Web-based on-demand information extraction system for building information models

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Building Information Modeling (BIM) is regarded as the next paradigm of information technology application in the construction industry. The key concept of BIM is a complete object-oriented digital model of the building. The current application of BIM in the construction stage is sparse, due to the limited number of computing devices and trained personnel on construction sites. Compared to traditional computing, web-based applications and mobile computing is more suitable for use on construction sites.

Ibrahim et al. (2004) proposed a classification of BIM implementation: the integrated (or all-purpose) application and the distributed (or referential) approach. By extending Ibrahim’s alternative referential BIM approach and considering current BIM applications, a categorization of all available BIM applications is hereby proposed as: BIM authoring tools, BIM updating tools, and BIM viewing tools. BIM authoring tools have long been the focus of the industry and are expected to be the core of BIM implementation. They are powerful, complex and costly software applications that allow one to build a BIM model from scratch. Examples of BIM authoring tools include Autodesk® Revit®, Bentley® and ArchiCAD®. BIM viewing tools are those software applications that can only view the content of an existing model without making any changes. A lot of IFC model viewers are available on the market and most of them are free to the user. Besides the simple viewing and exploration function, the viewing tools should also be equipped with basic database search and query functions.

While BIM authoring tools and BIM viewing tools are widely available, BIM updating tools are unexpectedly scarce. We define those tools as those software applications that can make specific updates to an existing model. While less powerful than BIM authoring tools, BIM updating tools should be specifically designed for some tasks, simple to learn and use and highly responsive. Also, they should be much less expensive. The highly limited application field of those tools is right the niche for them to survive and prosper. The system proposed in this paper fits in this category.

Industry Foundation Classes (IFC) is a set of definitions describing the consistent data representation of all building components. By marking the contents with meaningful semantic tags, eXtensible Markup Language (XML) stores a document’s structure and content information, enabling automatic information matching and extraction from data files. IFC has built-in support for XML.

This study proposes a web-based solution for accessing information stored in building information models on construction sites. The system is composed of three layers and two processes, as illustrated in Figure 1.
The first layer, which is a webpage, is the user interface to accept user input and to output the query result to the user. This is also the only layer that resides on the user’s computing device. All the other two layers and both the processes will be executed on the server, which is expected to be a powerful computer located remotely in the designer or general contractor or owner’s central office. The middle layer is the building model expressed in XML format. The query process is the process located between those two layers. The query would use the query language XQuery based on XML, i.e. the semi-structured database model. The bottom layer is the building model stored in IFC format. Most of the commercial BIM authoring tools have the function to export the building model into the IFC format. The transfer process between the IFC model and ifcXML utilizes an internal IFC engine and currently there are software tools available to finish this task (AEC3, 2009).

On the user interface, there are mainly two ways for user input on the webpage. The first one is by searching using a keyword, like “window”. The query process would be activated and all the building elements satisfy the search will be returned and displayed on the webpage. Then the user could pick the one they want or refine the keywords and do another search. The other more efficient way would be to acquire a unique ID for the intended building element by other means. This ID will be unique throughout the lifecycle of the building so this ID-acquisition is needed only once for every element. Then this ID could be used for input and the right element would be found precisely.

The query process is based on XQuery, which is a standard high-level querying language for a database containing XML data. It is the semi-structured equivalent to the Structured Query Language (SQL) in a relational database. The query allows minor information editing and update, even adding the user-defined data field under the condition that the data schema remains untouched. If the user does need to alter the data schema, they should look for a BIM authoring tool or contact the designer. This limitation does not only ensure system responsiveness, but also takes into consideration of data security. The reason is that generally an update of the schema means an update of the model itself, which means a change to the design. This will usually trigger a change-order process and should not be able to be easily executed by someone on a job site.

References