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Author: Mr. Timothy Cole
The John Hopkins University Applied Physics Laboratory, United States, timothy.cole@jhuapl.edu

THE MECHANICAL DESIGN OF A EARTH-BASED DEMONSTRATOR FOR THE ROBOTIC LUNAR LANDER DEVELOPMENT PROJECT

Abstract

The Robotic Lunar Lander Development Project (RLLDP) consists of a core team of engineers and scientist at the Johns Hopkins University / Applied Physics Laboratory and NASA's Marshall Space Flight Center. The RLLDP team has been designing a robotic landing missions since 2005. Several different robotic landers and lander mission designs have been developed including: 1) a human precursor mission to the lunar surface, 2) a lander that performs experiments to extract volatiles near the lunar South Pole, 3) multiple landers to form a lunar seismic network, and 4) a Near Earth Asteroid (NEA) lander to study the composition of an asteroid. For the last 18 months, the RLLDP has been focusing on building a full scale representation of one of the lander designs. The goal of this risk reduction activity is to use this lander to demonstrate several of the landing profiles currently under consideration for a lunar, or a NEA mission. This demonstration lander operates using a peroxide propulsion system and is referred to as the Warm-Gas Test Article (WGTA). The WGTA operates in Earth's 1-G environment and therefore is designed with an Earth-cancelling thruster oriented along its central axis to compensate for Earth's gravity. Three descent thrusters provide thrust to slow down the descent rate and 12 attitude control thrusters manage roll, pitch and yaw orientation to ensure an upright landing. The WGTA structure is designed to minimize mass while maximize structural stiffness. By reducing the structural mass, the WGTA achieves additional flight duration, whereas the robotic mission design benefits by having additional payload carrying capacity. The structure is designed with 3 energy-absorbing legs that dissipate energy during the impact of landing and lessen the loads transferred to the WGTA instruments and electronics. The WGTA legs and structure are geometrically arranged to ensure a dynamically stable lander that maximizes the probability of an upright landing during various approach scenarios. The WGTA instrument decks employ lightweight composite fabrication techniques to minimize its mass. Due to the schedule constraints, all-aluminum decks using ortho-grid construction were substituted for the composite decks in order to accelerate integration time. This paper describes: the mechanical design of the WGTA, the challenges of incorporating the robotic lander design into a lander capable of operating in a 1-G environment, the difficulties in providing a compact, lightweight structure that meets the strength requirements of the overall lander while working to an accelerated delivery schedule.