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SPACE EXPLORATION SYMPOSIUM (A3)
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THE ROBOTIC IN-SITU SURFACE EXPLORATION SYSTEM FOR SPACE EXPLORATION OBJECTIVES

Abstract

Approximation of asteroid properties, for body drilling and manipulation, is an important component of the upcoming NASA Asteroid Redirect Mission (ARM). To aid in these objectives, the Robotic In-situ Surface Exploration System (RISES) was proposed and accepted for funding through the NASA Early Stage Innovations program. The concept of RISES is to integrate two terrestrial non-destructive testing methods with robotic systems for extra-terrestrial material and structural differentiation. The Schmidt hammer and ultrasonic pulse velocity (UPV) methods were chosen for evaluation because of their feasibility, simplicity, and applicability to space conditions. The RISES project incorporates traditional and novel system testing for both methods. The second RISES prototype, based on Schmidt hammer methodology, was titled the Impact Sensor-2 (IS-2) system. The IS-2 system incorporates a simplified Schmidt hammer tool integrated with a NASA on-board force torque sensor (FTS). While a Schmidt hammer is based solely on an analog reading of the rebound value, analysis was conducted to determine if similar information could be obtained through use of the full time history of the force readings provided by the FTS. Benchmark testing with the IS-2 system included impacts with asteroid analogous in-tact rock core samples, isotropic samples, and fibrous samples for material differentiation; as well as, friable and monolithic structure samples for structural differentiation. Material and structural correlations have been observed through various metrics extracted from the collected force readings. The RISES robotic integration for the UPV system is being designed and fabricated. The system will involve FTS adapters to hold UPV transducers that can be integrated with existing NASA ARM ground protocol grippers (e.g. the micro-spine gripper assembly). While the standard UPV procedure involves measuring the path of signal travel by analog methods, the RISES procedure will incorporate forward kinematics to determine the distance between transducers. Testing will be performed on controlled property concrete beams, rock cores, and isotropic samples. For both non-destructive evaluation methods in the RISES project, completion of benchmark testing will involve IS-2 and RISES UPV system testing on a 1-5 meter field specimen. Testing will be performed with each system separately as well as in combination to determine how each method can contribute to the overall solution. The goal is to continually improve RISES technology design and methodology to address NASA space exploration objectives and increase the technology readiness level for space flight and beyond.