# A Building Modeling using the Library-based Texture Mapping

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**Abstract** A 3D modeling of urban area can be composed the terrain modeling that can express specific and shape of the terrain and the object modeling such as buildings, trees and facilities which are found in urban areas. Especially in a 3D modeling of building, it is very important to make a unit model by simplifying 3D structure and to take a texture mapping, which can help visualize surface information. In this study, the texture mapping technique, based on library for 3D urban modeling, was used for building modeling. This technique applies the texture map in the form of library which is constructed as building types, and then take mapping to the 3D building frame. For effectively apply, this technique, we classified buildings automatically using LiDAR data and made 3D frame using LiDAR and digital map. To express the realistic building texture, we made the texture library using real building photograph.
**Keywords:** LiDAR, Library, Texture Mappintg, Building Modeling, Automatic Building Classification

## 1. Introduction

A majority of the researches conducted on 3D urban modeling is focused on terrain process. Especially, for the 3D model creation of various facilities, the method of acquiring structure and texture information from aerial imagery or high resolution satellite image is mainly used.

The high accuracy DTM(digital terrain model) and building models including realistic texture is a key factor in 3D urban modeling. Especially in the case of broad area such as urban areas, because there are quite a few numbers of buildings and many kinds of buildings in the urban areas, it takes up a lot of time and cost to acquire 3D information of each building.

In this papar, we automatically extracted buildings in the study area using LiDAR data, and chose the frame model and texture information of each building from pre-constructed library Then, based on these information, we developed building models, which is a library based texture mapping technique for 3D urban modeling.

## 2. Construction of Building Model

The data process of this paper as follows.

**Table 1. Data processing diagram**
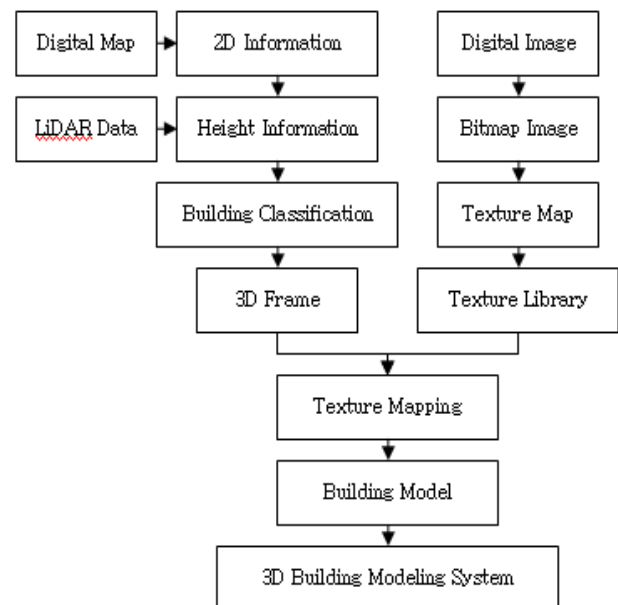


**1) Automatic Building Extraction using LiDAR Data**
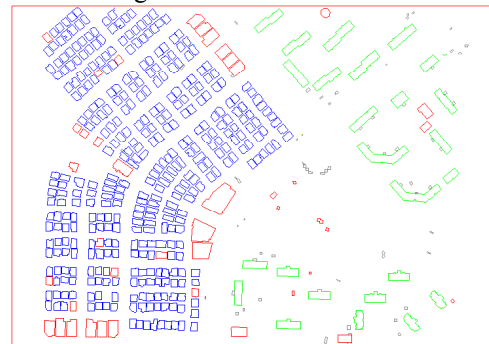
1. Extracting 2D Information



**Fig. 1. Extracting bulding polygons from digital map.**

We separated building polygons from the digital map and extracted 2D information of each polygon.

## 2. Extracting Height Information

We extracted building height information using the difference between DSM and DEM. The mean values for each polygon were used as the height of buildings.



**Fig. 2. Extracting bulding height information.**
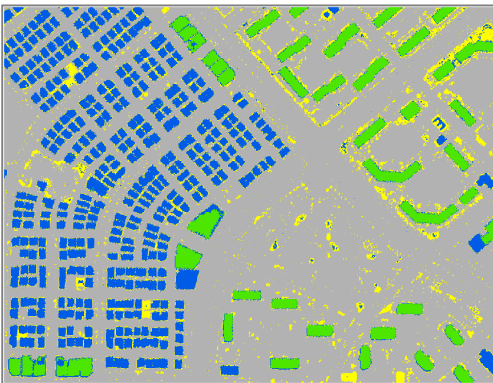
## 3. Building Classification



**Fig. 3. Classification by height.**



**Fig. 4. Classification by building area.**

With respect to the distribution of buildings, we used five kinds of classification items which includes were used for classification, which is single residence, tenement house, apartment and so on. First, we classified extracted buildings by height and area. But, as a result of the first classification, there were unclassified buildings, which were taken as second classification by building shapes and location.

## 4. Accuracy Assessment

We classified every building (500EA) in the study area, and then evaluated classification accuracy by comparing the results with the digital map.

