Construction and Simulation of CAD System Model of Architectural Structure Based on Multimedia Technology

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Abstract. With the continuous development of multimedia technology, computer-aided design (CAD) system can run through the whole life cycle of architectural engineering, can meet the needs of different stages such as design, construction, operation and maintenance, and gradually become a common modeling method in the field of architectural design and mapping. The construction and simulation of CAD system model of architectural structure based on multimedia technology is to use computer to solve, design and optimize the structural stiffness, strength, stability, dynamic response, and elastic-plastic performance of architectural engineering and the analysis and calculation of their mechanical performances. Therefore, on the basis of summarizing and analyzing previous research works, this paper elaborated the research status and significance of the construction and simulation of CAD system model of architectural structure, elaborated the development background, current status and future challenges of multimedia technology, proposed a design-object-oriented spatial morphology modeling method, conducted the collaborative processing optimization of multimedia technology, constructed the CAD system model of architectural structure based on multimedia technology, analyzed the CAD simulation performance of architectural structure, explored the CAD solution scheme of architectural structure, simulated the CAD system model of architectural structure based on multimedia technology, and finally discussed the submission technology of multimedia design results and the unified presentation mechanism of multi-dimensional data field. The results show that the CAD system model of architectural structure based on multimedia technology can apply computer-aided architectural design to solve the problems of structure design, spatial expression, data calculation, optimization analysis, engineering drawing in the process of modeling, and it can greatly improve the efficiency of architectural structure design, make the system design to the collaborative, standardized, and international aspects of development, and hence bring huge economic benefits to construction industry. The research results of this paper provide a reference for further researches on the construction and simulation of CAD system model of architectural structure based on multimedia technology.

Keywords: Architectural Structure; Computer-aided Design; Model Simulation; Multimedia Technology
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1 INTRODUCTION

Computer-aided design (CAD) is a method and technology that uses software system and computer hardware to help designers solve engineering design. The CAD system of architectural structure based on multimedia technology is an approximate numerical analysis system that is to use computer to solve, design and optimize the structural stiffness, strength, stability, dynamic response, and elastic-plastic performance of architectural engineering and the analysis and calculation of their mechanical performances [1]. Wagter [2] pointed out that architectural structure model is a three-dimensional model based on various relevant information data of construction project, which simulates the real architectural information through digital information, and realizes three-dimensional architectural model, project supervision, property management, equipment management, digital processing, engineering management, and other functions of a three-dimensional model. The model also has information relevance and consistency, which can simulate the construction side, design side, construction and supervision unit together, and simulate the construction project visually, which is conducive to fine design and construction of the construction project. Architectural designers focus on the use of the architectural function and architectural aesthetics and other aspects of the design of architectural plan, for columns, beams, walls and other architectural components of the precise layout and shape, size and other details do not pay attention to. Maver [3] suggested that structural designers also focus on the feasibility of construction, as far as possible to achieve the requirements of the architectural half surface drawing, design in line with the structural mechanics, and reflect the precise component layout, shape and size of the structural plan and other construction drawings.

With the continuous development of multimedia technology, the CAD system can run through the whole life cycle of architectural engineering, can meet the needs of different stages such as design, construction, operation and maintenance, and gradually become a common modeling method in the field of architectural design and mapping [4]. Pérez-Sánchez et al. [5] suggested that the CAD drawing size standard is clear, so can use CAD plane, elevation view; the application of architectural structure CAD system based on multimedia technology will be two-dimensional drawings into three-dimensional model of abstraction, which can accurately reflect the exact dimensions of architectural components, and can ensure the quality of engineering design, good effect of the figure. In practical calculation, a large part of architectural structure components is simplified to rods and modern architectural structures are becoming more and more complex and larger in scale. In the structural design of architectures, they must be calculated to determine whether the designed structure is safe and reliable and the general architectural structure often has tens of thousands of rods. Under this circumstance, it is not practical to write input data files by hand. Therefore, Lawson and Roberts [6] concluded that it is necessary to study the CAD system model of architectural structure based on multimedia technology, using this model to establish the spatial structure model, and then forming the input data file required by the calculation program. This is the pre-processing part of structural analysis, which is one of the important parts of modern structural analysis.

