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TESTING AND VALIDATION OF INNOVATIVE EXTENDED REALITY TECHNOLOGIES FOR ASTRONAUT TRAINING IN A PARTIAL-GRAVITY PARABOLIC FLIGHT CAMPAIGN

Abstract

The use of eXtended Reality (XR) technologies in the space domain has increased significantly over the past few years as it can offer many advantages when simulating complex and challenging environments. Space agencies are currently using these disruptive tools to train astronauts for Extravehicular Activities (EVAs), to test equipment and procedures, and to assess spacecraft and hardware designs.

With the Moon being the current focus of the next generation of space exploration missions, simulating its harsh environment is one of the key areas where XR can be applied, such as to support design assessment and astronaut training activities. Distinct lunar lighting conditions in combination with reduced gravity levels will highly impact human locomotion especially for movements such as walking, jumping, and running. In order to execute operations on the lunar surface and to safely live on the Moon for an extended period of time, innovative training methodologies and tools such as XR are becoming paramount to perform pre-mission validation and certification.

To further increase the maturity level of the associated XR technologies, the experts of the European Astronaut Centre (EAC) in Cologne, Germany, have developed two experiments that have been conducted during a partial-gravity parabolic flight campaign. The first experiment examines how well different commercial-of-the-shelf and custom-made XR headsets perform in lunar gravity while also evaluating how users can grasp and carry different payload mockups during a simulated lunar EVA. The second experiment uses multiple motion tracking cameras to accurately capture user's motion in partial gravity conditions and to further improve existing locomotion models.

This research work presents the findings of two experiments aimed at exploring the integration of XR technology and parabolic flight activities for astronaut training. In addition, the study aims to consolidate these findings into a set of guidelines that can assist future researchers who wish to incorporate XR technology into lunar training and preparation activities, including the use of such XR tools during long duration missions.