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Computer-Aided Design AND APPLICATIONS

Innovative Design of Cultural Souvenirs Based on Deep Learning and CAD

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Abstract. With the progress of society and the growth of technology, people's demand and expectations for cultural souvenirs are also increasing. The rapid growth of deep learning (DL) and computer-aided design (CAD) has provided possibilities for innovation in cultural souvenir design. In order to innovate the design methods of cultural souvenirs, this article proposes an innovative design process for cultural souvenirs based on DL and CAD, and introduces various aspects of the process, including design requirement analysis, DL model construction and training, CAD model generation and optimization, etc. By using the results of consumer demand prediction, designers can accurately grasp consumer preferences and market trends, and thus optimize them in a targeted manner in design. Overall, research findings contribute to promoting innovation and development in cultural souvenir design. Future research will further deepen the research and application of DL and CAD, exploring more design possibilities and innovative points.

Keywords: Deep Learning; CAD; Cultural Souvenirs
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1 INTRODUCTION

Cultural souvenirs not only bear historical and cultural significance, but also are important carriers for modern people to pursue quality of life, personality display and spiritual sustenance. This transformation can not only improve the operational efficiency of enterprises, but also create unique competitive advantages for enterprises under the goal of sustainable development. Alabdali and Salam [1] focus on digital transformation, enterprises can achieve process automation, improve production efficiency and quality. For example, through artificial intelligence and machine learning technologies, enterprises can automate tasks such as data collection, analysis, and decision-making, reducing human intervention and errors. Digital technology can help enterprises quickly obtain and analyze market information, gain insight into customer needs, and thus launch new products and services more quickly. In addition, digital technology can also promote internal innovation within

enterprises, encouraging employees to propose new ideas and solutions. Through digital transformation, enterprises can provide more personalized and convenient services, thereby improving customer satisfaction. For example, enterprises can maintain contact with customers through mobile applications, social media, and other digital channels, providing timely and accurate information and services, enhance their own competitiveness and innovation capabilities, and adapt to the ever-changing market environment. In supply chain procurement, digital transformation can be reflected in the following aspects: electronic procurement, big data analysis, artificial intelligence assisted decision-making, etc. These technologies can enable enterprises to manage suppliers more efficiently, reduce procurement costs, optimize inventory structure, and thus create competitive advantages. Quantitatively analyze the degree of digital transformation and competitive advantages of supply chain procurement by collecting data from 500 enterprises. The results show that enterprises with high levels of digital transformation have significantly higher competitive advantages in supply chain procurement compared to enterprises with low levels of transformation. However, the traditional design methods of cultural souvenirs are often limited by the designer's personal experience and aesthetics, and cannot meet the diversified and personalized market demand.

Therefore, how to innovate the design method of cultural souvenirs by means of modern science and technology has become a problem worthy of study. In industrial design education, this technology provides teachers and students with an immersive learning environment, changing the traditional design teaching mode. Bernardo and Duarte [2] aim to explore how immersive virtual reality affects and changes the perspectives of our educators and learners. The current industrial design education still mainly relies on traditional classroom teaching and practical mode. This model has its limitations, such as high equipment costs, low student participation, and incomplete feedback mechanisms. Nevertheless, industrial design education still needs to face constantly changing industry standards and increasing design complexity. Immersive virtual reality technology can enable students to more intuitively experience and understand design. By immersing themselves in a virtual environment, students can gain a deeper understanding of the appearance, structure, and function of products, thereby enabling better design. Secondly, immersive virtual reality technology can greatly improve the flexibility of design. In a virtual environment, students can freely try and modify products during the design, testing, and optimization process. This flexibility allows students to more freely unleash their creativity and imagination, thereby designing more outstanding products. Finally, immersive virtual reality technology can improve the efficiency of design. In a virtual environment, students can conduct simulation testing and optimization after product design is completed, in order to identify and solve problems before actual production. This testing and optimization process can greatly reduce the cost and time of subsequent production and modification, thereby improving the efficiency of design. This technology can also simulate various actual production environments, helping students better understand and master production processes. The rapid growth of DL and CAD provides the possibility for the innovation of cultural souvenir design. DL can automatically extract and learn a large quantity of design features, and realize intelligent and personalized design. CAD can quickly generate, optimize and present the design scheme in the computer. With the development of social economy and technological progress, people's demand for culture is increasing day by day. As an important ethnic group in China, the Yi ethnic group has rich intangible cultural heritage, such as traditional music, dance, handicrafts, etc. However, the inheritance and development of these cultural heritage faces many challenges. Chen et al. [3] proposed a creative product design based on QFD-TRIZ for the intangible cultural heritage of the Yi people. QFD (Quality Function Deployment) is a design and development method that transforms user requirements into products or services. TRIZ (Theory of Problem Solving for Invention) is an innovative method based on systems engineering and theory of invention and creation. QFD-TRIZ combines the theoretical advantages of QFD and TRIZ to systematically analyze user needs and apply innovative thinking to solve problems. Use TRIZ theory to analyze user needs and identify potential design conflicts and issues, such as the conflict between cultural heritage and modern aesthetics, the combination of traditional craftsmanship and modern technology, etc. Based on the results of problem analysis, use QFD method for innovative design to find the best solution to the problem. For

example, designing creative products with Yi ethnic characteristics not only preserves traditional cultural elements but also meets modern aesthetic and practical needs. The innovative design of cultural souvenirs based on DL and CAD can not only break through the limitations of traditional design methods, but also provide designers with more inspiration and tools to stimulate the creativity and imagination of design.

