Corso di Dottorato in ICT
Doctoral Course in ICT

Research project for a PhD curriculum in ICT – Research topic linked to the I-SHARM project: Intelligent SHared Autonomy for Robotic Manipulation systems.

Tutor: Prof. LUIGI BIAGIOTTI
(Possibile) Italian Co-tutor:
(Possibile) Foreign Co-tutor:

Proposed Title of the research: Context Aware Shared Autonomy for Robotic Manipulation Tasks
Keywords: Human-Robot Interaction, Human Intention Prediction, Multimodal Interaction, Robotic Manipulation and grasping.

Research objectives:
The goal of this research is to develop an innovative shared control framework for robotic manipulation systems, where both the human and the robot act as peers, each contributing autonomously to the completion of a task. The project is motivated by the need to balance human decision-making with robotic automation, reducing cognitive workload while maintaining user involvement. In particular, we aim to explore dynamic cooperation strategies in Human-Robot Interaction (HRI), where functions such as sensing, planning, and action execution are distributed intelligently between the two agents. The focus is on enabling the robot to infer human intentions without explicit commands, leveraging sensory inputs and contextual awareness. This shared autonomy will be applied to dexterous robotic hands, where full control of all degrees of freedom is impractical for the user. Our approach will integrate concepts like synergies and adaptive control to simplify interaction while preserving the essential role of human guidance.

Proposed research activity
This research focuses on developing a shared autonomy framework for robotic manipulation through advanced scene understanding and intuitive human-robot cooperation. While sEMG signals will be used to allow the user to trigger basic actions such as hand opening and closing, the core of the project lies in enabling the robotic system to perceive and interpret the environment autonomously. A wearable camera system, integrated into custom glasses, will be used to capture RGB, depth, and gaze information, allowing the system to recognize objects, estimate their geometry, and understand the user's intended task. Sensor fusion, combining vision with IMU data and local hand sensors, will support object tracking and motion prediction. Machine learning models will integrate temporal and multimodal data to infer grasp intent and adapt the robot's behavior accordingly. The grasp strategy will be selected based on the object's characteristics and user context (e.g., grasping a bottle to pour vs. to open). The control architecture will define a clear division of roles, with the robot autonomously managing grasp configuration and refinement, while the human retains high-level control. The approach will be tested in prosthetic-like and collaborative robotic setups.

Supporting research projects (and Department)
The research activity will be carried out as part of a joint initiative between the Department of Engineering 'Enzo Ferrari' at the University of Modena and Reggio Emilia and the Department of Electrical, Electronic and Information Engineering 'Guglielmo Marconi' at the University of

Bologna, under the PRIN project I-SHARM: Intelligent SHared Autonomy for Robotic Manipulation systems.

Possible connections with research groups, companies, universities.

Prof. Claudio Melchiorri e Gianluca Palli, Università di Bologna (Laboratory of Automation and Robotics) – Partner of the project

Prof. Alin Albu-Schäffer, Institute of Robotics and Mechatronics at the German Aerospace Center (DLR)