

스마트폰에서 건축설계 3D 모델링

한정수*

백석대학교 정보통신학부*

Construction Design 3D Modeling in Smart Phone

Jung-Soo Han *

Division of Information & Communication, Baekseok University *

요약 본 논문은 스마트폰에서 건축설계를 할 수 있도록 3D로 설계과정을 표현하였다. 먼저 건축자재들을 컴포넌트로 구성하고 컴포넌트들을 패턴으로 조립하여 패턴 단위로 건축설계가 이루어지도록 하였다. 모바일 환경에서 건축설계가 이루어 질수 있도록 4가지의 View로 구성하여 각각의 기능을 기술하였다. 또한 각 View에서 필요한 기술들을 사용한 라이브러리를 통하여 자세히 설명하였다. 이러한 구현 기술을 바탕으로 각 View가 어떻게 그 기능을 수행하여 서로 상호 보완적인 방법으로 동작하는지 그 과정과 자재 계산 결과들을 모바일을 통하여 보여주었다.

주제어 : 건축설계, 스틸하우스, 3D, 모바일, 스테드

Abstract This paper was aimed to represent 3D design process to enable the construction design in a smart phone. The construction design was done in pattern units, by composing construction materials in components first, followed by assembling the components in pattern. Four types of views were constructed and each function was described to enable construction design in mobile environment. In addition, the skills needed for each view were described in detail through the libraries used. The process and calculation results were shown in mobiles how each view performed its function and behave worked together with a complementary way based on this implementation technique,

Key Words : Construction Design, Steel House, 3D, Mobile, Stud

1. Introduction

This paper proposes pattern ontology for a steel house design allowing efficient architecture design in pattern unit with assembly of patterns of components composited with steel house architectural materials by adapting the steel house construction. The steel house construction is a representative construction method for easy assembly of wall panels made with panels and

trusses. The steel house assembly construction technology is the prefabricated construction method receiving attentions more than any other methods. If architectural design contents are developed by combining this design method with IT, a house or a building can be designed easily not only by an architecture, but by a user as well[1][2]. Therefore, this study aims the automatic information creation of

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Corresponding Author: Jung-Soo Han(Baekseok University)

Email: jshan@bu.ac.kr

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required patterns for material change and the changed architecture during a design by composing steel construction materials into patterns. Also, this study allows users design easily in owners' positions, and supports architectural design by providing not only cost estimation utilizing changed material information according to design changes but repository establishments based on pattern information composed with components[3][4].

Also, to change an architecture built with assembly method, patterns are supported according to the ontology of selected area to change as well as the needful information for re-building to designers through required material and pattern information analysis. In general, since an architecture is composited with several hundreds of parts, it is impossible for a designer to work to assembly on screen by selecting each part name separately. Therefore, for an efficient performance of the process, pattern type 3D viewer is proposed.

2. Steel House Animation

This paper is the first to target as many buildings steel house method using the materials for building the components of the sample extract and configure the metadata for each component was composed of components comprise the metadata for patterns were Each component configuration patterns have implications for relationships to be associated with the pattern of relationships was Part of architectural design patterns using the relevant components of the surrounding automatically modified according to the pattern takes place as the new building is designed[5]

Using the 3ds Max tools have a house finished animation to proceed. By default, the first to have the value of the animation used in the frame to give as much to increase the value of the auto key to change the setting through the frame-by-frame look is the key

to save the value. If a change of coordinates, recognizes the value of setting key and is stored in the corresponding frame. At first, you do not change the original text on the screen in the frame changes due to changes in the coordinates of the screen to the frame to move the changes taking place in the frame will be stored. Therefore, in order to build buildings where required to move the frame and the frame to apply the value of the key by performing the operation is repeated, leading to a scene a scene while animating 3D screen 3D animation showing the results of the building is to be made. 3D animation through the steel for the building to be built in house moving visual effect can be granted[6].

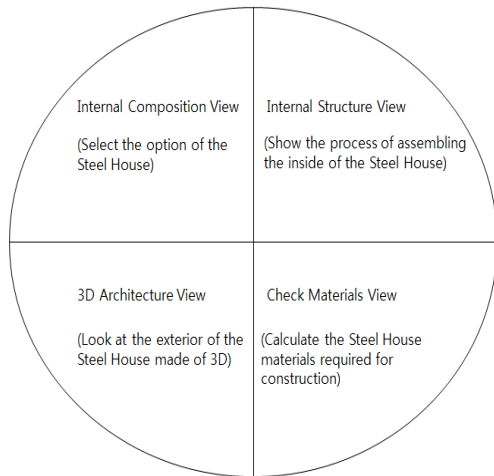
3. Mobile Technology

3.1 Structure of the system in a mobile environment

The system structure in the mobile environment is classified into four types as in [Fig. 1].

