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Computer-Aided Design AND APPLICATIONS

Application of Virtual Reality and CAD Technology in the Design and Development of Cultural Creativity Products

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Abstract. At present, computer technology has been greatly developed, and computer-aided technology has appeared, which is applied to all kinds of modern product design. VR (Virtual reality) and CAD (Computer aided design) technologies have played a great role in the design, production and sales of modern cultural creativity (Culture and creativity) products. This article discusses the application of VR and CAD in the research and growth of cultural creativity products, and puts forward an innovative 3D modeling method of product modeling based on VR and CAD. The key links and technologies of virtual environment modeling are emphatically analyzed, including 3D modeling optimization process, structure optimization, model optimization and hierarchical simplification algorithm based on k_dop. Simulation results show that the accuracy of the proposed algorithm is high, and it is basically stable above 90%. The fastest running speed can reach 0.201s. Moreover, the model achieves the purpose of realism, real-time and interactivity, which can meet the actual needs. In the design of cultural creativity products, VR and CAD not only improve the design quality, reduce the production cost, but also shorten the design time of cultural creativity products. The method in this article provides new technical means for the research and growth of cultural creativity products, and opens up the possibility of product design and innovation.

Keywords: Virtual Reality; Computer Aided Design; Cultural Creativity Products; Research and Growth of Products
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1 INTRODUCTION

With the increasing income and education level of consumer groups in China, their demand for Cultural creativity products is increasing. Cultural creativity products not only have practical value, but also contain spirit and culture, which is a manifestation of cultural innovation in the market field. In the process design of molecular products, there is uncertainty in the properties due to

various factors such as raw materials, environment, and equipment. This uncertainty may lead to instability in the process, decreased product quality, and even production accidents. Therefore, how to effectively respond to property uncertainty, improve the reliability of molecular product process design, and optimize the production process is an urgent problem to be solved. Frutiger et al. [1] introduced a strategy based on Monte Carlo optimization to solve molecular product process design problems under property uncertainty. Traditional design methods often only consider certain property conditions and overlook the uncertainty of properties. When faced with complex and uncertain molecular product process design, traditional methods often fall short. Monte Carlo optimization strategy, as an optimization method based on probability and statistical theory, can comprehensively consider various possible property conditions and find the optimal design solution. The basic principle of Monte Carlo optimization strategy is to simulate random sampling and search for probability distribution of design variables to find the optimal solution that meets certain performance indicators. In the production mode of the network era, product design has made CAD widely used, and produced a variety of products, including aided design. With the continuous development of technology, computer-aided art design and production have become a topic of great concern. Guo and Li [2] discussed "Computer Aided Art Design and Production Based on Video Streaming". It explores technical principles, application scenarios, and case studies, and looks forward to its future development prospects. Computer assisted art design and production based on video streams mainly involve related technologies such as image processing, sound processing, and motion estimation. Image processing mainly includes operations such as image enhancement, image filtering, image segmentation, and feature extraction, aiming to improve image quality, extract useful information, or achieve specific functions. Sound processing involves techniques such as analysis, synthesis, and effect processing of audio signals to achieve optimization, artistry, or use for specific purposes of sound. Motion estimation is the process of detecting, tracking, and predicting the motion of objects in a video, thereby achieving stable and smooth display of the video stream. In the field of advertising, computer-aided technology can achieve rapid prototype design of creativity, simulation and evaluation of advertising effects, and improve the visual performance of advertising. At present, CAD has been applied to the design of goods, and it is gradually increasing in the field of cultural creativity products. CAD has great advantages in data processing, but also has many personalized functions, which can improve the personalized level of design scheme and solve the shortcomings of insufficient accuracy of cultural creativity products. With the continuous development of the mechanical manufacturing industry, computer-aided design (CAD) plays an increasingly important role in mechanical product design, especially in the design of assembly models. There is a close correlation between the structure and function of mechanical CAD assembly models, which provides an important theoretical basis for model design and analysis. Han et al. [3] discussed the structural functional correlation analysis and functional semantic annotation of mechanical CAD assembly models. In mechanical CAD assembly models, there are complex structural and functional relationships between various components.

