and of the optimisation tools for node positioning and configuration.
- Analysis of the types of data and tracks generated by heterogeneous sensors, identifying critical issues related to resolution, uncertainty and synchronisation.

Year 2

- Development of the first predictive models for estimating sensing system performance as a function of node configuration and operational scenario.
- Development of optimisation tools for the positioning and configuration of fixed and mobile nodes, also in cooperative and multi-platform configurations.
- Introduction of near-real-time update logics to adapt the system configuration to the evolution of the scenario.
- Development of the first data fusion modules for tracks from heterogeneous sensors, with uncertainty management and information correlation.
- Preliminary integration of the developed models and modules into simulation and validation environments.

Year 3

- Consolidation and validation of the predictive models and optimisation tools in representative application scenarios.
- Verification of the system's ability to dynamically adapt node positioning and configuration to operating conditions and mission priorities.
- Advanced development and optimisation of the data fusion modules, building coherent and up-to-date representations of the operational context.
- Integration of the developed modules into mission systems and distributed sensing management frameworks.
- Structuring of the results in reusable form and preparation for technology transfer, through the definition of modular components and integration criteria for product systems.

Requirements:

The ideal candidate would have a Master's degree in Telecommunication, Electronic, Computer, Robotics or Automation Engineering, Computer Science, Physics, or a closely related discipline. A background in signal processing, estimation and data fusion (e.g., Bayesian filtering, multi-target tracking), optimisation and programming (Python, C++ or MATLAB) is appreciated; knowledge of underwater acoustics is a plus.

References:

- R. Costanzi, D. Fenucci, V. Manzari, M. Micheli, L. Morlando, D. Terracciano, A. Caiti, M. Stifani, A. Tesei, "Interoperability Among Unmanned Maritime Vehicles: Review and First In-field Experimentation," in *Frontiers in Robotics and AI, vol. 7, 91*, 2020.
- R. Costanzi, D. Fenucci, V. Manzari, A. Caiti, R. Petroccia, "Towards an Autonomous Underwater Vehicles Test Range: At-sea Experimentation of Bearing-only Tracking Algorithms," in *Annual Reviews in Control*, 2018.
- M. Bresciani, G. Peralta, F. Ruscio, L. Bazzarello, A. Caiti, R. Costanzi, "Cooperative ASV/AUV System Exploiting Active Acoustic Localization," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2021.

Company name and link (for industrial projects):

Fincantieri S.p.A., Trieste – https://www.fincantieri.com

Number of positions available: 1

Main Research Site

The research activities will be carried out at:

- University of Pisa – Department of Information Engineering (DII), Pisa (hosting institution);
- University of Genoa – ISME (Interuniversity Research Center on Integrated Systems for the Marine Environment), c/o DIBRIS, Genoa – administrative seat of the PhD programme;
- Fincantieri S.p.A. – company sites, according to the research programme agreed between the scientific referents.

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Funding Scheme: This doctorate grant is funded by Fincantieri S.p.A. under the agreement with the University of Genoa – ISME (Interuniversity Research Center on Integrated Systems for the Marine Environment) for the National PhD Programme in Robotics and Intelligent Machines (DRIM), XLII cycle.

Scholarship Amount:

- Fascia 4: 19,500 €/year

3. Intelligent and Safe Robotic Systems for Complex and Unstructured Environments – The Italian Institute of Artificial Intelligence (AI4I)

Curriculum: Hostile and unstructured environments	AI4I AI FOR INDUSTRY The Italian Institute of Artificial Intelligence
Hosting Institution: The Italian Institute of Artificial Intelligence (AI4I), Turin	
Laboratory: IDeaLS Lab – Intelligent Development and Large-Scale Systems Lab	
Tutor(s): Sebastiano Panichella	

Description:

The PhD project focuses on the development of intelligent, adaptive, and trustworthy robotic systems capable of operating reliably in complex, dynamic, and uncertain environments. The research will investigate how Artificial Intelligence, Machine Learning, Software Engineering, and advanced robotic technologies can be integrated to enable autonomous systems to perceive, reason, adapt, and operate safely in environments characterized by uncertainty, changing conditions, and limited predictability.

The research activities will explore AI-based perception, learning and decision-making, simulation-based development and testing, uncertainty estimation, runtime monitoring, safety mechanisms, and self-adaptation for intelligent robotic systems. Particular emphasis will be placed on developing approaches that allow robotic systems to identify and cope with unexpected environmental conditions, anomalous behaviours, and potentially unsafe situations during operation.

