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Author: Ms. Siri Maley
Carnegie Mellon University, United States, smaley@andrew.cmu.edu

Mr. Paulo Fisch
Carnegie Mellon University, United States, pfisch@cmu.edu
Mr. Nicholas Acuna
Carnegie Mellon University, United States, nacuna42@gmail.com
Ms. Raewyn Duvall
Carnegie Mellon University, United States, raewynd@cmu.edu
Prof. William Whittaker
Carnegie Mellon University, United States, red@cmu.edu

DEVELOPMENT AND FLIGHT RESULTS OF NOVEL CARBON FIBER CHASSIS AND WHEELS FOR LUNAR NANOROVER

Abstract

Traditional lunar rovers have been at least tens of kilograms in mass and tens of centimeters in dimension, and have used conventional metal alloys for the majority of their construction. Decreasing the overall mass and the ratio of mass to internal volume for rover designs directly decreases their cost of flight while increasing their potential payload capacity. However, decreasing the mass of nanorover structures and drivelines while retaining mobility and providing sufficient volume to integrate payloads requires new approaches to material selection and fabrication.

This paper presents the mechanical design and flight testing of the Iris Lunar Rover, a novel 2.3-kilogram nanorover with a chassis and wheels composed primarily of carbon fiber. The requirements of lunar nanorover structure and mobility are contextualized relative to the issues of mass minimization that drove Iris's configuration and material selection. Other advantages and disadvantages of carbon fiber in this context are also discussed, along with the resulting structural design. Iris's final design reduces the total wheel mass to under 120 grams for a skid-steered four-wheel drive rover.

Beyond overall design considerations, this paper further presents the detailed development and flight fabrication of the Iris Lunar Rover's carbon fiber chassis and wheels. The initial computer modeling, analysis, and design evolution of each subsystem are discussed. Final performance specifications and results of successful modeling and terrestrial testing are relayed, including a ground clearance of 4.5 centimeters and the ability to surmount 6-centimeter obstacles. Lessons learned are conveyed regarding the in-house fabrication and assembly of a monocoque, prepreg carbon fiber chassis and of multi-ply carbon fiber wheels. Results of successful environmental qualification are presented, including vibration testing compliant with GSFC-STD-7000. Finally, the results of flight are summarized, including launch survival and the turning of a wheel in space post-launch.