3D Model Reconstruction of CAD Virtual Reality Digital Building Based on BIM Model

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Abstract. Virtual reality 3D building model modeling technology depending on BIM model is well suited to today's area of urban planning and construction, and it is extensively utilized in topography mapping and construction project inspection. A technique of constructing virtual reality digital building 3D model based on BIM model is provided to tackle the problem that the accuracy of virtual reality digital building 3D model reconstruction is not high and difficult to operate in practical application. To begin, the BIM model is imported into the digital building 3D model and changed as needed. The 3D model of a CAD virtual reality digital building based on a BIM model is then compared to and optimized against the standard model. Finally, the X model is exported on the BIM model platform and imported into the skyline platform for 3D scene integration when the virtual reality 3D building model modeling is done. The CAD virtual reality digital building three-dimensional model based on BIM model has been proven to be more suited for the present building mode. The results reveal that the performance of the BIM-based model is better than that of the conventional model that the operation is easier, and that performance optimization is enhanced by 20%, making it worthy of widespread adoption and use.

Keywords: BIM model; CAD; Virtual reality; Digital architecture; Three-dimensional model
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1 INTRODUCTION

The combination of BIM model and virtual reality 3D building model modeling technology has been widely used in urban planning and building construction design. Based on BIM model, the advantages of virtual reality technology can be fully reflected, and the building space information can be obtained more efficiently, quickly and accurately, and presented intuitively and vividly, which provides an important reference for building model modeling. The virtual reality 3D building

model modeling technology based on BIM model is very suitable for the current field of urban planning and construction, and is widely used in topographic mapping and construction project survey.

Three-dimensional building model modeling has been widely used in the field of urban planning and construction, and the planning methods and management means have become more perfect. The acquisition of information gradually transits from two-dimensional image to three-dimensional model, and displays complex terrain space and buildings through more vivid three-dimensional model. Virtual reality technology plays a very important role. At present, when building model modeling is carried out through three-dimensional virtual technology, BIM model is applied to fully reflect the functional advantages of virtual technology in three-dimensional building model modeling, and it has been widely used in building virtual reality modeling. In the process of virtual reality 3D building model modeling based on BIM model, first determine the regional scope of modeling, and carry out regional division and hierarchical division of interior model, so as to prepare for the field work of 3D modeling. Secondly, the field texture viewfinder shooting is carried out, and the obtained target building image needs to be processed by Photoshop software to obtain the building texture image. While taking photos in the field, refer to the 1:1000 or 1:500 topographic map data to obtain the building closed polygon vector data, and form a relatively complete building model through BIM model modeling. Virtual reality technology is quite useful. When three-dimensional virtual technology is used to model buildings, the BIM model is used to completely express the practical benefits of virtual technology in three-dimensional building model modeling, and it is extensively utilized in building virtual reality modeling. Building information model (BIM) is a three-dimensional digital building model. The present building mode is better suited to the CAD virtual reality digital building three-dimensional model based on BIM model. The national government and firms are promoting and implementing BIM Technology as the future path of China's building industry innovation. At this time, the architectural texture image is mapped on the model surface to complete the three-dimensional modeling. As shown in Figure 1:

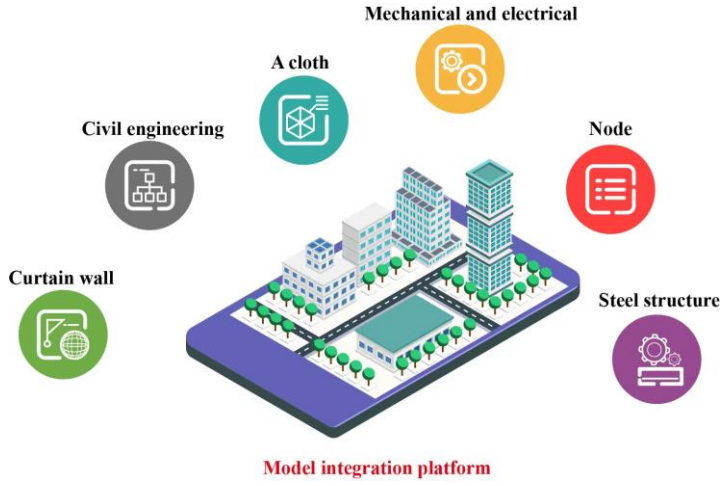

Figure 1: BIM model modeling.

