RECREATING THE PAST CITY MODEL OF HISTORICAL TOWN KAWAGOE FROM ANTIQUE MAP

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ABSTRACT:

Existing colorful antique maps were mostly produced at the Edo period in Japan, and these antique maps which show situation of land use and streets in those days often give important information for studying history of city planning, civil engineering, architecture and so on. In particular, visualization of the past city model help to make understanding for situation at the time when the antique maps were produced more efficiently. On the other hands, virtual archeology has recently received more attention from possibility that people can appreciate or experience the archeological objects, the past space and art through the computer at any time and without going to the museum.
With this motive, the authors have been concentrating on recreating the past city model and visualization using the attribute data such as shrine, house, street, river and so on which exist in the antique maps. Visualization of historical castle town Kawagoe, Saitama was demonstrated using 3D Computer Graphics in this paper.

1. INTRODUCTION

Existing antique maps and pictorial maps were mostly produced at the Edo period in Japan, and these maps which show situation of land use and streets in those days often give important information for studying history of city planning, civil engineering, architecture and so on. As one of utilization of these maps, virtual reality has recently received more attention from possibility so that people can appreciate or experience the archeological objects or historical spaces and arts through the computer at any time and without going to the museum.
Although VR and digital archive share a common content from the view point of preservation of structures and items of cultural heritage, which will be decrepit, deteriorated, disappeared and lost, an efficient method for city modeling is still issue since reliable descriptions in VR or digital archives required huge labor, time, and expense.
An automatic house modification and arrangement system were developed by the authors using spatial data such as kind of houses, positions and directions which were extracted from an antique map. In order to evaluate the system, recreating of historical castle town Kawagoe, Saitama was investigated in this paper.

2. KAWAGOE

Castle town Kawagoe shows the rows of houses of fireproof traditional tradesman houses and preservation activities have been performing positively as a preservation area for the traditional house groups under the ordinance by local government based on the Cultural Properties Protection Law. Various culture in Kawagoe where had been prospered as a commercial town had been extremely influenced by the Edo culture, this is why Kawagoe is still called as “Little Edo”. In 1893, the Great conflagration broke out and 1/3 of the town burned down. The fire was the main reason why Kura-dukuri houses which show fireproof traditional commercial style exist today, and these houses still adorn the streets surrounding the main street.

Figure 1. The rows of houses in Kawagoe

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The Kawagoe Castle was built in 1457; the Castle that exists today was rebuilt in 1848. In the Edo period, the castle was regarded importantly as the northern guardian of Edo, and the chief retainers of the Edo shogunate were appointed as the Lord of Kawagoe Castle from generation to generation.

Figure 2. The Kawagoe Castle

The bell tower has been telling time for over 350 years, and it is an important symbol of Kawagoe. It is said that Lord of the Kawagoe Castle built the bell tower between 1624-1643. The present bell tower was rebuilt in 1894 after the Great Kawagoe Conflagration. The 16.2m height bell tower was made of wood and consists of 3 floors.

Figure 3. The Bell Tower

3. EFFICIENT CITY MODELING

3D models for representative houses were recreated previously under the historical evidence. Furthermore, geometric data such as the center of gravity, areas, inclinations, and aspect ratios for the residence area were acquired using the antique map (Fig. 4). Attribute data such as the kind of houses was decided using color which showed resident's status. As a result, the rows of houses are efficiently reconstructed since the houses are modified and arranged automatically based on geometric data. The detail procedures for the modeling method are as follows.

Figure 4. Antique map of Kawagoe

3.1 Recreating Representative House Models

Castle town Kawagoe in 1703 was a big town which have more than 300 tradesman's houses. According to the present map which were created based on the antique map in 1778 (Fig. 5), the castle town was roughly divided into some blocks such as tradesman residences, samurai residences, temple and shrine. Moreover, it was forbidden to intermingle with samurai residences and tradesman in principle.

With these results, 6 kinds of 3D house models were recreated under the historical material[1)]. Fig.6 shows recreated 3D models. Model 1, 2 show residences for samurai, Model 3, 4 show residences for tradesman, Model 5 shows temple and Model 6 shows shrine. Moreover, 3D model of the Kawagoe castle and the bell tower recreated separately since these were typical structures in Kawagoe at those days. Fig.7 shows the map of the Kawagoe castle. In addition, 3D Studio MAX was used in this paper as 3DCG software.

