Development and Application of Revit 3D Display Technology (Postprint)

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Abstract

Building model visualization constitutes a crucial pathway for information exchange and sharing among various disciplines within digital modeling technology, wherein intuitive, efficient, and accurate model display serves as a robust guarantee for smooth project progression. Currently, Revit implements region-based 3D model display through its "section box"function; however, this functionality is constrained by model size and hardware configuration. Furthermore, in practical application, issues persist including repeated rotation of model views, constant adjustment of section box boundaries, redundant operations, and low work efficiency. Based on this foundation, this paper analyzes the key application points of Revit model visualization technology, proposes a novel region-based 3D model display function, and realizes the development of this function through integration with Revit API development technology. Finally, the key development process is introduced, and the application effect is demonstrated using a prefabricated steel structure as an application example, thereby providing a reference for promoting the development of other technologies in BIM software:

Full Text

Preamble

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Development and Application of Revit Three-Dimensional Display Technology

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Abstract: Visualization of building models is a critical pathway for digital modeling technology to enable information exchange and sharing among different disciplines. Intuitive, efficient, and accurate model display serves as a powerful guarantee for successful project delivery. Currently, Revit implements region-based 3D model display through the "section box"function. However, this function is constrained by model size and hardware configuration, and its practical application suffers from repetitive model view rotation, continuous section box boundary adjustment, redundant operations, and low efficiency. Based on this foundation, this paper analyzes the key application points of Revit model visualization technology, proposes a novel region-based 3D model display function, and achieves its development through Revit API technology. Finally, the paper introduces the key development processes and demonstrates the application effects using a prefabricated steel structure project as an example, providing a reference for advancing other BIM software technologies.

Keywords: BIM; Visualization; Section Box; Region Display

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The BIM concept originated from Chuck Eastman at Carnegie Mellon University, representing the integration of computer digital information technology and graphics technology. BIM is essentially a database encompassing the entire lifecycle of construction projects. During different project phases, model information can be transmitted bidirectionally along the project chain, with dynamic association, real-time sharing, and transformation, ensuring information uniqueness throughout the project and enabling collaborative cooperation among cost consultants, designers, and construction participants while avoiding "information silos." Additionally, through 3D graphics technology, BIM visualizes model information, achieving the transition from traditional 2D construction drawings to 3D spatial models and enabling intuitive demonstration of various components, which significantly improves clash detection efficiency.

BIM technology serves as a powerful tool for collaborative building design. Since each discipline' s technical software has its own data storage format, naming conventions, and mapping relationships, achieving accurate and efficient information exchange among different specialties has become a key challenge in BIM application.

Currently, Revit plugin development primarily focuses on enabling information exchange and sharing among different disciplines. However, efficiently and accurately displaying the model information required by project personnel, enriching view display functions, and truly achieving "what you see is what you want" are equally critical for the comprehensive application of BIM technology. Regarding visualization technology research, most domestic and international scholars have only addressed implementation methods for standardized layers and 3D model view management, without achieving secondary development, resulting in limited innovation and practicality. Although some software development companies have created relevant view display functions, their proprietary nature means they do not disclose key backend development steps, providing insufficient theoretical background and leaving many researchers without clear direction for in-depth study, thus limiting the academic research significance.

BIM visualization technology holds important application value for investors, designers, and construction parties. In Revit, it can not only display the spatial layout of various equipment and components in real-time to provide design basis for preliminary modeling, but also comprehensively showcase complex node details and the position and dimensional information of adjacent components, greatly improving the efficiency of subsequent clash detection. Revit models also incorporate process equipment attributes, building material properties, model environment, lighting rendering, and other information, enhancing model realism.

Given the above context, this paper analyzes Revit model visualization applications and achieves secondary development of 3D display technology through Revit API, with detailed explanation of key development techniques.

Generally, determining the section box position requires repeated model rotation. For large models, this undoubtedly entails waiting time. Moreover, for areas with complex model assemblies, it is difficult to stretch the section box to the appropriate position. Modelers often need to use visibility functions to hide unnecessary types, making the operation overly cumbersome.

