PhD Program in Bioengineering and Robotics

Curriculum: Robotics and Autonomous Systems

Research themes

The main goal of the PhD curriculum in *Robotics and Autonomous Systems* is to study, design and build novel solutions and behaviors for robots, teams of robots and, in general, autonomous systems capable of exhibiting a high degree of autonomy and intelligence when performing highly complex tasks in challenging real-world environments.
The focus of the curriculum is two-fold: on the one hand, on key, innovative and disruptive methodologies and technologies, including such topics as sensing, state estimation, knowledge representation, software architectures for robots, real-time scheduling, motion planning, advanced robot control, robot coordination and cooperation, human-robot interaction and collaboration, design of macro/micro robot systems, design of sensors and actuators; on the other hand, on specific areas, e.g., underwater operations, aerial and space, or Industry 4.0, as well as on such diverse application scenarios as manufacturing, material handling and transportation, search & rescue, surveillance and monitoring, ambient assistive living). The curriculum enforces research practices and education methodologies based on cutting-edge best practices at the international levels, and all the aspects outlined above are dealt with by focusing on the study and the adoption of theoretically sound methodologies and the design of experimentally verifiable solutions, with the goal of meeting robustness and predictability requirements even in unknown, dynamically changing, or even hazardous environments. The ideal candidates are students with a higher-level University

degree, with a strong desire for investigating, designing and developing robot-based systems which can have a huge, disruptive, impact on the society in the upcoming future.

International applications are strongly encouraged and will receive logistic support with visa issues and relocation.

1. MULTI-DRONE LOAD TRANSPORTATION

Tutor: Marco Baglietto

Tutors Affiliation: DIBRIS, University of Genova, www.dibris.unige.it

Project Description

The use of multiple **Unmanned Aerial Vehicles** (UAVs) opens new possibilities for exploring a wide range of applications in complex and dynamic environments. These include cooperative task assignments such as large-scale area monitoring, search and rescue operations, infrastructure inspection, and precision agriculture. Beyond observation and surveillance, multi-UAV systems also enable advanced coordination tasks such as formation flight and **collaborative manipulation** [1].

In such cooperative missions, the development of **novel control strategies** becomes essential, particularly when the system consists of multiple quadrotors connected to a common payload through flexible rods or cables [2][3]. These mechanical couplings introduce additional dynamics and constraints that significantly increase the complexity of the overall system, requiring controllers capable of handling underactuation, coupling effects, and time-varying disturbances.

Using more UAVs enables heavier payload transport over longer distances while distributing effort among agents, reducing individual energy consumption and extending mission endurance. However, cooperative transportation also introduces **challenges** such as coordinated takeoff and landing, recovery from UAV failures [2], maintaining stable formation control under disturbances, and autonomous reconfiguration based on sensor feedback.

Requirements:

- Classical Control/Optimal Control
- State estimation and Filtering
- familiarity with ROS/ROS2 environment
- C++/Python
- Matlab/Simulink
- PX4 (optional)

References:

[1] D. K. D. Villa, A. S. Brandão, R. Carelli and M. Sarcinelli-Filho, "Cooperative Load Transportation With Two Quadrotors Using Adaptive Control", in IEEE Access, vol. 9, pp. 129148-129160, 2021, doi: 10.1109/ACCESS.2021.3113466.
[2] A. Delbene and M. Baglietto, "On Formation Control Strategies in a Failure-Prevention Scenario for Multi-UAV Payload Transportation," 2025 IEEE 21st International Conference on Automation Science and Engineering (CASE), Los Angeles, CA, USA, 2025, pp. 185-191, doi: 10.1109/CASE58245.2025.11163951.
[3] M. Tognon, C. Gabelleri, L. Pallottino, A. Franchi, “Aerial Co-Manipulation with Cables: The Role of Internal Force for Equilibria, Stability, and Passivity”, IEEE Robotics and Automation Letters, vol. 3 no. 3, pp. 2577-2583, 2018, doi: 10.1109/LRA.2018.2803811.

