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DEVELOPMENT OF A VIRTUAL REALITY DEMONSTRATOR FOR ROBOTICS INTERACTIONS AT THE EUROPEAN ASTRONAUT CENTRE

Abstract

Part of astronauts' tasks during their stay on-board the International Space Station (ISS) revolves around robotics operations. When not controlled from the Ground, those activities may include the manipulation of Mobile Servicing System (MSS) components, such as the Space Station Remote Manipulator System (SSRMS – also known as Canadarm2, a 17m-long robotic arm) from inside the Station. These operations consist of capturing visiting vehicles, inspecting Station elements or assisting astronauts during Extravehicular Activities (EVAs – also known as spacewalks). To complete these tasks, the astronaut on-board the ISS (thereafter the "operator") is controlling the robotic arm while monitoring its surroundings to avoid any risk of collision with other Station structures. The monitoring is enabled through three screens, which display camera views selected by the operator. However, these cameras are in finite number and are placed at fixed locations (either on the ISS outside structures or on the SSRMS itself). Moreover, the prediction of the arm's motion with respect to operator's input is particularly error-prone since the arm has 7 Degrees of Freedom (DoF) with inherent singularities. These challenges (limited/fixed camera views, difficult arm motion prediction) not only appear while training on the Ground, but persist during real-time operations. To mitigate the issues, the European Astronaut Centre (EAC) is developing two computer applications to investigate robotics operations and training using Virtual Reality (VR). The *Joint Investigation into VR for Education* (JIVE) currently explores the best combination of tools to aid robotics instructors with astronaut lesson delivery. More specifically, the JIVE test case is a set of learning concepts essentials to the Generic Robotics Training (GRT – first stage of astronaut robotics training). A comparative study of VR-enhanced vs current training will be performed on test subjects from EAC and NASA's Johnson Space Center (JSC) to evaluate the project outcome. The *VR for Operations and Robotics Training EXpansion* (VORTEX) project aims further ahead. It develops manned lunar surface exploration concepts by extrapolating the knowledge EAC has acquired from ISS robotics. VORTEX builds an immersive lunar robotic operation environment in VR that features full operator walking freedom. In experimenting by means of innovative robotic asset designs and more intuitive ways of operating the arm and monitoring its surroundings, VORTEX demonstrates how to ease the operator in maintaining situational awareness in a complex scenario. It reduces both human error and the amount of skills training time on the ground for the operator.