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ADVANCING LUNAR EXPLORATION THROUGH VIRTUAL REALITY SIMULATIONS: A FRAMEWORK FOR FUTURE HUMAN MISSIONS

Abstract

In an era marked by renewed interest in lunar exploration and the prospect of establishing a sustainable human presence on the Moon, innovative approaches supporting mission preparation and astronaut training are imperative. To this end, the advancements in Virtual Reality (VR) technology offer a promising avenue to simulate and optimize future human missions to the Moon. Through VR simulations, tests can be performed quickly, with different environment parameters and a human-centered perspective can be maintained throughout the experiments. This paper presents a comprehensive framework that harnesses VR simulations to replicate the challenges and opportunities of lunar exploration, aiming to enhance astronaut readiness and mission success. Multiple environments with physical and visual characteristics that reflect those found in interesting Moon regions have been modeled and integrated into simulations based on the Unity graphical engine. We exploit VR to allow the user to fully immerse in the simulations and interact with assets in the same way as in real contexts. Different scenarios have been replicated, from upcoming exploration missions where it is possible to deploy scientific payloads, collect samples, and traverse the surrounding environment, to long-term habitation in a futuristic lunar base, performing everyday activities. Moreover, our framework allows us to simulate human-robot collaboration and surveillance directly displaying sensor readings and scheduled tasks of autonomous agents which will be part of future hybrid missions, leveraging the ROS2-Unity bridge. Thus, the entire project can be summarized as a desire to define cornerstones for human-machine design and interaction, astronaut training, and learning of potential weak points in the context of future lunar missions, through targeted operations in a variety of contexts as close to reality as possible.