INTEGRATION OF BUILDING MODELS WITH INFORMATION-BASED ATTRIBUTES

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ABSTRACT: Recently, 3Dbuilding model has become a new research focus for its diversified functionalities and applications. In geoinformatics, the level of detail (LOD) of the city model is well-defined by the Open Geospatial Consortium (OGC). Textures and shapes of the buildings shall correspond to vary with the zoom level defines. However, if the system requires very detailed information on objects and attributes, such as individual beam, structure and properties, current OGC specification may be inadequate.
On the other hand, Building Information Modeling (BIM) is an object-orientated approach for producing independent objects within a model structure. This helps engineers and designers visualize and manage spatial applications more easily. In other words, there are two approaches in model construction, namely top-down approach in geoinfoematics and button-up method in BIM. This study aims to integrate geomatic approach with the BIM for 3D building and city modeling during the life cycle of the buildings in real world. The concept to construct such models is to build individual structure with spatial attributes and to form a complete building model. This model not only provides the users with 3D visualization but also spatial information for further applications within a building.

1. INTRODUCTION

3D virtual environments such as Google Earth and Skyline have brought significant impact to the use of geoinformatic applications (Zhu, 2010). In recent years, the construction of 3D building models has been widely used in such systems for diversified applications. For instance, touring guide and city development commonly utilize 3D models to make the vivid environment in a computer-generated environment. There are many ways to construct 3D building models such as Light Detection and Ranging (LIDAR) technique and close-range photogrammetry. Through these methods, accurate 3D building models can be constructed effectively and used in the 3D geo-informatic system. Furthermore, it will be helpful to users if the models are associated with corresponding attributes. In building construction and management, the use of virtual models is an important issue during the life cycle. Building Information Modeling (BIM) is regarded as a useful way to manage 3D buildings in virtual systems (Lee, 2006). However, BIM is preferred in designing before building constructions. In geomatics, to reconstruct the models of buildings which are already in real world is a more commonly adopted approach.
In the CityGML specification by the Open Geospatial Consortium (OGC), Level of Detail (LOD) can be used to represent city models in different scales and details according to different requirements. In OGC CityGML, LOD4 is the finest level for representing building details, including indoor objects. However, in order to give information to a detailed model, it is necessary to construct independent objects within a building through botton-up method of BIM (Jung, 2011). Besides, a BIM model provides an easy approach to change the design and attribute. On the other hand, the whole model is first constructed and then the detailed parts are added gradually in geoinformatic approaches. In order to take advantages of both approaches, this study integrate geomatic building models with BIM to construct detail building models with useful attributes. With the objects within a building, the complete building model can

then be created by combining all objects. Corresponding attribute information is also associated with objects of the constructed model, so they can be used in various applications.

2. MATERIALS AND METHODS

2.1 Original data

At the beginning of constructing 3D models, the basic data used in this study are 2D designing graphs as displayed in Figure 1. With this graph, data pre-processing is necessary to assure that the very detailed models can be constructed. This research than utilize an object-orientated approach to reconstruct the building model (Jung, 2011).

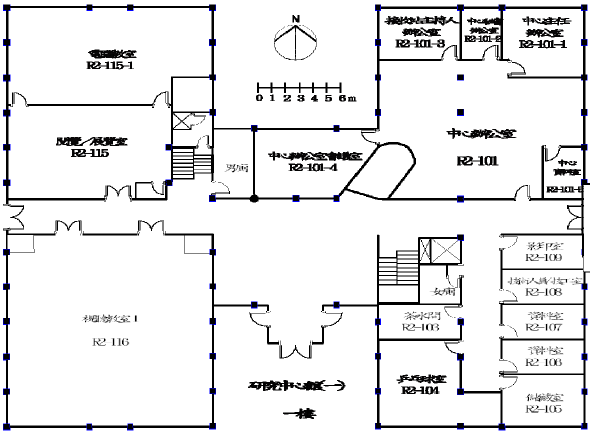


Figure 1. 2D floor plan

2.2 Data processing and model reconstruction

The first step of this process in to convert important objects and features into a CAD (Computer-Aided Design) system for object model reconstruction (Isildag, 2010). Figure 2 is the vector format of the simplified floor plan of Figure 1 in CAD environment. The 2D vector plan includes important objects such as stairs, walls and rooms with doors in order to recognize the position and size in 3D building models. In the developed object-orientated method, only one floor can be dealt with at a time. As each object and floor is reconstructed, both LOD3 and LOD4 models are almost completed by putting together the objects. Some details such as windows and beams are shown in 3D vector model as in Figure 3. The position and size of the details including exterior façades are estimated through photographs.