The structural relationship mainly manifests in the interrelationships between the geometric shape, size, and position of components; The functional relationship is reflected in the interaction, force, and motion transmission between components. These relationships collectively determine the overall performance and functionality of mechanical CAD assembly models. In order to better analyze the structural functional correlation of mechanical CAD assembly models, we can use modular design methods to decompose the model into multiple modules and analyze them separately. The structural relationships between modules can be defined and associated through their interfaces, while the functional relationships between modules can be analyzed through the information and energy flows between modules. VR is a brand-new technology developed in the 20th century. Through the intervention of various interactive devices, it integrates and interacts multi-source information to form a 3D dynamic scene, which blends with entities in the virtual environment in deep immersion, resulting in immersive interactive scene simulation and information exchange. VR emphasizes the leading role of people in the virtual system, so it has two characteristics: interactivity and immersion. It is the essential difference between VR and

other related technologies, and it is the innovation of human-computer interaction content and interaction mode. VR plays a key role in the design of cultural creativity products.

With the continuous progress of technology, computer-aided design and virtual simulation technology have increasingly become one of the key technologies in the textile and clothing industry. Knitted fabrics, as an important part of the textile and clothing industry, have significant importance in improving production efficiency, reducing costs, improving product quality, and optimizing design through computer-aided design and virtual clothing simulation technology. Indrie et al. [4] introduced the related content of computer-aided design and virtual clothing simulation for knitted fabrics, in order to provide reference for research and application in related fields. Knitting machine fabric computer-aided design is a method of using computer technology for fabric design, mainly involving image processing, model construction, and fabric simulation. Through computer-aided design software, designers can easily perform operations such as fabric pattern design, organizational structure modeling, and fabric performance simulation. In terms of image processing, computer-aided design of knitted fabrics usually involves operations such as preprocessing, feature extraction, and recognition of fabric images. For example, designers can use image processing technology to denoise and smooth the surface of fabrics to improve image quality, and extract feature information such as texture, color, and shape of the fabric. At present, the integration of VR and CAD is increasingly showing its great potential and value in the research and development field of cultural creativity products. The combination of these two technologies provides a new perspective and method for the design, research and development and promotion of cultural creativity products, which greatly promotes the innovation and growth of cultural creativity industry. The parameterized assembly model exchange method based on neutral assembly constraints proposed by Kim et al. [5] provides broader innovation space for product development. Firstly, this method can overcome the shortcomings of traditional model exchange methods under specific constraint conditions and adapt to a wider range of application scenarios. Secondly, by introducing neutral assembly constraints, it is possible to better consider the common features and requirements between assemblies, thereby promoting innovative product design. In addition, this method can also reduce dependence on specific software platforms and improve the efficiency of cross platform collaboration. This article focuses on the research of "parametric assembly model exchange based on neutral assembly constraints" and proposes a new method. Through practical application scenarios, it has been verified that this method has high efficiency and model quality when dealing with assembly model exchange under different constraint conditions. However, there are still some shortcomings, such as the need for further improvement in the selection and parameterization of neutral assembly constraints to adapt to more complex assembly environments and requirements. At the same time, the combination of VR and CAD has a positive impact on the marketing and consumer experience of cultural creativity products. Through VR, consumers can experience the whole picture and function of the product before buying, which improves the confidence and satisfaction of buying.

At the same time, the application of CAD also makes the production of products more efficient and accurate, which provides strong support for the marketing of cultural creativity products. Kwon and Kwon [6] used CAE simulation software to simulate and analyze the design of the high-pressure die-casting gate system. Based on actual production needs, establish a 3D model and import it into CAE software. Then, using fluid mechanics theory, material properties, boundary conditions, and other parameters are set to simulate the flow behavior of metal liquid at the gate. By comparing different design schemes, identify the optimal gate structure form. To verify the effectiveness of the optimized design, we conducted experimental comparisons. Firstly, modify the gate system according to the optimized design plan, and use CAE software to simulate and analyze the modified system. Then, select several sets of experimental data and compare and analyze the filling speed, mold temperature field, porosity, shrinkage rate, and other indicators before and after optimization. The experimental results show that the optimized gate system has achieved significant results in increasing filling speed, improving the uniformity of mold cavity filling, and reducing porosity and shrinkage. At the same time, the design of the overflow tank effectively avoids the problem of metal liquid overflow and improves production efficiency. At present, in the

design of cultural creativity products, we should rely on VR and CAD, based on the design principles and requirements of cultural creativity products, and rationally apply technical means to improve the rationality of cultural creativity product design and make the products more attractive.

