Time-based Database for Creation of Korean Traditional Wooden Building

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***Abstract*— this paper is designed to define and categorize the architectural components of the Korean traditional buildings on the basis of their time periods. By incorporating the time-based criteria and component relations into the existing data-base, this study is expected to improve time and accuracy in reconstructing and remodeling the Korean traditional wooden buildings.**

***Index Terms*—HBIM, Database, Korean Traditional Wooden Building.**

I. Introduction

The Korean traditional wooden building is known for its complexity of the inner-structure. It is composed of hundreds of components which are assembled into higher level assembly units in a successive manner. Consequently, it is challenging and often impossible to reconstruct the architectural heritages.

The adoption of a new system called Building Information Modeling (BIM) has significantly helped the Korean architectures to reconstruct the Korean traditional buildings. Although more efficient than the traditional surfacing modeling, BIM method still suffers from its own limitations. The current application of BIM focuses mainly on the spatial coordination of each compartment, and thus, the database is only categorized by the final form of the building. However, we observe numerous examples of the traditional buildings which have been reconstructed many times. When it comes to estimating the transitional forms of the historical architectures, it is essential to have a database reflect the time-periods of each component of the building.

Establishing the time-based BIM is different from the data-building process of the existing spatial-based BIM method. First, we need to identify the historical changes of each component. The Korean traditional buildings share the commonalities throughout history. Their components are largely divided into five classes: Ground, Frame, Gongpo, Roof and Decoration class. The inner-structures of each class, however, are varying across times. However, there have been few attempts to classify the historical modifications of each part.

Second, the time-based database is to be a relational database of each compartment. Estimating the transitional forms of the historical building is not merely changing one compartment to another. The entire assembling style of the building can be affected by a change of a small part. One of the ultimate objectives of this project is to generate a dataset in which all possible combinations of the compartments are stored.

II. Related Works

Many researchers have tried to integrate visual materials such as scanned data and photographs in the BIM environment. This Historic Building Information Modeling (HBIM) entails the three dimensional parametric representation and component modeling tools and semantic structures for reconstruction and management of the related data on architectural heritages [1].

In the European architectural scholarship, study on the building information system that uses semantic structure and temporal fragmentation for managing, storing and representing building history is one of the most popular topics [2]. For instance, there are also researches on a web-based information system for management and the dissemination of Cultural heritage data at spatial and temporal levels [3]. Dudek (2005) researched a time-based database and representation for the virtual heritages for information search and visualization [4].

There are a number of researches on architectural heritage digitization based on BIM in Korea. However, the previous studies on the BIM digitalization of the Korean architectural heritages focus mainly on the spatial aspect of the heritages and tend to under-estimate the importance of the time-changes of each components.

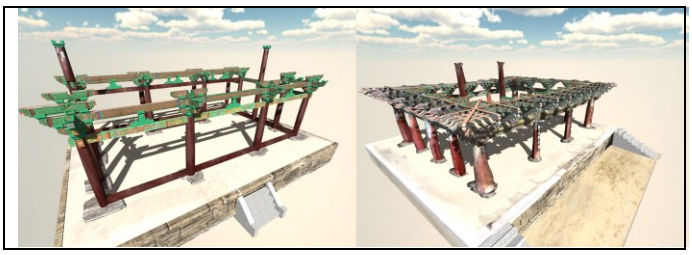

Fig. 1. Digital Heritage Simulation for Korean Architectural Heritage by ETRI

ETRI is one of the leading institutions that attempt to restore and reconstruct the Korean traditional buildings in Korea. It is developing a software named the Digital Heritage Simulation Technology [5]. The software provides a variety of tools to reconstruct the heritage buildings and appurtenances by using geometric modeling, dynamic simulation, computer animation, computer-aided design (CAD) and BIM technologies. To simulate a building, ETRI creates a model with photographs and CAD blueprint, and then, the digital

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component-modeling software starts to create a database of components-templates. Digital building data and animations are retrieved from the description of traditional architecture buildings. By demonstrating the rebuilding processes, the software is tremendously useful to simulate and estimate the final form of the building. They created digital heritage contents to preserve and educate structure and the construction techniques of two Korean traditional buildings (Bongjeong Temple and Cheongryong Temple).

