Restoration of Cityscape in Early Modern Naniwa

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Abstract

Naniwa is the old name for the city of Osaka in Japan. It was prosperous as the commercial center of Japan in the Edo period (1603-1867), although the political center was Edo (Tokyo at present) because of the seat of the Edo shogunate government. However, many historical cityscapes symbolizing Naniwa have been lost during the urban modernization from the Meiji period (1868-1912) downward. It is the purpose of this study to restore Naniwa in the early modern times with referring the ukiyoe (Japanese prints) especially called as the Osaka prints by using geo-information technology and to acquire the clues to the future cityscape by making a comparison between the past and the present.

1. Introduction

In modern Japan, the improving urban infrastructure focused on productivity was carried out through the reconstruction period after the World War II and the period of rapid economy growth. As a result, rich society has been built up quantitatively. On the other hand, the natural and historical landscape such as paddy fields in rural districts and historic buildings in urban districts has been lost rapidly. Therefore the Landscape Act was established in 2004 to attempt the formation of a beautiful and dignified

country, the creation of a charming rich living environment, and the realization of a community that is individual and vital. Especially, the efforts such as utilization and conservation of historic buildings have been promoted, and the Act on Maintenance and Improvement of Historical Scenic Beauty was enacted in January 2008. Under the present conditions, the concept is being shifted from preservation and conservation of the existing historical environment to more positive restoration of the lost environment. The harmony and adjustment between traditional architectures and modern architectures, and the restoration of historical landscape have been major urban subjects in modern Japan because many cities have rich histories.

2. Purpose and method

Naniwa is the old name for the city of Osaka in Japan. It was prosperous as the commercial center of Japan in the Edo period (1603-1867), although the political center was Edo (Tokyo at present) because of the seat of the Edo shogunate government. However, many historical cityscapes symbolizing Naniwa have been lost during the urban modernization from the Meiji period (1868-1912) downward. It is the purpose of this study to restore Naniwa in the early modern times with referring the ukiyoe (Japanese prints) especially called as the Osaka prints by using geo-information technology and to acquire the clues to the future cityscape by making a comparison between the past and the present.

As a concrete study method, the geo-information technology such as GIS and CAD/CG is integrated and utilized to analyze and restore the early modern Naniwa. From the viewpoint over a wide area, the early modern topographical model is built by utilizing the present spatial data and the historical facts constructively, and topographical analysis is conducted. From the viewpoint over a small area, the spatial relationship between the sights and highways in Naniwa is clarified by putting highways on the distribution map of the famous sights drawn on various scenic prints by using GIS. Furthermore, the construction of both 3D urban models of the past and present performs the comparison of cityscape beyond the times. The past model is based on the collected scenic prints, drawings, and maps. It is emphasized that the Shiten-no Temple area, which is noted for the old temples and historic interests, is specified as a restoration area by hot spot analysis on locations of the sights drawn on the Osaka prints.

3. Former countries and counties

There were many people who visited Naniwa as a tourist resort during the Edo period, because the worship circulation for shrines and temples became common after expansion of highway networks in the early modern times for the daimyo's (feudal lord's) alternate-year residence in Edo that is one of the shogunate government's regulations on daimyos. Osaka City is the seat of the Osaka Prefectural Office now, but Osaka Prefecture consists of three former countries, Settsu, Kawachi, and Izumi, and their administrative boundaries were rather different from the present prefectural boundaries. Therefore the authors understood the spatial location of Osaka by showing the country and county boundaries related to the three former countries. Figure 1 shows that Osaka was located on GIS with geometric correction of the paper maps (1/20,000) provided as the old editions in the Meiji period by the Geospatial Information Authority of Japan (Shimizu and Fuse, 2003). Osaka area in the early modern times consisted of three counties. Although it was included in Settsu, it was also close to Izumi and Kawachi.

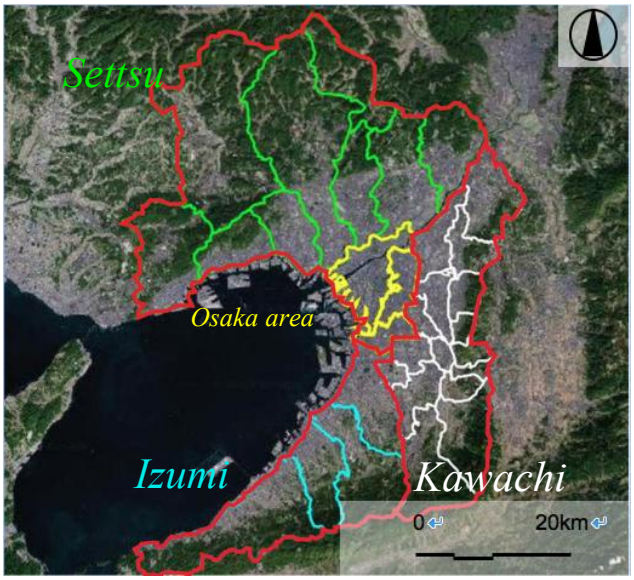

Fig. 1. Location of Osaka area and three former countries, Settsu, Izumi, and Kawachi

