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Research on User Emotional Interaction Mechanism in Digitalized Green Product Design

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Abstract: This paper systematically explores the user emotional interaction mechanism in digitalized green product design. It comprehensively analyzes the role of digital technology in stimulating, disseminating, and regulating user emotions, ranging from theoretical foundations and mechanism construction to path design and evaluation optimization. By integrating emotional cognitive models, multi-modal interaction design principles, and big data analysis techniques, it proposes a scientific indicator system and experimental method, providing theoretical support for the deep dissemination of green concepts and the transformation of user behavior. In practice, it constructs a closed-loop feedback mechanism of personalized customization and dynamic adjustment to ensure continuous optimization of user experience. The research results have important theoretical value for promoting the digital transformation of green design and facilitating the dissemination of green values, providing an innovative approach to achieving green sustainable development goals. In the future, with the continuous development of intelligent algorithms and multi-modal interaction technologies, the user emotional interaction mechanism will play an increasingly important role in green innovation.

1. Introduction

Globally, environmental protection and sustainable development have become core issues in socio-economic development. Green products, as important vehicles for achieving green transformation, are undergoing continuous deepening and expansion in their design concepts. With the rapid integration of digital technologies, digital green design has become a crucial pathway for promoting industrial upgrading and user engagement [1]. Digital technologies, such as the Internet of Things, big data, virtual reality, and augmented reality, not only greatly enrich the expressive forms of green products but also imbue the design process with higher levels of intelligence and interactivity, bringing revolutionary changes to the user experience of green products. Green design emphasizes the balance between ecological benefits and user needs, while digital means play a key role in improving design efficiency, enhancing product interaction, and realizing personalized customization [2].

In the promotion of green products, the emotional experience of users has gradually attracted attention from academia and industry[3,4]. User emotions not only influence the cognitive acceptance of products but also play an indispensable role in the development and continuous use of

green behaviors. Emotional factors enhance users' sense of belonging, identity, and accomplishment, thereby strengthening their recognition of green concepts and willingness to participate, effectively promoting the transformation of green consumer behavior. However, traditional green design often focuses on the technical or functional aspects, neglecting the user-centered emotional interaction mechanism, which limits the potential market penetration of green products.

In this context, exploring the user emotional interaction mechanism in the digital environment is not only of theoretical innovation significance but also related to the optimization of green design practices[5,6]. Building an interaction model with user emotion as the core helps to achieve a deep connection between users and green products, enhance their sense of experience and loyalty, thereby promoting the widespread acceptance and promotion of green products. How to combine the advantages of digital technology to deeply explore and stimulate users' emotional needs, and form an effective emotional feedback and interaction mechanism, has become an important research topic in green product design[7].

This article aims to systematically analyze the characteristics of user emotions in digital green product design, explore the construction path of its interaction mechanism, and provide theoretical support and practical guidance for the design optimization of green products through a combination of theoretical frameworks and practical applications. This research not only enriches the interdisciplinary content of affective computing and green design but also provides innovative design strategies for promoting green sustainable development, which is expected to have a positive impact on industrial upgrading, policy-making, and user behavior guidance.

2. Digitalized Green Product Design and User Emotional Characteristic Analysis

2.1 Theoretical Basis

With the rapid development of information technology, the application of digital technology in green product design continues to expand, providing strong technical support for realizing green design concepts. The Internet of Things (IoT), as a bridge connecting physical entities and virtual spaces, uses sensor networks to collect environmental parameters and user behavior data in real-time, enabling green products to achieve intelligent monitoring and regulation. The application of this technology not only improves the environmental adaptability of green products but also provides users with an intuitive and dynamic interactive experience, strengthening users' awareness and recognition of green concepts [8].

Virtual Reality (VR) and Augmented Reality (AR) technologies play an important role in the virtual simulation, visualization, and experience of green design. The immersion and interactivity of virtual environments effectively stimulate users' interest and emotional identification, allowing users to feel the beauty and value of green design in virtual spaces, thereby promoting the establishment of their emotional identification. Especially in the experience, education, and promotion of green products, the introduction of VR and AR greatly enriches users' sensory experience and enhances their emotional resonance.

Green design principles emphasize the eco-efficiency, resource conservation, and renewability of the product's entire life cycle. In a digital environment, these principles are digitally translated through data-driven design methods, forming a dynamically optimized design process. For example, embedding ecological footprint analysis, energy efficiency simulation, etc., into design software enables real-time correction and optimization of green concepts, providing users with more practical green design solutions. In addition, based on big data and cloud computing technologies, design teams can analyze a large amount of user preferences and behavioral data, integrate multi-source information, and support personalized green product design, thereby meeting the emotional needs of different users.

