

AN INTERACTIVE DIGITAL ARCHIVE FOR JAPANESE HISTORICAL ARCHITECTURE

WOOKHYUN YEO, CHEONGW AI LOU
ATSUKO KAGA, TSUYOSHI SASADA
*Department of Environment Engineering, Graduate School of
Engineering, Osaka University*
yeo@env.eng.osaka-u.ac.jp
ray@env.eng.osaka-u.ac.jp
kaga_atsuko@env.eng.osaka-u.ac.jp
sasada@env.eng.osaka-u.ac.jp

AND

CHANGSOO BYUN, TOSHIRO IKEGAMI
*Environment Design, Faculty of Fine Arts,
Kyoto City University of Arts*
byun@kcua.ac.jp
ikegami@kcua.ac.jp

Abstract. Digitization of cultural assets is crucial in preserving, restoring, reproducing and publicizing information on valuable cultural assets through the use of up-to-date technologies. These materials can be used as educational material for future generations. This study proposes and demonstrates a new method of creating a multi-purpose interactive digital archive, which makes use of a 5-story pagoda in the Kyouou-gokoku-ji Temple in Kyoto, Japan.

1. Introduction

Most historical Japanese buildings are made of wood. Such buildings manifest the technology and culture of the period when they were built. Wooden buildings, which showed unique designs native to their region, were built using techniques of their era. Such information provides us with important historical and cultural values.

However, wood is easily damaged; it is difficult for their forms and the quality of the material to be preserved for a long period of time. They have been damaged by external conditions, but were recovered for their original forms. It is important to preserve these forms in order to record the

techniques used to make them, and other practical knowledge which can be derived from the study of their make.

This study intends to make a digital archive of traditional structures with new preservation methods. It also intends to prove its usefulness by providing an example of a 5-story pagoda in the Kyouou-gokoku-ji Temple in Kyoto.

2. Examples of Expressions in Traditional Building

So far, many researchers have contained knowledge of traditional cultural assets in various media. This study, using the following examples, will explain how Sasadalab (Osaka University in Japan) have been handed down: Edo-jo Castle (1987), Heijou-kyu Suzaku-mon Gate (1987), Lou-lan (1988), Emperor Nintoku Mausoleum (1994), Touseu-dai-ji Temple (1997), and the Ueno kan-ei-ji Temple (1998). *Figure 1 to 5* have showed these projects.

Edo-jo Castle was recovered by using 3DCG (3-Dementional Computer Graphics). Animated and televised, Heijou-kyu Suzaku-mon Gate has more vivid detail than Edo-jo Castle (for example, its internal nails are made visible.) The Chinese Lou-lan City, which had already disappeared, was reproduced by 3DCG (likewise animated and televised.)

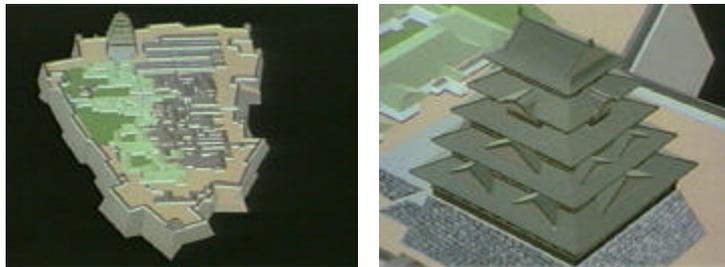


Figure 1. The project of Edo-jo Castle

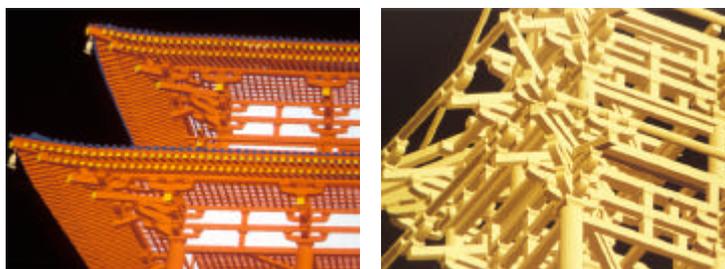


Figure 2. The project of Heijou-kyu Suzaku-mon Gate

AN INTERACTIVE DIGITAL ARCHIVE FOR JAPANESE...



