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EXPERIMENTAL ANALYSIS OF THE PERFORMANCE OF A SLIM MESHED WHEEL DESIGN FOR A MICRO LUNAR ROVER APPLICATION

Abstract

The moon has been of great interest throughout human history, from early astronomy to the Apollo era, and now during the Artemis program, engineers have sought to push the boundaries of lunar knowledge. Our team is tasked with redesigning and prototyping the drive system of the PEEKbot lunar rover, a university-led project, done in collaboration with the Canadian Space Agency that aims at building a repairable rover made of thermoplastics. This report concerns itself with the performance of the rover's meshed wheel design. The original design was driven by the tight volume constraints for micro rovers, which led to very slim wheels. The goal of our project is to evaluate and improve this space-efficient design which, if effective, will maximize the volume available to the rover structure and instruments. The initial design of the rover wheel consisted of a central hub connected to four spokes, which supported a stainless-steel woven mesh, that was wrapped around the spokes to form the outer geometry. In such a way, the mesh is the main component interacting with the lunar regolith. To characterize the performance of the initial design, the single wheel tests (SWT) were performed in a controlled environment, in the Concordia Aerospace Robotics Laboratory. The laboratory is equipped with a Macron Dynamics MCD-USC-XYZ robotic gantry, which controls the position and orientation of the wheel, as well as a sandbox with Glenn Research Center -1 Soil Simulant (GRC-1). The goal was to run the test at various slip angles (0 deg - 30 deg) and longitudinal slip ratios (0 - 0.6) to gather data such as sinkage, drawbar-pull, normal, and lateral forces. The results demonstrated oscillatory behavior with respect to the angular position of the wheel at all test conditions. For example, the wheel was observed to sink and then rise in the simulant as it rotated. It was concluded that this behavior was due to two primary factors: the poor circularity of the wheel and its inconsistent footprint. To improve these factors, various design changes were implemented. Most significantly, two additional spokes were added, and the mesh was changed from

a continuous steel component to a segmented aluminum assembly. A change in material selection has led to a decrease in mass of 53%. The redesigned drive system is currently being manufactured and the second SWT campaign is to begin by the end of February 2022, followed by a full rover test campaign in March.