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Computer-Aided Design AND APPLICATIONS

Traditional Visual Element Product Design Based on Graphic and Image Fusion

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Abstract. Traditional visual elements have played an important role in the development history of China civilization for thousands of years. Exploring excellent traditional visual elements, exploring the reasonable combination of traditional China cultural elements and modern design, and applying excellent traditional China visual elements to modern product design are the only way to make the design with China characteristics go global. Based on this, this paper explores the application of traditional visual elements in product design with the help of AI (Artificial intelligence) and CAD (Computer aided design) technologies. At the same time, a method of product feature modeling by combining graphics and images is proposed. In order to verify the performance of the model, a product example is designed through simulation. The results show that the algorithm in this paper has faster convergence speed and greater computing power, and the user time is reduced to about 4 s. At the same time, users are satisfied with the use of the proposed product design scheme, and their satisfaction evaluation has reached 95.11%. This shows that the application of traditional visual elements supported by AI and CAD technology in product design has been recognized by users. In addition, the good flexibility of this method enables it to adapt to many types of product design.

Keywords: Artificial Intelligence; Computer Aided Design; Traditional Culture; Graphic Images; Product Design; Product Features
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1 INTRODUCTION

Traditional visual elements are not only a reflection of traditional culture, but also an artistic embodiment of the Chinese nation in the process of creation. At present, the social and economic development shows a diversified trend. People have greatly satisfied their material life and put forward newer and higher requirements for the spiritual level. During the design stage of

traditional visual elements, designers mainly focus on the appearance and visual effects of the product. They usually apply aesthetic and design principles to create attractive and unique products. The design at this stage mainly focuses on the appearance and surface treatment of the product, such as color, shape, material, and texture. Auernhammer and Roth [1] conducted product innovation and user experience through product thinking. They combine the design process with user needs and Market trend to ensure that the product can meet user needs. Designers will also adopt innovative technologies and materials to improve product performance and sustainability. In the process of Innovation management, the importance of design thinking is gradually highlighted. Design thinking emphasizes user centeredness, solving problems through innovative and systematic methods. At this stage, designers will pay more attention to the functionality, interaction, and scalability of the product. They will apply innovative technologies and strategies in their design to achieve a better user experience and product value. From traditional visual element product design to design thinking in Innovation management, designers need to constantly expand their design knowledge and skills to adapt to changing market needs and user needs. By introducing the concept of Innovation management, designers can better use design thinking, combine innovation with user needs, and achieve more competitive and innovative product design. The rational application of traditional visual elements to product design can well meet people's needs, which is a brand-new design trend. In fact, the application of traditional visual elements in product design also has certain principles to follow, and creating on this basis can always bring more possibilities and surprises. Chen [2] utilizes artificial intelligence technology to generate visual elements for Le bathroom products. The visual elements generated by the deep learning algorithm can be textures, patterns, colors, etc., which can be adjusted and optimized according to user needs and Market trend. When designing the visual elements of bathroom products, it takes into account the matching relationship between different elements. Utilize artificial intelligence technology to combine and adjust different elements to achieve the best visual effect. The generated visual elements need to be evaluated and optimized to ensure their quality and effectiveness. Machine learning algorithms can be used to evaluate the generated visual elements, such as through user surveys, image quality assessments, and other methods. Overall, the innovative design of visual elements assisted by artificial intelligence technology for bathroom products can help designers design and generate visual elements more efficiently. At the same time, adjustment and optimization in combination with user needs and Market trend can better meet user needs and improve the competitiveness and innovation of sanitary products. In the era of cultural self-confidence, product design should focus on Chinese excellent traditional culture while developing in multiple dimensions, integrate the uniqueness of traditional visual elements with the innovation of modern design, and promote the excellent traditional culture while promoting the development of product design industry. With the development of AI, emerging industries and models are increasing, and people's demand for leading new technologies and shaping new life in the field of industrial product design is increasingly prominent. Feng et al. [3] conducted intelligent data-driven product decision design analysis. In data-driven product design, interdisciplinary expert collaboration is required, including engineering, design, marketing, psychology, and more. Through interdisciplinary cooperation, multiple knowledge and skills can be integrated to achieve more comprehensive and efficient design. User engagement is crucial in data-driven product design. You can obtain user feedback and needs through user research, user testing, and other methods, and design and optimize based on user feedback. Through repeated iteration and optimization, product design can be more consistent with user needs and Market trend, and product competitiveness and quality can be improved. Overall, data-driven product design for intelligent manufacturing is an innovative design method based on data and artificial intelligence technology. By collecting and analyzing data, defining design requirements, data-driven design, interdisciplinary design, user engagement, and iterative optimization, more efficient, intelligent, and market responsive product design can be achieved.

George et al. [4] conducted an analysis of machine automation technology in the design process of additive manufacturing work. It adopts the platform design of commercial automation, and its analysis considers the computer-aided design of part model under multi process flow.

