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Computer-Aided Design AND APPLICATIONS

Data Mining and Pattern Recognition of the Integration of Art Design Style and CAD System

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Abstract. Based on data mining technology, this article puts forward an effective method to integrate artistic design style with a CAD (Computer-aided design) system and develops a CAD prototype system with artistic design style. To assess the efficacy and practicality of the approach outlined in this article for integrating art design styles with CAD systems, a simulation experiment was devised and executed. The experimental findings reveal that, in comparison to prior research outcomes, the proposed method exhibits improved performance in the integration of art design styles with CAD systems. Specifically, this method has achieved higher accuracy (above 94%) in the task of artistic style classification, and this method can evaluate the quality of design works more accurately and identify users' habits and preference patterns more accurately. Accurately identifying and classifying the patterns in the integration of artistic design style and CAD system can provide designers with more accurate design support and suggestions, thus improving design performance.

Keywords: Artistic Style; Art Design; CAD System Integration; Data Mining; Pattern Recognition
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1 INTRODUCTION

With the swift advancement of science and technology, CAD systems have transformed into an essential instrument in the realm of design. Live theatrical art and performance, as an important component of human culture, are also facing unprecedented opportunities and challenges. Baía and Ashmore [1] delve into the current development status and future trends of live theatre art and performance in the metaverse from an academic, reflective, and creative perspective. How to utilize the latest VR technology to achieve realistic and high-quality virtual live theatrical performances, providing audiences with an immersive viewing experience. Fully showcase the artistic elements of live drama, such as plot, character shaping, and stage scheduling in a virtual environment, ensuring the artistic quality of virtual performance how to design an effective interaction mechanism that

allows the audience to interact with the virtual theatre environment, enhancing their sense of participation and immersion. With the development of virtual reality technology, the boundary between reality and virtuality in live theatrical performances is gradually blurred. How should we view this phenomenon, and how can we maintain the authenticity of art while developing technology? In the metaverse, the audience's viewing experience has undergone profound changes. How to achieve inheritance and innovation in the context of the metaverse, as an important component of traditional culture, live drama art. These systems offer robust modelling, rendering, and analysis functionalities, significantly enhancing design performance. However, CAD systems are currently primarily utilized in the fields of engineering and architectural design, with relatively limited applications in the domain of art design. The application of sculpture design not only provides artists with a broader creative space but also provides audiences with an unprecedented viewing experience. Cabero et al. [2] explore the application of hybrid, augmented, and virtual reality technologies in the history of sculpture art and design, as well as their impact on art and design styles. Hybrid reality technology brings new possibilities to sculpture art design by combining virtual elements with the real environment. Artists can use mixed reality technology to create sculptures that incorporate more digital elements while maintaining their physical characteristics. The application of this technology not only enhances the interactivity and dynamism of sculpture works but also provides viewers with a richer viewing experience. Augmented reality technology provides a new perspective for sculpture art design by overlaying virtual information onto real scenes. Artists can use augmented reality technology to provide viewers with a more in-depth viewing experience, such as virtual commentary and interactive displays of sculpture works through mobile phones or special devices. In addition, augmented reality technology can also be used to restore and protect historical sculpture works, providing them with digital protective shells. Art design, renowned for its creativity and expressiveness, encompasses a wide array of intricate styles, often challenging the capabilities of conventional CAD systems.

Especially in painting art, deep learning methods have played a huge role in pattern extraction and recognition. Castellano and Vessio [3] review relevant research in this field, with a focus on exploring the neural computing and application of deep learning methods in painting art. In addition to pattern extraction, deep learning methods have also made significant progress in pattern recognition in painting. For example, deep learning techniques have been applied to style transfer, work age recognition, and author identity recognition in painting works. These applications not only enhance our understanding of painting art but also provide new tools and methods for art appraisal, art history research, and other fields. Neural computing is an important theoretical foundation of deep learning, playing a crucial role in explaining how deep learning processes and analyzes art data. Through neural computing, we can better understand how deep learning models extract and recognize patterns from artwork, further revealing the underlying mechanisms of artistic creation. In addition, the application of deep learning in painting art also includes generative adversarial networks (GANs) to generate new works of art, automatic completion of artistic creation, and other aspects, all of which bring new possibilities and challenges to art creation and art education. Therefore, exploring methods to seamlessly integrate art design styles with CAD systems holds immense significance in propelling the progress of the art design field and elevating design efficiency. In the teaching of ballet art and stage design in universities, intelligent virtual reality technology provides a new teaching method and perspective for teachers and students. Feng [4] explored the impact of intelligent virtual reality technology on the teaching of ballet art and stage design in universities. Through intelligent virtual reality technology, students can practice ballet movements in simulated three-dimensional space. The system can analyze students' movements in real-time and provide feedback to help them correct errors. Intelligent virtual reality technology can simulate various ballet performance scenes, allowing students to practice in a safe virtual environment and enhancing their performance on the real stage. By using virtual reality technology to simulate situations such as tension and stress, students can receive psychological training and improve their psychological qualities during performances. Intelligent virtual reality technology can simulate real scenes and props, saving teaching costs. Intelligent virtual reality technology provides students with unlimited innovation space, encouraging them to try different ideas and solutions in virtual environments.

