

FUSION OF GEOMETRIC MODELS FROM VLS OVERLAPPING PROFILES

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1. INTRODUCTION

Vehicle-based laser scanning (VLS) in recent several years has been developing quickly, but the greater and greater amount of the relevant sampling points makes data post-processing suffer from the hazardous workload [1]. Moreover, the processing techniques in real 3D sense, especially for efficient 3D modeling, have not caught up with the progress of VLS hardware. Hence, how to extract the typical features and then model the complex objects from VLS point clouds, which can convert the point-oriented operations into the object-oriented, attracts so many attentions now.

The profile-based methods which simplify 3D processing into 2D space can work as an alternative plan for this problem. The planar surface extraction method based on profiles, assuming points on a scan line which belong to a planar surface form a straight line segment, was presented earlier [2]. The surface segmentation method, which groups points by combining the intersecting profiles by proximity, was also proposed for bridge recognition [3]. There are also some attributions advanced in the research area of robot navigation [4-6]. The last functional step of integrating the achieved 2D geometric entities spatially in parallel into 3D architectures, however, has not been explored efficiently.

This issue will become more complex when profiles overlapping encountered, as illustrated in Fig. 1. With the ranging distance adding, the phenomena of overlapping become more severe. Nevertheless, the overlapped points can also supply redundant information for 3D modeling. Thus, how to fuse the different profiles from different emitting points needs to be considered. With plane extraction from VLS point clouds [7] as the studying goal, this paper strives for new appropriate algorithms to fuse 2D geometric entities into 3D objects by exploring the advantages of profiles overlapping.

2. MATERIALS

The point clouds collected by Sensei VLS system, which was established in Finnish Geodetic Institute (FGI), are studied. Sensei contains a Faro LS880 laser scanner, and this kind of scanners can provide samplings with four profiles, synchronized with external positioning and data logs. The position and attitude information for each 3D

point can be derived. The angle between the neighboring profiles is 0.8° , which means that after 50m there is a maximum horizontal spacing interval of 2.8m.

The experimental data was measured at Espoonlahti, Finland on May 6, 2009. The reference area includes roads, buildings, trees and poles, which can work as the typical data for validating the method for fusing 2D geometric entities from the overlapping profiles to extract planes. The *in situ* sampling records and the related aerial images are accompanied to compare the results.

3. METHODOLOGY

The fusion method comprises three procedures, namely line segment extraction from profiles, fusion of the acquired 2D geometric primitives from all sets of overlapping profiles, and the final structure revising based on the original distribution of the points in the model-related window. The first procedure assumes the random sample consensus (RANSAC) based line segment extraction method [8-10], and as a matured method this step will not be discussed much in this paper. The temporary result is illustrated in Fig. 2.

The second procedure is the key part of the work introduced in this paper. The maximum a posteriori (MAP) [11] estimation method is used to fuse the 2D geometric depictions into 3D models. The iterative convergence process is similar with super-resolution reconstruction [12], and the iteration can be stopped when the objective function outputs the stable values close to a constant. The modeling results will be constructed by 3D geometric primitives such as polygons.

The third procedure applies the fitting-checking method to revise the derived 3D models. The original points are segmented by the primitives-related regions to fit with the local models. If the statistical differences are over the given threshold, the related local models must be shifted, reduced or expanded by the trial-and-error strategy until minimum reached. Otherwise, the results can be assumed as the geometric reconstructions.

4. DISCUSSIONS AND CONCLUSION

The method currently cannot reflect all the line segments imbedded in the profiles of VLS point clouds. The fine-scale variations of the digital surface model (DSM), i.e. changes from road surfaces to curbstones, cannot all be characterized. Multi-scale RANSAC based line segments extraction needs to be explored to enhance the scale-adaptability.

The diverse distribution of various objects in the studying environments makes the applicability of this fusion method limited. The low bush close to a house cannot be distinguished with a little slope, so other variables such as echo intensity shall be combined to establish more accurate models.