4. Terrain model

The space of landscape level consisting of topographical features has an important meaning in the cityscape simulation. Then, the terrain model modified in reference to historical facts was built using DEM (Digital Elevation Model) data at present, with two types of grid intervals, published by the Geospatial Information Authority of Japan (Yoshikawa, 2005; Yoshikawa and Tanaka, 2011). The 50m grid data was used in the range that includes the present Osaka City (20km square) adding the ground subsidence quantity, and the 250m grid data was used in the range other than that (Figure 2).

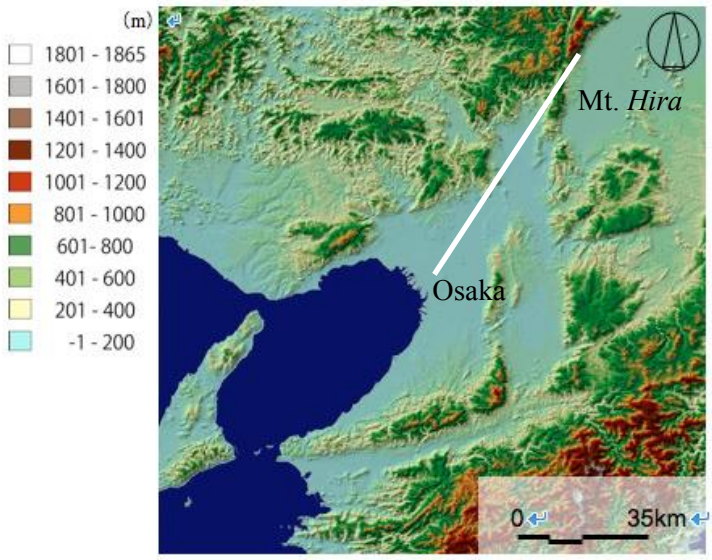

Fig. 2. The early modern terrain model set up for 140 km square centering on Osaka

The Ino Map completed in 1821 in the late Edo period is the one of the historical materials showing the early modern Japan (Hoshino, 2010). The geodesic lines from the survey points to the objects drawn on the Ino Map were specifically used. The creation range of the early modern terrain model was set up for 140 km square centering on Osaka by defining 70 km for the maximum cognitive distance from Osaka of those days, because the geodesic line from Osaka to the Mt. Hira was drawn on the Ino Map, and the form of Mt. Hira was drawn in perspective there, too. Next, the change

of the coastline by reclamation was represented in reference to the old editions of topographical maps. Then the terrain model in consideration of land subsidence was represented by adding the subsidence quantity to the modern altitude data in reference to a subsidence quantity map constructed on the basis of the point distribution about the accumulation of land subsidence (Maeda et al., 2006).

In order to check whether the constructed terrain model was suitable for use of cityscape restoration, the degree of reappearance was verified from the sectional view and the landscape simulation based on the geodesic line and the mountain form drawn on the Ino Map (Figure 3; Figure 4).

