Exploration and Development Trends of Artificial Intelligence in Industrial Design

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Abstract: Currently, artificial intelligence has become a powerful engine for global economic growth, driving the intelligent development of various industries. Coupled with the maturity of technologies such as big data and the Internet of Things, the application of artificial intelligence in the industrial field has become increasingly complex. It not only changes the operational processes of the industrial design industry but also promotes the innovation of industrial design concepts. This paper briefly outlines the basic concepts of artificial intelligence and industrial design, as well as the impact of artificial intelligence on industrial design. It focuses on exploring the application of artificial intelligence in industrial design and analyzes the future trends of artificial intelligence in industrial design for reference.

Keywords: Artificial intelligence; Industrial design; Application

1. Introduction

With the rapid development of science and technology, the application prospect of artificial intelligence in various industries has become increasingly broad, and it has become an important force promoting the innovation of the manufacturing industry. Industrial design is an interdisciplinary subject. The application of artificial intelligence technology in industrial product design can improve design efficiency and optimize the design process. It conforms to the characteristics of modern industrial development and is also an important development direction of the industrial design industry in the future. This paper explores the application of artificial intelligence in industrial design, hoping to promote the digital transformation and development of industrial design.

2. Overview of artificial intelligence and industrial Design

Artificial intelligence is a technology that enables computers and machines to simulate human intelligent thinking and behavior, with the ability to exert autonomy and creativity. By virtue of technical means such as deep learning and computer vision, intelligent systems or machines can learn from data, achieve evolution, and be competent for some tasks that originally required humans to accomplish [1]. Currently, artificial intelligence technology is built on the stage

of rapid development of human information, making the interconnection of everything possible. However, artificial intelligence technology is still in the initial stage of development, and there is still a long way to explore.

The so-called industrial design is the design of industrial products based on aesthetics, psychology, mechanical structure, and economics. In daily life, almost all the industrial products we come into contact with will go through the industrial design link to meet the needs. In short, industrial designers take humans as the core and meeting people's needs as the goal, carry out product innovation by comprehensively applying knowledge of science, art, technology, etc., and optimize the provided services. It is different from other production activities, process production, etc[2].

Although artificial intelligence and industrial design seem to be two unrelated fields, their development has been closely linked from a historical perspective. The development of artificial intelligence began in 1943 with the proposal of the mathematical model of neurons, while industrial design also experienced the transformation from manual design to modern industrial design in the second half of the 18th century. After the 20th century, the two began to gradually integrate. In recent years, with the development of technologies such as machine learning and big data, the connection between artificial intelligence and industrial design has become increasingly close, which not only improves the efficiency of industrial design but also provides more possibilities for innovation.

3. The impact of artificial intelligence on industrial design

3.1. product design process

In the past, the effectiveness of product design mainly depended on the experience and ability of designers. However, with the development of artificial intelligence technology, the product design process has become more simplified, and the efficiency of product design has also been improved [3]. For example, in the initial stage of product design, designers can use artificial intelligence to analyze a large amount of data and grasp market and user needs. During the product design process, designers can use artificial intelligence technology to create product models in advance, and shorten the product design cycle and reduce the expenditure of the product design process through repeated deliberation [4]. In general, the main roles of artificial intelligence in the industrial design process are as follows: First, with the help of artificial intelligence, industrial product design sketches can be generated in advance, and various schemes can be designed by inputting different parameters, creating more possibilities; Second, artificial intelligence has the functions of simulation and prediction. With this advantage, industrial designers can pre-calculate the cost of product design and development, providing a reference for engineering design decisions.

3.2. Product design and development

Innovating the product development process through intelligent tools and algorithms can improve the efficiency and quality of industrial product design. Artificial intelligence has machine learning capabilities, which can quickly extract valuable information from historical data to optimize product structures and shorten product design cycles. For example, combined with the performance requirements of products, the most cost-effective materials can be screened out with the help of artificial intelligence algorithms, reducing the trial-and-error cost in the product design process; or with the assistance of artificial intelligence technology, complex product structures can be simplified, and different product structure design drawings can be quickly generated, providing designers with different options [5]. In addition, with the help of technologies such as virtual reality, artificial intelligence creates a realistic product design environment, allowing designers to test and evaluate the user experience of products in a simulated environment and solve potential problems in product design.

3.3. Product user experience

User experience and sense of use are important considerations in industrial design, and the application of artificial intelligence technology can effectively improve users' experience of products. The application of artificial intelligence

technology can collect a large range of user data, so that industrial designers can grasp users' needs and preferences to design products [6]. Similarly, it can also understand user feedback and optimize product design in a timely manner. In addition, the application of artificial intelligence technology can make the product interface more simplified, intuitive, and operable, optimizing the interactive function of the product. Artificial intelligence can also be used in the self-optimization of products, that is, industrial designers can improve the intelligence of products through user interaction, thereby enhancing users' satisfaction with products.

