Research on the Application of BIM Model Based on CIM Platform on the Background of Smart City

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Keywords: Smart city, BIM model, CIM platform, modeling standards, lightweight applications.

Abstract: Based on the background of the rapid development of new smart city construction, analyze the domestic CIM platform application and set up the standards for BIM model ,summarize the problems of BIM model application in CIM platform, propose the establishment of project-level BIM modeling standards, optimize the model surface triangle number, and unify the output format of BIM model and develop the ideas for a web-based BIM model output plug-in. Use cloud servers to achieve massive BIM model data synchronization, information sharing, and achieve the purpose of information management and application of CIM platform terminals. In the 5G era, give full play to the characteristics of BIM model + Internet, and lay the foundation for information management of smart cities.

1. Introduction

From the 1980s to the present, most countries in the world have experienced three development processes in the development of informatization: information ports, digital cities, and smart cities. At present, smart cities have been adopted worldwide as the final goal of urban informatization construction. In 2008, the International Business Machines Corporation (IBM) proposed the concept of a smart city, which was defined in the smart city white paper: "It can fully utilize information and communication technology to sense, analyze, and integrate key information about the core system of urban operations. So as to respond intelligently to various needs including people's livelihood, environmental protection, public safety, urban services, industrial and commercial activities, and create a better city life for human beings. "[4] At present, many scholars at home and abroad Cities have given relevant definitions of concepts, and there is no completely unified statement. Wang Yukai, a member of the China National Informatization Expert Advisory Committee and a professor of the National School of Administration, believes that smart cities are widely used in the process of urban construction and development, such as the Internet, wireless Internet, the Internet of Things, cloud computing, and big data. This kind of system can improve the government's public service and social management level, meet the intelligent needs of the city, and provide services to the citizens.

At present, more than 100 cities in more than 500 cities in China have begun pilot smart city construction, and information technology has been continuously enriched. The CIM (City

Information Modeling) platform for urban information management through planning, construction, operation and maintenance of various professional fields The information at different levels is effectively organized to achieve a full range of intelligent early warning prediction and information management of the city. In the CIM platform, the entire urban area has been under construction, under construction, and the proposed buildings are virtualized through BIM models.

2. The Application of the Overall Professional System in the City is Monitored in Real Time to Realize the Integrated Application of Regulations and Supervision.

In the process of building a smart city, the CIM platform comprehensively uses GIS+BIM+IOT+AI technology to create a base map of a digital city. Informatization of urban construction and management. As a digital platform that can store, extract, update, and modify all city-related information, CIM needs to complete multiple functions such as data collection, data storage, collaboration platform, and information transfer. [1] Taking the smart fire project in Nanshan District, Shenzhen as an example, firstly using UAV multi-angle flight tilt photography to geometrically reconstruct the city model, obtain the terrain surface model and point cloud data, complete the data collection, and form the urban area coordinate positioning. GIS forms a data storage platform, and forms a certain range of spatial features above and below the terrain surface. Subsequent point cloud real-life modeling and BIM modeling are used to create a macro overall outdoor model to create model data for the digital city floor.

Figure 1: Oblique photography+GIS to build a 3D model of the city.

Now the types of CIM platforms supported by each pilot smart city have not been unified. The CIM platforms of most projects are still in the independent research and development stage. Based on the practical experience of the two pilot projects in Beijing and Shenzhen, the two CIM platforms used in the project are compared shown in Figure 1.

In the construction of smart cities, GB-level or even TB-level massive project 3D data is taken for granted. Both Skyline and CityMaker can meet the 3D data organization and management of large-scale projects. At present, the use of these two platforms for successful smart city construction has different project cases. The city's smart parks, smart buildings, etc. also involve different professional fields such as the city's three-dimensional platforms, emergency systems, disaster relief services, and transportation railway environmental monitoring. In the past two years, there have been new CIM platforms launched in China, such as CityEye launched by Luban Software, which integrates BIM, GSD, IoT, cloud computing and big data collections, and establishes a digital baseboard for urban visualization and big data management. For example, the intelligent construction site platform launched by Guanglianda Software Co., Ltd. helps the project to realize digitalization, systematization and intelligence, and builds an intelligent "battlefield command center" for the project management team. At the same time, more and more cities have begun to

independently develop related CIM platforms during the project construction process. Relying on these different levels of CIM management and control platforms, they have realized the "intelligent + professional" operating mode, which is a big data for smart cities. The application provides support.

Table 1: Basic information of common CIM platforms.

