DETECTABILITY OF DEGRADATION OF LUNAR IMPACT CRATERS BY SELENE TERRAIN CAMERA

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Introduction: The degradation states of lunar impact craters provide information about the ages of eruption of lunar maria. In 2006, a Moon explorer named SELENE (SELenological and ENgineering Explorer) will be launched by an H-2A rocket of the Japan Aerospace Exploration Agency (JAXA) that was recently established with combining Japanese three space agencies: National Space Development Agency of Japan (NASDA), the Institute of Space and Astronautical Science (ISAS), and the National Aerospace Laboratory (NAL). The photometric data taken by the Terrain Camera (TC) installed on SELENE will be useful for the investigation of degradation of lunar impact craters.

The identification of eruption age of each geological unit of the Moon is necessary to understand the lunar thermal history. The most reliable ages of the lunar surface formation has been described on the basis of the age identification of lunar samples. However, since geological units whose eruption ages are represented by lunar samples are so limited, alternative dating methods using remote sensing data are significant and have been developed by previous workers. Though the most commonly accepted method of lunar dating by using remote sensing data is crater counting, it has large dating errors for small geological units (e.g., [1]).

One of other methods is the D/H method [2,3] based on an idea that the eruption age of a lunar geological unit relates to the smallest crater diameter of interior slopes of 1°(DL) in the unit. The Imbrian region has a DL value of larger than 240m, the Eratosthenian of 240-100m, and the Copernican of smaller than nearly 100m, respectively [2,3,4]. Though the Clementine is the most recent lunar explorer installing imagers and took images for whole surface of the Moon with the resolution of nearly 200m/pixel [5], its imagery data is not suitable for the DL method since it almost operated at higher solar elevation angles. To classify Eratosthenian and Copernican maria in detail using DL method, high-resolution stereo pair data to provide the D/H of such small craters is limited so far, and is demanded to obtain in a future lunar exploration.

Detectability of degradation of lunar craters by Terrain Camera: The SELENE is 3-axis stabilizing spacecraft and its operation altitude is 100km +/- 30km. It is planned that the SELNENE nominal mission period is one year, and longer operation and/or lower altitude missions will be carried out depending on the fuel status at the end of the nominal period. On the SELENE, we install a high quality optical imager / spectrometer system named LISM (Lunar Imager / SpectroMeter). The LISM consists of three subsystems: the Terrain Camera (TC); the Multi-band Imager (MI); and the Spectral Profiler (SP) [6].

The degradation of lunar impact craters will be investigated using the TC data in detail. The TC will take images of whole surface of the Moon with a nominal spatial resolution of 10m/pixel. The TC has two slant telescopes with line CCD sensors of 4096 pixels. The off-nadir angle of each telescope is +/- 15° to the SELENE flight direction, thus the nominal height-resolution of stereo images by TC is ideally about 17m/pixel. We note that a crater of 2km diameter with highly degraded interior slope of 1° has its depth of 17m.

In the nominal operation, the TC will carry out a DCT data lossy compression. We have installed 32 quantization table patterns, and will use appropriate tables considering the acceptable image quality down and the allowed data amount. The nominal compression rate is planned to be 70% level (when the compression rate of non-compression is 0% level). The dynamic range of the TC sensors is 10bit wide and its dark signal level has been adjusted to be nearly 50 digit number (DN). The TC has three modes for exposure time: long (L), middle (M), short (S) for 6.5msec, 3.25msec, and 1.675msec, respectively. The radiance factor (RAFD, defined in [7]) value of saturation level for each exposure mode is adjusted to be 0.08, 0.16, and 0.32 for L, M, and S mode, respectively. The radiance factor (RAFD, defined in [7]) value of saturation level for each exposure mode is adjusted to be 0.08, 0.16, and 0.32 for L, M, and S mode, respectively. Figure 1 presents a result of RAFD values calculated for solar elevation angles in the case of that the azimuth angle is 90°, the emission angle of 15° corresponding to the TC slant angle, and the Hapke parameters are values for the dark terrain referred from [8]. The TC will provide no...
saturation image for the lunar dark terrain even if RADF values of the Moon surface are twice of calculated values.

The TC is planned to execute stereoscopic imagery at solar elevation angles in the range from 30° to 60° and monoscopic imagery for solar elevation angles of less than 30° for both of early morning and late evening times. At the end of the nominal SELENE mission period of one year, we will have obtained the high spatial resolution stereo pairs and high contrast images for the whole surface of the Moon.

Figure 2 shows the difference of RADF values of surfaces of level and of 1° slope at solar elevation angles from 0° to 60°. From this difference, we predict the difference of DN values (before quantization) (see Fig. 3, which is for the TC L mode) that are correspondent to a requirement for upper limit of TC total noise to distinguish the surfaces of level from those of 1° slope on TC images.

The current SELENE development status is the flight model fabrication and test phase. We have measured the total noise composed of the dark current noise with the cross talk noise due not only to LISM other components but to SELENE other components, photo-shot noises, and differences of offset level in odd-even read out lines. We are confirming that the total noise for the L mode at RADF = 0.01 is of less than 2.5DN for each DCT compression unit of 8x8 pixels. The surfaces of 1° slope will be distinguishable from those of level on TC images taken at solar elevation angles of lower than 20° (see Fig. 3). A possible noise may be taken place by the Lunar Radar Sounder (LRS) sounding, which has not been measured in the previous tests and will be investigated at the SELENE electromagnetic compatibility test.

References: