Design and Processing of the Lunar North Pole Mosaic

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Abstract #1582

Introduction
The Lunar Reconnaissance Orbiter Narrow Angle Camera (NAC) consists of two line-scan cameras aimed side-by-side with a combined 3.7° FOV. The NAC acquired images with a pixel scale of 0.5 m from a 50 km near-circular orbit from 2009 through 2011, and pixel scales with a range of 0.5-2 m from a ~30°-180 km orbit since December 2011 [1].

In the northern hemisphere, where the orbit is highest, the relatively large size of NAC footprints allows for complete coverage at consistent incidence angles and high resolution to a startling distance from the pole. We have used this coverage to produce the Lunar North Pole Mosaic (LNPM), a 2 m/pixel mosaic from 60°N to the pole, currently released on the internet at lroc.sese.asu.edu/gigapan/. We released the first version of this mosaic in January 2014 [2,3], and have now finished the second version, with improved image selection in many regions. The current version contains 681 gigapixel images of real images, which are usually long strips with a ~10:1 length:width ratio, were trimmed to remove the part of the image on the opposite side of the pole from the sub-solar point. This list was then manually adjusted to clean up areas with inconsistent lighting, using a 100 m/pix preview mosaic created using pixel-by-pixel, lowest-incidence-angle ordering (a very slow algorithm, which leaves some edge-of-image artifacts) as a “best possible” reference image.

The Lunar North Pole Mosaic (LNPM) – It’s Really Big

This mosaic contains 10,088 images (an additional 6,388 images were used as source files, but ended up entirely covered by other images), mostly with the Sun as high above the horizon as possible for that latitude. The mosaic contains 681 gigapixel pixels of the lunar surface, and if printed out at 300dpi (the quality of most of the figures on this poster), the surface, and if printed out at 300dpi (the quality of most of the figures on this poster), the pixels that contain real image data would more than fill an American football field (~0.98 soccer pitches). The geographic area covered is larger than Alaska and Texas combined.

Processing

The processing method for the LNPM was driven by the format required by Gigapan.com, the site we use to host the LNPM. The site requires millions of data from 10,088 images. We are currently working on expanding this mosaic out to 40°N, which will include just over 2 terapixels of image data.

The sixteen 256-pixel tiles at zoom level 3.

Upcoming Expansion: 2 Terapixels

Below 60°N, NAC images on adjacent orbits no longer overlap, so the collar image sequences that make up the bulk of the current mosaic (see box “Image Selection – Collars (60°-82°N)” to the upper-right) are not possible. In order to expand the mosaic, we are selecting images from the large existing dataset and targeting new observations to fill gaps (see the “Image Selection – 40°-60°N” box to the right). We intend to produce a mosaic that extends from the north pole to 40°N, with a total of just over two terapixels of non-null pixels (more than 3x the size of the current mosaic). The gore-filling campaign is expected to finish sometime in late 2016.

This planned expansion is near the limit of what is reasonable for the polar stereographic map projection. In this projection, pixel size decreases as the projection expands towards the equator, and at 40°N, the pixel scale is 1.6 m, which barely avoids oversampling the average NAC pixel scale of ~1.5 m at that latitude. For any eventual expansion south of 40°N, we would need to change to a different map projection for the equatorial section.

This expanded version will also require additional segmentation of the processing of the mosaic, as the estimated disk space for intermediate products (~100TB) will far exceed what our systems can reasonably handle.

References

Image Selection – 40°-60°N

Since collar sequences are not possible below 60°N, for the future 40°-60°N expansion of the LNPM, we are selecting images from the large existing imag dataset and targeting new observations to fill gaps in the high-Sun coverage. We are restricting image selection to those images with a beta angle (angle between the orbital plane and the Sun-Moon vector) less than 45°, which gives over 55,000 images in this region. The mid-latitude expansion campaign is estimated to finish sometime in 2016.

We have not yet finalized the ordering criteria for this expansion. While a simple “minimum incidence angle” approach gives acceptable results, it leaves many locations where adjacent images are lit from opposite directions. We are currently looking into algorithms to find clusters of images with similar lighting direction, so that while the mosaic as a whole may not have uniform lighting, there will be near-uniform regional lighting.

Despite these issues, this expansion will result in a complete mosaic from 40° to the pole, covering ~18° of the Moon at 2 m/pix. At over two terapixels of data, this will likely be the largest uniform-resolution photographic mosaic ever produced.