4. Specific applications of artificial intelligence in industrial design

4.1. Intelligent modeling design

The most common aspect of industrial design is appearance design, which is a comprehensive field. Designers need to comprehensively consider factors such as product functions, image, and user experience to create a meet - the - requirement appearance design. Before designing a product's appearance, artificial intelligence can be used to collect a large amount of relevant data and extract valuable design information and rules from it. On this basis, artificial intelligence can generate preliminary design schemes and inspire designers' creativity [7]. The design scheme can also be optimized according to the functional design and aesthetic needs of the product. Take automobile appearance design as an example. In the traditional automobile appearance design process, repeated adjustments and modifications will consume a lot of time. In the context of the application of artificial intelligence, through real - time simulation of the aerodynamics of automobiles, immediate feedback on the advantages and disadvantages of the design can be obtained, so that designers can identify and solve potential problems at an early stage. Through artificial intelligence, automobile manufacturers can also provide consumers with an interactive design platform. Consumers can choose their favorite vehicle colors, materials, body shapes, etc. This can ensure that the designed cars can meet consumers' aesthetic pursuit, as well as ensure the practicality and manufacturability of the vehicles.

4.2. Intelligent color design

In industrial design, apart from the shape, the most intuitive feeling that products bring to consumers is the product color. The choice of color in product design is purposeful and functional [8]. The application of artificial intelligence in product color design can realize automatic color matching and carry out creative color matching, bringing new design inspiration to designers. Specifically, through machine learning algorithms, a large amount of color matching data can be trained. The machine learning model, by learning the rules and characteristics, can intelligently optimize and expand the existing color matching schemes, generate new color combinations, and make the original color matching more harmonious and beautiful. At the same time, artificial intelligence can also recommend appropriate color matching schemes according to the creative style and needs of the design, improving the work efficiency of designers and the quality of product design [9]. However, artificial intelligence plays an intelligent auxiliary role rather than completely replacing the work of designers. Designers need to conduct manual evaluation and polishing of the color matching schemes and suggestions generated by artificial intelligence based on their own experience to determine the final scheme.

4.3. Intelligent Ergonomic Design

It is an indispensable key link in human-computer interaction industrial design. Especially against the background of the rapid development of information technology, human-computer interaction systems have been widely applied to various products. Therefore, one of the focuses of industrial design work is to pay attention to how to ensure more natural interaction between products and users and provide users with a better experience [10]. Artificial intelligence can ensure the improvement of human-computer interaction design and user experience. Designers can carry out optimization through the following design and technical means: First, recurrent neural networks and variational autoencoders can be introduced to enable artificial intelligence systems to more accurately understand the instructions input by designers. At

the same time, convolutional neural networks can be used to analyze users' operation behaviors to assist designers in optimizing page layouts. Second, establish an interactive system that integrates multiple modalities such as language and gestures. Through fusion learning and reinforcement learning algorithms, artificial intelligence systems can adaptively adjust interaction strategies to help designers optimize their designs. To optimize human-computer interaction design and improve user experience, when designing ergonomics, not only factors such as humans, machines, and the environment should be considered, but also the construction of the product's own system [11]. That is, designers should not only consider the equipment performance of the product but also its human-machine characteristics, safety protection, etc., to ensure that the ergonomic design meets relevant standard requirements.

4.4. Intelligent design management

Industrial design includes links such as intelligent modeling design, intelligent color design, and ergonomic design, which is a great test for managers' management capabilities. To optimize the management process and achieve the goal of collaborative design, the form of user group management can be adopted [12]. This model can fully tap and reflect the value of elements such as intelligent modeling design, intelligent color design, and ergonomic design. By integrating and analyzing the needs and feedback of user groups, all links can cooperate closely and operate efficiently. In the process of intelligent design management research, many experts have actively innovated management methods and proposed a series of intelligent management tools, expecting to provide designers with information references and decision-making suggestions through advanced algorithms and data analysis models. In addition, information management systems also play an important role in design management. By collecting a large amount of design data, user data, etc., and analyzing and sorting them out, they help designers make more accurate decisions.