In the design and manufacturing process of molecular products, there is a large amount of uncertainty due to the complexity of material properties, environmental conditions, and manufacturing processes. These uncertainties may stem from variations in material properties, fluctuations in process parameters, and inaccuracies in model predictions. Therefore, to ensure product quality and efficiency, it is necessary to consider and address these uncertainties throughout the entire design and manufacturing process. Frutiger et al. [4] simulate possible process parameters and material properties using Monte Carlo method. Each simulation should generate process parameters and material property values based on a certain probability distribution. Evaluate the objective function values for each simulation and find the optimal solution. Based on the optimal solution, optimize the design of process parameters and material properties to reduce the impact of uncertainty on product performance. To put forward an innovative design process of cultural souvenirs based on DL and CAD through the comprehensive application of DL and CAD. The process includes design requirement analysis, DL model construction and training, CAD model generation and optimization, etc., aiming at realizing the automation, intelligence and personalization of cultural souvenir design. Through the research and practice of this process, in order to achieve this goal, this article first analyzes the related theories and technologies, including DL algorithm, CAD, design theory and so on. Then combined with the actual needs, the innovative DL and CAD is designed, and each link in the process is introduced and explained in detail. Finally, the effectiveness and feasibility of this method are verified, which proves that the innovative design process of cultural souvenirs based on DL and CAD can provide designers with more efficient, smarter and more personalized design tools and methods. Most studies are still based on traditional design methods, relying on designers' experience and aesthetics, which may limit the innovation and diversity of design.

(1) This article puts forward the innovative design process of cultural souvenirs based on DL and CAD. DL is used to automatically extract and learn design features, while CAD is used to quickly generate and optimize design schemes.

(2) This article provides a comprehensive design process, covering the whole process from design requirement analysis to CAD model generation and optimization, to ensure the consistency and efficiency of design.

(3) Compared with previous studies, this article analyzes consumers' needs more deeply, and integrates these needs into the design process to ensure that the design scheme is closer to the actual expectations of the market and consumers.

This article first expounds the use of DL and CAD in the design of cultural souvenirs. Then a comprehensive design process is provided, covering the whole process from design requirement analysis to CAD model generation and optimization. Combined with the assessment of the effect of cultural souvenir design; Finally, the research results and development direction are summarized.

2 APPLICATION OF DL AND CAD IN CULTURAL SOUVENIR DESIGN

Gilal et al. [5] aimed to explore this relationship and conduct cross-cultural surveys on it. Product design, as an important component of a product, plays a crucial role in stimulating consumers' desire to purchase. Internal motivation, such as the pursuit of achievement, the exploration of innovation, and the desire for freedom, can serve as the core concept of product design. These concepts are reflected in product design and can stimulate consumers' intrinsic motivation, thereby enhancing the attractiveness of the product. The research results of this article indicate that incorporating intrinsic motivation into product design and brand image can effectively improve the attractiveness of products and the level of brand attachment among consumers. Therefore, for enterprises, how to better stimulate consumers' intrinsic motivation in product design and brand communication is an

important strategy to improve market competitiveness. With the widespread application of 3D data, the need for classification and retrieval of 3D objects has become increasingly important. To meet this requirement, Hoang et al. [6] proposed a deep learning method based on global point feature addition (DWRN). This method can effectively classify 3D objects and perform object retrieval based on the classification results. Extract features from 3D objects by adding global point features. Specifically, we divide each 3D object into multiple small regions and extract features from each small region. These features include the geometric shape of the object, texture information, etc. Combine these features together to obtain a global feature representation. This global feature can be used to classify 3D objects. In the section "To verify the effectiveness of our method, we conducted experiments on multiple 3D datasets", you clearly conducted detailed empirical research, which is very good. Using multiple 3D datasets for experiments can increase the generalization of research and the reliability of results. Compared with traditional 3D object classification and retrieval methods, our method has higher accuracy and faster running speed. Computer aided design (CAD) and 3D reality technology in animation design. The introduction of these technologies not only changes traditional animation production methods, but also improves the efficiency and expressiveness of animation design. Through 3D reality technology, designers can build 3D models that are exactly consistent with the precise proportions and detailed features of objects, characters, and scenes in the real world. This means that designers can create a realistic immersive environment that makes the audience feel immersive. In addition, designers can also leverage the advantages of 3D technology to meticulously depict characters and scenes in animations, making them more detailed and eye-catching. At the same time, the application of CAD (Computer Aided Design) technology has also played a crucial role in improving animation design. CAD software provides designers with a fast, accurate, and easily modifiable way to design and modify animation scenes and characters. Through CAD software, designers can easily perform complex tasks such as modeling, rendering, material mapping, lighting settings, and provide real-time feedback during the design process to quickly adjust and optimize the design. Jing and Song's [7] research also found that the combination of 3D reality technology and CAD allows designers to design and produce animations on a unified platform. This integration enables designers to work more efficiently and maintain data consistency and accuracy throughout the entire design process. Overall, 3D reality technology and CAD provide animation designers with a new tool and method to create more vivid, realistic, and engaging animation works. These technologies not only change the way animation design is created, but also improve the quality and appearance of animation, making animation works more attractive and artistic value. 3D reality technology can also achieve real-time rendering and interaction, allowing designers to adjust and improve animation shapes in a timely manner during the production process. CAD technology is mainly applied to character bone binding and scene modeling in animation design. By using CAD software, designers can easily create complex character bones and scene models. In addition, CAD can also parameterize animations, making the production of animations more precise and controllable. By using CAD technology for bone binding and animation parameter settings, the character's actions are made more natural and vivid. Finally, the entire animation is completed through rendering and post-processing. Explored how to use machine learning technology to optimize injection molding processes, thereby improving product quality and production efficiency. The application of machine learning technology in injection molding processes has achieved significant results through quality prediction and control, process optimization, and other means. We collected historical data from a plastic product factory, including various parameters and product quality indicators during the injection molding process. Then, we established a quality prediction model using support vector machine algorithm and used this model to predict product quality in future production processes. At the same time, we also utilized genetic algorithms to optimize the process parameters and found the optimal process combination. The experimental results indicate that the application of machine learning technology has significantly improved product quality and production efficiency. Specifically, the accuracy of the quality prediction model reached 90%, while process optimization improved production efficiency by 20%.

