LUNAR EXOCAM - SURFACE MEASUREMENT OF LUNAR DUST PLUME MIGRATION

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ABSTRACT

The behavior of regolith plume migration in the lunar surface environment caused by lunar lander rocket propulsion remains largely unobserved. No sensor has directly measured the ejecta from lunar rocket engine plumes. With NASA's forthcoming Artemis program [1] focusing on lunar settlement in the coming years, a full characterization of these physical systems is essential.

Previous first-hand observations of Surveyor 3 [2] by the Apollo 12 astronauts highlighted the adverse effects of regolith migration at a considerable distance from arriving spacecraft. By and large this is a well-recognized and concerning information gap in the lunar science community. Both design and proximity of landing areas and co-located physical structures will depend on lessons gathered from reliable regolith migration data.

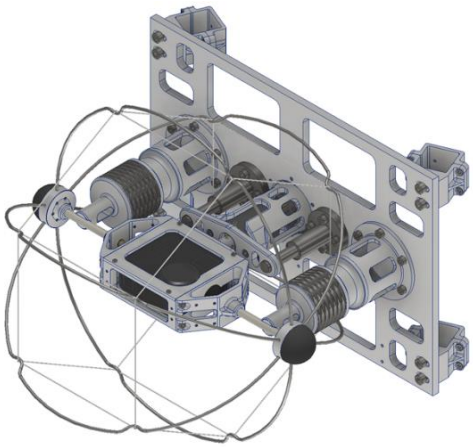
"Lunar ExoCam" is a remotely deployed lunar payload that will eject during the final moments of descent of a lunar lander, for the purpose of safely landing a small camera / sensor module within the high-speed regolith dispersion cloud. Once ejected, this module will employ a 360° FOV high-definition video and particle-impact sensor suite for gathering in situ data to better inform future modeling efforts. This instrumentation set assures simplicity of ExoCam payload design, as no specific orientation or moving parts are required.

CURRENT DEVELOPMENT

In October 2020, Lunar ExoCam was awarded a grant under the NASA "Flight Opportunities" [3] program. These funds will enable advancement of the system via an October 2021 test flight on board the Masten Space Systems Xodiac suborbital rocket, further elevating the ExoCam Technology Readiness Level and demonstrating overall payload effectiveness in terrestrial environment.

Fig. 1 – Early development of the Lunar ExoCam 360° field-of-view HD video camera / particle-impact sensor suite

The NASA Flight Opportunities program provides for funded inclusion of an educational institution. Arizona State University is currently engaged with two individual teams developing and enhancing the overall scientific viability of the ExoCam payload (pictured below):



1. Team One is developing image enhancement tools for analysis of visual data captured in the 360° HD video format, including complex pre-visualization renders and post-launch analysis.

2. Team Two is developing a particle sensor [Fig.1] that will be affixed to the exterior of the video camera. Piezoelectric sensors will be mounted on all six outward faces without interfering with the dual-lens camera FOVs.

SENSOR OPERATIONS

Dropped near the landing site, the goal of this multi-angle particle sensor will be to measure size and frequency of particle impacts dispersed by the landing plume. These data, when combined with detailed analysis of the video captured by the video camera system, will help improve dispersion models that can be used to plan surface science exploration and protect emplaced lunar surface infrastructure.

REFERENCE

[1] https://www.nasa.gov/specials/artemis/

[2] https://www.theverge.com/2019/7/17/18663203/apollo-11-anniversary-moon-dust-landing-high-speed

[3] https://go.nasa.gov/3xjzplC