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Implementation of Art Design Optimization Algorithm Based on Big Data and CAD Technology

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Abstract. The core of this study is to use big data (BD) and computer-aided design (CAD) technology to jointly promote innovation in optimization algorithms for art and design, aiming to improve the operational efficiency and visual aesthetics of user interface (UI). To achieve this goal, we conducted an in-depth analysis of the user behaviour and design preferences revealed by BD and utilized the precise modelling ability of CAD technology for targeted design optimization. Through a detailed comparison of new and old user UIs, the results show that the new UI exhibits significant advantages in multiple dimensions. Specifically, when using the new UI, users not only complete tasks faster but also significantly reduce the error rate, resulting in a significant improvement in overall efficiency. Moreover, the new UI has also performed better in colour matching, layout, icon design, and dynamic effect display. These improvements not only optimize the user's operating experience but also make the UI more attractive. Research has shown that art design optimization algorithms based on BD and CAD technologies are practical and feasible. This algorithm not only improves the efficiency of user UI usage but also enhances its visual appeal, which has a positive impact on improving the overall quality and market competitiveness of the product.

Keywords: Big Data; CAD; Art Design; UI Design
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1 INTRODUCTION

As science and technology advance rapidly, BD and CAD technologies have increasingly made their way into various aspects of life, particularly in the realm of artistic design, presenting designers with unparalleled opportunities for creativity. Artistic design is an inherently creative endeavour, and the intricacies involved in developing its optimization algorithms are invaluable for elevating the overall design quality. With the continuous development of technology, machine learning and image recognition technologies have made significant progress. The application of these technologies in the

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field of art and design makes automatic typesetting and page layout possible. Cabero et al. [1] explored how to use machine learning and image recognition techniques to achieve automatic layout and page layout in art and design. Machine learning and image recognition technologies have broad application prospects in art and design layout. Firstly, through image recognition technology, elements and features in the image can be automatically recognized, providing a basis for layout. Secondly, using machine learning algorithms, intelligent typesetting can be performed based on historical data and user preferences, improving the accuracy and efficiency of typesetting. It utilizes machine learning algorithms to automatically layout pages and arrange elements based on extracted features and historical data, improving the efficiency and accuracy of typesetting. Automatically adjust the layout results based on user preferences and feedback to meet personalized needs. Through automation technology, batch processing and fast output are achieved to improve the efficiency of art and design work.

With the rapid development of technology, the application of big data and CAD (computer-aided design) technology in the field of art and design is becoming increasingly widespread. Among them, how to effectively display sensor data has become an important issue in art design. Ceccarini et al. [2] explored how to use big data and CAD technology to design an interface that can display sensor data in order to improve the efficiency and visualization of art design. It uses CAD technology to present sensor data graphically, making the data more intuitive and understandable. Meanwhile, through big data technology, a large amount of data can be processed and analyzed to extract valuable information. By collecting data through sensors and utilizing CAD technology, real-time data can be reflected in art and design works, achieving dynamic visual effects. With the continuous development of technology, the application of human-computer interaction technology in electronic music products is becoming increasingly widespread. ERP (Event Related Potential) technology, as a type of EEG measurement technology, can reflect human cognitive and emotional states and is of great significance for optimizing the layout of human-computer interaction interfaces. Han [3] discussed how to use ERP technology to optimize the human-computer interaction interface layout of electronic music products. By using ERP technology to measure the user's EEG response to different interface layouts, analyze the user's cognitive process and efficiency towards the layout, optimize the interface layout, and improve the accuracy and efficiency of user operations. The research on optimizing the layout of human-computer interaction interfaces for electronic music products based on ERP technology has important theoretical and practical significance. Through ERP technology, users can gain a deeper understanding of their cognitive and emotional responses, providing a scientific basis for interface layout. The principal objective of this study is to delve into the intricacies of designing and implementing an optimization algorithm tailored for artistic design, leveraging the synergies of BD and CAD technologies. This endeavour aims to furnish fresh theoretical insights and practical directives for both researchers and practitioners in the realm of artistic design. As a precursor to this exploration, the study will sketch out the potential applications of BD and CAD technologies within the artistic design domain. BD technology can provide rich materials and inspiration for art design through the in-depth excavation of massive data and help designers grasp market demand and user preferences more accurately. CAD technology, by its efficient design transformation ability, greatly improves the speed of design realization. The combination of the two indicates that the field of art design will usher in more innovative breakthroughs.

With the rapid development of technology, the application of intelligent adaptive systems in various fields is becoming increasingly widespread. In the field of art and design, the application of intelligent adaptive systems also demonstrates enormous potential and value. Hoang et al. [4] explored how to use intelligent adaptive systems to form individual trajectories in art colour matching, layout, and icon design, enhancing design creativity and personalization. The application of intelligent adaptive systems in art colour matching mainly relies on machine learning and artificial intelligence technology to automatically or semi-automatically complete the design of colour schemes. This technology can automatically adjust colour combinations and proportions based on user needs and preferences to achieve the best visual effect. Meanwhile, the intelligent adaptive system can also provide users with colour schemes that are in line with emotional expression based on the principles of colour psychology. In terms of artistic layout, the application of intelligent

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adaptive systems is mainly reflected in automatic typesetting and page layout. Through machine learning and image recognition technology, intelligent adaptive systems can automatically recognize images and text elements and perform automatic typesetting and layout adjustments based on aesthetic principles and design rules. This greatly improves the efficiency and aesthetics of design while also providing designers with more creative space and possibilities.