Information Type	Basic Feature	Product series
Skyline	The data production, 3D visualization, and network publishing functions are easily and orderly implemented. It has a 3D geographic information cloud service platform and a fully automatic 3D modeling function for oblique photography. It uses the 3D desktop and web-based applications to quickly share information.	Terrabuilder Terraexplore Skylineglobe Server、 Photomesh
Citymaker	Covering the entire process of 3D data production, management, and application development, 3D GIS platform software with 3D GIS as its core technology can manage multiple types of large-scale geographic feature data, and perform accurate spatial analysis and calculation capabilities, using 3D rendering Engine technology, realizing 2D and 3D integration of visualization and analysis functions.	Citymaker Builder、 Citymaker Server、 Citymaker Explore、 Citymaker SDK Citymaker Automesh、 Citymaker Connect

3. Overview of BIM Modeling Standards in China

China has made reference to international standards such as ISO, buildingSMART and other developed countries such as the United States and the United Kingdom when formulating domestic BIM standards. The Ministry of Housing and Urban-Rural Development of the People's Republic of China has issued 5 national BIM standards since 2017, including the "Building Information Model Classification and Coding Standard", "Building Information Model Design Delivery Standard", "Building Information Model Construction Application Standard" and "Building Information Model Construction Application Standard" The Engineering Design Information Model Drafting Standards have all been compiled and officially issued. The fifth "Building Information Model Storage Standards" has been collected on April 26, 2019 and the opinions will be finalized and issued. The unified formulation of national BIM standards has laid an important foundation for the establishment and development of the industry's BIM technology system. It has established the consistency of the building information model in the data classification, process turnover, and information summary processes, and has realized data communication and resource sharing, which laid the foundation for the effective extraction of BIM models in the CIM platform.

In actual projects, in order to further improve the fluency of the BIM model on the CIM platform, the BIM model meets national standards. The construction resources and construction attributes of each element and component of the BIM model running on the same platform will be based on

project characteristics and model The basic requirements of accuracy, while reflecting the optimization of the rendering effect, guarantee the consistency of data information and geometric information.

4. Application of BIM Model Based on CIM Platform

4.1.Distorted Details of Construction Model Facade

The visual 3D city generated by the 3D GIS platform, the main appearance model mainly comes from the combination of oblique photography and MAX technology, the point cloud modeling realizes the 3D city modeling, and then the model optimization is performed. Running the city model on the CityMaker platform, the model generated by oblique photography as a whole looks clear and the details are relatively rich, but after the zoom lens is adjusted to the vicinity of the building, many details are missing, and the model problem exposes local gaps and holes. Problems such as distortion of the lines.

4.2.BIM Model Data Loss

In order to meet the compatibility of the CIM platform information and the accuracy of the visual viewing effect, the attribute information of all structural components during the creation of the building information model not only includes basic geometric information, physical material types such as building material types, thermal energy data, strength analysis data, but also Covers the project information of the subject, such as the configuration of manpower and machine during the construction process, and engineering cost data. Massive data forms a BIM model of a single building. Massive BIM models constitute a huge information resource for the CIM platform. In the practice of the project, it was found that whether it is based on the international universal IFC format or the BIM file loading format that is independently applicable by each CIM platform, there will be a certain degree of data loss in the BIM model after the loading is completed. Loss of attribute data associated with components is the most common phenomenon. For example, materials such as aluminum, steel, and iron given by metal components will be lost. In the BIM model, indoor and outdoor maps to ensure the accuracy of visualization will be widely lost. Components will be lost, resulting in the loss of BIM model data, and it will take a lot of time to check and repair the model later.

4.3.Massive BIM Model Does Not Run Smoothly

As a part of CIM, the BIM model needs to place a BIM-based building model on a GIS-based geographic information system model. When creating a building model in Revit software, use the measurement coordinate points to map the building model coordinate system to the GIS model coordinate system. Positioning to ensure that the BIM model can be imported into CityMaker can coincide with the actual coordinate points of the project, to achieve the spatial integration of the BIM model and the GIS scene on the CityMaker platform, and to ensure the real-world transition of internal and external space. The BIM model file of a single building ranges from several hundred M to several G. Massive BIM models are imported into CityMaker, which causes the platform to run slowly, the space conversion is not smooth, and the phenomenon of flashing and ghosting in the landscape is very serious.

5. Scheme Analysis of BIM Model Lightweight

The BIM model covers the entire life cycle of the project, from project design to construction process, cost control to later operation and maintenance. The information covers a large amount and involves a wide variety of project personnel. Any reading and modification of the BIM model will be fed back to the model at the same time. All participants must optimize the BIM model in order to ensure the immediate reading, timely modification, rights management, and information storage of the model on the CIM platform. During the optimization process, on the one hand, the accuracy of the geometric information of the building components of the BIM model must be considered, and the reduction and loss of the model volume must not occur. At the same time, the completeness of the information data must be taken into account, and the physical properties of the material of the building components will not appear. The loss of the BIM model makes it impossible to modify it arbitrarily in the process. It can only be studied from the basic rules before the model was established, the amount of stored data and read methods of the finished product at a later stage, and to achieve the "self-slimming" of the model, that is, to realize the The lightweight application of the CIM platform. The research method of lightweight research on the BIM model in this paper is mainly carried out from the following four aspects.