The candidate will contribute to the development and experimental evaluation of novel AI-enabled approaches for autonomous robotic systems, combining simulation environments, Digital Twins, and physical robotic platforms. The research may involve the investigation of autonomous aerial and ground robotic systems, multi-robot and collaborative robotic systems, and other intelligent machines operating in complex environments.

An important aspect of the research will concern the development of methods for bridging the gap between simulated and real-world robotic environments. This includes investigating how simulation can be used for the development, testing, validation, and evolution of intelligent robotic systems, while accounting for differences between simulated and physical environments and for the non-deterministic behaviour that may emerge during real-world operation.

The project will also investigate methods for monitoring and assessing the behaviour of autonomous robotic systems at runtime. Such approaches may combine data-driven techniques, machine learning, uncertainty estimation, and software engineering techniques to identify changes in system behaviour and support timely adaptation of robotic systems to new or unexpected conditions.

The research may further consider teams of autonomous robots operating collaboratively. In such settings, the focus will extend from the behaviour of individual robotic systems to the behaviour of the overall team, investigating how collective safety, uncertainty, coordination, and robustness can be assessed and improved.

The candidate will have the opportunity to investigate different AI and machine learning approaches, including learning-based and reinforcement-learning-based techniques,

depending on the specific research direction and application scenario. The research will combine methodological development with experimental evaluation on representative robotic use cases.

The project will contribute to the broader development of trustworthy intelligent machines capable of operating safely and effectively in real-world environments, with potential applications in autonomous inspection, infrastructure monitoring, industrial environments, mobility, emergency response, and other scenarios where robotic systems must operate under uncertainty and interact with complex environments.

Requirements:

The ideal candidate would have a degree in Computer Science, Artificial Intelligence, Robotics, Computer Engineering, Electrical Engineering, Mechanical Engineering, or a closely related discipline.

A strong interest in Artificial Intelligence, Machine Learning, Robotics, Autonomous Systems, Software Engineering, or Cyber-Physical Systems is expected. Experience with programming, machine learning, robotics, simulation environments, or experimental research is considered an advantage.

References:

- S. Panichella, C. Birchler, S. Khatiri, P. Rani, T. Kehrer, "A Roadmap for Simulation-Based Testing of Autonomous Cyber-Physical Systems: Challenges and Future Direction," in *ACM Transactions on Software Engineering and Methodology*, 2025.
- S. Khatiri, S. Panichella, P. Tonella, "Simulation-based Test Case Generation for Unmanned Aerial Vehicles in the Neighborhood of Real Flights," in *IEEE International Conference on Software Testing, Verification and Validation*, 2023.
- C. Birchler, T. Kombarabettu Mohammed, P. Rani, T. Nechita, T. Kehrer, S. Panichella, "How does Simulation-based Testing for Self-driving Cars match Human Perception?" in *ACM International Conference on the Foundations of Software Engineering*, 2024.

Number of positions available: 1

Main Research Site

Italian Institute of Artificial Intelligence for Industry (AI4I), Turin

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Funding Scheme: This doctorate grant is funded by the Italian Institute of Artificial Intelligence for Industry (AI4I), Turin

Scholarship Amount:

- Fascia 4: 19,500 €/year

4. Learning, Reasoning, and Decision-Making in Humans and Social Artificial Systems – University of Milano-Bicocca

Curriculum: Hostile and unstructured environments	
Hosting Institution: University of Milano-Bicocca	
Department: Department of Psychology – BiConnect Lab	
Tutor(s): Prof. Dimitri Ognibene	

Research theme description

This research examines how attention, learning, and reasoning shape decisions at individual and collective levels, and how computational models can inform systems that support human wellbeing. It connects three complementary themes: attention and ecological interaction in dynamic environments; social learning and reasoning in natural and artificial intelligence; and information systems that support collective wellbeing.

The programme will investigate how individuals select and interpret information, adapt to changing environments, and learn through interaction with others and with intelligent systems. It will also examine how social and technological environments shape these processes, linking individual cognition to collective behaviour and outcomes.

Combining behavioural research, computational modelling, and artificial intelligence, the research aims to develop an integrated understanding of cognition and interaction across scales, informing the design of human-centred systems that support adaptive decisions, effective learning, and collective wellbeing.

Requirements:

Proposed: MSc degArree in Computer Science, Artificial Intelligence, Robotics, Cognitive Science, Psychology, or a related discipline. Background in behavioural research, computational modelling, or machine learning; programming and quantitative analysis skills desirable.

