Personalized Architectural Design Under the Cooperation of Parametric Modeling

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Abstract. This paper aims to explore the personalized architectural design method with the cooperation of parametric modelling and CAD technology. By leveraging two cutting-edge technologies to construct a customized architectural design model, this study strives to cater to the unique preferences of diverse users and enhance the precision and personalization of architectural designs. The research results obtained accurate user demand simulation in experimental cases of architectural design. Strict model requirement verification has been conducted for effectiveness and practicality. The model can effectively demonstrate outstanding performance and design functional aesthetics. It achieved a high score of 90% in the evaluation of comprehensive performance. This indicates that the model proposed in this article has a high value in terms of aesthetic functionality. The study not only combines the aesthetic design of architecture and technology but also presents a new design demonstration of the integration of powerful architectural design.

Keywords: Personalized Architectural Design; Parametric Modeling; CAD Technology; Interdisciplinary Integration
DOI: https://doi.org/10.14733/cadaps.2025.S2.211-226

1 INTRODUCTION

From the perspective of architectural design, the parameterized design of prefabricated buildings based on BIM achieves the linkage of information models in a three-dimensional form, which solves not only the problems of low modeling efficiency caused by model duplication but also economic losses caused by design changes. At the same time, it also conforms to the development direction of BIM positive design and conforms to the trend of the integration of building informatization and industrialization. From the perspective of energy conservation and emission reduction, the current calculation of carbon emissions from prefabricated buildings mostly remains in the stage of calculation statistics and empirical calculation [1]. A user interaction window was designed using

WPF, and a visual parameter adjustment interface for modelling and reinforcement of prefabricated components was designed. Combined with parameter identification, a linkage control model was created and modified. Establish a database of carbon emission factors and consumption quotas for prefabricated construction projects, input data information into modelling software, and construct a model-based carbon emission calculation system to automatically calculate the carbon emissions of prefabricated components [2]. Based on existing parameterized models, write a program to automatically extract the quantity of concrete and steel reinforcement engineering. To define the boundary of carbon emission calculation, use a carbon emission calculation model. The developed parametric modelling program for prefabricated components was applied to a prefabricated shear wall structure building engineering example, and the feasibility and engineering universality of the plugin were verified through a parameter-driven model, achieving visualization of the design process. By using the modelling method, the carbon emissions of prefabricated components can be unified and informationized, improving accuracy while also providing designers with more choices based on corresponding emission reduction strategies [3].

Based on preserving the important geometric and visual features of the model, focus on the data organization and management requirements of the 3D building model. Designing a multi-resolution 3D building model data organization and management method based on a global position grid has become particularly important. And make the texture information-rich areas of the 3D building model more fully preserved, thereby achieving better visualization effects. Some scholars have further introduced global location grids to organize and manage multi-resolution 3D building models. A 3D building model mesh simplification algorithm based on "local vertex" texture features is proposed to address the issues of existing 3D building model simplification algorithms not being able to preserve model detail features well and easily causing texture distortion. Thus achieving hierarchical management of multi-resolution 3D building model data, thereby improving the query, retrieval, and computational efficiency of building models. This algorithm uses geometric and texture factors to optimize the quadratic error measurement, which can maximize the preservation of the appearance of the original 3D building model. Based on this method, three-dimensional urban scene visualization is established using the relational database PostgreSQL to establish a three-dimensional building model database for experimental verification. Build a WebGIS visualization experimental system based on a global location grid [4]. The proposed high-quality 3D building model simplification algorithm and multi-resolution 3D building model organization and management method can meet the needs of real-world 3D construction of different scales and complexities. Based on the GeoSOT grid-based multi-resolution 3D building model data organization and management method, design a WebGIS visualization system for 3D building model query, retrieval, measurement, and analysis. This can provide a solution for collaborative updating of multi-source heterogeneous data and systematic management of urban 3D model data, supporting the management, storage, integration, and visualization of geospatial data. For example, when exploring the correlation between optics and architectural design, we found commonalities between the two in terms of initial input simulation and process similarity [5]. Based on this interdisciplinary thinking, some scholars have proposed a method for establishing computer-aided design heuristic algorithms in the fields of optics and architectural design. This method will develop into an expert system under the roof of artificial intelligence, which can automatically generate architectural design solutions that meet the personalized needs and preferences of different users. This interdisciplinary connection inspires us to utilize advanced technologies in the field of optics to optimize the simulation process of architectural design, thereby achieving more accurate and personalized simulation of light and shadow effects. Especially in the field of personalized architectural design, interdisciplinary connections are particularly important because they provide us with new perspectives and methods to create more unique and innovative designs. BIM technology can not only achieve digital expression of architectural design but also integrate and collaborate various aspects of the architectural design process, thereby improving design efficiency and quality [6]. This method combines the precise calculations of optical experts with the aesthetic and design concepts of architectural experts and achieves rapid iteration and optimization of personalized architectural design through computer simulation technology. In addition, our experience gained for the first time in the intersection of optics and architectural design provides important insights for us to further expand into other themes. By combining BIM technology with personalized architectural design, we can achieve digital management of the entire process from design to construction. In the near future, we see the prospect of using new technologies in personalized architectural design - Building Information Modeling (BIM). Ensure that the design scheme can be accurately translated into actual buildings and meet the personalized needs of users. We believe that through interdisciplinary communication and cooperation, we can apply the concepts and methods of personalized architectural design to a wider range of fields, such as urban planning, landscape design, interior design, etc., thereby creating more unique and innovative design works [7].

