

Optimization and Application of Artificial Intelligence Algorithms in Computer-aided Interior Design

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Abstract—Influenced by traditional interior design concepts, the application effect of computer-aided interior design is not satisfactory and cannot effectively meet people's requirements for interior design. Therefore, in practice, to fully develop the effect of the application of computer-aided interior design, its optimization and improvement must be carried out. To this end, the article combined the advantages of artificial intelligence (AI) algorithms in computer-aided interior design, starting from three aspects: graphic rendering technology, 3D modeling technology, and computer-aided interior design based on intelligent algorithms, and conducted a specific analysis and exploration of the utilization of AI algorithms in computer-aided interior design. The results showed that the accuracy of computer-aided interior design based on AI algorithms reached up to 95%, which can better serve customers.

Keywords—interior design, computer-aided technology, artificial intelligence algorithm, graphics rendering, 3-dimensional model

I. INTRODUCTION

As China's rapid economic level and people's requirements for interior design continue to improve, computer-aided interior design as an emerging technology has received widespread attention and application. However, due to the influence of traditional interior design concepts, the utilization effect of computer-aided interior design is not ideal and cannot fully meet people's needs for interior design. To fully tap into the potential of computer-aided interior design and achieve higher quality design results, there is a need to optimize and improve it.

The article takes the utilization of AI algorithms in computer-aided interior design as the starting point, aiming to explore how to improve the utilization effect of computer-aided interior design through optimization and improvement. Starting from the perspective of graphic rendering technology, how to use AI algorithms to achieve more realistic lighting effects and material details is analyzed, in order to enhance the realism of design effects. Next, 3D modeling technology is focused on, and how to use AI algorithms to assist designers in transforming creativity into specific object shapes is explored. Design details are adjusted and optimized in real-time to provide more accurate design guidance.

II. RELATED WORK

There is currently a lot of research on computer-aided interior design. For example, Xu Qingchao explored the utilization of computer-aided design software in interior design [1]. Sun Meng mainly analyzed the utilization of computer-aided design software in interior design, hoping to provide guidance for industry designers [2]. Zhang Weimin mainly analyzed the advantages of using computer-aided software in interior design, and analyzed the utilization methods of computer-aided software in interior design from various aspects [3]. Tang Letian forward the analysis of the innovation strategy of interior design teaching based on virtual reality technology [4]. Combined with the application of lighting simulation technology in interior design teaching, Zang Hui proposed the application path of lighting simulation technology in interior design teaching [5]. The above research has played a certain role in enhancing the effectiveness of interior design, but still needs improvement.

Of course, many people have discussed the application of artificial intelligence algorithms. Le Gallo, Manuel, proposed a 64-core hybrid signal memory computing chip based on phase change memory for deep neural network inference [6]. Charbuty, Bahzad studied the classification based on the decision tree algorithm for Azure Machine Learning Integration [7]. Palanisamy, Rajarathinam used an improved genetic algorithm to optimize the experimental study and comparative harmonics to improve the power quality [8]. Nurkholis, Andi applied the optimal parameter SVM and the firefly data algorithm to the data Openi film [9]. Aldino, Ahmad Ari studied the application of support vector machine algorithm in the classification of low corner community in Timur City [10]. These studies are very thorough for the application of each AI algorithm, but they are not very universal.

III. COMPUTER-AIDED INTERIOR DESIGN SYSTEM

The article first studies the framework of a computer-aided interior design system, which combines AI algorithm optimization and practical design applications. The following provides a detailed introduction to the various modules and their interrelationships of this system framework. The main content of the system framework is shown in Figure 1.

