New Lunar Crater Search Using LROC-NAC vs LOIRP Lunar Orbiter Images

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The Process of Using the Lunar Orbiter II and LROC Image Data to Search For Undiscovered Craters

In 1966 and 1967 NASA sent five Lunar Orbiters to photograph nearly the full surface of the moon. Each orbiter launched took images of different areas of the moons surface, or very high resolution images corresponding to lower resolution images previously taken. Lunar Orbiter Image Recovery Project (LOIRP) is one of the several projects using these images for research.

We are in possession of 1,478 2" original analog tapes from 3 Deep Space Network ground stations. We have taken a subset of those analog tapes from Lunar Orbiter II and converted them to digital form; with the majority of them being from Lunar Orbiter II which took images with 0.8 to 1 meter resolution.

Overview

The finding of new craters will help us determine the age of older craters by looking at the baseline color of the regolith from known dates between the Lunar Orbiter and LROC images. The craters found per unit area will also provide a boundary on the current small body population of the inner solar system.

Assembly

With the analog signal from the tape converted to digital images we are able to overlay them with Lunar Reconnaissance Orbiter Narrow Angle Camera (LROC NAC), which has a similar resolution of 0.5 to 1 meter. The overlays enable us to compare the two images and visually look for changes, specifically new craters.

The overlay is accomplished by searching for LROC NAC and Lunar Orbiter II images from the same areas, and that have similar sun angle geometry. Coarse alignment is done visually by toggling the opacity of the Lunar Orbiter image and scaling and rotating to roughly match surface features with one another. Software that matches images by aligning similar features is used to fine-tune the overlay alignment.

Comparison (Student Intern Work)

The project that we were working on required us to look and compare two similar images of the same area of the moon. We took an image from the LROC NAC and did an overlay of the LO-II image that covered the same area. We utilized the LROC NAC images because they used very high resolution, similar to that of Lunar Orbiter II. We constrained our image selection to those whose lighting characteristics were similar in order to improve the chances of detection of new craters.

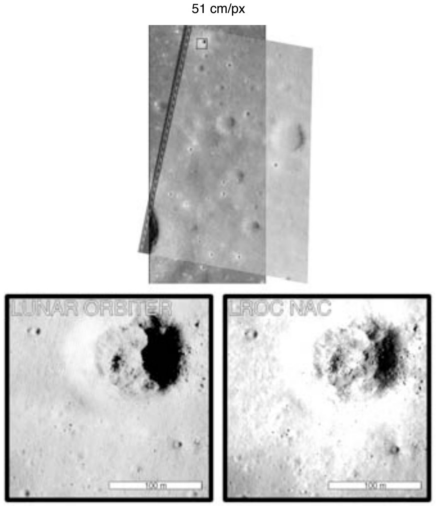
The three student lead authors compared the images manually through the use of image layers in Adobe Photoshop. For each overlap, an operator zoomed in on one overlay image at a time and slowly scanned it while simultaneously switching back and forth between the LROC NAC image and the Lunar Orbiter II image in order to compare the two surfaces thoroughly. The total area covered by the overlapping sections was approximately 300 km^2.

Expected Findings vs. Actual Findings, or Lack Thereof...

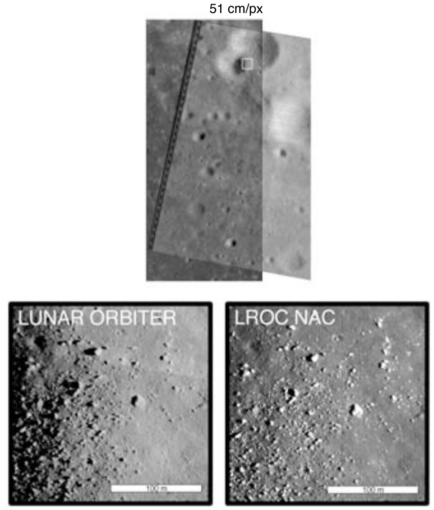
The highest resolution data from Lunar Orbiter II with pixel resolution of approximately 2 meters or less covers only about 20,000 km^2 (or 0.05% of the total Lunar surface). The very simplest overlays between this data and LROC data, where images had been fully assembled by LOIRP and sun angles were similar, provided fewer than 500 km^2 of overlap. Given the small areas covered it was highly unlikely that new craters would be found. While some candidate craters were observed that appeared in LROC data but not in Lunar Orbiter data, these were all very near the edge of discernable feature size and are almost certainly explained by various differences between the images (e.g. sun angle or viewing geometry).

While our initial search did not find any discernable new cratering, we have shown that data from the original analog Lunar Orbiter tapes, as recovered by the Lunar Orbiter Image Recovery project, possesses the characteristics necessary to discern new craters at reasonably small sizes. If the entire Lunar Orbiter data set was recovered in this manner it may be possible for future researchers to apply automated methods to detect changes with much better chances of success.

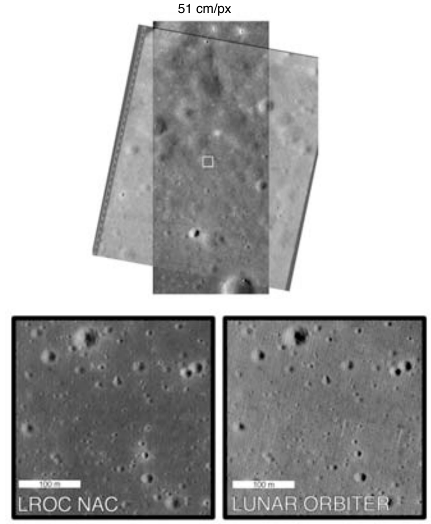
LROC: M113792706RE
Lunar Orbiter: LOII-072-H3
51 cm/px



LROC: M113792706LE
Lunar Orbiter: LOII-073-H2
51 cm/px



LROC: M113792706RE
Lunar Orbiter: LOII-072-H2
51 cm/px



LROC: M114030162RE
Lunar Orbiter: LOII-2112-H3
75 cm/px