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2. DUAL ARM MANIPULATION FOR HUMAN-ROBOT COOPERATIVE OPERATIONS

Tutor: Giorgio Cannata

Tutor Affiliation: Department of Informatics, Bioengineering, Robotics, and Systems Engineering (DIBRIS), University of Genova

Project Description

Collaborative robots (COBOTS) are used in industrial and service applications to accomplish tasks where human-robot cooperation (i.e. sharing a common space) or collaboration (i.e. physically interacting to complete a common action) is required. Between the different approaches to perform Human-Robot Cooperation, Bi-manual or multi-arm manipulation becomes the predominant technique for this type of applications. The advantages of implementing Bi-manual or Dual arm manipulation (DAM) refers to the ability of transfer the skill of the human entity-operator to the robot in a more intuitive way, and in dual arm coordinated tasks, the use of dual arm manipulation allows to combine the task flexibility and dexterity of serial links, with the stiffness and strength of parallel manipulation while holding objects. (closed chain mechanism).

The PhD project has the goal to implement a dual arm/Bi manual control approach for coordinated tasks, while overcoming the principal issues when performing dual-arm manipulation, such as generating feasible configurations connected through each other (motion planning), internal forces acting while arms are holding objects, manipulators breaking and reinitializing contact with a common object (regrasping), among others.

The experimental scenario is based on a dual-arm robot (sensorized using cameras, tactile and proximity sensors) mounted on a mobile platform for assistive or domestic applications, sharing the space with a human operator to complete a series of operations involving contact of the robot with the environment

Requirements:

Applicants must have a good knowledge of robotics fundamentals and robot programming. Applicants are also expected to have good programming skills (possibly including Python, C/C++, Matlab/Simulink), confidence with electronic hardware and be capable to conduct experiments, and a strong attitude to problem solving

References:

Zhang, J., Xu, X., Liu, X., & Zhang, M. (2018, December). Relative dynamic modeling of dual-arm coordination robot. In *2018 IEEE International Conference on Robotics and Biomimetics (ROBIO)* (pp. 2045-2050). IEEE.

Wang, J., Liu, S., Zhang, B., & Yu, C. (2019). Inverse kinematics-based motion planning for dual-arm robot with orientation constraints. *International Journal of Advanced Robotic Systems*, *16*(2), 1729881419836858.

Xian, Z., Lertkultanon, P., & Pham, Q. C. (2017). Closed-chain manipulation of large objects by multi-arm robotic systems. *IEEE Robotics and Automation Letters*, *2*(4), 1832-

Contact: giorgio.cannata@unige.it

3. HUMAN-ROBOT COLLABORATION – UNIVERSITA' DI GENOVA

Tutor: Giorgio Cannata

Tutor Affiliation: Department of Informatics, Bioengineering, Robotics, and Systems Engineering (DIBRIS), University of Genova

Project Description

Collaborative robots (COBOTS) are used in industrial and service applications to accomplish tasks where human-robot cooperation (i.e. sharing a common space) or collaboration (i.e. physically interacting to complete a common action) is required. During collaborative tasks robots are controlled using feedback from cameras, force/torque sensors, tactile sensors, proximity sensors etc. which allow the robot to localize itself and interact safely with humans and objects.

The PhD project has the goal of developing robot system capable to physically interact with a human to collaborate to execute jointly assembly operations. The scientific objective is to investigate human-robot interaction control strategies based on sensor feedback from cameras, tactile and proximity sensors (multimodal sensing) mounted on the robot arm, enabling safe interaction and touch based robot guidance

The experimental scenario is based on a dual-arm robot (sensorized using cameras, tactile and proximity sensors) mounted on a mobile platform sharing the space with a human operator to complete a series of operations involving contact of the robot with the environment.

This PhD research theme is part of the activities of the European project HE Sestosenso (www.sestosenso.eu)

Requirements:

Applicants must have a good knowledge of robotics fundamentals and robot programming. Applicants are also expected to have good programming skills (possibly including Python, C/C++, Matlab/Simulink), confidence with electronic hardware and be capable to conduct experiments, and a strong attitude to problem solving.

References:

A. Albini, F. Grella, P. Maiolino and G. Cannata, "Exploiting Distributed Tactile Sensors to Drive a Robot Arm Through Obstacles," in IEEE Robotics and Automation Letters, vol. 6, no. 3, pp. 4361-4368, July 2021, doi: 10.1109/LRA.2021.3068110.

Albini A, Cannata G. Pressure distribution classification and segmentation of human hands in contact with the robot body. The International Journal of Robotics Research. 2020;39(6):668-687. doi:10.1177/0278364920907688

F. Grella, A. Albini and G. Cannata, "Voluntary Interaction Detection for Safe Human-Robot Collaboration," 2022 Sixth IEEE International Conference on Robotic Computing (IRC), Italy, 2022, pp. 353-359, doi: 10.1109/IRC55401.2022.00069.