The application of this technology makes art design and production processes more efficient and precise while also providing artists with more creative expression methods. Guo and Li [5] discussed computer-aided art design and production based on artistic design styles. Art and design style is the soul of a work of art, reflecting the artist's aesthetic concepts, emotional expression, and unique pursuit of beauty. In computer-aided art design and production, artistic design style also plays a crucial role. Through computer technology, artists can express their creativity and ideas more freely, creating more personalized and infectious works. In practice, computer-aided art design and production based on artistic design styles need to combine the artist's personal style and aesthetic concepts. Computer-assisted art design and production based on artistic design style is an efficient, precise, and personalized creative approach. It not only improves the efficiency and quality of art design and production but also provides artists with a broader space for creative expression. As an important component of the VR environment, the quality of artistic 3D models directly affects the user's immersive experience. Huang and Lee [6] analyzed various factors that affect artistic 3D models in virtual reality environments. High-quality artistic 3D models should have rich details, including texture, lighting, shadow processing, etc., in order to provide users with a more realistic visual experience. The selection of colours and materials is crucial for the visual effect of 3D models. Appropriate colours and materials can enhance the texture and three-dimensional sense of the model and improve artistic expression. In the design of 3D models, the rationality of scale and structure is crucial. Unreasonable proportions and structures can disrupt the visual aesthetics of the model and affect the user's immersive experience. Efficient rendering speed is the key to ensuring a smooth user experience. Optimizing algorithms and reducing redundant data are effective ways to improve rendering speed. Good interaction performance can enhance user engagement and immersion. Optimize interaction logic and response time to provide a more natural and intuitive way of interaction. Hardware performance limitations can affect the rendering effect and user experience of 3D models. Optimize model data and algorithms to adapt to different hardware configurations. At present, the research on the integration of art design style and CAD systems is still in the primary stage. Although some research work attempts to integrate artistic design elements and styles into CAD systems, these studies are often only aimed at specific artistic styles or design requirements, lacking systematicness and universality. In addition, the existing CAD system often ignores the diversity and complexity of artistic style in the design process, which leads to a lack of artistry and innovation in the design results. Therefore, effectively integrating art design style with CAD systems is an important challenge for current research.

This study mainly discusses how to integrate art design style with CAD system and explores how to extract and analyze the characteristics and laws of art design style through DM and pattern recognition technology. The specific research contents include:

(1) Analyze the diversity and complexity of artistic design style and extract its key features;

(2) Study how to integrate the extracted artistic design style features into the CAD system;

(3) Optimize and improve the integrated CAD system through DM and pattern recognition technology;

(4) Evaluate the performance and application effect of the integrated system.

The innovations are as follows:

(1) In this article, pattern recognition technology is comprehensively applied to artistic design style recognition, user behaviour analysis, quality evaluation of design works, and future trend prediction, forming a complete technical system.

(2) Through image processing and computer vision technology, this article constructs a rich artistic style feature library, which can accurately extract and identify the features of different artistic styles and provide designers with more diversified design support and inspiration.

(3) Using pattern recognition technology to train the classifier, the automatic evaluation of the quality of design works is realized, and reasonable scores and suggestions are given, which is helpful for designers to quickly understand the advantages and disadvantages of works and make improvements.

(4) This article combines the theories and methods of computer science, art design, market analysis, and other disciplines to form a brand-new research idea and method system, which has certain academic innovation and practicality.

The article is organized as follows: The Introduction outlines the background, significance, and current state of research. Section Two provides a comprehensive overview of pattern recognition technology, covering both theory and methodology. Section Three details the utilization of pattern recognition techniques for feature extraction and classification in artistic designs, as well as the analysis of user behaviour within CAD systems. Section Four delves into the integration of art design styles and CAD systems through the application of DM and pattern recognition. Section Five presents the results of experiments and analyses. Finally, the Conclusion summarizes the key findings and contributions of this article, offering directions and recommendations for future research.

2 RELATED WORK

Traditional art sketching teaching is facing tremendous changes. This transformation not only brings new possibilities to teaching but also provides a broader creative space for teachers and students. Hui et al. [7] explored the transformation and development of art sketching teaching practice with the support of virtual reality technology integrated with art design styles and CAD systems. In traditional sketching teaching, students usually need to practice for a long time to master basic skills and artistic perception. However, with the integration of CAD systems and art design styles, students can quickly try different styles and techniques in a virtual environment, greatly improving learning efficiency. In addition, CAD systems can help students better understand the structure and lighting effects of objects, providing more inspiration for sketch creation. Virtual reality technology has brought revolutionary changes to sketch teaching. Through VR devices, students can sketch and create in a virtual environment as if they are in a real scene. This immersive learning experience enhances not only students' interest in learning but also their spatial perception and artistic expression. In addition, virtual reality technology can also provide real-time feedback on student work, helping students quickly discover and correct errors. Jin and Yang [8] discussed the application and impact of computer-aided design software in environmental art and design teaching. Through computer-aided design software, students can create more realistic and vivid 3D models and use rendering techniques to present high-quality visual effects. This helps to enhance students' design expression and communication skills. Computer-aided design software supports multi-person collaboration, enabling students to work together to complete design tasks and improve teamwork skills. Computer-aided design software provides students with more creative expression methods, helping them break through the limitations of traditional thinking and stimulate innovative inspiration. Taking the architectural design course as an example, teachers guide students in using computer-aided design software to conceptualize, model, render, and visualize architectural design schemes. Through practical operations, students can gain a deep understanding of the principles and methods of architectural design and improve their practical skills. At the same time, teachers can also use computer-aided design software to teach virtual reality technology, allowing students to have a more intuitive understanding of the performance of design schemes in actual environments. 3D immersive virtual reality, as a representative of this technology, has opened up a new dimension for the art field. Kim and Lee [9] discussed how 3D immersive virtual reality can shape a new perspective on future art consumption. Beyond traditional visual art, through multisensory stimulation, the audience can experience the charm of art from multiple aspects, such as hearing and touch. Viewers can interact with artworks in virtual environments, providing them with a richer sense of participation and experience. Virtual reality technology has broken the limitations of traditional art and provided artists with unlimited innovation space. 3D immersive virtual reality will drive the development of art forms from traditional painting, sculpture, etc., to more diverse directions. Viewers can customize unique artistic experiences according to their preferences and achieve personalized artistic consumption. Virtual reality technology has broken geographical limitations and made it more convenient for artworks to be spread to various parts of the world. Combining virtual reality with augmented reality

