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Research on the Construction of Substation Equipment Model Library Based on BIM Three-Dimensional Modeling

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Abstract. Substation equipment has a large amount of heterogeneous information during its life cycle. However, when Autodesk Revit is used as the modeling software to build a BIM model of traction substation equipment, due to the limited type of model attribute parameters and parameter grouping methods, the model cannot meet the requirements. Requirements for information integration in the entire life cycle of equipment. Based on this, the thesis uses the MVC model of three-dimensional modeling platform and the technical support of synchronous calculation to propose a BIM-based substation equipment graphics calculation system. Taking the common cable trench, cover plate and foundation earthwork calculation in substation station engineering as an example, the realization method of main technology is explained.

Keywords: Substation equipment, three-dimensional modeling, equipment model.

1. Introduction

BIM is short for Building Information Modeling. BIM technology has the characteristics of visualization, coordination, simulation, optimization, and graphing. It also has powerful computing capabilities and collaboration capabilities, and is capable of virtual construction and information integration. The core of BIM technology lies in information. The information model established in the early stage can not only be applied to the design and construction phases, but also has a huge help in the phases of property, operation, maintenance, and demolition. Building information models are suitable for the entire life cycle of the project. The establishment of the building information model provides a platform for information exchange and sharing for all project participants. This platform gathers all the information needed for the construction project, and all parties can obtain useful information according to their own needs [1]. At the same time, the use of BIM technology can eliminate various hidden dangers that may lead to construction delays and cost waste, improve the level of refined management of the project's life cycle, and greatly improve project benefits.

High-speed electrified railways in my country mostly adopt AT power supply mode. The AT power supply mode has a large distance between traction substations and a small number of traction substations. The power supply range of traction substations is large. The range of influence caused by power outages in the whole station also increases, which increases the impact on traction substations. The requirements for stable and reliable operation of equipment, and with the continuous increase in the density of high-speed trains, this requirement has also been further improved, which puts forward higher requirements for the business capabilities of the operation and maintenance unit of the traction substation. Obtain the required equipment information quickly, timely and accurately, and fully grasp the current situation of the traction substation is a prerequisite for the operation and maintenance personnel of the traction substation to make correct decisions, accurate maintenance and rapid repair. However, the current equipment information is mainly composed of two-dimensional drawings and documents. Documents and SCADA system data are provided, and a small amount of information is provided by other information systems. This kind of information storage and management method has the following problems: (1) The information at each stage of the construction period is missing in the delivery process, causing information faults and causing operation and maintenance units the obtained construction period information is incomplete. (2) The information among the various information systems, drawings and documents form a self-contained system and cross each other to form an "information island". A large amount of redundant information appears, and it is difficult to coordinate and modify the information, resulting in inconsistent and inconsistent information. The communication of information is not timely and smooth. (3) Due to the difficulty of information modification, the information is not updated in time, which causes inconsistency between the drawings and the reality. This paper takes traction transformer as an example, analyses the non-geometric information of traction transformer, proposes a classification and integration method for non-geometric information, and develops plug-in based on Revitalize to realize the integration method.

2. Establish a BIM-based 3D calculation model

The use of 2D CAD design drawings to convert and output 3D BIM model modeling technology, combined with the characteristics of the multi-body model professional project division of the engineering station area, form a power grid engineering substation simulation Revitalize BIM model with the professional division as the system architecture, and use BIM as the carrier Adopt the innovative technology of true three-dimensional solution graph calculation, accurately calculate and standardize the output of basic data of power grid engineering infrastructure technology and economics, and form a BIM-based power grid engineering infrastructure technology and economic work management platform to facilitate communication, exchange, and communication between technical and economic personnel in various links [2]. Collaboration to improve the efficiency and quality of engineering infrastructure technical and economic work.

