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Integration and Application of CAD and Reinforcement Learning in Advertising Art Design

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Abstract. This article aims to explore the integration and application value of CAD (Computer-Aided Design) and RL (Reinforcement Learning) in advertising art design. In order to achieve this goal, this article constructs an advertising art design model based on a CAD system, introduces an RL algorithm to optimize the design scheme, and verifies its effectiveness and superiority through simulation experiments. During the experiment, the initial advertising design scheme was generated by using CAD software, and it was input into the RL algorithm for training and optimization. The results show that the quality score of the design scheme of this method is as high as 9 points, and the average response time is only about 1.89 seconds. The score of the scheme before optimization is only about 5.3, while the score after optimization is as high as 9.4. This shows that the optimized design scheme has shown significant improvement in attractiveness, innovation, and other evaluation indicators. At the same time, the combination of CAD and RL can improve the efficiency of advertising art design. This research confirms that the combination of CAD and RL in advertising art design holds substantial practical worth and ample room for further development.

Keywords: Computer-Aided Design; Reinforcement Learning; Advertising Art Design
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1 INTRODUCTION

In modern society, advertising art design has become one of the important means of commercial competition. An excellent advertising design can not only attract consumers' attention but also effectively convey the core value of products or services, thus promoting sales. With the rapid development of digital technology, the analysis and feature extraction of advertising art images have become key tasks in the advertising industry. The introduction of advanced technologies such as computer-aided design (CAD) and reinforcement learning has brought revolutionary changes to this field. Amura et al. [1] explored how to use CAD and reinforcement learning for the analysis and feature extraction of advertising art images and analyzed how they jointly promote the progress of

advertising art. Advertising art images are an important carrier of advertising creativity and brand image. Conducting an in-depth analysis of advertising art images and extracting their key features can help to understand the theme, emotions, and intentions of advertising more accurately, thereby better attracting the attention of the target audience. CAD, as a powerful design tool, is used not only for advertising art creation but also for image analysis. Through CAD software, designers can accurately measure, locate, and edit advertising art images, thereby extracting key features of the image, such as shape, colour, texture, etc. These features provide an important basis for subsequent optimization of advertising creativity and evaluation of advertising effectiveness. Therefore, advertising art design plays a vital role in marketing. With the advancement of computer technology, CAD (Computer-Aided Design) has become prevalent across various design disciplines, especially in advertising art design. With the rapid development of technology, artificial intelligence (AI) has gradually penetrated into every aspect of our lives, including the field of art. In the synthesis of advertising art images, AI technology is bringing unprecedented creative possibilities to creators with its unique advantages. Canet and Guljajeva [2] explored how artificial intelligence assists in the creative process of advertising art image synthesis in the context of interactive art. Interactive art is an art form that emphasizes audience participation and interaction, and artificial intelligence provides strong technical support for this art form. Through AI technology, artists can create interactive artworks that are more attractive and immersive, allowing audiences to experience and perceive art more deeply. By learning a large amount of data, AI can automatically generate creative advertising image content, such as unique backgrounds, interesting elements, etc., providing advertising designers with more sources of inspiration. CAD's robust drawing, editing, and analytical capabilities significantly enhance designers' productivity and output quality. With the rapid development and popularization of new media technology, museum advertising art design and display systems have also undergone revolutionary changes. New media provides museums with more diverse and interactive display methods, making advertising art and design more vividly presented to the audience. Cheng [3] discussed the interactive design of museum advertising art design display systems in the context of new media and analyzed the advantages and challenges it brings. The introduction of new media technology has enabled museum advertising art design to no longer be limited to traditional static displays but to present more vivid and three-dimensional advertising art design works to the audience through digital media, virtual reality (VR), augmented reality (AR) and other technological means. This transformation not only enriches the visual experience of the audience but also expands the creative space of advertising art design. In the context of new media, interactive design has become an important component of museum advertising art design display systems. Interactive design emphasizes the communication and interaction between the audience and advertising art and design works. In the realm of advertising art design, CAD facilitates the swift generation of precise graphics and images, enabling designers to achieve intricate design effects and meet dynamic market demands.

With the rapid development of computer technology, computer graphics processing plays an increasingly important role in advertising visual communication design. It not only greatly enriches the creative expression methods of advertising but also improves the dissemination effect and audience experience of advertising. Fan and Li [4] discussed the application and importance of computer graphics processing in advertising visual communication design. Computer graphics processing is a technology that utilizes computers and related software to process, edit, and create images. It can perform various operations such as transformation, synthesis, enhancement, and analysis of images, thereby generating rich and colourful visual effects. In advertising visual communication design, computer graphics processing technology provides designers with powerful tools and support. Computer graphics processing can optimize and adjust advertising images, improving their clarity and colour expression. By using techniques such as image enhancement and colour correction, advertising images can be made more vivid and realistic, attracting the attention of the audience. Recently, the emergence of artificial intelligence has ushered in fresh opportunities for design innovation. With the continuous progress of artificial intelligence (AI) technology, the education field is undergoing unprecedented changes. Especially in art advertising design education, AI-driven interactive learning methods provide students with a more personalized, efficient, and