References (maximum 3):

- Ognibene, D., Wilkens, R., Taibi, D., Hernández-Leo, D., Kruschwitz, U., et al. (2023). Challenging social media threats using collective well-being-aware recommendation algorithms and an educational virtual companion. Frontiers in Artificial Intelligence, 5, 654930.https://doi.org/10.3389/frai.2022.654930
- Taniguchi, T., Murata, S., Suzuki, M., Ognibene, D., Lanillos, P., Ugur, E., et al. (2023). World Models and Predictive Coding for Cognitive and Developmental Robotics: Frontiers and Challenges.Advanced Robotics, 37(13), 780–806. https://doi.org/10.1080/01691864.2023.2225232

- Patania, S., Annese, L., Koyuturk, C., & Ognibene, D. (2026). Teaching LLMs Naturally: Pedagogical Strategies for Interactive Knowledge Acquisition. In Proceedings of the 25th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2026), 3097–3105. https://doi.org/10.65109/JGLB4831

Number of positions available: 2

Main Research Site

BiConnect Lab, Department of Psychology, University of Milano-Bicocca, Building U6, Piazza dell'Ateneo Nuovo 1, 20126 Milano, Italy

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Funding Scheme: This doctorate grant is funded by University of Milano-Bicocca Progetto: URGO–ISI – Dinamiche e Soluzioni per l'Inclusività nelle Future Società Ibride, ID IRIS: 2025-NAZ-0163, Codice CUP: H45E26000440005

Scholarship Amount:

- Fascia 4: 19,500 €/year

5. Hierarchical Multi-Agent Reasoning and Safe Manipulation for Modular Lunar Robotic Systems – University of Genoa-ASI

Curriculum: Hostile and unstructured environments	
Hosting Institution: University of Genoa	
Department: Department of Informatics, Bioengineering, Robotics and Systems Engineering	
Tutor(s): Prof. Fulvio Mastrogiovanni	

Description:

The proposed PhD research project aims at developing a new generation of cognitive and control architectures for modular robotic systems operating in lunar environments, with a specific focus on safe manipulation, hierarchical reasoning, bounded autonomy, and multi-robot coordination. The project builds on recent work carried out at TheEngineRoom group of the Department of Informatics, Bioengineering, Robotics, and Systems Engineering, led by Prof. Fulvio Mastrogiovanni, on collision-aware robotic manipulation for lunar robots, where perception, mapping, motion planning, and execution were integrated into a unified framework and validated on both commercial and research-grade robotic manipulators in lunar-analogue scenarios.

The PhD work will investigate how local collision-aware manipulation capabilities can be elevated into a broader cognitive architecture for future lunar robotic teams. The central scientific hypothesis is that *manipulation in lunar exploration and outpost construction cannot rely only on local motion planning and control, but requires higher-level mechanisms for task reasoning, uncertainty handling, capability-aware decision making, and coordination across heterogeneous robotic embodiments*. The project will therefore integrate three tightly coupled research axes.

The first axis concerns hierarchical decision making for space robotics. The student will study architectures in which high-level task reasoning, mid-level task-and-motion planning, and low-level safe execution are linked in a recursive and adaptive way. Attention will be devoted to Active-Inference-inspired and partially observable decision frameworks, where task execution is continuously updated using new sensory evidence, environmental changes, and explicit uncertainty estimates.

The second axis concerns modular and multi-robot lunar manipulation. The PhD will investigate how manipulation actions can be allocated across heterogeneous or reconfigurable robotic embodiments. The goal is to move from single-arm manipulation to coordinated multi-robot behaviours for inspection, assembly, maintenance, transport, and construction support tasks in lunar-analogue environments. This includes reasoning on embodiment capabilities, collision-aware cooperation, and the possible use of distributed planning and shared world models.

The third axis concerns bounded autonomy and safety-aware operation. The PhD work will study how a robotic system can autonomously act under delayed or limited human supervision while remaining within explicit safety and decision boundaries. This includes the development of monitoring and recovery mechanisms, predictive models of task and environment evolution, and principled conditions under which the system may continue autonomously, degrade gracefully, or escalate to human operators.

Methodologically, the project combines robotics, AI, control, cognitive architectures, and space systems engineering. It will exploit simulation and digital-twin environments, ROS2-based robotic middleware, GPU-accelerated planning, probabilistic reasoning, and experimental validation on robotic hardware and (possibly) lunar-analogue testbeds. The interdisciplinary character of the project lies precisely in the integration of embodied robotics, AI-based reasoning, safe autonomy, and space mission constraints.

Requirements: The ideal candidate would have a degree in Robotics Engineering, Computer Engineering, Computer Science, or related fields. Applicants are expected to have an excellent background in robot perception, reasoning, and task-motion planning, as well as AI-based cognitive approaches to robotics.