(AR) and mixed reality (MR) technologies to provide viewers with a richer and more three-dimensional artistic experience.

In graphic art design, artistic design style is an important means of expressing the designer's emotions, thoughts, and aesthetics. It reflects the designer's unique understanding and pursuit of beauty, as well as their unique handling of form, colour, composition, and other aspects. Different art and design styles have different characteristics and forms of expression, such as abstraction, concreteness, minimalism, decoration, etc. The application of computer-aided design (CAD) systems makes the design process more efficient and accurate. The development of data mining and pattern recognition technology provides a new perspective for understanding art and design styles. Kimani et al. [10] explored data mining and pattern recognition for the integration of artistic design styles and CAD systems in graphic art design. CAD systems play a crucial role in graphic art design. Through CAD systems, designers can quickly create, modify, and optimize design works, improving design efficiency. At the same time, CAD systems also provide rich graphic editing tools, allowing designers to express their creativity more freely and achieve personalized design styles. It integrates graphic art design styles with CAD systems, which can achieve automation and intelligence in the design process. Through data mining and pattern recognition techniques, CAD systems can automatically identify the style preferences and creative habits of designers, providing them with personalized design suggestions and materials. This not only improves design efficiency but also helps designers better achieve creative expression. As a branch of 3D digital art, with its unique visual expression and creative methods, it is gradually changing our aesthetic concepts. In order to adapt to this change, many art education institutions have begun to explore integrating three-dimensional digital art into traditional design sketching courses. Lei [11] explored how to conduct pre-class teaching of design sketching based on 3D digital art in the context of the big data era. 3D digital art breaks the two-dimensional limitations of traditional design sketching and presents works with richer and more three-dimensional visual effects through technologies such as virtual reality and augmented reality. Design sketching is no longer limited to traditional drawing tools. Designers can use digital software, 3D printers, and other technologies to create, improving the efficiency and accuracy of design. In the era of big data, designers can analyze massive amounts of data, extract inspiration, and combine 3D digital technology for innovative design. In the context of the big data era, the exploration of pre-class teaching for design sketching based on three-dimensional digital art is of great significance. Through reasonable teaching strategies and resource integration, students can better adapt to the changes in digital art and cultivate excellent designers with innovative thinking and practical abilities.

The application of immersive virtual reality technology that integrates art and design styles with CAD systems in intelligent manufacturing has brought revolutionary changes to product design and manufacturing processes. Lei et al. [12] explored the practical effects and value of this application. Art and design styles endow products with unique charm and appeal, while CAD systems provide designers with efficient design tools. By integrating the two, designers can quickly try different design styles in a virtual environment, iterate, and optimize, thereby improving design efficiency and quality. In addition, CAD systems can accurately simulate the physical properties and performance of products, providing designers with authentic design feedback. Immersive virtual reality technology creates highly realistic virtual environments, allowing users to experience products firsthand. This technology not only provides designers with authentic design feedback but also allows users to experience the appearance, functionality, and performance of the product before making a purchase. In addition, immersive virtual reality technology can also simulate the production process, help manufacturers predict and solve potential problems, and improve production efficiency. As a form of artistic expression, the innovation of artistic music is crucial. With the support of computer-aided design technology, art and music artists can better achieve creativity, break through traditional limitations, and create more unique and infectious works. Therefore, exploring CAD design patterns with art and music innovation as the core is of great significance. With the advancement of technology, the application of computer-aided design (CAD) in the field of art is becoming increasingly widespread. Especially in the fields of music, dance, drama, and other art forms, CAD technology provides artists with unprecedented creative expression methods. Liu and Yang [13] discussed the exploration and practice of contemporary art computer-aided CAD design mode with

art and music innovation as the core. By utilizing CAD technology, the visual presentation of dance and drama can be more vivid and stunning. For example, through computer-aided animation production, dance and drama backgrounds, costumes, props, etc., can present rich visual effects and enhance the audience's viewing experience. Through computer-aided design technology, artistic works can achieve interaction with the audience, bringing a more immersive experience to the audience. For example, using virtual reality (VR) technology, audiences can experience the beauty of art pieces firsthand.

