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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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DEVELOPMENT OF A COMPREHENSIVE LUNAR MINING SIMULATOR TO STUDY DESIGN AND DECISION-MAKING UNDER UNCERTAINTY

Abstract

This project describes the ongoing development of a Comprehensive Lunar Mining Simulator (CLMS). This project expands on the work done by Cardin et al. on real-options approaches to enable flexibility in systems design and operations (Cardin, 2014) and gamifying the decision processes of complex infrastructure systems under uncertainty (Cardin et al., 2015). The goal of this project is to study system design and decision-making in harsh conditions and under uncertainty, with an emphasis on exploring sustainable and flexible design methodologies in the context of Lunar In-Situ Resource Utilization (ISRU) – with an eye towards terrestrial mining applications. This will be accomplished using the proposed CLMS to act as a platform to address the project research questions. Specifically, this CLMS will serve as an experimental research platform where users can make managerial and design decisions under stochastic conditions in an immersive lunar mining environment. This includes exploring trade-offs in mining scale with regards to lunar regolith beneficiation, as described in Cilliers et al. (2020). Current work involves designing the simulation using a 'serious game' approach to be an effective decision support tool, and developing the experimental methods needed to fully utilize and evaluate this tool. Virtual Reality is one of the treatment conditions which is being investigated, and will be used in human-subject experiments that will assess user decision-making with respect to a real-options approach to maximize system sustainability over its lifetime. Although the project scope is currently limited to system design questions in the context of Lunar ISRU, there exists applications for studying human factors more broadly, and utilizing the CLMS as an educational and training tool for remote mining operations.

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