3D BUILDING MODELING FROM LASER SCANNING DATA USING A PLANE-BASED BINARY SPACE PARTITIONING TREE

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ABSTRACT: Previous studies related to building modeling have been mostly using airborne laser scanning data. In this regards, the building modeling approaches that they have been focusing on were not truly based on three-dimension but just 2.5 one. To make a building modeling methodology based on true 3 dimensions; this research suggests a new building modeling approach based a Plane-based Binary Space Partitioning Tree (PBSP-tree). For this work, a simulated laser point dataset is produced and the experiments are carried out. The performance of the proposed algorithm was evaluated by checking the intermediate and final results.

1. INTRODUCTION AND METHODOLOGY

The United Nations predicts that the number of dwellers in urban areas will rise up to almost 5 billion inhabitants by 2030 in the report entitles 'State of the World Cities 2006/7'. Such a population will constitute roughly 62% of the global population at that time. To successfully control social and environmental situations that might arise from this rapid urbanization, up-to-date geo-spatial information needs to be accessible in a timely manner and at a reasonable cost. In this regard, many researchers have been interested in automated procedures of 3D building modeling or reconstruction. Airborne laser scanning data has been widely used for building reconstruction. Since the airborne laser scanning data does not fully supply all the points on façades one can tell that the building modeling using the airborne laser scanning data is not truly based on three-dimension but 2.5 one (Brenner, 2005; Kim et al., 2008; Ma, 2004; Rottensteiner and Briese, 2002; Sampath and Shan, 2007; Sohn and Dowman, 2007; Sohn et al., 2008). On the other hand, a terrestrial laser scanner provides a lot of laser point clouds reflected from façades. Hence, it is possible to construct true 3D building models not just 2.5D when the airborne and terrestrial laser datasets are integrated into one set. In this regards, this research proposed a new building modeling methodology which can deal with real three dimensional datasets. Binary Space Partitioning Tree (BSP-tree) is modified to be applicable to true 3D building modeling. Instead of using linear features which Sohn and Dowman (2007) and Sohn et al. (2008) used for their research, this study uses planar features which are derived from the segmentation and plane fitting processes (either manually or automatically). Hereafter, the newly proposed 3D building modeling approach will be called a *Plane-based Binary Space Partitioning Tree (PBSP-tree)* technique. This technique is applied to divide the whole 3D space into sparse ones using the computed planes. Main part of the framework consists of 1) Partitioning, 2) Scoring, 3) Space Dividing, 4) Classification, and 5) Grouping. More specifically, the initial boundary box will be, first, determined after reading the input dataset. Then, the whole space defined by the initial boundary box will be partitioned into two parts by each plane which is computed after the segmentation process. In other words, ten computed planes (for example) will make ten difference cases of space partitioning. After the partitioning process, all the cases will be scored by checking the level of laser point differences between two different partitioned spaces. The partitioning case which has the highest score will be selected and the space will be divided according to this case. The divided space will be classified into three cases: 1) open, 2) close, and 3) empty. In cases of "close", and "empty", the processes from the partitioning to the classification will not be applied to the space any more. Otherwise, these processes will be applied to the space (the case of "open") iteratively. Once all the iterative processes are ended, we will have the "close" or "empty" spaces. Finally, such spaces will be grouped and be merged into one space. The description of the dataset utilized and experimental results will be addressed in the next section.

2. DATASET AND EXPERIMENTAL RESULTS

To prove the performance of the proposed 3D building modeling approach, a simulated dataset is generated and used for the experiment. The point space of the dataset is 1cm by 1cm. The applied noise levels for horizontal and vertical directions are 0.5cm and 0.5cm, respectively. Figure 1 shows the produced simulated dataset. To test the proposed algorithm, a structure with a protruded small box is designed and the reflected laser points from the structure are generated as seen in the figure.

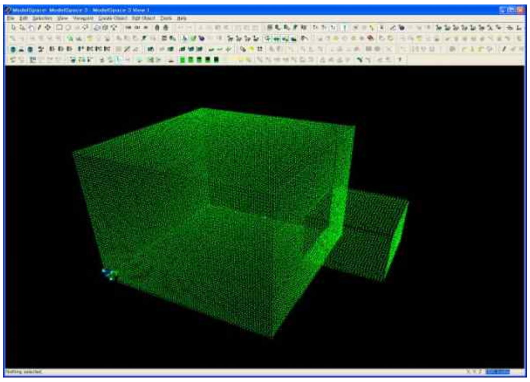
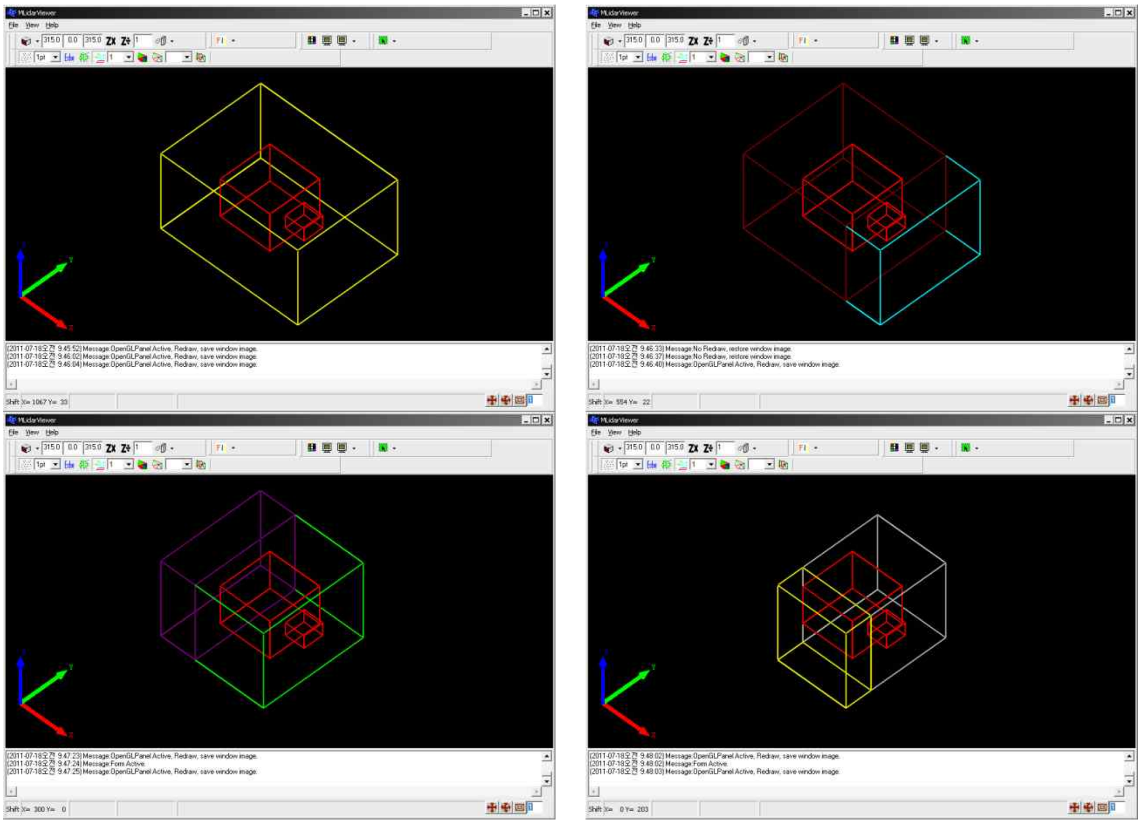


