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A Probabilistic-Based Framework for Automatic Co-registration of Terrestrial and Airborne Point Clouds in Forest Areas

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The link of field with the airborne laser scanning (ALS) measurements in sample plots is required in the ALS-based forest inventories. However, the registration of ALS and terrestrial laser scanning (TLS) in forests is challenging due to the complex forest structures and different viewing between terrestrial and areal point of views. For forest scenes, to extract the conventional geometric or semantic primitives that are widely used in the urban point clouds registration is tricky, since conventional interest points or features are rare in the point cloud data of forest scenes. In this study, we propose a probabilistic based method to robustly align ALS and multi-scan TLS point clouds in forest scenes. The proposed registration method consists of two steps, i.e. the keypoint extraction and alignment. The keypoints are derived from the modes, which represent the local maximums of the underlying probability density function (PDF) of ALS and multi-scan TLS point clouds of tree crowns. The alignment of the two keypoint sets are achieved through the coherent point drift (CPD) algorithm, which is independent of the descriptor similarities and considers the alignment as a maximum likelihood estimation (ML) problem. The recovered transformation between two keypoint sets is applied to the ALS dataset and the ALS point cloud was further refined through the standard Iterative Closest Point (ICP) algorithm. In contrast to existing methods, the proposed method does not take the tree locations as keypoints for registration and it does not rely on the descriptors around the keypoints to evaluate the similarities. Thus, the additional information such as tree diameters or heights are not required. The experiment was conducted on the ALS and TLS point clouds of one plot. The result showed that the proposed probabilistic based method obtains good performance.

Keywords: Airborne Laser Scanning (ALS), Terrestrial Laser Scanning (TLS), Forest, Point Clouds Registration, Probabilistic-Based.