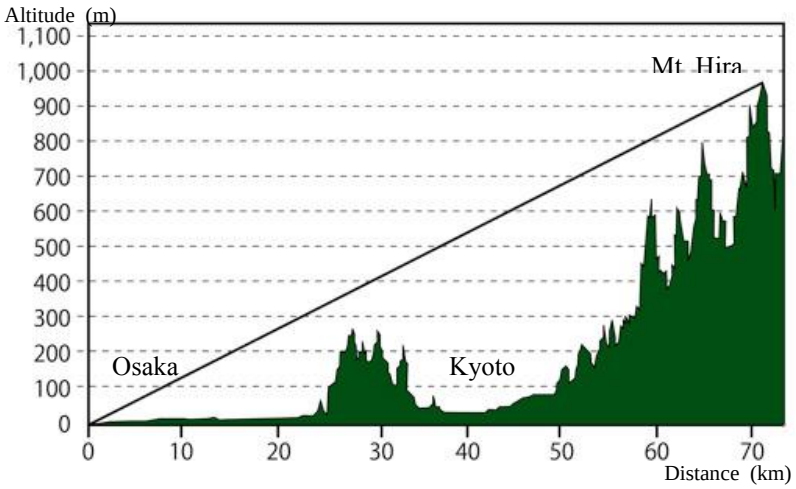

Fig. 3. Sectional view between Osaka and Mt. Hira

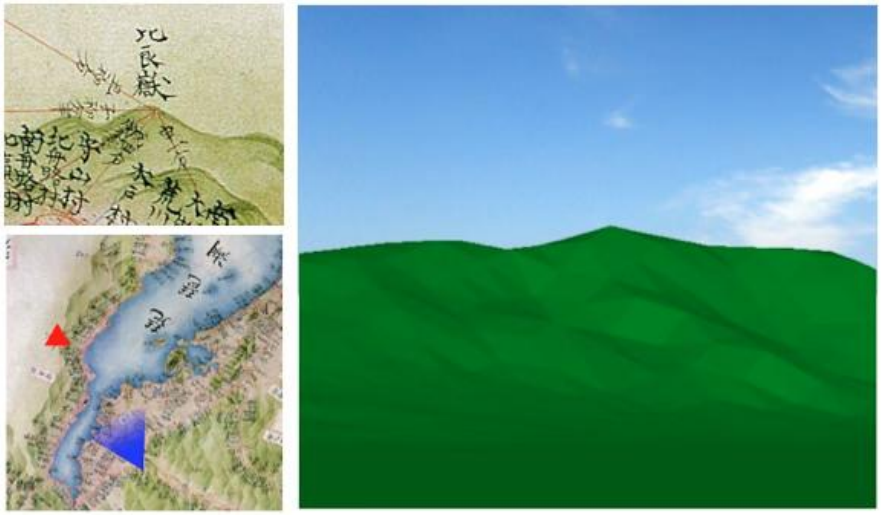

Fig. 4. Comparison between the mountain form drawn on the Ino Map and the landscape simulation image by CG from the same viewpoint in the distant view

5. Highways and sights

The highway system in Japan originated in Take-no-uchi highway (613), which was the oldest state road, and had been used as a main system until 1876 when the modern national highway system was established. For example, the Kumano highway and the Koya highway in the Kinki district were mainly used in the medieval times as visiting highways of the Imperial family or the aristocracy to shrines and temples. Most of highways, such as the Saikoku highway used as a public road of a daimyo's alternate-year residence in Edo and the Kyo highway connecting Osaka and Fushimi, were opened in the early modern times. Especially in the early modern times, because many ordinary citizens visited to shrines and temples and there were held festivals popularly, the use of highways increased, and many shrines and temples were drawn on the prints of the sights' collection series which were sightseeing guidebooks in those days.

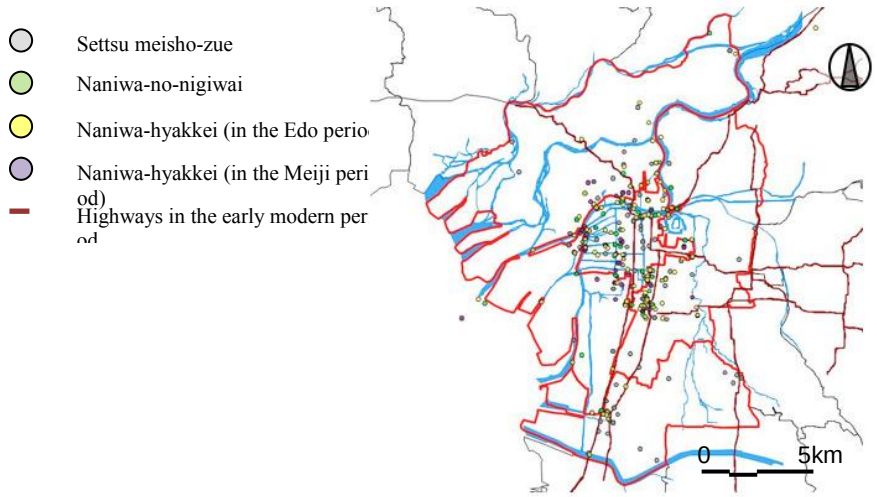

Fig. 5. Locations of highways and sights in the early modern period

Therefore the authors tried to understand the spatial relationship of the highways and also the geographical distribution of cityscapes drawn on the prints of those days (Figure 5). Concretely, 25 highways described in the old edition (1903) of the Osaka Prefectural Reports were located on GIS. And they selected four famous collections of the Osaka prints, "Settsu-meisho-zue (1796)", "Naniwa-no-nigiwai (1855), "Naniwa-hyakkei (the old edition at the end of Edo period)" and "Naniwa-hyakkei (the new edition in the early Meiji period)", as historical materials drawn the sights of Naniwa from the Edo period to the early Meiji period (382 scenes in total), and they located each scene on GIS, too. The Shiten-no Temple area, which is noted for the old temples and historic interests, is specified as a restoration area by hot spot analysis (Getis-Ord Gi*) on ArcMap (Figure 6). The area was significant as a node of highways connected to two countries, Yamato in the east and Kishu in the south.