2.1. Geometry information acquisition

Geometric information is the basis for establishing a three-dimensional geometric model. High-quality and accurate geometric information is a prerequisite to ensure the accuracy of the information model description and avoid discrepancies with actual conditions. In the traditional mode, the expression of geometric information is mainly based on two-dimensional drawings and related documentation. With the development of surveying and mapping technology, graphic image processing technology and pattern recognition technology, more diverse sources of information are provided for geometric information. The establishment of a three-dimensional geometric model of the traction substation equipment requires the three-dimensional geometric information and texture information of the traction substation equipment and the premises used. This section will analyse and compare the methods of obtaining these information [3]. In the realization process of the visualization module, this paper chooses the static LOD realization method to realize the LOD technology, establishes three-dimensional models of different complexity in advance, and selects the appropriate precision model to call according to the position relationship between the model and the viewpoint. Figure 1 shows the three-dimensional model of the geometric information of the substation traction equipment.

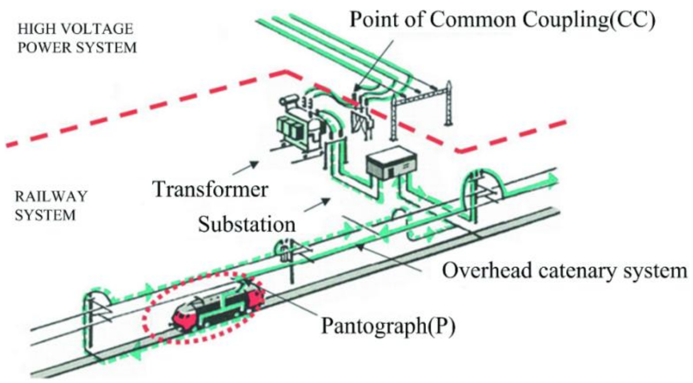

Figure 1. Three-dimensional model of geometric information of substation traction equipment.

2.2. Three-dimensional modeling

This paper considers the convenience of adding non-geometric information and the difficulty of secondary development of the three major BIM modeling platforms, combined with the characteristics of centralized traction substation equipment, similar to the modeling method of the construction industry, and select Autodesk Revit as Establish a modeling platform for the entire BIM model. In addition, this article selects ads MAX as the model rendering platform, and Unity3D as the realization platform of the visualization module. The software selection and usage are shown in Table 1.

Table 1. Software usage.

name of software	use
AutoCAD	2D drawing view
Autodesk Revit	Establishment of BIM model of the whole institute
ads MAX	Model rendering
Unity3D	Visualization module implementation

2.3. Realization of 3D modeling

In a word, 3D modeling and model rendering are planned to be realized by the following method, namely, the building model and equipment family library are constructed using the Revit modeling platform, and the information is used to realize that the BIM of the whole institute places the equipment family of the corresponding equipment in the building model according to the as-built drawing, and hang The establishment of non-geometric models. The data is simplified, texture and rendering are saved and imported as shown. Import the BIM model of the entire traction substation into 3DS MAX to model Unity3D to realize the system visualization module [4]. The specific process is shown in Figure 2.

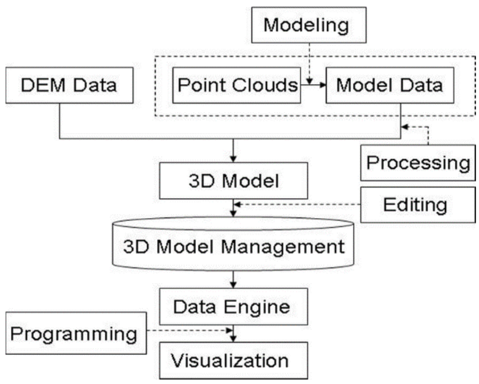

Figure 2. Flow chart of 3D modeling and visualization.

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Developed a three-dimensional Box index algorithm with retrieval complexity of Sqrt(n), which has high calculation accuracy. At the same time, it provides detailed calculation formulas for components and realizes manual calculation assisted comparison. At the same time, it is directly compared with the three-dimensional deducted model calculation graph to achieve the calculation process Consistent with traditional computing services, it can well assist business personnel in the transition from traditional mode to computerized mode, improve the speed and accuracy of model intersection detection, and solve the problem of deducting the amount of calculation for curved surfaces.

