FY24 R&TD Innovative Spontaneous Concepts (ISC)

Infrared Color Video for Artemis EVAs

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Strategic Focus Area: Innovative Spontaneous Concepts

Objective: Demonstrate a proof-of-concept for the use of an infrared color video system that could enable Artemis astronauts to discriminate the mineralogy of lunar rocks and to detect surface H_2O in real-time during EVAs.

Background: The human vision of astronauts and EVA-suit-mounted film cameras used for Apollo [1] could not unambiguously identify the mineralogy of potential samples due to their limitation to the visible spectral range, at which lunar rocks are spectrally ambiguous (gray). While the infrared color imagers employed on robotic lunar-orbiting missions (e.g. the Moon Minerology Mapper M^3 [2]), have demonstrated the ability to discriminate between the four dominant minerals that comprise ~98% of the lunar crust (plagioclase, olivine, pyroxene, and ilmenite) plus H_2O [3], such "pushbroom" instruments rely on controlled scanning, an approach which would not be suitable for an astronaut-mounted camera. Snapshot spectral imagers, however, acquire both spatial dimensions and the spectral dimension in a *single* exposure, making them ideally suited for use while mounted to an EVA suit. Combined with a forearm-mounted display or a helmet-mounted 'heads-up' display, such an infrared color video camera would allow astronauts (and Mission Control) to effectively 'see' the relative concentrations of H_2O and discriminate amongst lunar minerals and rock types in real-time (video-rate) false-color imagery of the lunar surface during EVAs.

Approach and Results:

We demonstrated an infrared color video camera with 200 × 200 spatial pixels and 36 spectral bands in the spectral range from 980 to 1646 nm in a laboratory environment and in two lunar-relevant system testbeds:

1. In the JPL Mars Yard, populated with lunar-relevant rocks, with the camera mounted on the operator's shoulder.
2. In JPL's Ice Lab, observing mixtures of lunar regolith simulant and H_2O ice.

The Mars Yard testing demonstrated the ability of this approach to distinguish between rocks consisting of olivine, pyroxene, and plagioclase mineralogies. In the Ice Lab demonstration, the depth of the 1450 nm spectral band measured by the camera correlated with the H_2O concentrations of the ice/regolith mixtures.

Significance/Benefits to JPL and NASA:

This approach could enable Artemis astronauts to quickly and reliably identify and select the most valuable suites of lunar samples for collection and return to Earth.

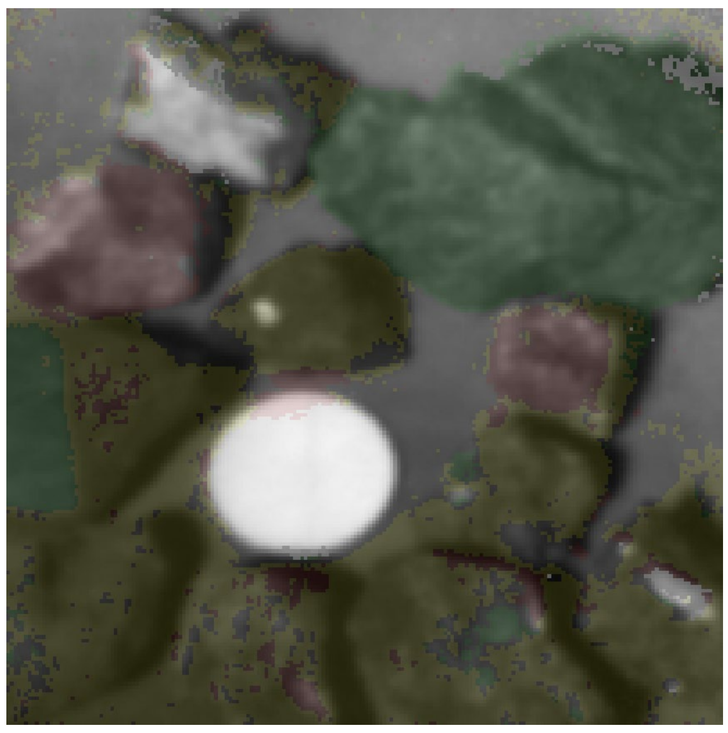

Figure 1. Infrared color image acquired in the laboratory. Green overlay identifies olivine, yellow overlay identifies plagioclase, and red over identifies pyroxene.

