Laser scanning based deformation analysis of a wooden dome under load

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Abstract

In this contribution a load test of a wooden dome, consisting of 12 connected timber beams, is presented. The test comprises five different load levels, during which the dome was measured by means of a scanning total station. In addition, four signalized points on the dome are tracked by means of a tacheometer.
The focus of this contribution is on the development of an automated processing chain for the deformation analysis of the complex structure. For this purpose, initially, a RANSAC-based segmentation is conducted to segment the individual beams. The estimation of B-spline curves provides the basis for a curve-to-curve comparison. To optimally model the beam's behaviour by means of B-spline curves, different parameterization strategies are investigated and compared, enabling the definition of corresponding points on models of different epochs. The influence of constraints that include prior knowledge of the beams' relative behaviour is investigated. Displacement vectors are derived based on corresponding curve points, which are defined by the curve parameter. The derived displacement vectors are analysed and their behaviour is compared to the movement of the signalized tacheometrically measured points.
The curves resulting from the investigated parameterization strategies differ w. r. t. the optimal number of control points, the sum of squared residuals as well as the sum of squared Euclidean distances. The comparison with the tacheometric measurements further reveals the importance of an appropriate parameterization strategy when using B-spline curves in a model-to-model-based deformation analysis. With the curve parameters enabling the definition of point correspondences, displacement vectors that reflect the beams' actual behaviour can be derived in case the point clouds have been appropriately parameterized.

Keywords: B-splines, Load test, Segmentation, Terrestrial laser scanning

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