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LAB-BASED TESTING OF A PASSIVE REGOLITH SAMPLER IN PREPARATION FOR LUNAR SURFACE OPERATIONS

Abstract

The Emirates Lunar Mission is an initiative by the United Arab Emirates to land a rover on the lunar surface. The Rashid rover, developed by the Mohamed Bin Rashid Space Center, is expected to land late April 2023. Amongst the rover's scientific payloads, are a collection of experiments hosted on the wheels, aiming to investigate interactions with lunar regolith (the Material Adhesion/Abrasion Detection experiment). The Space Enabled research group of the MIT Media Lab contributed two experiments to this collection. The Passive Regolith Sampler (PRS) is a simple device containing an aluminium tray with an array of holes, that uses the action of the wheels pressing into the surface to collect and retain regolith. The Passive Wax Thermometer (PWT) comprises samples of wax with differing melting temperatures. Each sample undergoes temperature-dependent changes in opacity, providing a method for inferring temperature via image analysis. Both devices provide low-complexity, lightweight sensors that may be added to future planetary rovers. During lunar operations, we will use the rover's mast camera to image the experiments as it traverses the lunar surface. We will process these images to determine the phase of the PWT wax samples (solid/liquid) and the fill-state (empty/filled) of the PRS holes. The image quality and hence image processing performance, are expected to be dependent on the viewing geometry and illumination conditions. To aid in preparation for surface operations and image processing workflow, we created a ground-based experimental setup to replicate images we expect to receive from the rover. The setup consists of replicas of the rover wheel and PRS and PWT devices, an adjustable LED lamp to control lighting direction, lunar regolith simulant, and a camera matching the rover viewing geometry. This paper details the design of this experimental setup, and a test procedure to generate example images of the experiments under a range of solar azimuths/elevations, and rover attitudes. We evaluate the lighting conditions under each setting, to identify constraints to the rover heading that ensure favourable image qualities. These results may be used to inform path planning in preparation for surface operations. We further detail the design and testing of the image processing workflow aiming to infer the fill fraction of PRS holes and temperature of the PWT. We generated labelled images of the experiments under known conditions to use as training data in supervised classification models. Preliminary results show these methods are effective in distinguishing between empty/filled holes.