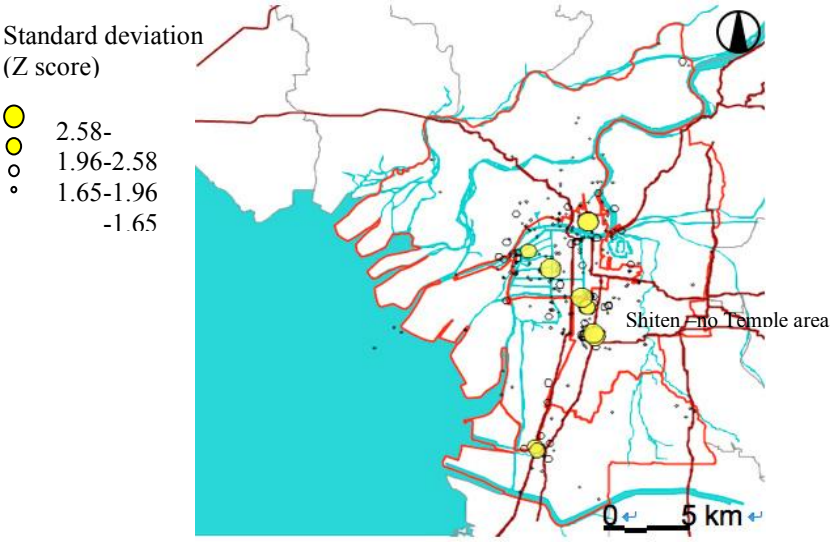

Fig. 6. Result of hot spot analysis on locations of the sights drawn on the Osaka prints

6. Cityscape simulations

As the Shiten-no Temple area is specified as a restoration area, the buildings of the temple were restored. The plot plan is a typical example of the oldest Buddhist temple named as the Shiten-no Temple type which a south main gate, a inner gate, a pagoda, a main hall and a auditorium were located on a straight axis from south to north. The five-storied pagoda became a historical and scenic landmark in Naniwa, and was often drawn on the collected prints. So, the drawings placed in the associated book (Fujishima, 1981) were used for modeling (Figure 7), and such main buildings as the five-storied pagoda, the main hall, the auditorium and so on were modeled (Figure 8). Since the roofing geometry of a Buddhist temple is an important element in cityscape simulation, a curvature roof was expressed by using the radial-shearing command on the transformation tool in the solid modeler (Yoshikawa, 2007).

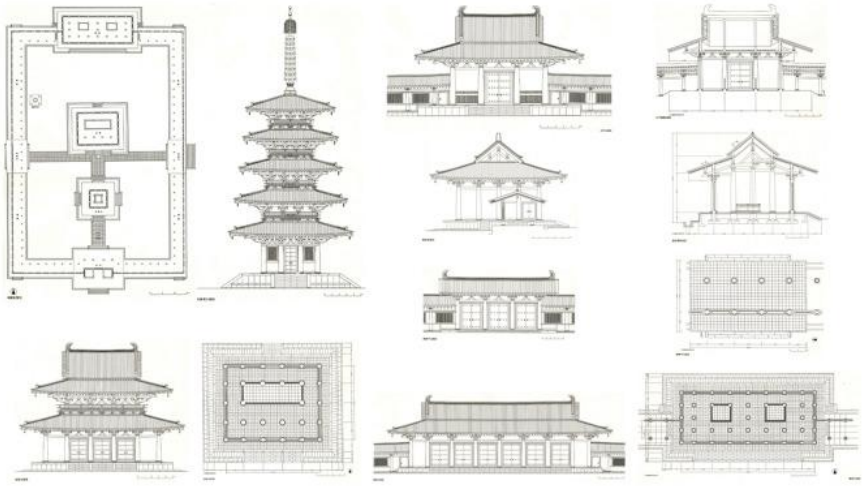

Fig. 7. Examples of the building drawings for the reconstruction of the Shiten-no Temple (Fujishima, 1981)