2.2 Theoretical Framework

Understanding user emotions is an important foundation for enhancing user experience in green product design. Emotional models such as the PAD (Pleasure-Arousal-Dominance) theory provide a structured framework for analyzing users' emotional experiences. This model decomposes emotion into three dimensions: pleasure, arousal, and dominance, which can comprehensively reflect users' subjective experience in the interaction process[9]. Using the PAD model for emotional assessment helps designers identify users' emotional changes in different interaction stages, thereby optimizing design strategies in a targeted manner.

In addition, the emotional cognitive model emphasizes the interactive relationship between emotion and cognition, believing that emotion is an important component of the cognitive process. By understanding users' cognitive load, values, and psychological expectations, it is possible to more accurately grasp users' emotional preferences and design green products that can stimulate positive emotions. User emotions also have complex psychological and behavioral characteristics. The psychological level includes a sense of belonging, identification, and security, while the behavioral level is manifested as the willingness to continue using, recommendation behavior, and the transformation of green actions. These characteristics determine users' emotional response to green products and their subsequent behavior, making them an indispensable consideration in the design process.

2.3 Mechanisms of Digitalization for Stimulating User Emotion

Digital methods play a crucial role in stimulating and regulating user emotions. Interactive experiences, through multi-sensory and multi-channel interaction design, enable users to deeply participate in the use of green products, enhancing their emotional investment. For example, the design of interactive interfaces should focus on the integration of emotional symbols, using elements such as color, sound, and animation to stimulate positive user emotions. Simultaneously, personalized recommendations and content customization, combined with user behavior data, provide users with green content that matches their preferences, thereby strengthening emotional connection.

Visual experience is particularly important in stimulating emotion. The color green symbolizes nature, tranquility, and harmony, and a rational visual layout and design style can evoke emotional resonance in users. In digital environments, the application of virtual reality and augmented reality technologies not only enhances immersion but also evokes users' emotional identification through the authenticity of virtual scenes. The authenticity and richness of these virtual environments, as a core mechanism for stimulating emotion, drive users to generate a sense of belonging and identification with green products.

The construction of a sense of participation relies on the rational layout of interactive design. Through task orientation, collaborative participation, and feedback mechanisms, users are motivated to gain a sense of accomplishment and satisfaction in the use of green products. Digital platforms provide rich social and sharing channels, allowing users to experience the emotional value of belonging to others through interaction, thereby further strengthening emotional bonds. In addition, emotional stimulation in the digital environment is also affected by environmental convenience, ease of operation, and information transparency. Good user experience design helps reduce cognitive burden and enhance positive emotional feedback.

The influencing factors of the digital environment on users' emotions cover multiple aspects externally. The shaping of the environmental atmosphere, the advancement of interaction technology, the personalization of content, and the real-time analysis of data all have a profound impact on users' emotional experiences. Understanding these influencing factors can guide the

emotional stimulation strategies in green product design, ensuring that the design plans receive positive emotional responses from users in real experiences and promoting the in-depth dissemination and practice of green concepts.

3. Construction of User Emotional Interaction Mechanism

3.1 Theoretical Model of Interaction Mechanism

The development and application of emotional cognitive theory serves as the core foundation when constructing a user emotional interaction mechanism. This theory emphasizes the guiding role of emotion in the cognitive process, suggesting that users' emotional responses during interaction with green products stem not only from the characteristics of the product itself, but also from the influence of cognitive evaluation, situational context, and social significance. Designing effective interaction strategies requires stimulating positive emotions while promoting users' cognitive integration, forming a strong emotional connection by guiding users' understanding of green value. For example, using a cognitive mapping model clarifies the relationship between emotion and cognition in different interaction stages, ensuring that each stage effectively evokes emotional resonance from users.

The principle of multimodal interaction design emphasizes the integration of multiple sensory experiences and information transmission channels to achieve information richness and deep emotional reach. The synergistic effect of visual, auditory, tactile, and even gustatory and olfactory multimodal elements helps enhance users' sense of immersion and emotional resonance. The design should fully consider the interactive characteristics of different senses, combining voice interaction, touch screens, gesture recognition, and other channels to create an interactive experience with rich expressiveness. This multimodal design not only enhances users' sense of participation and belonging but also subtly strengthens the transmission effect of green value, providing strong support for the subtle influence of environmental protection concepts.