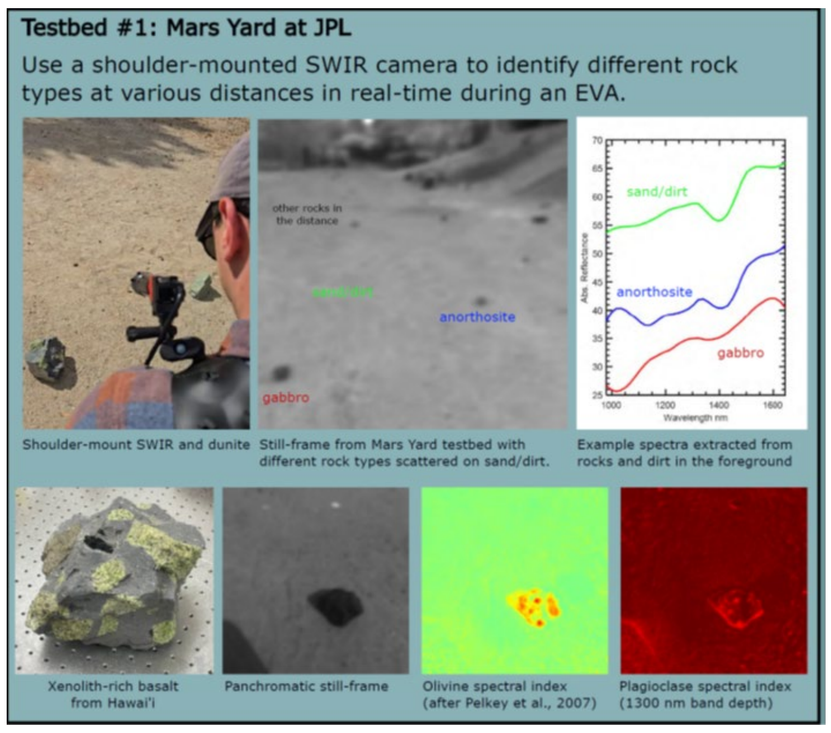

Figure 2. Infrared color video acquired in the Mars Yard demonstrated an EVA concept of operations.

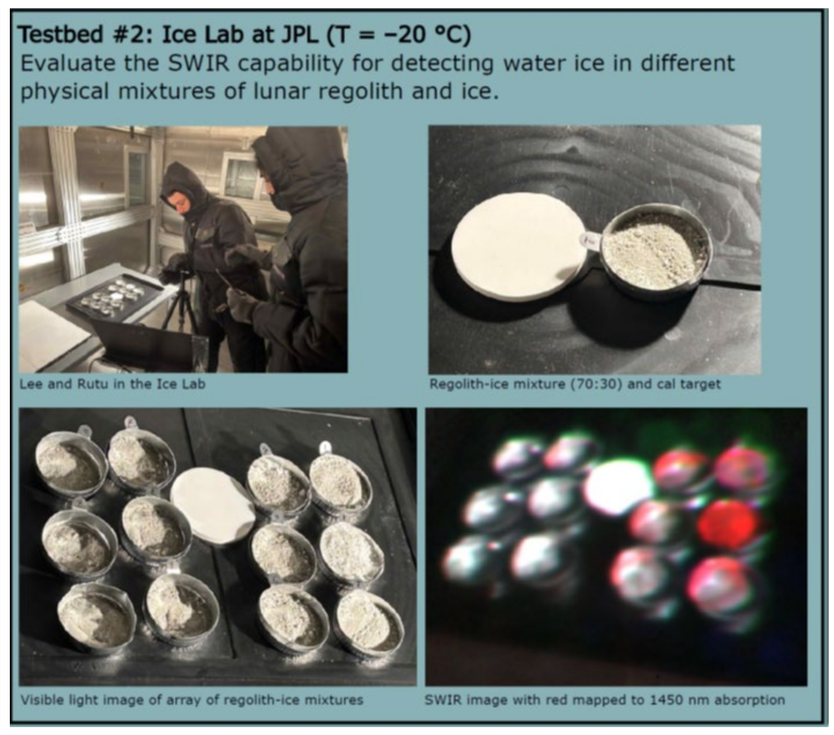

Figure 3. Testing of regolith-ice mixtures demonstrated the ability to image H_2O concentration.

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[2] S. Li, P. G. Lucey, R. E. Milliken, P. O. Hayne, E. Fisher, J. P. Williams, D. M. Hurley, and R. C. Elphic, "Direct evidence of surface exposed water ice in the lunar polar regions," (2018) *PNAS* **115** 8907-8912.

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Publications:

Lee Saper, René Heine, Yang Liu, Rutu A. Parekh, and R. Glenn Sellar, "Infrared Color Video for Artemis EVAs," accepted for presentation at the *Annual Meeting of the Lunar Exploration Analysis Group,* abstract 5067, Houston TX, 2024. https://www.hou.usra.edu/meetings/leag2024/pdf/5067.pdf

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