Ph.D. in Information Technology
Thesis Defenses

February 11th, 2022
at 10:45
Room 25.1.2

Davide BAZZI – XXXIV Cycle

Physical human-robot interaction through goal-driven manual guidance

Supervisor: Prof. **Paolo Rocco**

Abstract:

During the last decade, human-robot physical interaction and manual guidance operations have received increasing attention. On one hand, manual guidance can be an intuitive means to teach new paths to the robot, on the other hand, it relieves the user physical fatigue, increasing his/her precision and the safety of the operation.
Typical applications are the handling of large and heavy objects in industrial scenarios, rehabilitation and surgery in the healthcare. These operations are difficult to be completely automated. Hence, the joint work of a human and a robot represents the best solution to effectively accomplish the task.
This thesis aims at improving the effectiveness and the synergy of human-robot physical interaction in manual guidance operations, both in free space and in contact with an unknown environment. The developed control and estimation algorithms endow the robot with new capabilities, helping the human in complex manual guidance operations which also involve rotational motions and obstacles along the path towards the goal.
All the methods proposed in the thesis have been validated in experimental campaigns with volunteers operating on an industrial robot.

Costanza MESSERI – XXXIV Cycle

Enhancing the quality of human-robot cooperation through the optimization of human well-being, safety and productivity

Supervisor: Prof. **Paolo Rocco**

Abstract:

With the advent of Industry 4.0, collaborative robotics has become one of the enabling technologies of the smart factory. To improve the effectiveness and the fluency of cooperation, the collaborative robot (cobot) must be endowed with several advanced capabilities. In particular, it should be able

to select a strategy that ensures the adaptability to the behavioural, cognitive and physical features of the specific human co-worker, while guaranteeing the efficiency of the productive process.
This thesis proposes new applications and strategies that enhance the quality of human-robot interaction in industrial frameworks in terms of safety, workplace well-being and productivity. More specifically, the cobot has been endowed with the capability of better perceiving the presence of the human operator within the shared workspace and to optimize its motion trajectories, so as to increase both safety of the interaction and the team performance. A novel method exploiting a game-theoretic approach has been proposed to model the trade-off between the human performance maximization and the cognitive stress minimization. Then, by applying a suitable variation of the production pace, the cobot has been enabled to simultaneously increase the human productivity and mitigate the human cognitive stress. Ultimately, a real-time task allocation strategy has been developed to guarantee the optimization of the human physical fatigue, as well as the effectiveness of the production process.
The proposed methods have been experimentally validated in real human-robot collaborative scenarios involving several volunteers and the ABB dual-arm YuMi cobot.

PhD Committee

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