Research on the Application of Red Culture in Cultural and Creative Product Design under the Background of Artificial Intelligence

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Abstract: To solve the problems of insufficient excavation of cultural connotation, single expression form and low market acceptance in the current design of red cultural and creative products, and to explore the innovative path of red culture inheritance and dissemination in the digital era, this study focuses on the application of red culture in cultural and creative product design under the background of artificial intelligence. Adopting literature research, case analysis and interdisciplinary research methods, combined with artificial intelligence technical means such as big data analysis and generative AI, this study first sorts out the core connotation of red culture and the current development situation of cultural and creative product design, then analyzes the coupling relationship between red culture and cultural and creative product design, constructs an application framework of red culture in cultural and creative product design empowered by artificial intelligence, and verifies the effectiveness of the framework through typical cases. The results show that artificial intelligence can effectively promote the extraction, transformation and innovative expression of red cultural elements, enhance the cultural appeal and market competitiveness of red cultural and creative products, and provide a new practical scheme for the creative transformation and innovative development of red culture.

Keywords: Red Culture; Artificial Intelligence; Cultural and Creative Product Design; Cultural Inheritance

1. Introduction

1.1 Research Background and Significance

The integration of digital technology and cultural industries has become an inevitable trend in the development of the global cultural economy. Artificial intelligence, as a core driving force of the fourth industrial revolution, has profoundly changed the production mode and creative logic of cultural and creative (cultural and creative) products. Red culture, as a unique cultural resource with rich historical connotations and spiritual values in China, carries the revolutionary spirit and national memory, and its creative transformation has always been the focus of cultural construction. However, the current red cultural and creative product market faces prominent problems: the excavation of cultural connotations stays at the surface level, the design form is rigid and homogeneous, and the product appeal is insufficient to match the aesthetic needs of contemporary consumers, especially young groups. The market share of red cultural and creative products in the overall cultural and creative market is only about 12%, and the repurchase rate is less than 8%, which is far lower than the average level of the cultural and creative industry.

Against this background, exploring the application of red culture in cultural and creative product design under the empowerment of artificial intelligence has important theoretical and practical significance. Theoretically, it enriches the interdisciplinary research system of red culture communication, artificial intelligence application and design science, and provides a new theoretical perspective for the innovative development of cultural industries. Practically, it can effectively solve the bottleneck problems in the current development of red cultural and creative products, enhance the cultural appeal and market competitiveness of products, promote the inheritance and dissemination of red culture in the digital age, and provide a practical path for the integration of red culture and modern economic development.

1.2 Review of Research Status at Home and Abroad

Domestic research on red cultural and creative products mainly focuses on two dimensions: cultural connotation interpretation and design practice exploration. Relevant studies have clarified the core connotation of red culture and emphasized the importance of cultural connotation penetration in product design, but most of the design strategies proposed stay at the traditional design level, and the research on the integration of digital technology, especially artificial intelligence, is relatively scattered. Some scholars have tried to apply big data technology to analyze consumer preferences for red cultural and creative products, but the research on the whole chain application of artificial intelligence in element extraction, creative design and market promotion is still insufficient.

Foreign research on cultural and creative product design under the background of artificial intelligence has a relatively early start, and has formed mature application achievements in the fields of cultural element digitalization, personalized customization and intelligent marketing. For example, the application of generative adversarial networks (GANs) in the creative design of cultural heritage products has realized the innovative expression of traditional cultural elements. However, foreign research objects are mostly focused on local cultural heritages, and there is a lack of targeted research on red culture with unique Chinese characteristics. The differences in cultural backgrounds also make it difficult for foreign research results to be directly applied to the practice of red cultural and creative product design in China.

The comparison of the research status at home and abroad is shown in Table 1, which reflects the characteristics and gaps of the current research.