With the continuous development of technology, artificial intelligence has had a profound impact in many fields, including art and design. The application of machine learning technology in art creation and design laboratories is changing our understanding and participation in art and design. It provides new tools and ideas for artists and designers, as well as new perspectives for us to understand and appreciate artistic works. Liow et al. [7] analyzed the design of art works under machine learning. Supervised learning is the most common machine learning method that trains through existing labeled data to obtain a model that can predict new data. In artistic creation, supervised learning can be used for style transfer, applying one artistic style to another image. For example, this style can be applied to new paintings by learning from a large number of Van Gogh style paintings. This article discusses the application of VR and CAD in the research and growth of cultural creativity products, and puts forward an innovative 3D modeling method of product modeling based on VR and CAD. First of all, the introduction of VR enables designers to design models in an immersive environment. Through VR equipment, designers can intuitively see the 3D scene of the model and make design adjustments in real time, making the design process more intuitive and efficient. At the same time, VR also allows designers to operate and test products in real time in virtual environment, which greatly facilitates the design process of products. Secondly, the use of CAD makes it possible to digitize and automate product modeling. Designers can use CAD software to quickly generate product models according to established parameters or algorithms. This not only reduces the workload of designers, but also improves the accuracy and consistency of the model. In addition, CAD can also realize the modular and parametric design of products, which provides convenience for the later maintenance and upgrading of products. This article studies this and has the following innovations:

(1) Traditional product modeling methods often rely on designers' manual design and operation, which is not only inefficient, but also prone to errors in detail processing. The proposed new method combines the advantages of VR and CAD, and can quickly and accurately establish the product model in the virtual environment.

(2) The proposed method provides new possibilities for the research and growth of cultural creativity products. Through VR, we can better understand and experience cultural creativity products, such as cultural relics restoration and cultural display. At the same time, the application of CAD also makes the production process of cultural creativity products more efficient and accurate.

(3) In this article, the modeling idea, technical route and implementation method of building a 3D model of cultural creativity products based on the 3D geometric modeling method of 3DSMAX are put forward, and the modeling process of the 3D VR modeling technology based on 3DSMAX is given. This process is an improvement on the traditional process.

Firstly, this article summarizes the basic concepts of VR and CAD, and expounds its importance in cultural creativity industry. Then, from the perspective of cultural creativity's product design, this article discusses a variety of application methods of VR and CAD, such as product display, user interface design, virtual prototyping and so on. Then, an innovative 3D modeling method of product modeling based on VR and CAD is proposed. Finally, the experimental analysis is carried out and the development trend and prospect of related technologies in cultural creativity product research and development in the future are prospected.

2 RELATED WORK

With the increasingly fierce market competition, product optimization design has become one of the key factors to improve the competitiveness of enterprises. The user review of CAD data-driven product optimization design methods is an innovative design concept. Lu et al. [8] closely

combined the user needs of products with CAD data, providing new ideas and methods for product optimization design. The CAD data-driven product optimization design method refers to the integration of product data with user requirements through the CAD software platform, achieving rapid optimization and iteration of products. This method mainly involves knowledge in fields such as mechanical design and engineering drawing, and makes product design more accurate and efficient through precise model representation and simulation analysis. Before conducting user review CAD data-driven product optimization design, it is necessary to conduct in-depth analysis of user requirements. This includes clarifying the specific requirements of users for the functionality, performance, appearance, and other aspects of the product, as well as how to translate these requirements into executable design elements. In the process of clarifying user needs, it is necessary to collect data from market research, user research, and other aspects, and concretize these needs through data analysis.

