Street-side City Modeling from Ground-Level Imagery and a Digital Map

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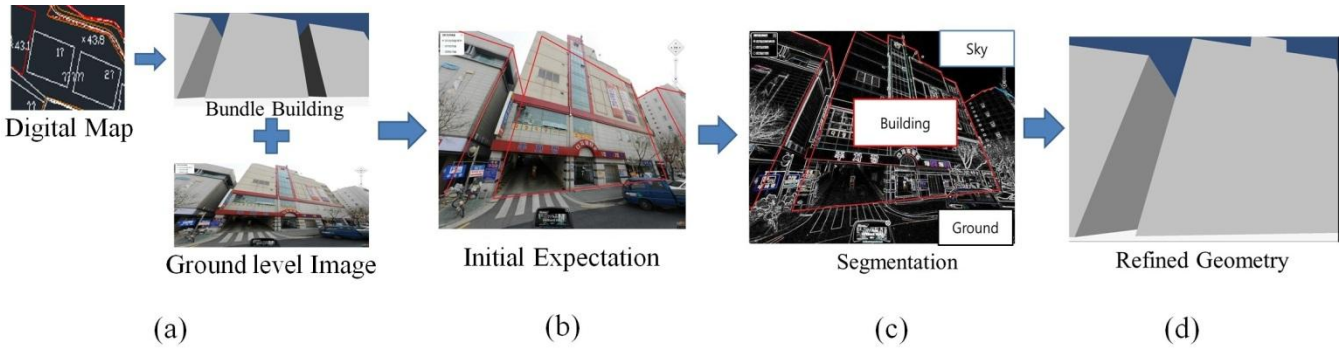

Figure 1: (a) The input is a digital map and ground-level imagery. From the footprint of the building in the digital map, we can obtain the bundle building geometry by extruding it. (b) We can predict where the buildings are in the picture. Recall that possible GPS inconsistencies between the digital map and the imagery will be corrected. (c) With the given building location and edge features from the bundle building as a clue, we can segment the image with a building façade and others. (d) From the segmented image, we can obtain the detailed shape of the façade and refine the geometry of the original bundle building. Further modeling process such as an image crop, warp and texturing will be straightforward.

1. Introduction

With the development of massive ground-level imagery gathering methods, image based automatic reconstruction studies for 3D city models are increasing. While novel approaches have led to dramatically improved quality of the resulting 3D city model, some limitations still exist.

In recent studies such as that by [Xiao 2009], we can see high-quality buildings, despite the fact that the proposed approach is fully automated. However, the underlying risk with an image-based approach is that the resulting quality of the building geometry relies on the number of images obtained. Because a point cloud is constructed via the structure from motion (SfM) method, the number of feature points determines how many points can be obtained. In addition, the processing takes a long time. That is especially true for the image segmentation process.

In this paper, we propose a means of solving the aforementioned problems in the image-based approach. Our approach will create a robust result for each building in a 3D city model with a relatively short processing time through cooperation with digital maps.

2. Our Approach

The key idea of our approach is its use of the footprint information of the buildings in a city. By extruding a footprint sketch, we initially gain the simple geometry of the building, as shown in Figure 1(a). We will call it as a "Bundle Building." This bundle building contains a geo-registered location and the location of each edge resulting from the extrusion process.

Then, for each building, we search for the closest picture position and insert vertical edges of the bundle building image into the ground-level image, as shown in Figure 1(b). Two issues can be expected at this stage. The first one is image distortion, in which the edges are not straight. This can be handled by an image rectification method or by remapping image with appropriate projection methods. The second issue is GPS inconsistency between data. This can be handled by adjusting the location of the ground imagery based on the bundle building to minimize the error of detected edges during the early segmentation stage, as depicted in Figure 1(c). The overall segmentation process will be similar with [Zheng 2011], which also addressed 3D reconstruction of building from few images.

In this way, we gain clues about which parts of the image are occupied by the building. Thus, we can shorten the segmentation time compared to an approach based solely on image. The last step involves refining the geometry, as shown in Figure 1(d). Because the footprint sketch does not give details pertaining to the façade geometry, a single-image-based reconstruction method can be applied at this stage to refine the geometry. The remaining parts, such as image cropping and texturing, are quite straightforward.

Currently, a company named NHN and ENGIT has agreed to provide the street-level imagery of Korea for research use, and at present we are conducting basic research on our approach. We are expecting that our approach will lead to robust results in a short time, demonstrating a fully automated process.

References

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