The work in this paper, however, still acts as an effective push-forward for profile-based 3D modeling, especially 3D plane extraction. The fusion process makes full use of the redundant information embedded in the profiles,

and the advanced algorithm also supplies a good framework for processing of the overlapping mode. The resulted 3D models of the goal regions as the fundamental geographic data can help extend VLS in more applications.

5. REFERENCES

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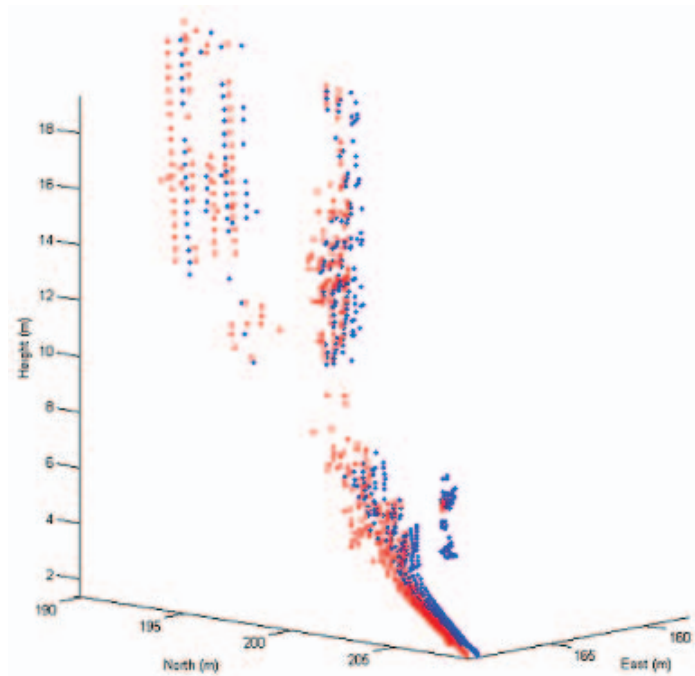


Fig. 1. Illustration of the overlapping profiles. Once-time sampling during moving is corresponded with four profiles with a little angle, and the whole profiles can be divided into four sets of parallel profiles internally.

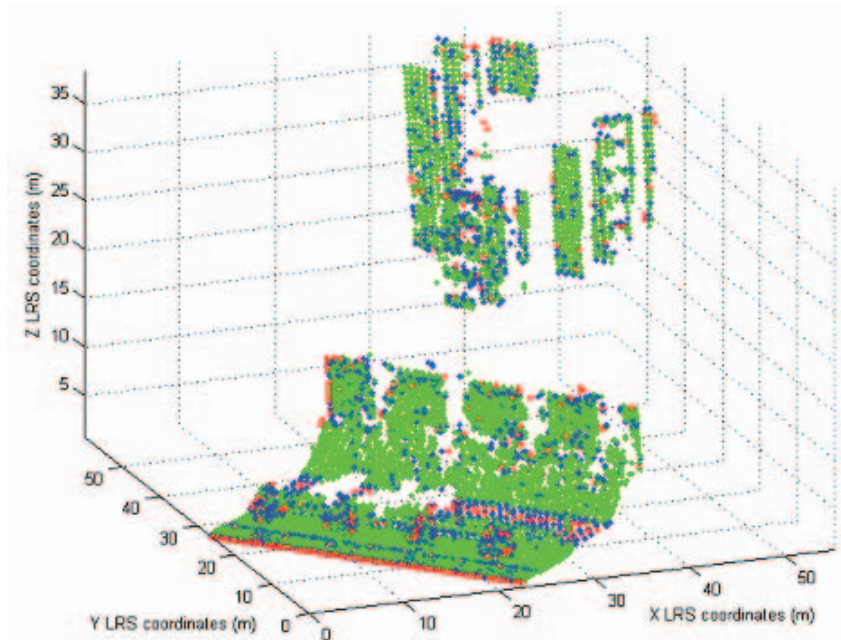


Fig. 2. Temporary result of profile-based segmentation. The red points denote the isolated points; the blue points mean the start or end points for line segments; the green points are the points belonging to line segments.