Through robot process automation technology, the design process of additive manufacturing can be automated. Robots can automatically complete the design, optimization, and manufacturing of parts according to design requirements, reducing the steps of manual intervention and improving design efficiency and quality. Robotic process automation technology can achieve the automated manufacturing process of additive manufacturing. Robots can automatically cut, print, and process materials based on designed models, improving manufacturing efficiency and quality. Robot process automation technology can also achieve automated testing of additive manufacturing. Robots can automatically detect manufactured parts, including size, shape, surface quality, etc., to ensure product quality and consistency. Computer image processing technology is used to understand and analyze images, which usually refers to preprocessing, segmenting, detecting the characteristics of objects in images and describing them with some data structure. Further analysis also includes classification, recognition and understanding according to image content. Geometrical figures and images are two data formats for describing objects in computers, and they are also two manifestations of the existence of objects in nature. They coexist and interact with each other. In the application of graphical user interface, it is the user's actions, that is, events, that control the running direction of the program, and each event can drive the running of a program. With the development of 3D graphics technology, establishing the corresponding 3D solid model in the computer can reflect the design intention more intuitively and comprehensively, and on the basis of the 3D model, virtual assembly, interference check, finite element analysis and motion analysis can be conveniently applied. Computer assisted art product design and production based on video streaming is a method that utilizes computer technology to assist in the design and production of art products. Through video streaming technology, dynamic design and production of art products are achieved. Computers can analyze and recognize captured video information through video stream analysis technology. For example, gestures and actions of designers can be recognized and converted into digital signals for controlling Computer-aided design software. At the same time, it can also identify and extract key frames during the design process for subsequent editing and optimization. Guo and Li [5] constructed development scenarios for the field of video synthesis digitization. This model has been extended to the design of computer categories for the transformation of artistic information in digital networks. By tracking and designing digital sharing for the new model, it proposes tracking and creating art sharing for information retrieval. Computer aided art product design and production based on video stream is a method that combines video stream technology and Computer-aided design. Through real-time capture, analysis, identification, control and rendering output technologies, real-time design and production of art products are realized. This method can help designers create art more efficiently, while also improving the quality and innovation of artistic products.

With the rapid development of Computer graphics, the space art sculpture based on CAD 3D modeling has made great progress. Guo and Wang [6] conducted hardware combinations of image 3D shapes through non depth of field 3D physical measurement analysis. Computer assisted modeling design can be used to optimize the visual effects of sculpture works. By using rendering and ray tracing techniques, realistic materials and lighting effects can be simulated, making sculpture works more realistic and vivid. This visual effect optimization technology can be applied to the display and promotion of sculpture works, enhancing their visual impact and artistic value. Computer assisted modeling design can be used for simulation analysis of sculpture works to evaluate their stability and performance. Through the simulation of the sculpture in terms of mechanics and Kinematics, we can predict its response and behavior under different conditions, so as to optimize its design and production process and improve its stability and reliability. Through the 3D modeling design of the product, the three-dimensional image of the designed product can be intuitively expressed, which is one of the important means to perfectly express the function and use value of the designed product. 3D CAD feature modeling is the main method of digital modeling of industrial products at present, but the current feature description mode can not describe complex apparent and heterogeneous material information. Product feature modeling based on graphic image fusion must solve the problems of image positioning, apparent detail measurement and feature description. The surface pattern mainly changes the visual and texture

surface morphology by affecting the optical structure, which means that the geometric details of the product surface contain a lot of functional information. In this paper, the application of traditional visual elements in product design is explored by using AI and CAD technology. At the same time, product feature modeling and design based on graphic and image fusion can effectively solve the above problems. In order to provide some ideas for the application of traditional visual elements in product design. The main achievements and innovations of this paper are as follows:

(1) Based on AI and CAD technology, a method of product feature modeling by combining graphics and images is proposed. Using this design method, we can give an intuitive image of the designed product, and at the same time, we can realize the product modeling design by applying the 3D modeling and rendering functions of AutoCAD.

(2) On the issue of product feature extraction, this paper describes it from the perspective of color features. According to the distribution of each parameter, the parameter with smaller standard deviation is selected as the input feature vector of the classifier. And principal component analysis is used to extract features, which reduces the dimension of texture features, eliminates the correlation between pattern features, highlights their differences and meets the input requirements of recognition layer. Finally, the simulation results show that the application of traditional visual elements supported by AI and CAD technology in product design has been recognized by users.

The research content and structure of this paper are as follows: Firstly, the research background, significance and other contents are introduced; Then, it summarizes and studies the relevant literature. Based on this, the application of traditional visual elements in product design supported by AI and CAD technology is discussed. Among them, the product design based on AI and CAD technology is studied emphatically, and the product feature modeling and design method based on graphic image fusion is put forward. At the same time, according to the relevant data, the actual test is carried out and the simulation results are obtained. Finally, it reviews the main contents and results of the full-text research and summarizes the research conclusions.

2 RELATED WORK

Sequence view refers to a representation method that serializes the geometric shape and texture information of a 3D scene or object surface from different viewpoints. In CAD image processing, sequence views are usually achieved through image sequences or point cloud sequences. Han et al. [7] analyzed the shape view construction model of 3D global features. By aggregating and training the content information of the view that introduces shapes, it preserves the average feature of the view in the pooling layer. Learning 3D global features refers to extracting global features of 3D scenes or object surfaces from sequence views through technologies such as computer vision and machine learning. The attention mechanism can make the model pay more attention to important geometric and texture information in the sequence view, thereby better extracting 3D global features. Overall, learning 3D global features through aggregated sequence views with attention is an important research direction in image processing. This technology can improve the efficiency and accuracy of the model, while also providing more accurate 3D global feature representation for subsequent image processing and applications. Hu [8] conducted analysis and research on CAD technology based on the engineering drawings of physical products. It constructs a three-dimensional parameterized object model projection represented by geometric information of digital technology. This digital model performs a three-dimensional analysis of the orthogonal view of the target object. 3D modeling technology can also be used to create product prototypes. By using 3D design software, industrial designers can directly create more complete and understandable prototypes. This not only saves time and cost of manual production, but also allows 3D modeling software to simulate different material characteristics, providing more options for prototype production. Jain and Xu [9] conducted a Feature selection analysis method based on dimension reduction and high-performance independent data regression. This will provide interactive learning refinement of multidimensional data sampling row features for machine