So as to solve the problem that the accuracy of virtual reality digital building 3D model reconstruction is not high and difficult to operate in practical application, a method of building virtual reality digital building 3D model based on BIM model is proposed. It is proved that the CAD virtual reality digital building three-dimensional model based on BIM model is more suitable for the current building mode.

The paper is organized into 6 sections, initially, Section 1 provides the global overview of the proposed work; Section 2 covers the research work done in the field; Section 3 presents the basic concepts of BIM model, Section 4 presents Experimental method, Section 5 present the discusses of the results of experimental analysis of the current study. The major conclusions drawn from the study are discussed in the Section 6.

2 PAGE SETUP

In today's era, the progress of science and technology has expanded people's vision. The mutual penetration and integration among marginal disciplines, cross-sectional disciplines and comprehensive disciplines makes the field of human knowledge show a development trend from analysis to synthesis. Architecture is no longer a simple use space with a certain function, and architectural creation is not only the engineering design of providing the final product, but also a complex comprehensive connection integrating daily use, virtual display, digital experience and diversified communication, involving computer technology, digital art, contemporary philosophy and even social ethics. While retaining its self-sufficiency, uni-directionality and selectivity, architecture also obtains the development opportunity of mixing, diversity and openness. Human resource in based on demographic varied firms should place a high priority on diversity openness. Organizational major reform initiatives, personal and team cultural sensitivity, and rewarding group-oriented behavior are all possible solutions. Culture mixing is the simultaneous presence of representative symbols from many civilizations in the same location. Based on the concept of complexity philosophy, profound changes have taken place in the field of contemporary architectural design and construction.

Intelligent buildings are structures that use complicated automated technologies to improve operating effectiveness and user comfort. Historically, the phrase was used to describe structures intended for long-term sustainability rather than smart technology. Intelligent buildings are ones that make it simple and natural for people to take use of the newest technology developments. Availability for the impaired, for example, with automated door opening, fall detection, voice control, and other features. Li, R. studied the integration model construction of intelligent building system, and formed the horizontal integration of the linkage and optimal combination among the three subsystems, so as to build the conceptual model of intelligent building [1]. As technology advances, our physical environments become increasingly complex. Each room may have several linked smart devices, many of which are incorporated directly into the structure itself [2, 3]. Unfortunately, complexity is not always a good thing: inefficient processes waste 30% of the energy utilized in the average commercial building [4, 5].

Engineers use intelligent building designs to make the most of physical space in novel and environmentally friendly ways. Intelligent buildings are constructions that utilize complex automated technology to increase operational efficiency and occupant comfort [6, 7]. Song, J. and others developed an intelligent building system integration platform based on Web services by using the framework structure of Web [8]. Kholol, M. and others designed a system integration model based on 3D display, and finally realized the complete 3D simulation scene platform of the building and the complete simulation of building equipment [9]. 3D simulation is a computer graphics technology that lets artists to incorporate realistic effects like as destruction, fire, liquids, fog, and particles to their scenes. Furthermore, aspects such as Internet of Things (IoT) devices, internet connectivity, and energy efficiency are shared by both intelligent and smart buildings [10, 11]. One notable difference is automation: although smart buildings give interfaces for regulating facility operations, intelligent buildings do it automatically. Sensors in sophisticated networks recognize and forecast tenant placements, allowing the building environment to be modified accordingly [12, 13]. Zhang, Y. realized the system integration by studying the web service-oriented integration function of the integration system and the topological organization structure of system integration [14].