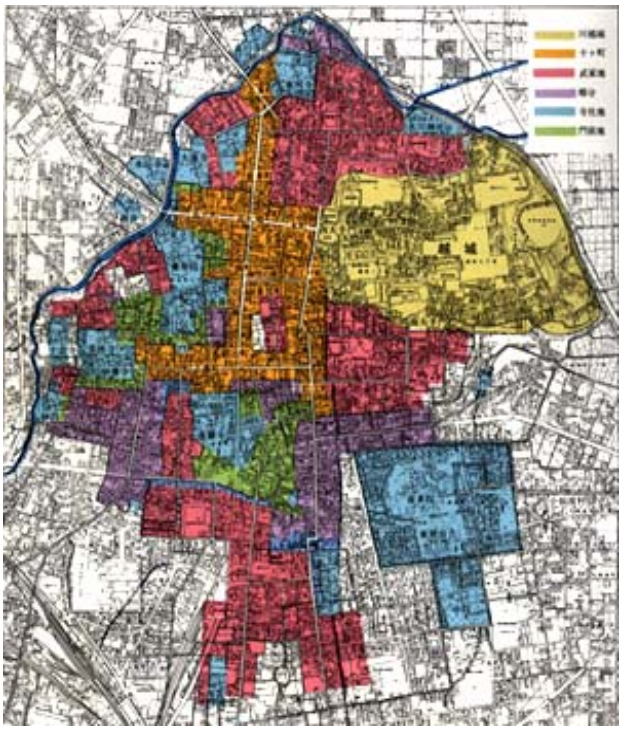

Figure 5. The map created based on the pictorial map in 1778

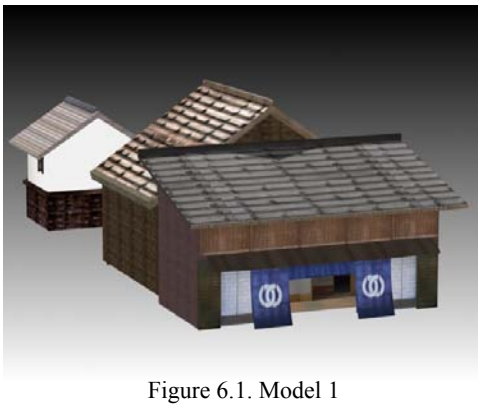

Figure 6.1. Model 1

Figure 6.2. Model 2

Figure 6.3. Model 3

Figure 6.4. Model 4

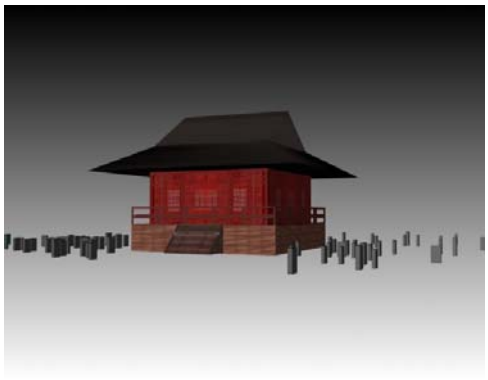

Figure 6.5. Temple model

Figure 6.6. Shrine model

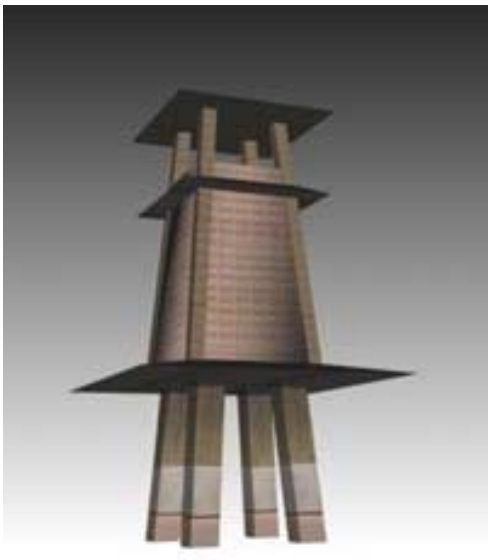

Figure 6.8. The Bell Tower model

Figure 6.7. The Kawagoe Castle model

Figure 7. Map of the Kawagoe Castle

3.2 Acquisition of Spatial Data

3.2.1 Extraction of Edge Image: After digitizing the antique map, line extraction was performed using mathematical morphology and edge image was obtained via image processing procedures such as binarization, noise reduction and thinning procedures. Fig.8 shows the edge image.

