CROWDPLAT

NASA JSC | NOIS2-174

CASE STUDY

NASA LUNAR MAP SUPER-RESOLUTION PIPELINE

AI/ML-powered DEM enhancement using LROC NAC data, ISIS, ASP, and deep learning

2m -> HR
LROC NAC TO HIGHER-RES DEMs

ISIS + ASP
DEM PRODUCTION PIPELINE

GAN
SUPER-RESOLUTION MODEL

Apache 2.0
OPEN-SOURCE DELIVERY

OVERVIEW

NASA Johnson Space Center partnered with CrowdPlat to develop an AI/ML-powered lunar mapping workflow that converts existing 2-meter-per-pixel LROC NAC data into higher-resolution Digital Elevation Models (DEMs). The delivered approach combined image selection, ISIS and Ames Stereo Pipeline processing, DEM production, and deep-learning super-resolution.

CHALLENGE

Lunar south-pole mapping requires careful image-pair selection and preprocessing because illumination geometry, shadowing, emission angle, overlap, and stereo strength directly affect DEM quality and downstream mission analysis.

- Select useful stereo image pairs from LROC NAC source imagery within target regions of interest.
- Produce DEMs using reproducible ISIS and ASP processing steps.
- Upscale DEM outputs through a configurable deep-learning model for improved terrain analysis.

Mission value

The workflow supports NASA lunar mission planning by improving terrain products used for navigation, hazard detection, landing-site analysis, simulation, and scientific studies.

DELIVERED WORKFLOW

CrowdPlat delivered a workflow that moved from LROC NAC image selection to DEM creation and then to super-resolution enhancement. The process combined NASA and USGS planetary-data tools with custom selection logic and a configurable GAN-based upscaling model.

STEP 1

Image Selection

Selected stereo image pairs using illumination geometry, incidence, emission, phase, resolution, base-to-height ratio, shadow-tip distance, and ROI overlap criteria.

STEP 2

Preprocessing

Used lronac2mosaic.py and ISIS steps including lronac2isis, spiceinit, lronaccal, lronacecho, noproj, handmos, cam2map, and custom footprint logic.

STEP 3

DEM Creation

Ran ASP parallel_stereo and point2dem, created DEM mosaics, tied outputs to LOLA altimetry, leveled and smoothed seams, and optionally filled holes.

STEP 4

Super-Resolution

Split DEMs into training/inference squares, removed null-value DEMs, and applied a GAN architecture with encoder-decoder attention generator and VGG discriminator.

TECHNICAL CONTROLS AND OUTPUTS

Element	Delivered / demonstrated capability
Source data	LROC NAC imagery and NAC DTM public data used for DEM creation, training labels, and super-resolution testing
Image-pair logic	Custom multi-step criteria evaluated overlap within ROI and imaging geometry from footprint-union centroids
Deep-learning model	Configurable 2x default scaling factor using a GAN model with encoder-decoder attention generator and VGG discriminator
Demonstrated results	Pipeline and super-resolution outputs shown for Connecting Ridge and Malapert Massif, including before/after enhancement views

OUTCOME

- Delivered an AI/ML-powered high-resolution lunar mapping tool workflow that converts existing LROC NAC DEM inputs into enhanced terrain products.
- Implemented the full pipeline from image selection and preprocessing through DEM production, mosaicking, leveling, smoothing, and super-resolution upscaling.
- Demonstrated test outputs for Connecting Ridge and Malapert Massif, including low-resolution versus super-resolution comparisons and squares-to-DEM pipeline results.
- Provided an open-source contribution under Apache 2.0 to support reuse, innovation, and future lunar mapping applications.

CROWDPLAT ADVANTAGE

1 End-to-end lunar data pipeline

CrowdPlat connected raw LROC NAC imagery, ISIS/ASP processing, DEM creation, and deep-learning enhancement into a coherent delivery workflow.

2 Custom image-selection logic

The approach improved data reliability by screening image pairs for overlap, illumination, stereo strength, resolution ratio, and ROI suitability.

3 AI-ready mapping outputs

The super-resolution workflow created enhanced DEM products useful for terrain analysis, hazard detection, navigation research, and mission simulation.

Bottom line

CrowdPlat helped NASA advance lunar terrain analysis by delivering a repeatable pipeline that transforms LROC NAC data into higher-resolution DEM outputs for mission-relevant use cases.