The artistic design of environmental spatial layout plays a crucial role in modern life. It affects not only people's aesthetic feelings but also, to a certain extent, their quality of life. Traditional environmental spatial layout art design often relies on the designer's manual drawing and experience. However, with the development of technology, computer-aided design software has begun to be widely used in this field. Jin and Yang [5] discussed the application of computer-aided design software in environmental spatial layout art design and its impact. Compared with traditional manual drawing, computer-aided design software has significant advantages in environmental spatial layout art design. Firstly, computer-aided design software has a high degree of accuracy, which can accurately simulate and predict the effect of spatial layout, helping designers better control the implementation of design schemes. Secondly, computer-aided design software has powerful data processing capabilities, which can quickly analyze and process a large amount of design data, improving the work efficiency of designers. Finally, computer-aided design software can generate realistic renderings, making the design scheme more visually presented to customers, which helps to enhance their awareness and understanding of the design scheme. Generative Adversarial Networks (GANs) have achieved significant results in the field of image generation. Especially in the field of art, the application of GAN provides new creative and learning tools for artists and educators. Jin et al. [6] explored how to use a large-scale image dataset based on GAN to construct an art education pencil drawing learning system and analyzed its learning. Firstly, we need to collect a large-scale dataset of pencil drawing images. These data can come from different artists, styles, and eras to ensure the system's diversity and generalization ability. Then, use GAN to process and generate these data to obtain samples that can be used for learning. The model uses GAN generators and discriminators to train the above data. The task of the generator is to learn the characteristics of data distribution in order to generate new pencil drawings of images. The task of the discriminator is to determine the authenticity of the generated image. By confronting each other, the quality of generated images can be gradually improved. Based on the trained GAN model, a pencil drawing learning system for art education was constructed. The system allows users to input some simple parameters or sketches and then use GAN to generate corresponding pencil drawings and images. In addition, users can also edit and modify the generated images to further meet their creative needs. With the advent of the big data era, digital art has gradually become an important branch in the field of art. As a form of digital art, the application scope of three-dimensional digital art is constantly expanding. Design sketching, as the foundation of artistic creation, is also constantly exploring new forms of expression in the context of the big data era. Lei [7] discussed how to explore and practice design sketching based on three-dimensional digital art in the context of the big data era. The advent of the big data era has brought unprecedented opportunities and challenges to various industries. In the field of art, digital art has gradually become mainstream, and three-dimensional digital art has received widespread attention due to its unique visual effects and expressive power. 3D digital art has achieved the reproduction and creation of the real world and imaginative space through digital technology, providing a new creative platform for traditional art forms such as design sketches. With the help of three-dimensional digital technology, designing sketch works can achieve dynamic interaction. Viewers can appreciate works from multiple perspectives and interact with them through devices such as touch screens, providing them with a richer sensory experience.

At present, there are still some limitations in the research of art design optimization algorithms, which often only focus on a specific field or problem and lack a systematic review of the overall design process. Therefore, this paper will conduct a comprehensive study and analysis of art design optimization algorithms from a more macro perspective. When introducing the design and implementation of an art design optimization algorithm based on BD and CAD in detail, this study will first build the basic framework of the algorithm, including key modules such as data collection, analysis, design scheme generation, evaluation and optimization. Subsequently, the specific

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implementation methods of each module will be elaborated, such as using crawler technology and API interface calls for data collection, using data mining and machine learning for data analysis, and using GA and neural networks to generate design schemes. To validate the real-world impact of the optimization algorithm, we will conduct a test using a design company's actual project as a case study. Through comparative experiments, we will assess its effectiveness in enhancing design efficiency, cost reduction, and quality improvement.

It must be admitted that although this study has achieved some results, we still face many challenges and limitations. For example, how to extract valuable information from a huge data set more effectively and how to apply the data analysis results more accurately to the formulation and optimization of design schemes still need to be further explored. With the continuous evolution of BD and CAD technology, future research also needs to keep pace with the times and constantly update and improve related technologies and methods.

Highlight Points:

(a) By integrating BD and CAD technologies, this study introduces technological advancements to the realm of art and design, fostering smarter design evolution.

(b) Leveraging BD insights, the research enriches art design with diverse materials and creativity, aligning design concepts closely with market trends and user preferences.

(c) The streamlined intelligent design approach not only boosts the efficiency of artistic endeavours but also maintains the excellence and precision of design outputs.

Organization:

This article commences by highlighting the pivotal role of BD and CAD technologies in art and design. It then proceeds to elaborate on the underpinning theoretical frameworks, encompassing the application of BD and CAD in artistic pursuits alongside the theories behind pertinent optimization algorithms. Following this, a comprehensive outline of the research methodologies is presented, spanning data acquisition, analysis, generation of design concepts, and optimization procedures. The empirical validation underscores the algorithm's efficacy and superiority. Concluding remarks summarize the study's contributions and limitations and offer insights into future research avenues and application potential.

2 THEORETICAL BASIS

Wireless image transmission networks have become an indispensable part of modern society. At the same time, the concept of sustainable computing is gradually receiving attention to address the challenges of environmental and social development. In this context, combining wireless image transmission networks with sustainable computing to achieve three-dimensional modelling of two-dimensional sketching and hand drawing is of great significance for artistic creation, cultural inheritance, and sustainable development. Li [8] discussed how to utilize wireless image transmission networks and sustainable computing technologies to build a 3D modelling system based on 2D sketching and hand drawing. Wireless image transmission networks have broad application prospects in 2D sketching and 3D modelling. Firstly, through wireless transmission, users can transmit hand-drawn 2D sketch images in real time to computers or other devices, providing raw data for subsequent 3D modelling. Secondly, utilizing the popularity and flexibility of wireless networks, a distributed 3D modelling system can be constructed to achieve collaboration and sharing among different users. Finally, through cloud services over wireless networks, modelling results can be stored, backed up, and remotely accessed, improving data security and scalability.