Jung et al. [8] explored the Machine learning technology is an artificial intelligence method that automatically identifies patterns and relationships by analyzing a large amount of data, thereby

achieving prediction of unknown data. Thereby achieving real-time monitoring and prediction of product quality during the production process. By monitoring and predicting product quality in real-time, manufacturers can promptly identify and solve potential quality problems, thereby improving product quality and reducing product defects. Secondly, it improves production efficiency. By analyzing production data through machine learning models, manufacturers can better understand the production process, optimize production parameters, and thereby improve production efficiency. Computer aided design (CAD) has played a crucial role in the field of industrial design. Especially in 3D CAD systems, it not only provides a more intuitive design environment, but also enables product simulation and optimization, providing the possibility for rapid industrial product design. In modern industrial design, 3D CAD systems have become indispensable tools. The 3D CAD system can provide powerful modeling functions, allowing designers to perform virtual design and modification of products on computers, greatly improving the efficiency and accuracy of design. Liu [9] decomposes the product into multiple modules, each of which can be designed and optimized separately. This method can enable designers to complete the design faster, while also helping to improve the reliability and maintainability of the product. Adopting advanced algorithms and software tools: for example, using artificial intelligence and machine learning algorithms to assist in design decisions. Alternatively, automated software tools can be used to perform routine and repetitive design tasks. This method emphasizes the use of real-time feedback and simulation capabilities of 3D CAD systems to iterate and optimize product design. A certain car manufacturer uses a 3D CAD system to design a new model. During the design process, the designer utilized a 3D CAD system for detailed modeling and simulation, ensuring the feasibility and performance superiority of the design. Meanwhile, through simulation testing and optimization, the design of the new model has achieved lower production costs and higher production efficiency while ensuring performance. In today's technology field, designing and manufacturing products with efficient performance and high quality is a challenging task. Especially in the fields of chemical industry, pharmaceuticals, and materials science, the molecular structure and properties of products play a decisive role in their performance. Therefore, developing a method and tool that can optimize molecular and hybrid product design, reducing production costs, and shortening research and development cycles. Liu et al. [10] introduced an - OptCAMD. OptCAMD simulates and predicts the structure, properties, and behavior of molecules by establishing precise molecular models. Users can optimize the design of molecules based on product requirements to improve product performance. For mixed products, OptCAMD can help users determine the optimal mixing ratio and composition. By establishing a hybrid model, OptCAMD can find the optimal hybrid solution to improve product performance. Visual communication design, as a profession that involves visual elements and information communication, has also been deeply influenced by these two major technologies. Liu et al. [11] aim to explore how to use AI and CAD technology to design an efficient visual communication teaching system. Through AI technology, customized learning paths can be provided for each individual based on their learning habits and progress, thereby improving learning outcomes. CAD software can help students create and modify designs more quickly and accurately. For example, using AI's image recognition and generation technology, students can automatically adjust the layout and style of design elements to comply with specific design rules. AI can analyze students' design works and provide real-time feedback to help them improve their designs. It should include user interfaces, learning resource libraries, AI engines, and CAD modules. The user interface is responsible for interacting with users, and the learning resource inventory stores various learning resources. The AI engine is responsible for processing and analyzing data, providing intelligent suggestions, while the CAD module provides design tools and automated design functions. The field of product design is no exception. VR technology provides designers with new design and display tools, making the design process more intuitive, flexible, and interactive. As an important carrier for conveying and sharing cultural value, the design process of cultural souvenirs requires the use of advanced technological means.