**Table 2. Classification accuracy.**

|  | First classification | | Second classification | |
|---|---|---|---|---|
|  | number | Accuracy (%) | number | Accuracy (%) |
| classified | 418 | 83.6 | 483 | 96.6 |
| miss-classified | 12 | 2.4 | 16 | 3.2 |
| unclassi-fied | 70 | 14 | 1 | 0.2 |

## 2) Constructing Building Library

### 1. Constructing Building Frame

Most buildings in the urban area have simple shapes, i.e., they are mostly rectangular in shape. So, we simplified the shape of building polygons and acquired the length, width and height from LiDAR data and digital map. Finally, we constructed 3D building frames. The parametric model method was used for determining the building frame models.

### 2. Constructing Unit Frame

We extracted building polygons from the building layer of digital map, and the center of gravity of each polygon was used for the base point of a unit model. The orientation and shape of building polygons were adjusted by least squares fitting to building edge from aerial imagery. The datum plane of unit models and the height value of each polygons were used for constructing unit models. The mean values of each building that were obtained from LiDAR data were used as height values.
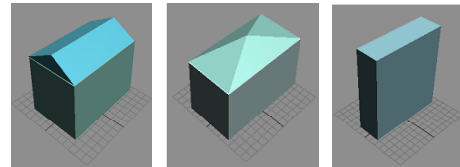Unit models were constructed as the form of library.



**Fig. 5. Constructing unit model.**

### 3. Construct Texture Library

The reality of model is a very important variable in 3D GIS as well as constructing 3D cyber city. Thus, in this paper, we took photographs of actual buildings and made texture images. Next, we plan to construct texture library structure by setting standard of representative texture of Korean buildings.
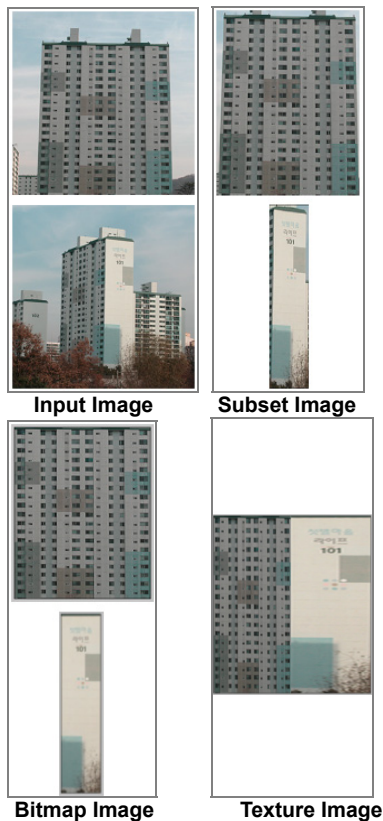
**Input Image**          **Subset Image**

**Bitmap Image**          **Texture Image**

**Fig. 6. Constructing texture image**

The textures of the buildings are can be easily recognized by the building structures, roof materials, colors and so on. Especially, in the case of apartments, we constructed database structure under the consideration that there are standardized patterns as set by the construction -companies.

4. Texture Mapping

We chose texture images from texture library of each buildings, and constructed building models by mapping them to 3D building frames.
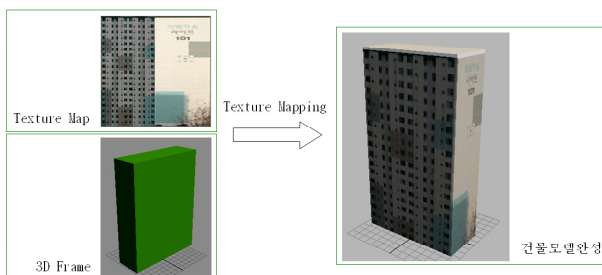


**Fig. 7. Texture maping.**

## 3. 3D Urban Modeling

We placed building models which were produced by library based texture mapping system on DEM and con-
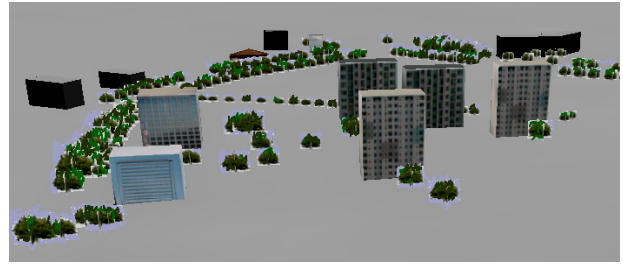
structed 3D urban model.



**Fig. 8. 3D urban modeling.**

## 4. Conclusions

This paper proposes library based texture mapping technique for effective urban modeling. It has merits in that various building models can be quickly and easily constructed on a broad piece of land. But it has demerits in that complex shapes of buildings can not be represented, and thus, building structure could be omitted during the modeling procedure. Therefore, it is necessary to develop an efficient frame structure that can represent the characters and structures of buildings and the research about library structure according to characters of building distribution in needed for solving these problems.

In this regard, the library-based modeling technique has meritious procedures such as the constructing building model which is simpler and takes up less time than compared with existing image-based modeling. Especially, in the case of modeling of broad area such as urban areas, it is expected to increase efficiency in terms of cost and time.

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