ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

CRT/DET - Socially-Aware Navigation for Autonomous Service Robots through learning-Based Approaches

Funded By	FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014] Dipartimento DET
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Context of the research activity	Development of perception, control, and evaluation methods for socially-aware navigation in service robotics. The project focuses on hybrid approaches combining model-based control with learning techniques, including Vision-Language Models, to enable autonomous robots to navigate populated environments safely and in accordance with social norms.
Objectives	This research topic addresses the open scientific and technological challenge of enabling robots to navigate complex spaces such as hospitals, airports, or public buildings while adhering to social norms and ensuring human comfort and safety. The PhD research will focus on several key areas: Hybrid Approaches: • Development of navigation algorithms that integrate model-based approaches, such as Model Predictive Control (MPC) or Model Predictive Path Integral (MPPI), with learning-based methods. • Exploration of hybrid techniques to address the limitations of strictly model-based control when dealing with unpredictable human behaviors. Integration of Visual Language Models (VLM): • Investigation of the use of Large Visual Language Models to provide semantic understanding and social context awareness for navigation tasks. Perception system for social navigation: • Development of real-time, reliable perception solutions to detect and track humans using low-cost sensors, including cameras and LiDAR. Evaluation framework and experimental validation: • Systematic testing of developed algorithms and perception systems using grounded robot platforms in controlled and uncontrolled scenarios. • Usage of comprehensive quantitative and qualitative metrics for assessing socially-aware navigation performance. The ideal candidate will possess: • A solid background in robotics, control engineering, and autonomous

	systems. • Practical experience with robot navigation algorithms and perception systems, including the use of the ROS2 platform and NAV2. • A strong interest in human-robot interaction and socially-aware robotics. This PhD position offers the opportunity to contribute to an emerging and impactful research area at the intersection of robotics, artificial intelligence, and human-centered design, with potential applications in service robotics, healthcare, public spaces, and beyond.

Skills and competencies for the development of the activity	The candidate is expected to have working knowledge on ROS and Gazebo, programming languages like Python and C++, and at least a basic knowledge about the artificial intelligence technologies described above, i.e. reinforcement learning, computer vision, logic and constraint programming.