Paper ID: 80414
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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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SUMMARY OF A PHASE 0/A STUDY REPORT OF A NOVEL ROBOTIC SYSTEM FOR LUNAR VOLATILES EXTRACTION

Abstract

In order to put mankind once again on the lunar surface, discretely high technological and humane requirements need to be met. An establishment on the moon should be extensively robust and self-sustainable in order to achieve an economic and smooth development over a span of a few decades. As already accepted by the scientific community, In-Situ Resource Utilization (ISRU) is potentially the way to go forward. Data from NASA's Stratospheric Observatory For Infrared Astronomy (SOFIA) missions, in 2020, conclusively confirmed the existence of limited concentrations of diffused water molecules present in the regolith within the moon's southern sunlit craters. Similarly, a multitude of other volatiles are extant in variable quantities within the Moon's surface and sub-surface. This scientific paper presents a summary of the results of a Phase 0/A study of a novel concept for a robotic system for the extraction of lunar volatiles. The study includes an overview of the state-of-the-art technologies, identification of key scientific and technical challenges, and the formulation of potential solutions. The discussed robotic system is designed to autonomously navigate the shadowed regions of the lunar surface and includes a drilling and sampling mechanism to collect soil. The integrated extraction system uses a combination of different thermal and imaging techniques to locate and extract volatiles such as water ice, and analyses them on-board for their composition and abundance. A detailed description of the integrated sub-systems and their design attributes, including the mass, communication, and an expected cost budget is also detailed within the paper. Furthermore, an overview of the results from simplified thermal and structural simulations of the robotic system during operation are also touched upon. The Phase 0/A study involved extensive research of the rover's mobility, extraction systems, and auxiliary analytical capabilities, which enables the identification of areas for improvement in next design iterations, including energy system efficiency and enhanced performance. The design description within the framework of this paper, essentially, demonstrates the feasibility of the novel robotic system for conducting ISRU on the Moon and provides a foundation for understanding the potential challenges and risks in terms of operation on the lunar surface. The findings of this study have implications for future lunar exploration and the utilization of lunar resources for sustained human presence on the Moon.