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Methods and experiments for the development of collaborative actions with cobots and digital twins

Alessio Cellupica[*1], Marco Cirelli*[1], Pier Paolo Valentini[1]

[1]*Department of Enterprise Engineering, University or Rome Tor Vergata, Rome, Italy*

**alessio.cellupica@uniroma2.it*
**marco.cirelli@uniroma2.it*

The primary aim of the project is to establish a Joint Lab dedicated to developing proof-of-concept and conducting activities through consistent collaboration between research and industry partners. This initiative includes two major innovative elements. The first is the creation of a pioneering, integrated laboratory that supports the development of advanced, multidisciplinary methodologies in engineering. This lab will bring together technologies such as virtual reality, augmented reality, reverse engineering, sensors, prototypes, robotics, advanced modeling and simulation, and the development of both model-driven and data-driven digital twins in a unified setting. The second, of a more methodological characteristic, is the development and testing of dedicated methodologies that allow the integration of the aforementioned enabling technologies in order to propose innovative cutting-edge methods to approach wide-ranging engineering problems. Several results have been achieved in recent months. Three digital twins have been created covering different areas: biomechanical [1], mechanisms [2] and structural [3]. Thanks to these new methodologies, it is possible to match the behavior of a physical twin to that of a digital twin capable of simulating the state of the system in real time and then adding additional information through augmented/virtual reality (AR/VR) tools. The realization of these complex systems necessarily passes through the development of innovative methods that sweep different areas: three-dimensional kinematics, structural analysis, computer science, electronics; as well as the study of existing technologies by analyzing the limits of applicability. From a methodological point of view, for example, short-order models have been developed for the real-time simulation of systems; as well as the development of techniques for importing real components into virtual reality scenes; methods for component recognition (image/model targeting); several approaches to automatically transfer data from IFC4 models to VR environment; approaches to improve the modeling using virtual reality. Furthermore, a Universal Robots UR10e cobot was added to the Joint Lab: The main objective is the communication between human input and the cobot's motion. The inclusion of augmented reality could facilitate human control of the cobot, leading to another objective: establishing triangular communication between the human, AR and the cobot. The triangular communication could also enhance AR user feedback by using the cobot's motors as a haptic device.
The results are remarkable, but this is just the beginning. The goal is to overturn current design methods by introducing innovative techniques that, relying on technologies such as virtual and augmented reality, facilitate the interaction of man with the machine and consequently simplify the procedures for building and analyzing models.

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