In the context of personalized architectural design, this study conducted an in-depth comparison of the availability and constraints of two 3D modelling methods in immersive virtual reality (IVR) - handheld user interface (HUI) and direct operation modelling (DM). These aspects are crucial for the implementation of personalized architectural design, as they directly affect whether designers can efficiently and accurately express and implement their design concepts in virtual environments [8]. Therefore, taking prefabricated components of prefabricated shear wall structures as the research object, adopting the parameterized design concept and utilizing the powerful scalability of Revit modelling software for secondary development, a parameterized model is proposed and applied. Replacing the need for manual modification of steel bars to adapt to geometric models, which rely on components as a whole, adaptive adjustment of parameterized steel bar models has been achieved [9]. By changing parameters, models can be shared across different projects. And designed a menu bar that can create different component models, a unified integration modelling interface, and improved the overall design of parametric modeling. Calculate the carbon emissions of prefabricated components through parameterized models, compare and analyze the main sources of carbon emissions, and guide the design direction based on carbon reduction strategies, providing reference value for parameterized design research. By designing geometric models of different types of prefabricated components, establish a logical relationship between the insertion point and positioning point of the model. The results indicate that parameterized modelling can achieve the modification of parameter linkage models, greatly improving efficiency. Write the main program for two modeling methods: driver system family and self-built family, and achieve automatic model creation with given parameters [10]. A modelling method based on prefabricated shear walls and edge component segmentation is proposed to address the issue of steel reinforcement configuration not being automatically changed according to the model during the modelling process. A parameterized method for creating openings was proposed for multi-opening shear walls. According to the design specifications for prefabricated buildings, a reinforcement model for prefabricated components was established. Use RevitAPI to generate a function for reinforcing steel, write a program for reinforcing steel, and automatically create reinforcing steel with the required parameters given [11].

In recent years, with the advancement of neural networks, people have gradually shifted their research focus from text to images. In response to the above-mentioned issues between architectural images, some scholars have proposed a key point extraction method based on a combination of traditional algorithms and convolutional neural networks and added attention mechanisms to improve accuracy. It is precisely because of the emergence of convolutional neural networks that image information can be transformed into a user-friendly form, making it easier for people to solve problems in the field of images. At present, traditional algorithms and convolutional neural networks are techniques for handling the relationships between images. The existing convolutional neural network models and traditional algorithms extract image features from different perspectives, and a single method alone cannot provide a comprehensive feature description of the image [12]. In the field of image keypoint extraction, architectural images cannot use a single method to improve the accuracy of matching due to the complexity of the information they contain. The foundation of the research is to handle the relationship between extracted image features, in order to solve problems in fields such as image recognition and image retrieval. Using the same method to describe key points, obtaining corresponding feature vectors and rich key point information, and conducting experimental verification to compare the accuracy with the original two algorithms. Combining the SIFT algorithm with the ORB algorithm to extract different key points and improve matching accuracy.

The innovative concepts proposed in this article cover multiple aspects of the field of architectural design. These innovations not only enhance the level of personalization and refinement in design but also promote the deep integration of technology and design, as well as a significant increase in user engagement.

Firstly, we introduced the concept of customized architectural design frameworks. The core of this framework lies in utilizing parametric modelling and CAD technology to take the architectural design process to a whole new level. Quickly generate building design solutions that meet their expectations through parametric modelling. This not only greatly enhances the personalized level of design, but also makes the design process more refined and flexible.

Secondly, we focus on the concept of interdisciplinary integration. In today's society, the rapid development of technology has brought unprecedented opportunities to various industries. This interdisciplinary integration concept not only promotes technological innovation in the field of architectural design but also injects new vitality into the development of the entire industry.