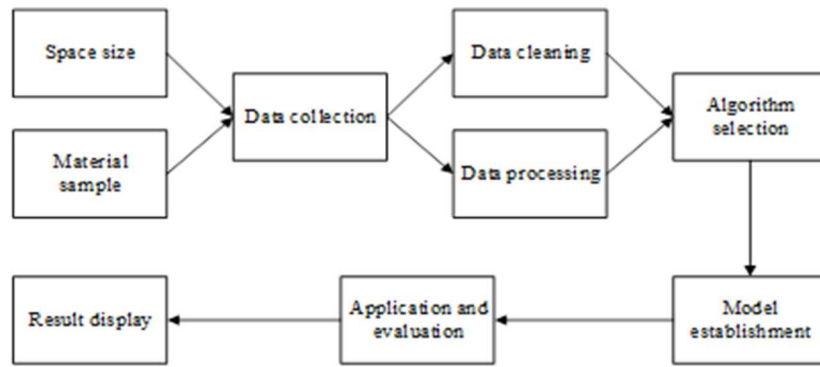


Fig. 1. System framework diagram

As shown in Figure 1, it is a computer-aided interior design system that includes a data acquisition and processing module: responsible for collecting interior design related data, such as spatial dimensions and material samples, cleaning and processing the data for subsequent analysis and application. The remaining modules include AI algorithm selection and modeling, application and evaluation, and result display and summary.

A. Graphic Rendering Technology

Graphic rendering technology is an important component of computer-aided interior design and one of the important contents of current interior design, playing a very important role. In practical applications, if the interior design renderings cannot reflect their intended visual effects, graphic rendering technology can be used to render them to meet people's needs for interior design renderings. Currently, there are two main forms of graphics rendering technology, namely hardware based graphics rendering and software based graphics rendering. Among them, hardware based graphics rendering refers to the use of computers to simulate the actual situation of physical objects in the real world, transforming them into data forms that computers can accept and recognize. Software based graphic rendering refers to the use of computers for data analysis and processing, simulating and displaying interior design schemes. These two graphic rendering techniques each have their own characteristics, but they have a very wide range of applications in interior design.

Hardware based graphics rendering technology is a common type of graphics rendering technology with a wide range of applications, mainly including computer graphics rendering, game development, and interior design scheme simulation. They use computers to simulate and showcase the virtual world, thereby enhancing the user's experience of the virtual environment and playing an important role in interior design.

The graphic rendering technology based on software implementation utilizes computer software to simulate and display interior design schemes, providing intuitive and clear images with flexibility and readability. Designers can simulate the visual effects of design schemes through software and make real-time modifications and adjustments, making the design process more intuitive and vivid. However, this technology may only be able to be demonstrated in simple ways and require extensive use of computer software for operation.

The impact of AI algorithm optimization on graphic rendering technology is mainly reflected in two aspects:

firstly, it can promote the development of graphic rendering technology, improve the quality of interior design renderings, and meet people's high requirements for indoor space environment. Secondly, in the process of computer-aided interior design, the reasonable use of AI algorithm optimization technology can improve the combination of graphic rendering technology and computer-aided systems to meet people's high demand for indoor space environment [11].

B. 3D Modeling Technology

In computer-aided interior design, spatial layout should be determined based on actual needs. In general, when conducting spatial layout, the following points should be considered: first, it is necessary to ensure that the indoor space has a certain spatial scale. Generally speaking, when conducting computer-aided interior design, it is important to ensure that the indoor space has a certain scale. For example, when placing the sofa, it should be ensured that it is in the center position in the living room. Meanwhile, the placement of sofas should also be determined based on people's daily usage habits and furniture placement. Secondly, it is important to ensure that the placement of furniture matches the spatial dimensions. In addition, attention should also be paid to the angle of furniture placement. For example, when designing a dining table, the distance between the table and the dining chairs should be considered. Thirdly, it is necessary to ensure that the indoor space has a certain degree of transparency. In general, when conducting computer-aided interior design, indoor space permeability issues should also be determined based on indoor environment and building characteristics. For example, when designing a bedroom, furniture can be placed in the center of the bedroom. In addition, the depth of the room should be reasonably controlled. In general, when the depth of a room exceeds 6 meters, a shallower furniture layout should be used to ensure that the indoor space has a certain degree of transparency.