Simulation assisted design is an important tool for achieving effective design of self-forming woven textiles. Through computer simulation technology, designers can design the structure and appearance of textiles in a virtual environment and predict their performance. Meiklejohn et al. [9] compared multiple solutions in a simulated environment to find the optimal design solution. This method not only improves design efficiency, but also reduces the cost of sample production, making the design more precise and efficient. Taking a self-forming woven textile with a complex weaving structure as an example, the designer first uses CAD software for preliminary design and uses simulation assisted design to simulate the weaving behavior. During the simulation process, the designer continuously adjusts the design plan until the optimal solution is found. The final textile sample produced is very close to the simulation results, and has excellent mechanical properties and beautiful appearance. Overall, the simulation aided design and application of self-forming woven textiles have greatly improved design efficiency and quality. Through simulation and optimization of weaving behavior, as well as precise control of decorative elements, designers can create textiles with various shapes and excellent performance. With the continuous development of technology, the application of computer-aided design in the industrial field is becoming increasingly widespread. Among them, 3D factory simulation software, as an innovative design tool, can play an important role in computer-aided participatory design of industrial workplaces and processes. Pelliccia et al. [10] explored the applicability of 3D factory simulation software in the industrial field, as well as its related technologies and application scenarios. 3D factory simulation software is a software developed based on theories and technologies such as computer graphics and process control. It can simulate industrial workplaces and processes through 3D models, helping designers better understand and optimize design. At the same time, the software also supports online collaboration among multiple people, which can greatly improve design efficiency and quality. In computer-aided participatory design of industrial workplaces and processes, 3D factory simulation software has many application scenarios. 3D factory simulation software can also be used for production line balancing, logistics optimization, energy management, and other aspects. These application scenarios can help industrial enterprises improve production efficiency, reduce costs, and improve work environments. Computer integrated manufacturing is a production mode that integrates design, manufacturing, and management, with CAD geometry and product manufacturing information being key components. The interoperability of CAD geometry and product manufacturing information in computer integrated manufacturing is crucial for achieving efficient and high-quality manufacturing processes. CAD geometric structure is a tool used in computer-aided design software to describe the shape and size of products, which contains all the geometric information required in the product manufacturing process. In computer integrated manufacturing, CAD geometric structures can be modified and optimized by designers to meet the functional and aesthetic requirements of product design. In order to achieve interoperability between CAD geometry and product manufacturing information, Ramnath et al. [11] adopted a unified data exchange format and communication protocol. Interoperability refers to the ability to exchange data and share information between different systems or platforms. In computer integrated manufacturing, CAD geometry and product manufacturing information need

to have interoperability for data exchange and information sharing between different software and hardware platforms.

With the continuous development of technology, computer-aided design (CAD) has become an indispensable part of modern product design. Through computer-aided design, designers can more efficiently design and optimize products, thereby improving their quality, performance, and appearance. Saleh et al. [12] explored the importance of computer-aided design for high-quality product design. Firstly, computer-aided design can improve the appearance of products. In traditional product design, designers often need to repeatedly modify and adjust the model to improve the appearance of the product. Through computer-aided design, designers can directly conduct modeling and simulation on computers to better control the shape, size, and lines of products. This not only reduces design time, but also improves the accuracy and aesthetics of the product. Secondly, computer-aided design can improve the functionality and performance of products. In product design, computer-aided design can provide powerful simulation and analysis tools to help designers predict and optimize the functionality and performance of products. In today's digital age, computer-aided design (CAD) and intelligent assembly modeling have become key components of the manufacturing industry. Through these techniques, Mo et al. [13] captured and expressed their design intent, and then transformed the design into actual products through models. The modeling of product information that captures design intent is crucial for achieving the efficiency, accuracy, and flexibility of this process. Design intent is the specific goal and purpose expressed by a designer through their design. This involves understanding the designer's creativity, ideas, and concepts, and then transforming them into three-dimensional models. In this process, designers need to capture and express all important details of the product, including its structure, function, materials, manufacturing methods, and assembly requirements. Product information modeling is the process of creating digital product data using 3D CAD software. The feature-based assembly information modeling method for complex product 3D assembly design is one of the most advanced design methods in today's manufacturing industry. This method utilizes the technology of computer-aided design (CAD) systems to establish a three-dimensional model of a product by identifying and describing its features, providing designers with a brand-new design experience. In the traditional product design process, designers usually use two-dimensional drawings for design, but this design method has many limitations, such as difficulty in expressing three-dimensional spatial information, difficulty in conducting interference checks, and so on. In contrast, feature based assembly information modeling methods are more efficient and accurate. They can decompose the design elements of products and express them through 3D models, making designers more intuitive in their design. Wang et al.'s [14] feature-based modeling method better describes the constraints and fit relationships of products during the assembly process, thereby reducing assembly errors and improving assembly accuracy. Digital twin technology is a technology that simulates physical entities or systems in a digital manner. In the manufacturing industry, digital twin technology simulates and optimizes the entire lifecycle of products by digitizing various processes such as product design, manufacturing, and testing. Compared with traditional manufacturing processes, digital twin technology has higher accuracy and flexibility, which can greatly shorten product development cycles, reduce manufacturing costs, and improve product quality. With the rapid development of the manufacturing industry, process planning plays a crucial role in improving production efficiency and reducing manufacturing costs. Digital twin technology, as an emerging technological means, can closely integrate the physical world with the virtual world, providing more efficient and accurate simulation methods for process planning. Xin et al. [15] introduced a computer-aided process planning fine simulation method based on digital twin technology, aiming to highlight the importance and application prospects of this technology in the manufacturing industry.

