LUNAR EXOCAM: ACTIVE FLIGHT TEST OF CAMERA AND SENSOR PAYLOAD SYSTEM FOR REMOTE CAPTURE OF LUNAR LANDER DESCENT AND LANDING.  Jason A. Mezilis\textsuperscript{1}, Rex W. Ridenoure\textsuperscript{2}, \textsuperscript{1}Zandel Deksit Inc., Los Angeles, CA  imezilis@gmail.com; \textsuperscript{2}IZUP LLC., Pasadena, CA

Introduction: In October 2020, Lunar ExoCam was awarded a funding grant under NASA's Flight Opportunities program. Funds will provide support for an untethered test flight onboard Masten Space Systems Xodis sub-orbital rocket in summer of 2021. Information captured through this terrestrial-analog test flight will supply critical design information and advance Technology Readiness Level (TRL) towards future development for lunar surface implementation.

Presentation: This poster outlines research to be carried throughout the Flight Opportunities program as well as the updated design of the Lunar ExoCam remote imaging/sensor module and notional ejection system. Lunar ExoCam is being developed specifically for recipients of the NASA-funded CLPS (Commercial Lunar Payload Services) lunar lander program contracts. The concepts and development contained herein were initially presented orally at the 2019 Microsymposium 60 \cite{1}. Initial mechanical systems engineering was subsequently developed utilizing IRAD funds from Honeybee Robotics in Feb-Mar. 2020, and further camera staging development has been carried out with support from Masten Space Systems.

Lunar Payload: Direct in situ imaging of a lunar landing from the lunar surface has never been attempted, nor has direct measurement of the regolith dispersion caused by a landing. Such data will inform the design and operation of future landers and emplaced lunar surface base/outpost infrastructure. An approach for capturing these unique data types involves deployment of one or more small Lunar ExoCam imaging/sensor modules carried to the Moon by the proposed commercial landers.

The modules initialize camera operations and eject from the host lander at ~50 m above the surface. The modules fall to the lunar surface under the influence of lunar gravity, whereas the lander typically descends at a slower, fixed pace, resulting in approximately 10-15 seconds for the onboard instrumentation to capture full-frame-rate video during descent to the lunar surface as the lander executes its final descent and landing.

The Lunar ExoCam system design includes a 360° spherical field-of-view color video camera, a particle sensor tailored to detect fine regolith particle impacts, a battery-based power subsystem, sequencing and control avionics, near-field RF subsystem to support data transfer back to the lander, and ruggedized mechanical packaging to accommodate deployment from the lander, lunar surface impact, sensor suite deployment and overall thermal balance. The design approach seeks to meet all requirements with low mass, low cost and with straightforward lander interfaces so that on any given lander more than one Lunar ExoCam system might be accommodated to enhance mission robustness and reliability, data capture and overall value.

Fig. 1 below demonstrates overall architecture of the ExoCam Module and corresponding Ejection System, depicted in horizontal-mount configuration. Not shown are some support avionics as part of the Ejection System, which would be mounted on the lander near the Ejection System.

Mars and other solar system bodies: The Lunar ExoCam payload will provide a benchmark from which future ExoCam systems designs for the Martian surface and other solar system bodies will be informed. Notional designs include options for extended surface usage; for example, the external visualization of human egress from lunar or Martian landers.

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References:
\cite{1} Microsymposium 60: Forward to the Moon to Stay -- Undertaking Transformative Lunar Science with Commercial Partners; A workshop held 2019 Mar 16-17, Woodlands, TX; Organized by Dr. Jim Head and Dr. Carle Peters, Brown University.