GLOBAL 3D DATA VISUALIZATION AND ANALYSIS PLATFORM WITH ADVANCED MACHINE LEARNING CAPABILITIES IN SUPPORT OF LUNAR EXPLORATION

Parul Agrawal[1], B.J. McDonald, G. Mackintosh, M.E. Peterson, I. Lopez-Francos, A. F. Zuniga , G.M. Del-Castillo
NASA Ames Research Center, Moffett Field CA 94035
1. POC: Parul.Agrawal-1@nasa.gov

CELESTIAL MAPPING SYSTEM (CMS) : 3D Platform for Planetary Exploration

Website : https://celestial.arc.nasa.gov/

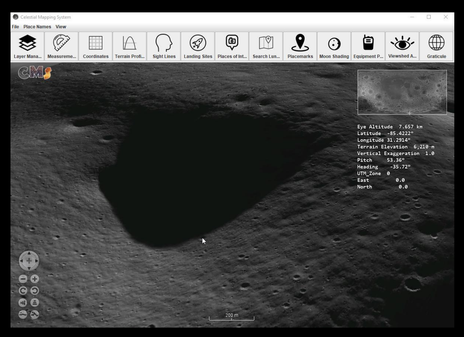
Key features:

1. Datasets rendering from USGS, NASA, JAXA
2. Optimized equipment placement on the lunar surface.
3. Line-of-sight (LOS) analysis.
4. 3D models for rovers, astronauts, equipment etc
5. Data engine hosting for new and derived observations
6. Real-time imagery and terrain updates
7. Cross-platform compatibility (Windows, Linux, iOS, Android).
8. Compatibility with Open Geospatial Consortium standards
9. Seamless adjustment to new lunar cartography standards
10. Mission traverse planning and hazard analysis

PLANETARY DATA INGESTION AND ILLUMINATION of PSRs

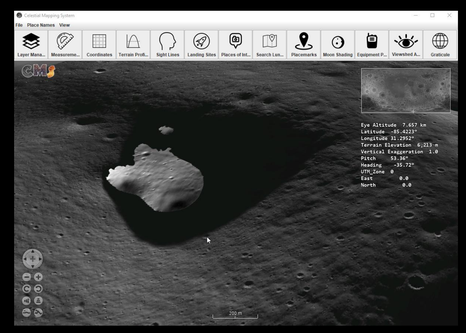
CMS can ingest and analyze data from both locally hosted and external third-party sources. Demonstrating this capability, we present our process for ingesting a unique dataset of super-enhanced images of the permanently shadowed regions (PSRs) in the Lunar South Pole. Utilizing the Hyper effective nOise Removal U-net Software (HORUS) [8], we enhanced the extremely low-light images of PSRs from the Lunar Reconnaissance Orbiter's (LRO) Narrow Angle Camera, enabling researchers to discern surface features such as boulders and craters down to 3 meters in size. These images were ingested and merged within CMS through a semi-automated process. In the near future, we plan to fully automate this process using AI-based tools.

Original NAC Image



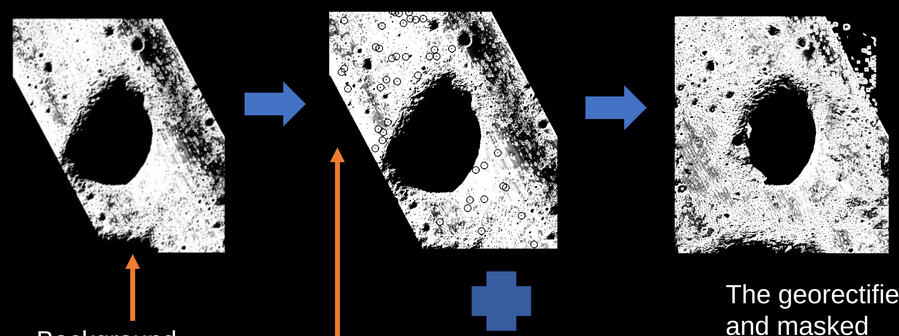
PSR in the Nobile region, selected site for VIPER mission; image rendered in LROC NAC layer of CMS

HORUS Illuminated PSR



HORUS ingested and merged images within the PSR shown with LROC NAC layer as baseline