Lorusso et al. [12] aim to explore how to conceptually model cultural souvenirs in a virtual reality environment. Virtual reality environments can also simulate the usage scenarios and environments of souvenirs, helping designers better understand user needs and experiences. By simulating different

usage scenarios, designers can observe the performance of souvenirs in different environments, thereby improving and optimizing the design. This interactive experience can help designers better understand user needs and create cultural souvenirs that better meet user expectations. In addition, virtual reality technology can also promote cross regional design cooperation. Designers can share and collaborate in a virtual environment, without being limited by geographical location. This helps to integrate design resources from different regions, improve design efficiency and innovation capabilities. Through virtual reality technology, souvenirs of different materials can be simulated, and designers can choose appropriate materials according to their needs. By setting colors and textures, souvenirs are made more culturally distinctive and artistic. Simulate the functions and usage scenarios of souvenirs in a virtual environment to make them more practical and interesting. Lu et al. [13] introduced the process and application of this design method. Based on the results of data analysis, optimize the design of the product. This includes improving product design, adding new features, optimizing user experience, and more. Optimization design should take into account the overall and systematic nature of the product, ensuring its sustainability while meeting user needs. The optimized product should undergo another user review to verify the effectiveness of the optimization measures. User review can be conducted through user testing, expert review, and other methods to ensure the actual effectiveness of product optimization design. The appearance design and material selection of the product are not aesthetically pleasing and durable enough. In response to this issue, the appearance design and material selection of the product have been improved, enhancing its aesthetics and durability. With the development of remote sensing technology, we have the ability to acquire and process large-scale 3D point cloud data. These data typically contain rich information, including shape, size, direction, texture, etc., and can be used for tasks such as ground object classification and scene understanding. The application of 3D point cloud data is becoming increasingly widespread in various fields, such as robot navigation, 3D reconstruction, autonomous driving, etc. In these applications, classifying 3D point cloud data is an important and challenging task. Traditional classification methods usually only consider the spatial information of point clouds, while ignoring the temporal information and local features of point clouds. To address this issue, Teruggi et al. [14] proposed a hierarchical machine learning method for multi-level and high-resolution 3D point cloud classification. Conduct experiments using high-resolution point cloud data to validate the effectiveness of our method. We have used various machine learning algorithms for classification, etc. The research results indicate that hierarchical machine learning methods can effectively classify multi-level and high-resolution 3D point cloud data. Our method not only improves the accuracy of classification, but also accelerates the speed of classification. Our research provides a new and effective approach for the classification of 3D point cloud data. Our method has higher accuracy and lower computational complexity. In today's highly competitive market environment, rapid and efficient product development has become a key factor for enterprise success. The Computer Aided Brand Product Development System (CBPD) development through automation and intelligent means. Product primitive recognition is the process of collecting and analyzing various data and information during the product development process, identifying and extracting the core elements and features of the product, thereby forming a guiding product primitive. Product primitive recognition is an important technology in CBPD. It deeply analyzes the data and information generated during the product development process, discovers and understands the core elements and features of the product, and provides guidance for product design, development, and optimization. Wang et al. [15] utilized to classify and recognize extracted product elements and features, thereby forming guiding product primitives.

3 INNOVATIVE DESIGN OF CULTURAL SOUVENIRS BASED ON DL AND CAD

Through DL, designers can quickly extract key features such as shapes, lines, color combinations, etc. from a large amount of design data. These features can be used to build a database of design elements for designers to reference and call upon at any time. DL technology can learn and imitate different artistic styles, allowing designers to automatically apply a certain style to cultural souvenir design, increasing the diversity and creativity of the design. By using the generation model, DL can

assist designers in generating new design solutions. Moreover, combined with reinforcement learning technology, DL can also optimize design solutions to meet design goals and constraints. CAD not only supports basic geometric modeling, but also enables designers to adjust and modify the design scheme more conveniently through parametric modeling. Modern CAD software is usually equipped with a real-time rendering engine, which allows designers to check the design effect immediately and improve the accuracy of the design. CAD can be seamlessly integrated with other manufacturing technologies, such as 3D printing and CNC machining. In the design stage, designers can make production simulation in advance through CAD software.

By integrating DL model, CAD tools can become more intelligent. For example, DL can help CAD tools to realize functions such as automatic layout and intelligent recommendation of design parameters. Combined with DL's big data analysis ability, designers can make more data-driven design decisions in CAD environment by using historical design data and user feedback. The combination of DL and CAD is expected to realize the end-to-end design process, that is, from the generation of design inspiration to the manufacture of design scheme, it can be completed through an integrated intelligent tool. DL and CAD not only reflect important significance in the design of cultural souvenirs, but their combination will bring more powerful and intelligent tools to designers. This explore the possibility of design more deeply and promote the innovation and growth of cultural souvenir design. DL has strong learning and creative ability. The combination of DL and CAD can bring unprecedented innovation and change to the design of cultural souvenirs. Through DL, a powerful feature extraction network can be established, which can automatically learn and capture the essential features of cultural souvenirs, such as shape features, color matching, material texture and so on. Designers can set certain conditions or constraints, such as style and theme, to guide the creative generation of models. It is a crucial step to transform the design idea generated or optimized by DL into a format recognizable by CAD. We can use specific algorithms and tools to ensure that the ideas generated by DL can be accurately presented in the CAD system. Using CAD, designers can model the design scheme carefully, including the accurate description of shape, structure and details. Moreover, combined with advanced rendering technology, designers can quickly check the real effect of the design scheme. Through CAD, the design scheme can be directly connected with manufacturing technologies such as 3D printing and CNC machining, which greatly simplifies the flow from design to production.

