Understanding landforms in 3D by hand-crafted cardboard model using high-definition 3D point cloud data

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Acquisition of three-dimensional high-definition topographic data by advanced techniques, including terrestrial laser scanning (TLS) and structure-from-motion multi-view stereo (SfM-MVS) photogrammetry using low-altitude aerial photographs from a small unmanned aerial vehicle (UAS), has recently been attracting attention in the field of earth and planetary science. Among these, UAS has become widely known in general through various news such as industrial applications and accidents in various places, and laser scanning and photogrammetry have also become socially well known as a core technology in the automatic driving of automobiles. However, as the present situation, the utilization of these technologies in the earth and planetary sciences has not fully been known in general. This is probably due to the fact that advanced research on earth and planetary sciences using high-definition topographical data is being promoted, but more general utilization of such the data as educational or learning materials has been limited so far.
Along with the development of three-dimensional printers, virtual reality (VR), and augmented reality (AR) technologies, it is expected that three-dimensional information based on the natural landscapes will also be effectively utilized. However, these latest 3D technologies have not been sufficiently used to reproduce complex natural landscapes, and further optimization and price reduction is required for easy, widespread utilizations. In this research, therefore, we present the methodology to reproduce three-dimensional high-definition topographic data of an actual natural landscape using more familiar materials. Based on the 3D point cloud data of a small island (Suzume-jima), located in the southernmost part of the Kujukuri Coast in Chiba, eastern Japan, we printed several slices of the point cloud data in the height direction (like contour lines) and pasted them on cardboard, which were cut out using scissors. The pieces of the sliced point cloud prints were stacked up to create a three-dimensional cardboard model. Through this process, the concepts of contour lines, signs of bedrock erosion, the processes of formation of overhanging cliffs and sea caves, and the morphological features of the entire island can be experienced and well understood. Such understandings of fully three-dimensional, complex landforms have hardly been achieved by the traditional topographic maps, and further applications are expected for various kinds of complex landforms including rockwalls, waterfalls, and caves.

Keywords: high-definition topographic data, terrestrial laser scanning (TLS), unmanned aerial system (UAS), SfM-MVS photogrammetry, three-dimensional point cloud, outreach