learning methods. The interactive high-dimensional product Feature selection algorithm based on dimension reduction can effectively select the most representative and relevant features from high-dimensional product features to improve the quality and efficiency of product design. The key of this algorithm is to select appropriate dimension reduction algorithm and Feature selection algorithm, and how to combine interactive adjustment with the algorithm to achieve efficient and accurate product design. At the same time, it is also necessary to consider factors such as the dimensions and scale of the data, as well as the correlation between the selected features and user needs. In general, this interactive high-dimensional product Feature selection algorithm based on dimension reduction can effectively improve the quality and efficiency of product design, and can further optimize the design results through user feedback and interactive adjustment. Culture and tradition are important factors in food and beverage packaging design. Folk themes can emphasize the combination of packaging design with regional culture and traditional characteristics, such as the use of traditional patterns, colors, and other elements to showcase local cultural characteristics. Jarossová and Gordanová [10] analyzed the important role of innovation and technology in food and beverage packaging design. Folk themes can emphasize the creativity and innovation of packaging design, such as using new materials and introducing intelligent technologies. User experience is an important factor in food and beverage packaging design. Folk themes can focus on the humanization and comfort of packaging design, such as optimizing packaging structure, improving packaging usability and portability. These folk themes can be integrated and supplemented with each other to achieve diversity and innovation in food and beverage packaging design. At the same time, designers need to flexibly apply these themes according to different products and consumer needs to enhance the value and attractiveness of packaging.

Liow et al. [11] conducted an analysis of the design and packaging of artistic products. Interactive adjustments are made based on the selected features to optimize product design. This step can be done through visualization tools, user feedback, and other means to better meet user needs. Through an art experimental platform, it matched better work designs for customers to ensure that their requirements were met. Virtual reality-based product design has been widely applied in spatial matching design in the visual field. Lorusso et al. [12] investigated and analyzed the growth of immersive technology under 3D technology. Studied the interactive relationship between geometric product parameter measurement changes. Computer-aided design (CAD) is a key tool for product design in virtual reality environment. CAD software allows designers to design and modify products through computers, as well as perform precise measurements and data analysis. Designers can create 3D models of products in CAD software, conduct simulations and tests, and make modifications and optimizations as needed. The virtual reality environment can support multiple individuals to simultaneously design products and achieve collaborative design. Multiple designers can jointly create and modify product models in the same virtual environment for discussion and collaboration. This collaborative design can accelerate product design and iteration speed, while also improving design diversity and innovation. In general, conceptual modeling and Computer-aided design and application in virtual reality environment can help designers to achieve more efficient, accurate and collaborative work in the process of product design. These technologies can be applied to various fields, including Automotive design, architectural design, product design, etc., to achieve better design results. Lydekaityte and Tambo [13] analyzed intelligent packaging: definition, modeling, and packaging as mediators between digital and physical product management. Intelligent packaging is a type of packaging with intelligent functions, which can achieve intelligent management and monitoring of products through technologies such as sensors, communication technology, and data processing. Intelligent packaging is a type of packaging that integrates multiple technologies, including sensors, communication modules, data processing modules, etc. Intelligent packaging can establish digital models to optimize the management of physical products through simulation and prediction. Digital models can develop appropriate packaging plans based on the characteristics and needs of the physical object, improving the protection and regulatory effectiveness of the product. Intelligent packaging can provide personalized packaging services, designing the most suitable

packaging solution based on product characteristics and user needs. At the same time, intelligent packaging can also provide intelligent manufacturing services, achieving efficient production and manufacturing through automation technology. Overall, intelligent packaging plays an important role in the management of digital and physical products. It can achieve intelligent management and monitoring of products, while also improving product protection and regulatory effectiveness through digital models and personalized packaging services. Marion and Fixson [14] analyzed and explored the development and construction of digital subset products. The use of information technology in tools is essential for analyzing the design process of things. By arranging the efficiency of digital enterprise rules and processes, it discusses the Product development based on the combination of traditional elements. Digital tools can quickly create product prototypes, allowing designers and stakeholders to evaluate and iterate products before actual manufacturing. This rapid prototyping design can greatly shorten the time for Product development, and can also reduce costs and risks. The application of digital tools in Product development has changed the traditional innovation process and improved the design efficiency and market competitiveness of products. However, digital tools are only auxiliary tools, and the true innovation process still requires the professional knowledge and experience of designers and developers.