Virtual reality (VR) technology has penetrated into various fields, including the art field. As a type of traditional painting art, oil painting has significantly improved its appreciation and cognitive abilities with the help of VR technology. Liu and Phongsatha [14] will explore how virtual reality technology can enhance the appreciation and cognitive ability of oil painting art. Traditional oil painting appreciation is usually limited to the painting itself, and the audience can only observe it with the naked eye, unable to deeply feel the painting from multiple angles and dimensions. However, the introduction of VR technology provides a new perspective on the appreciation of oil painting. Through VR devices, viewers can immerse themselves in the artwork, appreciate it from different angles and distances, and gain a deeper understanding of the artist's creative intentions and techniques. To verify the effectiveness of VR technology in enhancing cognitive abilities in oil painting appreciation, we conducted an empirical study. By comparing the cognitive abilities of the experimental group and the control group in oil painting appreciation in VR and non-VR environments, it was found that the experimental group's cognitive abilities in VR environments were significantly higher than those in the control group. The experimental group performed better in understanding paintings, observing details, and emotional resonance. 3D computer-aided design (3D CAD) has become an indispensable tool in industrial design and manufacturing today. With the rise of STEM (Science, Technology, Engineering, and Mathematics) education, integrating 3D CAD with STEM provides new possibilities for artistic creation. Ng and Chan [15] discussed how to enhance the artistic creation of shape and space through this integrated approach. 3D CAD software has powerful modelling and rendering capabilities, which can accurately create and modify the shape, size, and position of objects. STEM education emphasizes interdisciplinary knowledge application and innovative thinking. By combining the two, students can apply scientific and engineering knowledge to artistic creation while learning. Through 3D CAD, students can freely try various shapes and spatial combinations in a virtual environment without being limited by physics. This degree of freedom greatly stimulates students' innovative thinking. 3D CAD provides precise modelling tools that enable students to create artwork with rich details and coordinated proportions. In summary, by integrating 3D CAD with STEM, we can significantly enhance the artistic creation of shape and space.

In marine environmental art design, the artistic design style often needs to consider the unique characteristics of the marine environment, such as marine ecology, underwater architecture, and other factors. As an efficient design tool, CAD systems can help designers accurately simulate and design various elements in the marine environment. By integrating art and design styles with CAD systems, designers can more efficiently achieve design goals while ensuring the feasibility and practicality of the design. The application of virtual reality technology that integrates art and design styles with CAD systems in ocean environment art design can provide designers with a more intuitive and realistic design experience to improve design quality and efficiency. Shi and Niu [16] discussed the application research of this technology in marine environmental art design. In marine environmental art design, the artistic design style often needs to consider the unique characteristics of the marine environment, such as marine ecology, underwater architecture, and other factors. As an efficient design tool, CAD systems can help designers accurately simulate and design various elements in the marine environment. In the field of agricultural product packaging design, intelligent computer-aided design (CAD) technology is also changing the traditional packaging design mode, making the artistic style of agricultural product packaging more diverse and diverse. Zhao et al. [17] explored the appearance design of agricultural product packaging art style with the assistance of intelligent computers. Intelligent computer-aided design can also help designers achieve more refined and accurate designs. Through precise mathematical calculations and simulations, designers can better grasp the structure and mechanical properties of packaging, thereby designing more

stable and safe agricultural product packaging. Intelligent computer-aided design can also help designers achieve more diverse artistic styles. Through advanced graphics processing and rendering techniques, designers can create more artistic and visually impactful agricultural product packaging designs. The artistic style design of agricultural product packaging has been greatly expanded. Designers can utilize the powerful graphics processing capabilities of intelligent computers to create more delicate and rich textures and patterns, making agricultural product packaging more textured and visually appealing.

3 APPLICATION OF DM AND PATTERN RECOGNITION IN THE INTEGRATION OF ARTISTIC DESIGN STYLE AND CAD SYSTEM

3.1 Art Design Style and CAD System Integration -DM

Artistic design style pertains to the distinctive traits and patterns observed in artistic works, encompassing form, content, and expression. Varying artistic design styles are representative of diverse epochs, cultures, and aesthetic ideologies, serving as pivotal modes of expression throughout an artist's creative journey. The extensive range and intricacy of artistic design styles contribute to the profound implications and exquisite aesthetic sensibilities embedded within works of art. CAD systems constitute a design instrumentality fortified by computer technology. These systems empower designers to execute designs efficiently, courtesy of their robust modelling, rendering, and analysis functionalities. The core of the CAD system is computer graphics technology, which can create, edit, and render three-dimensional models, providing designers with an intuitive design environment and convenient design tools.

It is a complex and challenging task to integrate artistic design style into a CAD system. Here are some possible integration methods:

(1) Style feature extraction: Firstly, it is necessary to deeply analyze the style of the art design and extract its key features, such as colour, shape, and texture. These features can be extracted and quantified by image processing, computer vision, and other technologies.

(2) Style model construction: After extracting the characteristics of artistic design style, we need to build the corresponding style model. This can be achieved by machine learning, DL, and other technologies, and a large number of works of art data are used for training and learning to get a model that can express a specific artistic style.

(3) Improvement of CAD system: It is necessary to improve and optimize the algorithm and technology of the CAD system to integrate the constructed style model into the CAD system. For example, the constraint conditions of the style model can be introduced into the modelling process of the CAD system to make the design results meet the specific artistic style requirements.

(4) User interaction design: In order to facilitate designers' use of the integrated CAD system, it is necessary to provide good user interaction design. Designers can choose and apply different artistic styles through simple operations, and the system can also provide real-time feedback and adjustment suggestions to help designers better achieve their design goals. DM entails the extraction of insightful information and knowledge from extensive datasets. It leverages statistics, machine learning, pattern recognition, and other sophisticated technologies to thoroughly analyze data, unearthing concealed patterns and trends. The primary responsibilities of DM encompass classification, clustering, association rule mining, and time series analysis. These undertakings facilitate a deeper comprehension and utilization of data to inform decision-making processes. During the integration of artistic design styles into CAD systems, a substantial amount of data is amassed, encompassing design creations, user interactions, system logs, and more. These data contain abundant information and knowledge, which can be extracted and analyzed by DM technology. In this article, DM technology is used to make an in-depth analysis of artistic design works, and the main contents are as follows:

(1) Feature extraction of artistic design works

Application of image processing technology: through advanced image processing technology, the artistic design works are carefully analyzed and processed. This includes the extraction and quantification of visual elements such as colour, shape, and texture. The image projection model is shown in Figure 1.