Firstly, the market demand, consumer preference and design trend are analyzed by DL method. Using big data analysis technology, DL model can extract and learn key market features and design elements, and provide accurate guidance for subsequent design. Based on the extracted market characteristics and design elements, DL model further drives the generation of design. By generating advanced technologies such as countermeasure network, the model can create diverse design ideas and provide designers with rich sources of inspiration. Moreover, DL can also combine design rules and optimization algorithms to preliminarily screen and optimize the generated design to ensure the practicality and innovation of the design. The design scheme optimized by DL is transformed into a CAD model for fine design and presentation. The design scheme, and carry out fine operations such as geometric modeling and surface modeling. The CAD system also provides advanced rendering and visualization tools, which enables designers to preview the actual effect of the design scheme in real time and make adjustments and improvements. The construction stage of user portrait of cultural souvenirs is shown in Figure 1.

First of all, we need to collect data about the needs of cultural souvenirs users. This can include users' online search history, purchase records, browsing behavior, user feedback and assessment, etc. In addition, we can also consider external data, such as market trends, social and cultural environment, etc. After collecting the data, it is needed to preprocess the data to prepare for the subsequent cluster analysis. Data preprocessing can include data cleaning, feature extraction and feature transformation. For example, for text data, text mining and natural language processing may be needed to transform it into numerical features that can be used for clustering. According to the business requirements and design goals, select relevant features from the preprocessed data. These characteristics may include user's preference, purchasing power, age, gender, etc. The cluster analysis process of cultural souvenir user demand prediction is shown in Figure 2.

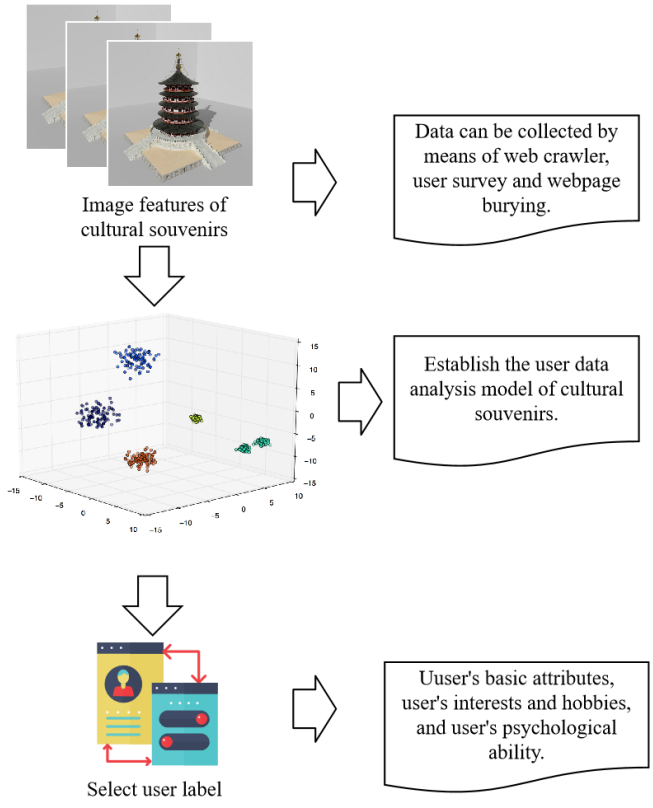

Figure 1: User portrait construction process.

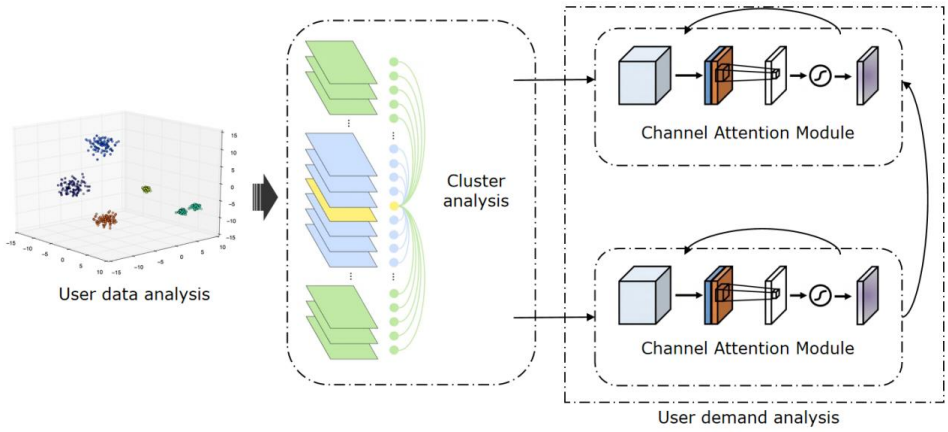

Figure 2: Cluster analysis of user demand forecast.

