PRELIMINARY TEST OF ACCURACY OF DIGITAL TERRAIN MODEL DERIVED FROM SELENE/LISM/TC DATA.

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Introduction: Topographic information of terrestrial planets and satellites provides a key to understand not only these surface but also these inner thermal evolution, sometime these origin. In the previous explorations, the detailed topography of the Moon has been mainly investigated using stereo images taken by Apollo. At the point of the limits of spatial resolution and these coverage on the Moon, however, these are not enough to have a proper understanding of the whole of the Moon. In the future missions, the whole coverage images which has high-resolution and constant qualities such as sun elevation condition.

The Terrain Camera (TC) installed on SELENE which is preparing to launch to the Moon in summer, 2007 give us high-resolution images (res. 10 m/pixel, from nominal altitude of 100 km) [1, 2, 3, 4]. The TC has two optical line heads to take stereo images with slant angles of +/- 15 degrees from nadir vector. Thus, the base to height (B/H) ratio is 0.57. The global stereoscopic operation will be executed in the SELENE nominal operation period of one year. Since stereo-pair data acquired by past lunar missions cover only 20 % or less of the surface of the Moon and almost are the data of Apollo missions which were established nearly 30 years ago, the global TC data will be fundamental ones for future lunar sciences and explorations.

The Digital Terrain Model (DTM) will be produced from TC stereo images [e.g., 3, 4]. The DTM is a first terrain elevation model that will cover the whole of the Moon with a high resolution. The main procedures of the DTM production system are divided into two parts: (1) consists of multi-stages matching loop to search the same pixel point on the Moon from the stereo-pair images using some kinds of size of correlation window and (2) performs a three-dimensional measurement using the bundle adjustment.

Preliminary result of our DTM system: An example set of products by the core programs in the DTM production system is shown in Figure 1. The left side is an ortho image generated from a set of stereo-pair images taken by the Apollo 15 panoramic camera (AS15-P-9298 and 9303). The right side is a shaded relief produced from a DTM data which is obtained from our DTM system because of to compare its ortho image. These product images are projected onto simple cylindrical system. The width of each image is about 20 km with about 4000 pixels, in other words, about a few m/pixel resolution.

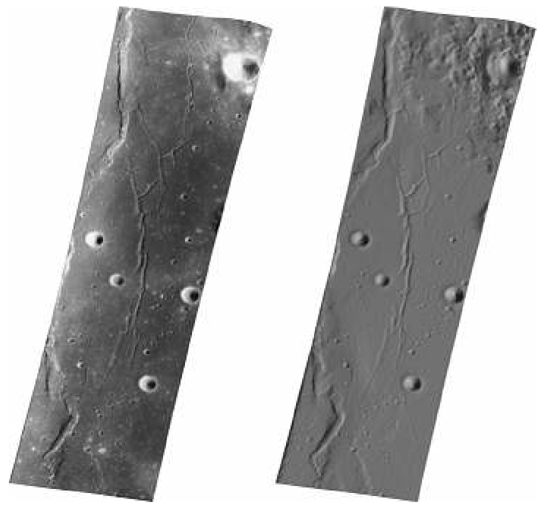

Figure 1. Ortho image (left) and shaded image (right)

In the right of Figure 1, most craters of diameter greater than a several 100 m can be clearly recognized in the shaded image, and the features of rill with about 1 km width that locates in the center of the image are well duplicated. In the upper-right area of right figure, unrealistic features such as full of small bumps are emerged, which are likely due to mismatching or insufficient parameter tuning for proceeding.

The purpose of this study is to evaluate an accuracy of our DTM system before the launch of SELENE. First, we investigate effects of a terrain type (highland / mare) and a photometric condition (sun elevation angle and solar azimuth direction) on the DTM product (Table 1). Furthermore, the degree of reproducibility of the crater morphology is quantitatively evaluated.

