Enabling Autonomous Robotics for Lunar Surface Missions and Resource Prospecting

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MISSION CONTROL

Software for Earth, Moon, and Mars

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 ISRU-relevant activities such as resource prospecting, excavation, and construction.

Identification of Lunar Surface Features

- Intelligent decision-making processes onboard require a semantic representation of the terrain
- Mission Control has developed technology to classify known geological features using deep learning models at a macro-level

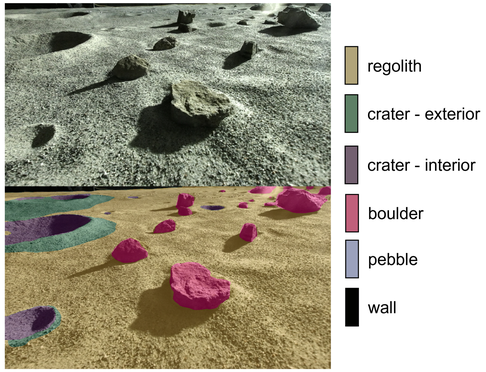

Figure 1. *Example output of our latest terrain classifier, processing an image taken from our lunar analogue testbed*

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Data Aggregation and Mapping

- Geological features classified from depth information aid in building a rich map-based data product that can be used by the flight software suite to enable tasks such as autonomous instrument targeting and data collection
- On the ground segment, this data product can also be more easily integrated into GIS tools for rapid analysis with the context of scale and other information layers derived from in situ or orbital sensors
- This is key to support comprehensive scientific mapping and resource prospective efforts

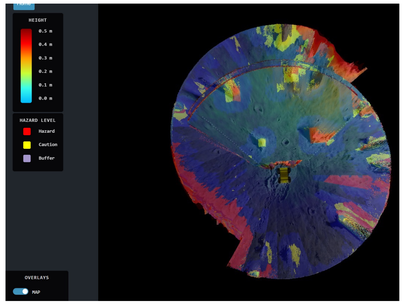
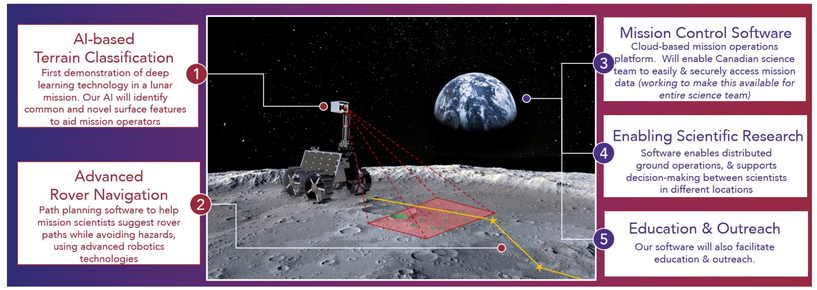


Figure 2. *An overheard map generated from stereo images over the duration of the rover's traverse. Hazard and elevation overlays are toggled on.*

AI Demo on the Lunar Surface

Mission Control will fly a payload on the first ispace mission M1 in 2022 and conduct the first demonstration of Deep Learning on the lunar surface and will support the Emirates Lunar Mission.



Autonomous Decision-Making

- Onboard systems can be programmed with decision-making capabilities, including planning and executing safe and efficient trajectories to maximize key objectives in prospecting scenarios
- The rover can make intelligent decisions to target payloads to collect high-priority data for immediate downlink to support operator decision cycles
- Mission Control can integrate this comprehensive flight software suite on a high-performance processor to enable lunar rovers to autonomously conduct critical activities for resource prospecting, mining, and more

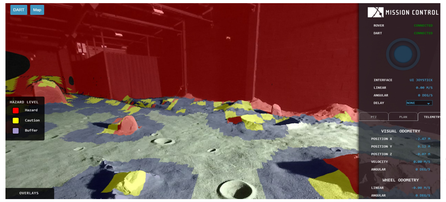


Figure 3. *Our Mission Control Software Platform, a web-based user interface for remote teleoperation.*

ESA Space Resources Challenge

In 2021, Mission Control participated in the ESA-ESRIC Space Resources Challenge. Teams were tasked with resource prospecting under challenging illumination conditions and potential loss of signal events. We made it into the top 5 and will participate in Phase 2 in Luxembourg this year.

Figure 4. (left) *Our rover in the ESA analogue lunar terrain during the challenge. Credit: ESA*
Figure 5. (right) *Our team after successfully completing the challenge.*