Finally, we emphasize the importance of user engagement and feedback integration. In the traditional architectural design process, users often passively accept the design results, making it difficult to express their true needs and opinions. Our research continuously improves the design framework based on user input, enabling users to actively participate in the design process.

2 RELATED WORK

As the scale, shape, and function of engineering construction projects become increasingly complex, building system design tends to be refined and personalized. Máder et al. [13] designed an Auto CAD network architectural design teaching system with personalized architectural design as the core. This system not only analyzes and compares teaching modes based on network architecture design but also introduces clustering analysis technology into course resource management to more accurately push course resources that meet the interests and needs of students. This system is based on Auto CAD technology and supports collaborative design by professionals, enabling them to jointly build complex Auto CAD models. Nicoletti et al. [14] share models, communicate design ideas in real-time and quickly adjust design solutions based on user-personalized needs. Through this approach, designers can more efficiently and accurately meet the personalized needs of users. Through cluster analysis, the system can intelligently recommend relevant architectural design cases, teaching videos, and exercise questions to students based on their learning history, academic performance, and interest preferences, thereby achieving personalized learning. The traditional 2D design has limitations in expressing complex building structures and spatial relationships, while interdisciplinary collaborative design based on Auto CAD technology can fully utilize 3D modelling and simulation techniques. Curriculum teaching not only has a certain degree of innovation and practicality but also provides strong support for cultivating design talents with innovative spirit and practical ability. Through this system, students can gain a deeper understanding of the concepts and methods of personalized architectural design, master advanced architectural design tools and technologies, and continuously improve their design abilities and innovative literacy in practice. In addition, the system also analyzed and compared the characteristics of traditional 2D design and interdisciplinary collaborative design based on Auto CAD technology.

In personalized architectural design, especially in modern architectural design that imitates or integrates traditional elements. It is crucial to have a deep understanding of the forms and structures of ancient architecture. In order to improve the feature matching performance between images, especially when precise matching of ancient architectural elements is required in personalized architectural design, Nie et al. [15] proposed a new method FM_GMC based on grid partitioning and high-density clustering of key points in the grid. The image-based 3D reconstruction technology of ancient Chinese architecture has shown great potential in this field, but image matching is still an urgent problem to be solved. Then, divide the image into multiple grids and calculate the density of key points in each grid. Determine anchor units (i.e. areas with high key density), adjacent units (areas adjacent to anchor units), and boundary units (areas located at the edge of the image) based on the density of key points. This method not only helps to accurately capture the details of ancient buildings in 3D reconstruction but also provides strong data support for personalized architectural design. Next, based on the similarity of local regions, we cluster these marked grid regions to form multiple clusters. The grid regions within each cluster have high similarity in key point density and local features, which provides a strong foundation for subsequent key point matching. By comparing the distance ratio between each key point and its nearest neighbour and second nearest neighbour, we can select a reliable pair of matching points. To verify the effectiveness of our proposed method in personalized architectural design, Parn and Edwards [16] analyzed the network threats faced by digital building environments, as well as common data environment vulnerabilities and blockchain. It conducted experiments on the 3D reconstruction dataset of Jin Temple and 141 typical architectural images. BIM technology focuses on the planning and management of the entire lifecycle of construction projects, while GIS technology focuses on describing the existing objective reality world. Pepe and Costantino [17] are based on the industry application background, starting with the integration of the most representative IFC standard and CityGML standard in BIM and GIS. Studied the concepts of IFC standard and CityGML standard, and analyzed their characteristics and similarities and differences from three aspects: standard architecture, geometric expression, and semantic description. Combine with the surrounding three-dimensional geographic information to build a three-dimensional visualization scene that integrates BIM and GIS data. Import BIM individual building models with rich attribute information as data sources into a GIS platform that can perform large-scale spatial display. A technical roadmap for converting IFC standard building models to CityGML standard data is proposed through four main steps: geometric information, multi-scale semantic mapping, geometric expression reconstruction, and attribute information association. There are significant differences in the way they describe entity objects, and the two cannot directly achieve the interconnection of data information, which affects the efficiency of information sharing. Tastan et al. [18] analyzed the advantages of component individualization and information management in Revit software based on BIM technology, in order to draw BIM building models and integrate them with GIS platforms. The study compared the functions and data formats of traditional 3D modelling platforms and BIM modelling platforms in the construction industry. We conducted research on data fusion technology in the field of architecture based on semantic constraints and studied the characteristics of different 3D GIS platforms, as well as the display effect and semantic inheritance ability of BIM 3D building models. Taking a small villa as an example, using Revit software to draw a BIM model, and using the SuperMap plugin to achieve data conversion from BIM to GIS. The selection of the SuperMap platform as the GIS development platform for researching the integration of BIM and GIS data ensures the monolithic management of building model components and the consistency and integrity of data before and after conversion.

