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DESIGN OF INFLATABLE MULTI-PURPOSE TOWER FOR SUPPORT OF ROBOTIC AND CREWED LUNAR SURFACE OPERATIONS

Abstract

Plans for sustainable human presence on lunar surface require integration of diverse surface elements, pressurized and unpressurized, to support robotic and crewed operations. The University of Houston and Embry-Riddle Aeronautical University's proposal to assemble an inflatable multi-task tower on the moon was developed in response to the NASA Big Ideas Challenge 2024. The challenge was to develop a novel inflatable structure that presented a solution for future space operations. This paper outlines major design aspects and novelty of the proposed tower, UNIT (Unique and Novel Inflatable Tower), implementing advanced concepts through innovative design and deployment strategies on the lunar surface. Project development stages include computer generated design, detailed drawings development, inflation process analysis, scaled prototyping and proof of concept testing. Scalability emerges as a fundamental aspect of UNIT's design, allowing for adaptability to the diverse requirements of many missions. The tower concept allows for versatile integration of existing and new technologies and is designed for segmented deployment for scalability and flexibility. The tower's modular design enables scaling up based on operational needs, from communication and navigation to illumination. This flexibility facilitates the integration with Artemis LUNANET and/or establishment of a large-scale network of interconnected towers, each serving specific functions while contributing to broader goals of lunar exploration and settlement. UNIT represents a pivotal advancement in approaching lunar exploration operations by combining advanced concepts in inflatable structure technology and stabilization system design to allow for rapid deployment on challenging terrain. The tower will be built using materials best for inflation integrated with various hardware. A prototype of the tower will be evaluated through a series of verification tests, such as pressure, vibration, and stabilization testing. The paper concludes with evaluation of project life expectancy and cost efficiency. Projected to last 5-7 years, the lifespan of UNIT hinges on its de-

signed resiliency with the environmental conditions it encounters. This lifespan estimation is based on the challenges of deploying and maintaining commercial-grade inflatables in extreme environments. UNIT's parameters such as size, weight, power needs, and technology readiness levels are being carefully considered to align with the goals of the Artemis program. Its inflatable deployment capability allows for swift establishment of lunar infrastructure, thereby streamlining mission timelines and resource allocation. The project's focus on cost-effectiveness ensures a balance between performance and expenditure, making sustained lunar exploration more feasible. Together, these attributes underscore UNIT's role in improving the quality, quantity, and cost-efficiency of mission outputs.