MOBILITY DESIGN, ANALYSIS, AND EXPERIMENTAL CHARACTERIZATION OF THE JUNO ROVER

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The Juno rover is a modular multi-purpose lunar rover prototype developed by the Neptec Rover Team (NRT) through Canadian Space Agency (CSA) funded contracts. The Juno rover has a number of operating configurations which make it an adaptable platform for lunar analogue mission ranging from precursor scientific and technology validation scenarios to In-situ Resource Utilization (ISRU) and lunar base site preparation. The U-shaped chassis frame can accommodate a variety of payloads, while batteries mounted inside the chassis frame can be easily replaced during field operations. The rover electronics are also housed within the rover chassis, protecting them from the environment. One traction motor per drive unit is used to propel a wheel pair, while the drive units themselves are mounted to the chassis via a pivot point and a rear-mounted walking beam. The walking beam suspension provides an even load distribution of the rover weight amongst the four wheels, even in irregular terrain. The drive unit is also designed such that it can accommodate tracks, as required by the mission scenario. Furthermore, semi-active suspension components can be used to assist in difficult manoeuvres. Lastly, an actuated articulate linkage is available to couple two independent Juno rovers in a Tandem configuration for missions requiring larger payload space and mass.

To design such a rover, a synthesis of the performance metrics and a ranking of their relative importance with respect to the intended use of the rover, was conducted. The relative importance of the performance metrics then guided the subsystem conceptual design. The mobility performance, which will be the focus of the work presented, can be broadly classified into three categories: Trafficability, Manoeuvrability, and Terrainability. In this work, Trafficability is defined as the ability to traverse soft soil and slopes, Manoeuvrability addresses the performance as it relates to the vehicle’s ability to turn efficiently, whereas Terrainability performance includes obstacle and rough terrain traversal at low and high speeds. Analytical models were created to evaluate the performance of each rover configuration. The analytical models developed include a traction evaluation tool based on Bekker’s terramechanics relationships, a quarter-car model to evaluate the vibration response of the rover on rough terrain, a mission scenario evaluation tool to determine the operational performance of the rover, and various Computer Aided Design (CAD) and kinematic models.

Experimental investigation of the performance metrics for each rover configuration was conducted during field deployment to verify the theoretical predictions, and characterize the rover performance. These tests included ramp, range of motion, slope climbing, turning efficiency, driving efficiency, and rough terrain vibration response tests. The results of this experimental analysis also lead to insight into future improvements of the Juno rover. These improvements have led to the development of alternative path-to-flight traction systems, an upgrade to the two-speed gearbox and DC brushless motors, adaptable modular payload interface plates, and more sophisticated sensors and control systems.

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