DEVELOPMENT MODEL OF DUST MITIGATION SYSTEM FOR LUNAR SURFACE MISSION

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Introduction: GrainCams which is a payload candidate on NASA-CLPS (Commercial Lunar Payload Services), is a suite of two light field cameras for lunar surface mission [1]. Its science goal is understanding characteristics of the uppermost regolith and levitating dust on the Moon. GrainCams will operate on lunar surface with a rover, and it has two light field cameras that are surface camera (SurfCam) and levitating dust camera (LevCam) [2].

SurfCam will take light field images of the upper few millimeters of the regolith with various region near the landing site. Thus, dust mitigation system is required to control lunar surface dust from the SurfCam lens. Dust mitigation module to be attached at the front end of the optical barrel, and the piezoelectric sensors (vibratory) are mounted inside of this module as dust removing parts. In this paper, we present the development model of dust mitigation system with verification and test results.

Design: Dust mitigation system consists of a module (Figure 1) in which housing structure parts, cover glass and piezoelectric board are assembled, and an electric box. It has a vibration displacement (> 0.1 μm) requirement for entire cover glass area. Vibration amplitude and frequency can be selectable and also each piezoelectric sensor can be controlled separately. This system has ~200 g mass and power consumption of 4 W (one-shot) with RS-422 communication interface.

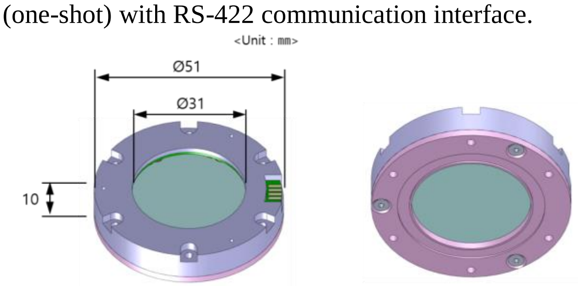

Figure 1 Dust mitigation module design

Analysis: Vibration displacement analysis of development model design was conducted to verify performance requirement. Displacement analysis was identified for various frequency modes, and also it has been confirmed by 2D scan test (PSV-400 equipment) for various operation modes.

Structural analysis is also performed for structural stability and space environment verification. Margin of safety is confirmed to be above zero.

Performance test: Achieving a dust mitigation performance with lunar soil simulant is essential for the success of the mission in the lunar dust environment. Test configuration is camera with flat light source, test box and JSC lunar regolith simulant. The performance of mitigation has been verified by comparing the amount of light before and after the operation of this system with lunar soil simulant. In a clean state (100%, amount of light), dust was sprinkled to make 50% or less, and then dust mitigation was operated. This system taken amount of light up to 90% or more for one-shot operation.

Environment test: Vibration and shock tests are performed preferentially to verify reliability of this system for the launch and space environment. Dust mitigation module is passed twice for vibration (Quasi-static load, sinusoidal, random) and shock tests based on GEVS (GSFC-STD-7000A).

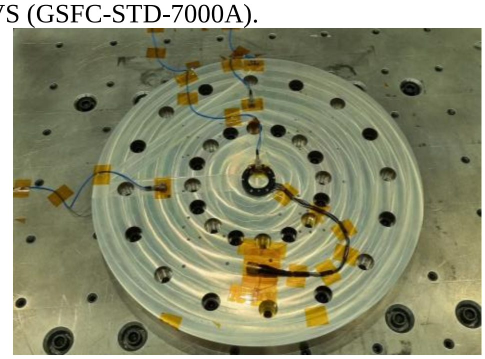

Figure 2 Vibration test set up for development model of dust mitigation module

Future Works: Development model of dust mitigation system will be verified for thermal vacuum and total ionizing dose test. In addition, performance of this system will be finalized by examining additional function/simulation tests.

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References: [1] C.K. Sim et al. (2023) 54th Lunar and Planetary Science Conference, Abstract #1494., [2] D. Lee et al. (2023) 54th Lunar and Planetary Science Conference, Abstract #1772.