Building Information Modeling is extremely beneficial to architects. The way architects approach building design has drastically altered as a result of this enhanced modelling software. Building Information Modeling (BIM) is a method for architects and engineers to enhance the way they design and construct buildings. The 3D representation can contain a variety of data and information that can be used outside of the authoring tool. Kil, W carried out a comprehensive design from building personnel management tracking and personnel indoor positioning system, building equipment intelligent control system, wireless sensor network and other technologies, discussed and analyzed the overall system architecture, and preliminarily completed the design of intelligent building management informatization [15]. Intelligent building management systems control the technologies in modern structures (IBMS). IBMS is formed by merging building management systems, the internet, and the associated IT infrastructure [16, 17]. An Internet protocol (IP) network connects all of the building's management systems to the IBMS. The IBMS manages all of its subsystems using a single front-end interface. The rise of the construction sector is essentially driving the IBMS market [18, 19]. The demand for dependable infrastructure develops in tandem with the world's population.

In addition, as new and innovative management systems are installed in buildings to handle technology applications, the demand for IBMS has increased. [20, 21] Zhang, S studied the function realization of three main subsystems of Intelligent Building: building automation system, communication automation system and office automation system, and designed and realized the integration model of building management system [22]. Li, C. put forward the integration scheme of building intelligent system by using open standard technology to solve the problems of many subsystems and equipment of intelligent system and closed protocol [23]. Kulikajevas, A. comprehensively evaluated the factors affecting integration such as system architecture, protocol and security environment, focusing on the impact of different system architectures on integration effect [24]. Gao, G. analyzed the combination point of BIM Technology and building automation management, and obtained the feasibility and superiority of BIM Technology in building automation evacuation management [25]. Kress, B.C. and others studied the establishment of building information database based on BIM model, developed building management system based on BIM, and preliminarily realized the main functional modules and information integration requirements of building management system, such as three-dimensional browsing, information query and positioning, system management and so on [26]. Building systems may now combine the plethora of data from IoT devices and occupant behavior independently to apply learning, enhance performance, and increase environmental efficiency thanks to AI. Deep learning is a subset of artificial intelligence that is a sort of machine learning. Deep learning is about computers learning to think using architecture modelled after the human brain. Machine learning is about computers learning to think and behave with minimal human involvement.

Based on the current research, this paper proposes to use CAD virtual reality digital building 3D reconstruction based on BIM model. This paper attempts to explore the Enlightenment of digital technology to architectural design and construction by understanding the feedback and interaction mechanism between design problems, design information, design media and design generation. At the same time, integrate the theoretical insights inspired by the research, attention and thinking in relevant fields in recent years, and objectively analyze the typical engineering cases designed and completed by using digital technology [27]. The CAD virtual reality digital building three-dimensional model based on BIM model is more suitable for the current building mode. The results show that the model based on BIM has better performance, simpler operation and 20% improvement in performance optimization.

3 CAD VIRTUAL REALITY DIGITAL BUILDING 3D MODEL RECONSTRUCTION

3.1 Basic Concepts of BIM Model

3.1.1 BIM theory

From the current situation and problems of building intelligent system integration management, it can be seen that the key to realize the real intelligence of system integration management lies in the innovation of science and technology. In recent years, the BIM Technology promoted and applied by the national government and enterprises is the future direction of the innovation of China's construction industry. At the "high level Forum on BIM Technology Promoting the modernization of construction industry" grandly held by China Academy of Building Sciences, the Vice Minister of housing and urban rural development repeatedly stressed the important role of BIM Technology in promoting the modernization of construction industry, and pointed out that "Whoever master the whole process of BIM application will win the future".

3.1.2 Connotation of BIM

BIM (building information model) is a new multi-dimensional model modeling and information integration technology since the 1990s. The earliest concept was "architectural description system" proposed by Professor Chuck Eastman in 1975. Until 1999, he redefined "architectural description system" as "architectural product model", believing that "architectural product model" can provide rich products and integrated information in the whole life cycle of Architecture [28]. Until 2002, the world's largest graphics development software Autodesk Company first proposed BIM (building information modeling), that is, today's well-known building information model. BIM (building information model) is a digital building model based on three-dimensional digital technology. It is a three-dimensional parametric expression of the functional and physical characteristics of the building; BIM technology makes it simpler to offer owners with precise and up-to-date "as-built" information so they can manage their buildings more expense over time. Enhancing data sharing capabilities boosts project productivity, resulting in a more efficient construction ecosystem. By visualizing and organizing site logistics ahead of time, BIM may assist enhance construction safety by identifying dangers before they become difficulties and avoiding risks. BIM's data model can provide all participants with shared model resources in the stages of planning, design, construction and operation and maintenance, and provide efficient and convenient decision-making basis for the application and management of all participants in the whole life cycle of the building.