5.1. Establish Project-level BIM Model Modeling Standards

According to the BIM model standards that have been issued by the country, local BIM standards have been introduced one after another. Each city has introduced and explained the application of BIM technology in terms of local projects in terms of data preparation, operation processes and application results. Application capabilities. At present, some large domestic enterprises have also formulated enterprise-level BIM standards, and some large-scale projects such as Shanghai Disneyland and China Zun have formulated project-level BIM standards. [10] The BIM model is the main carrier of information management in smart cities. The BIM model standard based on the CIM platform has not yet been prepared. The characteristic BIM model standards based on various smart city pilot project areas and parks still attract attention.

"Building Information Model Design and Delivery Standards" divides the BIM model into model-level units at the project level, function machine, component level, and part level, which in turn correspond to model finenesses ranging from LOD 1.0 to LOD 4.0. [11] Combined with the project's specific use of CIM platform data conversion, storage and reading capabilities, the RGB values of the BIM model component-level model unit names, construction parameters, graphic thickness scale tones, and material visualization effects should be the same and the same Consistent components, such as walls and columns, improve the reading speed of the model by making the material properties of the same line of sight consistent, and increase the speed of the overall rendering of the CIM platform.

5.2. Optimize the Number of Triangular Faces on the Surface of Component Elements

The BIM model will generate a 3D model synchronously when the elevation model is created. The accuracy of the 3D scene model can be adjusted for the display accuracy setting in the corresponding 3D view state. The high-precision setting in the realistic state of the visualization effect corresponds to the loading time of the model. extend. The three-dimensional model scene display uses a certain refresh frequency to realize the real-time dynamic display process of the scene picture. The real-time graphics rendering technology is essentially a time-limited computing technology, which requires the algorithm to complete the rendering of the scene within a certain time. [2] For the component elements in the building model, if the accuracy of modeling is allowed,

the principle of geometric simplification of the 3D model is used. For curved components, approximate polygons can be used instead. By simplifying the model, the number of edges and The number of vertices can reduce the number of triangular faces formed when the model is generated, thereby reducing the calculation time of the three-dimensional model, and achieving the purpose of increasing the model display rate.
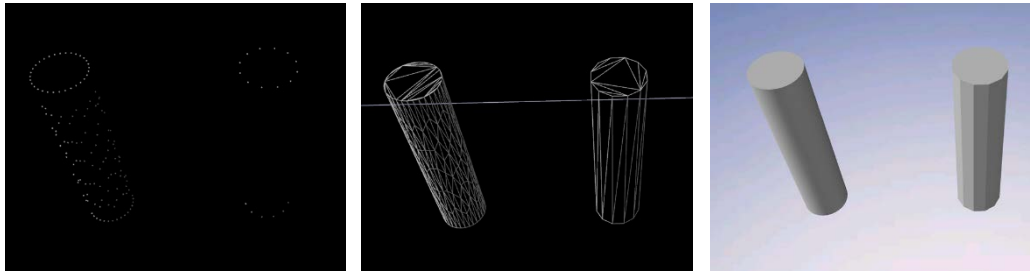

Figure 2: Simplified schematic diagram of a triangular surface on a cylindrical surface.

5.3.Adjust Model Output Format

The BIM model can deliver data files in different formats based on the purpose, object, and subsequent use of the design delivery. For example, when relying on the BIM model established by Autodesk software company for model delivery purposes, in order to ensure the integrity of data resources, it is generally possible to use its proprietary data formats such as RVT, RFT, etc .; In the design and delivery, it will provide NWD, DWF and IFC formats. Modeling software of different software companies all have their own proprietary data formats. Incompatible formats are difficult to achieve the core value of BIM sharing and exchange. The formulation of the international universal BIM model IFC standard provides a data foundation for the interaction of BIM models. After nearly 10 years of expansion and improvement, currently commonly used BIM modeling software such as Autodesk Revit, Bentley, and TEKLA have supported the import of IFC format And export, the completeness and openness of information transmission during the interactive use of BIM model are realized.
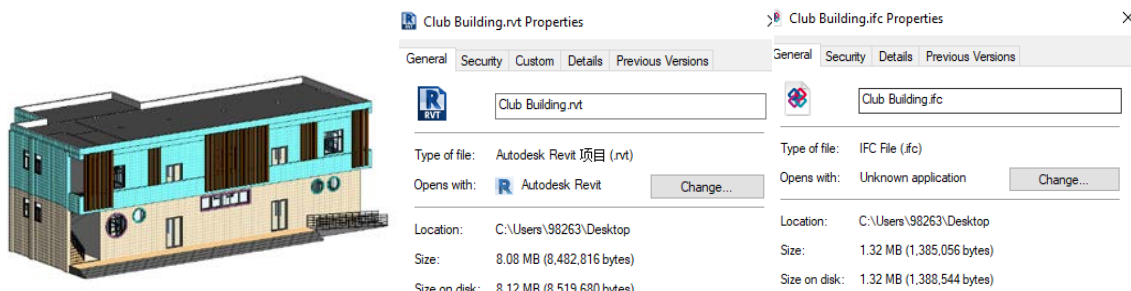