Furniture placement is also a very important aspect in computer-aided interior design. The rationality of furniture placement directly affects the quality of the entire interior design scheme. Therefore, when placing furniture, attention should be paid to the following points: first, spatial layout should be emphasized. When conducting computer-aided interior design, the spatial layout should be determined based on the interior design scheme and customer needs, in order to better improve the level of computer-aided interior design. At the same time, reasonable arrangements should be made for furniture placement, color matching, and other content to improve the effectiveness of computer-aided interior design. Secondly, attention should be paid to the rationality of

furniture placement. When placing furniture, the position and direction of furniture placement should be determined based on customer needs and spatial layout to better meet people's needs. Meanwhile, attention should also be paid to the distance between furniture and walls. In practical work, usually when the room area is small, it can be used as the main furniture placement position. Thirdly, attention should be paid to color matching. When conducting computer-aided interior design, it is necessary to apply it reasonably based on the characteristics of different colors. Usually, color matching schemes should be determined based on spatial layout and customer needs. Meanwhile, attention should also be paid to the impact of color matching on the interior design effect.

In practical work, it is necessary to combine the characteristics of the room, the owner's preferences, and other factors to arrange decorative paintings and ornaments reasonably. In general, the placement of decorative paintings and ornaments should be coordinated with the spatial layout and should be in line with the owner's preferences. For example, in decorative paintings, flowers, animals, etc., can be used as the main decorative content to enhance the owner's interest in life. In addition, when placing decorative paintings, attention should also be paid to the following points: first, the selection of decorative paintings and ornaments should be combined with the overall style and decoration effect of the room. Usually, when choosing decorative paintings and ornaments, the overall style of the room should be taken into consideration. In interior design, color is an important design element. Meanwhile, attention should also be paid to avoiding the occurrence of too many or too few colors. Finally, attention should also be paid to the size of the frame. Usually, the size of the frame has a significant impact on the placement of decorative paintings. Therefore, in practical work, the issue of frame size should be reasonably controlled. Therefore, in practical work, the level of AI algorithms should be continuously optimized and improved to improve design quality and effectiveness [12].

C. Computer-aided Interior Design Based on Intelligent Algorithms

In the current era, the utilization advantages of AI algorithms in computer-aided interior design are mainly reflected in the following aspects: (1) it promotes the improvement of design efficiency. AI algorithms can effectively improve design efficiency and have high design quality. (2) It can effectively solve problems that are difficult to solve manually. The application of AI algorithms in interior design can effectively solve problems that are difficult to solve manually, thereby improving the quality of interior design. (3) AI algorithms have certain advantages in interior design. It can fully leverage its advantages in data processing and image processing, thereby promoting the improvement of computer-aided interior design level. In summary, computer-aided interior design based on AI algorithms has certain advantages in practical work, which can effectively improve the efficiency and quality of computer-aided interior design and promote the growth of China's interior design industry.

In computer-aided interior design, intelligent algorithms can mainly achieve automatic generation of interior design schemes, which have high practicality and accuracy, and can effectively enhance the efficiency of interior design. The intelligent algorithms used in the article include linear regression model, support vector machine, and neural network. The main calculation formulas are as follows:

$$y = \gamma_0 + \gamma_1 a_1 + \dots + \gamma_n a_n + \delta \quad (1)$$

In Formula (1), y is the dependent variable; a is the independent variable; γ is the regression coefficient; δ is the error term.

$$f(x) = \sum_{i=1}^n u_i v_i K(x_i, x) + b \quad (2)$$

In Formula (2), $f(x)$ is the output result of the classifier; u_i represents the Lagrange multiplier; v_i represents the sample label; $K(x_i, x)$ indicates the kernel function; b shows the bias term.

$$q = \sum_{i=1}^n w_i c_i + b \quad (3)$$

In Formula (3), q represents the output result of the neural network; w_i represents the connection strength between the input layer and the hidden layer; c_i represents the nodes of the input layer [13].