3.2 Modeling the 3D Building Model

3.2.1 Key points of modeling the 3D building model

1) It shall be executed and operated by professional technicians, skillfully apply BIM model technology, and effectively obtain relevant data and documents such as two-dimensional vector graphics and three-dimensional collected vector graphics according to model coding specifications, so as to make sufficient preparations for structural modeling.
2) In the two-dimensional vector data processing, the contents of layer retention, simplification and deletion need to be processed scientifically and reasonably, and strictly checked and modified. Layer properties, contour lines of various organizational parts and current ground features are all the contents that need to be checked [29].
3) Texture acquisition and mapping. In the process of texture acquisition, it is necessary to take photos one by one according to the building number to achieve order and avoid omission, including both the main building and the identification number plate. Try to fully reflect the architectural features in the photos. At the same time, the use function of the building is also the content to be considered in texture acquisition. The purpose of mapping

is to improve the effect of photos to better reflect the characteristics of buildings. Through the processing of unit photos, layer photos and facade photos, PS software is used to present good photo effects and fully meet the needs of three-dimensional building model modeling. As shown in Figure 2.

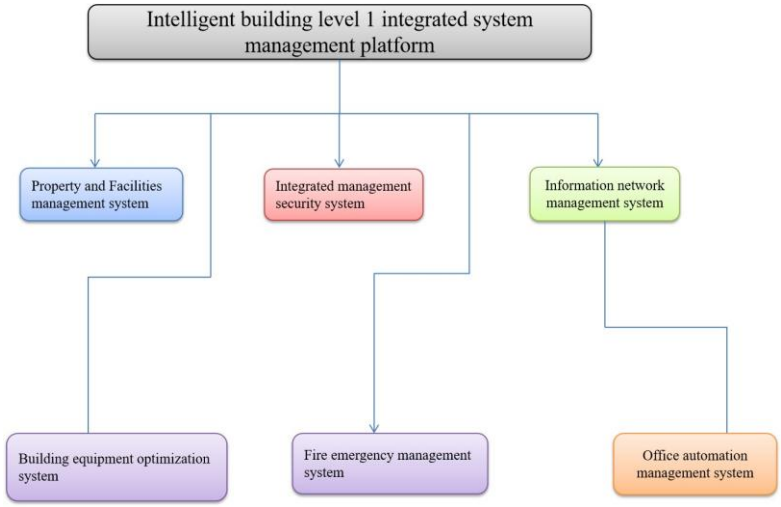

Figure 2: 3D model modeling process.

3.2.2 Virtual reality digital building 3D model based on BIM model

The construction of the model is based on aerial photography to build a three-dimensional environment, collect the structural lines of the model to be made in the three-dimensional environment, build the basic three-dimensional model structure, and combine it with the BIM model to adjust the fine structure of the complex model. Thus, it can not only meet the position accuracy and elevation accuracy of the model, but also carry out the fine and beautiful operation that cannot be achieved by stereo measurement with the help of BIM model [30]. The process of extracting the coordinates of each three-phase texture model based on the aerial measurement is the same as that of the three-phase texture model. However, due to the limitations and requirements of aerial photogrammetry on flight height, angle and accuracy, the model texture obtained by extracting texture has great limitations, such as the shielding of trees to houses, the mutual shielding between houses in densely populated areas, the shielding at the bottom of high-rise buildings and the obvious difference of house darkness caused by sunlight. These problems need to be handled by operators in the process of operation. For texture editing, common methods can select photos with better viewing angle at the same position for texture replacement, and combine with Photoshop to carry out texture color, brightness, occlusion processing, position adjustment and other operations. For the texture of special structure, special treatment should be done.

For example, some hospitals or shopping malls will have artistic fonts standing above the building. Texture treatment can also be carried out through Photoshop, and the expected results can be obtained by connecting channel α with BIM model [31]. After the texture editing is completed, it is necessary to render the texture of all models and add light files to make the texture clearer, brighter, more realistic and ornamental. Once released to the compiler platform, it will work with the application or display the results. As shown in Figure 3.