creative learning experience. Fan and Li [5] explored the interactive application of artificial intelligence in art advertising and design education and analyzed its potential impact on teaching effectiveness and learner ability development. The introduction of artificial intelligence technology has enabled education to no longer be limited to traditional one-way teaching modes but to develop towards a more interactive and personalized direction. In art advertising design education, AI can customize personalized learning paths and content for students by analyzing their learning data, interests, and preferences. At the same time, AI can also provide real-time feedback and suggestions, helping students master knowledge and skills faster. The introduction of AI technology has brought new possibilities to art advertising and design education, helping to promote educational innovation and reform and laying the foundation for the future development of art education. Reinforcement Learning (RL), a pivotal machine learning approach, holds immense promise in intelligent design. RL continuously optimizes decision-making by facilitating interactive learning between agents and their environment to attain specific objectives.

In advertising design, pattern design plays a crucial role. In order to create unique and culturally distinctive advertising patterns, designers often need to draw on and integrate various traditional elements. Hu et al. [6] explored how to combine shape grammar and artificial neural networks to design advertising patterns with ethnic characteristics and analyzed the advantages and application prospects of this method. Shape syntax is a rule system that describes shape generation and transformation. It generates complex patterns and shapes by combining, transforming, and iterating basic shapes. In advertising pattern design, shape grammar can help designers systematically create graphics with unique aesthetics and cultural connotations. By training artificial neural networks to learn the characteristics and styles of ethnic patterns, designers can generate advertising patterns with ethnic characteristics. These patterns can maintain the uniqueness of national culture while also meeting the needs of modern aesthetics and advertising communication. In advertising art design, RL's potential applications include automated design scheme generation and parameter optimization, paving the way for more intelligent designs. Real-time interactive advertising art utilizes advanced technological means to provide viewers with a more engaging and immersive experience. Among them, the particle reinforcement learning system, as an advanced machine learning method, has brought more creativity and possibilities for real-time interactive advertising art. Jeon [7] discussed how to use particle reinforcement learning systems for real-time interactive advertising art practice and analyzed how technology and art can be integrated to promote the development of advertising art jointly. A particle reinforcement learning system is a machine learning algorithm based on reinforcement learning, which combines a particle swarm optimization algorithm with reinforcement learning to find the optimal solution by simulating the motion and behaviour of particles. Particle reinforcement learning systems can automatically generate creative advertising content by learning a large amount of data. In real-time interactive advertising art, particle reinforcement learning systems can be used to control the movement trajectory and interaction mode of advertising elements in order to achieve more vivid and interesting advertising effects.

This study aims to investigate the combined utilization of CAD and RL in advertising art design. By fusing CAD's precision with RL's intelligence, we aspire to devise a novel advertising art design methodology that elevates design efficiency, refines design schemes, and steers advertising art design toward greater intelligence. Our key innovations are: (1) Introducing a hybrid advertising art design model that integrates a CAD system with an RL algorithm, automating and intellectualizing the design process. (2) Tailoring effective state spaces, action selection strategies, and reward functions to align with advertising design's unique characteristics and demands, ensuring RL's optimal performance in this domain. (3) Validating our model's effectiveness and superiority through simulation experiments bolstering the advertising design industry's innovative development.

The paper is structured as follows: First, we present the research background and objectives, emphasizing the exploration of CAD and RL's synergistic potential in advertising art design. Next, we elaborate on the research methodologies employed and construct the CAD-RL advertising art design model. Subsequently, we showcase experimental results demonstrating the model's efficacy in enhancing design quality and efficiency. Finally, we delve into the experimental findings, summarizing the study's contributions to the field.

2 RELATED WORK

With the rapid development of artificial intelligence and machine learning, deep reinforcement learning (DRL) has gradually penetrated into multiple fields, including advertising engineering design. Lee et al. [8] explored the application cases of DRL in advertising engineering design, especially in the field of flowing sculpture art design. Case studies demonstrate how DRL can assist designers in creating more attractive and dynamic advertising works. Advertising engineering design aims to attract the audience's attention and convey brand information through innovative visual and dynamic effects. Traditional advertising design methods mainly rely on the creativity and experience of designers, but with the advancement of technology, data-driven design methods have gradually become mainstream. Deep reinforcement learning, as a powerful machine learning method, can automatically learn and optimize design decisions, bringing new possibilities to advertising engineering design. Deep reinforcement learning combines the perceptual ability of deep learning with the decision-making ability of reinforcement learning, enabling machines to learn and optimize complex tasks automatically. In advertising engineering design, DRL can be applied in multiple aspects, such as generating dynamic advertising content, optimizing user interaction, and so on. The application of computer-aided design (CAD) and reinforcement learning technologies in the field of advertising art design is gradually emerging. CAD technology provides precise and efficient drawing and design tools for advertising art design, while reinforcement learning brings intelligent and adaptive optimization capabilities to advertising art design. Li [9] discussed the application of CAD and reinforcement learning in advertising art design and analyzed how they jointly promote innovation and development in advertising art. CAD, as a powerful design tool, is widely used in various fields of advertising art design. Through CAD, designers can accurately draw two-dimensional and three-dimensional graphics, achieving precise expression and presentation of advertising works. CAD technology not only improves design efficiency but also reduces design costs, making advertising art design more efficient, accurate, and flexible. Reinforcement learning is a machine learning technique that enables machines to learn and optimize decision strategies in interaction with the environment to achieve specific goals. In advertising art design, reinforcement learning can be applied to optimize the display of advertising content, user interaction, and advertising effectiveness.