Fishbein model is a comprehensive framework for forecasting and understanding consumers' needs and preferences. Under the background of cultural souvenir design, this model can help researchers to deeply understand users' attitudes and preferences towards multiple attributes of products, and make demand prediction accordingly. In this model, the demand forecast of consumers is based on the comprehensive assessment of multiple attributes of products. These attributes may include

product design, material, functionality, price, brand reputation and so on. Each attribute is given a certain weight to reflect the importance consumers attach to different attributes. Through market research and user data analysis, researchers identify and determine the key attributes related to cultural souvenirs. Then, by aggregating the attitudes of these attribute levels, the model generates an overall user demand forecast. The fishbein model of user demand forecast is described as:

$$A_0 = \sum_{i=1}^{N} b_i e_i \tag{1}$$

$$\text{support } X \to Y = \frac{P(X,Y)}{P(I)} = \frac{P(X \cup Y)}{P(I)} \tag{2}$$

$$confidence\ X \to Y = P(Y \mid X) = \frac{P(X,Y)}{P(X)} = \frac{P(X \cup Y)}{P(X)} \tag{3}$$

$$lift\ X \to Y = \frac{P(Y \mid X)}{P(Y)} \tag{4}$$

$$y = a + bx \tag{5}$$

$$b = \frac{\sum_{i=1}^{n} (x_i - \overline{x})(y_i - \overline{y})}{\sum_{i=1}^{n} (x_i - \overline{x})^2} \tag{6}$$

Where x_i is the predicted value of the i comment.

In-depth analysis and interpretation of the user needs predicted by fishbein model. This includes identifying consumers' preferences, attitudes and importance to different attributes. These analysis results will provide a direction for the generation and optimization of CAD models. The weight of each intermediate node word in the interest spanning tree is:

$$Node(p_j) \cdot w_j = \sum_{i=1}^{k} w_i \tag{7}$$

The freshness of each intermediate node word is:

$$Node(p_j) \cdot x_j = \sum_{i=1}^{k} \left(\frac{w_i x_i}{w_j} \right) \tag{8}$$

Among them, w_j is the weight of intermediate node p_j, x_j is the freshness of entries of intermediate node p_j, k is the quantity of children of node p_j, w_i is the weight of children's interesting entries p_i, and x_i is the freshness of children's interesting entries p_i.

According to the prediction results of users' needs, the key elements related to cultural souvenir design are extracted. These elements may include shape, color, material, texture, etc. Ensure that these elements match the preferences and needs of users. Using CAD software and technology, according to the extracted design elements, a preliminary CAD model of cultural souvenirs is generated. In this process, parametric design method and feature modeling technology can be used to flexibly adjust and optimize the design scheme.

Provide highly similar texts to designers:

$$\cos(w_1, w_2) = \frac{\sum_{1}^{N} a_i \times b_i}{\sqrt{\sum_{1}^{N} a_i^2} \times \sqrt{\sum_{1}^{N} b_i^2}} \tag{9}$$

Establish a task-to-task network model:

$$G_t = \left[T, T_{t-t}\right] \tag{10}$$

The generated CAD model is compared with the user's demand prediction results, and the design scheme is optimized according to the user's preference and attitude. This may involve adjusting the shape, size and material selection of the model to ensure that the design scheme matches the needs of the target market. In the optimization process, many iterations and feedback loops may be needed. This includes comparing the optimized design scheme with the user's needs again, obtaining the feedback from the user, and further optimizing accordingly. Through continuous iteration and feedback, the satisfaction and adaptability of the design scheme can be gradually improved. By combining DL and optimization algorithm, the automation and support of design decision can be further realized. So as to generate a design scheme that meets the needs.

4 EXPERIMENT AND VERIFICATION

In data analysis, some quantitative data may affect the accuracy and effectiveness of analysis due to abnormal values, extreme values or uneven data distribution. Eliminating these special data directly may lead to the loss of important information, so a method is needed to deal with these data properly, rather than simply excluding them. The interval discretization processing shown in Figure 3 is a method of processing quantitative data. The purpose of interval discretization is to divide the data into a series of discrete intervals, so as to better understand and analyze the distribution characteristics of the data. Doing so can reduce the volatility of data and highlight the main trends and patterns of data. By converting quantitative data into interval form, it is easier to identify the overall characteristics and laws of data, while retaining those data points with particularity.

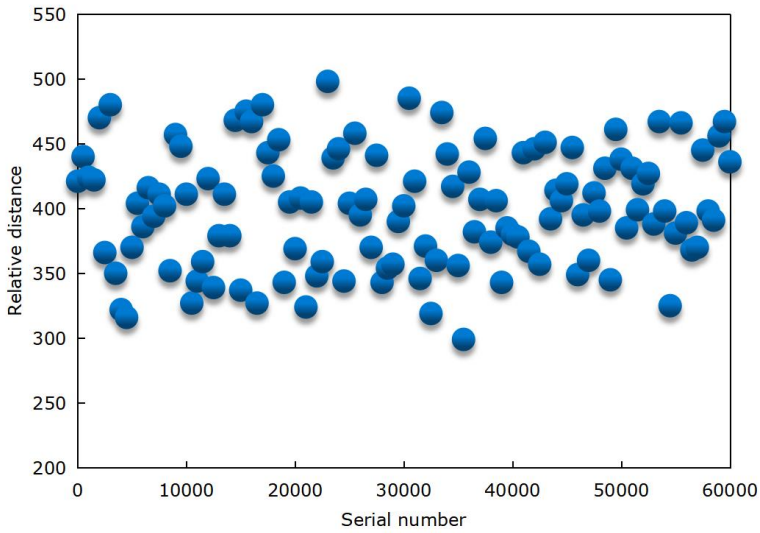

Figure 3: Data outlier removal processing.

Figures 4 and 5 show the recall and accuracy of the algorithm in consumer preference and demand forecasting. The algorithm shows a relatively high value in the prediction of consumer demand, both in recall and accuracy, which means that the algorithm has a high accuracy in predicting consumer demand. The high recall rate means that the algorithm can capture the real consumption demand more comprehensively, that is, it misses less actual purchases. The high accuracy means that the prediction result of this algorithm is more accurate when predicting the consumption demand, that is, there are fewer misjudgments.