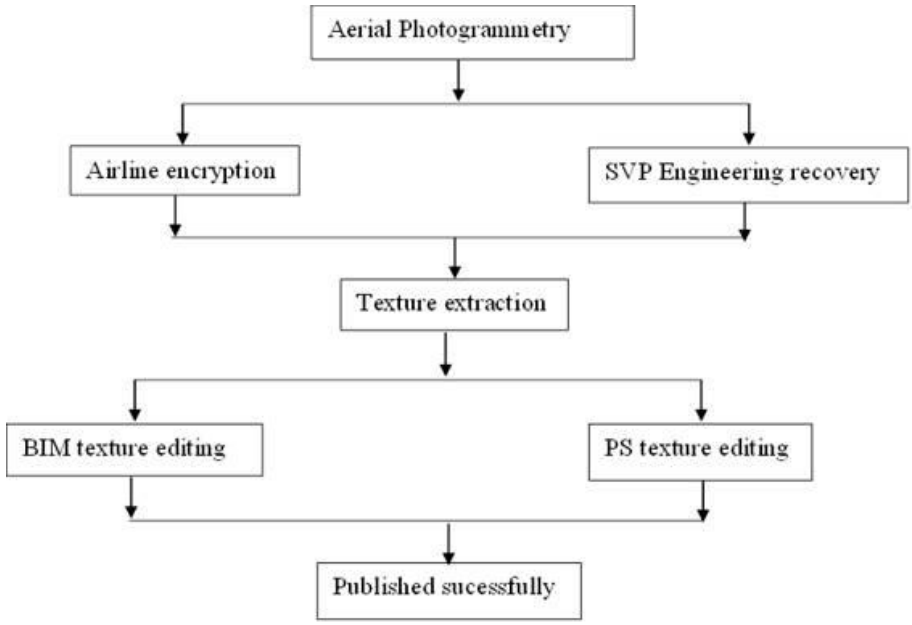

Figure 3: Virtual reality digital building 3D model of BIM model.

3.3 Application of CAD Technology

The two-dimensional function and three-dimensional function of CAD technology can provide many conveniences for designers, especially the intuition of three-dimensional function. The design of CAD three-dimensional model can set the material of each part, different materials have different displays, and the composition of the overall model in a deeper sense can be seen at a glance.

3.3.1 Parameterization, easy to adjust parts

The parameterization of CAD is the reason for designers to adjust conveniently and improve design efficiency. Mechanical design is generally designed manually by designers with drawing tools. Every modification must be completely redrawn, which increases a lot of meaningless workload and affects the smooth progress of design work. However, this modification is inevitable and frequent. When using CAD software, when individual parts need to be modified, the surrounding parts can be modified to allow them to naturally join the original design, which improves the accuracy and quality of the product model, avoids meaningless redrawing, and improves the efficiency of mechanical design. Combined with the model database, designers can assemble or disassemble relevant design graphics while following the design concept. By referring to the surrounding components of the part to be modified, the designer can easily directly change the parameters of the part [32].

3.3.2 Improve design efficiency and shorten design cycle

CAD technology can improve the working mode of mechanical design, replace manual operation with mechanical operation, reduce the working pressure of designers and improve work efficiency. Once, manual hand drawing was based on the spatial imagination of the human brain, which was difficult. It needed to consider the repeated verification and modification of the structure, the operation was cumbersome, and it was easy to become irreparable due to small mistakes. In this process, a lot of time and human resources will be wasted. CAD software can generate mechanical design drawings as long as data is input. While ensuring the accuracy of data, CAD can modify and retain relevant data, and emphasize the display of important designs for easy viewing and

modification [33]. CAD software can save historical data samples, allowing designers to mobilize and reuse. Only some parts that need to be redesigned and manufactured can improve the design efficiency by more than three times. According to the survey, the time required for mechanical design today is only 60% of that in the past. As long as data is entered, CAD software can create mechanical design drawings. CAD may alter and maintain key data while assuring data correctness, and highlight the display of critical designs for simple viewing and adjustment. CAD technology may enhance the working style of mechanical design, minimise designer stress, and increase productivity.

