

## 12. Basic Study on Deep Learning Method for Estimating Soil Particle Size Distributions

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Soil particle size distribution, or PSD, is a key indicator that determines the mechanical properties of the ground and soil compaction characteristics. It is difficult to estimate PSD with sieve analysis frequently for soil generated in large quantities at construction sites. One method proposed to estimate the PSD of soil is based on image analysis including edge detection of particles. However, this method cannot be applied to soil composed of small particles with unclear contours.

Applying deep convolutional neural network models, we performed basic experiments to estimate the PSD of fine and sandy soil composed of small particles based on soil images. In this experiment, 1050 soil images divided into seven categories of the particle sizes and 3000 augmented images processed by splitting and combining soil images were arranged as training data. As test data, 30 sets of images each of sandy and fine soil were used for PSD estimates. We applied transfer learning to the training models to improve the accuracy of the estimates. The best estimate model achieved performance of less than 10% root mean square error.

**Key words:** sandy soil, fine soil, PSD, convolutional neural network, VGG16, transfer learning