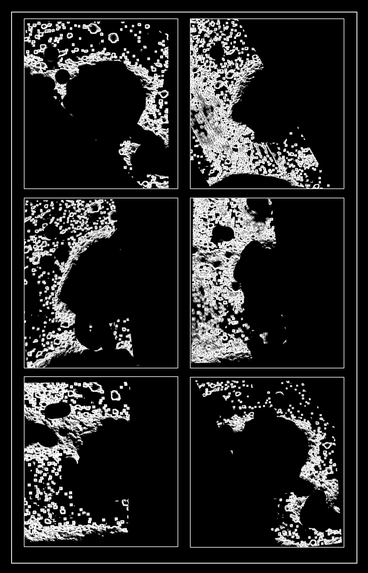
DATA PIPELINE ENHANCEMENT by AI



Background image (Nobile crater) selected using a scoring function based on the average stddev of pixels

A feature similarity search is used to select control points to georectify the remaining overlapping images

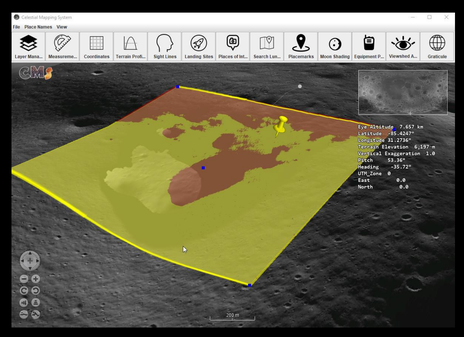
The georectified and masked images are then stacked onto the background to produce the final composite image



Overlapping images are georectified and masked to remove areas with low information density using the same pixel stddev function as the masking threshold criterium

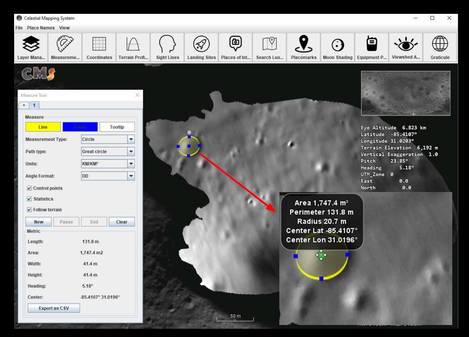
FUNCTIONAL ANALYSIS on ILLUMINATED PSRs

Visibility Analysis



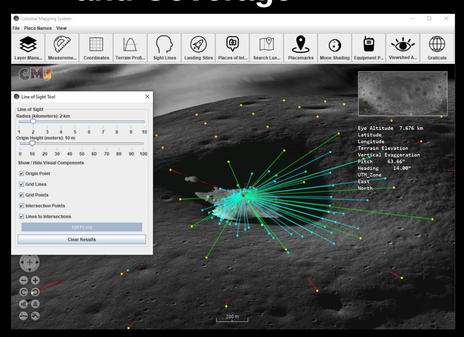
Viewshed Analysis of the same PSR with observer location shown by yellow pin

Measurements



Measurement of a crater inside the PSR by 3D measurement tool

Equipment Placement and Coverage



Equipment placement and Line Of Sight (LOS) analysis

Acknowledgments:
NASA interns G.K. Norman, K. J. Dickinson, T. A. Lucarz; HORUS team member V.T. Bickel; Yousaf Butt, Department of Defense, Trent Hare, Brent Archinal USGS Astrogeology; M. Robinson, LRO MOON LROC 2 EDR V1.0, LRO-L-LROC-2-EDR-V1.0, NASA Planetary Data System (PDS), 2009. https://doi.org/10.17189/1520643 for enabling NAC base layers

References

[1]NASA/SP-20205009602 [2] Feldman, W. C. et al. (2001), JGR 106, 23231–23251 [3] Mahanti, P. et. al. (2023) IEEE IGARSS, 4162-4165 [4] NASA Sending Five Payloads to Moon on Astrobotic's Peregrine Lander - NASA [5]https://celestial.arc.nasa.gov [6] Agrawal, P. et. al., (2022), LSSW, Abstract # 5007 [7] Agrawal, P. et. al., LSIC 2023 Fall meeting [8] Bickel V. et al. (2021) Nat Commun 12, 5607

LUNAR AND PLANETARY SCIENCE CONFERENCE

Ames Research Center