In today's society, environmental protection and sustainable development have become a global consensus. Product packaging design, as an important means of corporate image and product promotion, should also comply with the green concept to achieve sustainable development. Yu and Sinigh [16] discussed the application of green concept-based CAD in product packaging design. Designers should try to choose environmentally friendly materials with low

energy consumption and cost, reduce packaging volume and weight, and avoid excessive packaging. Designers should design packaging that is easy to recycle for reuse or degradation after use, thereby reducing environmental pollution. Taking the packaging design of a certain brand of chewing gum as an example, the design adopts CAD technology based on green concepts. By using CAD technology to optimize the design of packaging structures, it makes them more portable and user-friendly, while also reducing unnecessary waste. The entire packaging design fully embodies the green concept, which is both environmentally friendly and practical. With the rapid development of technology, more and more innovative technologies are being applied in various fields, including packaging design. This article will explore how to optimize packaging design by combining virtual reality (VR) technology with computer-aided design (CAD) software. By analyzing the application of VR technology in packaging design, the advantages of CAD software in packaging design, and the optimization strategies brought by the combination of the two, Yun and Leng [17] emphasized the importance of optimizing packaging design and provided reference for future research. Virtual reality technology provides new possibilities for packaging design. In the product design phase, designers can use VR technology for product modeling and simulation to better evaluate their visual effects and interactivity. Through head-worn devices, designers can immersively experience the appearance, structure, and function of products, thereby more accurately grasping market demand. In addition, VR technology can also achieve real-time interaction between users and products, allowing users to feel the characteristics and advantages of the product during the experience process. In the process of design and creation, human emotions have a significant impact on the design results. In recent years, designer sentiment analysis has gradually become a research hotspot. Collaborative and traditional computer-aided design are two common design methods, and Zhou et al. [18] explored the application of designer sentiment analysis in these two design methods. Collaborative design is a collaborative design method that emphasizes interaction and collaboration among team members. Research team members' expression and cognition of self-awareness during the design process. By understanding the self-awareness of team members, we can better understand their design concepts and ideas, and provide a more comprehensive design solution for the team. Traditional computer-aided design is a design method based on computer technology, emphasizing the optimization of human-computer interaction and cognitive load. Study the changes in cognitive load of designers during the computer-aided design process. By understanding the changes in cognitive load, design solutions and tools can be optimized, reducing designers' cognitive load, and improving design efficiency.

The above research provides a solid theoretical basis and practical guidance for the use of VR and CAD in cultural creativity product development. Based on this, this article summarizes the basic concepts of VR and CAD, and expounds its importance in cultural creativity industry. At the same time, an innovative 3D modeling method of product modeling based on VR and CAD is proposed.