In order to improve the realism and user experience of virtual environments, it is necessary to extract useful features from a large amount of data and conduct semantic analysis. Li and Li [9] proposed a virtual environment art design framework based on feature extraction and comprehensive semantic data analysis to improve the realism and user satisfaction of virtual environments. Feature extraction is a crucial step in virtual environment art design. These features may include colour, shape, texture, layout, etc. By extracting these features, data can be better

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understood, and a highly realistic virtual environment can be generated. In addition, using feature extraction techniques, objects and scenes in the virtual environment can be classified and recognized, further improving the realism of the virtual environment. Next, use semantic analysis techniques to conduct an in-depth analysis of the extracted features and understand the user's intentions and needs. Then, generate a realistic virtual environment based on the results of the analysis. Finally, evaluate the realism and user satisfaction of the virtual environment through user feedback and further optimize and improve the virtual environment art design framework. WebBIM, as a form of BIM, can achieve the sharing and collaborative management of building information through the Internet. In WebBIM, icon design is an important component of artistic scenes, and its design quality and effect directly affect the user experience. However, due to the need to consider many factors in icon design, such as design style, cultural background, user experience, etc., effective scheduling and management are necessary. Li et al. [10] proposed an icon design scheduling algorithm based on CEB collaboration, aiming to improve the efficiency and quality of icon design in WebBIM art scenes. The CEB collaborative icon design scheduling algorithm is a method based on collaborative filtering and multi-granularity interest scheduling. This algorithm uses collaborative filtering technology to assign icon design tasks with similar needs to the same designer or design team, thereby improving the quality and efficiency of icon design. At the same time, the algorithm also combines multi-granularity interest scheduling to assign more suitable tasks to designers or design teams based on their interests and expertise.

Especially in the field of art, gesture recognition has broad application prospects for virtual reality, augmented reality, and human-machine art creation. Li and Zhao [11] proposed a novel artistic gesture recognition model based on a dual channel regional convolutional neural network (Regional CNN), aiming to improve the accuracy and robustness of gesture recognition. In early research, gesture recognition mainly relied on feature extraction and classifier design. It proposes a novel artistic gesture recognition model based on a channel regional convolutional neural network. This model consists of two independent CNN channels, which process RGB images and depth images of gestures, respectively. To verify the effectiveness of the proposed model, we conducted experiments on a large artistic gesture dataset. The experimental results show that compared with traditional single-channel CNN, the proposed dual-channel regional convolutional neural network has higher accuracy and robustness in artistic gesture recognition. Dynamic information layout, as an effective way of presenting information, can improve user search performance by integrating visual motion cognition theory into art pattern design. Shao et al. [12] explored how dynamic information layout affects user search performance and how visual motion cognition can be integrated into art pattern design to enhance user experience. Dynamic information layout adjusts the position, size, and colour attributes of page elements dynamically, allowing the user's visual focus to move with the dynamic changes in information. This design helps guide users' visual attention and focus, making it easier for them to focus on key information, thereby improving search efficiency. The theory of visual motor cognition suggests that people are more likely to perceive and understand moving objects. Therefore, integrating visual motion cognition into artistic pattern design can create more dynamic and guiding visual effects. By utilizing visual elements such as colour, lines, and shape, designers can create dynamic paths in artistic patterns that guide user visual attention, thereby helping users locate and identify key information more quickly.

Design thinking is an innovative way of thinking that emphasizes seeking the best solution through iteration and collaboration, starting with user needs and problems. In the field of sculpture art, the application of design thinking can help artists better understand the function, form, and meaning of works, thereby creating more innovative and practical works. Meanwhile, manufacturing design, as an important means of achieving innovation, can further improve the design level and quality of sculpture art by integrating design thinking into the manufacturing process. In sculpture artworks, user needs are mainly reflected in two aspects: aesthetics and functionality. Artists can gain a deeper understanding of the audience's needs and preferences through observation, research, and communication in order to better meet these needs in their works. Manufacturing design can help artists optimize material selection and processing. By analyzing the properties and processing techniques of materials, artists can find the most suitable materials for their works while improving

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their practicality and durability. Reasonable structural design can enhance the stability and safety of sculpture works. Manufacturing design can help artists analyze and optimize the structure of their works in detail, ensuring that the works not only meet aesthetic needs but also have sufficient structural strength and stability [13]. With the rapid development of new media technology, visual communication design has become an important means of information dissemination. At the same time, computer-aided technology also provides new possibilities and infinite innovation space for visual communication. In the context of new media, the development and application of computer-aided interaction technology have blurred the boundary between visual communication design and art. The combination of the two has brought new ways of expression and user experience to new media. Computer-assisted technology can help designers create dynamic visual effects, making information communication more vivid and expressive. Wang [14] uses computer graphics and animation techniques to create complex dynamic images and visual effects. In the context of new media, computer-aided interaction technology has not only played an important role in visual communication design but also provided new forms of expression and creative tools for artistic creation. Artists can create unique and expressive works of art by using computer-aided technology. This combination of technology and art not only broadens the forms of artistic expression but also improves the efficiency and quality of artistic creation.

Digital sculpture technology utilizes computer software to create and operate virtual three-dimensional spaces, allowing designers to achieve complex form design and production on computers. This technology brings more possibilities to architectural design, allowing designers to express their creativity and ideas more freely. Meanwhile, digital sculpture technology also provides new opportunities for the inheritance of traditional art forms. Through digital sculpture technology, Xu et al. [15] transformed traditional artistic elements and forms into digital forms and applied and innovated them in architectural design. This approach not only preserves the essence of traditional art but also injects new vitality into modern architectural design. Students need to use digital sculpture technology for innovative practice, combining traditional art elements with modern architectural design to create works with unique styles. This practice can help students better understand the modern application value of traditional art. Digital interface icon design is an indispensable part of modern design and is widely used in various software, applications, and websites. By analyzing a large amount of user data and understanding user needs and behavioural habits, we can design interface icons that better meet user needs. Yi and Tan [16] utilize artificial intelligence technology to develop intelligent design tools, helping designers quickly generate high-quality icon design solutions. Based on big data analysis, provide users with personalized icon design solutions to improve user experience. By introducing digital interface icon design, the creative methods and forms of printmaking can be enriched, making printmaking works more modern and creative. Introducing digital interface icon design in printmaking teaching can help students master modern design concepts and methods and improve their design abilities. Combining printmaking with digital interface icon design can promote interdisciplinary communication between art and technology, tradition and modernity, and promote the development of art education.