The generation of interior design schemes mainly includes the following aspects: (1) the requirements and aesthetic requirements that people put forward for the indoor environment in the current era are analyzed; (2) based on the needs of different groups of people for indoor environment, indoor design schemes that meet the needs of different groups of people are determined; (3) in the design process, intelligent algorithms are utilized to analyze the indoor environment needs of different groups of people, to determine interior design solutions that meet the needs of different groups of people. In the above steps, AI algorithms can effectively achieve automatic generation of interior design schemes. Among them, AI algorithms have strong feasibility and accuracy. Based on this, relevant personnel can automatically generate interior design schemes through intelligent algorithms, thereby improving the level of computer-aided interior design.

The main purpose of drawing indoor renderings is to showcase the spatial layout, size, required decorative materials, and various furniture of the interior. In interior design, AI algorithms can fully leverage their advantages and promote the drawing of interior design renderings through their own advantages. Therefore, in computer-aided interior design, AI algorithm based computer-aided interior design technology should be actively adopted to promote the improvement of the level of interior design rendering. In addition, when carrying out computer-aided interior design, the collection and organization of relevant data should be strengthened, and according to the relevant data, scientific and reasonable interior rendering drawing program is formulated, so as to effectively improve the level of interior rendering drawing [14].

IV. SYSTEM TESTING EXPERIMENT RESULTS AND DISCUSSION

Before conducting the experiment, the article first collected a dataset from the system data of a certain decoration and design company, as shown in Table 1.

TABLE I. RELATED DATASETS

Name	Type	Size	Description
Interior design material library	Images, Text	1024, 530	Includes interior design materials of different styles, such as furniture, decorations, etc.
User behavior	User	1.3	User's operational behavior

data	behavior records	million	data in interior design software
Interior design case data	Images, Text	420	Data of interior design cases of different styles
Interior design parameter data	Numerical	1120	Data of different interior design parameters, such as space size, furniture layout, etc.
Interior design effect evaluation data	Text, Numerical	370	User's evaluation data of different interior design effects

Table 1 lists several datasets used in computer-aided interior design. These datasets include an interior design material library, user behavior data, interior design case data, interior design parameter data, and interior design effect evaluation data. Next, the article evaluated the application effect of AI algorithms in computer-aided interior design from three aspects: accuracy, efficiency, and innovation based on the above dataset. The results are shown in Figure 2, Figure 3, and Figure 4, respectively.

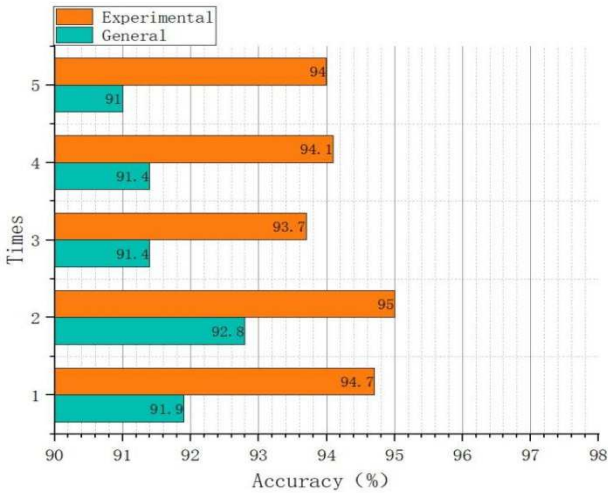


Fig. 2. Accuracy

Through the analysis of Figure 2, it can be seen that the accuracy of general computer-aided interior design was the highest at 92.8% and the lowest at 91%, and the calculated average accuracy was 91.7%; the accuracy of computer-aided interior design studied by the experimental institute reached 95% at the highest and 93.7% at the lowest, with an average accuracy of 94.3% calculated. The computer-aided interior design based on AI algorithms studied by the experimental institute had higher accuracy and could better design their ideal living environment for customers.