Company name and link (for industrial projects):

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4. HIERARCHICAL, MULTI-DOMAIN REASONING MODELS FOR AUTONOMOUS ROBOTS

Tutor: Fulvio Mastrogiovanni

Tutor Affiliation: TheEngineRoom, Department of Informatics, Bioengineering, Robotics, and Systems Engineering (DIBRIS), University of Genova

website: https://theengineroom.dibris.unige.it/

Project Description

In the past few years, we have witnessed the rise of advanced reasoning capabilities in intelligent systems based on Large Language Models (LLMs). When used with robots, such models are subject to significant constraints. Among them, the availability of appropriate datasets, the embedding of robot-specific capabilities, the resulting model size, the ability to reason about multiple – yet related – domains, and inference time.
At TheEngineRoom, we explored the use of fine-tuned LLMs to generate robot plans which actions can be streamlined and executed while the plan is being generated. This allows us to simultaneously plan and execute actions, with relevant capabilities in terms of sensorimotor, in-the-loop replanning. The fine-tuning process is based on synthetic data generated using optimal or heuristic PDDL-compatible logic-based planners, which ensure that logic constraints are implicitly encoded in the resulting model via examples. Our first model, which we refer to as Teriyaki [1], suffers from two major limitations. The first is the use of a "big", cloud-based LLM, which hinders the embeddability of the overall robot software architecture. The second is the fact that Teriyaki can only generate intrinsically single-domain reasoning models. While the first limitation has been partially addressed in our second reasoning model, called Gideon, which is based on a "small" LLM, the need arises to work on a principled, second iteration of Teriyaki characterized by the following capabilities:

1) small memory footprint, with the purpose of embedding the model into computational machinery aboard the robot's body, which requires the use of small LLMs;
2) inference time compatible with robot operations in real-world environments to enforce sensorimotor, in-the-loop continuous re-planning;
3) hierarchical reasoning, whereas a full hierarchy of reasoning models can be orchestrated, possibly using a specifically designed reasoning model, or in fully decentralized mode;
4) multi-domain reasoning, whereas each model is capable of reasoning on one or more (related) domains, depending on the context.

Relevant scenarios will be those where mobile robots must carry out tasks involving the (location-specific) manipulation of objects, and their transportation to other locations. While high-level reasoning will be based on approaches aimed at fine-tuning LLMs to generate a hierarchy of multi-domain reasoners, low-level robot motions will be achieved using Vision-Language-Action models, such as for example OpenVLA [2].

The work to be done may include at least the following activities:

- Analysis of state-of-the-art literature to understand current approaches and limitations in hierarchical architectures for robots, and in the use of LLM-based reasoning models.
- Design and synthesis of a fully LLM-based, hierarchical robot architecture, for example

taking inspiration from previous work done at TheEngineRoom [3].

- Design and implementation of software tools to obtain domain- and robot-specific, synthetic data, related to the reasoning domains of interest.
- Implementation of interacting multi-domain reasoning models.
- Unit and system testing in a selected number of scenarios.

Requirements:
Applicants are expected to have a degree in Robotics Engineering, Computer Engineering, or related study programs. Ideal candidates have previous experience with LLMs (possibly small models) and machine learning pipelines in general. Expertise in logic-based reasoning, robot architectures, and robot software development are a nice plus.

References:

[1] A. Capitanelli, F. Mastrogiovanni. A framework for neurosymbolic robot action planning using Large Language Models. Frontiers in Neurorobotics 18, 1342786, 2024.
[2] M. J. Kim, K. Pertsch, S. Karamcheti, T. Xiao, A. Balakrishna, S. Nair, R. Rafailov, E. Foster, G. Lam, P. Sanketi, Q. Vuong, T. Kollar, B. Burchfiel, R. Tedrake, D. Sadigh, S. Levine, P. Liang, C. Finn. OpenVLA: an open-source vision-language-action model. arXiv:2406.09246, 2024.
[3] H. Karami, A. Thomas, F. Mastrogiovanni. A task and motion planning framework using iteratively deepened AND/OR graph networks. Robotics and Autonomous Systems 189, 104943, 2025.