Visual communication has become an important way of information transmission. Icon design art and virtual reality technology, as key elements in visual communication, are gradually changing the way we interact with the world. Zhang and Zhao [17] explore how to combine icon design art with virtual reality technology to achieve more efficient and attractive visual communication. Icon design is a visual communication method that can convey information and concepts in concise graphic language. Virtual reality technology creates a three-dimensional virtual environment, allowing users to immerse themselves and interact with it. Virtual reality technology can provide an immersive experience, allowing users to immerse themselves in the context of information transmission. Users can interact with icons and other elements in a virtual environment to increase participation and effectiveness in information transmission. Through virtual reality technology, icon design can transcend the limitations of two-dimensional planes and display more diverse and three-dimensional visual effects. With the popularization of technology and the advancement of standardization, the application of icon design art and virtual reality technology in visual communication will become more widespread and standardized. This will help improve the efficiency and effectiveness of information

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transmission and promote the rapid dissemination and development of information. Virtual animation art interaction technology has become an important tool in modern product design. Through virtual animation art interaction technology, designers can construct three-dimensional models of products on computers and conduct various simulations and tests to optimize product design and performance. Zhou [18] discussed the application of virtual animation art interaction technology in product model construction and design, as well as its impact on modern product design. Virtual animation art interaction technology can provide strong support and flexibility for product model construction. Designers can create 3D models of products through software and make modifications and adjustments as needed. This technology not only improves design efficiency and reduces the need for physical prototypes but also enables the identification and resolution of potential design issues in the early stages. In addition, virtual animation art interaction technology can also achieve product visualization, allowing designers to better understand the appearance, structure, and function of the product. This visualization is of great significance for improving product design, evaluating the effectiveness of design solutions, and enhancing user experience.

3 OPTIMIZATION ALGORITHM OF ART DESIGN BASED ON BD AND CAD TECHNOLOGY

BD, a prominent hallmark of the information era, has exhibited profound utility across numerous domains, with art design being no different. The fundamental principles of BD encompass pivotal elements like data acquisition, retention, manipulation, and interpretation.

(1) Acquiring data

The inception of BD utilization in art design predominantly relies on techniques like web scraping, social media engagement, and monitoring of user actions. These datasets are multifaceted, encompassing text, visuals, audio, and videos. Ensuring their integrity, authenticity, and currency during the collection phase is paramount, paving the way for robust data manipulation and interpretation down the line.

(2) Retaining data

Considering BD's inherent traits of volume, variety, velocity, and veracity, conventional storage methods prove inadequate. Hence, innovative approaches like distributed storage architectures and cloud-based technologies have emerged as pivotal solutions for BD retention. Within the realm of art and design, data storage must also prioritize scalability, accessibility, and security to guarantee its longevity and efficient utilization.

(3) Data processing

As the core of BD application, data processing involves a series of operations such as cleaning, integration, conversion and compression. In art design, the purpose of these processes is to extract valuable information from the original data and provide strong support for subsequent in-depth analysis and design optimization.

(4) Data analysis

BD analysis aims to dig deep into the potential value behind the data and provide a scientific basis for decision-making. In the context of art design, data analysis includes many methods, such as statistics, correlation, clustering and prediction, which help designers grasp the market pulse and user preferences more accurately so as to create design works that meet the needs more accurately.

CAD technology combines the efficient computing and graphics processing capabilities of computers, which significantly improves the speed and accuracy of design work. In the field of art design, CAD technology has become an indispensable weapon for designers. Its theoretical basis is rooted in the three pillars of graphics, computer vision and human-computer interaction.

(1) the application of graphics

As the foundation of CAD technology, graphics focuses on the study of the construction, generation, processing and display mechanism of computer graphics. In art design practice, graphics technology mainly contributes to the drawing, editing and rendering of 2D and 3D graphics. With the

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help of graphics, designers can quickly transform creative ideas into intuitive and visual graphic expressions and then show the design charm more vividly.

(2) the integration of computer vision

Computer vision also plays a key role in CAD technology. It is devoted to exploring how to make computers gain insight from visual information and make intelligent responses. In the art design scene, computer vision technology is widely used in image recognition, scene interpretation and automatic labelling. Therefore, designers can efficiently process massive image data, draw inspiration from it and extract valuable design elements.

(3) The bridge function of human-computer interaction

Human-computer interaction is the key link between CAD technology and users, focusing on creating a user-friendly UI and interactive experience. In the stage of art design, human-computer interaction technology makes the display, adjustment and evaluation of design schemes more intuitive and convenient. Through this technology, designers can establish closer communication with users, accurately grasp the needs of users, and then cr

Optimization algorithms, as powerful tools for identifying optimal solutions, possess vast applicability in the art design realm, specifically aiding in the enhancement and invention of design concepts. Their theoretical underpinnings primarily encompass mathematical programming, heuristic approaches, and intelligent optimization techniques.

(1) Mathematical programming techniques

Mathematical programming relies on mathematical models to tackle optimization challenges. By formulating precise mathematical representations such as objective functions and constraints, it pinpoints the most favourable outcomes through numerical computations. Within art design, this methodology facilitates precise adjustments to design elements and rigorous evaluations of design proposals. Designers can exercise greater control over parameters and variables, ultimately attaining more satisfactory design outcomes.

(2) Heuristic approaches

Heuristic methods draw upon experiential knowledge to guide the search for optimal solutions. They mimic natural phenomena or processes to uncover favourable solutions efficiently. In the context of art design, heuristic strategies prove invaluable during the conceptualization and refinement stages of design projects. Designers can navigate the design landscape more freely, fostering diversity and ingenuity in their creations.