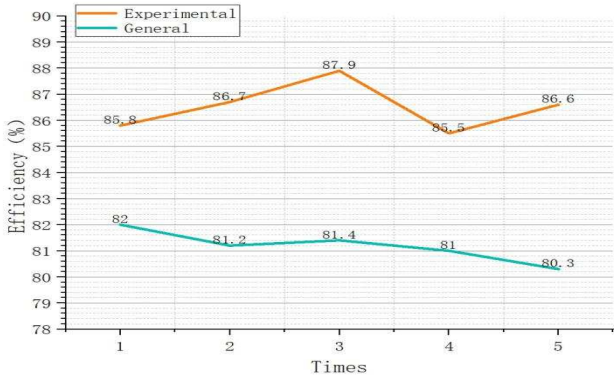


Fig. 3. Efficiency

Through the analysis of Figure 3, it can be seen that the efficiency of computer-aided interior design was generally the highest at 82% and the lowest at 80.3%, and the calculated average efficiency was 81.18%; the efficiency of computer-aided interior design studied by the experimental institute reached the highest of 87.9% and the lowest of 85.5%, and the calculated average efficiency was 86.5%. The computer-aided interior design based on AI algorithms studied by the experimental institute had higher efficiency and could provide services to customers more efficiently.

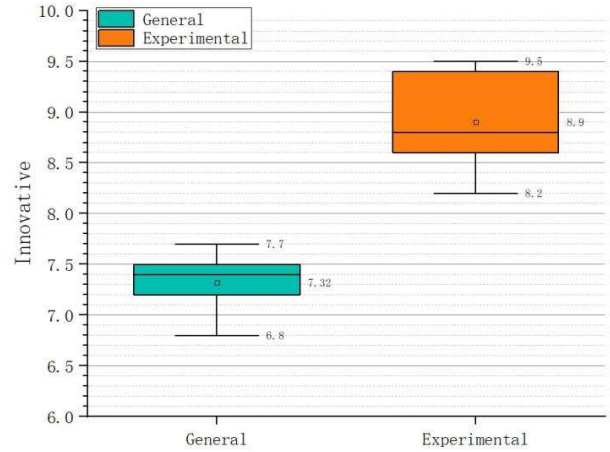


Fig. 4. Innovation

Through the analysis of Figure 4, it can be seen that the innovation score of the design results of general computer-aided interior design was the highest at 7.7 points and the lowest at 6.8 points, and the calculated average score was 7.32 points; the innovation score of the design results of computer-aided interior design studied by the experimental institute was the highest at 9.5 points and the lowest at 8.2 points, and the calculated average score was 8.9 points. The design results of computer-aided interior design based on AI algorithms studied by the experimental institute had higher innovation. Finally, the article applied the developed computer-aided interior design method to practical operations and conduct a satisfaction survey. The findings are described in Table 2.

TABLE II. SATISFACTION SURVEY

	Excellent	Great	Good	General	Poor
Convenience	18%	20%	20%	37%	5%
Interface design	18%	15%	23%	36%	8%
Interaction effect	17%	20%	23%	30%	10%
Functionality	18%	15%	20%	37%	10%

In Table 2, among the satisfaction survey results on convenience, 18% of respondents thought it was excellent; 20% thought it was very good; 20% thought it was good; 37% thought it was average; 5% thought it was poor. In the satisfaction survey results of interface design, 18% of respondents thought it was excellent; 15% thought it was very good; 23% thought it was good; 36% thought it was average; 8% thought it was poor. In the satisfaction survey results on the interaction effect, 17% of respondents thought it was excellent; 20% thought it was very good; 23% thought it was good; 30% thought it was average; 10% thought it was poor. In the results of the functional satisfaction survey, 18% of respondents thought it was excellent; 15% thought it was very good; 20% thought it was good; 37% thought it was average; 10% thought it was poor.

