Supervoxel-based targetless registration and identification of stable areas for deformed point clouds

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ABSTRACT

Accurate and robust 3D point clouds registration is the crucial part of the processing chain in terrestrial laser scanning (TLS)-based deformation monitoring that has been widely investigated in the last two decades. For the scenarios without signalized targets, however, automatic and robust point cloud registration becomes more challenging, especially when significant deformations and changes exist between the sequence of scans which may cause erroneous registrations. In this contribution, a fully automatic registration algorithm for point clouds with partially unstable areas is proposed, which does not require artificial targets or extracted feature points. In this method, coarsely registered point clouds are firstly over-segmented and represented by supervoxels based on the local consistency assumption of deformed objects. A confidence interval based on an approximate assumption of the stochastic model is considered to determine the local minimum detectable deformation for the identification of stable areas. The significantly deformed supervoxels between two scans can be detected progressively by an efficient iterative process, solely retaining the stable areas to be utilized for the fine registration. The proposed registration method is demonstrated on two datasets (both with two-epoch scans): An indoor scene simulated with different kinds of changes, including rigid body movement and shape deformation, and the Nesslrinna landslide close to Obergurgl, Austria. The experimental results show that the proposed algorithm exhibits a higher registration accuracy and thus a better detection of deformations in TLS point clouds compared with the existing voxel-based method and the variants of the iterative closest point (ICP) algorithm.

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