3 PARAMETRIC MODELING AND CAD TECHNOLOGY

3.1 Overview of Parametric Modeling

Image parameterization processing also plays a very important role in the field of architecture. To complete the parameterization processing of color-building images. Therefore, proposing a parameterized image segmentation algorithm that can meet functional requirements and is highly adaptable for the construction field is of great practical value. Whether it is image analysis or further understanding of image semantics, it is often necessary to perform segmentation operations on image parameterization and then extract meaningful regional features obtained from segmentation. In terms of current image-parameterized segmentation methods, there are two categories: one is colour image segmentation algorithms with universal applicability, and the other is segmentation algorithms proposed for specific segmentation objects in certain application fields. On the basis of using a universal colour image segmentation algorithm for parameterized segmentation of colour-building images, it is necessary to analyze the features in the building images that are highly distinguishable and can reflect the differences between different parts to the greatest extent, and integrate them into the segmentation process. So, in the field of architecture, image segmentation is a fundamental and very important task. This type of algorithm analyzes the characteristics and salient features of segmented objects and proposes corresponding segmentation methods based on this to achieve better segmentation results. In order to achieve better segmentation results, many fields have studied and improved segmentation algorithms, making them more parameterized and applicable to images in that field. There is no such targeted algorithm in the field of architecture, and any existing universal algorithm makes it difficult to achieve satisfactory results in image segmentation in any field. The current problems in the application of image parametric segmentation mainly include the following two aspects. Firstly, the algorithm has high complexity, long running time, and cannot meet the real-time segmentation requirements of users. The second is that the algorithm segmentation effect is not ideal, and the user's requirements for image segmentation quality are not met. Therefore, this article studies the algorithms in these two aspects and provides improvement plans, proposing an efficient image segmentation algorithm suitable for the construction field. Table 1 shows the typical application cases of parametric modelling in architectural design.

Application area	*Application case description*	*Advantages/effects*
Design of complex architectural skin	Designers use parametric modelling to create architectural skins with complex shapes and textures.	The architectural appearance is more artistic and modern.
Performance optimization of green building	Parametric modelling is combined with building performance analysis software to optimize energy saving, lighting and ventilation performance by adjusting design parameters.	Improve the environmental protection and sustainability of buildings.
Modular architectural design	Parametric modelling supports the design of modular buildings and quickly generates and combines building modules with preset module parameters.	Improve design efficiency and speed up project progress.

Table 1: Typical application cases of parametric modelling in architectural design.

3.2 Overview of CAD Technology

Since its birth, CAD technology has experienced many stages of development, from 2D drawing to 3D modeling, from single function to integration, and from stand-alone operation to networking. The main features of CAD technology are shown in Table 2:

Characteristic	*Characteristic description*
Precision	Provide high-precision 3D modelling and rendering.
High efficiency	Significantly improve design efficiency and reduce drawing time.
Visualization	Present the design with a 3D model to facilitate communication.
Easy to modify	Easily modify and adjust the design.
Data Sharing	Support multi-person collaborative design, data sharing, and exchange.
Automation	Provide automatic tools and algorithms to improve the design quality.
Graphic editing	Perfect graphics drawing and editing functions
Format conversion	Support a variety of graphic format conversions.
Cross-platform	Compatible with a variety of operating platforms and hardware devices

Table 2: Main characteristics of CAD technology.

The functions of CAD technology in architectural design are very rich, including 2D drawing, 3D modelling, rendering and animation demonstration. In the field of architectural design, the main applications of CAD technology are shown in Table 3:

Application area	*CAD technical function*	*Functional description*
Drawing and modification of architectural design scheme	2D drawing	Designers use CAD software to draw plans, elevations, sections, etc. to show the overall layout and details of architectural design.
	Graphic editing	Provide powerful graphic editing function to support designers to modify, adjust and improve design drawings.
3D modelling and rendering	3D modeling	Designers use CAD software to build a 3D model of the building and show the spatial structure and appearance of the building.
	Texture mapping	Adding material maps to the 3D model makes the appearance of the building more realistic and increases the visual effect of the design.
	Light and shadow rendering	Render light and shadow to simulate the real lighting effects, and make the 3D model more vivid and stereoscopic.
Virtual reality and roaming	Virtual reality scene creation	Designers create virtual reality scenes of buildings through CAD software so that users can immerse themselves in the virtual environment for roaming and experience.
	Interactive design	In the virtual reality scene, users are supported to interact with buildings, such as opening and closing doors and windows, adjusting the position of furniture, etc.
Construction drawing	Construction drawing	Use CAD software to draw construction drawings, including structural drawings, water supply and drainage drawings, electrical drawings, etc., to provide accurate guidance for construction.
	Labeling and annotation	Add annotations and notes to the construction drawing to clarify the construction requirements, material specifications, dimensions, and other information.

Table 3: Application function of CAD technology in architectural design.

3.3 Collaborative Mechanism of Parametric Modeling and CAD Technology

The collaborative mechanism of parametric modelling and CAD technology is based on their complementarity and interdependence in architectural design.

In the process of collaboration between parametric modelling and CAD technology, some challenges may be encountered, such as compatibility of data exchange and complexity of software operation. In order to solve these challenges, the measures in Table 4 can be taken:

Challenge	*Solution*
Compatibility of data exchange	Choose a software platform that supports multiple data formats.
Complexity of software operation	Provide designer training and technical support.
Collaboration of collaborative work	Formulate clear cooperative work norms and

	processes.

Table 4: Collaborative challenges and solutions.

4 CONSTRUCTION OF PERSONALIZED ARCHITECTURAL DESIGN MODEL

4.1 Design Requirements Analysis

Understanding and accurately grasping the needs of users is crucial in the early stages of personalized architectural design. In order to do this, this paper first conducts a detailed survey of user needs. Through in-depth communication and questionnaire surveys with potential users (including owners, architects, designers, etc.), we have collected a lot of demands and expectations about personalized architectural design.

Next, this paper carefully analyzes and sorts out the collected requirements and extracts the key design principles. These principles not only reflect users' specific requirements on the appearance, function, and performance of buildings but also reflect their pursuit of modern design concepts such as environmental protection, sustainability, and cultural integration. These principles will serve as the basis and guidance for the subsequent design model construction.

4.2 Design Model Construction

After defining the design requirements, we began to build a model of personalized architectural design. In the design model construction stage, this paper first defines and quantifies the design objectives. These goals include the appearance effect, functional layout and performance of the building, and also consider the requirements of users for environmental protection and sustainability.

$$F = f\begin{pmatrix} \text{Appearance effect} \\ \text{Functional layout} \\ \text{Performance performance} \\ \text{Environmental protection requirements} \end{pmatrix} \tag{1}$$

$$P = \ \ p_1, p_2, p_3, \ldots, p_n \tag{2}$$

Where p_i stands for the i design parameters, such as building size, shape, material selection, structural type, etc.

In this study, we employ the SA (Simulated Annealing) algorithm to refine the design parameters. This approach mimics the cooling process during solid annealing, effectively preventing entrapment in local optimum solutions. The SA algorithm, inspired by the annealing procedure undergone by solid materials, is a heuristic global optimization technique. This process involves heating the material to a specific temperature followed by gradual cooling, aiming to enhance its internal structure (refer to Figure 1). Similarly, in the optimization problem, the SA algorithm can jump out of the local optimal solution by allowing the poor solution to be accepted at higher temperatures, gradually fine-tuning the quality of the solution with the decrease of temperature, and finally approaching the global optimal solution.

In this algorithm, the objective function: $F\ \ x$. The objective function value when evaluating the design parameter BB, such as the cost, performance, or other indicators of the building.

Initial temperature: T_0 . The temperature setting at the beginning of the algorithm affects the initial exploration stage. Temperature drop function:

$$T\ \ t\ \ = T_0 \cdot e^{-\frac{t}{\tau}} \tag{3}$$

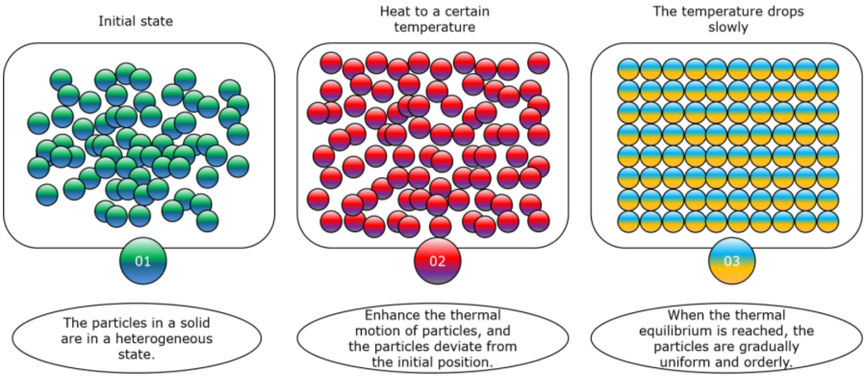

Figure 1: SA algorithm.