(3) Intelligent optimization techniques

Intelligent optimization algorithms integrate artificial intelligence principles to mimic human cognitive processes in seeking optimal solutions. In art design, these algorithms facilitate automated design generation and optimization. Leveraging intelligent optimization technology, designers can streamline their workflow, elevating the overall calibre of their designs. Furthermore, this technology aids designers in gaining deeper insights into various design principles and methodologies, thereby fostering creativity and artistic expression in their works. The swift advancement of BD and CAD technology has sparked unprecedented transformations in art design. This study in art design optimization aims to construct a holistic methodology framework underpinned by BD and CAD technologies. Its objective is to automate the generation, evaluation, and optimization of design schemes using efficient models and algorithms. The methodology's essence lies in its refined models and algorithms, which collectively form the bedrock of design optimization.

The data acquisition and processing model is an important part of this study. In order to extract valuable design information from multi-source heterogeneous data, we designed a comprehensive model that can integrate data from different channels, including professional design websites, social media platforms, design competitions and exhibitions, design companies, and institutions. These data sources provide a variety of artistic design data, covering many types, such as text, images and videos. In data acquisition, this paper adopts various methods to adapt to the characteristics of different data sources. For publicly accessible websites and platforms, web crawler technology is used

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to automatically grab data. Moreover, API interface calls are also used to obtain data within the scope of authorization. This method is especially suitable for social media platforms and other data sources that provide API interfaces. The business process of art design feature data mining is shown in Figure 1.

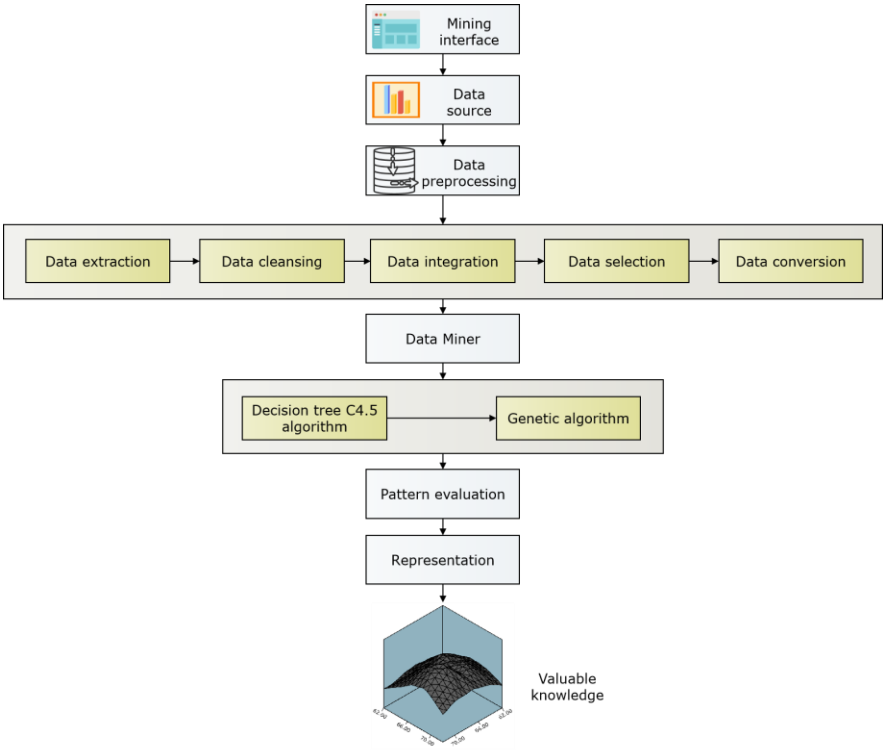

Figure 1: Business stage of feature data mining.

The collected raw data often has problems such as noise, redundancy, and inconsistency, so it needs to go through a series of processing processes before it can be used for subsequent analysis and design scheme generation. The data processing process includes steps such as data cleaning, data conversion, data annotation, and data integration. Data cleaning aims to remove duplicate, invalid, and erroneous data and correct spelling and formatting errors in the data. Data conversion converts unstructured data into structured data format for subsequent processing and analysis. Data annotation is the manual or semi-automatic annotation of image and video data, extracting key design elements and attributes. Finally, data integration integrates data from different sources and types into a unified dataset, ensuring data consistency and accessibility.

The p order linear prediction of the feature signal involves utilizing a linear combination of art image feature sampling values derived from previous p moments. This approach aims to forecast the feature signal sampling value for the subsequent moment with the least amount of prediction error. Consequently, the anticipated value $x\ n$ is determined.

$$\hat{x}\ n = \sum_{i=1}^{p} a_i x\ n - i \tag{1}$$

a_k is designated as the p order linear prediction coefficient within this context. The discrepancy between the predicted and actual values is referred to as the prediction error:

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$$e\ n\ = x\ n\ - \hat{x}\ n\ = x\ n\ - \sum_{i=1}^{p} a_i x\ n-i \tag{2}$$

The output of a system with a specified system transfer function is derived from the prediction error sequence, which results from applying the Z transformation to the given equation:

$$A\ z\ = 1 - \sum_{k=1}^{p} a_k z^{-k} \tag{3}$$

By the p order linear prediction definition, the calculation E, which represents the cumulative squared prediction errors for the artistic attributes of the current frame, is as follows:

$$E = \sum_{n=p}^{N-1} \left[x\ n\ - \sum_{i=1}^{p} a_i x_{n-i} \right]^2 \tag{4}$$

The minimum prediction coefficient a_k associated E corresponds precisely to the parameter a_k within the system function of the digital model that is produced by the artistic feature signal.

