ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

MUR DM 117/Sipal - Service robotics and enabling technologies such as artificial intelligence and machine learning in advanced logistics

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Context of the research activity	This research focuses on the utilization of service robotics and enabling technologies such as artificial intelligence and machine learning in advanced logistics. Service robotics refers to the integration of robots into various service-oriented tasks, specifically in the logistics industry. These robots are equipped with advanced capabilities to enhance efficiency, productivity, and accuracy in logistics operations. Additionally, technologies like artificial intelligence and machine learning play a crucial role in enabling these robots to perform complex tasks, understand patterns, and make autonomous decisions. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23002000004
	1. Introduction: The proposed PhD project aims to investigate and develop advanced service robotics solutions using artificial intelligence (AI) and machine learning (ML) technologies in the domain of logistics. The project will explore the integration of these enabling technologies to enhance the efficiency, effectiveness, and automation capabilities of logistics operations while providing significant economic and environmental benefits. 2. Scope: The research will focus on the following key areas: a. Service Robotics in Logistics:

Objectives	- Investigate the potential applications of service robots in various logistics processes such as material handling, order fulfillment, inventory management, and warehouse operations. - Evaluate the existing robotics platforms and technologies and their suitability for logistics applications. - Identify the challenges and opportunities associated with the adoption of service robotics in logistics. b. Artificial Intelligence and Machine Learning: - Utilize AI and ML techniques to develop intelligent algorithms and decision-making models for robotics-driven logistics systems. - Investigate how AI and ML can improve task allocation, path planning, object recognition, and manipulation capabilities in logistics robots. - Enhance the efficiency, adaptability, and autonomy of service robots through AI and ML technologies. c. Advanced Logistics Systems Integration: - Investigate the integration of service robots with existing logistics systems, including warehouse management systems (WMS), enterprise resource planning (ERP) systems, and Internet of Things (IoT) platforms. - Develop frameworks and protocols to facilitate seamless communication and interoperability between service robots and logistics infrastructure. - Explore the potential of cloud computing and edge computing for real-time data processing, analysis, and decision-making in logistics operations. 3. Objectives: The primary objectives of the proposed PhD project are as follows: a. Investigate State-of-the-Art Technologies: - Review the latest developments in service robotics, artificial intelligence, and machine learning specifically related to logistics applications. - Undertake a comprehensive literature review to identify the existing gaps and challenges in the field. b. Develop Intelligent Robotics Algorithms: - Design and develop intelligent algorithms using AI and ML techniques to enhance the perception, planning, and control capabilities of service robots in logistics. - Evaluate and compare the performance of different algorithms and determine their suitability for various logistics tasks. c. Prototyping and Experimental Evaluation: - Build prototypes of logistics robots or utilize existing platforms to implement and test the developed algorithms in real-world scenarios. - Conduct extensive experimental evaluations to assess the performance, scalability, and reliability of the proposed solutions. - Identify limitations and suggest improvements based on the empirical findings. d. Integration with Existing Logistics Systems: - Investigate the integration challenges and requirements for seamlessly integrating service robots into existing logistics systems. - Develop frameworks and protocols for effective data exchange, synchronization, and interoperability with different logistics software and hardware components. - Perform integration tests and evaluate the overall system performance in a

	realistic logistics environment. e. Economic and Environmental Assessment: - Conduct a cost-benefit analysis to assess the economic impact of implementing service robotics in logistics operations. - Evaluate the environmental benefits of using robotics-driven solutions, such as reduced energy consumption, lower carbon emissions, and optimized resource utilization. f. Impact and Knowledge Dissemination: - Publish research findings in esteemed peer-reviewed journals and conferences to contribute to the academic community. - Collaborate with industry partners to ensure practical applicability and relevance of the research outcomes. - Participate in workshops, seminars, and relevant industry events to disseminate knowledge and receive valuable feedback. 4. Conclusion: The proposed 3-year PhD project aims to deepen the understanding of service robotics and their integration with AI and ML technologies in advanced logistics. The research will contribute to the development of intelligent and autonomous logistics systems capable of providing efficient, cost-effective, and sustainable solutions for modern supply chains.

Skills and competencies for the development of the activity	Strong background in robotics: A solid foundation in robotics principles, dynamics, and control is necessary to understand the complexities of service robotics and its application in logistics. Proficiency in AI and ML: In-depth knowledge of AI techniques, including neural networks, deep learning, reinforcement learning, and ML algorithms, is critical for developing intelligent systems capable of decision-making and adaptation in logistics scenarios. Expertise in computer vision: Understanding computer vision techniques, such as object detection, tracking, and recognition, is essential for enabling robots to perceive and interact with their environment effectively. Programming skills: Proficiency in languages like Python, C++, or Java is necessary for developing robot control systems, implementing AI/ML algorithms, and integrating various software components.