Geophysical Research Abstracts
Vol. 14, EGU2012-936, 2012
EGU General Assembly 2012

Structure-from-Motion photogrammetry: a novel, low-cost tool for geomorphological applications

M. Westoby (1), J. Brasington (2), N.F. Glasser (1), M.J. Hambrey (1), and J.M. Reynolds (3)

(1) Institute of Geography and Earth Sciences, Aberystwyth University, Wales, UK (mjw08@aber.ac.uk), (2) School of Geography, Queen Mary Unversity of London, UK, (3) Reynolds International Ltd, Mold, UK

Presently, high-resolution surveying methods for geomorphological applications are accompanied by high start-up and data acquisition costs, as well as difficult portability. Consequently, the relative remoteness and inaccessibility of many field sites may render these approaches impractical. This paper outlines a revolutionary novel, low-cost, user-friendly photogrammetric technique for obtaining high-resolution datasets at a range of scales. Termed 'Structure-from-Motion' (SfM), the technique operates under the same basic assumption of stereoscopic photogrammetry, namely that 3-D structure can be resolved from two or more overlapping, offset images. Traditional softcopy photogrammetric methods require the 3-D location and pose of the camera(s), or the 3-D location of a series of control points to be known to facilitate scene triangulation and reconstruction. In contrast, the SfM approach requires neither of the above to be known prior to scene reconstruction. Instead, camera pose and scene geometry are reconstructed simultaneously through identification of matching features, or keypoints, in multiple images, and the subsequent application of an iterative, least-squares solution. However, SfM output is fixed into a relative, not absolute, co-ordinate system, and so some degree of ground control is required if the data are to be used quantitatively.

We provide a brief introduction to the principles of the SfM approach and outline the workflow employed, from photoset acquisition, through to the production of high-resolution (<cm scale), fully rendered digital terrain models. Examples are drawn from a range of settings and scales. At the meso-scale, DTMs of the Dig Tsho moraine dam complex in Mt. Everest National Park, Nepal, are presented. The site has produced a catastrophic glacial outburst flood, and as a result an impressive breach ($\sim$40 m high, $\sim$70 m wide) dissects the terminal moraine. This, and other distinct morphological features are resolved faithfully, facilitating the extraction of precise metric data pertaining to breach dimensions, volumes of water released from the basin, and volumes of material removed from the dam during breaching. Such data are invaluable for detailed hydrodynamic modelling and subsequent hazard assessments. To conclude, SfM output is compared with Terrestrial Laser Scanner (TLS) data acquired over a $\sim$80 m high sea cliff near Aberystwyth, Wales, UK. Digital Elevation Models of difference (DoD's) were produced, allowing for a detailed interrogation of SfM data accuracy.