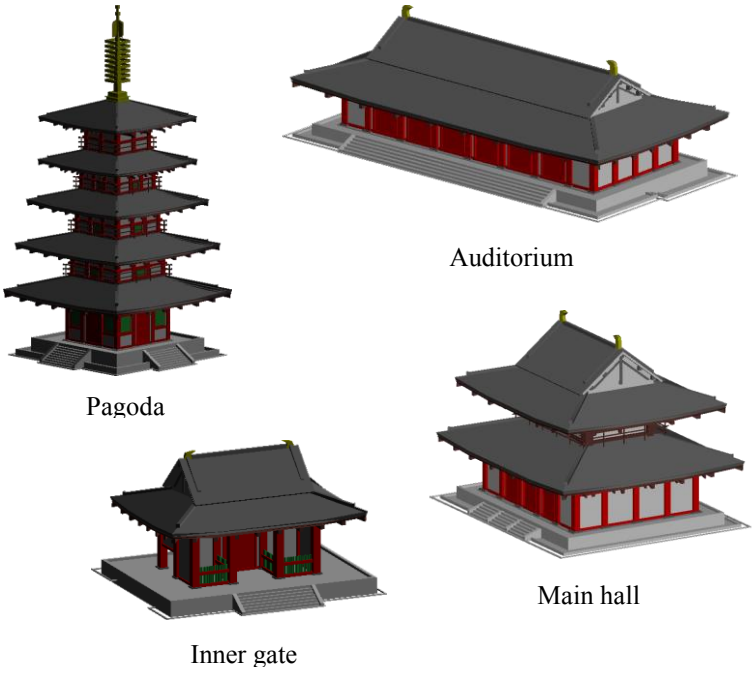

Fig. 8. Examples of the building models in the Shiten-no Temple

The cityscape simulation using 3-D urban models always poses a problem that the data volume is huge. So, the division of visual distance in landscape is used for 3-D urban modeling to reduce the data volume (Yoshikawa and Tanaka, 2011). Based on the human perception, the concept of the gazing angle is applied. The optic angle that the human can clearly look an object is generally one degree. As the optic angle is small, it is defined as H/D (Figure 9). It becomes $\pi/180=H/D$.

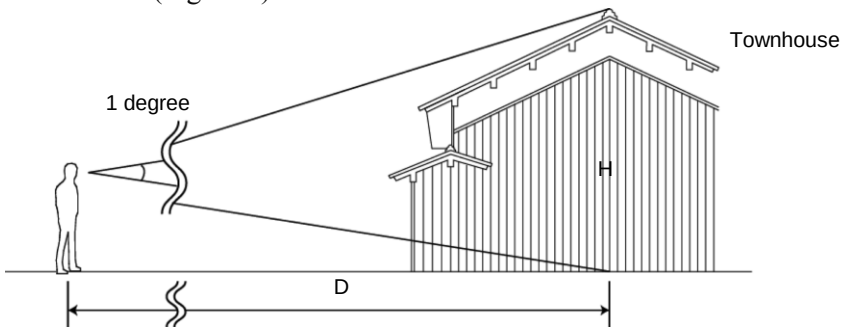

Fig. 9. Calculation of close view region

So the limit of close view region can be calculated by the following equations:

$$D=57.3H \tag{6.1}$$

where D is the visual distance and H is the object height.

On the other hand, when the viewed object is extremely small, we come to catch it as a point. This concept is based on the circle of confusion in optics. In photography, the diameter of the circle limit for the final image is often defined as between 1/1,000 and 1/1,500 of the diagonal on the picture screen (Takahashi, 1994). Here, if there is a screen including a full sight of 60 degrees cone at the position 250mm distant from a viewpoint where the human can see with ease, the size of the screen becomes 288.7mm square. At this time the size of the diagonal line becomes 408.3mm (Figure 10).

If the diameter of the circle is 1/1,250 between 1/1,000 and 1/1,500 for the diagonal of the picture screen, it becomes 408.3/1,250 = 0.3mm. Because the size on the screen and the size of the object are related to similarity, Equation 6.2 can be set up (Figure 11):

$$D=833.3H \tag{6.2}$$

where D is the visual distance and H is the object height as well as Equation 6.1.

The authors decided the accuracy of the generated models as follows based on the average height (6m) of townhouses (Figure 12).

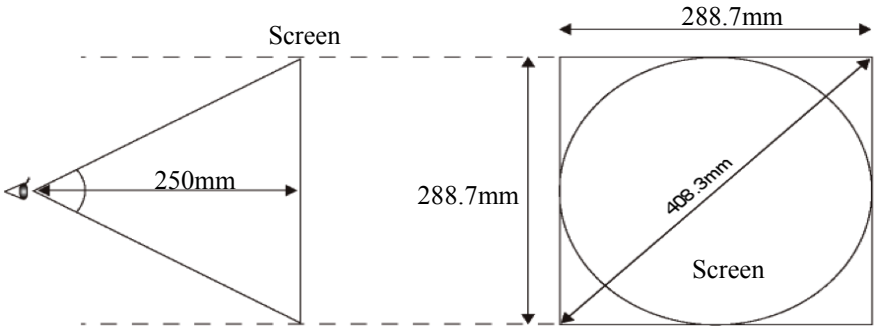

Fig. 10. Screen including sight of 60 degrees cone

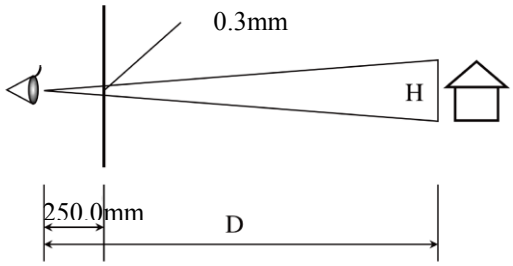

Fig. 11. Relation between screen and object

In close view region the terrain model was constructed every lot based on the registry map of land in the Meiji period and the townhouse model was located in consideration of a building lot. In middle view region the terrain model was constructed every block based on the old edition of maps in the Meiji period and the townhouse model was changed to the simple model as to a block. Since the distant view region is over the recognition distance of the townhouse, the terrain model was only represented by DEM data as mentioned above.