With the rapid development of information technology, big data and interactive virtual technology have gradually become important forces driving innovation in the advertising industry. In this context, digital art advertising design systems based on big data technology and interactive virtual technology have emerged, bringing unprecedented changes to the advertising industry. Li [10] discussed the principle, application, and impact of this system and looked forward to future development directions. Big data technology refers to the technique of processing data sets that are difficult to manage and process using conventional methods through specific techniques. In digital art advertising design systems, big data technology plays a crucial role. Interactive virtual technology is a computer technology that can create and experience virtual worlds. In digital art advertising design systems, interactive virtual technology provides advertising designers with vast creative space. Through technologies such as virtual reality (VR) and augmented reality (AR), designers can create an immersive advertising experience that makes users feel like they are in an advertising scene, creating a closer emotional connection with the advertising content. With the rapid progress of technology, the application of computer-aided design (CAD) in the field of advertising art is becoming increasingly widespread. It is not just a tool but also a bridge for creative realization, transforming designers' imagination into reality. In contemporary advertising art, the combination of creativity and computer-aided design has brought unprecedented innovation and development to advertising art. In advertising art design, creativity is the soul, and computer-aided design is the powerful assistant to achieve creativity. Liu and Yang [11] use CAD technology to quickly transform creative ideas in their minds into concrete images and models, enabling more intuitive and efficient design. Meanwhile, CAD technology can also assist designers in data analysis and optimization, further improving the creative effect of advertising. Computer-aided design not only provides rich creative means for advertising art but also promotes the continuous development of advertising art creativity. Through the application of CAD technology, designers can delve deeper into the connotation and potential of advertising, thereby creating more unique and creative advertising works.

With the rapid development of artificial intelligence technology, reinforcement learning, as an important machine learning method, is gradually penetrating various fields, including advertising, art, and design. The introduction of reinforcement learning artificial intelligence has had a profound impact on the process of advertising art design, not only improving design efficiency but also providing designers with new creative ideas. Qin and Jiang [12] analyzed the process in which the intelligent agent selects corresponding actions based on the current environmental state. And receive rewards or punishments based on the results of actions, thereby continuously optimizing one's behavioural strategies. In advertising art design, reinforcement learning artificial intelligence can automatically explore the optimal design solution by learning and analyzing a large amount of design data. The traditional advertising art design process requires designers to spend a lot of time and effort on manual drawing and adjustment. Reinforcement learning artificial intelligence can quickly generate multiple design solutions for designers to choose from through automated algorithms, greatly improving design efficiency. In the context of the new media era, the combination of visual communication technology and art advertising has become an important driving force for promoting innovation in the advertising industry. With the continuous development of computer-aided interaction technology, this combination has become more compact and efficient. Wang [13] explored the computer-aided interaction between visual communication technology and art advertising in new media scenarios and analyzed how they jointly promote the progress and development of the advertising industry. In the new media environment, visual communication technology has been widely applied and has become an important means of artistic advertising design and dissemination. By utilizing advanced visual design techniques and tools, designers can create more vivid, interesting, and creative advertising works, attract user attention, and improve advertising conversion rates. Through interactive design, art advertisements can interact more closely and naturally with users, improving their engagement and experience. Meanwhile, computer-aided interaction technology can also help designers better understand and analyze user behaviour and needs, thereby optimizing advertising design and dissemination strategies.

The computer perception image system has become an important tool for the design and evaluation of advertising cultural and creative products. It provides objective and quantitative evaluation criteria for designers by intelligently analyzing and processing images, helping to optimize the design of advertising cultural and creative products. Xu and Zheng [14] discussed the advantages, methods, and future development directions of designing and evaluating advertising cultural creative products based on computer perception image systems. The computer perception image system can objectively and quantitatively evaluate advertising cultural and creative products based on preset algorithms and standards. It avoids the influence of subjective factors and improves the accuracy and reliability of evaluation. Computer perception image systems can recognize and analyze subtle differences in images, such as colour, texture, shape, etc., providing designers with accurate evaluation results. This helps designers to more accurately grasp the design points of advertising cultural creative products. Virtual reality (VR) technology has brought revolutionary changes to the advertising industry. At the same time, folk art, as an important component of traditional culture, has gradually been integrated into modern advertising design. Zhang and Zhao [15] explored the application of folk art and virtual reality technology in visual advertising and analyzed how they work together to create unique and eye-catching advertising works. Folk art, as a treasure of traditional culture, has unique artistic charm and cultural connotations. The use of folk art elements in visual advertising can not only attract the attention of the audience but also convey the unique values and cultural heritage of the brand. Through the clever application of folk art elements, advertising works can be closer to the target audience and generate resonance and emotional connection. Virtual reality technology has brought a new way of expression to visual advertising with its immersive experience and highly realistic visual effects. Through virtual reality technology, advertising can create scenes and interactive experiences that transcend reality, making the audience feel as if they are immersed in the world of advertising. This innovative presentation method enhances not only the attractiveness of advertising but also audience engagement and memory.