GA mimics the biological evolution process as an optimization tool, seeking the most favourable solution through a sequence of actions, including selection, crossover, and mutation. We have adapted GA for art and design applications, developing a model tailored for generating design schemes. This model identifies the most suitable design within the search space by encoding potential designs, initiating a population, assessing their fitness, and undergoing the typical GA operations of selection, crossover, and mutation. The calculation of the selection probability s_k for chromosome k, which possesses a fitness level denoted as f_k is determined as follows:

$$s_k = \frac{r_k}{\sum_{i=1}^{pop\_size} f_i} \tag{5}$$

Next, the fitness values of all chromosomes within the population are aggregated to obtain their sum.

$$F = \sum_{i=1}^{pop\_size} f_i \tag{6}$$

For every individual chromosome, the likelihood of selection, denoted as c_k, is determined through a specific calculation.

$$s_k = \frac{r_k}{F} \tag{7}$$

For every chromosome, compute its respective cumulative probability, designated as t_k :

$$t_k = \sum_{i=1}^{pop\_size} s_i \tag{8}$$

Data standardization is a procedure that involves proportionally scaling data, resulting in standardized data confined to a narrower, predefined range. One of the most common standardization techniques is the z-score method, which ensures that the processed eigenvalues adhere to a standard normal distribution. The formula for this transformation is as follows:

$$x' = \ x - \mu\ \ / \sigma \tag{9}$$

In the given formula, x it signifies the original feature while x' denoting the standardized feature. μ Represents the mean of the sample, while δ it stands for the sample's standard deviation. Both of these values μ δ can be derived from the sample itself. The z-score normalization method proves to be highly effective when a sufficient number of samples are available, making it particularly

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well-suited for addressing contemporary situations involving large volumes of noisy data. Through the lens of z-score normalization, we can standardize the mean and standard deviation associated with the attribute A. The standardized value, designated as v' pertains to A or v is determined using the subsequent formula:

$$v' = \frac{v - \bar{A}}{\sigma_A} \tag{10}$$

The average value A is determined as follows:

$$\bar{A} = \frac{\sum A}{n} \tag{11}$$

The measure of dispersion, known as the standard deviation, A is calculated as follows:

$$\sigma_A = \sqrt{\frac{\sum A - \bar{A}^{2}}{n-1}} \tag{12}$$

Following normalization, the average of all variables becomes zero while their variance equals one. The interval scaling technique employs the extreme values of the feature data to confine the feature values to a predefined range. In this article, we utilize two extremal values for scaling the feature data. The mathematical representation of this transformation is given by:

$$x' = \frac{x - \min x}{\max x - \min x} \tag{13}$$

In this context, $\min x$ it represents the minimum value while $\max x$ denoting the maximum value within the sample data. By utilizing this approach, the data can be confined within the range of [0,1]. Binarization, on the other hand, involves establishing a threshold designated as T. Values exceeding T are assigned a value of 1, whereas values below T are assigned a value of 0. The mathematical formula for this process is as follows:

$$x' = \begin{cases} 1, & x > threshold \\ 0, & x \le threshold \end{cases} \tag{14}$$

This section constructs a comprehensive methodological framework in the field of art and design optimization, which achieves automated generation and optimization of design schemes through core components such as data collection and processing models and design scheme generation algorithms.

4 ALGORITHM TESTING AND ANALYSIS

To assess the real-world effectiveness of the artistic design approach introduced in this article for UI design, we carried out comprehensive testing. The testing mainly focuses on five key indicators: user satisfaction, task completion rate, error rate, learning curve, and overall performance. I hope that through these tests, we can comprehensively and objectively assess the practicality and superiority of the new method in the field of UI design.

Figure 2 shows an example of using both old and new methods for designing the UI graphics of the sika deer. The UI designed using new methods is more beautiful and fresh, and the use of sika deer elements is more natural and harmonious. Moreover, the layout of the new method is more reasonable and user-friendly, in line with the trend of modern UI design and user needs.

After conducting a questionnaire survey and user interviews, we collected user satisfaction ratings regarding new and old UI designs. Figure 3 shows the difference in user satisfaction between new and old UI designs. UI design based on new methods has achieved higher ratings in user satisfaction.

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Figure 2: UI graphic design example.

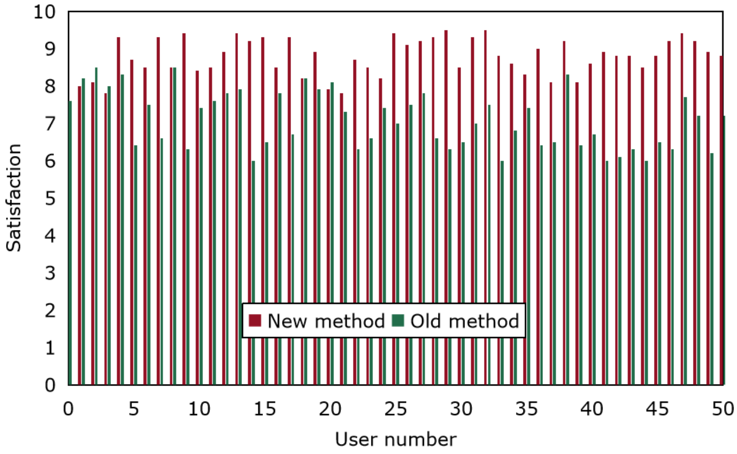

Figure 3: Differences in user satisfaction between new and old UI designs.

The new UI design adopts art design optimization algorithms based on BD and CAD technology. This algorithm can extract valuable design information from a large amount of data and automatically generate design solutions that meet user needs and aesthetic trends. During the design process, the user's operating habits and needs were fully considered, and the UI layout and operating process were optimized. This enables users to complete tasks more easily and quickly, improving their work efficiency and satisfaction.

An excellent UI design can not only provide a beautiful visual experience but also significantly improve the efficiency of users in completing tasks. Figure 4 shows the efficiency data of users completing specific tasks when using the new UI, from which it can be seen that the new UI has achieved good performance in both basic and advanced tasks.

Basic tasks are the most common operations that users encounter when using software or applications, such as navigation, search, input, etc. The efficiency of these tasks directly affects the overall satisfaction of users with the product. When using the new UI, users have significantly improved speed and accuracy in completing basic tasks. The new UI adopts a clearer layout, more intuitive navigation, and smarter interaction, allowing users to quickly find the information or features they need. Advanced tasks typically require users to perform more complex operations or decisions, such as data analysis, image processing, or multi-step processes. These tasks require higher requirements for UI design, as users need more information and tool support to complete the

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tasks. The data in Figure 4 indicates that the new UI performs equally well in advanced tasks. This is because the new UI provides richer functional options, more flexible operating methods, and more effective information display.

