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

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ENABLING COST-EFFECTIVE LUNAR EXPLORATION BY LEVERAGING FLEXIBLE AND MODULAR ROVER DESIGNS.

Abstract

The cooperation between different organizations and industries in the effort to return to the Moon is evident. While remote, teleoperated robot exploration has mainly focused on Mars since the 1970s, the journey towards establishing a sustainable human presence on the Moon will involve numerous missions making use of a series of complex autonomous systems, starting with modular concepts that cut costs by avoiding the necessity of redesigning an entire rover for each specific task. At GMV, we are committed to supporting these missions by highlighting the versatility and flexibility offered by our modular designs for both lunar and planetary exploration ventures and adopting innovative approaches in software systems. In this paper, a range of modular approaches for lunar exploration will be introduced, beginning with the European Moon Rover System design and the insights gained for creating small missions using a similar modular framework. Subsequently, these lunar rovers will leverage autonomy through the integration a GNC system, which is flexible, modular and enabled by AI. Operators on Earth may then execute complex multi-robot tasks while the rovers autonomously decide between different tasks. This capability is strengthened by employing diverse positioning, navigation, and timing (PNT) methods investigated by GMV. The EMRS demonstrated the broad capacity of a rover design for diverse missions, incorporating various locomotion modes and autonomous software capabilities. Building upon this rover, we have developed designs for smaller missions capable of multitasking and managing diverse payloads, with minimal alterations to the initial design. This consideration is also taken into account when collaborating with astronauts in ISRU tasks, integrating social navigation and AI into a GNC system that prioritizes placing the astronaut at the centre and ensuring their well-being at all times. Furthermore, through PNT, our rovers will be able to assist in extra-vehicular navigation tasks, contingency scenarios, or precise object manipulation cases. These approaches contribute to the development of a novel fast rover concept, inherited from the ESA funded RAPID and FASTNAV activities, capable of traversing the lunar surface at unprecedented speeds. To prepare for these missions, various mission and ground operations analyses are necessary. At GMV, we not only develop GNC, Robotics and Systems engineering solutions augmented by new technologies such as AI or XR (extended Reality); we also develop simulators, employing AI and XR technologies that integrate robot control with a comprehensive user experience, enabling the early detection of design flaws and achieving a robust final design.