3 REALIZATION OF ADVERTISING ART DESIGN MODEL

3.1 CAD System Design

RL is a crucial subfield of machine learning that attains specific objectives through interactive learning between agents and their environment. In recent years, the consistent advancement of deep learning technology has propelled RL to achieve noteworthy progress and produce impactful applications across diverse domains. Within the design sphere, RL finds extensive utilization in design optimization, automated design processes, and more. Although CAD technology and RL have broad application prospects and potential in the design field, there are relatively few studies on combining them for fusion application. At present, some research mainly focuses on how to optimize the operation flow and parameter setting of CAD software by using the RL algorithm. These studies train agents to learn the operation skills and rules of CAD software by defining appropriate state space, action space, and reward function so as to realize a more efficient and accurate CAD design process. However, the research on the combination of CAD and RL in the field of advertising art design is relatively few and not deep enough. Therefore, this study will focus on the integration of CAD and RL in advertising art design and its potential advantages and values. In advertising art design, the CAD system plays a vital role, in provides comprehensive design support from concept to finished product. In this study, the concrete realization of the CAD system involves the following aspects:

(1) Selection of design tools

According to the characteristics and requirements of advertising art design, this article chooses CAD software with powerful functions and easy integration as the design tool. It not only supports drawing, editing, and rendering of two-dimensional and three-dimensional graphics but also provides rich material libraries and templates, which makes it convenient for designers to build and modify design schemes quickly. At the same time, the software also supports collaborative work with other design software and tools, ensuring the smooth progress of the design process.

In three-dimensional modelling, many mathematical tools such as vector, matrix, geometric transformation, and illumination models will be used. In three-dimensional space, a point can be represented by three coordinate values x, y, z :

$$P = x, y, z \tag{1}$$

Vector is used to represent direction or displacement, and it is also composed of three components in three-dimensional space:

$$\vec{V} = v_x, v_y, v_z \tag{2}$$

The length of the vector is as follows:

$$\left|\vec{V}\right| = \sqrt{v_x^2, v_y^2, v_z^2} \tag{3}$$

(2) Formulation of design process

In advertising art design, a clear and efficient design process is the key to ensuring design quality and improving design efficiency. In order to meet the unique needs of advertising design, this article closely combines the functions of CAD software with the characteristics of advertising design and constructs the following design process:

Requirement analysis: As the starting point of design, requirement analysis is very important. At this stage, this article digs into the core goal, target audience, and market competition environment of advertising design and forms a clear list of design requirements and constraints. These requirements and conditions not only guide the whole design process but are also important criteria for evaluating the design results.

Conceptual design: Based on the results of requirements analysis, this article begins conceptual design by using the powerful functions of CAD software. This stage focuses on the creative conception and overall layout planning, involving the preliminary division of the advertising layout, the

preliminary idea of colour matching and the preliminary selection of font style. The formation of a conceptual design sketch provides a solid framework and direction for subsequent detailed design.

Detailed design: Under the guidance of conceptual design, the detailed design stage further refines each element of the design. This article accurately adjusts the specific size of the advertisement, the details of colour matching, the size and style of the font, etc., to ensure that each design element meets the design requirements and constraints. The design work at this stage is more specific and in-depth, which is the key step for the design results to move from concept to realization.

Rendering and preview: In order to make designers and customers feel the design results more intuitively, this article uses the rendering function of CAD software to visualize. Through high-quality rendering preview, the final effect of the advertisement can be clearly displayed, which is convenient for designers and customers to make comprehensive evaluations and feedback on the design. Ray equation describes the propagation path of light in three-dimensional space. For any point in the light, it can be expressed as:

$$P\ t\ = o + td \tag{4}$$

Where: t is a parameter indicating the distance of light propagation. The lighting model describes how the surface of an object interacts with light and the final colour. For example, the Phong lighting model considers the contribution of ambient light, diffuse reflection and specular reflection:

$$I = I_a k_a + I_l \left(k_d\ 1 \cdot n\ + k_s\ r \cdot v\ ^n \right) \tag{5}$$

Where: I is the final colour intensity. I_a And I_l are the intensities of ambient light and point light, respectively. k_a, k_d and k_s are the reflection coefficients of the object surface to ambient light, diffuse reflection and specular reflection, respectively. The schematic diagram of the coordinate system transformation is as follows (Figure 1).

