Geophysical Research Abstracts
Vol. 19, EGU2017-15074, 2017
EGU General Assembly 2017

3D landslide motion from a UAV-derived time-series of morphological attributes

Maria Valasia Peppa (1), Jon Philip Mills (1), Philip Moore (1), Pauline Miller (2), and Jon Chambers (3)

(1) Newcastle University, Civil Engineering and Geosciences, UK - m.v.peppa@ncl.ac.uk, (2) The James Hutton Institute, Aberdeen, UK - pauline.miller@hutton.ac.uk, (3) British Geological Survey, Keyworth Nottingham, UK - jecha@bgs.ac.uk

Landslides are recognised as dynamic and significantly hazardous phenomena. Time-series observations can improve the understanding of a landslide's complex behaviour and aid assessment of its geometry and kinematics. Conventional quantification of landslide motion involves the installation of survey markers into the ground at discrete locations and periodic observations over time. However, such surveying is labour intensive, provides limited spatial resolution, is occasionally hazardous for steep terrain, or even impossible for inaccessible mountainous areas. The emergence of mini unmanned aerial vehicles (UAVs) equipped with off-the-shelf compact cameras, alongside the structure-from-motion (SfM) photogrammetric pipeline and modern pixel-based matching approaches, has expedited the automatic generation of high resolution digital elevation models (DEMs). Moreover, cross-correlation functions applied to finely co-registered consecutive orthomosaics and/or DEMs have been widely used to determine the displacement of moving features in an automated way, resulting in high spatial resolution motion vectors. This research focuses on estimating the 3D displacement field of an active slow moving earth-slide earth-flow landslide located in Lias mudrocks of North Yorkshire, UK, with the ultimate aim of assessing landslide deformation patterns. The landslide extends approximately 290 m E-W and 230 m N-S, with an average slope of 12° and 50 m elevation difference from N-S. Cross-correlation functions were applied to an eighteen-month duration, UAV-derived, time-series of morphological attributes in order to determine motion vectors for subsequent landslide analysis.

A self-calibrating bundle adjustment was firstly incorporated into the SfM pipeline and utilised to process imagery acquired using a Panasonic Lumix DMC-LX5 compact camera from a mini fixed-wing Quest 300 UAV, with 2 m wingspan and maximum 5 kg payload. Data from six field campaigns were used to generate a DEM time-series at 6 cm spatial resolution. DEMs were georeferenced into a common reference frame using control information from surveyed ground control points. The accuracy of the co-registration was estimated from planimetric and vertical RMS errors at independent checkpoints as 4 cm and 3 cm respectively. Afterwards, various morphological attributes, including shaded relief, curvature and openness were calculated from the UAV-derived DEMs. These attributes are indicative of the local structures of discernible geomorphological features (e.g. scarps, ridges, cracks, etc.), the motion of which can be monitored using the cross-correlation algorithm. Multiple experiments were conducted to test the performance of the cross-correlation function implemented on successive epochs. Two benchmark datasets were used for validation of the cross-correlation results: a) the motion vectors generated from the surveyed 3D position of installed markers; b) the calculated displacements of features, manually tracked from successive UAV-derived orthomosaics. Both benchmark datasets detected a maximum planimetric displacement of approximately 1 m at the foot of the landslide, with a dominant N-S orientation, between December 2014 and May 2016. Preliminary cross-correlation results illustrated a similar planimetric motion in both magnitude and orientation, however user intervention was required to filter spurious displacement vectors.