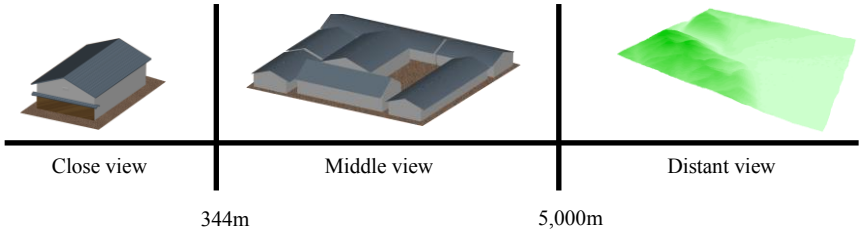

Fig. 12. Division of visual distance and generated model

In the cityscape simulation, the Shiten-no Temple is approached as a visual object from both sides of a distant view and a close view. So the buildings of the temple were modeled. Especially the five-storied pagoda became a historical and scenic landmark in early modern Naniwa, and was often drawn on the collected and arranged prints as mentioned above. Figure 13 shows the whole database displayed by 3-D viewer (Navis Works).

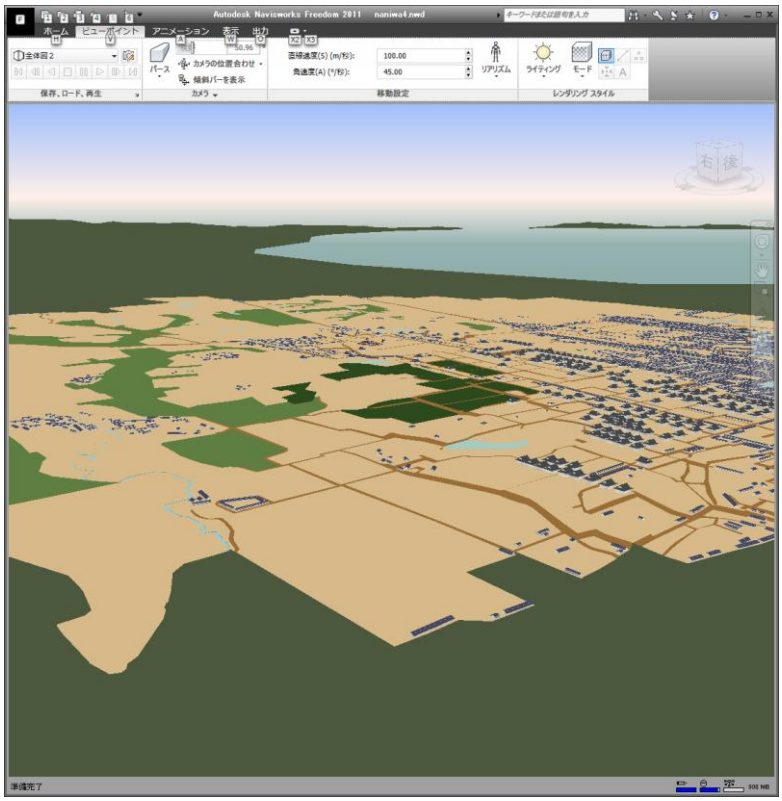

Fig. 13. Whole database displayed by the real-time 3-D viewer (Navis Works)

In the distant view simulation, two kinds of Naniwa-hyakkei were simulated first. In the simulation from the same viewpoint as Naniwa-hyakkei (the new edition in the early Meiji period) drawn by Sadanobu Hasegawa, it was clarified that the five-storied pagoda and mountains drawn on the print cannot be seen (Figure 14).

Fig. 14. Distant view simulation from the same viewpoint as Naniwa-hyakkei (the new edition in the early Meiji period) drawn by Sadanobu Hasegawa

Moreover, in the simulation from the same viewpoint as Naniwa-hyakkei (the old edition at the end of Edo period) drawn by Kunikazu Utagawa and others (Figure 15), the early modern scene was simulated in comparison with the modern one based on the constructed modern urban model (Yoshikawa, 2005). As a result, high-rise buildings interrupt the view from the Tamae Bridge in the modern space, and it shows clearly that the former scene, which the five-storied pagoda was viewed as a vista, is no longer acquired (Figure 16).

In the close view simulation, the Shiten-no Temple drawn on Naniwa-no-nigiwai was visualized. Although the mountain range existed in a background was covered with fog and could not be seen in the print, the mountain range of Ikoma spreads in a background and the real scene of those days in the Shiten-no Temple can be visualized from the same viewpoint as the print in the simulation (Figure 17).

