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

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AUTONOMOUS SOIL ASSESSMENT SYSTEM: CONTEXTUALIZING ROCKS, ANOMALIES AND TERRAINS IN EXPLORATORY ROBOTIC SCIENCE (ASAS-CRATERS)

Abstract

The characterization of a planetary surface from visual imagery is a common initial step in many scientific investigations that may use specialized instruments for remote sensing, contact sensing, and sample analysis. Mission Control is developing ASAS-CRATERS, a multi-mission technology, to address the need for automated geologic scene characterization on planetary rover missions, which can benefit a wide range of science investigations, rover navigation, and activities like resource prospecting. It comprises algorithms for terrain classification and novelty detection using convolutional neural networks, and for data aggregation to produce relevant data products for supporting science operations.

Built on cutting-edge algorithms and off-the-shelf computing components, it offers low-cost ways to speed up tactical decision-making in next-generation commercial lunar missions. As a science support too, it provides information on detected geological classes and novel features. Novelty detection can aid scientists that may outright miss features or spend valuable time in looking for them. The data product itself is a low-dimensional representation which optimizes downlink. For high-priority features, it can inform algorithms onboard for autonomous instrument targeting, data triage, and prioritized downlink. As a semantically useful terrain representation, it can inform path planning algorithms to enable autonomous and intelligent navigation.

The terrain classifier was first developed by Mission Control under the ASAS project funded by the Canadian Space Agency. In 2019, it was used to classify eight terrain types in real-time at 15 FPS as the rover drove at 20cm/s; the outputs were used to inform tactical science decision-making. This was a part of SAND-E (Semi-Autonomous Navigation for Detrital Environments), a NASA PSTAR funded project led by Dr. Ryan Ewing at Texas AM University, which leverages Mission Control Software to integrate robotic terrain analysis, geochemistry, and sedimentology for the assessment of sediment transport pathways at sites in Iceland.

ASAS-CRATERS will be developed with a Science Committee that will inform its applicability to various lunar mission scenarios, using publicly available data from Chang'E-3 and 4 missions. In parallel, the algorithms will be tested in operations during the 2020 SAND-E tests in Iceland. Results from these tests will be presented in the paper. A prototyping phase will follow completion of the concept

development and field testing. ASAS-CRATERS algorithms will be hybridized for implementation on a high-performance and low-power COTS onboard computer with operational flight heritage. While ASAS-CRATERS is designed to be a mission-agnostic payload, near-term demonstrations are targeted for upcoming lunar rover missions in 2021 and 2022.