On the basis of summarizing and analyzing previous research works, this paper elaborated the research status and significance of the construction and simulation of CAD system model of architectural structure, elaborated the development background, current status and future challenges of multimedia technology, proposed a design-object-oriented spatial morphology modeling method, conducted the collaborative processing optimization of multimedia technology, constructed the CAD system model of architectural structure based on multimedia technology, analyzed the CAD simulation performance of architectural structure, explored the CAD solution scheme of architectural structure, simulated the CAD system model of architectural structure based on multimedia technology, and finally discussed the submission technology of multimedia

design results and the unified presentation mechanism of multi-dimensional data field. The research results of this paper provide a reference for further researches on the construction and simulation of CAD system model of architectural structure based on multimedia technology. The detailed chapters are as follows: Section 2 constructs the CAD system model of architectural structure based on multimedia technology; Section 3 simulates the CAD system model of architectural structure based on multimedia technology; Section 4 discusses the submission technology of multimedia design results and the unified presentation mechanism of multi-dimensional data field. Section 5 is conclusion.

2 CAD SYSTEM MODEL CONSTRUCTION BASED ON MULTIMEDIA TECHNOLOGY

2.1 Design-object-oriented Morphological Modeling

The model proofreading of architectural structure CAD based on multimedia technology should run through the whole process of auxiliary design. In the data pre-processing stage, most structural analysis software has data self-check and graphic check functions, and designers should also check and proofread the results of human-computer interaction data entry timely, and correct the common problems such as formatting errors and load omissions that do not meet the software requirements in time. The correctness of the calculation results mentioned above can also enable the designer to check the rationality of the structural scheme, the appropriateness of the calculation software, the accuracy of the simplification of the calculation model, and the correctness of the input data from a macro perspective. Now the architectural structure analysis software all attaches great importance to the research and development of post-processing, generally can automatically generate the structure construction drawing according to the calculation results, and can use a variety of forms of drawing expression, such as drawing method, list method, plane overall representation, greatly simplifying the drawing work of structural engineers. Rahimian and Ibrahim [7] suggested that the designers should pay attention to the computer drawing is far from perfect and the designer should focus on convenient construction, constructing reasonable requirements, such as the earnest revision. When it is necessary to beam steel hanger, additional stirrups and stirrup encryption range such as accounting, it will not take the computer generated by the construction drawing without any modification and adjustment is to sign out figure irresponsible. At the same time, it is also not allowed to arbitrarily change the calculation results and improve the security degree during the drawing. Figure 1 shows the design-object-oriented morphological modeling in CAD system model construction based on multimedia technology.

After the calculation and the results of all components of the structures, architectural structure CAD system model based on multimedia technology can manually adjust the reinforcement and component merge, determine the drawing in the column and floor beam, and then combine these components according to their kinds, layer number, across several and drawing conditions such as the capacity of permutation and combination, respectively, into several new flat and framework. These new frames are mainly for the purpose of drawing and also carry out some auxiliary structural design, engineering calculation, which can be respectively composed of drawing columns without drawing beams, or drawing beams without drawing beams, or drawing both columns and beams. The positions of the components in the frame are not the actual positions of the components, but they are arranged together for drawing. However, because it is a planar frame, all the design and drawing work of multilayer and high-rise spatial structures can be completed. In the column of high-rise architectural, there must be many repeated floors, and the method of compression expression can be adopted when drawing, so that a floor represents the number of repeated floors. In multi-layer and high-rise design, the designer always has to make some adjustments to the reinforcement of part of the bar, and it is rare to match the reinforcement according to the electric optimal results exactly. Sometimes designers also need to modify the geometry of the bar, stirrups to determine whether to add bending reinforcement, and so on.

Therefore, in order to adapt to this requirement, any CAD system should provide extremely convenient and effective man-machine dialogue means of manual intervention.

