Hierarchical extraction of multiple objects from mobile laser scanning data based on multi-scale supervoxel

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ABSTRACT:

1 Introduction

Extracting geometric features and objects from mobile laser scanning (MLS) point clouds is becoming a high active topic in the field of photogrammetry, computer vision, and robotics. A lot of methods for extracting objects from MLS point clouds have been reported [1-6], which can be classified into three categories. (1) extract objects (e.g., buildings, trees) with the support of scanning lines [1-2]; (2) convert MLS point clouds into images, then extract objects with image processing techniques [3-4]; and (3) divide MLS point clouds into 3D voxels, and extract objects with the classification and segmentation of voxels [5-6].

Although the existing methods are generally able to extract a specific kind of object based on segmentation results, they still have the following common limitations, namely, the quality of segmentation is relatively poor, leading to wrong results of objects extracting, particularly in complex scenes with multiple types of objects. To overcome the shortcomings, this paper proposes a supervoxel-based method to extract multiple types of objects from MLS point clouds.

2 Method and Innovations

The proposed method consists of four key steps: ground points filtering, multi-scale supervoxel generation, supervoxels classification and segmentation, and the hierarchical extraction of multiple objects. The proposed method generates multi-scale supervoxels from MLS point clouds using colors, intensities, and spatial distances of points after removing ground points. Secondly, a graph-based segmentation method is applied to segment the supervoxels by integrating their colors, intensities, normal vectors, and principal directions. Each segment belongs to an object or part of an object. And then the saliency of each segment is calculated and the most salient segment is selected as a seed segment for clustering. Finally, the clusters are classified and re-clustered with prior knowledge of objects, resulting in hierarchical extraction of multiple types of objects. The framework of the proposed method is elaborated in Figure1.

Compared with the previous methods, the proposed method generates multi-scale supervoxels from MLS points and improves the quality of segments by integrating the geometry features (e.g., shapes, sizes), colors, and intensities of supervoxels. Good segmentations thus lead to better extraction of objects. On the other hand, the hierarchical extraction strategy extracts objects with the order of saliency of segments, eliminating the wrong extraction of objects close to each other.

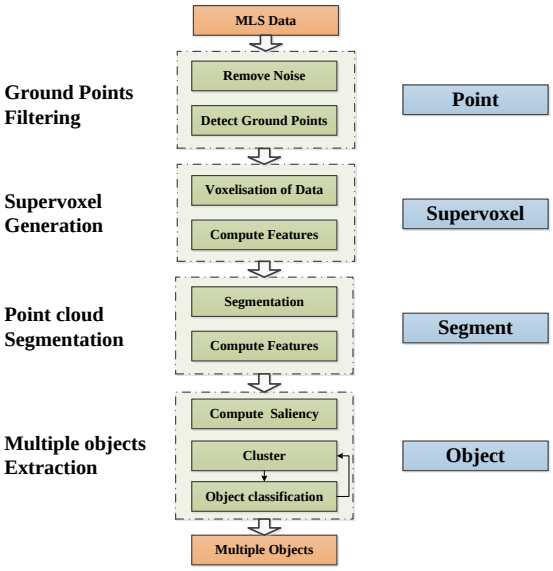

Fig.1 Framework of multiple types of objects extraction

3 Results

Two test areas of 3.85 km*2.9km and 8.15km*5.02 km were selected to verify the validities of the proposed method. The results of multiple types of objects extraction show that the proposed method is stable and robust for extracting buildings, ground, streetlamps, trees, telegraph poles, traffic signs, cars, and enclosures, and achieves an overall accuracy of 92.3%. Moreover, the proposed method extracts and classifies objects in the areas of mixed objects correctly. For example, it extracts streetlamps (Fig. 2(a)), traffic signs (Fig. 2(b)), buildings (Fig. 2(c)), telegraph poles (Fig. 2(d)) from the area of many objects mixed. However, a few misclassification still occurred in objects extraction. For example, the trees without canopy were misclassified as others (Fig. 2(e)). A few streetlamps largely occluded by the trees were misclassified as trees (Fig. 2(f)).

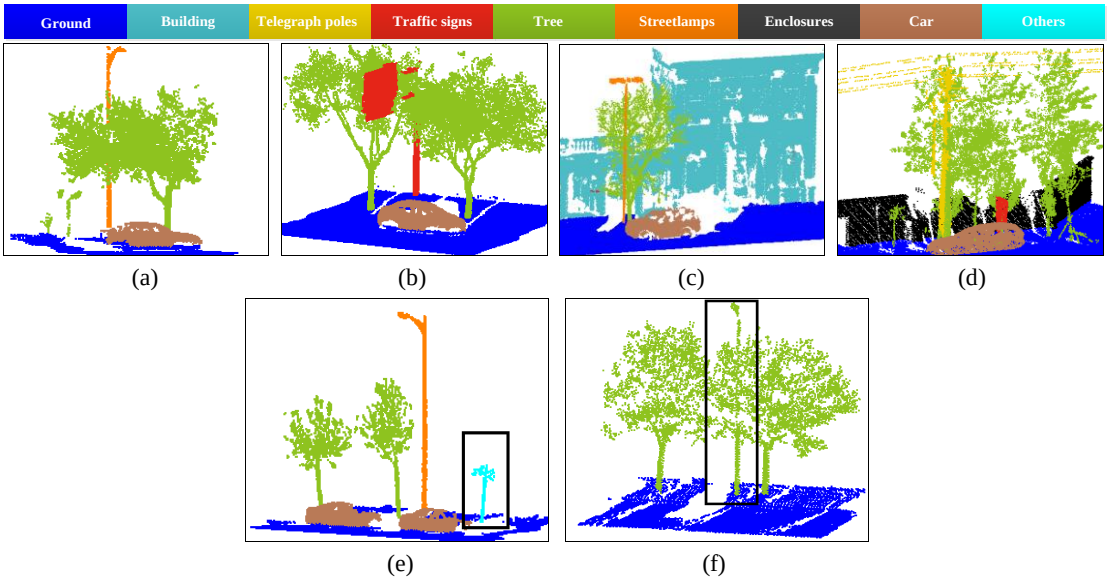

Fig.2 The details of multiple types of objects extraction

4 Conclusions

The proposed method shows a robust solution for extracting multiple types of objects from MLS point clouds in terms of good accuracy and low time costs. It proves that the segmentation based on supervoxles produces good quality of segmentation results, resulting in good classification of objects and reducing the wrong extraction of

objects. Future work will focus on automatically modelling the multiple types of objects based on the segmentation and extraction results.

5 References

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