4 EXPERIMENTAL METHOD

4.1 Application of BIM Model

4.1.1 Advantages of BIM

The integrated facilities research center of Stanford University has investigated the application value and economic benefit evaluation of BIM Technology in 32 engineering construction projects in the United States, and concluded that BIM can play the following advantages in the application of engineering projects: Shorten the project cost estimation time by 80%, reduce the project budget change by 40%, reduce the project cost by 10%, control the cost change within the range of 3%, and shorten the project construction period by 7%. BIM can play such great application value in engineering projects, mainly because BIM Technology itself has powerful advantages unmatched by two-dimensional CAD technology, such as three-dimensional visualization, information integration, parameter collaboration and other advantages of BIM Technology [34].

1) Advantages of 3D visualization: 3D visualization is one of the biggest advantages of BIM, especially in modern construction industry. Compared with the traditional two-dimensional CAD, the three-dimensional visualization feature of BIM itself is an invisible value. Because the structure and shape of modern buildings are becoming more and more complex and abstract, traditional architectural designers need to describe the complex components and structures of buildings through rich spatial imagination. However, the three-dimensional model established by BIM Technology can intuitively show the space, structure, shape and complex node parts of the whole building, which greatly improves the designer's understanding of architecture and can, help the designer design better architectural works. During the construction period of the building, participants can use the powerful three-dimensional visualization advantages of BIM Technology to model, collision inspection, pipeline optimization, construction simulation, cost management and other applications to better assist the construction, shorten the construction period and reduce the construction cost [35]. During the operation and maintenance period of the building, managers can quickly understand and master the relevant physical information, spatial information, equipment and facilities of the building with the help of BIM model, so as to improve the efficiency of building operation and maintenance and reduce the maintenance cost. Relationship between BIM modeling and 3D visualization is shown in Figure 4.
2) Parameter synergy advantage: The building components in the building information model are realized by the parametric design of BIM. Parametric design is another important advantage of BIM Technology. Through three-dimensional parametric collaborative design, designers of different specialties can carry out multi-specialty collaborative design based on the same building information model, which not only ensures the accuracy of architectural design, but also avoids the long design process of traditional designers of different specialties, which can greatly shorten the cycle of architectural design. In the operation and maintenance stage, building maintenance personnel can quickly modify the equipment and facilities that need to be changed through the parametric characteristics of BIM model, and can also use BIM parameterization to assist the reconstruction and expansion of buildings, so as to improve the accuracy of building maintenance [36] as shown in Figure 5.

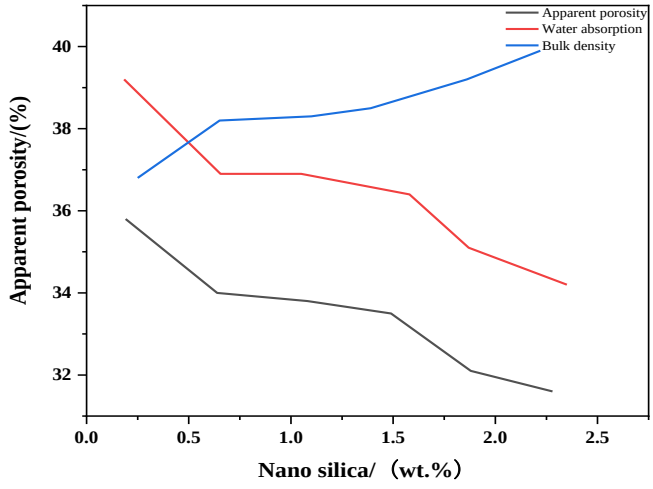

Figure 4: Relationship between BIM modeling and 3D visualization.

