Geophysical Research Abstracts
Vol. 16, EGU2014-7293, 2014
EGU General Assembly 2014

The effect of object characteristics and image quality on 3D-modelling by Structure-from-Motion

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Structure-from-Motion (SfM) methodology is becoming more and more common in soil erosion research and geomorphology. It allows a fast and accurate automated reconstruction of surface shapes. It is based on an automated detection of features within images and their identification in pairs of them. In a 2nd step, the position of the camera is reconstructed. Based on this, the 3D location of the features are calculated to generate a point cloud of the object. By the combination of different positions and angles it is nowadays used to digitally reconstruct 3-dimensional surfaces, even complex ones such as gullies. It may be used for the generation of detailed DEM of small catchments from aerial photographies taken by many different platforms, but also for a detailed characterisation of soil surfaces. As a consequence, SfM is becoming a real alternative to e.g. terrestrial laser scanning technologies.
It is obvious that the quality of the generated surfaces depends not only on the accuracy of the algorithm, but also on the scheme of photography, and the characteristics of the object.
We present here a systematic study on the accuracy of SfM 3D reconstruction, and its dependency on changes of light and colour of the photographed object.
Therefore, we quantified the detectable error in models of structured flat surfaces first. Then, we generated a complex surface of wet, clayey soil. This one was photographed with 2 different illuminations: 1) bright diffuse and, 2) bright direct, with shadows. Additionally, the clay soil was exposed to a slow stream of warm air to dry out the soil surface gradually to generate different soil colours.
First results show that SfM produces, with close range photography, a moise in height calculations of about 3-5 times the pixel size at ground.
We also experienced that, despite an overlapping of the images >80%, the algorithms had considerable difficulties in pairwise detection of features when the distance of the photographing positions was too big. In addition, the processing of images with shadows showed that within them feature detection is only weak. Contrasting with this, soil colour changes seem to have a positive effect on feature detection.
The results show that the systematic of photography has to be taken into account very carefully, as well as the conditions, such as in which they are taken.