Figure 8. Edge image for the residence

3.2.2 Acquisition of Geometric Data: In order to acquire geometric data such as the center of gravity, area, and inclination for each residence area which are required for automatic arrangement of house models, the templates for corner detection were created and the image coordinates for the 4 corners of each residence area were calculated. Furthermore, after conjugation of the antique map (Fig.4) to the present map (Fig.5) using TIN and Affine transformation, the distorted corners were rectified. Geometric corrections in this paper are shown in Fig.9.

As geometric data which are required for arrangement, the center of gravity, width and depth for each residence area were computed from the corner coordinates.

Figure 9.1. The original map

Figure 9.2. The present map

Figure 9.3. TIN

Figure 9.4. Affine transformation

3.2.3 Acquisition of attribute data: Attribute data is the kind of house models for each residence area in this paper, and detail procedure for acquisition of attribute data are as follows:

- Detection of color information for the center of gravity
- Determination of block by the color information
- Attribute data is acquired using the block.

Furthermore, one of 3D house model in the case of tradesman and samurai residence area is determined using the in-every-direction ratio since two house models are prepared for each residence area.

3.3 Reconstruction of Rows of Houses

In order to automatic reconstruction of rows of houses, software was developed by the authors so that automatic classification, modification and arrangement can be performed automatically. 3D modeling for a historical row of hoses is performed automatically exporting spatial and attribute data on 3DCG. Moreover, trees and geographical model can be arranged to reconstructed 3D city model since the remarkable point of the software has ability to arrange trees and geographical model. Fig. 10 shows 3D city model which was recreated automatically.

Figure 10. The model of rows of houses

4. LANDSCAPE SIMULATION

Fig. 11.1 shows scene for the present rows of houses in Kawagoe. Fig. 11.2 shows the landscape model for the Edo period from the same viewpoint, which was obtained using created city model. Only top of the bell tower which is representative structure can be seen due to existing big building in Fig.11.1. On the other hand, the bell tower can be seen in Fig. 11.2 since large buildings do not exist in the Edo period.

Figure 11.1. The present Kawagoe

Figure 11.2. Landscape model in Edo period

Hence, future landscape maintenance is proposed by compare with the scene of rows of houses in the Edo period and the present scene. For example, Fig. 12.1 shows the landscape simulation of the main street in the Edo period, and Fig. 12.2 shows the present scene of the same place. From these figures, it can be said that Kura-dukuri houses stand in a row now and show historical landscape, 3 or more floors building obstruct the historical view. Moreover, the width of the street which has not changed in fact is felt narrow by existence of asphalt, sidewalks and vehicles. Then, 3 or more floors buildings were changed to traditional style house, and asphalt, sidewalks and vehicles were removed in this paper. Fig. 12.3 shows the recreated landscape simulation by the above, and it can be seen how change the view and show historical landscape. Therefore, it is concluded that city modeling give important information for city planning including preservation of historical view.

Figure 12.1. Landscape simulation in Edo period

Figure 12.2. The present Kawagoe

Figure 12.3. Proposed landscape simulation

5. CONCLUSION

In generally, huge labor, time and expense are needed for reconstruction rows of houses using 3DCG since the models should be recreated and arranged manually one by one. However, these issues are drastically reduced by the method which was developed by the authors. In order to evaluate the efficiency of the method, city modeling for the historical castle town Kawagoe in the Edo period was investigated.

Nevertheless, there are more than 700 residence areas, and it is demanded to recreate more than 2000 house models for city modeling of Kawagoe since tradesman and samurai residences have warehouses or employee's dwellings, efficient city modeling of Kawagoe was demonstrated in this paper. It is concluded that the efficient city modeling give important information for city planning and it can be said that the developed method have ability to use wider landscape simulation.

However, there is issue which need to be resolved before this system may become more operational. This problem is automatic edge extraction from the antique map since characters are included residence areas and edges shows indistinct line.

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