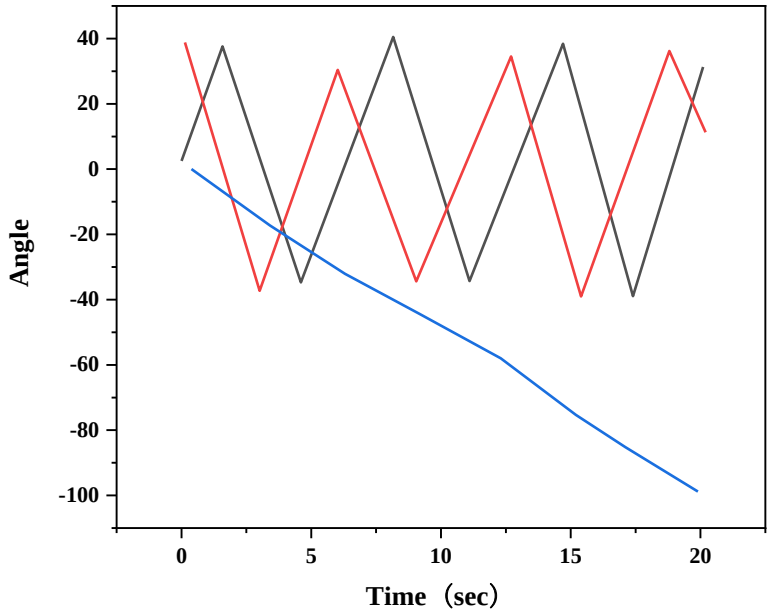

Figure 5: Relationship between BIM modeling and parameter collaboration.

3) Advantages of information integration: Model is only the carrier of BIM, and information is the core of BIM. BIM integrates all engineering geometric information and non-geometric information in the whole process of project development. Project participants can quickly extract and store BIM model information in different application environments. Based on

the integrated information of BIM, the designer can analyze the relevant performance of the building; verify the load bearing capacity and find design errors, so as to optimize the design work [37]. The construction party can use the information integrated by BIM to carry out collision inspection and comprehensive optimization before construction, so as to reduce errors and changes in construction by prepositioning construction problems. Building maintenance and management personnel can quickly grasp the basic situation of the building through the completion information integrated by BIM, including structure, space, electromechanical equipment, property facilities, firefighting, elevator and other information, so as to assist them in better building maintenance and repair management; Through the system integration of BIM model and building management system, the operation and maintenance management and real-time monitoring management of buildings can be realized under the unified 3D management platform. As shown in Figure 6.

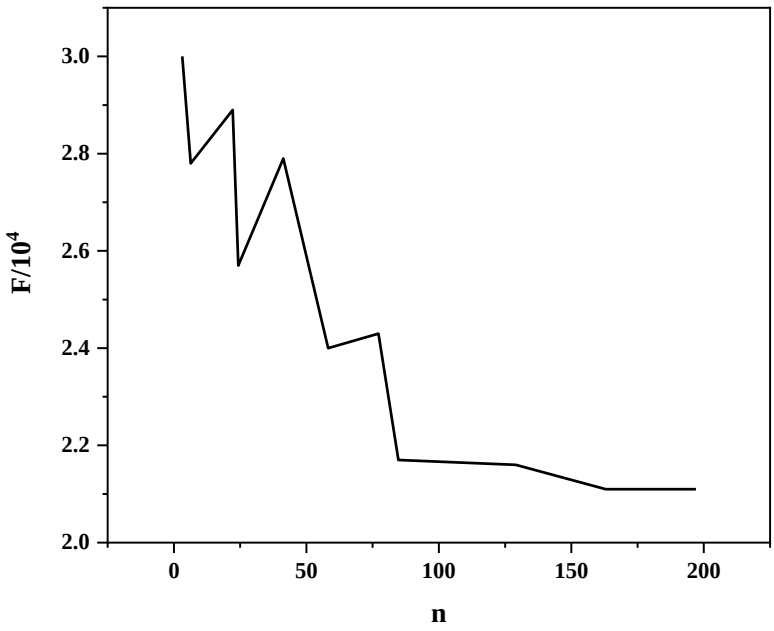

Figure 6: Relationship between BIM modeling and information integration.