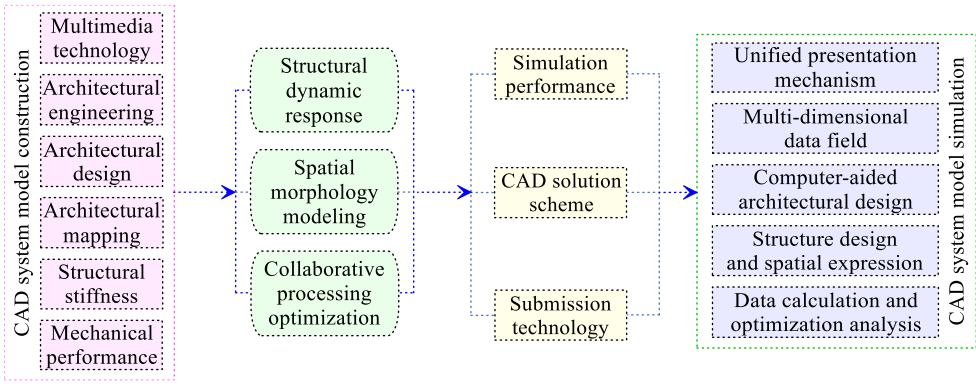

Figure 1: Design-object-oriented morphological modeling in CAD system model construction based on multimedia technology.

2.2 Collaborative Processing Optimization of Multimedia Technology

The CAD system of architectural structure based on multimedia technology is an approximate numerical analysis system that is to use computer to solve, design and optimize the structural stiffness, strength, stability, dynamic response, and elastic-plastic performance of architectural engineering and the analysis and calculation of their mechanical performances. The CAD system model simulation can also be called virtual reality technology in architectural structure analysis, which has real-time interaction, multi-perception, sense of existence and autonomy. In other words, designers can simulate and observe the structure before getting the standard works more actively and intuitively through simulation analysis, verify the availability of data, and further improve the works, or even provide space for other fantastic ideas. In the design of the structure, the first should be a reasonable structure selection, according to the use of conditions and design conditions to determine the structure form, and then based on this basis for the next step of analysis, and then the use of finite element software for demonstration and analysis, and finally the actual modeling to verify and improve (Figure 2). Modern architectural structures are becoming more and more complex and larger in scale and the general architectural structure often has tens of thousands of rods [8]. Under this circumstance, it is not practical to write input data files by hand. According to the guidance of the theory, the material and time consumed in making the model can be greatly reduced during the optimization design of structural model, so as to make full use of the strength of the material, ensure that the stiffness and strength of the structure meet the requirements at the same time, and achieve a good optimization design effect.

In practical calculation, a large part of architectural structure components are simplified to rods and in the structural design of architectures, they must be calculated to determine whether the designed structure is safe and reliable. Two-dimensional CAD drawings are common in engineering and their main limitation is that their intuitiveness is not strong. For non-professionals, they are relatively abstract, and it is difficult to imagine three-dimensional real effects by using two-dimensional drawings in their minds. In the early days, the input data files needed by the calculation program were written by the user and then entered into the computer. For more complex structures, this process was extremely cumbersome and error-prone. The architectural structure CAD system model construction based on multimedia technology can set the wall height, attribute, depth and color and other attribute information, select the center line positioning method of the wall to draw the wall of each floor according to each plane view. In the actual drawing project, the wall can be drawn in a variety of ways, such as arc, polygon according to the project's requirements. Therefore, it is necessary to study the CAD system model of architectural

structure based on multimedia technology, using this model to establish the spatial structure model, and then forming the input data file required by calculation program. This is the processing part of structural analysis, which is one of the important parts of modern structural analysis.

