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Deformation measurement using terrestrial laser scanning data and least squares 3D surface matching

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Abstract

The use of Terrestrial Laser Scanning (TLS) data for deformation measurement is gaining increasing interest. This paper is focused on a new procedure for land deformation monitoring based on repeated TLS scans. The kernel of the procedure is the least squares 3D surface matching proposed by Gruen and Akca [Gruen, A., Akca, D., 2005. Least squares 3D surface and curve matching. ISPRS Journal of Photogrammetry and Remote Sensing 59 (3), 151â^'174]. This paper describes the three main steps of the procedure, namely the acquisition of the TLS data, the global co-registration of the point clouds, and the estimation of the deformation parameters using local surface matchings. The paper briefly outlines the key advantages of the proposed approach, such as the capability to exploit the available high data redundancy using advanced analysis tools, the flexibility of the proposed solution, and the capability of providing fully

3D deformation measurements, including displacement vectors and rotations. Furthermore, it illustrates the performance of the proposed procedure with a validation experiment where a deformation measurement scenario was simulated and TLS and topographic data were acquired. From the analysis of this experiment, interesting features are highlighted: the validation errors below 1Â cm in the displacements and below 1Â gon in the rotations of small targets measured at a distance of 134Â m; the increase by factor two of the errors when the same scene is measured from a distance of 225Â m; and the importance of an accurate global co-registration in order to avoid systematic errors in the estimated deformation parameters. It is interesting to note that the above results were achieved under non-optimal conditions, e.g. using non-calibrated data and sub-optimal targets from the matching viewpoint. Besides the simulation experiment, the validation results achieved on landslide test site are briefly discussed.

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Keywords

Laser scanning; TLS; Point cloud; Estimation; Matching; Error; Landslides

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