Figure 3. The project of Lou-lan

Based on extant tombs, the original form of the Emperor Nintoku Mausoleum was reproduced by 3DCG. The main Buddhist hall of the existing Tōshō-dai-ji Temple was also reproduced by 3DCG, with its internal structure expressed in detail. This was produced by high-vision for the purpose of broadcasting education.

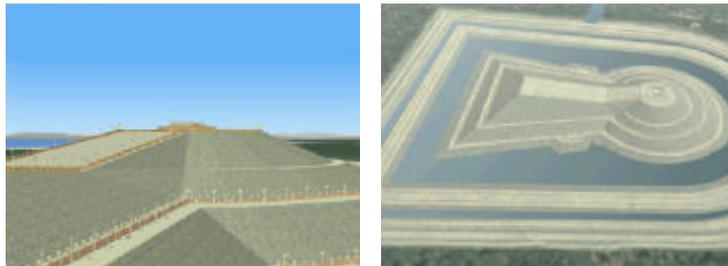


Figure 4. The project of Emperor Nintoku Mausoleum

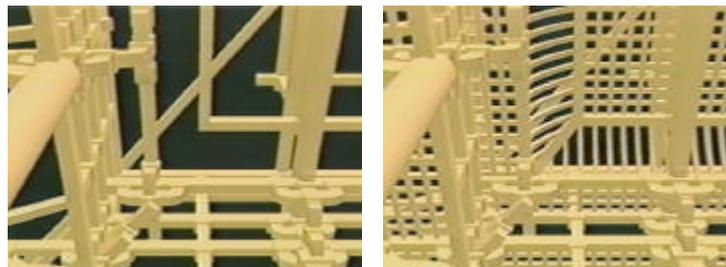


Figure 5. The project of Tōshō-dai-ji temple

Ueno kan-ei-ji Temple has a structure that can be easily grasped. All of its parts are produced by 3DCG, with the result produced by high-vision. This shows the concrete angle and composition of wooded joints in detail. The model is used for self-education where traditional wooden buildings are produced.

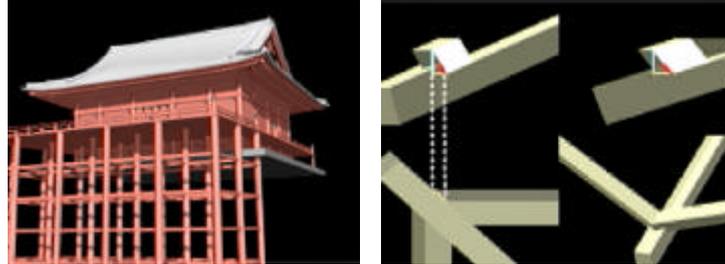


Figure 6. The project of Ueno kan-ei-ji temple

Most of the examples that have been used so far are produced for a specific purpose. They have mostly been expressed by VHS, high-vision video, and digital video. All the data prepared by this research team was studied and then animated. When used for broadcasting, however, sufficient data used for animation was generally prepared.

The data is usually prepared again, to be re-used for any purpose other than what it was meant for. Traditional buildings that are culturally and technically significant are used for various fields: architecture, history, sociology. The data is insufficient to cover such various demands.

Through the examples above, this research team has sought to recognize the need for a digital archive applicable to any case; to make a digital archive with reference to 5-Story Pagoda in the Kyouou-gokoku-ji Temple; and based on the data, to use the archive with various types of media.

3. Preparing the Digital 3D Models

This team took the 5-story pagoda in the Kyouou-gokoku-ji Temple (selected as a world culture asset in 1994) in Kyoto as an example. This is the only extant pagoda left among others that were created with the advanced technique that was in use during the Japanese Heian Era.

This giant wooden pagoda, 54m high, is significant in the fact that no higher building than this pagoda can be built to preserve its historical grand view. Its key point depends on its structure, which is responsible for the building's longevity; the pagoda has in fact survived many earthquakes or typhoons in Japan. For this project, it is difficult to obtain detailed information of the structure from literature.

AN INTERACTIVE DIGITAL ARCHIVE FOR JAPANESE...



Figure 7. (Left). The present figure of 5-story pagoda. (Right). The figure of 5-story pagoda when it was first constructed.



Figure 8. (Left)(Right). Inside of 5-story pagoda.