1. Analysis of 3D Display Technology Application

In Revit, various element objects are classified by category, family, and type, as shown in [Figure 1: see original paper]. Different categories represent broad classifications based on object functional attributes: for example, walls, beams, slabs, columns, doors, and cabinets are model categories, while reference lines, reference points, and sections belong to annotation categories. Each category is further divided into different families based on material, geometric configuration, parameter definition, construction process, and other aspects. Further instantiation of families, such as different sizes, creates different types. Therefore, Revit' s basic 3D view display commands like "Visibility/Graphics" and "Filters" are all based on this classification principle.

However, taking kitchen furniture models from Revit' s built-in architectural template first-floor kitchen as an example (position information and component type information shown in [Figure 2: see original paper] and [Figure 3: see original paper]), it is evident that a single model component may contain different category information. Consequently, Revit introduces the "Section Box" command to enable region display by continuously adjusting the section box boundaries to define the display space.

[**Figure 3: see original paper**] shows the model' s element type information.

Revit Element Classification

How can the section box boundaries be quickly determined? Can the section box position and dimensions be directly defined based on objects in the current view to achieve the function illustrated in [Figure 4: see original paper]?

When any single object is selected, all types within that object' s region are displayed, as shown in [FIGURE:4(a)]. Since areas and are not selected, the section box directly cuts portions outside the region. When multiple objects are selected, as shown in [FIGURE:4(b)], because is selected and the section box is a parallel hexahedron, the display region expands along the Y-direction to include part of the faucet height, and area is also displayed.

[**Figure 4: see original paper**] Comparison of 3D solid display effects

Based on the above requirements, this paper utilizes the Revit secondary development platform to conduct secondary development of 3D region display technology and achieve the described functional effects.

3. Key Development Points

3.1 Development Tools

Revit provides a comprehensive secondary development platform. Users can develop applications through Revit's Application Programming Interface (API) by referencing the Revit SDK manual and programming with any .NET-compatible language such as Visual Basic.NET, C#, or C++/CLI. This development is based on Revit 2016 version, using VS2012 development environment and C# programming language.

3.2 Development Process

Each view has a crop box that determines which portion of the model is displayed in the view. BoundingBoxXYZ defines a 3D axis-aligned rectangular box, with its spatial position determined by two property parameters: Max (the upper-right-front corner) and Min (the lower-left-back corner). For 3D views, there is another concept—the SectionBox. The SectionBox property accepts a BoundingBoxXYZ instance to define the visible portion of the 3D model. Although view boundaries can be defined through the view' s CropBox property, the SectionBox determines model visibility—portions outside the SectionBox cannot be displayed even if within the CropBox. Based on this theoretical foundation, the key development process is established as follows:

1. Create a new crop box BoundingBoxXYZ box;
2. Select objects in the current 3D view interface and generate a collection List elementIds. box2 determines its position parameters Max() and Min() by storing the location information of elementIds;

3. Pass the spatial position parameters of box2 to box;
4. Update the crop box box' s spatial position parameters to the current 3D view to achieve 3D display of the selected region.

3.3 Programming Points

Since this technology' s prerequisite is operation in 3D views, the program must first determine whether doc.ActiveView is View3D, displaying a warning box if the condition is not met. The elementIds collection is obtained directly through mouse clicks by the user, so an IList collection must first be defined to store the picked objects.

This technology employs extension storage technology and requires reference to the Schema class. In object-oriented languages, a Schema is like a class, while an Entity is its object instance. This technology can store any data on any Entity in Revit and set access permissions. This paper first creates a Schema, and box2 is an Entity type created based on this schema. After box2' s Max() and Min() parameter values are determined, they are associated with the corresponding parameters of the crop box box defined in the previous step, achieving spatial position transfer and completing the 3D view display of local objects. This process is primarily implemented through the function view.SetEntity(box2).