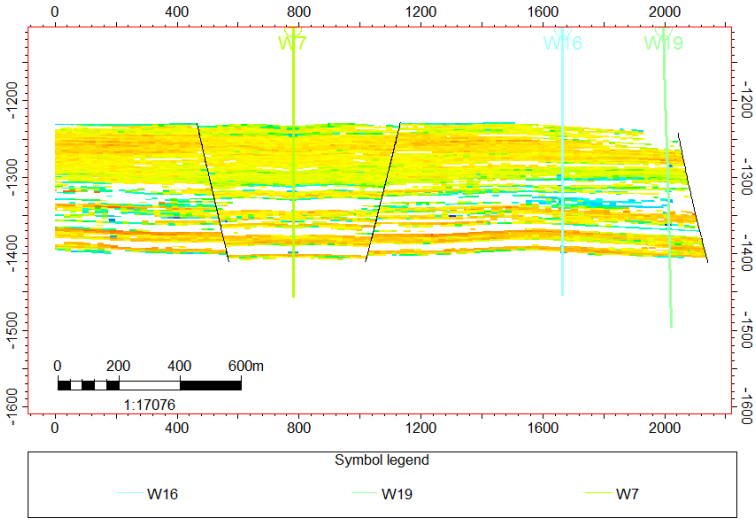

Figure 2: Collaborative processing optimization of multimedia technology in CAD system model construction based on multimedia technology.

3 CAD SYSTEM MODEL SIMULATION BASED ON MULTIMEDIA TECHNOLOGY

3.1 CAD Solution Scheme of Architectural Structure

The CAD system model of architectural structure based on multimedia technology combined with Internet technology can realize the sharing of resource information and the rapid response of construction projects. Personnel from various departments and professions can upload their designed schemes to the cloud server of the construction project, and the design platform will integrate the resources of various schemes. In the process of site construction management, it is found that the perfect three-dimensional data can effectively reduce the process of answering questions between technical personnel. After simple training, most of the foundation construction personnel can have a good understanding of the overall construction technology and process of the architectural, and can quickly enter the state of the construction of the steel structure on site. The standardization and unification of prefabricated components can help designers to save design time and allocate more time for diversified layout design of architectural patterns, which increases the possibility of meeting the diversified needs of owners for architectures (Figure 3). Frame structure has the advantages of simple use, fast transportation and light weight and these characteristics make it widely used in construction [9]. It is usually used in the construction of some high-rise architecture, which is the main trend of the current construction. In the prefabricated frame structure system, the most important part is the prefabricated laminated plate and the prefabricated laminated quantity. The components of these two parts can be directly processed and manufactured in the production line of the factory, and only need to be simply poured and welded when transported to the construction site.

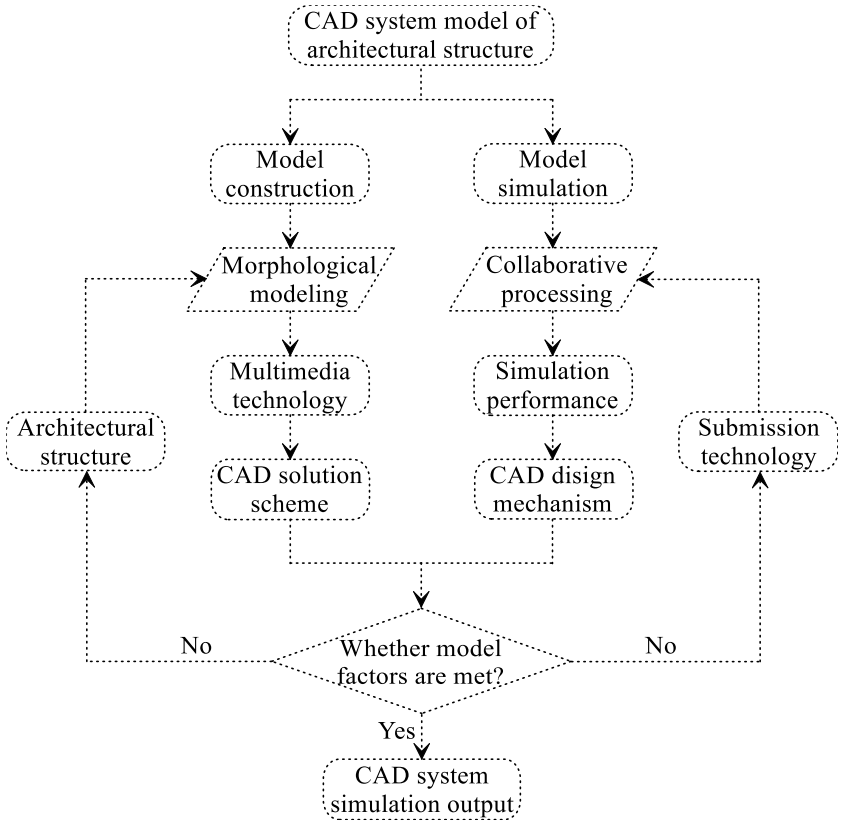

Figure 3: Flowchart of the solution scheme of architectural structure in CAD system model simulation based on multimedia technology.