Where t is the number of iteration steps and τ is the temperature attenuation parameter, which determines the speed of temperature drop.

The acceptance probability function determines whether the current solution x' should be accepted, and its formula is:

$$P\ acceptance\left|F\ x',F\ x\right.=\min\left(1,\exp\left(-\frac{F\ x'-F\ x}{T\ t}\right)\right) \tag{4}$$

Here, $F\ x'$ represents the objective function value of the newly generated solution, while $F\ x$ denoting the objective function value of the current solution. With decreasing temperature, the algorithm increasingly favours the acceptance of superior solutions.

Design parameter update formula:

$$X_{new}=X_{old}+\alpha\cdot\Delta x \tag{5}$$

Where x is the step coefficient and Δx is the new design parameter variation, which is obtained by simulating the solid annealing process at the current temperature?

Iteration termination condition:

$$\begin{aligned}&if\ T\ t\ \leq \text{Termination temperature}\\&\quad\text{or The number of iterations reaches the limit.}\end{aligned} \tag{6}$$

When the temperature reaches the preset stopping temperature or the maximum iteration count is hit, the algorithm halts its iteration process.

Meanwhile, this study also utilizes the PSO (Particle Swarm Optimization) algorithm to refine the architectural design scheme. The PSO algorithm, which simulates birds' foraging behaviours, is an optimization method rooted in swarm intelligence.

$$x_i^{|k+1|}\ d\ =x_i^{|k|}\ d\ +v_i^{|k|}\ d \tag{7}$$

$$v_i^{|k+1|}\ d\ =w\cdot v_i^{|k|}\ d\ +c_1\cdot r_1\cdot\left(p_i^{|k|}\ d\ -x_i^{|k|}\ d\right)+c_2\cdot r_2\cdot\left(g^{|k|}\ d\ -x_i^{|k|}\ d\right) \tag{8}$$

$$g^{|k+1|}\ d\ =x_i^{|k+1|}\ d \tag{9}$$

$$U=u\ \text{User demand},S \tag{10}$$

After many iterations and optimization, a personalized architectural design model that meets the needs of users and is innovative is finally obtained.

4.3 Model Verification and Optimization

After completing the preliminary construction of the design model, it is necessary to verify its rationality and effectiveness. The specific steps of the simulation experiment in this section are as follows: ⊖ According to the experimental requirements, select appropriate simulation software, including BIM software and parametric design software. ⊜ According to the characteristics and requirements of personalized architectural design, design an experimental scene that conforms to the actual situation, including the building environment, climatic conditions, use functions, etc. ⊛

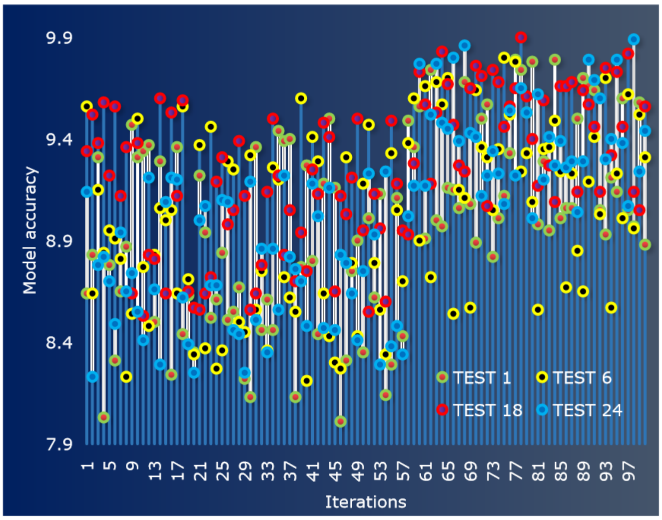

Figure 2: Accuracy of model.