Figure 3: Optimized comparison of stored data in BIM model RVT format and IFC format.

As a universal format for BIM data interaction, the IFC format can not only ensure the perfection of information [8], but also greatly reduce the weight of the BIM model. Taking the BIM model created by Autodesk Revit as an example, according to the difference in the amount of sample data implanted in the initial establishment of the model, most of the models after building creation can achieve a large proportion of lightweight. As shown in the figure below, a two-story frame structure building with a building area of 500 square meters. The file used by Autodesk Revit to directly output the rvt interactive file is 8.08M, and the file converted to IFC format is only 1.49M, which optimizes the storage space by 81.6%. The BIM model can be output individually in IFC format, or

multiple BIM models can be integrated and output in IFC format. Massive BIM models use the lightweight transfer of IFC format, which provides great benefits for the smooth operation of BIM models on the CIM platform convenient.

5.4.Develop a Web-based Model Output Plug-in

At present, most BIM models are based on PC-side modeling software. Most models also need to be viewed in PC-side BIM software, which brings the disadvantages of the project staff other than the model creator who cannot view the model anytime, anywhere. At the same time, the system linkage performance of the BIM model. Any modification of the model during the viewing process will cause the model to be modified in the same place in different parts of the participating parties. Cause unnecessary trouble. [7] In the actual project operation and maintenance management process, non-model creators generally do not need much model modification. Under the premise of ensuring the integrity of the data information, how to separate the model from the complex modeling software and the heavy The synchronization of the PC end has become a major research direction of the current research on the lightweight of BIM models.

Based on the application research of displaying 3D models on the web page, the BIM model display platform can be installed not only on the PC, but also on mobile devices, such as tablet computers and mobile phones. Convenience. [5] Widespread use of cloud servers, more and more software companies have developed BIM cloud platforms to set up private cloud spaces for users. Model creators can store model information in the cloud and use the PC side during the project. Modification and storage of model information on the Web-based App program, real-time changes and rendering on the Web-based cloud server, synchronization to the viewer's terminal, and the BIM model is always the latest model in the database.
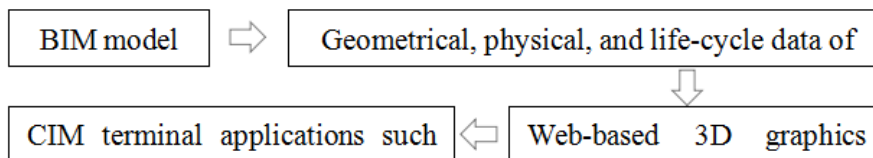

Figure 4: Structural system from BIM model to CIM application.

As the application of the web-based model output platform becomes more and more common, in the operation and maintenance process of the BIM model, the time information, cost information, change information, and inspection records of the building components are reported to the project site staff in real time. The cloud server is associated with the corresponding component information, making the BIM model truly from design to construction to operation and maintenance, becoming a true information model. Through the secondary development of the plug-in interface, the web terminal output port is connected to the CIM platform to ensure that the data from the BIM model layer to the data layer can directly interface with the platform layer, and achieve the information terminal management goal of the smart city application layer.

6. Conclusions

The BIM building model on the CIM platform has a huge capacity and a large amount of data in one. The precision of the BIM model establishment standard is closely related to the platform model display fluency and data association perfection. At present, various pilot smart cities in China are targeting BIM of buildings in the CIM platform. The problems appearing in the model are monitored in multiple dimensions, using cloud platform big data summary analysis, continuous modification of the BIM model, and unified standards for the creation of urban area models.

Through repeated testing and optimization on the CIM platform, it is feasible to gradually realize the smart management of the city while presenting the results. Sex. The application and promotion of 5G networks brings the era of Internet-based informationization from smart homes, smart homes, smart communities, smart construction sites to smart cities. The BIM engine developed twice allows the BIM model to achieve Internet +, ensuring the synergy and simulation of the CIM platform. And monitoring, all of which will provide strong technical support for the realization of the wisdom, interconnection and integration of new smart cities.

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