INNOVATIVE FEATURES OF NASA'S CELESTIAL MAPPING SYSTEM TO SUPPORT EXPLORATION IN THE LUNAR SOUTH POLE

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Introduction

NASA's Celestial Mapping System (CMS) is designed to provide 3D tools for planetary exploration and science.

Key features:

1. Optimized equipment placement on the lunar surface.
2. Line-of-sight (LOS) analysis.
3. 3D visualization tools for rovers, astronauts, equipment, and resource maps.
4. Data engine hosting for new and derived observations not available in other lunar data tools (e.g.: HORUS denoised PSR images – Fig. 2, 3)
5. Real-time imagery and terrain updates.
6. Cross-platform compatibility (Windows, Linux, iOS, Android).
7. Compatibility with Open Geospatial Consortium standards.
8. Integration with datasets from various sources, including the Astrogeology Science Center of USGS, NASA, and JAXA. (Fig. 3)
9. Seamlessly adjusts to new lunar cartography standards set by global geospatial authorities.
10. Mission traverse planning and hazard analysis

LROC Narrow Angle Camera Mosaic

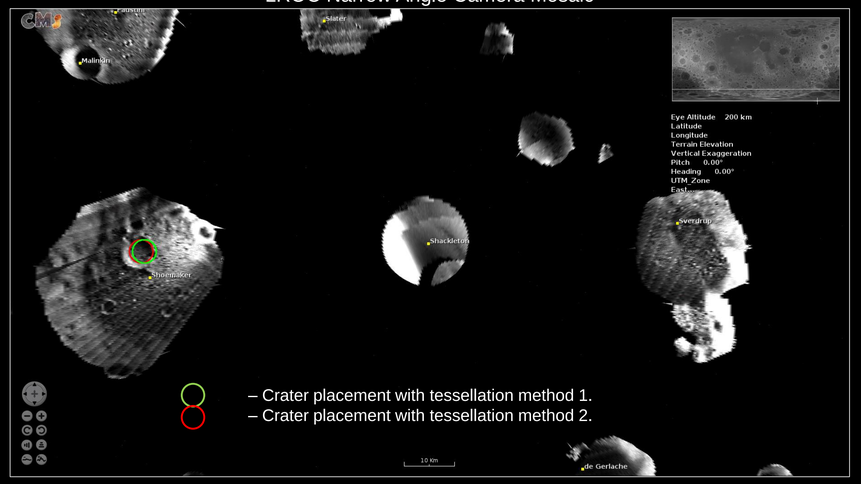

Fig. 1: Distortion due to tessellation at Shoemaker crater shown in USGS NAC layer. Source NASA CMS.

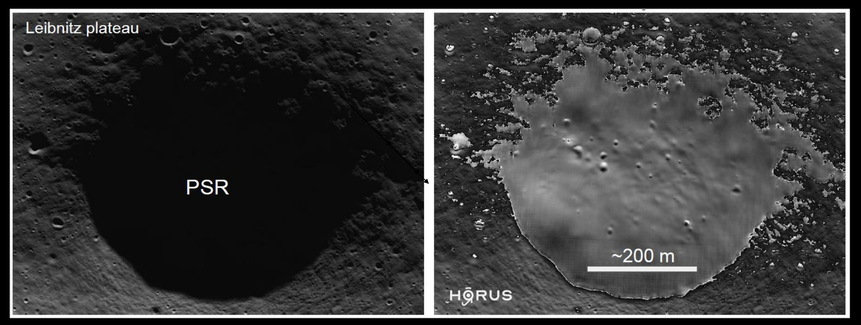

Fig 2: (Left) LRO NAC image of a PSR; (right) HORUS-enhanced layer overlaid on top of the NAC image, clearly revealing surface features inside the PSR. Source: Bickel et al (2021)

Fig. 3 Visualization of HORUS-enhanced layer over 4 PSRs in the Nobile region. Source: CMS.

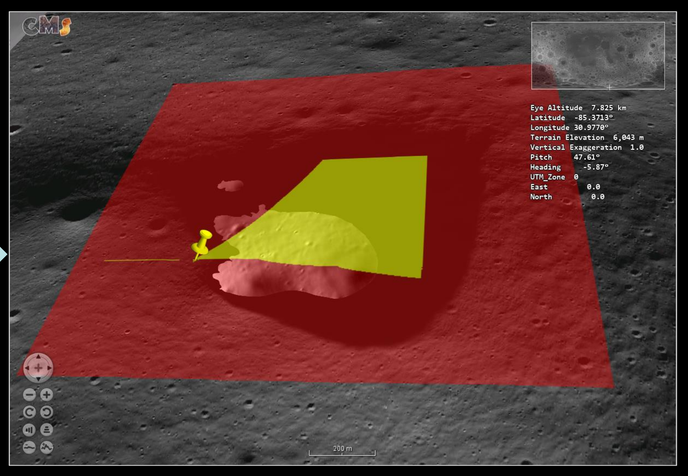

Fig. 4: LOS Analysis of a remote observer (yellow pin) over a PSR. Visible portion is shown in yellow. Source: CMS.

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Overcoming Polar Distortions

Issue: Traditional 3D geospatial tools show distortions at polar regions due to source imagery, tessellation algorithms, and map projections.

Solution: The CMS team is developing methods to correct these distortions using new tessellation algorithms and better-suited data projections.

Fig 1 - Shows the potential error introduced by different tessellation methods, represented by the red and green circles for Shoemaker crater. There is ~2 Km difference in the placement of the crater.

Line-Of-Sight Analysis and Traverse Planning

Tool Integration: CMS includes a LOS tool that assesses terrain profiles to determine visibility.

Application: Fig 4 - Visibility analysis for the upcoming NASA VIPER mission site at the lunar South Pole's Nobile region.

Ongoing Development: Extended visibility analysis considering various observer heights aids in designing improved navigation paths in the PSR.

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] Agrawal et. al., “Science Investigations and Exploration in Celestial Mapping System LSSW 17, June 2022 [4] https://worldwind.arc.nasa.gov/ [5] Bickel et al. (2021) Nat Commun 12, 5607