In order to facilitate the post-processing of CAD system model simulation of architectural structure, that is, to display the displacement, stress and strain of the structure, it is necessary to carry out class abstraction for the calculated structure. According to this situation, several basic structural classes can be abstracted and the multimedia system mainly calculates beams, plates and shells. Plate structure is one of the most common structural forms, such as thin plate, elastic foundation plate, layered foundation and multilayer composite material, which can be abstracted as plate structure according to the angles and angles shown in the CAD system model of architectural structure. The CAD system model of the architectural structure based on multimedia technology shows the deformation and displacement of the structure under stress, and can use the powerful three-dimensional modeling ability of the model to carry out three-dimensional projection and rendering, and enhance the visualization effect of the calculation results (Figure 4). Considering that the visualization in the finite element analysis includes the visualization of scalar field and the visualization of vector field, different methods are used to deal with it. For scalar fields such as temperature field and strain field, color method is adopted, while for visualization of vector fields such as stress field, arrow line segment representation method is adopted. Since the dynamic connection library can only contain sub-functions or sub-procedures, it cannot exist in the main program, so the main program in the source program must be changed into the corresponding sub-functions. Data that was originally read from a file by the source program can now be passed directly to sub-functions using parameter passing.

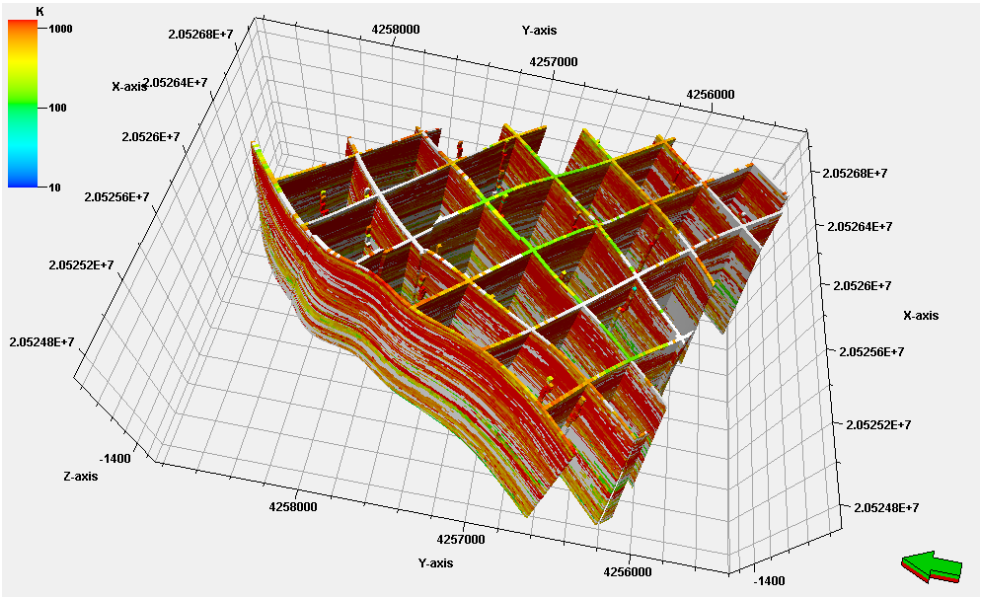

Figure 4: Architectural structure result in the CAD system model simulation based on multimedia technology.