Figure 1. The simulated laser point dataset

Manually derived segmentation results were used for plane parameter computation. Using the computed plane parameters, all the intermediate results from the iterative steps were illustrated in Figure 2. As abovementioned, the four steps, which are partitioning, scoring, space dividing, classification, and grouping, are applied to the simulated dataset.



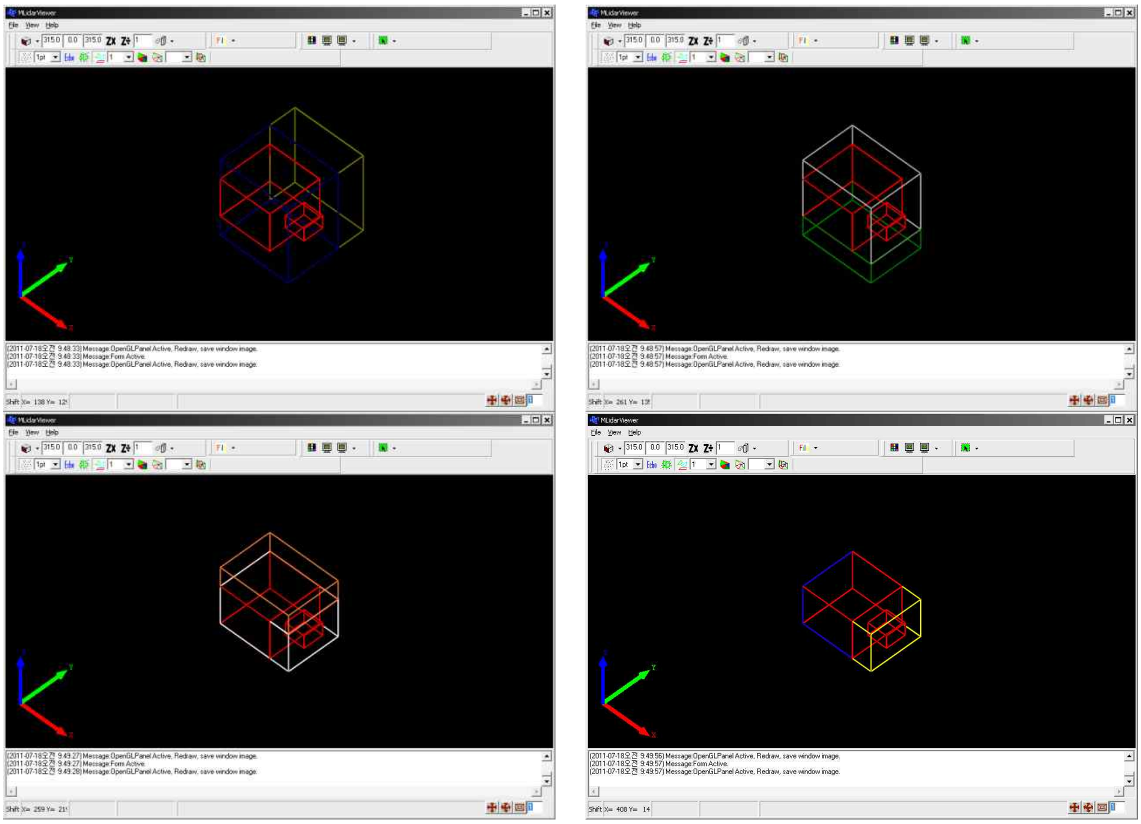


Figure 2. Intermediate results by applying a Plane-based Space Partitioning Tree algorithm

3. DISCUSSIONS AND CONCLUSIONS

By applying the proposed PBSP-tree algorithm to the simulated dataset, it is proved that the proposed algorithm works well with the dataset which reflected even from the protruded structure and produces 3D building models. The problems which come from the partially occluded areas will be also resolved by the proposed PBSP-tree algorithm. The future research will focus on the experimental tests with real datasets which can be produced by integrating airborne and terrestrial laser datasets.

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