Pelliccia et al. [15] conducted digital simulation of engineering industrial design concepts using digital technology. It analyzed the site suitability requirements for cost collaboration 3D simulation analysis construction. The results of this model have effectively improved the digital cost-effectiveness of factory product production. 3D factory simulation software can provide an interactive environment that allows designers and users to design in virtual spaces. This interactive design allows designers to more intuitively understand user needs and feedback, thereby better meeting user requirements. Through 3D factory simulation software, designs can be validated and tested in virtual spaces. This virtual testing can identify and solve potential design issues in advance, thereby reducing errors and costs during actual manufacturing and installation processes. 3D factory simulation software can visually display design results, enabling designers and users to more intuitively understand and evaluate designs. This visual display can enhance communication and understanding between designers and users, thereby improving design satisfaction. Overall, 3D factory simulation software has important application value in CAPD. Through interactive design, collaborative design, design verification, visual display, simulation and other functions, it can better meet the needs of computer-aided Participatory design of industrial products and improve the efficiency and quality of design. Salahuddin et al. [16] analyzed the use of CAD intelligent technology for dough forming products. Through finite element analysis, it constructed a stress static construction graph performance including machine distribution calculation results. The product performance of the machine was compared for critical strength. By using finite element analysis, the high inclusion dough forming machine can be decomposed into discrete elements and the stress and strain of each element can be calculated. This can help designers understand the structural performance of machines under different load conditions and potential problems that may occur. In CAD models, finite element analysis can be used to study the heat conduction and thermal stress of high inclusion dough forming machines under different temperature conditions. This helps to evaluate the performance of the machine in different temperature ranges and optimize thermal management to improve the stability and lifespan of the machine. Saleh et al. [17] conducted a survey and analysis of a wide range of product specifications using computer-aided tools. By using CAD software for product design, errors and waste in traditional drawing and manufacturing processes can be reduced. CAD software can accurately control and optimize dimensions, thereby reducing waste and rework in the product manufacturing process. The use of CAD software can accelerate the speed and efficiency of product design, enable rapid design and modification on a computer, and facilitate the comparison and optimization of multiple solutions. High quality product design through CAD software can make products more competitive in the market. By optimizing the appearance and functionality of the product, it can attract more consumers and increase its sales volume and market share. Using CAD software can support multiple designers to collaborate on the same platform, thereby improving design efficiency and quality. Collaborative design can promote communication and

cooperation among designers, making product design more comprehensive and refined. Zhou et al. [18] developed a parameter element detection model for virtual objects. Through the fusion of shallow and deep network information features, it analyzes the effectiveness of experimental evaluation in target detection. Real time monitoring and intelligent detection of small objects can be realized through industrial network Physical system. When the state or parameters of a small object exceed a preset threshold, the system can trigger corresponding alarms or control strategies. At the same time, the system can also predict and maintain the performance of small objects, improving product quality and stability. By using the industrial network Physical system to realize the digital twin intelligent small object detection in intelligent manufacturing, it can realize real-time monitoring, control and maintenance of small objects, improve the quality and stability of products, and reduce production costs and production cycle.

3 PRODUCT DESIGN BASED ON AI AND CAD TECHNOLOGY

Industrial product design has the characteristics of duality, coordination and innovation. It is an important mission of industrial product design in the future to explore the specific application of "intelligence+design" and increase the design boundary by using scientific and technological advantages. For product design, we need to seriously consider how to effectively enhance the characteristics of the design works in creative design. If the design works lack characteristics, it will be difficult to leave a deep impression on the viewers, and naturally it will be impossible to enhance the influence of product design. Therefore, exploring the reasonable combination of traditional visual elements and modern design, applying excellent China traditional visual elements to modern product design, making modern product design full of national and local cultural characteristics, and making products more in line with the usage habits of China consumers is the only way to make the design with China characteristics go global. In recent years, the research on AI and CAD related technologies is increasing day by day, and the related theories have also made great breakthroughs. With the support of AI and CAD technology, exploring the application of traditional visual elements in product design will further promote the development of related fields.

AI aims to replace people's mental work in life with intelligent system simulation, and learn, store and improve people's intelligence with a complete system. At present, there are two mainstream research methods: physical symbol method with symbol processing as the core; Connection mechanism method based on network connection, CAD is the general name of design activities such as overall design, drawing, analysis and preparation of technical documents for products or projects by engineers and technicians with their own professional knowledge. One of the main development directions of CAD technology is the integration of CAD/CAM. In order to realize integration, we must first solve the problem of describing the geometric, material and technological characteristics of parts in the product manufacturing process, which is the product modeling problem of CAD system. Feature modeling technology regards features as basic information units and describes products as an information set composed of several features with certain engineering meanings and functional attributes. Figure 1 shows the management and control of product design quality data.

In product design, the visualization characteristics of machine vision improve the coincidence degree between the 3D design model of the product and the real world, which is helpful to strengthen the designer's realistic visual experience. The interactive feature enables designers to exchange information through the machine vision interface, modify the design model in time, and collaborate to innovate products. It is very convenient and fast to create product model by using 3D CAD solid modeling function and coloring and rendering technology. A variety of materials can be established, realistic rendering renderings can be produced, and product design models can be displayed to users in all directions and layers. However, the current geometric modeling technology can no longer meet the needs of the development of modern CAD integration, so a modeling method-feature modeling for the whole product design process and manufacturing process has emerged.

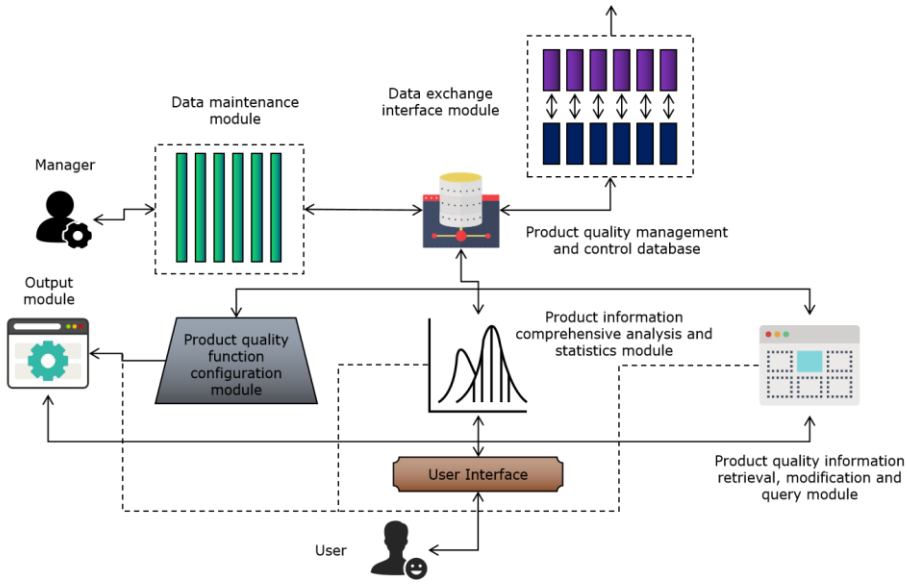

Figure 1: Product design quality data management and control.