3.2 CAD Simulation Performance of Architectural Structure

In terms of pipeline optimization of architectural structure CAD system model based on multimedia technology, the steps are modeling first, and then analyzing the possible collision parts after pipeline modeling, so as to adjust the modeling and establish scientific and reliable drawings. Through a series of steps such as joint review of drawings, model establishment, problem reporting, meeting organization, drawing, change and so on, the pipeline planned in the drawings can be implemented in practice, and finally achieve reasonable guidance and management of architectural construction. For the special equipment in the construction, it is necessary to optimize it in depth. The modern technology of parameter modeling is used to provide a fine adjustment plan for the use of the equipment, so as to ensure the authenticity and detail of the data information in the equipment modeling and bidding and procurement. In the actual process of the project to optimize management, the CAD system model can be used in a comprehensive way of cooperative management to strengthen the supervision of the construction content and management, the management of specific provision of the agreement in specific ways [10]. It also makes better use of regulations and the business communication and cooperation can lay the solid foundation to ensure the construction quality of the final. For construction unit, it shall be carried out in accordance with the architectural structure CAD system model the analysis of the architectural design, the design of the corresponding departments and regulators at the request of the project owner process analysis, to construction involves the design of specific content, regulatory content, construction specifications, such as strict quality check, finally the comprehensive optimization of pipeline layout diagram.

In order to extract the structural information module and obtain the positional relationship between components, the system automatically records the topological relationship between components formed in the process of interaction. For example, the handle of the beam or wall arranged on the network line should be recorded in the extended data of the network line. Meanwhile, the handle of the end point of the grid line should also be recorded in the extended data of the node. At the same time, the handle of the grid line that intersects with the node should also be stored on the node. In the process of architectural axis input, the system provides a variety of interactive commands, such as general line, a group of parallel lines, orthogonal line grid

and orthogonal arc grid and so on. After the axis input, the CAD system model of architectural structure based on multimedia technology automatically divides these axes into grid lines and grid nodes. The function of this module also includes automatic axis annotation, axis naming and axis name modification (Figure 5). These are highly intelligent and automated, without excessive user intervention, the system can automatically detect the position relationship between the axes. There are many components in a architectural structure, some similar components have the same section, in order to facilitate the management and reasonable use of resources, the system uses the method of standard components, that is, the definition of standard components, the components in the model are the reference of standard components. The geometrical dimensions and material information of the component are defined prior to the placement of the component and the component can also be defined at any time as needed.

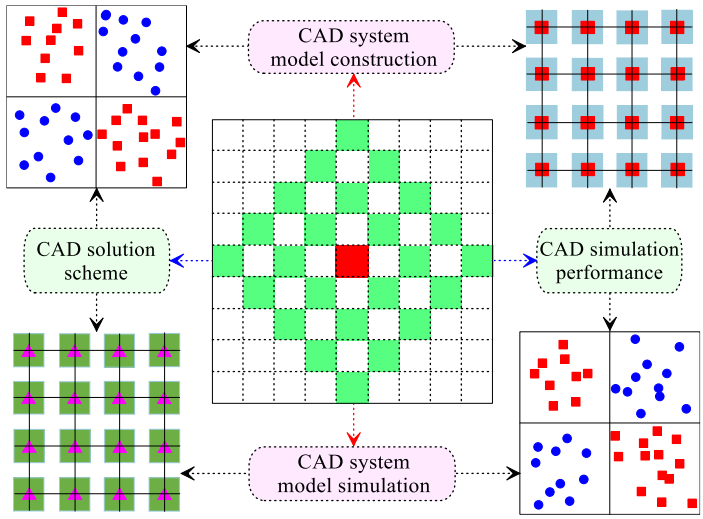

Figure 5: Simulation performance of architectural structure in CAD system model simulation based on multimedia technology.

4 DISCUSSIONS

4.1 Unified Representation Mechanism of Multidimensional Data Field

Thinking and vision are usually directly reflected as three-dimensional information and architectural structure CAD system model based on multimedia technology using a combination of several parameters to represent the construction of three-dimensional form, so that the designer directly design vision into three-dimensional design model, and then help complete from three-dimensional model to generate two-dimensional graphics and drawing work, improve efficiency and reduce errors. Finite element models and interface files for structural mechanics analysis can be generated automatically from three-dimensional architectural models to ensure the authenticity of data and realize the unification of design, drawing and mechanical analysis feedback, which meets the needs of traditional complete design work. In the architectural plan, the information that needs to be identified and used by the structural designer includes the axis system, architectural components and their layout, etc. The graphic composition features of the objects are described as grammar-relation, and the rule-based method is used to judge whether there is a graphical element group satisfying the grammar-relational relationship, so as to complete object identification (Figure 6). Each architectural component in the overall structure and its adjacent components in the vertical direction of the combination of constraints, such as the upper surface of

the floor can be determined by the current level of the horizontal plane with the relative drop. The upper surface of beam is generally equal to the adjacent floor surface. These component combination laws provide default data constraints in the vertical direction of spatial positioning of components. When the basic constraints are violated, the designer only needs to give displacement parameters relative to the height of the basic constraints.