However, in the case of estimating the original structure of the destroyed and repaired buildings, the ETRI tool is not able to collect appropriate components' information at the initial construction time. The component library is categorized only reflecting one-time period for each building. It is fairly limited to show the historical changes of the building's appearance and interior structures.

III. Methodology

A. Periodization of Korean Traditoinal Wooden Building

Korean traditional wooden building has something in common with a basic structure. Its components can be divided five classes, 1) Ground class, 2) Frame class, 3) Gong-po (Korean Bracket Structures) class 4) Roof class and 5) Decoration class.

The Gongpo can be easily observed under roof of traditional building. The function of the Gongpo is to transmit the weight of roof to the pillar. The styles of the Gongpo in Korean traditional wooden architectures are divided into three major types: 1. Jusimpo, 2. Dapo and 3. Ikgong. The above three styles are not used synchronically but there is always the prevailed style in each period. Therefore, we can imagine or hypothesize the Gongpo styles of the destroyed buildings with remains. The below table shows the changes of the component styles throughout periods.

TABLE I. Periodization of Traditional Building by Gongpo Style

Construction Period	*Gongpo Style*	*Gongpo between pillars*	*Pyeong bang*	*JUDU*	*Pillar*	*Chumcha*
Goryeo Dynasty (918~1392)	JUSIMPO	X	X	Heel shape	Entasis style	S shape
The early of Joseon Dynasty (1392~1506)	DAPO	O	O	Curve shape	Reverse style	Circular Arc shape
The middle and the late of Joseon Dynasty (1506~1897)	IK GONG	O	X	Curve shape	Reverse style	Circular Arc shape

B. Creating Time-based Database

We defined hierarchical structures and basic classification for presenting building construction. Upper classes are Ground, Frame, Gongpo, Roof and Decoration class. And Lower class is divided by component entities.

For presenting building's transformation, we defined attributes for building, component, relation and architectural style entities. We created architectural style table for transformation of building. Its attributes are Period and Gongpo style. According to Gongpo style, component structure and relation can be changed. When these attributes are attached to the 3D component model, components are placed in the historic existence place.

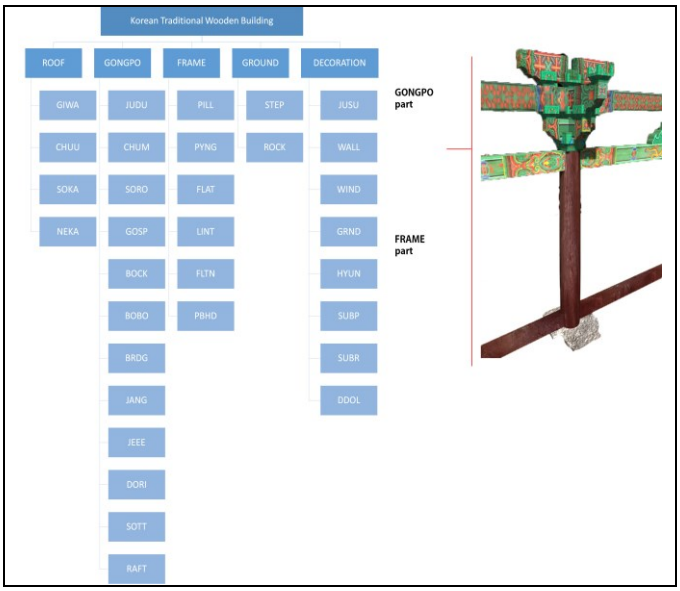

Fig. 2. A hierarchical structure of Korean Traditional Wooden Building

IV. Conclusion

This study includes periodization of the Korean traditional wooden building by Gongpo and recommended components' styles. In order to improve time and accuracy, we should collect voluminous information from the historical modifications of each class and compartment. Ultimately, this study will contribute to create contents for learning building history. Administrators can also refer to this database in managing the architectural heritages. For example, they can first examine building structures with component relations in the database and begin a remodeling project.

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