Feature modeling focuses on better expressing the complete function and production management information of products, and serves for establishing the integrated information model of products.

4 PRODUCT FEATURE MODELING AND DESIGN BASED ON GRAPHIC AND IMAGE FUSION

Images are another type of information that exists in nature. The design process of product graphic image is carried out together with product design, which is the key of product graphic design. Among many low-level features of image processing, the color feature of the image can directly express the visual effect, followed by the shape feature and volume feature of the image. The computer image is a discrete 2D digital image, which can be expressed as:

$$I(r,c) \tag{1}$$

Where r and c represent the rows and columns of the image respectively. Image data has the following characteristics: the information capacity is large and has nothing to do with the complexity of the description object; It can describe aesthetic design and visual information; It can describe any subtle level details only related to the required resolution accuracy; Data variable rules are easy to operate and deform; There are many means of collection and generation. At present, in image processing technology, there are various methods to obtain image color characteristics, such as common color sets, color aggregation vectors, color histograms, chromaticity moments and so on. Among them, the color feature data obtained by color set and color histogram are similar in describing the color information on the image surface.

The traditional technology takes geometric modeling technology as the core. At present, most mainstream CAD systems adopt parametric solid modeling technology integrating surface modeling and feature, which plays a very good auxiliary role in engineering design with geometric information processing as the main task. Generally, the parametric equation of spatial surface is:

$$m(u,v) = (x(u,v), y(u,v), z(u,v)) \tag{2}$$

That is, the space surface can be regarded as a mapping of 2D variable space u,v :

$$m:(u,v)\to(x,y,z) \tag{3}$$

Assuming the apparent attribute $A(x,y,z)$ of point (x,y,z) on the surface, the image attribute $I(u,v)$ of 2D space can be obtained through the inverse mapping of m mapping:

$$I(r,c) \tag{4}$$

The apparent properties of products can be expressed by 2D images. Therefore, in order to design the surface of products, it is necessary to introduce image description into the product model and carry out feature modeling through graphic image fusion. Inside the computer, the data structure of surface modeling is still a table structure, which provides not only the information of edges and vertices, but also the information of each component of 3D solid, that is, inside the computer, besides the vertex edges and edge tables, a surface table is also provided. Parametric design of products based on assembly hierarchy needs to extract the main parameters of products. Different models of products have similar main parameters. The expression factors of product modeling are composed of physical and technical conditions such as structure and material. After the modeling is completed, it should be able to reflect the unique aesthetic characteristics of the structural shapes and materials of each part of the product, and properly express the luster and color of the product artistically, so as to achieve the perfect unity of shape, color and quality in the appearance modeling. In product design quality, the comprehensive expression of element quantity and quality is:

$$P(i)=\gamma_i p_i \tag{5}$$

In the formula, p_i and γ_i respectively represent the quantity and quality of element i. According to the contribution of each element to product design, you can write the total contribution of the constituent elements:

$$P(n)=\sum_{i=1}^{n}\gamma_i p_i=\gamma_1 p_1+\gamma_2 p_2+\ldots+\gamma_n p_n \tag{6}$$

In the formula, γ_i is the quality of element i, and p_i is the quantity of element i. The contribution rate of element i to design quality is:

$$\Delta P_i=\frac{\gamma_i p_i}{P(n)}=\frac{\gamma_i p_i}{\sum_{i=1}^{n}\gamma_i p_i} \tag{7}$$

Creating a 3D solid model of a complex product can be regarded as constructing an assembly, because the assembly forms include superposition, cutting and synthesis. When constructing a scanned entity, firstly, we should use the 2D drawing command to draw the closed region that forms the scanned entity, then determine the stretching mode or axis of rotation, and finally form the scanned entity. In this paper, firstly, the parametric model of assembly is established; Then the model is checked by file standardization to ensure that the model meets the application standards of product design CAD; Then, the assembly features are assigned to the assembly model that meets the CAD application standards, so that it has the function of participating in automatic assembly; Finally, the designed different types of assembly files are placed in the library file path for calling. In the 2D space of the image, the position and orientation of the image are easy to determine. Without loss of generality, it can be considered as directly determined by the image origin $O_I(0,0)$. Therefore, the positioning of the image on the product surface is determined by the mapping point $O_P(x,y,z)$ of the image origin. The specific formula is as follows:

$$m: O_I(0,0) \rightarrow O_P(x, y, z) \tag{8}$$

The positioning of the image on the geometric model is shown in Figure 2.