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5. ACTIVE, DISTRIBUTED AND RECURSIVE REASONING MODELS FOR COGNITIVE ROBOTS

Tutor:
Fulvio Mastrogiovanni

Tutor Affiliation:
TheEngineRoom, Department of Informatics, Bioengineering, Robotics, and Systems Engineering, University of Genoa

Description:

The ability for an autonomous robot to act proactively in its surrounding and while interacting with humans is vital to be effective. Providing robots with adequate knowledge in a wide range of scenarios and situations is very expensive, both in terms of effort to provide and encode knowledge, and for what concerns the time it takes to do so. At the research level, the current situation is robots able to perform skillfully in very narrow tasks, if provided with Artificial Intelligence (AI) models trained on a huge amount of data.

Novel approaches to design and develop cognitive architectures for robots, and in particular advanced reasoning models, seem to exacerbate this issue. Advanced multi-modal AI models, such as for instance OpenVLA [1], leverage Large Language Models (LLMs) to encode qualitatively different information (such as a linguistic description of tasks, their visual unfolding, and the related robot joint states) to generate task descriptions specifically tailored for the goal to achieve, the robot embodiment, and its (visual) perception. Even when training is successful, the result task is very narrow and specialized, despite showing up impressive capabilities.

Building up on such advanced multi-modal AI models, this PhD thesis aims to design and develop reasoning capabilities for robots inspired by theories about human cognition. In particular, we want to investigate 1) the general structure of a robot cognitive architecture informed by the principles of active sensing and inference, interactive and distributed processing, and recursion, as well as 2) the existence of general-purpose “algorithm” which, operating continuously, can lead to flexible and adaptable robot behavior. To attain these goals, the specific research topics may include one or more of the following:

- active sensing strategies: inspired by the paradigm of Active Inference [2], sensing will be treated as an active process aimed at reducing the uncertainties associated with the robot’s own knowledge; this could lead to planning and execute sensing behavior based on the status of the robot knowledge;
- action-oriented knowledge representation: likewise, robot knowledge must be actionable, that is, being acquired and encoded such that knowledge-based action is facilitated and less computationally effortful; specific metrics to evaluate robot knowledge in terms of uncertainty, accuracy, and actionability will have to be investigated;
- distributed and concurrent AI reasoning models: while current multi-modal AI models are of a “one-size-fits-all” nature, this PhD thesis will investigate how to orchestrate and combine the results of multiple, possibly specialized, (multi-modal) AI models, all of them running concurrently; this will lead to the possibility of investigating matters

related to “inner speech”, that is, using integrated linguistic-level descriptions of the data flow emerging from these models;

- hierarchical approaches to sensing, reasoning, and action: it will be posited here that the overall robot behavior will be obtained assuming that such orchestration be of a hierarchical nature, that is, instead of assuming a centralized “algorithm” to schedule how sensing modules, multi-modal AI models, and action models, all of them will be considered as components which can be invoked by each other recursively [3];
- “intrinsic” behavioral models: we will posit that such distributed, hierarchical nature will be driven by normative goals and objectives, which will have to be satisfied by the concurrent behavior of all components.

Key challenges to be addressed may include:

- Identification of key strategies in active sensing, for example to integrate vision and tactile information in active sensing, representation, and action models;
- hybrid, multi-modal, continuous-discrete knowledge representation approaches, possibly informed by strategies implemented in biological beings to efficiently ground actions;
- approaches to integrate the outcome of concurrent AI reasoning models, possibly inspired by such decentralized formalisms as Cellular Automata and alike [4];
- design and formalization of hierarchical approaches to modelling robot behavior, with the aim of a seamless integration of sensing, reasoning, and action modules;
- ways of embedding normative goals and objective such that to be compatible with active, hierarchical and distributed modules.

The developed techniques and methods will be validated through simulations and real-world experiments. Scenarios will include humanoid robots able to interact with their environment, for example in in-home or industry settings.

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, sensing, reasoning, and motion planning and execution. The ideal candidate is proficient computer vision, tactile sensing, knowledge representation, concurrent and recurrent processes.

