MAPPING OF LUNAR TOPOGRAPHIC ROUGHNESS BY DIGITAL TERRAIN MODEL. Y. Yokota[1], J. Haruyama[1], M. Ohtake[1], T. Matsunaga[2], C. Honda[1], T. Morota[1], M. Abe[1], M. Torii[1], Y. Ogawa[2], H. Demura[3], N. Hirata[3], and LISM Working Group, [1]Institute of Space and Astronautical Science / Japanese Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa, Japan, yokota@planeta.sci.isas.jaxa.jp, [2]National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba-City, Ibaraki, 305-8506, Japan, [3]University of Aizu, Aizu-Wakamatsu, Fukushima, 965-8580 Japan.

Introduction: The degree of roughness on lunar highland is a result of cumulative meteoroid impact and volcanic histories. The geological units of the highlands have been estimated based on stratigraphic study (e.g. [1]). Quantitative mapping method to indicate surface roughness may contribute significantly to the stratigraphic study of the Moon.

The lunar explorer SELENE (KAGUYA) has been successfully inserted to lunar polar orbit in October 2007. SELENE has three optical instruments for scientific observation: Terrain Camera (TC) [2,3], Multi-band Imager (MI) [4], and Spectral Profiler (SP) [5]. These instruments compose one system, called the Lunar Imager and SpectroMeter (LISM) [2]. TC will perform global stereoscopic mapping at middle solar-elevation angles, and global, high contrast mapping at lower solar-elevation angles with a spatial resolution of 10m [2,3]. The Digital Terrain Model (DTM) of entire lunar surface will be provided by using TC stereoscopic images. Accordingly, it is necessary to develop automatic processing methods for such a large DTM dataset. We report some improvement of the roughness mapping method after our previous report [6] and demonstration results.

Sample Digital Terrain Models: We prepared test DTM datasets using stereoscopic images of the Apollo Mapping Camera. Detail of the procedure has been reported in our earlier report [7]. More than 30 images are used to produce DTMs of three regions on the moon shown in Fig. 1.

Procedure of Roughness Mapping: Current procedure has three major differences from our previous report [6].

1. In the previous report [6], RMS deviation (Allan deviation) [8] was used as the indicator of roughness. Though the average slope of the cell (Unit area of the analysis) was subtracted as the background slope, the cell size was decided arbitrarily in that analysis. In order to decide the scale of the background slope deliberately, we used the Median differential slope method in this study. This method was introduced by Kreslavsky and Head [9] in Mars topographic data analysis. The differential slope α is given by

$$\tan(\alpha) = \frac{[h(x_i) - h(x_i + \Delta x)] - \Delta h_{offset}}{\Delta x},$$

where $h(x_i)$ is the height of the surface at point x_i, Δx is the horizontal step size (baseline), Δh_{offset} is the background slope determined by using twice large baseline around that point. Median of the differential slope α is calculated in a unit area of the analysis.

2. According to Kreslavsky and Head [9], median differential slope at three different baselines are used to make a composite RGB map (Red: 10km, Green: 3km, Blue: 1km).

3. To improve effective spatial resolution of roughness map, the $1°\times1°$ unit area for median differential slope computation is moved by smaller step, similar to running average method.

Results: Composite RGB map is shown in Figure 2. Baseline vs. median differential slope plot of eight selected point in Figure 2 are shown in Figure 3. Below is the list of features in Figure 3.

1. Median differential slope of Mare (a) is clearly smaller than highland at step size >3km.

2. Apollo 16 landing site region: Plain (c) and Descartes Mountain area (d) can be distinguished by median differential slope at baseline 2-10km.

3. Even in the highland, crater floor (e) has lower median differential slope than Mare (a) at Baseline <1km.

4. Plots of (b), (f), (g) and (h) have high median differential slope value, even at baseline 10-20km. This group can be distinguished from smooth group [(c) and (e)] and medium group [(d)].

Outlooks for SELENE Data Analysis: Lunar highland will be classified at least three level of surface roughness by the median differential slope method. However, calculation at a baseline longer than 20km may be required to distinguish geological units in far-side highland.

References: [1] Wilhelms D. (1987), *USGS professional paper 1348*. [2] Haruyama J. et al. (2007) *Earth Planets Space*, in press. [3] Haruyama J. et al. (2008) , This issue. [4] Ohtake M. et al. (2008), This issue. [5] Matsunaga T. et al. (2008), This issue. [6] Yokota Y. et al. (2007), *LPS XXXVIII*, Abstract #2430. [7] Yokota Y. et al. (2007) *Adv. Sp. Res.,* in press. [8] Shepard M. K., et al. (2001) JGR 106, E12, 32777-32796. [9] Kreslavsky M. A. and Head J. W., 2000. *JGR, 105, E11,* 26,695-26,711.

