Semi-automatic recognition of lunar geologic units based on texture and spectral features using image data of KAGUYA, LISM TC/MI

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Recognition of geologic units on image data is a fundamental analytical step of remote sensing. A single geologic unit could be defined as a region with its own particular features, which represent its origin. Criteria for determining the units are varied between previous and recent researches. In 1960's and 1970's, researchers in lunar science used panchromatic photographs to make lunar geologic maps. Their basic criteria of geologic units are defined by surface textures and topographic features in the photographs. Recently, variation of remote sensing data has greatly expanded. Resolution and coverage of image data are increase, and multi-spectral images of the moon have been obtained through modern lunar missions. We especially focus on recognition of geologic units by combining texture and spectral features extracted from image data.

In addition, many techniques for automatic or semi-automatic image classification are developed. If these techniques are effective for recognition of geologic units in remote sensing data, automatic or semi-automatic data processing would be an important method for production of geologic maps of the moon. We have already presented the preliminary method for semi-automatic recognition of geologic units using image data of Apollo and Clementine [1]. The purpose of this research is to test the preliminary method with lunar high-resolution images and multi-spectral images obtained by Terrain Camera (TC) [2] and Multiband Imager (MI) [3] onboard the Kaguya lunar explorer.

Texture is controlled by surface undulation and reflectance of the object, and illumination conditions. While the surface undulation controls the texture at low solar elevations, the reflectance governs at high solar elevations. The variance of digital number of pixels in certain area is one of the statistical indices for texture features, and is adopted in this research. Spectral features are representation of characteristics of reflectance spectra of materials. They are derived from image calculations of multi-spectral image data. Band ratio is widely utilized spectral features [4]. The band ratios are proxies of the slope of spectral continuum or the depth of absorption bands. For the lunar case, they represent the contents of mafic minerals and the degree of space weathering [5]. Absorption band depths are other possible spectral features, which are more direct representatives of the material type. K-means clustering algorithm is adopted to label pixels based on the both texture and spectral features in this research. The algorithm is one of the most popular methods for unsupervised image classification.

This research adopts following procedures as an experimental ones; 1) The value of variance is derived as the texture feature using so-called filtering process, 2) The band ratios and the absorption band depths are derived as the spectral features, 3) The texture and spectral features are normalized, 4) K-means clustering is applied for classification. Arbitrary number of texture feature maps and spectral feature maps are used as input data. We use high-resolution images (10m/pixel) observed by TC and 9-band multi-spectral images (VIS: 20m/pixel, NIR: 62m/pixel) observed by MI as test data of the classification procedure. Three combinations of the MI band are adopted to take the band ratios: 750nm/415nm, 750nm/950nm, and 415nm/750nm. They are common sets for lunar multi-band images. The absorption depth at 900nm, 950nm, 1000nm, 1050nm and 1250nm are also extracted.

At the meeting, we present the results of semi-automatic recognition of lunar geologic units based on above procedures.

References:

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