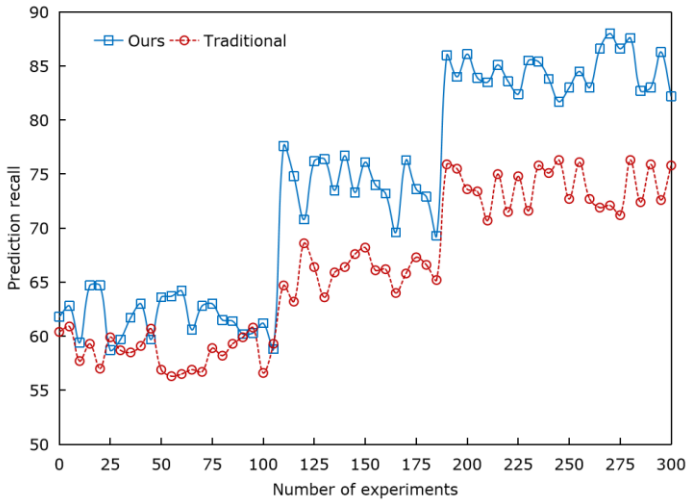

Figure 4: Recall of demand forecast.

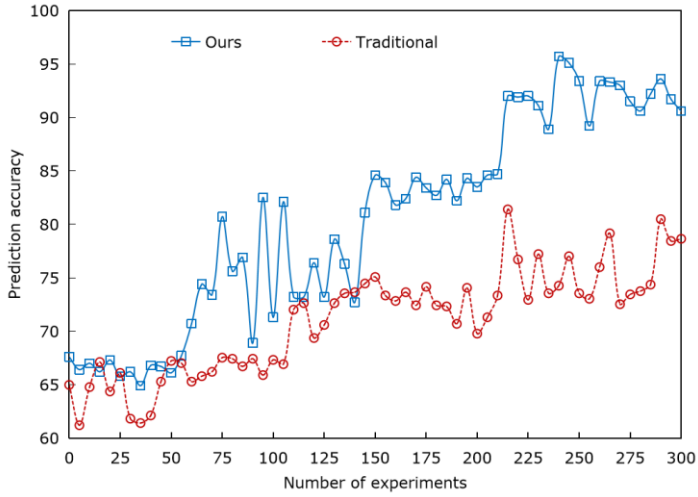

Figure 5: Accuracy of demand forecast.

The algorithm shows excellent performance in the prediction of cultural souvenir consumption demand. This may be because the algorithm comprehensively considers the multi-attribute attitude of consumers, thus more accurately grasping the preferences and needs of consumers. This provides strong data support for the design and marketing strategy of cultural souvenirs, and helps enterprises to meet the needs of consumers more accurately. Figure 6 shows the comparison of souvenir design effects before and after optimization combined with the prediction results of consumer demand.

Figure 6 shows the comparison of souvenir design effects before and after optimization based on consumer demand prediction results. The optimized souvenir design based on consumer demand prediction results has a certain improvement in visual effects. The color combination is more harmonious, the shape and lines are smoother, and the overall design is more unified and coordinated. By using the results of consumer demand prediction, designers can accurately grasp consumer preferences and market trends, and thus optimize them in a targeted manner in design.

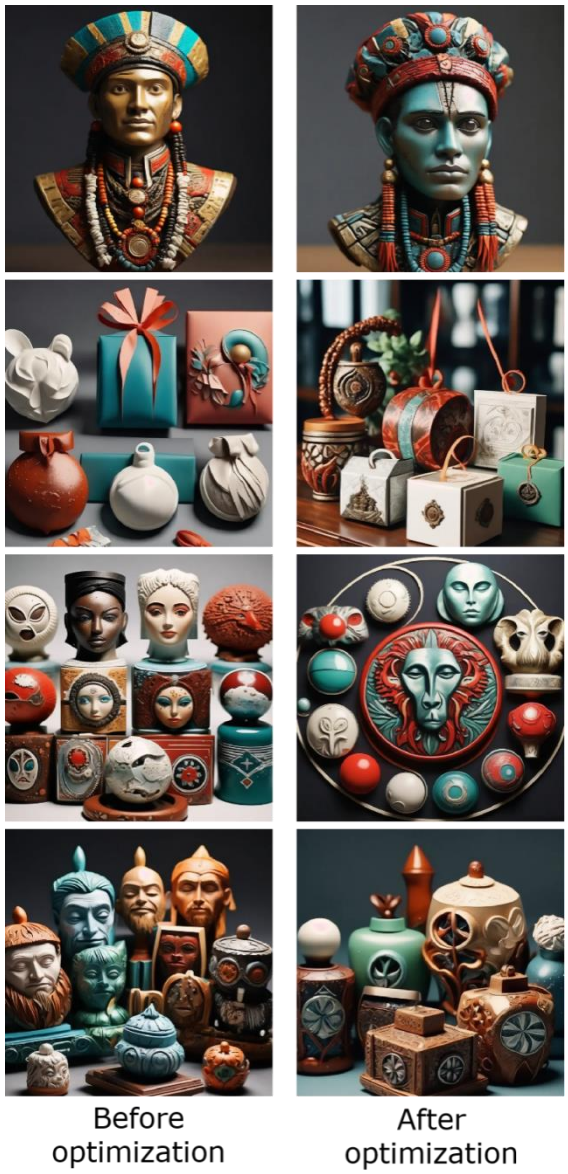

Figure 6: Comparison of souvenir design effects.

