Automated change detection in photogrammetric 4D point clouds – transferability and extension of 4D objects-by-change for monitoring riverbank dynamics using low-cost cameras

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Abstract

This paper is dedicated to an automated detection of geomorphological changes in photogrammetric 4D point clouds, which are acquired using low-cost wildlife cameras at a subarctic riverbank. In these regions, a better understanding of complex erosion processes is required for modelling sediment dynamics and to understand climate change effects. Therefore, a spati- otemporally detailed dataset was collected with two-hourly images from four cameras over six months (approx. 900 epochs). Changes are extracted as 4D objects-by-change (4D-OBCs), a method of spatiotemporal segmentation that considers time series information which was originally developed for permanent terrestrial laser scanning data. This contribution investi- gates the transferability of the 4D-OBC method to noisy photogrammetric point clouds in terms of detection reliability and quantification accuracy. Focus is on the detection methods for linear changes in time series. An extension of the method is developed for fusing 4D-OBCs in a second step, as the fully automatic extraction often leads to oversegmentation. This object fusion is based on spatial and temporal overlap of individual objects. For quantitative evaluation, reference objects are extracted manually. Further validation is performed visually using the original time-lapse photos. The analysis results in a total of 946 4D-OBCs extracted as erosion or accumulation events. The object fusion results in a significantly higher agreement with the reference objects (volume ratio between 4D-OBCs and references of 0.26 before and 0.85 after fusion). By this, our research increases the applicability of an automatic time series-based change analysis method to low-cost pho- togrammetric data and to new change types of riverbank erosion. The use case further contributes to the interpretation of riverbank processes in subarctic regions enabled by time-lapse photogrammetry.

Keywords: Spatiotemporal segmentation, Temporal smoothing, 3D time series, Geomorphic monitoring, Change detection

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