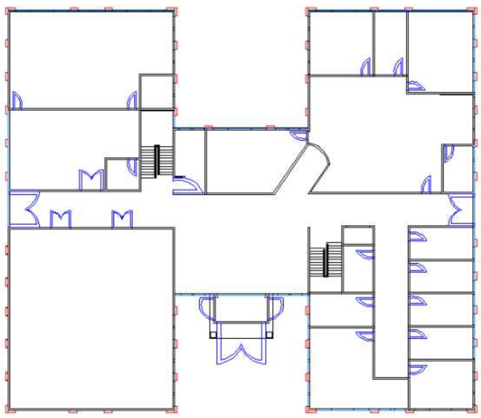


Figure 2. 2D vector floor plan

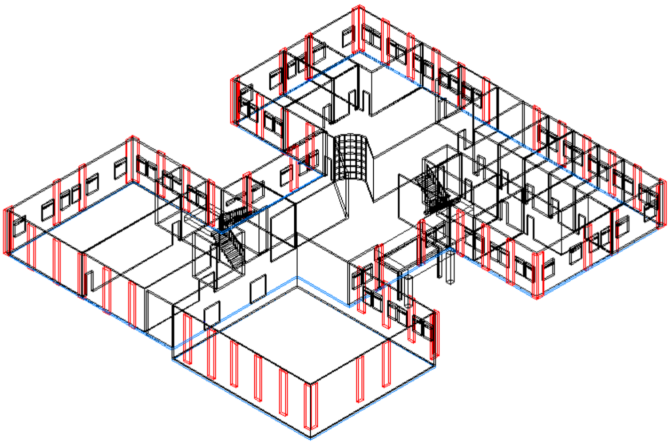


Figure 3. 3D vector model

3. INFORMATION-BASED ATTRIBUTES

3.1 Convert vector models to other 3D system

CAD models are useful for the design, construction and management of 3D virtual models. In addition, users can easily export or transfer the models to other 3D environment such as Sketchup or Skyline and for further editing (Isildag, 2010). For instance, users can attach appropriate textures to exterior façads and associate attributes to independent objects. Figure 4 is an example of converting original vector models into Sketchup format and acquiring block model objects. Figure5 shows an example of dividing the same building model into many independent objects and attaching realistic texture images to form an photo-realistic LOD4 model. A Building model with exterior textures and indoor partitions and objects is a LOD4 model in OGC CityGML while with BIM's approach. The merit of such approach is that to adjust objects within a building model is much easier than reshape the whole model even though in different virtual systems.

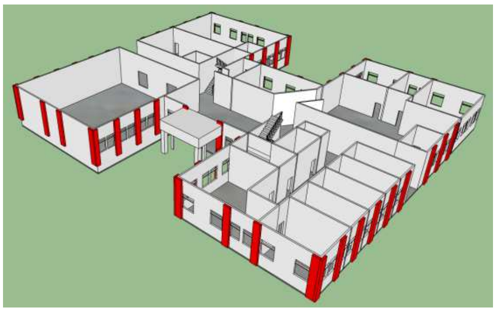
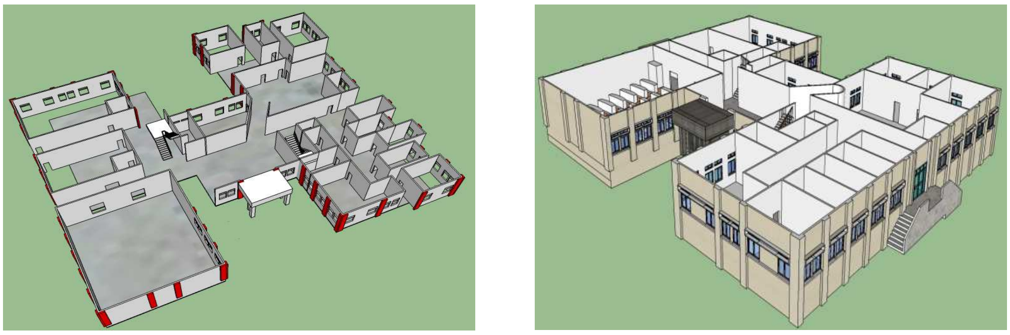


Figure 4. Model transformation



(a) (b)

Figure 5. (a) Independent objects with a building model (b) post-processing with textures

3.2 Associating attributes

The CAD model can provide accurate and detail geometric information, but there are no properties (attributes) in the bare-bone CAD model. After creating the 3D detail model, various attributes can be assigned to corresponding objects of the model. In this study, all models are eventually converted to KMZ format including KML files and model files. KML is actually an extensible markup language (XML) for information exchanging within computers (Lee, 2006). The merit of this kind of language is that independent objects and models with given attributes can be operated in other viewing systems such as Google Earth and Skyline and its flexibility.

In this study, attributes are separated into two types, namely geoinformatic and non-geomatic (Jung, 2011). Examples of geoinformatic attributes include coordinates, dimensions, area and the like, while non-geomatic attributes are inclusive of ownership, years of usage, price etc. Both types of attributes can be associated with corresponding objects or members of the building model. The resultant building models will have accurate and detailed geometric shapes, appearance, and spatial properties as well as useful spatial and non-spatial attributes. These models can be used in different 3D virtual systems for different applications. For example, Figure 6 displays one of the objects with information-based attributes in Google Earth. Although this example only lists the information (attributes) of building model, the associated attributes of different objects or members of the model can provide necessary information that are unavailable in conventional building models.

Figure 6. One of the block models with attributes showing on Google Earth

4. CONCLUSION

Traditionally, to construct 3D building models usually starts from the exterior shapes and façads for visualization and other applications. This paper presents a systematic approach to use 2D floor plans for the construction of detail building models and incorporate the concept of BIM to connect the model with attributes. Important objects of the floor plans are converted into vector format in a CAD system. Necessary spatial and non-spatial attributes are then associated with corresponding objects. These data are used to construct detail 3D building models that are conforming to OGC CityCML LOD4 standards and with information-based attributes. The resultant building models can be used in existing city models or visualization platforms and different objects would display corresponding attributes for querying and viewing in virtual environment. For further applications, this type of building model is very useful in providing more information within independent objects and for management during the life cycle of a building.

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