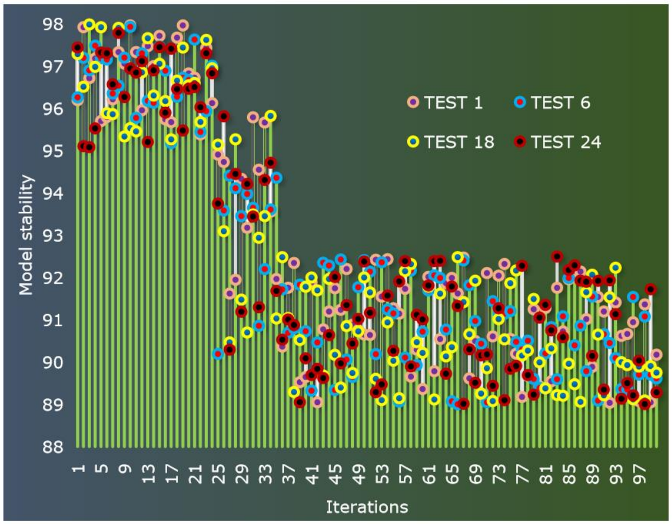

Figure 3: Stability of the model.

Build an experimental environment in the simulation software and set relevant parameters, such as building size, material properties, environmental variables, etc. ④ Run the simulation experiment according to the experimental steps and parameter settings, and observe and record the experimental results. When building an experimental environment, this paper focuses on simulating the complexity and diversity of the real world. By adjusting environmental parameters (such as temperature, humidity, illumination, etc.) and building parameters (such as structure type, material selection, building size, etc.), we have constructed several different experimental scenes. These scenarios aim to comprehensively evaluate the performance of personalized architectural design models under different conditions. In the parameter setting, this paper fully considers the user's needs and design requirements. By setting reasonable parameter ranges and constraint conditions, the rationality and feasibility of the design scheme are ensured. Figure 2 shows the accuracy of the model, and Figure 3 shows the stability of the model. Figure 4 shows the user's rating results. User feedback is shown in Table 5.

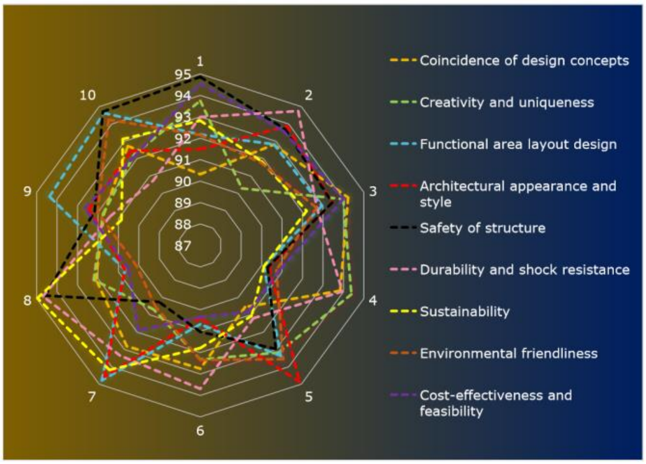

Figure 4: User's rating results.

Feedback type	*Design model evaluation*	*Practical application effect*	*Exist problem*
Positive feedback	Excellent	The design efficiency is improved.	A few functions need further optimization.
Negative feedback	Common	Some operations are not intuitive enough.	User experience needs to be improved.
Suggestion	Good	Meet individual needs	Expect to add more customization options.
Doubt	Tolerableness	Not yet fully experienced	Looking forward to more practical cases
Other	Qualified	Helps the project to advance.	Need more user education and support.

Table 5: User feedback table.

The model demonstrates remarkable accuracy, achieving over 96%. It also exhibits strong stability, maintaining a consistent performance of around 90%. Users have provided positive feedback, indicating that the model's rating results are satisfactory. High precision guarantees the model's data processing accuracy and reliability, while its stability ensures consistent performance under various conditions. The positive user feedback underscores the model's practical value and effectiveness. These accomplishments highlight the model design's reliability and pave the way for its future application and advancement.

5 PERSONALIZED ARCHITECTURAL DESIGN MODEL APPLICATION AND CASE ANALYSIS

The application scenarios of personalized architectural design models are varied, from residential buildings, and commercial buildings to public facilities, and each scenario has its unique needs and challenges. When applying a personalized architectural design model in different scenarios, it is necessary to formulate corresponding application strategies. First of all, we should clarify the specific needs and objectives of the project so as to choose the appropriate model and parameter settings. Secondly, the feasibility and operability of the project should be fully considered to ensure the smooth implementation of the design scheme. In addition, we need to pay attention to the sustainability and future development of the project to ensure that the design scheme can adapt to future changes and developments.