First, there is Internal Composition View where you can select the internal option of the steel house. By specifying the most basic things in prefabricated construction as the internal option, the action and computed values are derive in the remaining 3 Views (Internal Structure View, 3D Architecture View, and Check Material View) based on the initially set options. The second view is Internal Structure View that runs the option selected in Internal Composition View in video view. The assembly process is shown of the internal structure in units of component to fit each content. The third one is 3D Architecture View to show the appearance of the steel house that is most similar to the option selected in Internal Composition View. Various forms of 3D appearances are stored, which can be rotated using a vertical and horizontal drag in a mobile environment that recognizes the touch. The fourth Check Material View calculate the materials

required for construction based on the option selected from Internal Composition View. It performs initial calculations of construction materials needed for the steel house, and of materials required during the reconstruction of other models of the steel house using Restructure View.



[Fig. 1] System structure in mobile environment

3.2 Technology in each View

Options to choose from Internal Composition View are limited to the area, number of rooms and the shape of the roof. The input values of this option determine the number of doors, number of windows and number of baths. The number of doors and window was based on common housing. To the basic one door and one window, one door and one window are added for the increase of one room; the number of the baths is calculated based on the area and number of rooms.

Internal Structure View used Video View library provided by Android to show a video of the assembly process of internal structure created in 3D. The 3D files production by using a 3D Tool was transferred in units of component for each frame. Graphics capabilities are needed such as the OpenGL to run 3D files in a mobile environment such as smart phone. A jPCT 3D engine

open library that uses modified coordinate system based on the OpenGL ES was used to run the 3D file in 3D Architecture View of the Program.

The whole context is as follows of loading and horizontal/vertical spinning of 3ds file from jPCT-AE. After declaring GLSurfaceView object in charge of the screen drawn by the Activity in Android, it makes the screen as full screen.

The Renderer object of the GLRenderer is declared, followed by making of the corresponding inside class. MainActivity variables are declared, where Copy () method is declared to save the current information. The same tasks are performed too in onPause () and onResume of GLSurfaceView. Touching must be able to be detected first of all to rotate the 3D object in mobile, so MainActivity should be overridden by onTouchEvent () method. The variable to hold the touch coordinates should be declared by x and y coordinates, respectively. A 3D object can be rotated using the GLRenderer rotate () method in the above-declared onTouchEvent () class. For this, y-axis rotation and x-axis rotation values should be entered for the rotateX () method and rotateY () method of the Object3D class, respectively.

During horizontal dragging, counter-rotating may occur opposite to the touch; this phenomenon may be solved by adding "-" sign to the x and y coordinates rotating during drag, referring to the jPCT-AE coordinate system. Finally, each part of the 3D objects that read and configure files are combined, in order to create loadModel () method that returns in Object3D data type.

Check Material View requires list and formula of materials in order to calculate materials necessary for the steel house. Materials were limited to ones that make up large frames; the list includes Rafter, Ridge, Floor Joist, Track, Box type Header, I type Header and 140SL10 Stud; construction material calculation formula is as follows:[7].

$$\begin{aligned} \text{Rafter} &= ((\text{width} - 4)/49)+1 \\ \text{floor joist} &= ((\text{width} - 4)/49)+1 \\ \text{track} &= (\# \text{ of doors} \times 1) + (\# \text{ of windows} \times 2) \\ \text{Box type Header} &= \# \text{ of doors} \times 2 \\ \text{I type Header} &= \# \text{ of doors} \times 4 \\ \text{140SL10 Stud} &= (((\text{width}-4)/49)+1) + \\ &\quad (((\text{height}-14)/59)+1) \end{aligned}$$

Ridge is determined by the roof shape. For a flat roof, Ridge = 1; gable roof, Ridge = 2. In addition, the width and height in the formula are determined according to the acreage. In internal view called Restructure View was used to calculate the scant or spare materials for reconstruction of a steel house of different shape, using the method of subtracting initial material from that required for the reconstruction.

3.3 Material Increasing Technique depending on the weighting

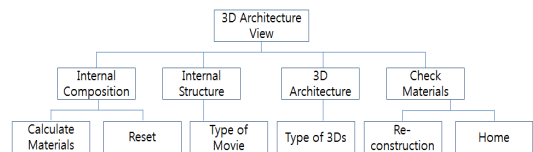
The text of the steel house material is divided into blocks consisting of a few sentences. Task units are extracted from each block. Task unit refers to the structure exactly consisting of "material + object.". Extracted units of task are written in flowchart. This is called materialization task flow process. The organization of the task activity follows. Materials in task units are conceptualized in order to eliminate the diversity of terms; task units are rewritten using the concept of intrinsic material information; and a task activity is constituted. Next, the task activities are organized in is-a hierarchy. The role of the input & output of the task activity is to be extracted and conceptualized. This is called the role of task activities. Now, the structure of the task needs analysis. Embodied task flow is to be generalized in order to obtain a general task flow for the construction materials. Attention should be paid to the input and output flows and interconnecting relationship of the task activity of the general task flow, in describing the object flow.

