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ENHANCING THE MAIT OF AEROSPACE SYSTEMS THROUGH AI-BASED IMMERSIVE TECHNOLOGIES

Abstract

The aerospace industry is witnessing a transformative paradigm shift driven by advancements in Cyber-Physical Systems (CPSs) and immersive reality technologies, often supported by Artificial Intelligence (AI)-based methods and approaches. Specifically, the integration of immersive technologies with CPSs and AI, which is characterized by the overlay of digital information onto the physical world, has gained substantial attention for its ability to enhance human-machine interactions in assembly processes. Several studies emphasize the capabilities to provide real-time visualizations, step-by-step instructions, and interactive overlays during complex tasks. This not only expedites the learning curve for shopfloor operators involved in the various steps of the Manufacturing-Assembly-Integration-Testing (MAIT) loop but also significantly reduces errors and improves the overall task efficiency and quality. Most of the tools implemented so far, however, are ad-hoc realizations driven by the specific process and application to be carried out, and the development of a generic framework and toolbox for these cases has not been accomplished. The aim of this work is to devise such framework so as to make the adoption of these approaches easily applicable in different cases and scenarios. In this framework, several challenges need to be addressed, namely: (i) the definition of a Domain-Specific Language (DSL) to be adopted for the assembly processes definition, including various artefacts such as tasks, actors, objects, tools; (ii) a process serialization, e.g., based on JSON or XML, suitable to be interpreted by a parser able to create the immersive objects; (iii) an objects renderer into some device (e.g., HoloLens), to be used by line-workers during the assembly process; (iv) a control system, based on video-cameras and image processing techniques, capable to match what is happening in the physical world with the expected outputs presented in immersive reality, and to raise appropriate messages used to correct actions, deliver quality assurance, etc. In this paper we will provide an overview of such a framework and toolbox and present proof-of-concepts (PoCs) over the various steps, with the final goal of delivering a comprehensive understanding of the potential benefits and challenges associated with the incorporation of AI and immersive technologies in aerospace MAIT procedures. Preliminary tests have been conducted with a CubeSat engineering model MAIT procedures and tasks, which will be used as study-case. A future upgrade will see the adoption of Large Language Model (LLM)-based approaches to semi-automatically extract the objects of the DSL from design documents and other artefacts used during the design process.