In the design of residential buildings, personalized demand is particularly prominent. Every family has its own unique lifestyle and aesthetic preferences, so the personalized architectural design model can provide customized design schemes according to the specific needs of users (as shown in Figure 5). The model can flexibly adjust the layout, function, and appearance of the house through parametric design to meet the user's requirements for comfort, privacy, and aesthetics. At the same time, the model can also consider the harmony between the house and the surrounding environment and realize the harmonious symbiosis between architecture and nature.

Figure 5: Example of residential building design.

The core of commercial building design is to attract customers and enhance commercial value. A personalized architectural design model can provide an attractive design scheme according to the positioning of commercial projects and target customer groups. By introducing innovative design concepts and elements, the model can create a unique business atmosphere and attract customers' attention and interest (Figure 6). In addition, the model can also consider the sustainable development of commercial buildings, reduce operating costs, and enhance commercial value through measures such as energy saving and environmental protection.

The design of public facilities needs to meet a wide range of social needs and public interests. Personalized architectural design models can provide a humanized, convenient, and beautiful design scheme according to the specific functions and use requirements of public facilities (Figure 7). In the design of educational facilities, the model can design a dynamic and innovative learning environment according to students' learning and living needs. In the design of medical facilities, the model can consider patients' physical and mental health and comfort and create a warm and quiet medical atmosphere.

Figure 6: Examples of commercial building design.

Figure 7: Examples of public facilities design.

In the design practice, this paper uses a personalized architectural design model to design the scheme. First of all, collect the relevant information and data of the project, and make clear the needs and objectives of the project. Then, according to the characteristics of the project, choose the appropriate model and parameter settings, and use the model to design the scheme. During the design process, this study prioritizes communication and feedback from users to guarantee that the design scheme aligns with their expectations and requirements.

After the design is completed, the application effect of the design scheme is evaluated and analyzed. This paper evaluates the effect of the design scheme from many angles, including appearance effect, functional layout, performance performance and so on. The specific results are shown in Figure 8.

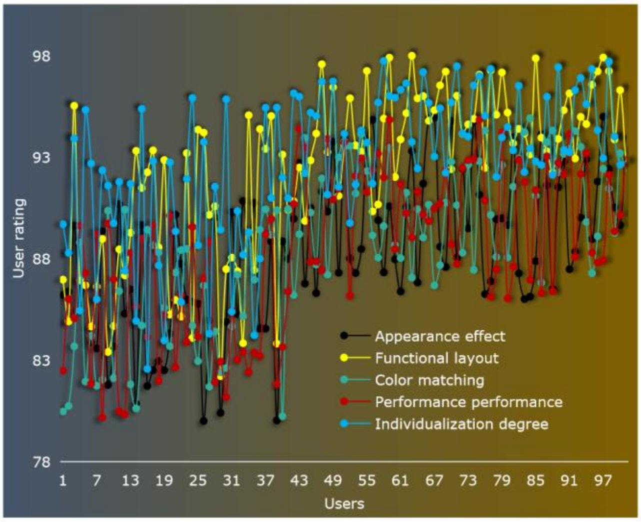

Figure 8: Comprehensive evaluation of the design scheme.

It can be seen that the design scheme has a high score in appearance effect, functional layout, performance and so on, reaching more than 90% comprehensively and performing well. This fully shows that the architectural design scheme has excellent design level and practical value, and can well meet the needs and expectations of users.

6 CONCLUSION AND PROSPECT

Through an in-depth exploration of personalized architectural design, the combination of parametric modelling and CAD technology has achieved remarkable results and discoveries. This achievement not only marks significant progress in the field of architectural design but also brings us profound industry insights. Firstly, a personalized architectural design model integrating parametric modelling and CAD technology was successfully constructed. The emergence of this model has completely changed the limitations of traditional architectural design, making the design truly customized according to users' personal needs and preferences. By accurately capturing every detail requirement of the user, our model can generate architectural design solutions that meet both user expectations and are full of personality. Secondly, through a series of rigorous simulation experiments and case studies, the effectiveness and practicability of this model are verified. The experimental results show that the model exhibits high efficiency and accuracy in generating personalized architectural designs. It can not only quickly generate design solutions but also make real-time adjustments and optimizations based on user feedback, ensuring that the final design results can perfectly meet user needs. During the research process, I deeply realized the enormous advantages of the synergistic effect of parametric modelling and CAD technology. The combination of these two technologies enables us to have a deeper understanding and control of every detail and variable in architectural design. Through parametric modelling, we can flexibly adjust various parameters of the building, such as size, shape, materials, etc., thereby generating an infinite number of possible design solutions. CAD technology provides powerful drawing and rendering capabilities, allowing us to present design results in a more intuitive and realistic way.

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