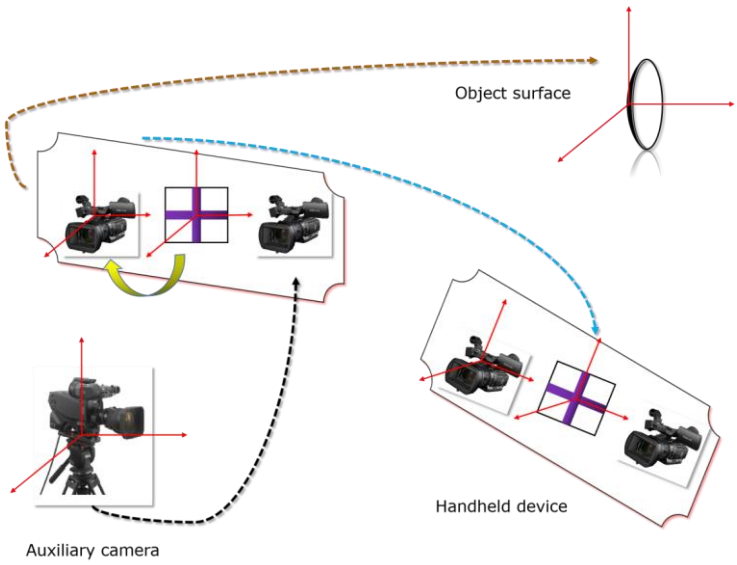

Figure 1: Schematic diagram of coordinate system transformation.

Modification and optimization: According to the feedback of the preview, this article modifies and optimizes the design on time. This process may involve fine-tuning the layout, re-matching colours, changing fonts, etc., in order to ensure that the design results are perfect and closer to customer

needs. Through continuous modification and optimization, we strive to make the design reach the best state.

Output and production: Finally, output the optimized design results to standard file formats, such as JPEG, PDF, etc. These files are convenient not only for archiving and transmission but also for subsequent advertising production and distribution. Through this process, this article realizes the complete transformation from design conception to final product, which provides a strong guarantee for the efficient realization of advertising design.

3.2 Application of RL Algorithm

In the advertising art design model, the application of the RL algorithm is the key to realizing automation and intelligence. Specifically, this article realizes the following RL elements in the model:

(1) Definition of state space

State space is a set of environmental states described in the RL algorithm, and the formula is as follows:

$$S = \left\{ s \middle| s = \left(p_1, p_2, p_3, \ldots, p_n \right) \right. \tag{6}$$

Where i represents the i th attribute of the design scheme, and n is the total number of attributes.

In advertising art design, the state is defined as the attributes of the current design scheme and their combinations, such as layout, colour, font, etc. These attributes can be quantified and coded by the parametric design function of the CAD system, thus forming a continuous or discrete state space.

(2) Action selection strategy

An action selection strategy is an agent's method of selecting the next action according to the current state in the RL algorithm. In this model, the method based on strategic gradient is used to train the agent to learn the choice of design action. The strategy network outputs the probability distribution $\pi\left(a \middle| s;\theta \right)$ of each possible action, where θ is the parameter of the strategy network. This function integrates many aspects of advertising, such as attractiveness, readability and innovation, to guide agents to optimize:

$$a \sim \pi\left(a \middle| s;\theta \right) \tag{7}$$

Agents learn the optimal design action selection strategy through the process of continuous exploration and trial and error.

In this article, a strategy network is defined to output the probability distribution of possible actions, and actions are sampled according to these probabilities. Through continual exploration and a process of trial and error, the agent acquires the ability to discern the most effective design action selection strategy.

(3) Design of reward function

The reward function $R\left(s,a \right)$ is used to evaluate the effect of the agent taking action a in the state s. In advertising art design, this article designs a comprehensive reward function according to the design objectives and constraints. This function takes into account the attractiveness, readability, innovation and other aspects of the advertisement, and scores and weights all the attributes of the design scheme according to these aspects. The specific formula is as follows:

$$R\left(s,a \right) = \sum_{i=1}^{m} w_i \cdot f_i\left(s,a \right) \tag{8}$$

In this way, the agent can be guided to optimize in the direction of meeting the design requirements and constraints.

3.3 Model Integration and Testing

Combining the CAD system with the RL algorithm is the key step to realizing the automation of the advertising art design model. This article integrates CAD software with the RL algorithm through an API interface and realizes the functions of automatic generation, evaluation, and optimization of design schemes. When the agent chooses a design action according to the current state, the CAD software will automatically perform the corresponding design operation and update the design scheme. Then, the RL algorithm will calculate the reward value according to the new design scheme and update the strategy network according to the reward value. In this way, the close integration and cooperation between the CAD system and RL algorithm can be realized. The development process and evaluation of product design are shown in Figure 2.