5. Future trends of artificial intelligence in industrial design

5.1. Positive impacts of artificial intelligence technology on industrial design

The application of artificial intelligence in the field of industrial design has promoted the transformation of industrial design concepts and methods. Traditional industrial design methods were mostly manual drawing, and later gradually evolved to the use of some computer-aided design systems. Against the backdrop of artificial intelligence, the development of new technologies and changes in social needs have forced designers to change their own design thinking and methods. At the same time, the application of artificial intelligence has also elevated the level of industrial design. With the support of technologies such as artificial intelligence, virtual simulation, and big data, the space and dimensions of industrial product design have been continuously expanded [13]. In addition, the integration of artificial intelligence and industrial design has brought profound impacts and changes to people's lives. For example, the increasingly intelligent transportation systems, the mechanization of agricultural production equipment, and the use of smart homes have brought great convenience to people's lives. Of course, with the assistance of artificial intelligence, not only the functions of industrial products have been improved, but also the appearance of products has become more aesthetic and artistic.

5.2. Future trends of artificial intelligence in industrial design

The concept of human-computer interaction has been proposed since the 1950s, and its development has experienced a leap from the early manual operation stage to the current intelligent human-computer interaction stage. In this process, the field of human-computer interaction has achieved some results, giving birth to computer products represented by smartphones and computer systems represented by virtual reality. However, despite the remarkable achievements, human-computer interaction still faces development bottlenecks.

Specifically, human-computer interaction technology has developed vigorously and its application in the field of industrial design has been expanded. For example, motion recognition technology has been applied to the design

of wearable computer products, providing users with a better interactive experience; tactile interaction technology is widely used in remote operations and remote-controlled robots [14]. However, the application of emerging technologies is a double-edged sword, as it brings opportunities along with many challenges. Firstly, although artificial intelligence can change the traditional design process and produce a large number of design schemes in a short time, parametric design after the scheme is determined and prototype trial production of products cannot yet be combined with artificial intelligence [15]. Secondly, the integration of artificial intelligence and industrial design is still in the exploration stage. Take visual gesture recognition as an example. Although this technology is widely used in technology enterprises and industrial industries, the developed products still have problems such as poor real-time performance and low recognition rate that have not been solved. Thirdly, the quality of industrial design ultimately depends on the professional literacy and ability of designers. In the context of artificial intelligence, there are higher requirements for the professional literacy of designers. Designers must not only understand fields such as modeling aesthetics, structural design, and market analysis and research, but also understand the essence of design, so that they can effectively screen and deepen the schemes generated by artificial intelligence and improve the design quality.

Disclosure statement

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References

[1]   Hou W, 2025, Research on the Application of AI Technology in Computer-Aided Industrial Design. Screen Printing Industry, 2025(04): 14-16.

[2]   He L, Wang Y, 2025, Strategies for Intelligent Technology Empowering Industrial Design in the Digital Context. Footwear Technology and Design, 5(06): 120-122.

[3]   Zhou Z, Hu H, Xu C, 2025, Research on the Impact of Artificial Intelligence Technology on Industrial Design Education. Screen Printing Industry, 2025(03): 112-114.

[4]   Ding C, 2025, Discussion on the Development of Industrial Product Design in the Digital Intelligence Era. China Plant Engineering, 2025(05): 12-14.

[5]   Li Q, 2024, Research on the Cultivation and Development Path of Industrial Design Industry under the Background of Industrial Revitalization. Modern Industrial Economy and Informationization, 14(12): 195-197.

[6]   Zhao X, 2024, Application and Development Trend of Intelligent Manufacturing in Industrial Design. Southern Agricultural Machinery, 55(S1): 92-95.

[7]   Wang J, 2024, Changes in Industrial Design Process in the AIGC Era and Its Teaching and Research Directions. Art Education Research, 2024(18): 79-81.

[8]   Jiang X, 2024, Innovation and Development of Industrial Design from the Perspective of Artificial Intelligence. Art and Design (Theory), 2(09): 88-90.

[9]   Luo S, Yu H, Yi P, 2024, New Paradigm of Industrial Design Knowledge Production in the Digital Intelligence Era. Journal of Machine Design, 41(08): 6-10.

[10] Zhang C, Zhang J, 2024, The Substitution Effect of Artificial Intelligence on Industrial Design and Teaching Responses. Journal of Huzhou Vocational and Technical College, 22(02): 63-66+94.

[11] Peng Y, Yang H, 2024, Research on the Organic Integration and Application of AIGC and Industrial Design. Art and Design (Theory), 2(03): 29-32.

[12] Li R, 2024, The Transformation of Industrial Design: Full-Process Application of Artificial Intelligence. Industrial Innovation Research, 2024(04): 38-40.

[13] Feng Y, 2024, Application and Thinking of AIGC in Industrial Design. Packaging Engineering, 45(08): 337-345.

[14] Shao F, Yuan X, 2023, Application and Development Trend of Intelligent Manufacturing Technology in Industrial Design. Modern Industrial Economy and Informationization, 13(10): 142-145.

[15] Chen J, 2023, Research on Relevant Criticisms of Artificial Intelligence Design. Nanjing University of the Arts, 2023.

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