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SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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A VIRTUAL REALITY APPROACH FOR STUDYING A FUTURE HUMAN LUNAR OUTPOST: AN INTEGRATED SIMULATION CASE STUDY OF A STAND ALONE POWER SYSTEM

Abstract

The exploration of the cis-lunar space and the exploitation of the lunar surface resources are the next targets to expand the human presence in space beyond Low Earth Orbit (LEO). The concept of a permanent Moon outpost which can provide a demonstration platform for exploration technologies, appears to be paramount to not jeopardize future Mars expeditions. The base can provide an efficient test-bed environment to assess critical technologies to sustain the manned space exploration of the solar system. Since lunar polar areas are potentially rich in volatiles to study and use, the reference scenario for this work has been set onto the lunar south pole. The particular ambient conditions of this region allows for the presence of permanently shadow regions where water ice is supposed to be present and mixed with regolith grains, as suggested by some survey missions. In Situ Resource Utilization (ISRU) techniques can provide most of the consumables needed for the Environmental and Life Support System (ECLSS), such oxygen and water, together with propellants for spacecraft. The purpose of the research here presented is to address the simulation of possible solutions to provide continuous power to the crewed settlement. The solution chosen to generate and regulate electricity, and store energy, is a photovoltaic-hydrogen Stand Alone Power System (SAPS). If abundant water reservoirs will be confirmed, hydrogen could be produced in-situ via electrolysis and used by fuel cells. The required energy for this chemical process and for supplying all the base loads could be supplied by solar panels during sunlight hours. Oxygen and hydrogen are stored in specific tanks and used during eclipse periods. Batteries are also present to absorb power peaks and are charged by the photovoltaic arrays. The SAPS performance has been estimated using a lumped parameter model. Since the outpost location is one of the crucial aspects for all the subsystems, and especially for solar panel positioning, a virtual reality environment has been used to simulate real time shadows. Ephemerides have been used to correct locate the celestial bodies for the chosen timeframe. This paper describe the integration and the results obtained by the different simulation environments and how these can help in the design process of a lunar base, which is part of an incremental architecture strategy towards future manned Martian exploration.