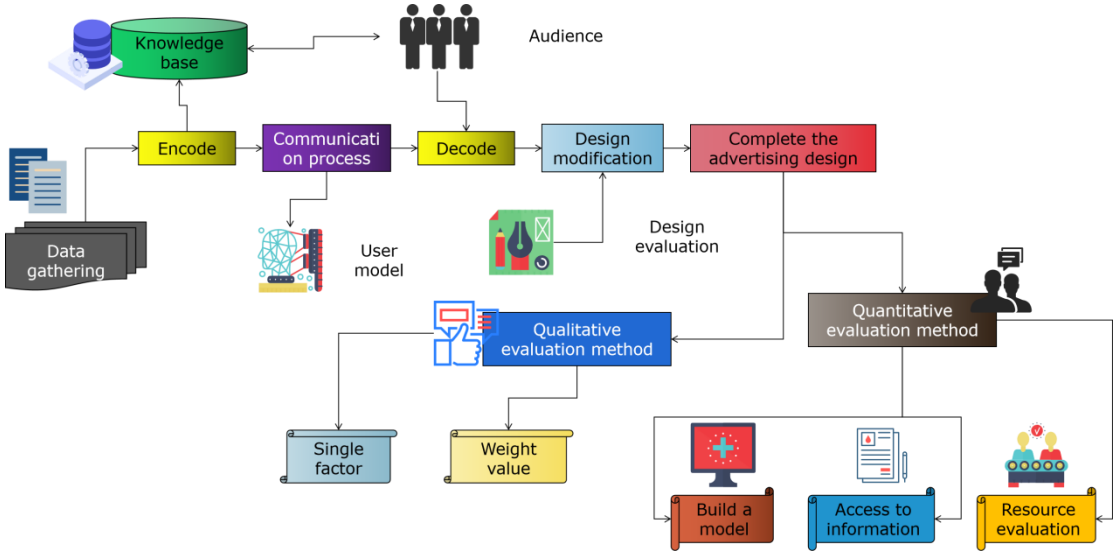

Figure 2: Development process and evaluation of product design.

After the model integration is completed, this article makes a preliminary test and debugging of the model. Firstly, some simple advertising design cases are used to train and verify the model to ensure that the model can correctly generate and evaluate the design scheme. Then, the performance of the model is tested and optimized to improve the speed and quality of generating the design scheme. Finally, the model is applied to some practical advertising design projects for field testing and application effect evaluation. To gain insight into the satisfaction and feedback of users of varying ages regarding products designed using the advertising art design model, this study surveyed users across different age groups. The findings are presented in Table 1.

Age bracket	*Degree of satisfaction (%)*	*Feedback*
18-25 years old	90.14	Very satisfied; the design is young and energetic.
26-35 years old	85.76	Satisfied, the design meets my needs.
36-45 years old	80.53	Generally, I hope to have more special experiences.
46-55 years old	75.89	Not satisfied, need to improve.
Over 56 years old	70.14	Not satisfied, not in line with my needs.

Table 1: A survey of users' satisfaction at different ages.

Table 1 shows the satisfaction and feedback of users of different age groups on artistic products designed by models. Satisfaction is expressed as a percentage, from very satisfied to dissatisfied. The feedback is summarized according to the user's description, which shows the evaluation and expectation of users of different ages on the design. Through this table, we can understand the needs and expectations of users of different ages and further optimize the model and design to meet the needs of more users. The above results show that the proposed advertising art design model has good feasibility and effectiveness in practical application.

4 SIMULATION EXPERIMENT AND RESULT ANALYSIS

4.1 Experimental Process and Results

In order to verify the application effect of the integration of CAD and RL in advertising art design, this section has carried out a series of simulation experiments. The experiment runs on a computer equipped with a high-performance graphics processor to ensure the smooth operation of CAD software and RL algorithm. The operating system adopts a stable professional version of Windows, and the necessary CAD software and Python programming environment are installed. In addition, some commonly used machine learning libraries and frameworks, such as TensorFlow and Keras, are used to support the implementation and training of the RL algorithm.

The experimental data mainly comes from two aspects: one is the real case base of advertising design, including various types, styles and sizes of advertising design works; The second is the user needs and evaluation criteria, which are obtained through the investigation and analysis of the target user groups. In the data preprocessing stage, this article classifies and labels advertising design cases and extracts key design elements and features, such as layout, colour, font and so on. At the same time, the user needs and evaluation criteria are transformed into quantifiable indicators for evaluation and comparison in the experiment. In the course of the experiment, a group of initial advertising design schemes are generated by using CAD software as baseline data. Then, these schemes are input into the RL algorithm for training and optimization. Through continuous iteration and trial and error, the algorithm gradually learned how to adjust and improve the design scheme according to the user's needs and evaluation criteria. Finally, a set of optimized advertising design schemes are obtained as experimental results (Figure 3).

Figure 3: Advertising design scheme.

The proposed advertising art design approach in this study exhibits significant advantages in terms of both quality and efficiency. When employed for advertising art design, the effectiveness and quality of the design plan are clearly demonstrated in Figure 4.