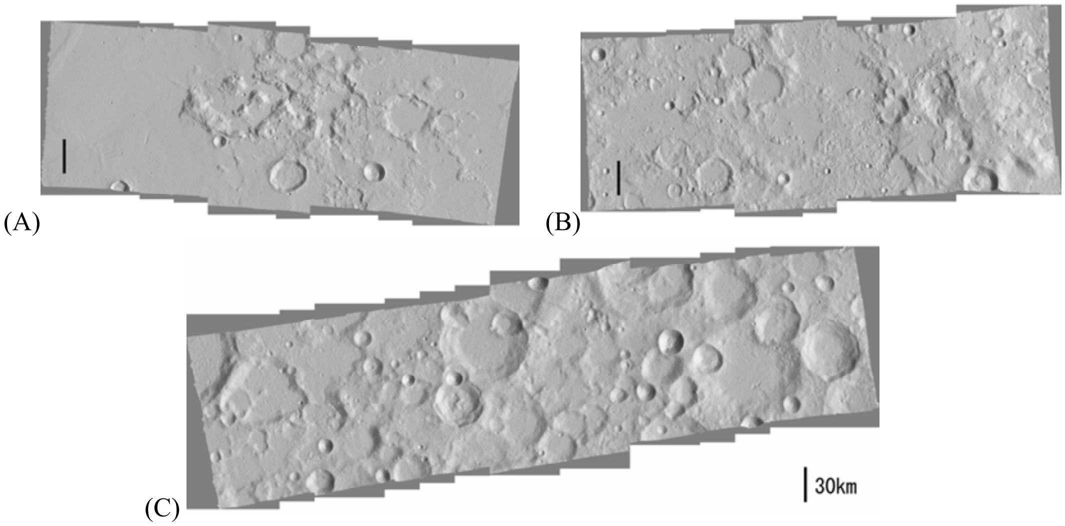

Figure 1. Shaded relief mosaics made from the test DTM data. (A) Apollo 17 landing site region. (B) Apollo 16 landing site region. (C) Highland of Lunar farside (~100 E).

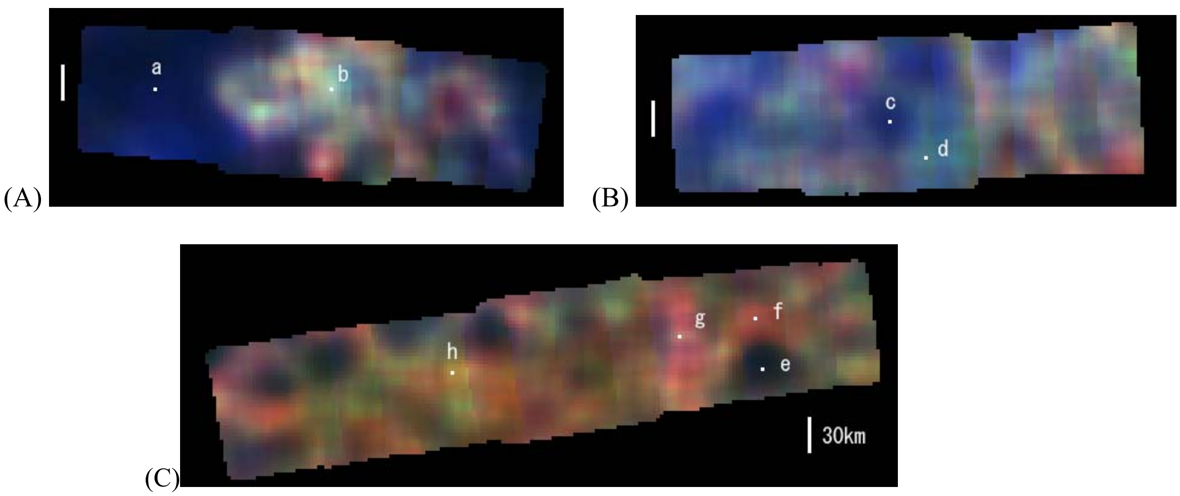

Figure 2. Map of kilometer-scale surface roughness. Median Differential Slope at 1-, 3-, and 10-km step size are used as the blue, green, and red channels, respectively.

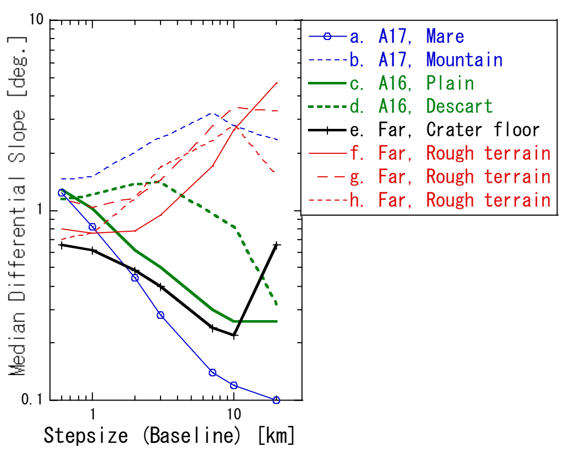

Figure 3. Dependence of the median differential slope on base-line length for the eight selected points in Figure 2.