4. Engineering Application

4.1 Project Background

This project is a dormitory building located in Chizhou City, Anhui Province. The building has a footprint of approximately 500 m^2, total floor area of about 3,000 m^2, six stories, and a height of 18 m. The structure is steel construction using prefabricated construction technology, as shown in [Figure 5: see original paper]. The Revit model creation and fabrication drawing design strictly followed Revit modeling and processing drawing requirements, as well as relevant requirements from the September 28, 2015 project prefabricated BIM model coordination meeting minutes.

[**Figure 5: see original paper**] Project model diagram

4.2 Application Effects

4.2.1 Rapid Regional Model Display During modeling, modelers typically use a "3D view + plan view" interface environment—modeling in plan view while observing model effects in real-time in 3D view. Overly large overall models affect view navigation, so 3D views are usually regional model views. Additionally, steel structure BIM models are created strictly according to construction drawings, but some nodes are modeled based on detailed node drawings. Therefore, fabrication drawings must combine detailed BIM model drawings with structural construction drawings to ensure successful prefabricated module installation. Consequently, this project requires extensive use of regional model views.

Taking the elevator area model view as an example, due to the large information volume of the overall model, using the "Section Box" command causes lag during model rotation and section box stretching, significantly reducing efficiency. Using the technology developed in this paper, as shown in [Figure 6: see original paper], four objects are selected in the current view interface (marked in the figure) as section box boundary conditions, generating the corresponding model view without rotating the view. This single-operation approach saves modelers substantial time.

[**Figure 6: see original paper**] Elevator area model display

4.2.2 Quick Inspection of Component Positions and Dimensions Although modelers create models strictly according to design drawings, limitations of 2D drawings inevitably lead to unreasonable component positioning and sizing in 3D models. To improve model quality before proceeding to the next workflow, modelers first check complex areas for collisions, intersections, and unreasonable positioning. In this project, mechanical and electrical pipelines are complex, making it difficult to verify pipeline positions and dimensions. Using the technology developed in this paper, as shown in [FIGURE:7(a)], four boundaries of the section box are determined in the model's "top view" to obtain the corresponding regional pipeline view. Meanwhile, due to reduced model information in the view, any critical area can be quickly inspected through mouse zoom, pan, and drag operations without lag or unsmooth performance, as shown in [FIGURE:7(b)].

[**Figure 7: see original paper**] Display of position and dimensions of complex pipelines

Visualization technology is a language that transforms abstraction into concrete reality, accurately and smoothly communicating engineering information among different disciplines. Region-based 3D display technology plays a particularly important role in model design and project communication. The "Section Box" function requires repeated rotation and stretching operations to determine position and dimensions, resulting in low efficiency. This paper develops a method that uses selected entity objects as boundary conditions to directly determine section box position and dimensions, achieving the goal in one step and greatly improving work efficiency, thereby shortening project cycles and reducing costs.

In terms of BIM software development, development companies possess substantial capabilities. However, due to current market environment and profit-driven nature, their development technologies are highly confidential, which is not conducive to BIM technology development. Scientific and technological progress requires joint efforts from all sectors of society. Properly articulating more technologies for scholars and technicians to study and research will have profound impacts on promoting BIM technology development and application.

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Development and Application of Three-Dimensional Display Technology of Revit

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Abstract: Visualization of building models is an important way for digital modeling technologies to realize information exchanges and sharing among different specialties, while direct, efficient and accurate model display is a powerful guarantee for the successful completion of the projects. At present, Revit realizes the 3D region model by the function of "section box" . But this function is affected by the size of the model and the limit of the configuration. In practical application process, we need to rotate the model view and stretch the boundaries of the section box repeatedly, which is inefficient. Based on those, the key points of the application of Revit model visualization technology are analysed. Based on the development of RevitAPI technology, a new way of displaying 3D view which is based on the spatial location is proposed. Then the key technologies are introduced and some application examples of an assembly type steel structure are demonstrated. This method provides a reference for the development of other technologies about BIM software.

Key Words: BIM; Visualization; Section Box; Region Display

Note: Figure translations are in progress. See original paper for figures.