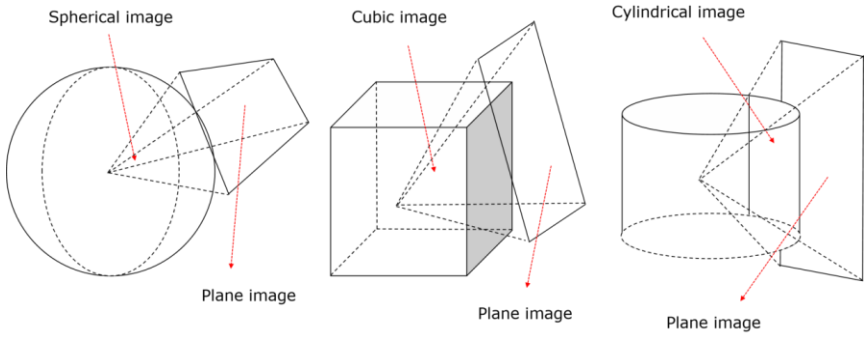

Figure 1: Image projection model.

Building a style feature library: After extracting the visual features of the works, this article further builds a style feature library. This library not only stores the data of various features but also classifies and labels these features through algorithms so as to facilitate subsequent identification and application. For an image:

$$X \in R^{W \times H \times D} \tag{1}$$

Where W is the width of the image; H is the height of the image; D stands for image channel. The length and width of the image are rounded down by 366, and the number of n_h segments with a length of 366 in the long direction and n_w segments with a width of 366 in the wide direction are obtained. Finally, an n artistic image with the size of $R^{366 \times 366 \times D}$ is obtained from one image, and the expression formula is as follows:

$$n_h = \left\lfloor \frac{H}{366} \right\rfloor \tag{2}$$

$$n_w = \left\lfloor \frac{W}{366} \right\rfloor \tag{3}$$

$$n = n_h \times n_w \tag{4}$$

Style feature identification: Based on the constructed style feature database, the style features in art design works can be accurately identified and extracted. This provides a way for designers to understand and classify different artistic styles quickly.

(2) Analysis of users' needs and preferences

User behaviour analysis of CAD system: By analyzing the user's operating behaviour and habits in the CAD system, we can deeply understand the user's needs and preferences for artistic design style. For example, users often use elements such as colours and shapes in the design process, and they have a preference for different design styles.

User demand mining: Through DM technology, users' potential needs and preferences can be mined. This helps designers to grasp users' needs more accurately and provide design schemes that meet users' preferences.

Personalized design suggestions: Based on an in-depth understanding of users' needs and preferences, designers can be provided with personalized design suggestions. These suggestions can help designers better meet the needs of users and improve the user satisfaction of design works.

(3) Evaluation of CAD system performance and application effect

Log DM: By mining and analyzing the log data of the CAD system, the performance and use effect of the system are evaluated. It includes the evaluation of system stability, response speed, and user interface friendliness. The formula is as follows:

$$H\ x\ = -\sum_{i=1}^{n} p\ x_i\ \log p\ x_i \tag{5}$$

Where $p\ x_i$ is the probability of the occurrence of the event x_i and satisfies the following formula:

$$\sum_{i=1}^{n} p\ x_i\ = 1 \tag{6}$$

Feedback of use effect: By combining the user's use behaviour and log data, we can understand the user's real use feelings and needs of the CAD system. This provides valuable feedback and suggestions for the optimization and improvement of the system.

(4) Forecast of future art design style and fashion trend

Historical data analysis: Using DM technology to analyze and mine historical data, we can understand the evolution law of past art design styles and fashion trends. It provides an important basis for predicting the possible styles and trends in the future.

Trend prediction model: Based on the analysis of historical data, a trend prediction model is constructed to predict the possible artistic design styles and fashion trends in the future. This provides designers with valuable market information and design direction guidance.

3.2 Art Design Style and CAD System Integration-Pattern Recognition

Pattern recognition is an important branch of computer science and artificial intelligence, which studies how to automatically extract useful information from data and classify and recognize this information. The core technologies of pattern recognition include feature extraction, classifier design, and model evaluation. Through pattern recognition technology, we can identify specific patterns or laws from complex data and provide support for tasks such as decision-making and prediction. Pattern recognition technology can play an important role in the integration of artistic design styles and CAD systems. This article uses pattern recognition technology to extract and classify the features of artistic design works and analyzes the user's operation behaviour and market dynamics in CAD system, which realizes the identification of artistic style, the mining of user's preference, the evaluation of design works' quality and the prediction of future trends.

(1) Feature extraction and classification of artistic design works

Feature extraction: The core of pattern recognition technology lies in feature extraction. For artistic design works, this article extracts key visual features such as colour, shape, and texture through image processing and computer vision technology. These characteristics constitute the basic elements of the work style.