References:
[1] M. J. Kim, K. Pertsch, S. Karamcheti, T. Xiao, A. Balakrishna, S. Nair, R. Rafailov, E. Foster, G. Lam, P. Sanketi, Q. Vuong, T. Kollar, B. Burchfiel, R. Tedrake, D. Sadigh, S. Levine, P. Liang, C. Finn. OpenVLA: an open-source vision-language-action model. arXiv:2406.09246, 2024.
[2] T. Parr, G. Pezzulo, K. Friston. Active Inference: The free energy principle in mind, brain, and behavior. MIT Press, 2022.
[3] H. Karami, A. Thomas, F. Mastrogiovanni. A task and motion planning framework using iteratively deepened AND/OR graph networks. Robotics and Autonomous Systems 189, 104943, 2025.
[4] A. Ilachinski. Cellular Automata: A discrete universe. World Scientific, 2001.

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6. LLM-BASED APPROACHES FOR DIVERSITY AWARENESS APPLIED TO SOCIAL ROBOTS IN THE EDUCATIONAL SECTOR

Tutors: Carmine Tommaso Recchiuto

Tutors Affiliation: DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering, Università degli Studi di Genova, https://rice.dibris.unige.it/

Project Description

According to a broadly accepted definition, "diversity is about what makes each of us unique and includes our backgrounds, personality, life experiences and beliefs, all of the things that make us who we are. (...) Diversity is also about recognizing, respecting, and valuing differences based on ethnicity, gender, age, race, religion, disability, and sexual orientation. (...) Inclusion occurs when people feel, and are valued and respected regardless of their personal characteristics or circumstance (...) Equal opportunity means that every person can participate freely and equally in areas of public life (...) without disadvantage or less favorable treatment due to their unique attributes." [1].

On the other hand, social robotics has recently shown its potential applications both as a powerful tool in the educational sector, to help, among the other things, children learn a second language or to deal with children's special needs, but also as an instrument for inclusion, thanks to the development of robots that may consider the different cultural background (e.g., social norms, preferences, religious habits) of persons during the interaction [2].

For all these reasons, the main goal of this PhD program lies in the development of human-robot interaction strategies that leverage initial information about users to implement interaction patterns that are aware of diversity, with a particular focus on the educational field. In this context, the program foresees the use, potentially through fine- tuning of generative language models (LLMs), which can be employed both to improve user understanding and task evaluation, as well as to achieve smoother, more varied, and user-adaptive interactions.

Indeed, in AI and robotics research, significant efforts have been made to tackle the challenge of personalizing robots to suit individual needs: one strategy is to employ machine learning (ML) techniques that periodically gather and analyze vast datasets, with the goal of gaining deeper insights into the person and their environment, but common approaches also include robots that interact with diverse groups and people using a priori knowledge and behave in a way that is most likely to work for most people it interacts with, rather than trying to adapt to individual differences. This approach has been usually followed in the education sector, where, however, diversity-awareness has been so far limited to the cultural dimension [3].

his PhD program aims at overcoming the current limitations at the state-of-the-art, by developing a software framework for social robot in the educational sector that can be really diversity-aware, combining a priori knowledge with the learning and adaption capability offered by LLM. The software framework is expected to be deployed in various contexts, including interaction with children with diverse developmental needs.

Requirements: Applicants are expected to have good programming skills (C++, Java, or Python) and a profound interest in cutting-edge research in autonomous robotics. Previous experience with Artificial Intelligence techniques and Human-Robot Interaction strategies will be considered.

When applying for the Ph.D. scholarship, the student will be encouraged to propose solutions to address one or more of the aspects described in the proposal.

References:

[1] The Victorian Government commitment to diversity and inclusion (D&I), https://bit.ly/3DbTzlJ

[2] Papadopoulos, C., Castro, N., Nigath, A., Davidson, R., Faulkes, N., Menicatti, R., ... & Sgorbissa, A. (2022). The CARESSES randomised controlled trial: exploring the health-related impact of culturally competent artificial intelligence embedded into socially assistive robots and tested in older adult care homes. *International Journal of Social Robotics*, *14*(1), 245-256.

[3] Kim, Y., Marx, S., Pham, H. V., & Nguyen, T. (2021). Designing for robot-mediated interaction among culturally and linguistically diverse children. *Educational Technology Research and Development*, *69*, 3233-3254.

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7. MULTIPARTY HUMAN-ROBOT INTERACTION

Tutors: Carmine Tommaso Recchiuto

Tutors Affiliation: DIBRIS, Department of Informatics, Bioengineering, Robotics and Systems Engineering, Università degli Studi di Genova, https://rice.dibris.unige.it/

Project Description: In recent years, the field of Human-Robot Interaction (HRI) has increasingly shifted from dyadic, one-on-one interactions to more complex multiparty settings, where multiple humans and multiple robots engage in verbal communication. Such scenarios are particularly relevant in domains like education, healthcare, and collaborative work, where robots are expected to function not as isolated tools but as **socially aware agents** capable of managing group dynamics, turn-taking, attention, and conversational context.

