Development of a detection system for new craters using feature-based image registration

*Emi Morikawa[1], Keisuke Onodera[2,3], Kei Shirai[4], Mitsuo Yamamoto[5], Satoshi Tanaka[5]

1. The University of Tokyo, 2. University of Paris / Institut de Physique du Globe de Paris, 3. The Graduate University for Advanced Studies (SOKENDAI), 4. Kobe University, 5. Institute of Space and Astronautical Science (ISAS) / Japan Aerospace Exploration Agency

Finding new craters leads to a better understanding of the lunar surface environment by estimating the contemporary crater-production rate. Moreover, the precise information about the locations of lunar impact flashes would help us investigate the internal structure (e.g. [1]). In particular, little was known about small changes on the lunar surface due to the limitations of image resolution. However Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera (NAC) images make it possible to find small changes on the lunar surface, because the resolution of the images is 0.5 m per pixel at an altitude of 50 km. Thus, we developed a detection system for new craters using LROC NAC images in order to detect small changes.

Speyerer *et al.,* (2016) proposed a method using pair images (called temporal pair) taken before and after at the same spatial area under similar lightning conditions [2]. Instead of template matching algorithms used in a previous research [2], We used another approach for image registration of temporal pair, feature detection and matching algorithm. In general, feature-based image registration makes it faster and more robust for image scaling, rotation and lightning condition than template matching. In this study, we used SIFT (Scale Invariant Feature Transform; [3]) for feature detection algorithm and FLANN (Fast Library for Approximate Nearest Neighbors; [4]) for feature match algorithm.

A few locations are tying with lunar impact flash events. As a test operation, we applied our detection system to one of the locations, at 17.2°S, 339.6°W. Firstly, Temporal pairs were made under similar conditions to the previous study, such as an incident angle of less than 50°. These data were obtained from NAC ancillary information. Then 7 temporal pairs were made. Regarding this location, our detection system detected 55 spots as surface reflectance changes and the true positive rate was 61.8%. In our detection system, it was possible to compare temporal pairs whose incident angles were over 50°, which were not applied in the previous research to avoid the influence of shadows [2]. Therefore, more temporal pairs could be created than the previous studies, although more differences between the temporal pairs are detected. As a next step, we try to precisely locate 16 lunar impact flashes observed in period from 2017 to 2019, by collaboration of ISAS/JAXA, The University of Electro-Communications and Nihon University.

References:

[1] Onodera et al. (2019), JpGU2019, Chiba, Japan.
[2] Speyerer et al. (2016), Nature, 538, 215-218.
[3] Lowe, D. (2004), Int. Journal of Computer Vision, 60(2), pp.91-110.
[4] Muja et al. (2009), VISAPP (1) 2.331-340 (2009): 2.

Keywords: moon, automatic detection, LROC, crater

