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Automatic Identification of Changes on the Lunar Surface

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Since June 2009, the Lunar Reconnaissance Orbiter (LRO) has maintained a stable polar orbit enabling the twin Narrow Angle Cameras (NACs) to acquire high-resolution observations of the lunar surface (pixel scale of 0.25 to 2 m/pixel). This orbital configuration facilitates occasional repeat coverage with similar lighting geometries. These before and after observations, referred to in this study as temporal pairs, enable the identification of changes to the surface based on applying a series of change detection techniques.

Manual inspection of the temporal pairs by LROC team members resulted in the discovery of hundreds of new changes across the lunar surface [1]. However, this manual process is time consuming (2-4 hours per temporal pair) and each analyst must apply their own judgment on whether they have discovered a real change or an artifact in the image pair. Thus far, the LROC team has identified 650 surface changes as well as 19 resolved craters using the manual approach.

Leveraging image processing techniques developed by the LROC team, we started automatically scanning and identifying these changes. The new automated algorithm locates changes based on albedo variations and changes in surface texture. The program provides a list of potential new features for later manual inspection and classification (disturbance lacking resolvable crater or crater with a rim diameter of X meters). This new approach eliminates the human inspector from scanning up to 5.22*10^9 pixels in each temporal pair and instead provides cropped cutouts with the detected changes centered in the thumbnail image.

The LROC NACs have already collected thousands of temporal pair observations and will continue to do so over the remaining extended mission. Highest fidelity change detection comes from temporal pairs with nearly identical lighting geometries. In the next two years, the progression of the LRO orbit with respect to beta angle will enable direct illumination matches (<2 degrees difference in incidence and azimuth) with images acquired in 2009 and 2010. This long temporal baseline will enable the LROC team to investigate changes on the lunar surface over a five-year period and strengthen our estimates on the current impact rate and quantifying the potential hazard to current and future surface missions.

References: [1]: S.D. Thompson et al. (2014) Recent Impacts on the Moon, LPSC, #2769.