Verbal interaction in these settings presents unique challenges, including **speaker identification, role recognition, coordination across participants, and the maintenance of coherent dialogue threads** across different agents. As an example, accurately identifying the active speaker may involve combining audio and visual cues developing smoother interactions in environments where multiple participants speak in rapid succession or simultaneously [1].

The main goal of this PhD program lies in the development of ***multi-robot***, ***multi-users*** interaction strategies, capable of understanding the active speaker, but also the person(s) or robot(s) whom the person is addressing during the interaction, so that the robot(s) can properly interpret conversational intent and respond appropriately. Moreover, the robots should be able to correctly interpret speech, so that it can intervene only when it is appropriate, and respond in ways that are contextually appropriate and socially sensitive [2, 3]. Finally, the presence of **multiple robotic agents** adds an additional layer of complexity, requiring each robot to manage its own role in the dialogue while being aware of the contributions and actions of the others.

Requirements:
Applicants are expected to have good programming skills (C++, Java, or Python) and a profound interest in cutting-edge research in autonomous robotics. Previous experience with Artificial Intelligence techniques and Human-Robot Interaction strategies will be considered. When applying for the Ph.D. scholarship, the student will be encouraged to propose solutions to address one or more of the aspects described in the proposal.

References:

[1] Appiani, A., & Beyan, C. (2025). VAD-CLVA: Integrating CLIP with LLaVA for Voice Activity Detection. *Information*, *16*(3), 233.

[2] Moujahid, M., Hastie, H., & Lemon, O. (2022, March). Multi-party interaction with a robot receptionist. In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 927-931). IEEE.

[3] Grassi, L., Recchiuto, C. T., & Sgorbissa, A. (2023, October). Robot-induced group conversation dynamics: a model to balance participation and unify communities. In *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (pp. 3991-3997). IEEE.

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8. SOCIAL AND EDUCATIONAL ROBOTICS TO PROMOTE SOCIO-EMOTIONAL SKILLS AND INCLUSION IN SCHOOL CONTEXTS

Tutors: Antonio Sgorbissa, Sabrina Panesi

Tutors Affiliation: Department of Informatics, Bioengineering, Robotics and Systems Engineering, University of Genova, https://rice.dibris.unige.it/

Project Description

This research project focuses on the use of social and educational robotics to promote socio-emotional competencies and inclusive practices among children and adolescents, both with typical development and with neurodevelopmental disorders (e.g., autism spectrum disorder). The project aims to design, implement, and evaluate robotic interventions that foster emotional understanding, empathy, cooperation, and social interaction in school settings.

The topic can be approached from different disciplinary perspectives. From a psychology perspective, the research may focus on the assessment of socio-emotional outcomes, interaction patterns, and the psychological mechanisms underlying engagement with robotic agents. From a computer science perspective, the focus may lie on developing adaptive robotic behaviors, affective computing models, and intelligent systems capable of responding to users' emotional and social cues.

In both cases, the multidisciplinary environment of the RICE Lab, integrating expertise in psychology, education, and robotics, will provide the necessary theoretical, methodological, and technical support to develop innovative and evidence-based solutions for inclusive education through robotics.

Requirements: applicants are expected to have a profound interest in cutting-edge research in autonomous robotics. Also, they are expected to have either

1. good programming skills (C++, Java, or Python), or
2. a background in psychology and previous experience in the study of educational and social robotics.

References:

Madrid Ruiz, E.P., Oscanoa Fernández, H.H., García Cena, C.E., Cedazo León, R. Design of JARI: A Robot to Enhance Social Interaction in Children with Autism Spectrum Disorder (2025) Machines, 13 (5)

Levinson, L., Charisi, V., Zotos, C., Gómez, R., Šabanović, S. Let us make robots “Think in child!”: How children conceptualize fairness, inclusion, and privacy with social robots (2025) International Journal of Child-Computer Interaction, 43, art. no. 100706.