Furthermore, we can experience 3D space with the walk-through and fry-through function on 3DVR, too (Figure 18). It provides us free view-points to examine the cityscapes on real-time (Yamano and Yoshikawa, 2005; Yoshikawa, 2007).

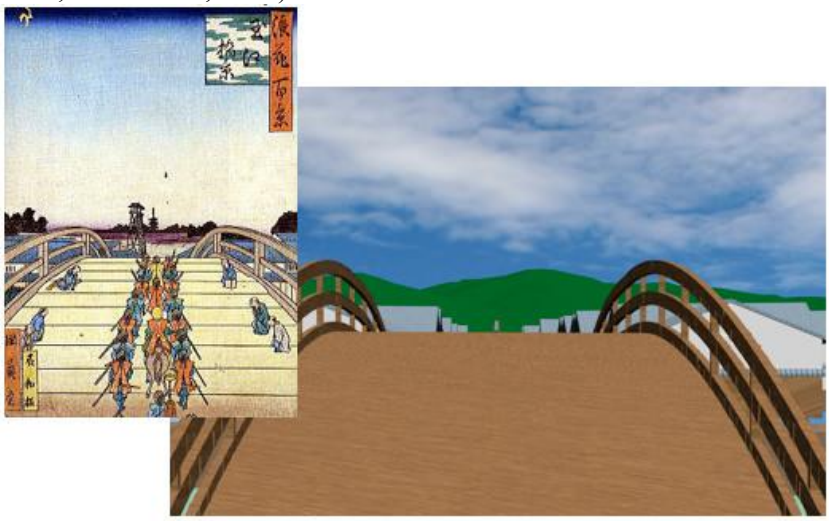

Fig. 15. Distant view simulation from the same viewpoint as Naniwa-hyakkei (the old edition at the end of Edo period) drawn by Kunikazu Utagawa and others