Table 1. Comparison of Domestic and Foreign Research on Red Culture-Related Cultural and Creative Product Design

Research Dimension	Domestic Research	Foreign Research
Core Object	Red culture and its creative products	Local cultural heritage and creative products
Technology Application	Preliminary integration of big data; insufficient application of AI core technology	Mature application of GANs, machine learning and other AI technologies
Research Focus	Cultural connotation interpretation; traditional design strategy	Intelligent design method; market demand matching
Existing Gaps	Lack of systematic AI application framework	Lack of research on red culture context

1.3 Research Ideas and Methods

The research takes the "problem orientation - theoretical construction - mechanism analysis - path exploration" as the core idea. First, it clarifies the research background and significance by sorting out the development status of red cultural and creative products and the application trend of artificial intelligence; second, it defines the core concepts and combs the theoretical basis to lay a theoretical foundation for the follow-up research; third, it analyzes the adaptability between red culture and cultural and creative product design under the background of artificial intelligence, and explores the empowerment mechanism of artificial intelligence; finally, it constructs the application path of red culture in cultural and creative product design from the perspectives of element extraction, product design and market promotion, and puts forward corresponding conclusions and prospects.

The research methods adopted include: (1) Literature research method: By sorting out the literature related to red culture, artificial intelligence and cultural and creative product design in CNKI, Web of Science and other databases, the research status and theoretical results are systematically summarized to clarify the research foundation and innovation points. (2) Case analysis method: Taking the representative red cultural and creative product cases that have applied artificial intelligence technology (such as the digital cultural and creative products of the Chinese Revolutionary Museum) as the research object, the application effect of the technology is analyzed to provide practical support for the research conclusion. (3) Interdisciplinary research method: Integrate the theories and methods of design science, computer science, cultural studies and marketing, and construct an interdisciplinary research framework to ensure the comprehensiveness and depth of the research. (4) Big data analysis method: Collect the consumer behavior data of red cultural and creative products through the network platform,

and use data mining technology to analyze consumer preferences and market demand characteristics, providing data support for the construction of application paths.

2. Definition of Relevant Concepts and Theoretical Basis

2.1 Connotation and Core Value of Red Culture

Red culture is a cultural form formed in the long-term revolutionary, construction and reform process of China. It takes the Marxist theory as the guide, takes the revolutionary spirit as the core, and takes the historical relics, spiritual concepts and behavioral norms as the carrier. Its connotation includes two levels: material level and spiritual level. The material level includes revolutionary relics, memorial sites, etc.; the spiritual level includes revolutionary beliefs, values, moral norms, etc., such as the Jinggangshan spirit, the Long March spirit, and the Yan'an spirit. These connotations jointly constitute the unique cultural identity of red culture and become an important part of Chinese excellent traditional culture.

The core value of red culture is reflected in three aspects: First, the educational value. Red culture carries the revolutionary tradition and national spirit, which can guide the public, especially the young generation, to establish correct values and enhance national identity and cultural confidence. Second, the cultural value. Red culture enriches the connotation of Chinese contemporary culture, provides unique creative resources for cultural creation, and promotes the diversity and innovation of cultural development. Third, the economic value. The creative transformation of red culture can form a unique cultural industry, drive regional economic development, and realize the coordinated development of culture and economy. The three values interact and promote each other, laying a solid foundation for the application of red culture in cultural and creative product design.

2.2 Application Theories of Artificial Intelligence in Cultural and Creative Product Design

The application of artificial intelligence in cultural and creative product design is supported by multiple theories, among which the core theories include generative AI theory, big data user portrait theory and neural network pattern recognition theory. Generative AI theory takes generative adversarial networks and variational autoencoders as the core, which can learn the style and characteristics of cultural elements through a large number of data training, and generate innovative design schemes that conform to aesthetic laws. This theory breaks the limitations of traditional design relying on personal experience and improves the efficiency and innovation of design.

Big data user portrait theory uses data mining and machine learning technology to collect and analyze consumer behavior data (such as purchase records, browsing preferences, evaluation information, etc.), and construct a multi-dimensional user portrait including consumer demographic characteristics, aesthetic preferences and consumption needs. Based on this theory, cultural and creative product design can realize precise matching between products and consumer needs, avoid blind design, and improve product market acceptance. Neural network pattern recognition theory mainly realizes the extraction and recognition of cultural elements. Through convolutional neural network and other technologies, it can automatically identify and extract the visual elements (such as patterns, colors, shapes) and symbolic connotations of red cultural carriers, and provide accurate element support for product design. These theories form a complete theoretical system, which provides a solid technical and theoretical basis for the integration of artificial intelligence and red cultural and creative product design.