Classification of artistic style: After extracting the key features, this article uses a support vector machine algorithm to classify these features. Suppose there are l samples randomly and independently extracted from the unknown probability distribution function to form a training sample set:

$$x_i, y_i\ , i = 1,2,3,\ldots,l \qquad x_i \in R^d \tag{7}$$

Among them, $y_i \in +1,-1$ it serves as the categorical identification for two distinct sample types. In the event that x_i it is classified under the first category, the resulting output value will be positive; conversely, if it falls under the second category, the output value will be negative. The objective of the learning process is to formulate a function capable of accurately classifying a maximum number of samples while simultaneously maximizing the classification interval. This translates into the following optimization problem.

$$\min_{w,b,\xi} \frac{1}{2} w^T w + C \sum_{i=1}^{l} \xi_i \tag{8}$$

$$s.t. \quad y_i \ w^T x_i + b \ \geq 1 - \xi_i \tag{9}$$

$$\xi_i \geq 0, \ \ i = 1,2,3,\ldots,l \tag{10}$$

In this context, C it is the penalty parameter. As its value increases, the severity of the punishment for classification errors also intensifies, thereby heightening the emphasis on achieving precise classification accuracy. The result of classification can identify the artistic style of the work, such as modern, classical, or abstract. This classification is not only based on visual characteristics but also combines artistic history and aesthetic rules to ensure the accuracy of classification.

Designer's support and guidance: the accurate classification of artistic style provides valuable inspiration and guidance for designers. Designers can refer to the characteristics of different styles and integrate them into their own designs, thus creating more abundant and diverse works of art.

(2) Analysis of user's operation behaviour in CAD system

Behaviour data collection: By analyzing the user's operation behaviour in the CAD system, a large amount of user behaviour data is collected. These data include tools used by users in the design process, colours selected, shapes drawn, etc.

Application of pattern recognition technology: Use pattern recognition technology to identify users' habits and preferences from these behavioural data. For example, some users may prefer to use specific colour combinations or design elements.

Personalized design suggestions: based on the identification of users' habits and preferences, provide users with personalized design suggestions and recommendations. These suggestions can help users find the design scheme that suits their preferences faster and improve the design efficiency.

(3) Quality evaluation of design works

Quality feature extraction: In addition to artistic style features, this article also extracts features related to design quality, such as complexity, innovation, and practicality of design.

Classifier training and evaluation: by training classifiers, high-quality and low-quality design works can be automatically identified. The training of the classifier is based on a large number of labelled data, which contains experts' evaluations of the quality of design works.

Automatic grading and suggestion: once the classifier is trained, it can automatically give quality grading and suggestions for new design works. This helps designers to quickly understand the advantages and disadvantages of their works and make timely adjustments and improvements.

(4) Forecast of future art design style and fashion trend

Historical data analysis: By analyzing historical data, we can understand the evolution process of past art design styles and fashion trends, which provides an important reference for predicting the future.

Market dynamic analysis: Combined with the current market dynamics, such as fashion trends and social and cultural changes, further analyze the possible art design styles and fashion trends in the future.

Trend prediction and guidance: Based on the analysis of historical data and market trends, use pattern recognition technology to predict future art design styles and fashion trends. This provides designers with valuable market information and design direction guidance to help them grasp market trends and plan ahead.

From the above analysis, we can see that pattern recognition technology has played an important role in artistic design style recognition, user preference analysis, quality evaluation of design works, and future trend prediction, and has provided strong technical support and guidance for designers and related industries.

4 EXPERIMENTAL RESULTS AND ANALYSIS

To assess the efficacy and applicability of the methodology outlined in this article for integrating artistic design styles into CAD systems, this section outlines the design and execution of simulation experiments. The primary objective of these experiments is to evaluate the performance of the proposed method across various datasets and to compare its performance against existing methodologies. In terms of experimental design, a representative selection of datasets pertaining to artistic design works, encompassing a diverse range of styles and time periods, has been chosen. Additionally, data pertaining to user behaviour within the CAD system has been collected to gauge the practical performance of the proposed method in real-world scenarios.

In the implementation process, firstly, data preprocessing and feature extraction are carried out, including image processing, feature selection, and other steps. Then, the classifier is constructed using pattern recognition technology, and the classifier is trained and tested. Finally, the experimental results are statistically analyzed. Figure 2 shows the accuracy of artistic style classification.

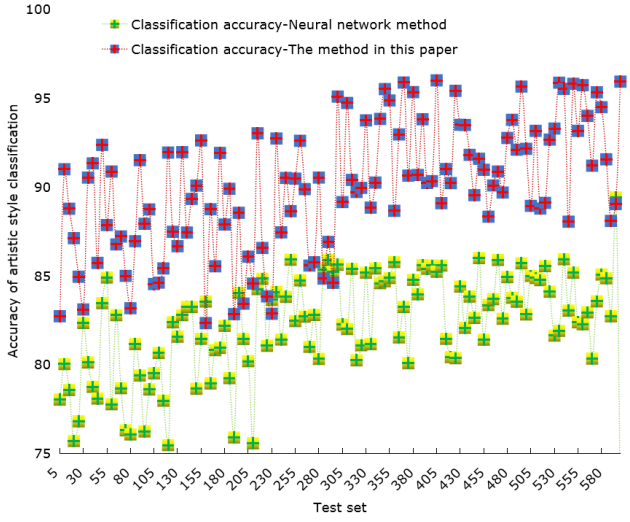

Figure 2: Accuracy of artistic style classification.

In comparison to prevailing methodologies, the approach outlined in this article has demonstrated superior accuracy in the classification of artistic styles, achieving an impressive accuracy rate exceeding 94%. This shows that this method can effectively extract and identify the characteristics of different artistic styles and provide more accurate design support and suggestions for designers. The result of user behaviour pattern recognition is shown in Figure 3.

