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

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ENABLING AUTONOMY FOR LUNAR ROVERS – SUPPORTING SCIENCE AND RESOURCE PROSPECTING MISSIONS

Abstract

The rise of commercial activities on the Moon requires increasingly self-reliant mission architectures to support a growing lunar economy, using on-site computing to enable real-time autonomous robotics just as we will increasingly rely upon in-situ resources. This is critical to mitigate Earth-Moon delays, expected or unforeseen network dropouts, and data transfer constraints. Therefore, vehicles and other systems must operate to a high degree of supervised autonomy. Mission Control is developing a suite of flight software applications to allow lunar rovers to autonomously and intelligently understand the lunar surface environment and make key decisions in support of rover-based scientific investigations and resource prospecting.

In this paper, we focus on how autonomous rovers can increasingly support science-driven and resource prospecting missions alike by providing an overview of key enabling technologies and operations strategies. We outline how a rover can visually identify lunar surface features for navigation and payload support, build a data-driven model to predict rover behaviour (e.g. wheel slip and energy consumption), and aggregate data from multiple sources in real-time to support navigation and payload operations. The data aggregation process also supports key activities such as geologic context mapping for scientific or ISRU missions. Subsequently, intelligent onboard decision-making can leverage these data products to perform important tasks autonomously. For rover navigation, this includes planning and executing safe and efficient trajectories that also maximize key objectives in prospecting and mining scenarios. Based on an understanding of lunar surface features, the rover can also make intelligent decisions to target payloads to collect high-priority data, and rank and prioritize data for immediate downlink to support operator decision cycles. Targeted actuation such as scooping, drilling, and robotic arm operations can also be achieved autonomously using the same methodology. Mission Control can integrate this comprehensive flight software suite on a high-performance compact processor to enable lunar rovers to execute key tasks autonomously.

Furthermore, we highlight demonstrations and advancements of this technology suite for lunar missions. First, this includes updates on the lunar surface Edge-AI demonstration payload on the ispace mission M1 in 2022, which will also directly support the Emirates Lunar Mission micro-rover. Second,

we report on Mission Control's participation in the ESA-ESRIC Space Resources Challenge, where our team successfully completed a lunar analogue mission at ESA ESTEC in 2021, and will conduct a second mission at ESRIC in September 2022.

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