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Author: Mr. Jerome Gilleron
Georgia Institute of Technology, United States, jgilleron3@gatech.edu

Dr. Michael Balchanos
Georgia Institute of Technology, United States, michael.balchanos@asdl.gatech.edu
Dr. Olivia Fischer
Georgia Institute of Technology, United States, olivia.pinon@asdl.gatech.edu
Prof. Dimitri Mavris
School of Aerospace Engineering, Georgia Institute of Technology, United States,
dimitri.mavris@aerospace.gatech.edu

REQUIREMENT EXPLORATION AND IDENTIFICATION FOR SEMI-AUTONOMOUS ROBOTIC ASSEMBLY AND OPERATIONS OF A MOON SURFACE BASE

Abstract

In 2019, the focus of space agencies as well as commercial aerospace leaders is on establishing a permanent presence in the vicinity of the Moon. While the lunar orbital aspect (called Gateway) is under way, lunar surface projects are still in the preliminary study phases. NASA, public-private and academic studies all agree on the fact that robotic systems will execute most or all tasks - from construction to operations - on the Moon. However, the need and importance of robotic systems are not clearly defined in those studies. The reason is related to the lack of a common framework to analyze, map and follow the requirements throughout the design processes. Even if robotic systems appear as valuable options, metrics need to be correctly defined to compare alternatives. Moreover, different operational scenarios - such as full power mode (peak-demand in energy), emergency mode, science mode (instruments ON) - need to be further defined. Consequently, the objective of this research is to explore and identify the requirements for robotic assets concerned with the assembly and operations of a lunar base. A second objective is to conduct a gap analysis to help identify future development and research needs as they relate to deploying robots on the surface of the Moon. The selected baseline mission for this research is a Lunar version of the NASA Habitat Demonstration Unit – Deep Space Habitat (HDU-DSH). Alternatives are created that include additional robotic systems. The resulting architectures are fully defined, including their performance relative to the metric values compared to the baseline as well as to other architectures. The uncertainty relative to both human and robotic system operations is also captured. It is expected that the proposed framework will provide a process to capture changes in architecture and necessary robotic capability as requirements evolve. Doing so will allow for potential technological gaps to be identified and will eventually help drive future efforts in lunar robotic system technology development.