MANAGEMENT AND PRODUCTION ENGINEERING

Ammin/CRT/DIGEP - Human-AI Symbiosis in Smart Manufacturing Environment: Operator 5.0

Funded By	Dipartimento di Ingegneria Gestionale e della Produzione [P.iva/CF:00518460019] Politecnico di TORINO [P.iva/CF:00518460019] FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014]
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Context of the research activity	The new digitalization strategies, typical of Industry 5.0, aim at integrating the representation of human beings into the digital world, including their intentions, behaviors and conditions, paving the way for supporting workers in a human-aware context. This approach leads to the definition of a new role, the Operator 5.0, i.e., an intelligent and competent operator capable of leveraging advanced human-computer interaction and adaptive automation technologies to realize symbiotic human-automation work systems.
	The need to comply with shorter product life cycles, diversified market demands and enlarged global competitiveness is leading to a drastic increment of production systems requirements in terms of adaptability and responsiveness. These challenges are addressed through increasingly pervasive digitalization processes that impact all the areas of a company, creating a growing burden on workers, who are required to operate and interact with even more complex systems. The Operator 5.0 is seen as a hybrid resource resulting from the interconnection between humans and machines, where the focus is on the one hand on treating automation as a further extension of human physical, sensorial and cognitive capabilities, and on the other hand on considering human expertise core within the intelligent production environment. This is the background for the evolution from Cyber Physical System (CPS) to Human-Cyber-Physical Systems (H-CPS), intentionally designed to enable collaboration between humans and machines and to harmoniously integrate humans and machines through Artificial Intelligence (AI) in advanced manufacturing environments according to the principle of Human Centred Artificial Intelligence (HCAI). Unlike CPSs, which follow rigid logics with little customisation, HCPSs use so-called Human Digital Twins, i.e., virtual models that replicate and simulate operators' conditions and behavior. Thanks to these technologies, workload and

Objectives	operating conditions can be customized to the needs of each worker, improving ergonomics, comfort and productivity. The concept of process automation is overcome by moving towards a true active collaboration between man and machine, optimizing performance and reducing the margin of error by supporting the combination of human intelligence and creativity with the precision and efficiency of advanced technologies. This research focuses on H-CPS and the creation of an Operator 5.0 framework capable of providing tools and methods to improve human-machine active collaboration, optimizing safety, adapting the working environment to the individual needs and improving productivity and performances. In this scenario, the research will deal with the mapping of the operator to create a dynamic digital model of the human body able to adapt the environment and workload to the actual conditions of the worker in complex scenarios through Artificial Intelligence (AI) algorithms and provide immediate feedback through the use of eXtended Reality (XR) or Haptic Feedback (HF) solutions in the Human Centred Artificial Intelligence (HCAI) scenario by exploiting Vision Language Models (VLM) paradigm. The research activity will be implemented involving local industrial stakeholders from the automation and robotics sector for properly mapping the actual industrial requirements and supporting the experimental validation of the developed framework in an “ecologically valid” scenario.

Skills and competencies for the development of the activity	The candidate should have a Master’s Degree in the area of Engineering, with competences and interests regarding Industry 5.0 and HCAI. The candidate should have good English communication and writing skills and be willing to work in our laboratory on 3D tools and methods for engineering (3D LAB) where the experiments take place.