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Title: Local-to-Global Point Cloud Registration using a Viewpoint Dictionary

Abstract

Local-to global point cloud registration is a challenging task due to the substantial differences between these two types of data, and the different techniques used to acquire them. Global clouds cover large-scale environments and are usually acquired aerially, e.g., 3D modeling of a city using Airborne Laser Scanning (ALS). In contrast, local clouds are often acquired from ground level at a much smaller range, using Terrestrial Laser Scanning (TLS). The differences are typically manifested in their point density distribution, occlusions' nature, and measurement noise characteristics. As a result of these differences, existing point cloud registration approaches, such as keypoint-based registration, tend to fail.

We propose a novel registration method that is robust to the different characteristics of global and local point clouds. The method is based on converting the global cloud into a viewpoint-based dictionary. We associate each viewpoint with a panoramic range-image, capturing the geometry of the visible environment. Then, plausible local-to-global transformations can be found via a dictionary search, i.e., finding the best matches between the local and dictionary panoramic range-images. We show efficient dictionary search can be done in the Discrete Fourier Transform (DFT) domain, using *phase correlation*. An efficient registration refinement method for *urban environments*, based on converting the point clouds into edge-maps, is also presented.

We demonstrate that the proposed viewpoint-dictionary-based registration method is superior to a state-of-the-art, keypoint-based method (FPFH - Fast Point Feature Histogram), even without any GPS measurements. For the evaluation, we used a challenging dataset of 108 TLS local clouds and an ALS large-scale global cloud, in a $1km^2$ urban environment.

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