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Geoscientific applications of a 3D laser scanner for small objects

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3D laser scanning has been frequently employed to acquire geospatial data especially in the last several years. Both airborne and terrestrial 3D scanning technology such as LiDAR and TSL has been used to obtain detailed topographic data in the field. High-resolution DEMs (Digital Elevation Models) constructed from airborne LiDAR receive attention as highly effective data for geomorphological studies. There are also 3D laser scanners of another type which permit very precise measurement and modeling of small (< 1 m) objects in the laboratory. Although such scanners are often used for constructing 3D models of industrial materials, art objects, and archaeological artifacts, their applications to geosciences have been very limited. Using a box-type laser scanner for small objects (Roland LPX-250), we scanned rock samples in the laboratory to conduct two geoscientific case studies. In the first case study, we scanned gravel particles collected from a river bed in central Japan. The gravel samples encompass various shapes from angular to well-rounded, with maximum lengths between 6 and 12 cm. The resultant 3D models of the samples with very fine resolution (< 1 mm) permit the accurate measurement of axis lengths, surface area and volume of each particle. Although surface area is necessary to compute gravel sphericity based on its original definition, manual measurement of the surface area of a complex object like a gravel particle is almost impossible. The obtained dimensions of gravel particles, including surface area, allowed the detailed evaluation of gravel shape parameters including sphericity and roundness. In the second case study, we scanned cut samples of sandstone, limestone and tuff during laboratory experiments of salt and frost weathering. Scanning was conducted at every interval between experimental cycles. The obtained 3D models provided detailed quantitative descriptions of rock decay and destruction processes, which had been discussed only qualitatively in preceding studies of rock weathering. The results allowed us to differentiate the effects of salt and frost weathering on rock destruction and evaluate the contrasting responses of rocks with different lithologies.

Keywords: Laser scanner, 3D model, Rock sample, Shape parameter, Rock weathering