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IFC and OpenGL-based representation and development of 3D realistic model in virtual construction

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In recent years, the virtual construction (VC) has been widely applied, as it can improve efficiency, reduce cost and shorten period for construction projects. However, existing VC systems have a number of disadvantages that limit their usage, including requirement for high-end computing hardware, high deployment cost and limited interoperability with other applications of architecture, engineering, construction, and facility management (AEC/FM) industries (Yi et al. 2007). Integrating VC technology, IFC and OpenGL, a lightweight and low-cost VC platform is developed to address these limitations in this research. It has the ability of sharing and exchange data with other IFC-compliant applications. This paper focuses on the IFC-based 3D realistic model, which is the basis of VC model in the VC platform.

IFC has been known as a common product and process model to provide interoperability among various IT systems for AEC/FM industries (Kim and Seo 2008). It is widely adopted as a specification for product model in AEC/FM industry, especially in building information model (BIM) (Fu et al. 2006). Through IFC, building information is represented by predefined classes. For example, physical components of a building (e.g., walls, doors and windows) are represented by IfcBuildingElement class. The associated information of design, construction etc. is captured by attributions of the IfcBuildingElement and its corresponding property sets.

To support rendering realistically in the VC platform, the 3D realistic model introduces additional material definition information (e.g., colour, diffuse reflection and texture), based on which the VC platform can obtain necessary information of colour, lighting effect and texture of the product model and generate realistic scenes. Accordingly, an IFC-based 3D realistic model is created in this paper that includes product model, material definition and geometric definition. In this realistic model, rendering information is managed through various IFC classes. For example, colour is represented by *IfcColourRgb* class; material is represented by *IfcSurfaceStyleRendering*; texture is represented by *IfcSurfaceTexture* and its subtypes; texture mapping is represented by *IfcTextureCoordinate* and its subtypes. In general, the IFC-based realistic model is a complete realistic model represented by IFC and of which the data can be shared with other applications.

Based on the 3D realistic model, this research has developed a platform using VC technology and OpenGL to perform VC tasks effectively and efficiently. Figure 1 shows the architecture of this IFC and OpenGL-based VC platform. The platform provides an interface to share and exchange realistic model with IFC-compliant applications through IFC files, so that the interoperability with the AEC/FM applications is achieved. Being the basis of VC, the VC model contains all the information for VC and results of VC. In addition, it consists of the 3D realistic model described above, along with construction and design information that will be described in IFC as well in the second phase of

this research. Based on this VC model, construction simulation can be carried on by construction simulation systems. And the OpenGL-based 3D graphic platform, developed in this research, is used to visualize the result and process of construction simulation realistically.

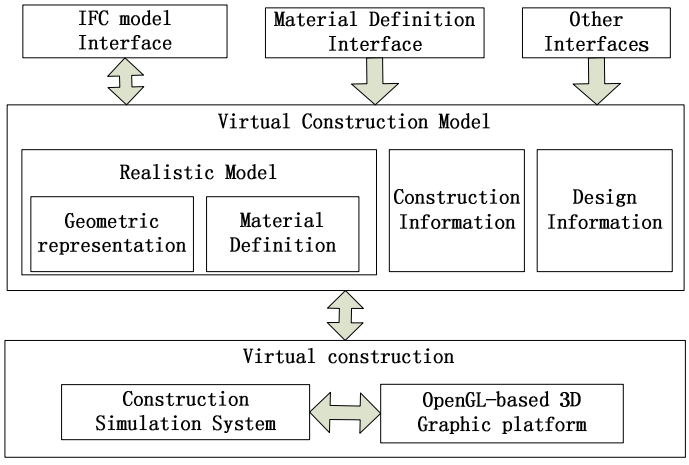

Figure 1. The architecture of the IFC and OpenGL-based VC platform.

The VC platform was tested in a real world project, the Guangzhou West Tower. The existing 3D realistic model was built with Architectural Desktop, and was exported to an IFC file. Then, by importing the IFC file, the VC platform shared the model and generated realistic model rapidly. Proven through these tests, the IFC-based realistic model presented in this paper is able to support VC tasks efficiently and can be shared between this platform and other IFC-compliant applications through IFC files. In addition, this platform is lightweight and can be run on commodity hardware.

In conclusion, this research presents an IFC-based realistic model, which can be shared with other applications through exporting as an IFC file. Then, based on this model a VC platform is developed by using VC technology and OpenGL. In general, the realistic model rendered by this platform is able to support VC tasks and the platform can provide interoperability, including data exchange and sharing, with other AEC/FM applications.

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