3.2 Emotional Arousal and Dissemination Paths

Achieving effective emotional arousal requires combining personalized push notifications with the design of emotional symbols to create interactive content with emotional color. The implementation of personalized push notifications relies on big data and artificial intelligence technologies. By analyzing user behavior, preferences, and historical interaction data, content that resonates emotionally is customized for each user. The content should not only match the user's interests but also incorporate green environmental protection elements to strengthen the emotional connection between the user and green values. The use of emotional symbols, such as green environmental protection visual symbols, emotional language expressions, and symbolic symbols, can stimulate users' empathy and resonance, deepening the emotional imprint of green products. For example, integrating green elements into interface icons, animation effects, and even virtual characters enhances users' sense of identity through the optimization of emotional colors.

In the interaction process, the design of the feedback mechanism is particularly important. Interaction feedback refers to the real-time response of the user during the operation process, while emotional feedback is the expression of the user's subjective feelings. This mechanism should promptly meet users' emotional needs and create a good interactive experience through dynamic adjustment of interface performance, sound feedback, and animation changes. In addition, building a closed-loop emotional feedback system can continuously collect users' emotional attitudes and preferences. Through machine learning and emotional analysis technology, interaction strategies can be continuously optimized to achieve personalized and intelligent emotional regulation. This

not only improves user satisfaction but also promotes users to internalize green concepts into behavioral habits, thereby achieving the continuous transformation of green actions.

3.3 Digital Platforms and Tools

Digital interfaces serve as the primary means for users to interact with green products. Their design should revolve around user experience, enhancing the convenience and emotional depth of the interaction. Interfaces should be streamlined and intuitive, incorporating visual elements that align with the green theme, creating a natural and warm atmosphere through color schemes and layout. Interactive elements should be highly responsive and support various input methods, such as touch, gestures, and voice commands, to provide personalized operational experiences for different users. Emotional guidance during the interaction, such as using animations to depict green vitality or employing warm color palettes, can cultivate a digital space with emotional warmth.

The introduction of virtual reality (VR) and augmented reality (AR) technologies makes immersive experiences possible. Building virtual environments not only simulates real-world scenarios but also strengthens the expression of green values in virtual spaces, such as virtual forests and ecosystems, allowing users to immerse themselves in nature and experience the charm of green living. Immersive experiences not only enhance user's emotional engagement but also strengthen their recognition of green and eco-friendly actions on an emotional level, gradually forming an internal motivation for green behavior.

Data collection and sentiment analysis technologies provide technical support for interaction mechanisms. By collecting multi-modal data such as user interaction trajectories, facial expressions, voice emotions, and behavioral preferences, and using machine learning and deep learning algorithms for emotion recognition, the emotional state of users can be analyzed in real time. This process not only accurately captures users' emotional changes but also enables personalized emotional regulation strategies, thereby optimizing the overall experience. Based on the results of sentiment analysis, interaction content and methods can be continuously adjusted to ensure that the interactive experience of green products continuously adapts to user needs, forming a positive emotional interaction loop.

In practice, the application of technical tools such as smart interfaces, virtual tours, and emotional robots provides users with more engaging and interactive green experience platforms. These tools can achieve humanized and emotional interaction, creating a natural, warm, and emotionally resonant digital environment for users, making the dissemination of green values more natural and effective. At the same time, the continuous optimization and innovation of these tools also provide a solid technical foundation for the continuous upgrading of green products.

4. Evaluation and Optimization of User Emotional Interaction Mechanisms

4.1 Construction of Evaluation Index System

When systematically evaluating user emotional interaction mechanisms, establishing a scientific and reasonable index system is particularly crucial. This system should cover the intrinsic emotional responses experienced by users during the interaction process, as well as the degree of transformation of green cognition and behavior, providing data support and theoretical basis for the continuous optimization of the mechanism.

User emotional experience indicators focus on users' subjective feelings during the interaction process, including multi-dimensional perceptual indicators such as pleasure, satisfaction, sense of belonging, security, and excitement. User emotional change trajectories can be obtained through questionnaire surveys, in-depth interviews, and emotional self-reports. These indicators reflect the

effectiveness of emotional stimulation in interaction design, help identify the different impact of different touchpoints on emotions, and provide intuitive feedback data for design optimization.

Green cognition indicators measure users' level of awareness and understanding of green concepts, including green value cognition, mastery of environmental knowledge, and cognitive willingness for green behavior. This data is mainly based on questionnaire tests, knowledge quizzes, and behavioral intention surveys, aiming to assess the depth of users' understanding of green concepts and the extent to which their sense of identity is stimulated through interaction.