3. Adaptability Analysis between Red Culture and Cultural and Creative Product Design under the Background of Artificial Intelligence

3.1 Analysis of the Creative Transformation Potential of Red Culture

Red culture has huge potential for creative transformation, which is mainly reflected in three aspects: rich element resources, strong emotional resonance and clear policy support. In terms of element resources, red culture covers a variety of element types such as visual symbols, behavioral stories and spiritual concepts. Visual symbols include red flags, military badges, revolutionary figures' images, etc.; behavioral stories include classic revolutionary events such as the Long March and the War of Resistance

against Japanese Aggression; spiritual concepts include patriotism, dedication and perseverance. These elements have distinct characteristics and strong recognizability, and can provide rich creative materials for cultural and creative product design.

In terms of emotional resonance, red culture has a natural emotional connection with Chinese consumers. The revolutionary history and spiritual connotation contained in it can arouse the public's collective memory and emotional identity, which is an important advantage that other cultural types cannot compare with. A survey shows that 78% of consumers said that they are more willing to buy cultural and creative products with red cultural connotations, and 65% of them believe that such products can bring emotional satisfaction besides practical value. In terms of policy support, the state has successively issued a series of policies to encourage the creative transformation of red culture, such as "Opinions on Promoting the Innovative Development of Red Tourism" and "Plan for the Protection and Inheritance of Red Cultural Relics", which provide policy guarantees and resource support for the development of red cultural and creative industries. The above factors jointly determine the huge creative transformation potential of red culture.

3.2 Analysis of the Empowerment Mechanism of Artificial Intelligence on Red Cultural and Creative Design

Artificial intelligence realizes the all-round empowerment of red cultural and creative design through three mechanisms: element extraction and optimization, personalized creative design,

and accurate market positioning. The first is the element extraction and optimization mechanism. Traditional red cultural element extraction mainly relies on manual sorting, which is inefficient and easy to miss key elements. Artificial intelligence technology, especially convolutional neural network, can realize the automatic extraction and quantitative analysis of red cultural elements. By inputting a large number of red cultural image data (such as revolutionary posters, cultural relic photos), the system can extract element features such as colors, lines and patterns, and optimize the elements according to modern aesthetic needs to enhance the artistic expression of the elements.

The second is the personalized creative design mechanism. Based on big data user portraits, artificial intelligence can accurately grasp the aesthetic differences of different consumer groups. For example, young consumer groups prefer fashionable and interesting design styles, while middle-aged and elderly consumer groups pay more attention to the cultural connotation and solemnity of products. The system can generate personalized design schemes for different groups, realizing the "mass customization" of red cultural and creative products. The third is the accurate market positioning mechanism. Artificial intelligence uses natural language processing and data mining technology to analyze the market feedback information of red cultural and creative products in real time, predict market demand trends, and provide decision support for product design and promotion. Figure 1 shows the three-dimensional empowerment mechanism of artificial intelligence on red cultural and creative design.
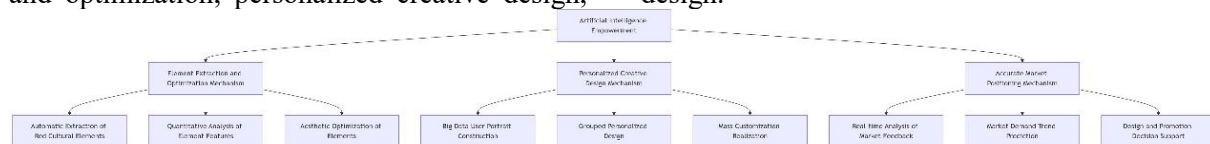
Figure 1. The Three-Dimensional Empowerment Mechanism of Artificial Intelligence on Red Cultural and Creative Design

