DEVELOPMENT OF A LIGHTWEIGHT, ENERGY ABSORBING SOFT-LANDING SYSTEM FOR ROBOTIC PROBES

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ABSTRACT

For more than 40 years, robotic probes have been landing on surfaces of extraterrestrial bodies. Near-term mission concepts continue to place a high value on robotic solar system exploration. Earth's moon and Mars have remained popular targets for study, while support is growing for surface missions to other bodies (more distant moons, asteroids and comets). In support of future missions, a joint NASA/MSFC and JHU/APL team aim to develop a robust, lightweight soft-landing system for bodies of scientific interest with little or no atmosphere.

This paper will focus on the soft-landing system development from a mechanical viewpoint. A preliminary set of requirements was established, with particular focus on energy absorption and landing stability. A detailed survey of past lander missions informed a set of trades performed on the mechanical design. The resulting baseline design was built around NASA's Robotic Lunar Lander mission requirements, but it has proven robust for a fairly large range of airless body surface missions in subsequent studies. In support of the Robotic Lunar Lander risk reduction development program, the team is designing an analogous full-scale soft-landing system for an Earth-based terminal descent and landing demonstrator. Despite Earth's significantly higher gravity, modifications to baseline component sizing support full-scale, autonomous closed loop descent and landing demonstration and testing.

The mechanical design team is focused on going beyond a baseline design of a soft-landing system for a Robotic Lunar Lander mission. The immediate goal is to gain an in-depth understanding of landing dynamics and energy absorbing landing systems. Once this understanding is demonstrated through analysis and test, the team aims to drive the detailed design to optimum mass efficiency. Only with optimum mass efficiency can the most aggressive of landed missions fit within constrained mission funding.

This paper gives an overview of the baseline design and the concept development process. Results of component and subassembly analysis and development testing are discussed, specifically as related to the development of the Earth-based landing demonstrator. The impact of the current effort, as related to future design optimization, is also discussed.