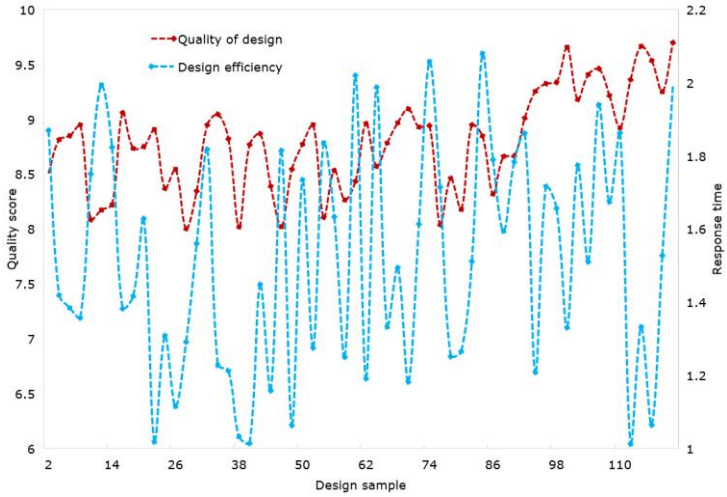

Figure 4: Design quality and efficiency.

Judging from the quality of the design scheme, the score of this method is as high as 9 points, which fully shows its effectiveness in advertising art design. High-quality design schemes can often convey the theme and information of advertisements more accurately, attract consumers' attention, and thus enhance the communication effect and commercial value of advertisements. This high score also reflects the excellent performance of this method in many aspects, such as creative conception, visual performance and user experience. In terms of efficiency, the average response time of this method is only about 1.89 seconds. In the fast-paced business environment, an efficient design process is very important to seize market opportunities and quickly respond to customer needs. A shorter response time means that designers can complete more design tasks in a shorter time, improve work efficiency, and also help to reduce design costs and enhance the competitiveness of enterprises.

In addition, the user rating results further verify the superiority of this method. The user's scoring results of the scheme before and after optimization are shown in Figure 5.
The results reveal a significant enhancement in the score of the design scheme, rising from approximately 5.3 before optimization to an impressive 9.4 after optimization. This substantial progress underscores the method's efficacy in elevating design quality and reflects users' approval and fondness for the refined approach. User satisfaction serves as a pivotal metric for gauging the success of a design scheme, indicating its alignment with user needs, expectations, and the subsequent enhancement of user experience and loyalty.

In conclusion, the advertising art design technique presented in this article has achieved notable advancements in both quality and efficiency. High-caliber designs adeptly convey advertising messages and captivate consumers, while a streamlined design process facilitates swift market response and cost reduction. Moreover, the substantial improvement in user rating bolsters the practicality and effectiveness of this approach.

Innovation is the cornerstone of advertising art design, disrupting traditional paradigms and introducing fresh visual experiences and emotions to the audience. Therefore, highly innovative design strategies often have a stronger likelihood of capturing audience attention, amplifying an advertisement's allure and communication impact. The advertising art design approach outlined in

this article exhibits clear innovative strengths, as illustrated in Figure 6. Furthermore, a comparative analysis with traditional designs, presented in Figure 7, further validates the substantial innovation enhancement achieved by the optimized scheme.

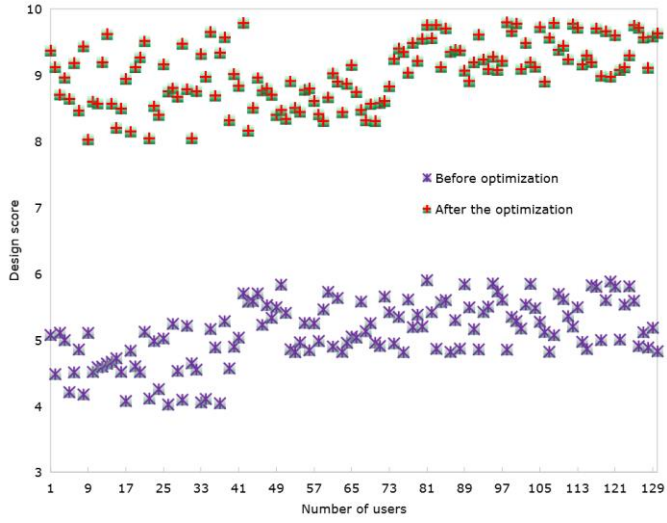

Figure 5: User's rating results for the scheme before and after optimization.

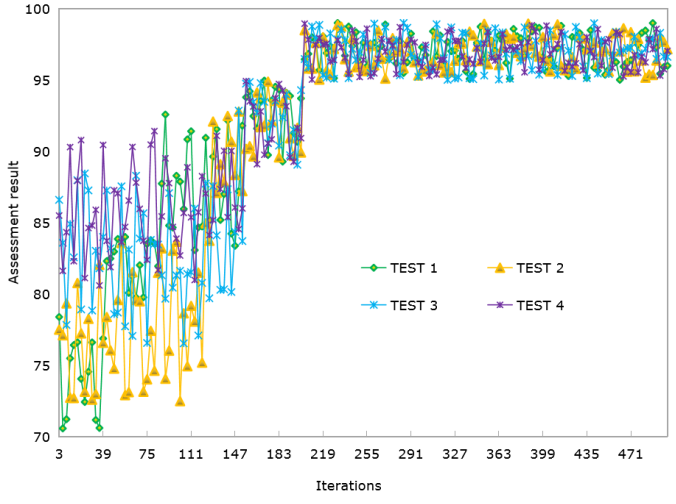

Figure 6: Innovative evaluation of scheme.