Behavioral transformation indicators emphasize changes in users' actual behavior, covering the growth of green consumption behavior, the frequency of participation in environmental protection actions, and the initiative of green decision-making. Behavior tracking, platform data analysis, and behavioral intention surveys help evaluate the specific effectiveness of the interaction mechanism in promoting users' green actions. These indicators provide hard evidence for evaluating the implementation effect of the mechanism and support subsequent strategy formulation.

Integrating the above indicators, building a dynamic and comprehensive evaluation system can effectively reflect the degree of change in users' emotional experience and green behavior, providing a scientific basis for continuous improvement of the mechanism. The use of multi-source and multi-angle evaluation methods ensures the comprehensiveness and reliability of the data. Time dimension should also be introduced in data analysis to observe users' emotional and behavioral changes at different stages, providing a time-series development perspective for mechanism optimization.

4.2 Mechanism Optimization Path

The continuous optimization of the user emotional interaction mechanism relies on the establishment of a personalized customization and dynamic adjustment system. Personalized paths analyze users' behavioral data and emotional characteristics to customize differentiated interaction content and methods for different users. By leveraging big data and artificial intelligence technologies, we can identify users' preferences, emotional states and cognitive levels in real time, adjust interaction strategies, and enhance users' emotional satisfaction and green cognitive levels. This dynamic regulation ensures that the interaction mechanism can adapt to the changes of different users, improving the consistency and effectiveness of the overall experience.

The dynamic adjustment mechanism emphasizes the dynamic adjustment of interaction content, feedback strategies and dissemination paths based on the real-time monitoring results of assessment indicators. In practical operation, key performance indicators (KPIs) can be set up, a monitoring platform can be established to closely track users' emotional changes and behavioral feedback, and specific adjustment plans can be formulated based on the results of data analysis. The application of artificial intelligence algorithms to achieve automatic response and personalized recommendation will gradually enable the mechanism

5. Conclusion

This article systematically analyzes the characteristics of user emotion in digital green product design, the construction path of the interaction mechanism, and its evaluation and optimization strategies. By integrating emotional cognitive theory, multimodal interaction design principles, and digital technology methods, the innovative design of user emotion stimulation, dissemination, and continuous regulation mechanisms is realized. The construction of a scientific and reasonable evaluation index system enables effective monitoring of user emotional experience, green cognition, and behavior transformation, providing a solid data foundation for the continuous optimization of the mechanism. Combining qualitative and quantitative experimental analysis methods, and

employing advanced technical means such as behavior tracking and emotion recognition, the psychological and behavioral changes of users in digital green interaction are effectively revealed, providing technical support for mechanism optimization. The establishment of a dynamic personalized adjustment and feedback closed-loop system ensures the continuous optimization of user experience and helps to achieve deep implantation of green concepts and behavior transformation. In the future, leveraging intelligent algorithms and big data technology to promote the continuous innovation of user emotional interaction mechanisms will play an important role in green design promotion and sustainable development, providing theoretical basis and practical guidance for the green transformation of related industries.

References

[1] Zheng Chengming. Research on the Application of Artificial Intelligence Technology in Digital Product Design [J]. Research on Art Education, 2025,(10):98-100.

[2] Zhang Xiaotong, Tian Jingwen, Zhou Hongtao. Research on Tactile Cognition and Art Product Design of the Blind Based on "Emotional Interaction" [J]. Design, 2023,36(18):124-127.

[3] Yang Ziwei, Luo Danfeng. Research on Digital Transformation and Innovation Strategies of Intangible Cultural Heritage Cultural and Creative Products [J]. Western Leather, 2025,47(10):33-35.

[4] Liu Xiangzhi. Design of Emotional Interaction Products for Rural Left-behind Children [D]. Hunan University of Technology, 2023.

[5] Zhang Yingying, Sun Xi. The Application and Practice of Digital Technology in the Brand Design of Museum Cultural and Creative Products [J]. Green Packaging, 2025,(05):176-180.

[6] Liu Zhuoya. Research on the Application of "Emotional" Packaging Design in Product Design [J] Light Textile Industry and Technology, 2021,50(11):24-25.

[7] Sun Jiawei, Zheng Gangqiang, Liu Lanyu. Analysis of Research Hotspots and Development Trends of User Experience Design for Digital Products [J]. Packaging Engineering, 2025,46(08):74-89.

[8] Shi Congwei. Research on Emotional Design Strategies of Intergenerational Interactive Education Products [D]. Wuhan University of Technology, 2021.

[9] Zhu Wei. Research on the Design of Interactive Multimedia Campus Cultural and Creative Products Based on Emotionalization Theory [D]. Guangdong University of Technology,2019.