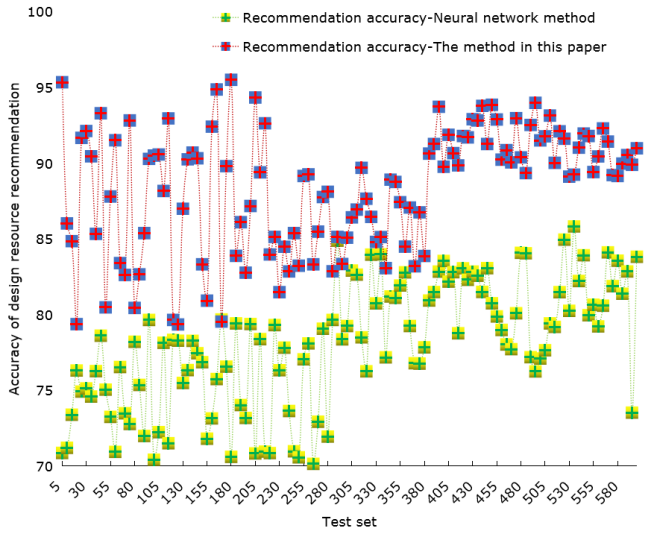

Figure 3: Accuracy of design scheme recommendation.

The overall accuracy of the design scheme recommendation is high, with an average value close to 89.8%. This shows that the recommendation algorithm used performs well in the task of recommending design resources and can effectively provide users with accurate design resources. By analyzing the data of users' operation behaviour in CAD systems, this method can accurately identify users' habits and preference patterns. This provides designers with more personalized design suggestions and recommendations and improves user satisfaction.

Figure 4 illustrates an instance of utilizing the system for architectural design, Figure 5 presents an example of employing the system for sculpting, and Figure 6 exemplifies the use of the system for paper-cut creations. Through analyzing these examples, we can observe the system's versatility and adaptability in handling various artistic mediums.

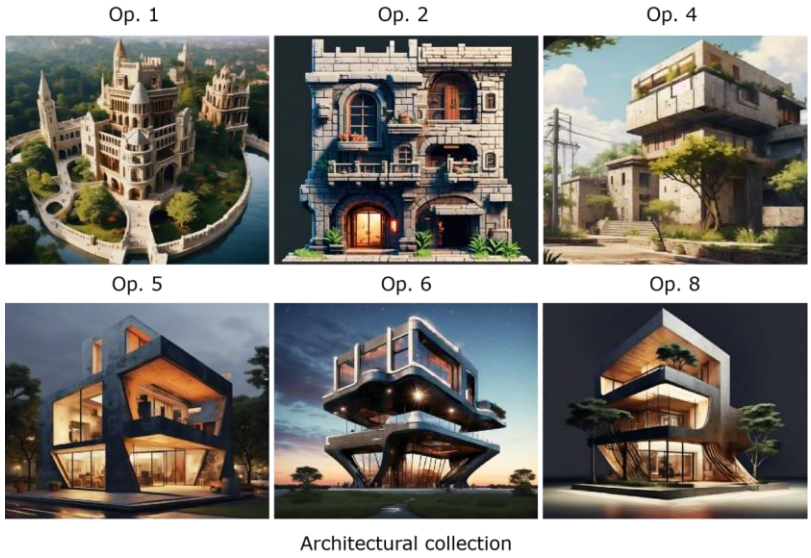

Figure 4: Architectural works.

The architectural works in Figure 4 show the application ability of this system under different architectural styles and functional requirements. From classical to modern, from residential to commercial buildings, the design details and overall layout of the works reflect the system's accurate grasp of architectural style and user needs.

Figure 5: Sculpture works.

The sculpture in Figure 5 shows the ability of the system in three-dimensional modelling and artistic expression. Whether it is abstract sculpture or concrete sculpture, the system can generate aesthetic and creative works according to the needs of users and the rules of artistic creation.

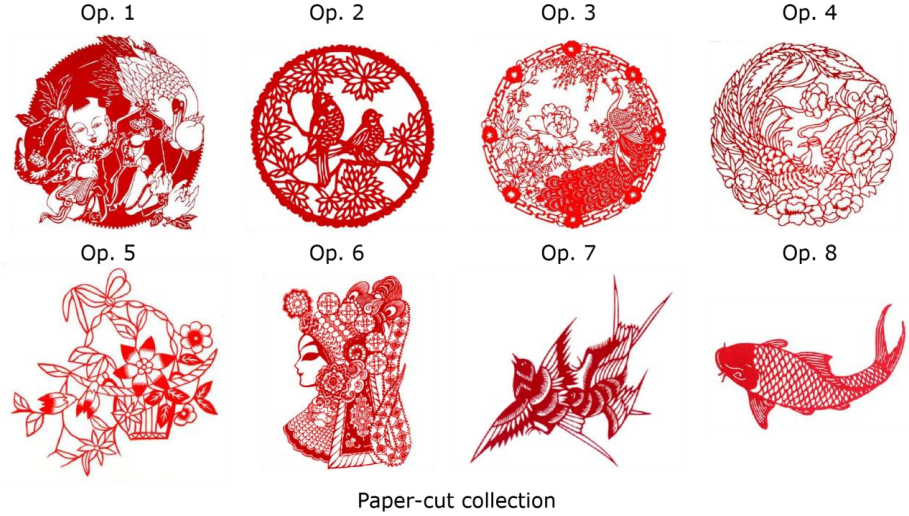

Figure 6: Paper-cut works.