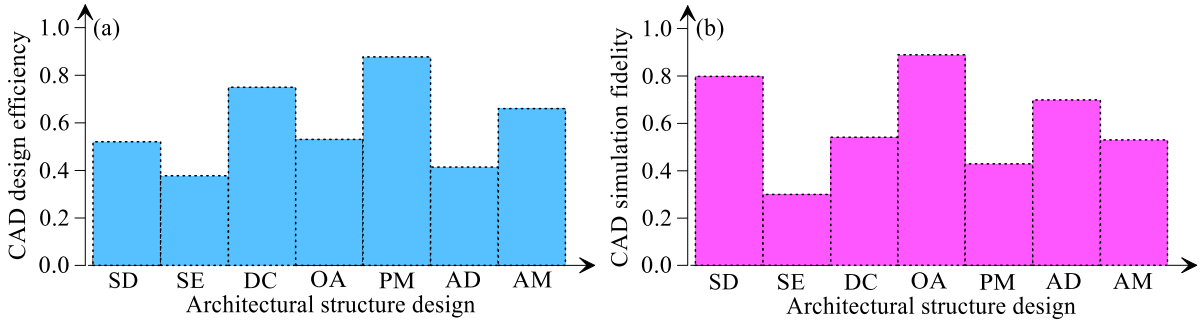

Figure 6: CAD design efficiency (a) and simulation fidelity (b) of seven architectural structure designs Notice: SD-Structure deign; SE-Spatial expression; DC-Data calculation; OA-Optimization analysis; PM-Process modeling; AD-Architectural design; AM-Architectural mapping.

Taking architecture and structure, the most important major in architectural design, as an example, multimedia technology is applied to convey the design intention to the structural engineer through the drawings after the architect constructs the architectural model. After the structural engineer understands the architect's design intention, the structural analysis and design software is applied to input the structural model to conduct preliminary structural analysis and design, and then the CAD system model of the architectural structure is used to transfer the revised design intention to the architect through drawings. Such a design process often needs to experience several, even a dozen back and forth, the need for architects and structural engineers repeatedly repeated labor. In fact, architectural structure CAD system is a complete architectural information model, it is different from the commonly used in two-dimensional floor plan, it contains all the relevant information in the architectural model, such as geometry information, cross section information, material information, and related information between the various components, it is actually a virtual three-dimensional entity model architectural. In CAD system model, the expression method of architectural model based on floor management can be seen that the architectural model expressed by a document usually corresponds to a project in the actual project. The project will have an associated construction site, and the construction site will be connected to the associated architectures; each architectural is connected to its related floors, and all floors are connected to its related architectural components.

4.2 Submission Technology of Multimedia Design Results

In the model simulation of architectural structure CAD system based on multimedia technology, the grid area of point height described by the graph element matrix is loaded into the model, and the wall built by these graph elements is added to the three-dimensional sub-graph elements by using the surface generator, so that the ground model with rectangular or triangular facets is built. The earliest principle was to calculate the intensity of surface color based only on the intensity of sunlight. If the calculated light intensity is less than the diffuse light intensity, set it to the same as the diffuse light intensity and then add the point source brightness. In order to make the former administrator files compatible to the higher version when applied in engineering projects, the system requires modifying the unit system of some established administrator files of engineering projects, and attaching new files, including composite drawings, with metric standard, etc. For example, all parameterized wall element models with their height information can be output at one

level of the diagram at the same time (Figure 7). The height information can be converted to a file that can then be entered into a database, making the wall heights in all databases around the world change with it. With the application of selection method, all the graph element models can be extracted within a certain range. According to their material classification number, the classification number can be changed in the free format file, and then the material classification number can be changed all over the world by entering this file.