3. Classification and integration method of non-geometric information of traction transformer

For the traction transformer BIM model, the more non-geometric information content, the finer the description of the traction transformer. However, it is not difficult to see from the above analysis that the amount of traction transformer engineering data is huge. If all the engineering documents are entered into the attribute parameters, in addition to the above-mentioned problems such as the limited grouping of the Revit attribute parameters, they will also face the input data Excessive volume, too high performance requirements for the hardware equipment processing the model, still unable to manage multimedia data such as video, and more difficult management of the model's non-geometric information [5]. Therefore, it is necessary to propose a new ensemble method based on the classification and classification of model non-geometric information.

3.1. Classification

The non-geometric information of traction transformers can be divided into basic information and detailed information according to the level of detail. The basic information of the basic information recording equipment is mainly expressed in words and data, such as equipment code, design unit, installation date, intermediate repair plan date, etc. The detailed information records the document files and multimedia materials of the traction transformer, such as construction drawings, inspection batch quality acceptance records, etc. This paper divides the non-geometric information of the traction transformer into basic information and detailed information, and then classifies it according to the time dimension and each stage, and separates the common basic information common to each stage, the specific classification method and the main the content is shown in Figure 3.

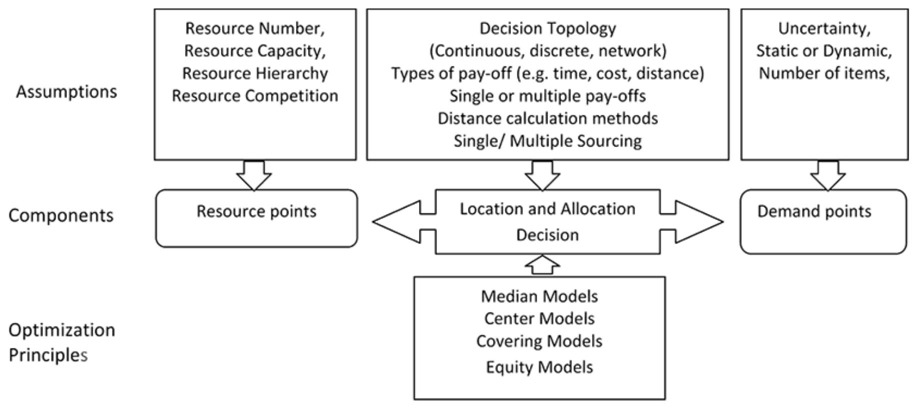

Figure 3. Classification and main content of non-geometric information.

3.2. Integration method

For the integration of basic information, it can still be stored in the attribute parameters of the traction transformer BIM model in the form of attribute parameters to understand the overall situation of the equipment. In the process of adding attribute parameters, you can directly add the parameters of the corresponding value type to the attribute according to the information value type. Since different types of traction transformers are stored in different family documents and the parameter lists and grouping methods have great commonality, in order to ensure that the attribute parameter lists are common among the traction transformer family documents, this article uses shared parameters to store the basic information of the traction transformer [6]. For the integration of detailed information, this article adds several document type parameters to the model attributes, and saves the document address of the detailed information in this parameter to realize the combination of the document address and the BIM model of the traction transformer. The above information can be viewed through the plug-in, or you can directly find the document address from the model properties to access and view. This integration method ensures the control of the volume of the model file, saves memory space, and improves operating efficiency.

4. Application case analysis

4.1. Realization of 3D modeling and deduction algorithm

By analysing the business characteristics of substation equipment cable trenches, it is concluded that there are about 5 types of common cable trenches. The intersection of each cable trench is divided into L-shaped, ten-shaped, and T-shaped. The system can realize the construction of cable trenches by adding parameter maps. Model and combine the design requirements of construction drawings to simulate the shape of the construction site. The operating process of the software is: new components; drawing primitives; summary calculation. The completed model includes components and cover plates composed of cable trenches, as shown in Figure 4. The system can realize the intelligent layout algorithm of the cable trench cover. At the intersection of T-shaped, cross-shaped, and corners, the size of the special-shaped cover can be automatically calculated, the insertion point and rotation angle of each cover can be determined, and the intersection can be accurately arranged. When multiple cable trenches are selected to be arranged according to the centre line, the size of the cover plate can be automatically cut according to the length of the line, and then accurately arranged on the cable trench one by one.