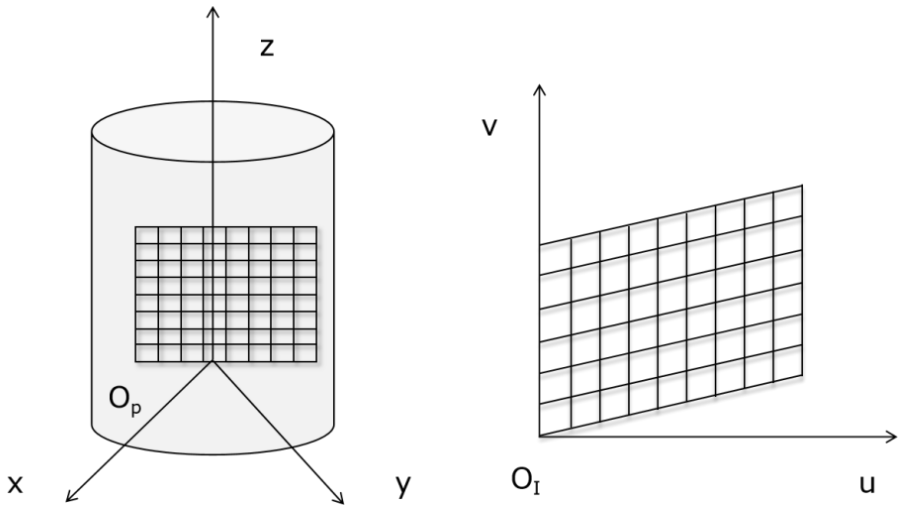

Figure 2: Location of image on geometric model.

Texture in an image is the best way to distinguish it from other images. Image texture features are often regarded as a way to distinguish other image features, which can not only directly reflect the statistical information of image gray value, but also make the spatial distribution information and structural information of image better presented. Texture mapping technology can depict the details of texture patterns on the constructed geometric model of the scene. Geometric texture mapping can simulate the microscopic uneven texture details of the scene surface, while color texture mapping can reveal various patterns, patterns and characters on the scene surface.

In top-down design, the prototype of product form is the unified geometric benchmark of product general assembly, sub-assembly at all levels and parts. The assembly datum of the product geometric features described by it is the coordinate origin, the default datum plane and the intersection of datum planes provided by the system. Product-level parametric design and part correlation design add parametric information on the basis of assembly structure, thus establishing parametric model of products. Usually, the product-level parametric design process includes three steps: determining the assembly hierarchy of the product, extracting the main parameters of the product and establishing the association between the main parameters and the part parameters. Firstly, the product shape is divided into several basic shapes, and each basic shape is created in turn according to the structural form of the shape. The feature of this modeling method is to create each basic shape in the same coordinate system, then align each basic shape according to the specified positional relationship through alignment and movement commands, and finally form the overall 3D modeling through Boolean operation. The measurement of apparent details can be considered from the following aspects: color and luster: determined by images and materials; Reflectivity: determined by image and geometric shape; Pattern: determined by image and mapping; Bump: determined by image and mapping. Therefore, the apparent detail measure A of the product can be expressed as:

$$A = f(G, M, I, m) \tag{9}$$

Where G represents the geometric shape of the part; M represents the material of the part; I represents an image describing the appearance of the part; m stands for mapping transformation

that fuses images with graphics. In fact, the attribution degree of quality factors is the problem of calculating the maximum leading degree of components in the distribution vector of quality factors. The calculation method of quality factor category attribution is as follows:

$$\eta\langle T\rangle=\eta\langle T(QE,t)\rangle=(\eta'-\psi+1)^{\arctan(N-1+\tan 1)} \tag{10}$$

Among them, the value of ψ can be determined by using the principle of half, or by means of average or other methods.

Through feature description, the image representing the product surface information is linked with the product shape to form a product model with engineering significance. The characteristics of graphic and image fusion are described as follows: Associated entity: geometry related to image. Associated surface: the surface patch to be described. Image positioning parameters: the positioning reference point and orientation of the image to be mapped. Detection parameters; Parameters to measure the demand of surface machining. Mapping transformation: the transformation function that fuses the image to the specified position on the specified surface of the product. Image data: image data describing apparent attributes. When building the product skeleton model, this paper pays more attention to capturing and extracting the interrelationships and dependencies between components from the overall layout of the prototype model of product form. In the later stage of design, the simple graphics of components in the original 3D sketch are replaced by parts with specific functions and complex shapes, thus realizing the whole process of top-down design. In addition, the appearance and color of the product is a very important aspect. Beautiful color design can improve the appearance quality of the product and enhance the competitiveness of the product in the market. Using the coloring and rendering functions of AutoCAD, a more realistic image with color and perspective effects can be obtained.

5 SIMULATION AND EXPERIMENT

5.1 Example of Product Design

Most of the product design needs mechanism design, and the ideal mechanism design method is a dynamic process. However, it is difficult to realize the dynamic design of connecting rod curve by traditional design method, which requires a lot of drawing work and strong personal professional mastery. With the development of AI technology, integrating intelligent elements into product design has become a mainstream direction of contemporary design. Therefore, this paper uses the design idea of "intelligence+design" and uses AI and CAD technology to design products. Before the dimension-driven work, all the dimension values of the entity should be transformed into variables of the Solid Edge system, and the names of the dimension values that have been transformed into variables should be modified to the names corresponding to the model features. This is to ensure the consistency of data in the system and the possibility of data transmission. As shown in Figure 3, a simplified model of the inner cylinder of a washing machine designed by this method is presented.

The product modeling results are given in the figure. Among them, the file size of the part model is 8MB, and if the part model is modeled in AutoCAD, the size is 2.56MB. Firstly, all the components are classified by Treeview control, and after the relationship between the components is clarified, these components are added to the nodes of Treeview control in turn. On the basis of standard parts library, the operation interface of standard parts calling is designed, and the selection and calling process of standard parts is realized by UG/Open tool. The operation interface is connected with the standard parts library, and users can access the standard parts library and automatically query the standard parts data. After selecting the base part and the height value expression of the part, the system lists the appropriate product part specifications for users to choose. It can be seen that the use of graphic image fusion technology can express the modeling effect of products, and in some cases, the description is more concise. At the same time, it is more convenient to use graphics and image fusion technology to model than to use geometric modeling alone.

