Research theme title:
Intelligent Control for Safe and Efficient Human-Robot Collaboration in Automated Warehouses

Description:
The Fourth Industrial Revolution, also known as Industry 4.0, is reshaping the way individuals live and work while providing a substantial influence on the manufacturing scenario. One of the key enabling technologies that has made Industry 4.0 a concrete reality is without doubt collaborative robotics, which is also evolving as a fundamental pillar of the next revolution. The so-called Industry 5.0 paradigm reinserts proactively humans back into the automation chain, allowing operators and robots to work significantly more closely together [1]. In contrast to robots that predominantly work independently from humans and often reside in a cage, collaborative robots (cobots) co-exist in the same environment together with humans, without renouncing to safety or efficiency [2].

The goal of this project is to develop innovative decision and control techniques for human robot collaboration (HRC) by ensuring the best trade-off between safety and ergonomics for the operator and efficiency for the industrial process. In particular, this project will focus on the automation of production processes in the context of internal logistics and therefore in industrial warehouses, not yet fully automated, in which there are significant margins for developing innovative solutions aimed at increasing productivity and profitability, with the simplification, planning, and scheduling of robot and operator activities in accordance with safety and ergonomics requirements [3].

The project activities will be based on the definition of artificial intelligence algorithms to monitor and predict the behaviour of operators (by collecting data from sensors such as artificial vision systems) and control algorithms to prevent collisions (by defining safety zones around the operator or danger zones around the robot), to detect hypothetical collisions, or to track the distance that drives the robot away from the operator. In addition to safety, ergonomic aspects implying psycho-physical well-being of workers will be assessed, having a crucial role in the industrial context. Indeed, cobots significantly reduce physical work by helping operators with repetitive tasks, but at the same time they could increase the psychological stress associated with close human-robot collaboration and therefore may lead to a decrease in performance. Therefore, both physical and cognitive ergonomics will be considered in the design of the control architecture.

The research activities will be conducted in close collaboration between the Decision and Control Laboratory (http://dclab.poliba.it/) of Polytechnic of Bari and ICAM Srl (https://www.icamonline.eu/), which is an Italian company specialized in automated solutions for automated warehousing and Logistics 4.0. Moreover, the PhD project is of absolute significance for the Italian National PhD Program in Autonomous Systems, given that robots allow logistic systems to automatically achieve efficiency and productivity objectives with an effective collaboration with human operators.

Finally, it is worthwhile mentioning that the objective of the PhD project is aligned with the Italian national development strategies, as well as with the international research directions, which are undergoing radical transformations, enabled by the progressive and pervasive adoption of automation and robotic technologies in the industrial sector. In particular, the project is coherent with the strategic pillars and horizontal principles of the Italian National Recovery and Resilience Plan (PNRR), being fundamental for Strategy M2C2 “Digitalization, innovation, and competitiveness in production systems” of PNRR.

References:
[1] Ferraguti et al. 2020. A unified architecture for physical and ergonomic human–robot collaboration. Robotica, 38(4), 669-683.
[2] Cherubini et al. 2016. Collaborative manufacturing with physical human–robot interaction. Robotics and Computer-Integrated Manufacturing. 40, 1-13.
[3] Proia et al. 2022. Control Techniques for Safe, Ergonomic, and Efficient Human-Robot Collaboration in the Digital Industry: A Survey. IEEE Transactions on Automation Science and Engineering. 19(3), 1798-1819.

Type of scholarship:
DM 117/2023 – Project on PNRR (Italy's Recovery and Resilience Plan)

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Study and research period outside the Hosting Institution:
Study and research period at the company:
ICAM Srl (https://www.icamonline.eu/)