3 VR AND CAD

VR and CAD are two hot topics in the field of sci & tech. VR is a computer technology that can create and experience a virtual world, while CAD is a process of designing with computer technology. These two technologies are widely used in different fields, but with the growth of sci & tech, the connection and combination between them become closer and closer. Among them, VR is a technology that can provide an immersive experience. It completely brings users into a virtual 3D environment through sensors such as head-mounted devices, handles and sounds. In this environment, users can freely explore, interact and interact with other people or objects. VR has a wide range of applications, such as games, entertainment, education, medical care, architecture and so on. In the game field, VR can provide a more realistic game experience, so that players can feel the immersive excitement; In the field of architecture, designers can communicate with customers more intuitively through VR to improve work efficiency. CAD is a kind of technology that uses computer to carry out design work. By using CAD software, designers can easily carry out all

kinds of complex design work, such as architecture, machinery, electronics and so on. The application of CAD enables designers to pay more attention to the design itself, without thinking too much about the tedious manual production process. At the same time, CAD can also carry out various accurate calculations and simulations, providing designers with more comprehensive information, so as to better grasp the quality and performance of design.

With the continuous growth of technology, VR and CAD technologies began to merge with each other, which brought revolutionary changes to the field of design and manufacturing. By combining VR with CAD, designers can design in a virtual environment and import the design results into the manufacturing process after completion. This combination can not only improve the design efficiency, but also shorten the product development cycle and reduce the cost. In the field of cultural creativity products, designers can use VR to design and display cultural creativity product models. Through CAD software, designers can easily create various Cultural creativity product models and present them in 3D form by VR. In this way, customers can personally experience the designer's design ideas and achievements through head-mounted devices, so as to feedback and evaluate more intuitively. Cultural creativity products need to conduct market research and analyze market demand at the beginning of design, so as to provide market reference for product design. Through VR and 3D animation technology, using WEB pages to conduct market research can fully arouse the interest of market research objects, improve the comprehensiveness and accuracy of market research, and improve the ability of product design to meet market demand. At the same time, the combination of VR and CAD can not only improve the work efficiency and quality of designers, but also bring customers a more comprehensive understanding and experience of cultural creativity products. The impact of the introduction of VR on cultural creativity industry is shown in Figure 1.

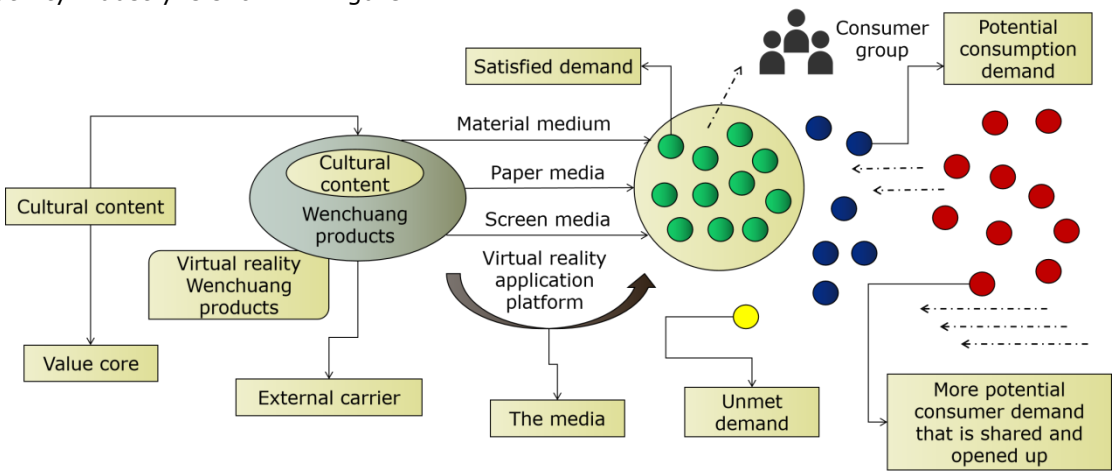

Figure 1: Influence of the introduction of VR on cultural creativity industry.

