Corso di Dottorato in ICT
Doctoral Course in ICT

Research project for a PhD curriculum in ICT

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

Proposed Title of the research: Methods for a novel collaborative robotics: from programming to human skills transfer

Keywords: Collaborative robotics, Programming by demonstration, Task learning, Human behavior prediction

Research objectives:
The goal of the research activity of the PhD student is fostering the development of a novel framework architecture to enable humans and machines for working hand in hand by achieving both human-robot and robot-robot collaboration in an effective, safe and flexible manner. Additional goals concern the self-learning of new tasks and the adaptation of the robot to perturbations in a fast and simple way.
This framework architecture will be obtained from the integration of stochastic planning methods with predictive algorithms and intelligent detection approaches based on vision and machine learning techniques. The outcome of the proposed research activity will be the design of novel algorithms, developed and tested in a simulative environment but then applied in a real-word scenario.

Proposed research activity
The PhD activities will concern the development of a general framework for making a robotic capable of learning new tasks or adapt to new conditions during a given operations. As usual, the PhD student's activity will be organized in two distinct phases. The first phase, aiming at gaining a cultural and professional growth of the candidate, will be focused on the study of the scientific literature about collaborative robotics with particular reference to human-robot interaction, programming by demonstration (PdB), and machine learning.
In the second phase, the PhD student should design innovative control/planning techniques with the aim of maximizing the information extracted from demonstrations to generalize the taught skills to new situations or variations of the same task. Learning of the task implies not only a kind of automatic programming of the demonstrated task but also a degree of generalization for variants of the demonstrated task without the need for further demonstrations. In this manner, collaborative robots can advance from being simple stand-alone manipulators passing e.g. tools or parts to a human collaborator to becoming autonomous co-workers. Note that there exists still a wide gap between the desire for humans and robots to work closely together and share control of operations, and how robustly we can measure and predict human motions and intentions in physical human-robot interaction operations and adapt the behavior of the robots to that of the human beings.
Supporting research projects (and Department)
The research activity will be accomplished at the Department of Engineering "Enzo Ferrari" and, at the moment of writing, is not supported by specific research projects.

Possible connections with research groups, companies, universities.
The company Ideativa, working on collaborative robotics, will host the PhD student for a period of 6 months.
Other possible connections are represented by:
Prof. Stan Birchfield, Principal Research Scientist and Senior Research Manager, NVIDIA; he is exploring the intersection of computer vision and robotics.
Prof. Claudio Melchiorri and Gianluca Palli, Università di Bologna (Laboratory of Automation and Robotics)