For example, if the predicted results show that consumers prefer minimalist designs, designers can emphasize minimalist elements in the design process, thereby increasing the attractiveness of the product to the target market. In addition to improving visual effects, optimization combined with consumer demand prediction results also enhances the artistic expression of souvenirs. Artistic expression is not only the pursuit of beauty, but also the expression of culture, emotions, and stories. By deeply understanding consumers' needs and preferences, designers can more accurately grasp these elements and integrate them into the design, making souvenirs not only visually appealing, but also emotional resonance and cultural value.

Figure 7 shows the subjective rating results of consumers for optimized cultural souvenirs. Consumers have given high praise to the color, shape, and texture of cultural souvenirs.

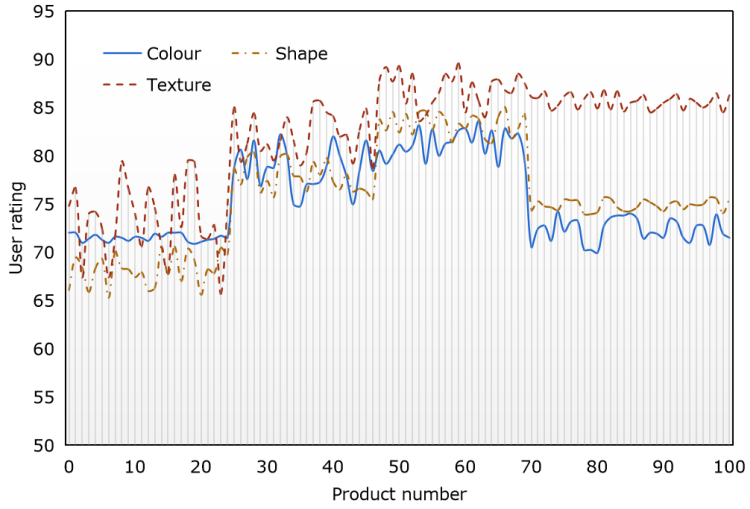

Figure 7: Subjective score of cultural souvenirs.

Consumers give high praise to the optimized color of cultural souvenirs, which shows that designers have chosen colors that meet the preferences of the target market, or successfully applied the principles of color psychology, making the products more attractive and emotionally resonant. Modeling is one of the core elements of cultural souvenir design, which reflects important significance in conveying cultural information and attracting consumers. Consumers give high praise to the optimized product shape, which shows that the designer has achieved success in shape design. This means that designers fully understand the needs and preferences of consumers and integrate these elements into product modeling. Texture refers to the tactile and visual feeling on the surface of objects, which greatly affects the quality of products and user experience. Consumers give high praise to the texture of cultural souvenirs, which shows that designers have achieved success in material selection and surface treatment.

The result analysis covers many aspects, from consumer demand prediction to cultural souvenir design optimization, including the accuracy of consumer demand prediction, the assessment of recall rate and accuracy, and the visual effect, artistic expression and subjective rating of consumers after the optimized design. These analysis results together constitute a comprehensive assessment system, which shows the importance of integrating consumer demand prediction into cultural souvenir design. Through the prediction of consumer demand, enterprises can more accurately grasp the market trends and consumer preferences, so as to design more popular cultural souvenirs. The design optimization combined with consumers' needs will help to improve the visual effect and artistic expression of souvenirs and make them more attractive and competitive. Consumers give higher assessment to the optimized cultural souvenirs, which means that their needs have been better met, thus enhancing user satisfaction and loyalty. Cultural souvenirs are not only commodities, but also carriers of culture. Innovative design combined with consumer demand can better meet the aesthetic and functional needs of modern consumers while inheriting culture.

5 CONCLUSION

Cultural souvenirs not only carry historical and cultural significance, but also serve as an important carrier for modern people to pursue quality of life, personality display, and spiritual sustenance. DL can automatically extract and learn a large quantity of design features, achieving intelligent and personalized design; CAD can quickly generate, optimize, and present design solutions in computers, improving the efficiency and accuracy of design. This article proposes a creative design process for

cultural souvenirs based on the comprehensive application of DL and CAD. Accurately predicting and understanding consumer demand is crucial for cultural souvenir design. Only by deeply understanding consumer preferences, purchasing behavior, and artistic aesthetics can designers create cultural souvenirs that meet market demand. By adjusting the design of colors, shapes, and textures according to consumer needs, souvenirs can better attract consumers' attention and evoke resonance. This optimization design method not only enhances the competitiveness of the product, but also enhances consumers' purchasing desire and satisfaction.

In summary, consumer demand prediction has irreplaceable significance for innovative design of cultural souvenirs. It provides designers with accurate design direction and inspiration sources, and helps enterprises better meet market demand, promoting the development and innovation of cultural souvenirs. In the future, we should continue to strengthen the research and application of consumer demand forecasting, continuously improve design methods and market strategies, and make greater contributions to the prosperity of the cultural souvenir industry.

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