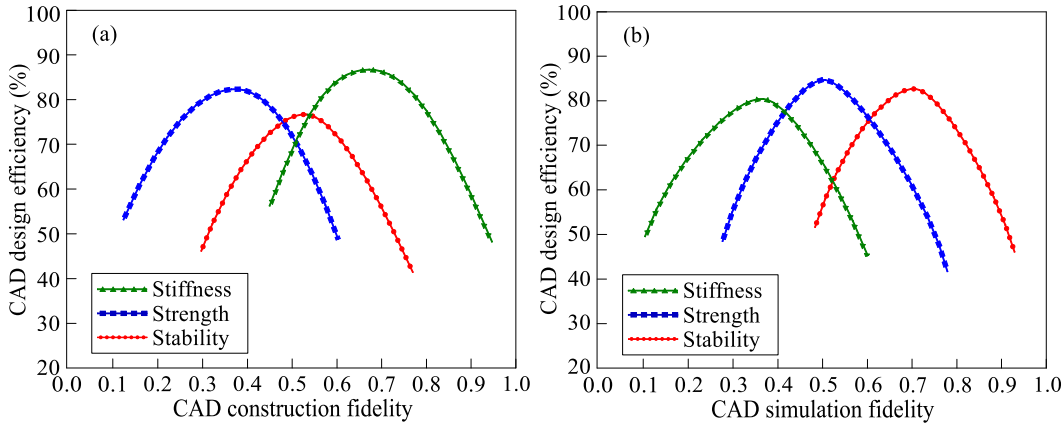

Figure 7: Relationship between CAD design efficiency and CAD construction (a) and simulation (b) fidelity in architectural stiffness, strength and stability.

All the architectural components supported by the current CAD system model, such as walls, plates, beams, columns, doors, windows, etc., the information of geometry, materials, properties of all these architectural components and their relationships with each other are included in the architectural model expressed by this model. As long as you master the expression method of architectural model based on CAD system model, designers can use the application software that supports CAD system model to realize information exchange and sharing. The difference of the architectural itself is mainly based on the scientific and reasonable setting of the architectural content and appearance, while the structural model needs to be designed and applied according to the contents of the relevant mechanics principles in the actual implementation process of the construction meaning. Although there are very obvious differences between the two, they are both the main supporting conditions of the architectural itself. For example, in practice, if there is a very obvious difference between the beam-column node and the beam-plate node of the architectural structure itself, the two belong to different basic objects. The fundamental reason for such a big difference between the two is that the basic object has certain difference in the actual form. If this difference is analyzed through the architectural structure model, the two can be regarded as an organic whole, but they bear different loads or stresses in the actual operation.

5 CONCLUSIONS

This paper proposed a design-object-oriented spatial morphology modeling method, conducted the collaborative processing optimization of multimedia technology, constructed the CAD system model of architectural structure based on multimedia technology, analyzed the CAD simulation performance of architectural structure, explored the CAD solution scheme of architectural structure, simulated the CAD system model of architectural structure based on multimedia technology, and finally discussed the submission technology of multimedia design results and the unified presentation mechanism of multi-dimensional data field. After the calculation and the results of all components of the structures, architectural structure CAD system model based on multimedia technology can manually adjust the reinforcement and component merge, determine the drawing in the column and floor beam, and then combine these components. Architectural structural CAD

system model based on multimedia technology using a combination of several parameters related to construction of three-dimensional form, so that the designer directly design vision into three-dimensional design model. After the structural engineer understands the architect's design intention, the structural analysis and design software is applied to input the structural model to conduct preliminary structural analysis and design, and then the CAD system model of the architectural structure is used to transfer the revised design intention to the architect through drawings. The results show that the CAD system model of architectural structure based on multimedia technology can apply computer-aided architectural design to solve the problems of structure design, spatial expression, data calculation, optimization analysis, engineering drawing in the process of modeling, and it can greatly improve the efficiency of architectural structure design, make the system design to the collaborative, standardized, and international aspects of development, and hence bring huge economic benefits to construction industry. The research results of this paper provide a reference for further researches on the construction and simulation of CAD system model of architectural structure based on multimedia technology.

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