LUNAR SCIENCE INVESTIGATIONS AND EXPLORATION IN CELESTIAL MAPPING SYSTEM. P. Agrawal[1] and G.K. Norman [1,2], I. Lopez-Francos [1,3], A. Zuniga[1], G. Mackintosh[1,4] [1]NASA Ames Research Center, Moffett Field, CA 94035-1000, parul.agrawal-1@nasa.gov, [2] USRA, [3]WYLE Labs, [4]BAERI.

Introduction: As NASA expands the mission portfolio on the lunar surface, there is a need for applications with a broad range of analytical and functional capabilities that can be simultaneously deployed onto multiple mobile and desktop platforms to perform in-situ operations and hence enabling extensive Lunar exploration. Celestial Mapping System (CMS) [1,2] is developed to address the need for tools for science investigations, mission planning, operations and support for planetary sciences. Built on top of NASA WorldWind libraries, CMS can be simultaneously deployed onto multiple platforms, has the flexibility to update to the latest imagery and terrain datasets as they are being acquired (in real time) before and/or during the exploration mission and has the potential to enable traverse path planning suited for rovers, EVA and surface mobility units. It can provide critical functionalities such as equipment planning and optimized placement on Lunar surface, line of sight analysis to inform the coverage area for various equipment, powerful measurement tools based on 3D terrain, 3D COLLADA models to represent rovers, humans and equipment, visualization of derived mapping products (e.g. resource maps), and a data engine for hosting new observations that are not available in other contemporary lunar data tools [1].

Visualization of PSRs: The current presentation focuses on the work performed by the authors, to consume a unique dataset of super-enhanced images of the permanently shadowed regions (PSRs) at the lunar poles which were produced by the Hyper-effective nOise Removal U-net Software (HORUS) tool [3]. This tool was developed in direct support of NASA's VIPER and Artemis programs to enhance the extremely low-light images of the interior of PSRs and provide the first-time ability to see within these regions at and discern surface features (i.e. boulders and craters) down to 3 meters in size. We focused on the region near Nobili crater near Lunar south pole, selected site for VIPER mission and stitched several images to create a high-resolution map within one of the PSR of Nobile crater.

Line of Sight Analysis and Traverse Planning in PSRs: We have developed an in-built line of sight analysis (LOS) tool in CMS that analyzes the terrain profile and obstructions and provides the visibility of a given terrain for a remote observer. This tool was utilized to perform viewshed analysis to investigate the area inside the PSR, a remote observer such as a rover could see without actually crossing the region. Figure 1 shows the viewshed analysis on the PSR in Nobile region. The yellow pin shows the observer location outside the PSR. The yellow area shows the visible part of PSR. The obstructed area with no visibility for the observer is shown in red.

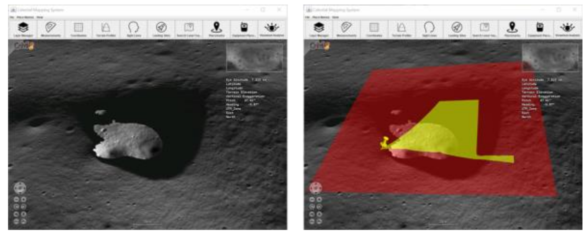

Figure 1: (left) PSR image on top of a high-resolution mosaic of sunlit images of a crater, in Nobile region (right) Viewshed Analysis of the same PSR with observer location shown by yellow pin.

This analysis was extended further to set different heights for various observers and then perform the viewshed analysis. Combining the different visibility profiles can help designing improved traverses within the crater.

Future plans: Eventually, HORUS datasets will be integrated into CMS as a layer in selected lunar polar regions. Hazard Maps will then be created based on terrain analysis in those regions. This integration will enable multiple scientific and exploration applications, such as designing traverses within PSRs, analyzing potential landing and science mission targets, investigating the meter-scale geomorphology of PSRs, including craters, boulder, surface roughness, mass wasting features and other indications of the presence of water-ice and other volatiles.

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References: [1] https://celestial.arc.nasa.gov [2] Agrawal et. al. “Celestial Mapping System for Lunar Surface Mapping and Analytics”, Lunar Surface Innovation Consortium, 2021 [3] Bickel V. et al. (2021) Nat Commun 12, 5607