Real movement or systematic errors? – TLS-based deformation analysis of a concrete wall

Berit Jost[1], Daniel Coopmann[1], Christoph Holst[2], Heiner Kuhlmann[1]

[1] University of Bonn, Nussallee 17, 53115 Bonn, Germany, (b.jost@igg.uni-bonn.de; coopmann@igg.uni-bonn.de; heiner.kuhlmann@uni-bonn.de)
[2] Technical University of Munich, Arcisstraße 21, 80333 Munich, Germany, (christoph.holst@tum.de)

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ABSTRACT

Performing deformation analyses with high accuracy demands using terrestrial laser scanners is very challenging due to insufficient knowledge about the error budget and correlations. Terrestrial laser scans suffer from random and systematic errors that mitigate the quality of the point cloud. Even though the vast majority of systematic errors can be calibrated, remaining errors or errors that vary with time or temperature influence spatially neighbored points in the same way. Hence, correlations between the measurements exist. Considering area-based deformation analyses, these correlations have two effects: On the one hand, they reduce the effective number of measurements in the point cloud, which mainly influences the decision whether the movement is significant or not. On the other hand, correlations caused by systematic errors in the scanner can lead to a misinterpretation as a deformation of the object. Within this study, we analyze the deformation of a concrete wall (9.50 m height, 50 m width), and we develop a workflow that avoids the misinterpretation of correlated measurements as deformations of the object. Therefore, we first calibrate the scanner to reduce the influence of systematic errors. Afterwards, we use the average of two-face measurements from several scanner stations to eliminate remaining systematic errors and correlated measurements. This study demonstrates that systematic effects can lead to errors of a few millimeters that are likely to be interpreted as small deformations, and it provides a strategy to avoid misinterpretation. Hence, it is inevitable either to model or to eliminate systematic errors of the scanner while performing a precise deformation analysis with a magnitude of a few millimeters.

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