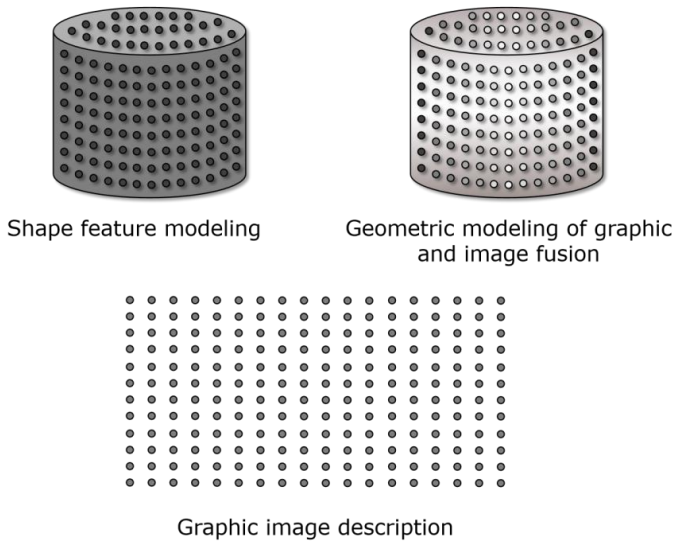

Figure 3: Simplified model of inner cylinder of washing machine.

One of the key steps of product modeling design is to render the created 3D solid model. The CAD model provides three rendering modes: RENDRER is the basic rendering; PHOTOREAL is realistic photo rendering; PHOTORAYTRACE is a ray tracing rendering of realistic photos, which is used to create reflection, refraction and accurate projection effects. In addition, the obtained pattern is properly processed to keep the visual characteristics of the pattern and meet the processing requirements, and the gray features of the pattern are extracted. At the same time, the image anchor point and angle are selected on the geometric surface through interactive operation.

5.2 Analysis of Experimental Results

Simulation is a virtual process from model to data for physical industry. Traditional simulation system requires designers to have a deep grasp of simulation optimization algorithms and simulation modeling tools, and it is difficult for non-simulation professionals to optimize a large number of operating parameters. At this time, the advantages of AI technology are revealed. This section analyzes and discusses the simulation results. Firstly, in order to establish the correlation between the connected parts and the connected parts, the CAD geometric connector and its API interface provided by high-end CAD software are cited, that is, the feature connection between parts is established by connecting elements. In addition, this paper uses Access as the development tool of integrated feature modeling system database. Access is good at processing data, such as establishing, classifying, sorting and summarizing data. Its most important feature is that there is no need to write programs. Figure 4 shows the iterative results of the algorithm.
It can be seen that with the continuous iteration of the algorithm, its error is decreasing and its accuracy is improving.

In the image histogram, all the color data are obtained after statistics by computer. It clearly describes the color distribution state and quantity in the whole image, and at the same time, the basic tone and color distribution information of the image can be reflected from the histogram, which can provide a good reference for the next image processing. In order to keep the relative position relationship between the interferometers and the matrix unchanged during the transformation from the assembly space to the matrix model space, this paper transforms the attitude and position of the interferometers in the assembly space, and the transformation process is realized by the transformation matrix of the interferometers, and the transformation matrix is

exactly the same as the inverse transformation matrix of the matrix parts. Figures 5 and 6 respectively reflect the time taken by users to design products in each generation of population under two different methods.

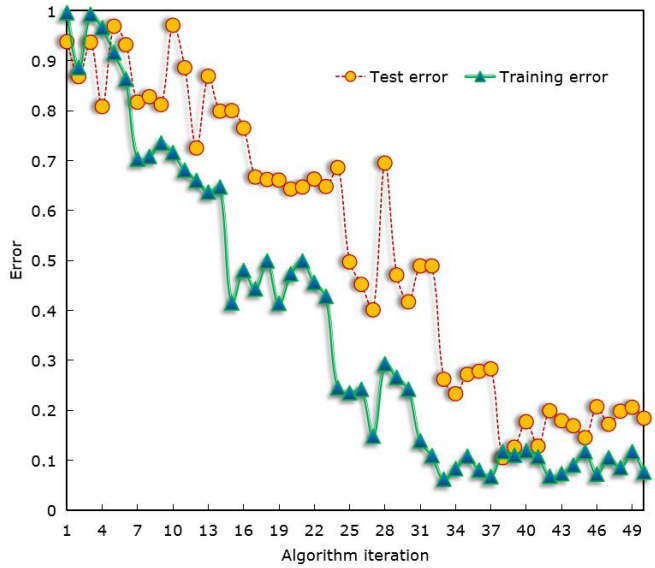

Figure 4: Iterative result of algorithm.

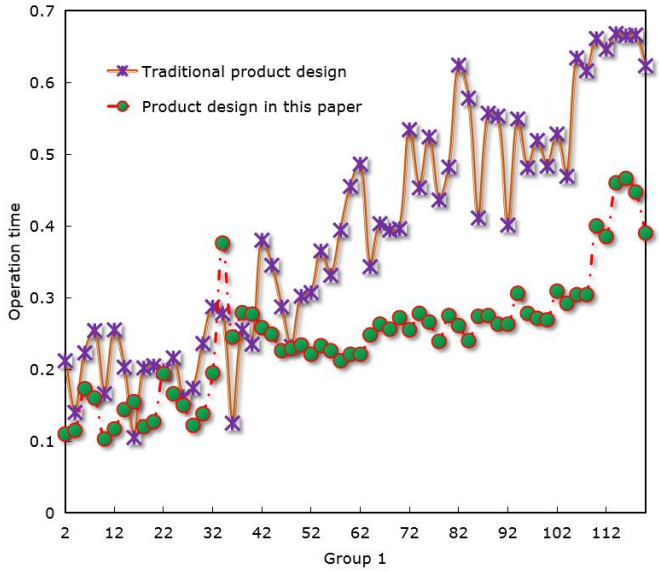

Figure 5: Time taken for a single operation by the first group of users.