References:

1. Bricarello *et al*. Experience-driven continual learning of terrain traversability for quadruped robots. arXiv preprint arXiv:2609.39755.
2. Thomas *et al*. Locally optimal solutions to constraint displacement problems via path-obstacle overlaps. Robotics and Autonomous Systems 196, 105251, 2026.
3. Karami *et al*. A task and motion planning framework using iteratively deepened AND/OR graph networks. Robotics and Autonomous Systems 189, 104943, 2025.

Company name and link (for industrial projects): The PhD work will be held jointly between the University of Genoa and Italian Space Agency.

Number of positions available: 1

Main Research Site: The PhD work will be at TheEngineRoom, research group affiliated with the Department of Informatics, Bioengineering, Robotics, and Systems Engineering, University of Genoa. The research activity, jointly carried out with the Italian Space Agency, will include visits at the European Space Agency (ESA), ESTEC.

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Funding Scheme: The doctorate scholarship is fully funded by a grand obtained from the Italian Space Agency.

Scholarship Amount:

- 18,500 €/year

6. Designing and developing humanoid robot companions – University of Genova

Curriculum: Hostile and unstructured environments	Università di Genova
Hosting Institution: University of Genova	
Department: DIBRIS	
Tutor(s): Prof. Antonio Sgorbissa	

Description:

Humanoid robot companions are increasingly expected to operate as intelligent partners in everyday human environments, supporting users through natural interaction, autonomous mobility, and meaningful engagement with domestic objects and spaces. Unlike industrial robots, humanoid companions must act in environments that are only partially structured, shared with humans, and characterized by dynamic objects, social conventions, and safety constraints. Platforms such Agibot X2 Ultra (available at the RICE lab), provide complementary opportunities to investigate how intelligent software architectures can enable humanoid robots to perceive, decide, navigate, and interact in human-centred contexts.



This PhD project focuses on the design and development of an integrated intelligent software framework for humanoid robot companions, structured along three progressive research directions.

The first direction addresses autonomous navigation in human environments. The robot will be required to move safely and efficiently in domestic or semi-domestic spaces, taking into account people, furniture, obstacles, and social constraints. Classical navigation and mapping techniques will be integrated with human-aware navigation strategies, allowing the robot to plan paths that are not only collision-free but also socially acceptable. The emphasis will be on robust mobility in environments that change over time and are not specifically designed for robotic operation.

The second direction concerns the development of a human-robot interaction framework enabling natural, context-aware, and socially appropriate communication. The system will integrate multimodal information, including speech, gestures, user position, facial cues, and interaction history, to support adaptive dialogue and personalized behaviour. Particular attention will be devoted to the robot's ability to interpret user intentions, manage interaction turns, and select actions that are understandable, acceptable, and useful in everyday scenarios.

The third direction extends the framework toward interaction with household objects and situated assistance tasks. The robot will learn to associate objects with their functions, locations, and possible uses within the home, enabling behaviours such as finding, approaching, referring to, or supporting interaction with everyday items. Perception, navigation, and dialogue will be integrated so that the robot can understand object-related requests, reason about the surrounding environment, and coordinate its actions with the user's needs. This direction will progressively support richer forms of embodied assistance, where the humanoid companion is able to combine social interaction, spatial awareness, and object-centred reasoning within a unified intelligent architecture.

Requirements:

The ideal candidate would have a degree in Robotics Engineering or Computer Engineering, with a strong background in programming.

References:

- Grassi L., Recchiuto C.T., Sgorbissa A. Strategies for Controlling the Conversation Dynamics in Multi-Party Human-Robot Interaction (2025) International Journal of Social Robotics, 17 (8), pp. 1517 - 1539
- Nardelli A., Sgorbissa A., Recchiuto C.T.Designing Robot Companions: Exploring the Impact of Robot Personality on Perceived Empathy, Trust, Sociability, and Enjoyability (2026) IEEE Transactions on Affective Computing
- Singamaneni P.T., Bachiller-Burgos P., Manso L.J., Garrell A., Sanfeliu A., Spalanzani A., Alami R., A survey on socially aware robot navigation: Taxonomy and future challenges, (2024) International Journal of Robotics Research, 43 (10), pp. 1533 – 1572
- Kabir I.K., Mysorewala M.F. Socially aware navigation for mobile robots: a survey on deep reinforcement learning approaches (2026) Applied Intelligence, 56 (1)

Number of positions available:

1

Main Research Site

RICE lab, https://rice.dibris.unige.it/, DIBRIS, University of Genoa, via All'Opera Pia 13, 16145 Genoa, Italy

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Funding Scheme: This doctorate grant is fully funded by the University of Genova

Scholarship Amount:

- Fascia 4: 19,500 €/year