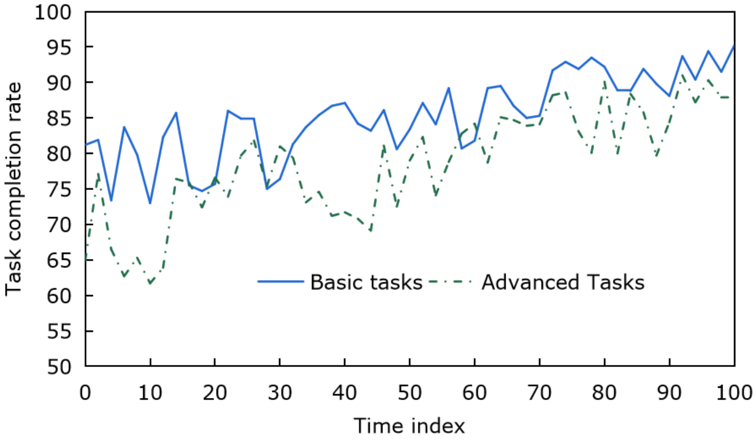

Figure 4: Task completion rate test.

An excellent UI design should guide users to complete operations correctly and efficiently while minimizing errors during the operation process. Figure 5 shows a comparison of the frequency of errors made by users when using the new and old UI, and the results show that users have a lower error rate when using the new UI.

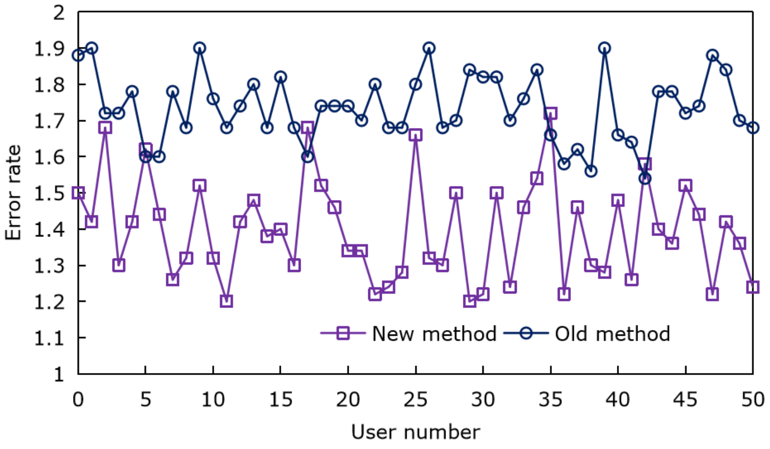

Figure 5: Error rate comparison.

The new UI design adopts a more intuitive and easily understandable UI layout and navigation approach, allowing users to quickly find the required features and information, thereby reducing navigation errors. Figure 6 compares the time required for users to complete tasks when using the new and old UI, and the results show that the time required for users to use the new UI is significantly reduced. The new UI design reduces the number of operational steps required for users to complete tasks by optimizing UI layout and navigation processes, thereby shortening task completion time.

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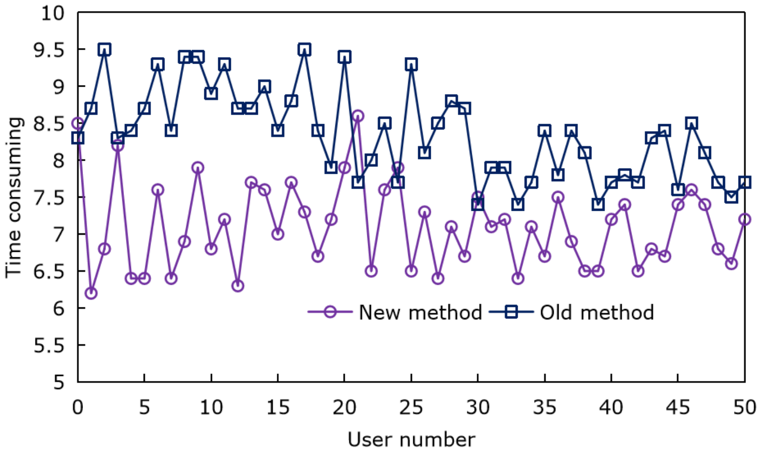

Figure 6: Time-consuming user use.

The data in Figure 6 clearly indicates that the new UI design has achieved significant results in improving user efficiency. Users can complete tasks faster and easier when using the new UI, which not only improves their work efficiency but also enhances their overall satisfaction.

Good visual communication not only attracts users' attention but also helps them understand and operate the UI more efficiently. Figure 7 shows the performance of the new and old UI in multiple visual communications, and the results show that the new UI exhibits better visual communication effects.

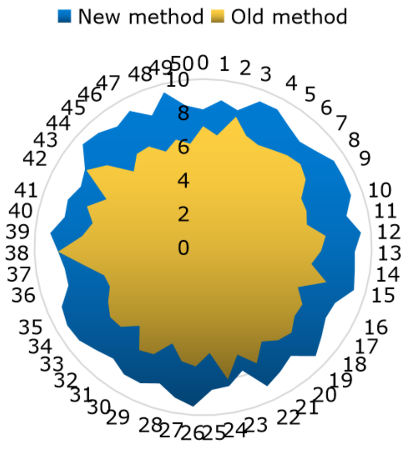

Figure 7: Visual communication effect.

The new UI is more outstanding in colour application, adopting colour combinations that are more in line with user psychological expectations and aesthetic trends. By optimizing contrast, the new UI makes key elements more prominent, improving user attention and operational accuracy. In contrast, the old UI is more conservative or outdated in colour selection and contrast, resulting in less vivid visual effects. By optimizing the distribution and spacing of UI elements, the new UI makes the

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entire UI more concise and orderly, reducing the cognitive burden on users. Moreover, the new UI adopts a layout that is more in line with user reading habits and operational processes, improving the readability and ease of understanding of information.