Result and Discussion: We evaluated an accuracy of the DTM that will be obtained by SELENE/LISM/TC data by a following procedures: (1) Terrains of lunar highland and mare are numerically simulated as following power-law distribution of craters. These simulated terrains is recognized as true value of DTM. (2) TC stereo images are produced from the simulated terrains and a simulated orbit of

SELENE. (3) DTMs are produced from the simulated TC stereo images by the DTM production system. (4) Comparing the output DTMs with the true DTMs, the accuracy of result of our DTM production system is evaluated as standard deviation of difference between output DTMs and true DTM. The Influence of photometric condition on the accuracy of DTM is investigated using TC images simulated in various conditions. The result of this test is shown in Figure 2 and 3. We found that errors of DTMs are smaller than an error of 17 m analytically calculated from a 10 m/pixel resolution of TC image and a B/H ratio (0.57), except for cases of high solar elevation in mare geology. The standard deviation of height estimation are 5 ~ 16 m and 5 ~ 25 m for highland and mare, respectively.

Future work: The DTM production system has numbers of parameters, for example, a template size of matching, a window size of smoothing filter. In this study, a nominal parameter set is used for all test cases. We will have to select parameter sets suited for various photometric conditions and terrain types. We will tune parameters to each photometric condition and terrain type before the launch.

References: [1] Haruyama, J., et al. (2003) *LPSC XXXIV*, #1565. [2] Haruyama, J., et al. (2004) *LPSC XXXV*, #1496. [3] Haruyama, J., et al. (2006) *LPSC XXXVII*, #1132. [4] Haruyama, J., et al. (2006) *Advances in Geoscience*, vol. 3: Planetary Scinece, 101-108.

Table 1. Photometric condition for the simulated TC images.

No.	Terrain Type	Sun Elevation	Solar Azimuth
1	Mare	5 °	0 °
2	Mare	30 °	0 °
3	Mare	5 °	45 °
4	Mare	30 °	45 °
5	Mare	5 °	90 °
6	Mare	30 °	90 °
7	Highland	5 °	0 °
8	Highland	30 °	0 °
9	Highland	5 °	45 °
10	Highland	30 °	45 °
11	Highland	5 °	90 °
12	Highland	30 °	90 °

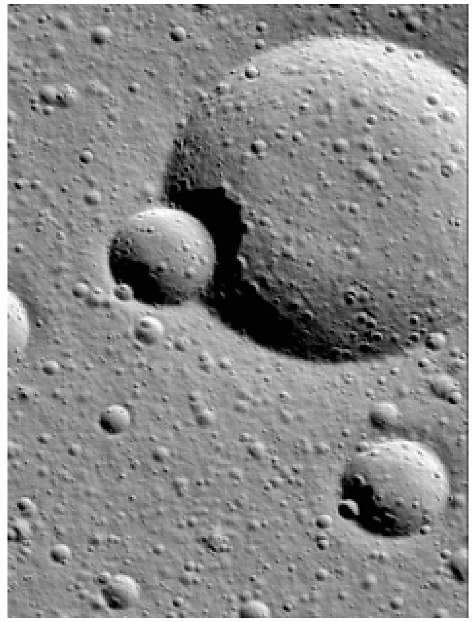

Figure 2. Simulated TC image of the highland terrain (Table 1, No. 10)

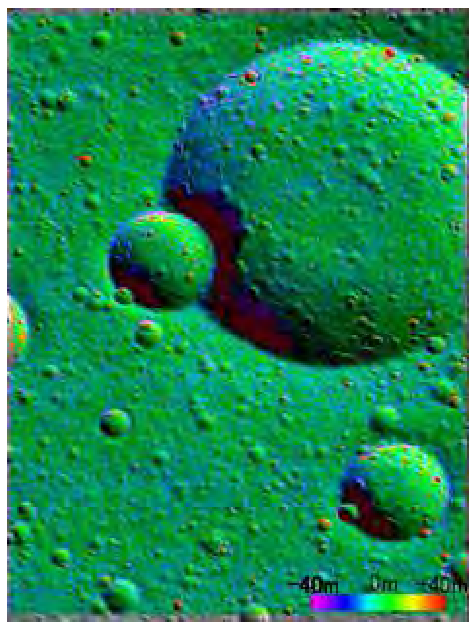

Figure 3. Difference between true DTM and output DTM