The innovative evaluation result of this design scheme is high. This means that the scheme has incorporated more innovative elements and novel ideas in the process of advertising art design. Compared with the traditional design scheme (Figure 7), we can find that the optimized scheme has a significant improvement in innovation. Traditional design schemes are often limited by fixed patterns and thinking patterns, lacking novelty and creativity. The optimization scheme proposed in this article has successfully broken the shackles of the traditional framework and achieved a breakthrough in innovation by introducing new design concepts and adopting innovative technical means.

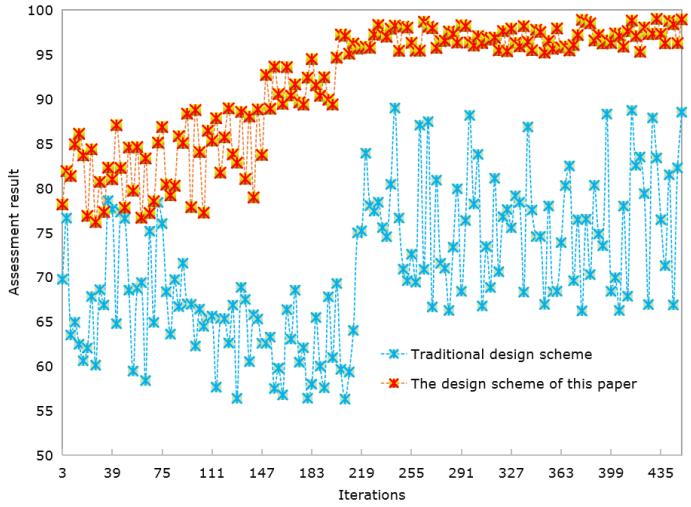

Figure 7: Innovative comparison of different schemes.

The experimental results in this section show that the advertisement design scheme optimized by the RL algorithm is superior to the baseline data in many evaluation indexes. Specifically, the optimized scheme has been significantly improved in terms of attractiveness, readability and innovation. This shows that the integrated application of CAD and RL can improve the quality of advertising art design.

4.2 Discussion on Experimental Results

Through in-depth analysis of the results, this article finds that the integration of CAD and RL has the following advantages in advertising art design: RL algorithm can automatically optimize the design scheme according to the user's needs and evaluation criteria, reducing the designer's workload; Through continuous iteration and trial and error, the algorithm can explore more innovative and attractive design schemes; The close integration of CAD software and RL algorithm makes the design process more automatic and intelligent. However, there are some shortcomings in the experiment: the training process of the RL algorithm needs a lot of time and computing resources, which limits its popularization in practical application to some extent. The algorithm may have some limitations for complex and changeable design problems, which need further improvement and optimization. The effect of the fusion application of CAD and RL is also affected by factors such as data source and quality, so it is necessary to strengthen the collection and processing of data.

Given the above shortcomings, this article puts forward the following suggestions for improvement: Optimize the training process of the RL algorithm to improve its convergence speed and stability; Research more complex and flexible modelling methods of design problems to meet the needs of different types and styles of advertising design; Strengthen the construction and sharing of data sets related to advertising design to provide more high-quality data resources for algorithm training.

5 CONCLUSIONS

This study explores the amalgamation and utilization of CAD and RL in advertising art design. By establishing an advertising art design model rooted in the CAD system and incorporating the RL algorithm for refinement, we validate the efficacy and predominance of this hybrid approach. In terms of quality, this methodology achieves a score exceeding 9, highlighting its proficiency in communicating advertising themes and information, captivating consumer interest, and elevating

the advertising communication impact and market value. Regarding efficiency, the average response time of this technique stands at merely 1.89 seconds, empowering designers to swiftly accomplish design tasks, enhance productivity, minimize costs, and ultimately bolster enterprise competitiveness. The findings indicate that the convergence of CAD and RL notably boosts the quality and efficiency of advertising art design, ushering in fresh growth opportunities for the advertising design industry. This hybrid application carries both theoretical significance and extensive practical application potential.

This research adds depth to the methodologies and theoretical frameworks within advertising art design, presenting fresh perspectives and insights for scholars and practitioners alike. Simultaneously, its outcomes positively influence the practical realm of advertising design, propelling technological advancements and industry transformation. Nonetheless, despite its accomplishments, this study acknowledges certain limitations, such as the constraints of the experimental setting and data sources, which might influence the results' universality. Additionally, further optimization of the RL algorithm's training process is warranted to enhance its efficiency and stability. Therefore, we remain committed to monitoring technological advancements and innovative applications in advertising design.

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