As a first step, the team collected information on the pagoda in cooperation with the Cultural Property Public Assistance Division in Kyoto Prefecture Board Of Education. Based on this information, research team then prepared a 3D Model. The internal and external parts were modelled in detail by the 3D Model Photos - taken during the information gathering stage - were mapped on the 3D Model data. The result very similar to the actual object being copied came out. The original details, as depicted in old literature, were successfully expressed. Texture mapping has made it realize to experience the real pagoda, and owing to an accurate digital archive, this model can now be used for educational purposes.

4. Development in Interactive Digital Archive

“Archive” originally meant “Document depository”. Such an archive suffered from problems of aging of data and inefficient nature of search. “Digital archive” solved such problems through digitization. This paper discusses the meaning of digital archive using indication properties such as data, historical cultural property, and scientific property such as structure and

method of construction, which were recorded along with high-quality digital image form and kept in the form of multimedia, database, etc.

The example introduced in Chapter 2 can be considered as “Digital archive”, with the problem “Archive” solved by creating “Digital archive”. Chapter 3 describes the digital archive of a 5-story pagoda created by the same system. However, such digital archive is still inseparable from the old form. Real-time simulation that enables 3D space was then manufactured, moving freely inside the 3D virtual space made in the previous stage. In this chapter, an interactive function is included in the digital archive created in Chapter 3 in real-time. It introduces the form wherein mutual knowledge transfer is possible; through the 3D space.

The digital archive created was used for a mutual knowledge delivery form and for another broadcasting project. Microsoft©Direct3D®-API based Virtools® was used for its preparation. Original interface was made using internal scripts.

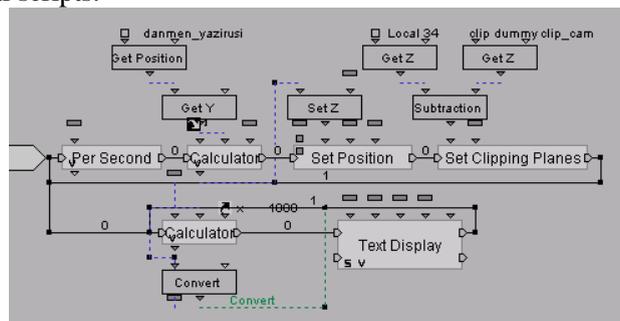


Figure 9. Scripts of a real-time simulation interface on Virtools®.

The following items show the interface functions of the scene:

- **Walkthrough** – Enables moving freely in space while observing your surroundings. It supports the ability to view objects in many directions. Both the interior and exterior of the building can be separately viewed. If the view of the interior is too narrow, the viewing angle can be adjusted.
- **Section & Plane Display** – Cuts the building and sees a section at any point elevation or plane. The section is displayed in a perspective mode in order to easily determine the depth.
- **Show/Hide Main Materials** – Shows or hides each part classified material into groups. You can see what is concealed by the external wall.
- **Parts Information Display** – Shows the simple information with reference to various literature, i.e., what were used and for what purpose

AN INTERACTIVE DIGITAL ARCHIVE FOR JAPANESE...



Figure 10. Work through outside (Left) and inside (Right)

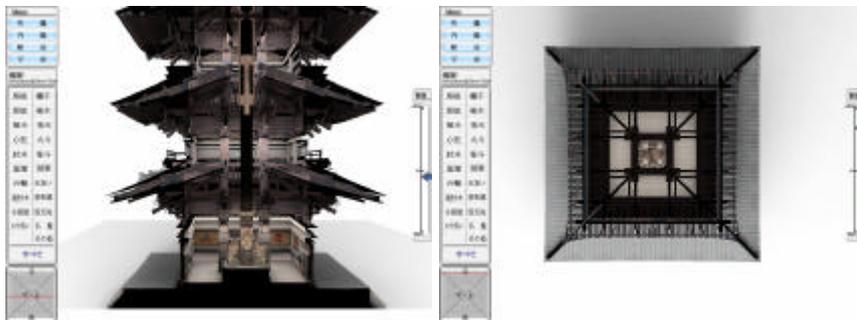


Figure 11. Section display, Elevation (Left) and Plan (Right)