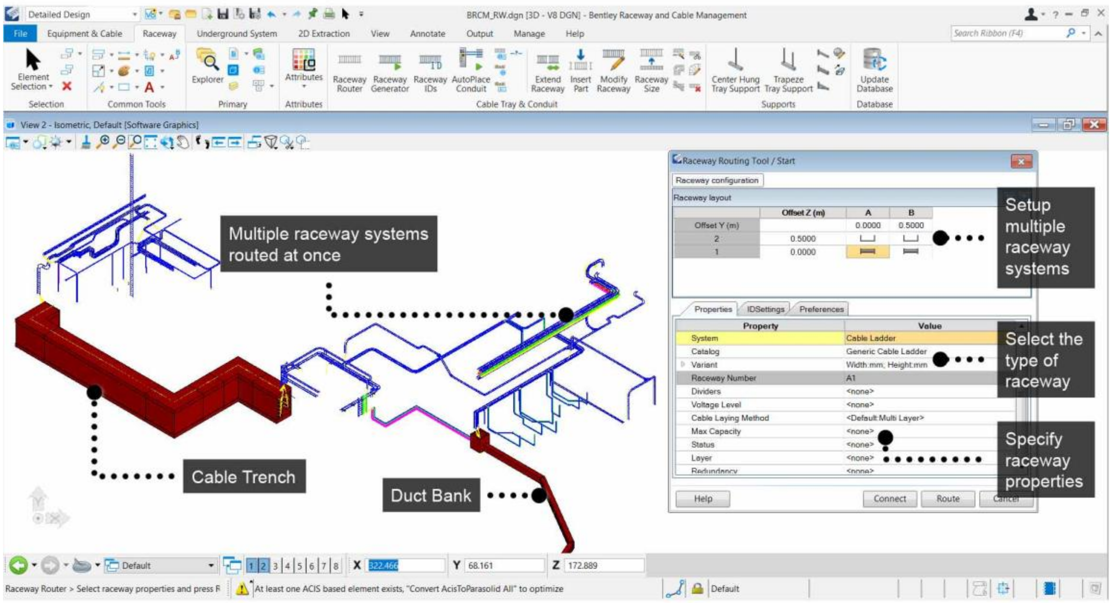

Figure 4. Calculation model of cable trench and cover in station area.

4.2. Realization of One Picture, More Calculation

There are different calculation rules for the calculation of earthwork quantities of power grid projects in the power budget, budget, and list pricing, and the rules are relatively different. Taking the

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calculation of the foundation earthwork of the main transformer as an example, the first-level inventory calculation rule calculates the excavation volume without considering the excavation work volume under the condition of grading, and the second-level inventory calculation rule considers the grading and the earthwork of the working face when calculating the excavation volume. According to different calculation rules, it is difficult for other cost software to realize multiple calculations in one picture. The system solves such problems. It satisfies the different calculation requirements of the primary and secondary lists of power grid projects by means of one map and multiple calculations, and can output different calculation data through fast switching rules, which greatly improves the technology and economics of the power grid. Staff productivity. The operating process of the software is: new equipment basic components; drawing equipment basic primitives; automatically generating earthwork; summary calculation.

5. Conclusion

In view of the problem of calculating the amount of substation equipment in the BIM mode, continuous research is needed, such as the realization of the joint calculation of the amount and price of the substation project, how to realize the automatic calculation of the 2D drawing to the three-dimensional calculation model, and how to expand to the transmission and transformation project Even issues such as comprehensive cost management of power grid projects and how to carry out digital project management based on 3D models still require follow-up development and research.

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