5 CONCLUSION

In the realm of art and design, the integration of BD and CAD technologies has ushered in unparalleled opportunities for designers to innovate. This study merges BD and CAD, injecting technological advancements into the creative sphere and propelling the field toward intelligent design evolution. The triumph of our revamped UI design owes much to the robust BD and CAD technologies. BD offers a wealth of user behaviour insights and market trends, empowering design teams to grasp user needs with precision and tailor optimizations accordingly. Leveraging CAD's precise modelling and simulation capabilities, design iterations and refinements can be swiftly executed within tight timeframes.

The revamped UI excels in both basic and complex tasks, showcasing superior usability and efficiency. Users can accomplish tasks expeditiously while experiencing a notable reduction in error rates. Furthermore, the UI pushes the boundaries of visual communication, incorporating design elements and interaction methods that resonate with user aesthetics and habits, thereby elevating the visual experience.

In essence, the endeavour to design and implement optimization algorithms in art and design, grounded in BD and CAD technologies, holds profound significance. It elevates product design efficiency and quality while granting users a richer, more efficient experience. As technology and user needs continue to evolve, we anticipate that future UI designs will capitalize on these strengths, unlocking further value for users.

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REFERENCES

[1] Cabero, A.-J.; Llorente, C.-C.; Martinez, R.-R.: The use of mixed, augmented and virtual reality in history of art teaching: A case study, Applied System Innovation, 5(3), 2022, 44. https://doi.org/10.3390/asi5030044

[2] Ceccarini, C.; Mirri, S.; Prandi, C.: Designing interfaces to display sensor data: A case study in the human-building interaction field targeting a university communit, Sensors, 22(9), 2022, 3361. https://doi.org/10.3390/s22093361

[3] Han, J.: Research on layouooptimization of human-computer interaction interface of electronic music products based on ERP technology, International Journal of Product Development, 27(1-2), 2023, 126-139. https://doi.org/10.1504/IJPD.2023.129315

[4] Hoang, C.; Avksentieva, E.; Fedosov, Y.: Forming an individual trajectory of teaching computer-aided design by means of an intelligent adaptive system, Ergodesign, 2021(1), 2021, 41-48. https://doi.org/10.30987/2658-4026-2021-1-41-48

[5] Jin, H.; Yang, J.: Using Computer-aided design software in teaching environmental art design, Computer-Aided Design and Applications, 19(S1), 2021, 173-183. https://doi.org/10.14733/cadaps.2022.S1.173-183

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[6] Jin, Y.; Li, P.; Wang, W.; Zhang, S.; Lin, D.; Yin, C.: GAN-based pencil drawing learning system for art education on large-scale image datasets with learning analytics, Interactive Learning Environments, 31(5), 2023, 2544-2561. https://doi.org/10.1080/10494820.2019.1636827
[7] Lei, Y.: Exploring the pre-teaching of design sketch course based on 3d digital art in the era of big data, Advances in Social Sciences, 10(2), 2021, 308-313. https://doi.org/10.12677/ASS.2021.102045
[8] Li, H.: Wireless image transmission network: 3D modelling based on 2D hand drawing with sustainable computing, International Journal of Networking and Virtual Organisations, 25(2), 2021, 174-196. https://doi.org/10.1504/IJNVO.2021.119065
[9] Li, K.; Li, X.: AI driven human–computer interaction design framework of virtual environment based on comprehensive semantic data analysis with feature extraction, International Journal of Speech Technology, 25(4), 2022, 863-877. https://doi.org/10.1007/s10772-021-09954-5
[10] Li, K.; Zhang, Q.; Jia, J.: CEB-collaboratively multi-granularity interest scheduling algorithm for loading large webbim scene, Journal of Computer-Aided Design & Computer Graphics, 33(9), 2021, 1388-1397. https://doi.org/10.3724/SP.J.1089.2021.18718--noPublish1ae
[11] Li, P.; Zhao, L.: A novel art gesture recognition model based on two channel region-based convolution neural network for explainable human-computer interaction understanding, Computer Science and Information Systems, 19(3), 2022, 1371-1388. https://doi.org/10.2298/CSIS220322037L
[12] Shao, J.; Wu, J.; Tang, W.; Xue, C.: How dynamic information layout in GIS interface affectusers' search performance: integrating visual motion cognition into map information design, Behaviour & Information Technology, 42(11), 2023, 1686-1703. https://doi.org/10.1080/0144929X.2022.2094830
[13] Toshiya, A.; Sugimori, J.: Practice of manufacturing education using an artwork based on design thinking, Journal of Japan Society for Design Engineering, 55(8), 2020, 511-526. https://doi.org/10.14953/jjsde.2019.2880
[14] Wang, R.: Computer-aided interaction of visual communication technology and art in new media scenes, Computer-Aided Design and Applications, 19(S3), 2021, 75-84. https://doi.org/10.14733/cadaps.2022.S3.75-84
[15] Xu, C.; Huang, Y.; Dewancker, B.: Art inheritance: an education course on traditional pattern morphological generation in architecture design based on digital sculpturism, Sustainability, 12(9), 2020, 3752. https://doi.org/10.3390/su12093752
[16] Yi, G.; Tan, Y.: Digital education and teaching of printmaking based on big data and intelligence, International Journal of E-Collaboration, 19(4), 2023, 1-18. https://doi.org/10.4018/ijec.316825
[17] Zhang, R.; Zhao, X.: The Application of folk art with virtual reality technology in visual communication, Intelligent Automation & Soft Computing, 26(4), 2020, 783-793. https://doi.org/10.32604/iasc.2020.010113
[18] Zhou, X.: Research on the application of virtual animation interaction technology in product model construction and design, Art and Performance Letters, 4(10), 2023, 45-53. https://doi.org/10.23977/artpl.2023.041008

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