Once the object flow is described, the task context role should be extracted, paying caution to the extracted object flow. The task context of role refers to the role among the entire tasks being noted. For example, the floor framing tasks include "joist", "rim track" and "joist bracing." The domain material vocabularies responsible for the task context are to be extracted. Finally, organization is needed of the concept of building material domain. The domain vocabulary for building materials should be abstracted, in order to extract concepts as well as clearly separate the role concept relying on the concept of a domain. In addition, the extracted domain concept is to be organized in is-a hierarchy[7][8].

4. Mobile Construction Process

[Fig. 2] is a system structure for construction design in mobiles. Here, 'Calculate Materials' calculates the materials required for construction of a steel house; 'Reset' initializes the option values selected in Internal Composition. Internal Structure shows the process of building the options of the rooms in a steel house in 3D and components to fit each content. 'Type of Movie' will show the structure selected in Internal Structure in an animation. This shows how the interiors are assembled in the steel house. 'Type of 3ds' shows the selected appearance models in 3D Architecture in pictures. Horizontal and vertical rotations are possible by using the touch function of the mobile.

In [Fig. 3], the Internal Composition in (a) can create 3D contents with a variety of room structure as in (b), by selecting the acreage and the number of rooms, roof



[Fig. 2] Mobile Structure

shape, number of doors, windows and baths. At this time, it supports the 3D View building a durable structure as in (c). Each room interacts each other; materials required are identified for transformation from a 2-bedroom structure to a 3-bed.

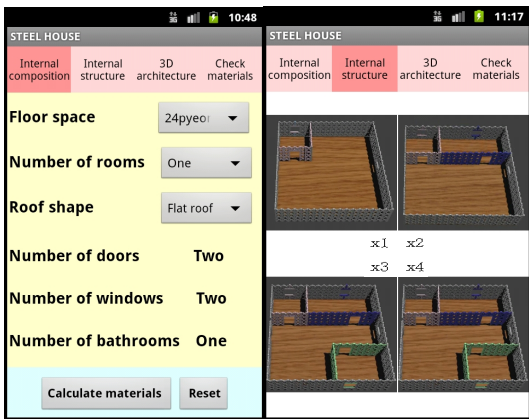
For Flexible Building Design of steel house, it in this paper was constructed to support not only a design using each pattern but also what materials change automatically when a user wants to change a type into another type among (b)-x1, x2, x3, x4 made in advance. The standard of building type is 99m² and it stores each data at DB. It enables to change the type and also provide data such as more needed materials, leftover materials, and recyclable materials by using a recyclable function which is one of the advantages of steel house when the type is changed.

5. Conclusion

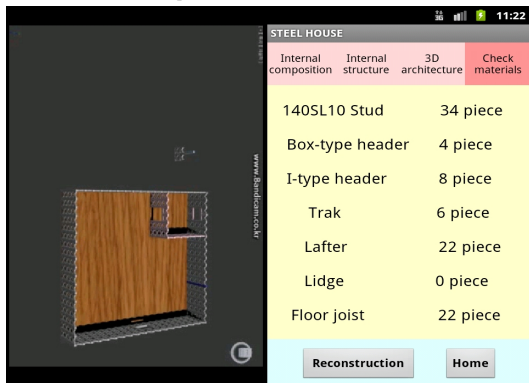
This paper enabled construction design in a smart phone and expressed the 3D design process. First, construction materials were composed in components, which were assembled in patterns, in order to do construction design in pattern units. To enable construction design in a mobile environment, four types of View were composed and each function was described. In addition, used libraries were described in detail through the methods that built the skills needed in each of the View. The process how each View performed its function and works in a complementary way based on this implemented technique, and the materials calculation result were shown through mobiles.

This paper did not target quite a many buildings but a few sampled buildings; components were extracted for the sampled buildings, metadata were composed for each component, and metadata were composed for the patterns consisting of components. Each of the components was made to have a significant relation for configuring the pattern, and the relation was connected with the relationship between the patterns. If a part of the building is designed using the pattern, a new construction design is accomplished by automatic reassembly of the surrounding components according to the pattern. In the case of common buildings, materials are composed of hundreds of parts, so it is not possible for the designer to select and work with a certain parts needed to assemble on screen. Therefore, a pattern assembly architectural design using studs-steelhouse construction material, and a virtual construction design simulation using 3ds Max were attempted in order to accomplish this effectively and, consequently producing automatical change output for the materials.

Future research is expected to enable postulate virtual building design by 3D modeling and automatic generation of architectural drawings.



(a)Internal Composition (b)Internal structure



(c) Type of movie (d) Check materials

[Fig. 3] Mobile Construction System

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한 정 수(Han, Jung Soo)



- 1990년 2월 : 경희대학교 전자계산 공학과 (공학사)
- 1992년 8월 : 경희대학교 전자계산 공학과(공학석사)
- 2000년 8월 : 경희대학교 전자계산 공학과(공학박사)
- 2001년 3월 ~ 현재 : 백석대학교 정보통신학부 교수

- 관심분야 : CBD, UML, 3D 모델링, Mobile Contents
- E-Mail : jshan@bu.ac.kr