Automated Identification of Particles in Rock Gravel of Small Bodies

*Yuta Shimizu[1], Hideaki Miyamoto[1]

1. University of Tokyo

Numerous boulders and fine particles are commonly distributed over the surface of small bodies, as revealed by the recent space exploration missions [e.g. 1]. Their mechanical properties, such as the shape and size distribution, are considered to be critical for the understanding of the geological surface processes [2], and for the landing safety of the landing/touchdown missions [3]. However, precise identification of the outlines of such particles is challenging due to irregular particle shapes, overlapping particles, image resolution limits. Here, we present a computational approach for the automated identification of particles based on the image feature extraction algorithm utilizing the convolutional neural networks (CNNs). We prepare images of the imitated surface of small bodies by using simulated material (simulant) of the regolith of small bodies [4], and then carefully identified thousands of particles manually. With the data of profiles, the model is trained, enabling nearly 80 % of profiles of particles of simulant to be correctly traced without the aid of manual analysis. Moreover, particles on the global surface of asteroid Itokawa are automatically identified by using tens of images taken in the Hayabusa mission, and identified profiles are mapped on the shape model. We measure the sizes of particles, revealing the cumulative size-frequency distribution (CSFD) of particles on the global surface of Itokawa to have the power-law index of -3.48±0.08, which is consistent with the CSFD calculated in the previous research [5]. The approach of this study can rapidly identify numerous particles, which can be a promising tool for analyzing countless images of the surface of small bodies taken in current and near future space exploration missions.

References

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