Paper ID: 14259
oral
student

SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Poster session (2D)

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DEVELOPMENT OF A NOVEL PERISTALTIC MOTION ROBOT DESIGNED TO BURROW WITHIN LUNAR AND MARTIAN REGOLITH

Abstract

Collection of lunar regolith was a critical aspect of the National Aeronautics and Space Administration (NASA) Apollo space program. From 1969 to 1972, NASA collected samples of lunar regolith on six different missions; thus enabling geologists to determine the mineral composition of the moon and how the lunar surface was impacted by extraterrestrial events. However, the maximum depth retrieval that the Apollo astronauts achieved was limited to three meters due to the logistical difficulty of the task. In order to broaden the understanding of lunar and other planetary regolith, future space missions will require a tool capable of coring to unexplored depths via an automatic device capable of collecting soil samples from varying depths. The SEgmented Robotic Platform for Exploration, seNsor Transport and Sampling (SERPENTS) project was initiated in order to design a robotic device intended to collect regolith samples from deeper depths than had been previously achieved. The project originated with a NASA Robotics Academy design team at Marshall Space Flight Center (MSFC) in 2010. The team worked with the National Space Science and Technology Center (NSSTC) on the SERPENTS conceptual design before the project was transferred to the University of Alabama in Huntsville (UAH) and Louisiana Tech (LA Tech) in August 2010 for further design refinement, fabrication, and testing. The UAH design team was charged with the task of replicating the peristaltic motion of an earthworm to propel the body of the SERPENTS robot through various regolith depths. The design, fabrication, and testing of the SERPENTS robot by the UAH team was completed utilizing NASA Systems Engineering (SE) design processes. The UAH SERPENTS design team completed extensive technical analysis associated with the structural load conditions, material stresses, and deflections. The UAH team also completed extensive verification tests including cyclic and bending compression tests in conjunction with the UAH Reliability and Failure Analysis Laboratory. The ultimate goal for the system is to become an instrumental platform, specifically in the scientific exploration of Mars and the moon, though applicable to other planetary bodies-including the Earth. The ability to return scientific samples at various depths, make in-situ measurements, or act as a sensor deployment system will open the door to previously unexplored scientific regions. The present paper will provide an overview of the SERPENTS project, with an emphasis on the UAH design, fabrication, and testing of the SERPENTS body segments.