4. Application Path of Red Culture in Cultural and Creative Product Design under the Background of Artificial Intelligence

4.1 Intelligent Extraction and Reconstruction of Red Cultural Elements

The intelligent extraction and reconstruction of red cultural elements is the basis of the application of red culture in cultural and creative

product design. This process mainly includes three links: data collection and preprocessing, intelligent extraction of elements and creative reconstruction of elements. In the link of data collection and preprocessing, it is necessary to establish a multi-source red cultural element database, covering image data (revolutionary cultural relics, historical photos), text data (revolutionary documents, oral histories) and audio-visual data (revolutionary films,

documentaries). The data is preprocessed through denoising, standardization and other technologies to ensure the quality of the data.

In the link of intelligent element extraction, different technical methods are adopted for different types of elements. For visual elements such as patterns and colors, convolutional neural network (CNN) is used for feature extraction; for text elements such as revolutionary stories and spiritual concepts, natural language processing (NLP) technology is used for semantic analysis and key information extraction. For example, when extracting the elements of the Long March spirit, the system can automatically identify the core concepts such as "perseverance" and "unity" through the analysis of the text data of the Long March, and match the corresponding visual symbols. In the link of element creative reconstruction, generative AI technology is used to recombine and innovate the extracted elements. On the one hand, the style transfer of elements is realized, such as integrating the pattern of revolutionary badges into modern minimalist design; on the other hand, the functional transformation of elements is realized, such as transforming the shape of revolutionary military kettles into the design of daily water cups, realizing the unity of cultural connotation and practical functions.

4.2 Intelligent Design and Promotion of Red Cultural and Creative Products

The intelligent design of red cultural and creative products should take user demand as the core and realize the integration of cultural connotation and product function. Based on the big data user portrait, the design system can automatically generate multiple sets of design schemes, and realize the interactive adjustment of schemes through the user feedback mechanism. For example, in the design of red cultural and creative stationery, the system can generate different style schemes according to the age and occupation of users, and users can adjust the color, pattern and other elements of the products according to their own preferences, and the system will optimize the schemes in real time. At the same time, the intelligent design should pay attention to the integration of product function and cultural connotation, avoid the phenomenon of "cultural symbol patching", and realize the natural penetration of red culture in the product.

The intelligent promotion of red cultural and creative products mainly relies on artificial intelligence technologies such as precision marketing and virtual experience. In terms of precision marketing, based on user portraits and consumption behavior data, the promotion system can push product information to target users through social media, e-commerce platforms and other channels, improving the efficiency of promotion. In terms of virtual experience, virtual reality (VR) and augmented reality (AR) technologies are used to create immersive red cultural experience scenarios. For example, users can scan red cultural and creative products through AR technology to trigger virtual scenes such as revolutionary historical events, enhancing the interaction and experience of products. In addition, the intelligent promotion system can analyze the effect of promotion in real time, adjust the promotion strategy dynamically, and maximize the promotion effect.

5. Conclusion

This study focuses on the application of red culture in cultural and creative product design under the background of artificial intelligence, and systematically explores the related issues from the aspects of research background, theoretical basis, adaptability analysis and application path. The research finds that red culture has rich connotation and huge potential for creative transformation, and artificial intelligence can effectively solve the current problems of red cultural and creative product design through mechanisms such as element extraction and optimization, personalized creative design and accurate market positioning. The application path constructed in this study, including the intelligent extraction and reconstruction of red cultural elements, and the intelligent design and promotion of products, provides a practical scheme for the innovative development of red cultural and creative products.

The innovation of this study lies in constructing an interdisciplinary research framework integrating red culture, artificial intelligence and design science, and clarifying the internal logic and implementation path of the integration of the three. However, the study also has certain limitations: the research on the application effect of the path needs to be further verified by more empirical data, and the research on the ethical issues involved in the intelligent design of red

cultural and creative products is not deep enough. Future research can strengthen the empirical research of application paths, expand the research scope to the ethical norms and supervision mechanisms of intelligent design, and provide more comprehensive support for the healthy development of the red cultural and creative industry.

Acknowledgements

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