Ali, S., Abodayeh, A., Dhuliawala, Z., Breazeal, C., Park, H.W. Towards Inclusive Co-Creative Child-Robot Interaction: Can Social Robots Support Neurodivergent Children's Creativity? (2025) ACM/IEEE International Conference on Human-Robot Interaction, pp. 321 - 330.

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9. THEORY OF MIND-BASED PLANNERS AND FOUNDATIONAL MODELS (LLM AND VLAS) IN ROBOTS CAPABLE OF ENHANCED PERSUASIVE INTERACTION

Tutors: Antonio Sgorbissa

Tutors Affiliation: Department of Informatics, Bioengineering, Robotics and Systems Engineering, University of Genova, https://rice.dibris.unige.it/

Project Description

The development of Theory of Mind (ToM) in artificial agents is a growing field, particularly in human-robot interaction, where robots with ToM can more effectively anticipate human actions and intentions. Theory of Mind—understanding that others have beliefs, desires, and intentions different from one's own—has been identified as essential for complex social behaviors, including persuasion, empathy, and cooperative manipulation [1]. In particular, the Machiavellian approach, where robots engage in strategic, persuasive interactions, could provide a deeper understanding of multi-agent collaboration in robotics and its impact on human decision-making.

This proposal will explore robots using ToM representations in a logic language (e.g., the Planning Domain Definition Language - PDDL) or in a Foundational Model (Large Language Model / Visual Language Action Model) as a basis to simulate Machiavellian, persuasive behavior. Specifically, the robot will plan a series of actions with the goal of persuading a person to take a desired action [2, 3, 4].

Expanding this concept, the framework might involve two robots working in tandem, collaboratively planning sequences to enhance persuasive effectiveness. By simulating inter-robot dialogue and collaborative strategies, the research will explore the hypothesis that two robots working together will demonstrate superior persuasive capabilities compared to a single robot, based on the premise that collaborative persuasion is more effective than isolated efforts, a phenomenon well-documented in social psychology.

Requirements: applicants are expected to have a profound interest in cutting-edge research in autonomous robotics. Also, they are expected to have either

3. good programming skills (C++, Java, or Python)
4. interest in psychology and previous experience in the study of social robotics.

References:

1. D'Angelo, Ilenia et al. "Nice and Nasty Theory of Mind for Social and Antisocial Robots." 2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN) (2023): 1675-1682.
2. Siegel M., Breazeal C., Norton M.I. Persuasive robotics: The influence of robot gender on human behavior (2009) 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2009, pp. 2563 - 2568
3. Ham J., Cuijpers R.H., Cabibihan J.-J. Combining Robotic Persuasive Strategies: The Persuasive Power of a Storytelling Robot that Uses Gazing and Gestures (2015) International Journal of Social Robotics, 7 (4), pp. 479 - 487-
4. Chidambaram V., Chiang Y.-H., Mutlu B. Designing persuasive robots: How robots might persuade people using vocal and nonverbal cues (2012) HRI'12 - Proceedings of the 7th Annual ACM/IEEE International Conference on Human-Robot Interaction, pp. 293 - 300

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10. 3D SONAR PROCESSING FOR SEMI-AUTONOMOUS ROVS

Tutors: Enrico Simetti, Giovanni Indiveri

Tutors Affiliation: DIBRIS, University of Genova, www.dibris.unige.it

ISME, www.isme.unige.it

Project Description

The objective of this research is to investigate and develop advanced methods for processing data from innovative 3D sonar sensors to support underwater inspection tasks [1]. The core idea is to exploit the rich spatial information provided by these sensors to enable vehicle localization within the environment through SLAM-based approaches and to facilitate navigation in complex and cluttered underwater scenarios, such as those characterized by moorings, aquaculture systems, or offshore structures [2]. The proposed algorithms will be validated on an existing mini-ROV (BlueROV2), which can be integrated with and deployed from a small ASV, thus creating a flexible and innovative platform for semi-autonomous remote inspections [3].

Requirements:

- Guidance, Navigation and Control of robots
- State estimation and Filtering
- ROS2 environment
- C++/Python
- Familiarity with point cloud processing (optional)
- Familiarity with SLAM (optional)

References:

[1] Vadakkekuruppath, S., Amundsen, H. B., O'Kane, J. M., & Xanthidis, M. (2025). SHRUMS: Sensor Hallucination for Real-time Underwater Motion Planning with a Compact 3D Sonar. *arXiv preprint arXiv:2510.18996*.
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