5 DISCUSSION

5.1 3D Modeling

5.1.1 Modeling the Urban building model

In urban planning and design, different model subjects need to be selected according to the positioning of buildings and scenes. In the BIM model platform, the main body of the model includes fine mold, medium mold and white film. Precision model refers to the surprise complexity model. It is an architectural model that can comprehensively display the structure and details of buildings, mainly for landmark buildings or landmark buildings. The overall structure, internal structure, light and shadow of the building can be accurately displayed in the fine mold. The

texture collection and mapping processing should be implemented in place to better give play to the functional role of virtual reality technology and implement and operate in strict accordance with the technical parameter standards of the fine mold. Compared with the fine model, the medium model has lower complexity, focuses on the geometric entity structure of the building and ignores the relevant details as much as possible, which can also truly reflect the actual situation of the building, mainly for urban residential buildings. Through the overall structure and outline of the building, it can reflect the specific characteristics of the building without fine display, and its technical parameter standard is relatively lower than that of fine model. The white model highlights the outline of the building. On the premise of ensuring the integrity and comprehensiveness of the modeling, the detailed results of the building can be completely ignored. It is mainly oriented to the dense areas of non-key buildings. When building the white model through the BIM model, the characteristics and functions of the building can be understood only according to the outline of the building, and the requirements for technical parameter standards are low [38].

5.1.2 Realization of virtual reality 3D building model modeling

After the virtual reality 3D building model modeling is completed, the X model is exported on the BIM model platform and imported into the skyline platform for 3D scene integration. Different functions are presented in different 3D scenes to improve their 3D visualization. In urban planning and design, BIM model can provide browsing, query, analysis and other related services to achieve the goal of virtual reality 3D building model modeling.

5.1.3 Practical application of 3D urban modeling

As a new surveying and mapping product separated from the inherent two-dimensional plane form, three-dimensional real city has some irreplaceable advantages of traditional products.

1) Three-dimensional display platform: The three-dimensional display platform, for a city, from landmark buildings to street signs and street lamps, is a real and vivid way of display, which not only enhances the appreciation, but also strengthens the publicity effect. Whether the publicity and education of the government to the public or the publicity and introduction of enterprises to consumers can be realized through the three-dimensional city platform, so that everyone can more truly feel the overall style of a city [39].
2) Urban Municipal Administration: In addition to the construction of architectural models, 3D urban modeling can also build urban facilities such as trees, street lamps and underground pipelines according to the real road conditions, more vividly and accurately understand the needs of the city, and improve the work efficiency and accuracy of Urban Municipal Administration [40].
3) Urban planning: In the process of urban planning, the traditional planning scheme needs to study and compare a large number of plane drawings. In order to obtain accurate results, it often takes a lot of manpower and energy, and the construction of three-dimensional city can greatly save these labor costs. In the three-dimensional city, we can build the planning model and combine the planning model with the real building model. For example, the expected effect of the planned land is displayed and compared with the existing state in the same environment. We can also compare several planning schemes in the same environment and select the best ones clearly. On the one hand, we can avoid the risk of planning and design; On the other hand, it can speed up the design speed and improve the quality of the scheme. In the transformation of urban shanty towns, the three-dimensional city can also enhance the confidence and satisfaction of residents by displaying the expected effect and try to avoid unnecessary disputes [41].

6 CONCLUSION

The introduction of digital technology or mathematical principles in the field of architecture, on the one hand, is to meet the growing material needs of human society; On the other hand, it is also

the inheritance and practice of architectural theory and architectural digital culture under the background of contemporary scientific concepts. Modern technology has sparked a reconsidering of production and construction technology as well as mathematical theory in the construction field, transforming traditional architectural expression methods and means. Architects' comprehension of space and form has broadened, and the effectiveness of conveying intended purpose and the "fitting" of results and intention has improved to unprecedented levels. Architects have gradually mastered new skills in mathematical logic, form exploration, virtual simulation and control and coordination of the whole design and construction process. New production and construction technologies have continuously realized the materialization of virtual models. The opening of this digital revolution in architecture is a foregone conclusion. Only by constantly accepting and exploring new technologies and methods, pursuing advantages and avoiding disadvantages, and cooperating can we promote the healthy development of architecture in more diversified directions. The results show that the BIM-based model outperforms the conventional model in terms of performance that operation is easier, and that performance optimization is improved by 20%, making it worthy of general acceptance and usage. The medium model is less complicated than the fine model, focusing on the geometric entity structure of the building and ignoring as many essential details as feasible.

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