The paper-cut works in Figure 6 reflect the advantages of the system in two-dimensional graphic design and the application of traditional cultural elements. Paper-cut works have smooth lines and exquisite composition, which shows the ability of the system to deal with complex graphics and maintain cultural characteristics. In addition, the proposed method can accurately evaluate the quality of design works and give reasonable scores and suggestions. This helps designers to quickly

understand the advantages and disadvantages of their works and make timely adjustments and improvements. The quality evaluation results of design works are shown in Figure 7.

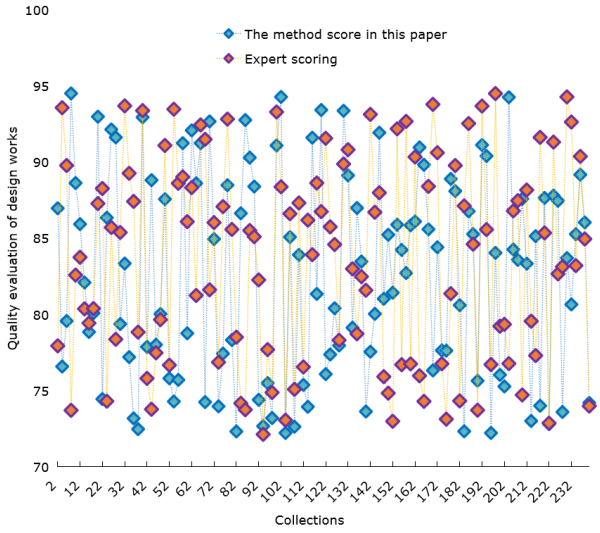

Figure 7: Quality evaluation of design works.

By analyzing the quality evaluation results of design works in Figure 7, it can be concluded that this method has high evaluation credibility and practical application value. It can not only effectively simulate the evaluation process of experts but also give the scoring results consistent with experts' opinions and provide valuable reference and guidance for designers and related industries in practical application. The forecast result of the market trend is shown in Figure 8.

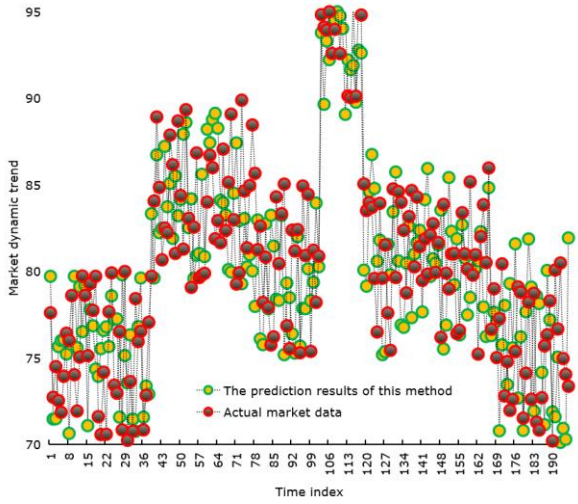

Figure 8: Market trend forecast results.

It can be seen that by analyzing historical data and current market trends, this method can predict the possible artistic design styles and fashion trends in the future. At different time points, the prediction results of this method are in good agreement with the actual market data. No matter the peak period or the trough period of the market, this method can give more accurate forecast values,

which further verifies the forecast accuracy of this method. This provides designers with valuable market information and design direction guidance to help them grasp market trends and plan ahead.

Generally speaking, the method proposed in this article has achieved remarkable experimental results in the integration of art design style and CAD system, which has important significance and possible influence:

(1) Improve design performance: By accurately identifying and classifying the patterns in the integration of art design style and CAD system, the proposed method can provide designers with more accurate design support and suggestions, thus improving design performance.

(2) Promote the growth of personalized design: By analyzing the data of users' operation behavior in the CAD system, the proposed method can identify users' habits and preference patterns and provide personalized design suggestions and recommendations for designers. This will promote the growth of personalized design and improve user satisfaction.

(3) Promote the accuracy of market trend prediction: By analyzing historical data and current market trends, the proposed method can predict possible future art design styles and fashion trends. This will provide designers with valuable market information and design direction guidance and help them grasp market trends and plan ahead.

5 CONCLUSIONS

This article introduces an efficient technique for integrating artistic design styles into CAD systems, resulting in the development of a CAD prototype system infused with artistic flair. The effectiveness and feasibility of this integrated system are substantiated through rigorous experiments. This innovation offers a fresh design tool and methodology for the artistic design domain, enhancing design capabilities and equipping designers with invaluable market insights and directional guidance. This empowers them to stay ahead of trends and plan accordingly.

The research presented in this article carries significant theoretical weight and practical value: (1) Theoretical significance: This article proposes an integration method for blending artistic design styles with CAD systems rooted in pattern recognition. This contributes to the enrichment of theoretical frameworks and methodologies concerning artistic style recognition and CAD system integration. Furthermore, the findings of this study serve as a valuable reference for research in related domains. (2) Practical value: The outcomes of this study empower designers with more precise design support and insight, elevating design performance. Additionally, this methodology finds application in personalized design, market trend forecasting, and beyond, bolstering the growth of associated industries.

Despite achieving impressive accuracy in artistic style classification, there are still challenges and opportunities for further exploration. Future research can delve deeper into feature extraction and recognition techniques tailored for diverse artistic styles, aiming to enhance classification accuracy and stability. Moreover, there is scope to refine the precision and timeliness of market trend predictions, arming designers with even more insightful market information and directional guidance.

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