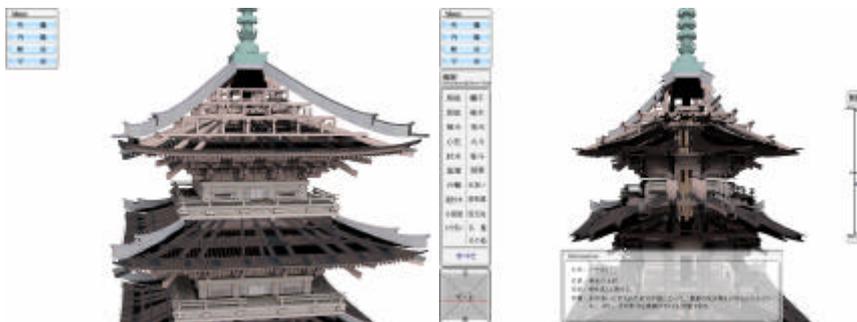


Figure 12. Show/Hide main materials (Left) and Part information display (Right)

Existing 3D games or real-time simulations focus only on the seemingly general portion and the Clipping technique that un-displays portion other than a visible portion, i.e., the level of detail (LOD) technique that simplifies data according to stage. In this research, however, such techniques are not used considering overall accuracy; instead, the method of showing the whole data in the present state is employed. Likewise, it is possible to acquire information not only by showing using 3D model data, but also including the function to show the information on various references while looking at this

tower. Moreover, detailed information is shown over an unclear internal structure by including the display function of the section and plane in a perspective state.

For example, this tower has a special structure-separation structure of Sinbasira, i.e., an internal main pillar, and Taruki supporting a roof. These are responsible for the building's longevity; in fact, the pagoda has survived several earthquakes and typhoons in Japan. Even if these contents are included in the explanation recorded in the references, however, how they are actually constituted is not very well understood. This problem is resolved by showing the internal contents at a perspective elevation and a plane. In order to show the portion classified by other objects, a function that enables showing and hiding was also included in each object and group. These digital archives contains such a function could be called interactive digital archives, which are developed from the digital archives.

This pagoda was composed of a detailed model. Actual photos were also mapped on the model, with 127MB data containing 1.1Milion polygons. This therefore required a special hardware to achieve smoother movements in real time. As such, the team prepared a portable high performance machine for the presentation.



Figure 13. Portable high performance machine for the presentation (CPU: Xeon Dual 2.8GHz, Graphic card: ATI RADEON 9700, Memory: DDR2100 2GB)

5. Conclusion

Japanese traditional architecture is culturally significant. It has been reproduced and recovered through various methods. This study introduces a few reproduction methods that have been used so far to analyse current problems. It also gives suggestions on the digital recovery of traditional buildings. To illustrate this, the digital archive of the 5-story pagoda in the

Kyouou-gokoku-ji Temple was used as an example. As shown above, the detailed digital archive is important in handing down culture and technique in traditional buildings to the future generations.

By using a digital data recorded in accurate detail, this study made use of a VR system with an interactive interface. The real-time simulation can be used for various purposes (knowledge exchange, education, and viewing the interfaces prepared in this study) by developing interfaces as needed.

The most difficult part of this study was collecting materials. Only the collective information of literatures was insufficient. In fact, the research team visited the inside of this pagoda several times in order to take pictures and materials at the field. If a digital archive similar to the one presented here would be prepared, it will omit the collection of materials the fieldwork.

Nevertheless, this study is useful in studying this pagoda or any other Japanese traditional building. The data used here can be used by various types in various fields of study.

Thus the interactive digital archive prepared here is a compilation of new learning on the techniques of how the building was first built and designed, and how it would look like in the past as compared to the present.

The preparation period for such projects should be reduced by the development of technology. Other cultural assets should also be prepared by the digital archive described here. If these can be successfully collected, it will not be improbable for a digital museum to be built in the future.

References

- Byun, C.S.: 2003, New possibility of the digital archives in a wooden old building: computer graphics of the new possibility 5-story pagoda in the Kyouou-gokoku-ji Temple of the digital archives in a wooden old building, *Kyoto City University of Arts*.
- Bae, H.S., Kim, M.R., Shin, S.Y., Kim, H.A. & Yoon, C.S.: 2002, An application of photogrammetry measuring technology to parametric modeling of Korean traditional, *CAADRIA2002*, PP139-146
- Sasada, T.:1999, Computer Graphics and Design, *CAADRIA99*, Shanghai, PP21-29.
- Lou, C.W., Kaga, A. & Sasada, T.:2002, Environment design with Huge Landscape in Real-time Simulation System: real-time simulation system to real project, *CAADRIA2002*, Malaysia, PP265-272.