According to the comparison results in Figure 5 and Figure 6, the method proposed in this paper effectively reduces the user operation time. Compared with traditional methods, it takes less time to design products using this method. The proposed algorithm has faster convergence speed and greater computing power, and the user's time is reduced to about 4 s. The model takes the public database as the core of information exchange. In the process of feature modeling, dimension driving and product feature data management, relevant information should be stored, extracted

and transmitted through the public database. And update the data synchronously with the database to keep the consistency and integrity of the data of the whole system.

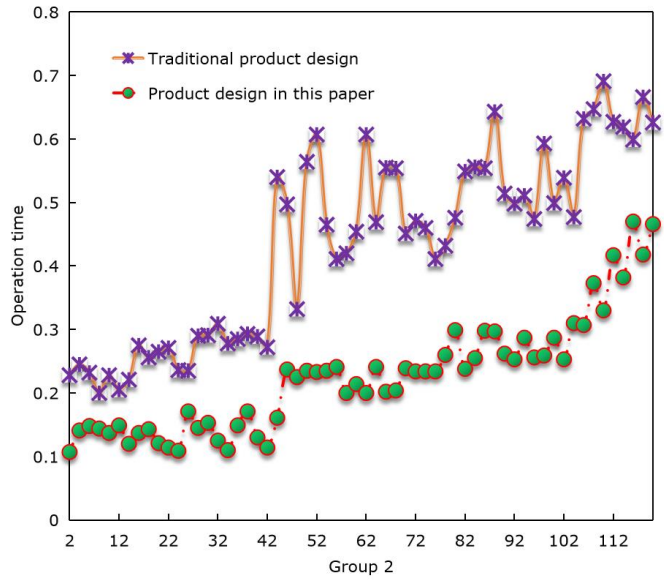

Figure 6: Time taken for a single operation by the second group of users.

The content of graphic elements of product appearance refers to its symbolic meaning. It takes some specific images as objects to express specific meanings. A good product, its graphics should be combined with the product itself, so that the product graphics have the significance of realizing its own value. Different product design methods are used to design the same kind of products, and Figure 7 shows the evaluation and comparison of user satisfaction of different product designs.

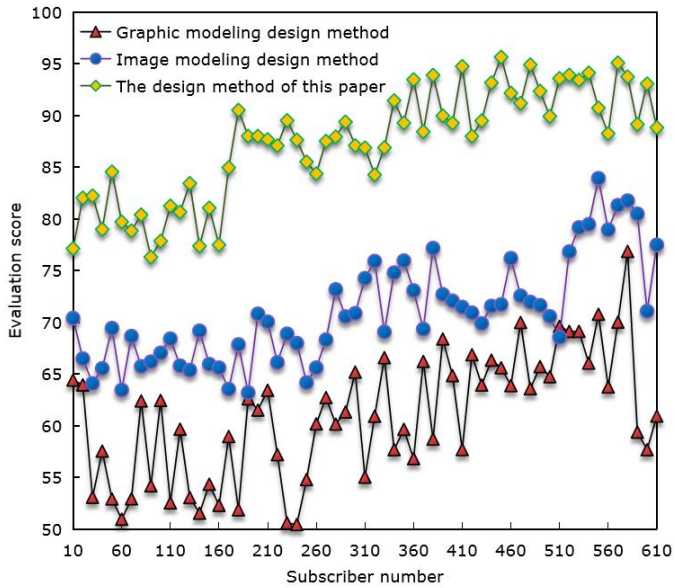

Figure 7: Subjective evaluation results of product design.

As can be seen from the figure, on the whole, users are satisfied with the use of the proposed product design scheme.

Based on the background of information development, the design industry will be more intelligent, digital and virtual. The application of AI and CAD technology in product design not only meets the basic functions, but also pays attention to its emotional design, which enhances the user experience and improves the quality of life of users. The simulation shows that the application of traditional visual elements based on AI and CAD technology in product design has been recognized by users, and the scientific and effective product design method based on AI and CAD technology has also been verified.

6 CONCLUSIONS

Visual communication design not only conveys a kind of visual content to the audience, but also is the key to impact the audience's visual nerve with rich cultural connotation and diversified forms. After incorporating the traditional visual elements of China, the exterior and interior of the works have been sublimated, which can help product design with a stronger and unique national style. In this paper, the application of traditional visual elements in product design is explored by using AI and CAD technology. At the same time, product feature modeling and design are based on the fusion of graphics and images. In order to verify the performance of the model, a product example is designed through simulation. The simulation results show that the algorithm in this paper has faster convergence speed and greater computing power, and the user time is reduced to about 4 s. At the same time, users are satisfied with the use of the proposed product design scheme, and their satisfaction evaluation has reached 95.11%. This shows that the application of traditional visual elements supported by AI and CAD technology in product design has been recognized by users, and it also verifies the scientific and effective product design method based on AI and CAD technology. In addition, the good flexibility of this method enables it to adapt to many types of product design. It is hoped that relevant personnel can reasonably apply the product design method based on AI and CAD technology according to the actual situation, so as to give full play to the role of traditional visual elements and promote the further development and progress of modern product design.

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