INTERUNIVERSITY PH.D. PROGRAM BETWEEN

POLITECNICO DI BARI AND UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

IN INDUSTRY 4.0

Decision and control techniques for collaborative robotic systems for Industry 4.0

PhD candidate

Silvia Proia

Tutors

Prof. Engr. Mariagrazia Dotoli

Dr. Engr. Raffaele Carli

Dr. Engr. Graziana Cavone

Description of the research topic

The fourth industrial revolution, known as **Industry 4.0**, is being increasingly adopted in the production, distribution and commercialization chains worldwide.

Without doubt, the way humans work together with robots is becoming ever more important in the era of automation and robotization. In this digital revolution, **collaborative robots** or **cobots** will play a key role.

In contrast to robotics deployments that typically work independently from humans and often reside in a cage, collaborative robots are capable of monitoring the environment and co-existing in the same facility together with humans without sacrificing performance or safety.

The industry development of cobots is ongoing in several different areas. The national research program for the next seven years will mainly focus on the digital industry and health-care sector and my research proposal is positioned exactly in this context of cobots development and evolution.

A preliminary analysis of the state of the art shows that new methodologies are needed to develop a safe and secure human-robot collaboration. Therefore, this research project aims to design innovative models and control methods in order to solve intricate issues connected to the **safety** concept of cobots.

The first research objective is to define the problem of cobots control in the industrial and or healthcare environment and thus to identify the main lacks in the related literature. To this aim an extensive and complete literature review on control architectures for collaborative robotics systems will be performed, with particular attention to: (1) the trajectory planning and tracking; (2) the collision avoidance algorithms that are necessary both in industrial and medical applications, like mini-invasive surgery; (3) the optimal predictive control; and (4) the learning techniques which are both useful in tele-robotics and rehabilitation process. In addition, in order to consolidate my competence and knowledge in robotics, I will pay attention to the mechanical aspects of the robotics devices such as statics, kinematics and dynamics.

The second research objective consists in developing advanced control algorithms for cobots with an increasing number of Degrees-of-Freedom (DoF) keeping in mind the structural and kinematic constraints to ensure safe interaction between human and robots (e.g., the Remote Center of Motion (RCM) and the trajectory tracking).

The third research objective regards the test of the mathematical assumptions and the defined control architecture(s) in a simulation environment and eventually in their validation by means of physical experiments on real cobots.

Throughout the whole research project, regular reports about the progress will be performed, comprehending weekly and milestone updates. Furthermore, scientific publications and material useful for the final dissertation fulfilment will be prepared on time.