22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
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Author: Ms. Zuzanna Filipecka
The Netherlands

Mr. Francesco Ventre
Space Generation Advisory Council (SGAC), Italy
Mr. Marcelo Boldt
Space Generation Advisory Council (SGAC), Germany
Mr. Felix Nitschke
Space Mining Technologies, Germany

DIGITAL MOON: USAGE OF ARTIFICIAL INTELLIGENCE AND DIGITAL TWINS FOR A SUSTAINABLE LUNAR ECONOMY

Abstract

The future of space exploration is envisioning, among other activities, human presence and exploration of the Moon or Mars, being the ARTEMIS Program is the biggest accord that nations are nowadays rallying around. In this context, it is evident that creating a sustainable long-term human presence poses significant challenges, from technical origins, as well as supply chain difficulties. Furthermore, and despite the currently existing challenges, lunar systems have to be scalable and modular to compensate for growing operations on the moon's surface and facilitate the expansion to other worlds. Hence, these systems have to be able to respond to changing conditions, such as an increasing demand for fuel production on short notice or the production of components for maintenance purposes. Several past and ongoing research efforts, such as SOFIA - Map of Water Near the Moon's South Pole - attempted to produce a more holistic understanding of Earth's only natural satellite. However, these efforts comprehend the first modeling level of a celestial body that has its complexities, like geological activity, a harsh space environment - space radiation, meteoroids, and more - and others that are not fully understood yet.// Artificial Intelligence (AI) and Digital Twins are some of the most promising technologies currently used for climate modeling, the design of vehicles, semiconductors, etc. Yet, their capacity has not been fully applied to problems of a planetary - or in this case Lunar - scale.// This research from the Commercial Space Project Group (CSPG) of the Space Generation Advisory Council (SGAC) aims to study - using qualitative analysis - the steps needed towards a sustainable lunar economy and the role AI and Digital Twin technologies can play in that future. The study begins by reviewing the current state-of-the-art on lunar economy identifying key drivers that will make it possible shortly not only for government and institutional activities but also for private commercial activities. Then a framework for implementation of these technologies is presented. The latter will incorporate three basic operations in its foundations - i.e., propellant production, geography for human settlements, and mineral reservoirs for expanded activities -. lastly, the study highlights the possible steps towards a long-term human presence on the moon, emphasizing the sustainability of operations.// Keywords: AI, Digital Twins, Lunar Economy, ARTEMIS ACCORD