Searching for lunar swirls with deep learning

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Lunar swirls are winding high albedo patterns not-correlated with topography.They have irregular shapes, distributions, and various spatial scales. About 10 swirls have been discovered so far by visual inspection. However, it is expected there would be more swirls. We have been working on applying Deep Learning to automaticallyfind lunar swirls candidates of small-medium size especially.

The objective of this study is building and updating learning models for automatic identification of lunar swirls and evaluating the models. We aim to search for lunar swirls with Deep Learning. We set the target area in Mare Ingenii area (20˚-50˚S, 150˚-180˚E).

The point to identifying swirl is to distinguish albedo features (swirls) from shading patterns (non-swirls). Therefore, we allocated two kinds of data to the 3 bands in RGB image: Camera imager for R band, and topography data for G and B bands following Kato et al. [2018].As camera image, we use the Multi-band Imager (MI) data from Kaguya satellite. As for DEM data, the data of SLDEM2013 are used. By creating such unique “Combined Image”, we can combine different kinds of information collectively as one image.

We built learning models using the framework of Caffe. We increased variation and quantity of training data to collect data from all confirmed swirl areas and to rotate original images in 3 directions. Totally 212 images (each image covers 1 by 1 deg.) were used as training data. We prepared correct answer data in target area and conduct cross validation for evaluation of results and models. The model building and evaluation were sequentially cycled.

Running the latest learning model, we found 275 images as swirl candidate scenes out of 832 images in the Mare Ingenii. Focusing on True positive rate, the best swirl detection was performed by the learning model built based on training data set which increases variation and quantity of swirl images and ratio of swirl images to non-swirl images.

Keywords: swirl, deep learning, Moon, automatic detection, exploration data

