Paper ID: 22417
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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Joint session on Human and Robotic Partnerships to Realize Human Spaceflight Goals (3-B3.6)

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DESIGN OF A HIGH TRACTION FLEXIBLE WHEEL FOR A MANNED LUNAR ROVER: CONCEPT OPTIMIZATION AND TESTING

Abstract

Foreseeing a permanent settlement on the moon, the astronauts will need a rover to explore the lunar environment on a daily basis. The goal of this project is to develop a new wheel that is able to provide more control, comfort, and drawbar pull in order to safely reach remote areas. Following a thorough design method, a new concept of flexible wheel that aims to provide a higher drawbar pull while being sturdy and able to operate under the moon environment for a long time without maintenance was achieved. The wheel requirements were obtained from a terramechanics study presented by the authors in another paper. Based on these requirements, this paper explains how the proposed concept was chosen and optimized accordingly. Hence, different locomotion types were first analyzed and the wheel was chosen over the track for its simplicity, higher efficiency and higher speed on a flat surface. Then, different damping mechanisms were compared and again, simplicity triumphed. The idea is that if a passive Coulomb damping system can meet our requirements, it will be more reliable and durable than a complex active system. Second, many wheel designs were analyzed and compared, and a coil type design using wire ropes to provide the necessary stiffness and damping was selected. The idea is to use the great flexibility of a wire rope to achieve the required flexion and to generate damping with the hundreds of strands sliding against each other and dissipating friction as heat. Third, the design parameters influencing the performances were determined and the three main ones (cable diameter, number of loops and cable configuration) were used to optimize the design toward meeting the requirements. Fourth, a full factorial design of experiments was carried in order to define an accurate linear experimental model of the concept that takes into account not only the design parameters, but also their interactions. This model was then optimized to meet the specifications while minimizing the total mass of the wheel. Finally, the vertical, lateral and longitudinal stiffness's and the vertical damping of the wheel were characterized using a shock dynamometer which confirmed that the model was reliable. Also, the effective drawbar pull was measured on a single-wheel test bench and compared to the terramechanics predictions. The wheel responded within expectations. Results are presented and discussed.