AI algorithms can provide more accurate and personalized design solutions by analyzing and learning from a large amount of interior design data. Through machine learning and deep learning algorithms, user preferences and needs can be analyzed, providing users with design solutions that better meet their needs. Meanwhile, it can improve design efficiency and quality by optimizing the design process. By optimizing each link in the design process, designers can reduce their workload, improve design efficiency, and ensure design quality. Through virtual reality and augmented reality technology, users can experience design solutions in a virtual environment, thereby gaining a more intuitive understanding of design effects and providing more references for the selection of design solutions.

V. CONCLUSIONS

Through the above analysis, it can be observed that in the process of computer-aided interior design, to make it more widely used, AI algorithms need to be continuously optimized and improved, so as to enhance the application effect of computer-aided interior design. With the continuous improvement of scientific and technological level, people's requirements for interior design are also constantly increasing. In the article, the application of AI algorithms in computer-aided interior design was analyzed and discussed in detail from three aspects: graphic rendering technology, 3D modeling technology, and computer-aided interior design based on intelligent algorithms. It is believed that with the continuous improvement of the advantages of AI algorithms in computer-aided interior design, its application effect would also be better reflected.

REFERENCES

- [1] Xu Qingchao. Discussion on the application of computer-aided design software in interior design [J]. Foshan Ceramics, 2023, 33(1):73-75
- [2] Sun Meng. Application of computer-aided design software in interior design [J]. Software, 2022, 43(2):4-6
- [3] Zhang Weimin. Effective application of computer-assisted design technology in interior design [J]. Electronic Testing, 2022, 36(16):119-121
- [4] Lateef Haroon PS, A., Patil, S.N., Bidare Divakarachari, P., Falkowski-Gilski, P. and Rafeeq, M.D., 2024. An optimized system for sensor ontology meta-matching using swarm intelligent algorithm. *Internet Technology Letters*, p.e498.
- [5] Zang Hui, Song Jirong. The integration methods and methods of lighting simulation technology and interior design teaching [J]. Lights and lighting, 2023, 47(2):6-9
- [6] Le Gallo, Manuel, et al. A 64-core mixed-signal in-memory compute chip based on phase-change memory for deep neural network inference [J]. *Nature Electronics* 2023 6(9): 680-693.
- [7] Charbuty, Bahzad, and Adnan Abdulazeez. Classification based on decision tree algorithm for machine learning [J]. *Journal of Applied Science and Technology Trends* 2021 2(01): 20-28.
- [8] Palanisamy, Rajarathinam, et al. Experimental investigation and comparative harmonic optimization of AMLI incorporate modified genetic algorithm using for power quality improvement [J]. *Journal of Intelligent & Fuzzy Systems* 2022 43(1): 1163-1176.
- [9] Nurkholis, Andi, Zaenal Abidin, and Heni Sulistiani. Optimasi Parameter Support Vector Machine Berbasis Algoritma Firefly Pada Data Opini Film [J]. *Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi)* 2021 5(5): 904-910.
- [10] Prudviraj, J., Sravani, Y. and Mohan, C.K., 2023. Incorporating attentive multi-scale context information for image captioning. *Multimedia Tools and Applications*, 82(7), pp.10017-10037.
- [11] Jiang Bowen. Global lighting technology in computer graphics rendering [J]. *Communication World*, 2021, 28(8):7-9
- [12] Deng Junyong and Ma Qingqing. A high-performance SpMV dedicated accelerator structure for graphics rendering [J]. *Small Microcomputer System*, 2021, 42(3):584-588
- [13] Guan Yang. Research on graphic texture rendering algorithm based on image enhancement [J]. *Information Technology*, 2021, 45(11):66-70
- [14] Patil, S., Balmuri, K.R., Frnda, J., Parameshachari, B.D., Konda, S. and Nedoma, J., 2022. Identification of Triple Negative Breast Cancer Genes Using Rough Set Based Feature Selection Algorithm & Ensemble Classifier. *Human-centric computing and information sciences*, 12.