Application of the Kinect sensor to analogue modeling of volcanic deformation

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The Kinect is a USB-input motion capture device originally intended for the Microsoft XBOX system. The device comprises a visible (RGB) camera and an infrared (IR) camera, refractor and light emitter emitting a known structured light pattern at the near-IR wavelength of 830 nm, plus a three-axis accelerometer and four microphones. Although designed for use with videogames, the Kinect can be exploited as a short range, low-cost camera-type laser scanner by scientists in various fields. In fact, thanks to the effort of the online developer community, by combining the IR pattern emitted by the projector and received by the camera we are able to quantify the distance from the Kinect to objects within its field-of-view.

Measuring and monitoring 3D surfaces is critical to many studies in the earth sciences, including volcanology. We envisage several possible applications of the small-scale, precise topographic data acquired by the Kinect in this field, including mapping inactive lava tubes, capturing topographic data on the outcrop scale, and mapping surface roughness variations on volcanic mass flow deposits. The Kinect's main limitations for exploitation in this field are its limited field-of-view, operating working distance (i.e. from 0.5 to 5 m), precision and accuracy of the measured distance, which ranges from 1 mm to 8 cm at 0.5 and 5 m, respectively. Moreover, environmental factors can limit its usage in the field. For example, the presence of other strong IR sources such as bright sunlight can saturate the sensor, and surfaces that absorb IR radiation cannot be accurately detected.

However, remarkable results can be obtained in visualizing and quantifying the deformation of analogue volcano models in the lab. As a demonstration, we will present a novel application of the Kinect as a tool for 2D quantitative analysis and 3D visualization of laboratory analogue models of volcanoes. We will describe the calibration process for the RGB and distance images to the color spectrum and modeling materials and demonstrate its effectiveness in quantifying deformation in analogue modeling experiments.

Besides being lighter, smaller and therefore more portable than equipment commonly used to collect field data, data can be recorded with free and open source software, demonstrating the cost-effectiveness of the Kinect, in particular where conditions may be unsuitable for the deployment of more costly instruments.