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Comparison of 3D Reconstruction Methods to Create 3D Indoor Models with Different LODs

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Abstract: ***A 3D indoor model becomes an indiscernible component of BIM (Building Information Modeling) and GIS (Geographic Information System). However, a huge amount of time and human resources are inevitable for collecting spatial measurements and creating such a 3D indoor model. Also, a varied forms of 3D indoor models exist depending on their purpose of use. Thus, in this study, three different 3D indoor models are defined as 1) omnidirectional images, 2) a 3D realistic model, and 3) 3D indoor as-built model. A series of reconstruction methods is then introduced to construct each type of 3D indoor models: they are an omnidirectional image acquisition method, a hybrid surveying method, and a terrestrial LiDAR-based method. The reconstruction methods are applied to a large and complex atrium, and their 3D modeling results are compared and analyzed.***

Keywords: 3D Indoor Model, 3D Indoor GIS, BIM, Spatial Information

I. Introduction

To satisfy varying demands of spatial information in construction management, disaster management and location-based service, three-dimensional models of building interiors are oftentimes desired as an indiscernible component of BIM (Building Information Modeling) and GIS (Geographic Information System)[1,2]. However, when designs of old building structures are not known, a huge amount of time and human resources are inevitable for collecting spatial measurements and creating such a 3D indoor model [3]. Also, even though 3D indoor models are available, 3D indoor models with different forms are created depending on their purposes of use[4]. Thus, in this research, a series of reconstruction methods is introduced to create 3D indoor models defined as three different LOD (Level of Detail) shown in Figure 1. The first LOD model, which is omnidirectional images, expresses the image that shows indoor space at a single point. The second LOD model, which is a realistic 3D model, defines the outlines of internal space and expresses the indoor space by texturizing each surface of a polyhedron into images. The third LOD model is the closest to the real world by expressing every single objects such as window, wall, doors, and others. The reconstruction methods are applied to a large and complex atrium for experimental purposes. Their 3D modeling results are compared and analyzed.

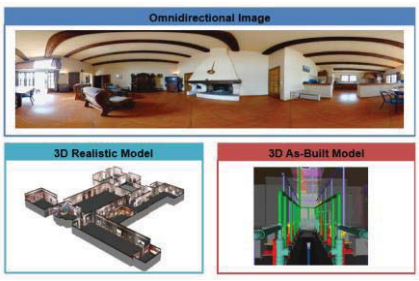

Figure 1. 3D Indoor Models

II. Reconstruction Method

In this section, three 3D reconstruction methods are introduced so as to create three different LOD of 3D indoor models. The first method is the “Omnidirectional Image Construction Method” that mainly uses a fish-eye camera fixed on a rotator at a selected locations. This method takes multiple images at one spot and generates an omnidirectional image through image stitching for producing automatic mosaic images. The second method is the “a hybrid surveying method” that employs multiple surveying techniques such as a total station, a construction drawing, and a camera. The constructed 3D model, so called 3D realistic model, has a structure of simplified polyhedron. It has limitations in expressing 3D space. The weakness of expression with a simplified polyhedron is supplemented by texturing the image of indoor space relevant to each surface. The third method uses point clouds from the terrestrial LiDAR-based method, to which a semi-automatic method or a manual operation is applied to generate a 3D as-built model.

Figure 2. 3D Reconstruction Methods and Their Applications

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III. Application and Results

The 3D reconstruction methods, introduced in this paper, are applied to a large and complex atrium. The modeling results are omnidirectional image, 3D realistic model, and 3D as-built model. The first method is the "Omnidirectional Image Construction Method." Together with the indoor network model, it can be applied to indoor navigation, indoor store view, and virtual experience at exhibitions or museums. The second method is the "a hybrid surveying method" that generates a 3D realistic model with simple geometry and texture. This model, which is already used in "Google Earth" and "V World" can be utilized as a virtual indoor tour and indoor space management. The third method is "a terrestrial LiDAR-based method" that generate a 3D as-built model. This model is the most similar to the real world by modeling every objects in indoor space, and it can be used as a BIM model for construction management purposes.

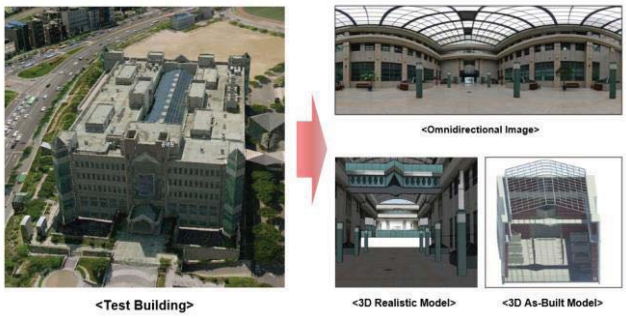

Figure 2. 3D Indoor Modeling Results from Reconstruction Methods

VI. Conclusion

According to the U.S. Environmental Protection Agency, individuals spend more than 80% of their time indoors on average. Moreover, the barrier between indoors and outdoors is gradually diminishing, because of the increase in smart devices that can receive spatial services at any time and place. 3D indoor models, depending on the application purpose, express the indoor space with different LOD. In this paper, a series of reconstruction methods are applied to a large and complex atrium, from which each type of 3D indoor LOD models are generated. Also, the modeling results of each indoor LOD's model are compared and analyzed. Based upon the modeling results, the reconstruction guide for each LOD of 3D indoor model would be developed.

Acknowledgements

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