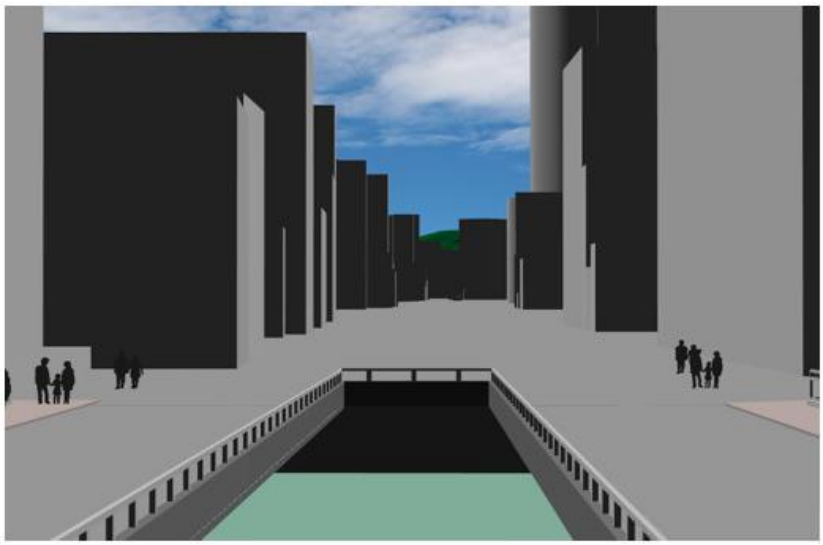

Fig. 16. Modern scene from the Tamae Bridge

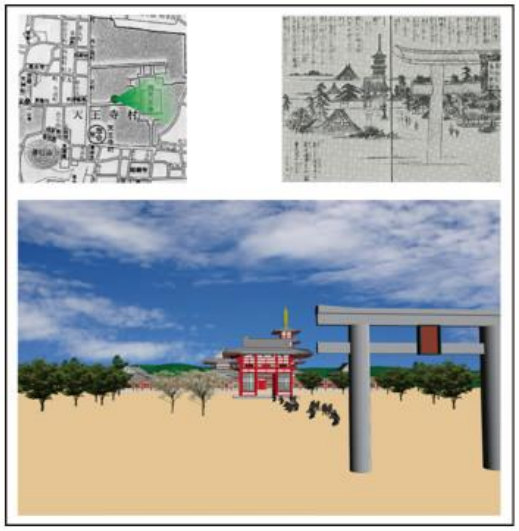

Fig. 17. Close view simulation from the same viewpoint as Naniwa-no-nigiwai

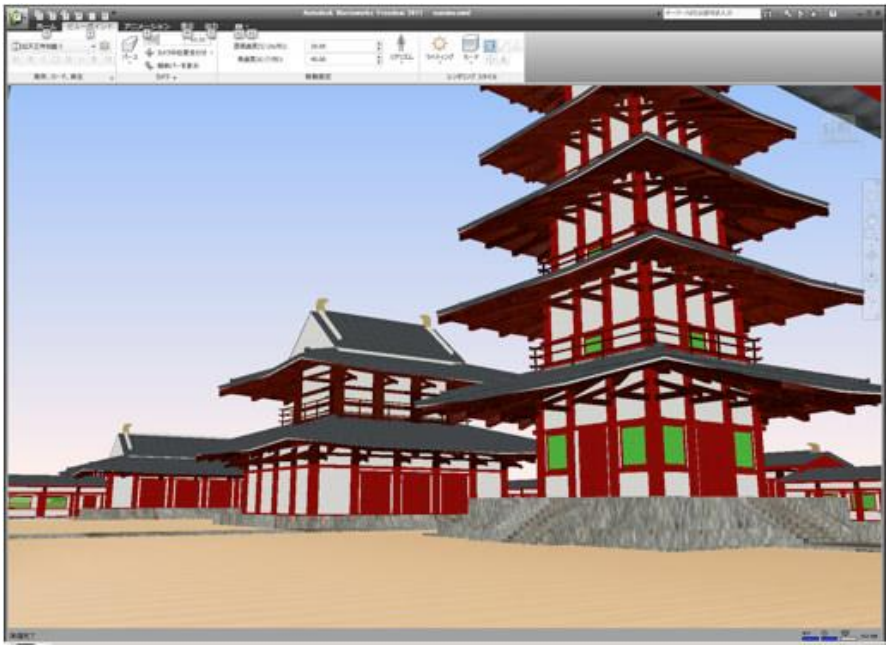

Fig. 18. Walk-through simulation by the real-time 3-D viewer (Navis Works)

7. Conclusions

In this study, the authors constructed 3D urban model of Naniwa in the early modern times by using the geo-information technology, and they understood historical facts of Naniwa by cityscape simulation. And also this study was the trial to clarify the comparison with the modern scene. The GIS database was constructed for 3D urban modeling by using actively the Ino map, the old edition topographical map, and the registry map of land. Furthermore, the main buildings of the Shiten-no Temple were modeled in detail in accordance with drawings. These results contribute the expansion of the digital archive of the historical environment in the city of Osaka.

However, the Shiten-no Temple area was only restored in Naniwa in the early modern times, and many real scenes are not yet clarified. Even in the Shiten-no Temple area, many spots drawn in the scenic prints and the fields in the background have not been expressed in detail. It is desirable to add these objects to reproduce a scene of Naniwa faithfully in the early modern times. In addition, it will bring about the whole image of Naniwa in the early modern times to accumulate local restorations of the other sights drawn on the scenic prints.

Furthermore, the trend from VR (Virtual Reality) to AR (Augmented Reality) has recently begun to occur by development of the information technology. So the authors intend to reproduce the past cityscape on the display of a tablet terminal and a smartphone through positional information.

Acknowledgements

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References

Fujishima, G. (1981) Reconstruction of the Shiten-no Temple, The Shiten-no Temple, Osaka (Japanese).

Hoshino, Y. (2010) Ino Tadataka: the person of the honesty to a fault who measured Japan for the first time, Yamakawa Publishing Co., Tokyo (Japanese).

Maeda, K. Yoshikawa, S. and Tanaka, K. (2006) Analysis of Urban Green Environment by Using Geo-information Technology, Papers and Proceedings of the Geographic Information Systems Association, 15, pp. 217-220 (Japanese).

Shimizu, E. and Fuse, T. (2003) Rubber-sheeting of Historical Maps in GIS and its Application to Landscape Visualization of Old-time Cities: Focusing on Tokyo of the Past, Proceedings of the 8th International Conference on Computers in Urban Planning and Urban Management (CUPUM 2003), May 27-29, 2003, Sendai, Japan, 11A3 (CD-Rom).

Takahashi, Y. (1994) Design of Lens, Tokai University Press, Hadano (Japanese).

Yamano, T. and Yoshikawa, S. (2005) Cityscape Analysis and Simulation with Three-dimensional Urban Model, Proceedings of the 9th International Conference on Computers in Urban Planning and Urban Management (CUPUM 2005), June 29-July 1, 2005, London, England, Paper171 (on Web).

Yoshikawa, S. (2005) Restoration of "Genroku" Space, Proceedings of the 9th International Conference on Computers in Urban Planning and Urban Management (CUPUM 2005), June 29-July 1, 2005, London, England, Paper180 (on Web).

Yoshikawa, S. (2007) Restoration of the Takatsuki Castle, Proceedings of the 10th International Conference on Computers in Urban Planning and Urban Management (CUPUM 2007), July 11-13, 2007, Foz do Iguaçu, Brazil, Paper88 (CD-Rom).

Yoshikawa, S. and Tanaka, T. (2011) Modeling of Nightscape, Proceedings of the 12th International Conference on Computers in Urban Planning and Urban Management (CUPUM 2011), July 5-8, 2011, Lake Louise, Canada, Paper180 (USB flash drive).