VR enriches and enhances the experience of cultural creativity products, which is mainly realized through the technical characteristics of VR itself, such as immersion and embodiment. At the same time, VR, as a platform technology, can attract more cultural lovers to participate in the generation and sharing of original content. VR is highly adaptable to 3D animation technology and the design of cultural creativity products, which can highlight the spiritual connotation of cultural creativity products and gradually integrate with the design process of such products. During the design of cultural products, designers should conduct in-depth research and choose reasonable ways to improve the design scheme of cultural creativity products and improve the value of products; At the same time, it is necessary to innovate Cultural creativity products, and adjust the parameters through computer simulation to ensure the reasonable design of cultural creativity products.

4 3D MODELING OF PRODUCT MODELING BASED ON VR AND CAD

Cultural creativity product positioning is a crucial step for a product, and the success of a product positioning is equivalent to half the success of the product. We can not only use the current big data to do product analysis, but also use VR to capture users' usage habits, focus, consumption habits and so on. The R&D design of cultural creativity products needs to start from multiple dimensions, and designers should be clear about the public's demand for products and lock in key points. Therefore, when designing Cultural creativity products, the design subject should have multi-dimensional thinking, evaluate all aspects of data and get information about product design. In this article, the steps of building a 3D model of product modeling based on VR and CAD are as follows: ① First, we need to collect and sort out all kinds of information and ideas about product design. Then, by using 3d scanner, we can convert our design concept into detailed digital data, and make preparations for the subsequent 3D modeling. ② After finishing the data, we can use 3DSMAX to build the virtual model of the product. This process transforms our design concept into a complete 3D model. ③ In the process of modeling, we need to define 3D coordinates, namely xyz axis. Then, various details of the product, such as the intensity of laser reflection, color and product information, are depicted on these axes. These details will be used to create a 3D mesh to prepare for the next rendering. ④ Next, we use VRML language to generate 3D graphics of the product. After that, you can use PS to make more fine adjustments and modifications to make the model look more realistic and accurate. Finally, AE software is used to preliminarily synthesize the 3D video and animation of the product. ⑤ With the preliminarily synthesized videos and animations, we can import them into the VRML environment for interactive design. This step will bring more interactive functions to Cultural creativity product model, thus completing the preliminary design stage of cultural creativity product. During the design of cultural products, it is necessary to enrich the functional modules of computer-aided system based on cultural creativity's product design requirements, which is beneficial for designers to analyze product parameters and modify design schemes. The optimization process of 3D modeling is shown in Figure 2.

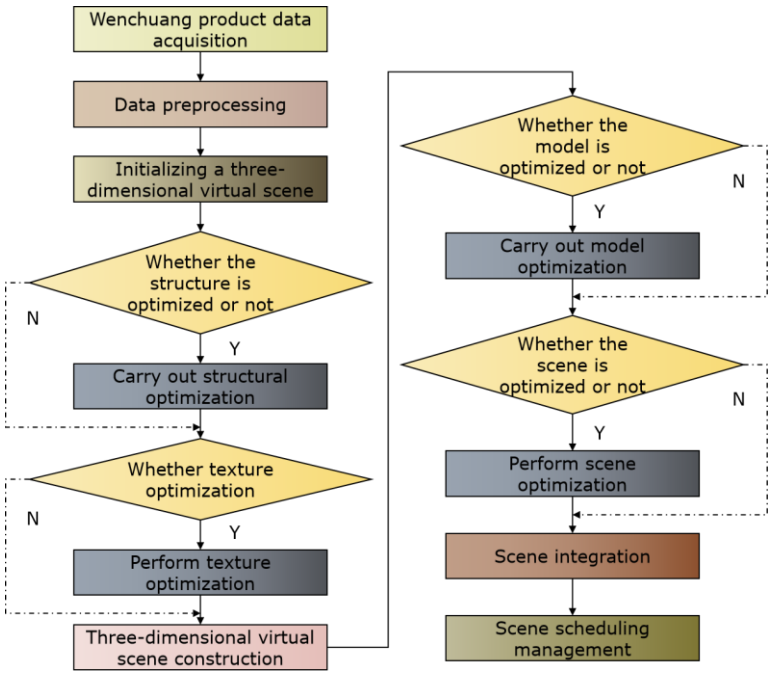

Figure 2: 3D modeling optimization process.

Even the simplest model needs to adjust the hierarchical structure of the model to achieve the purpose of optimization. In addition, the results of structural optimization according to the hierarchical modeling idea will also restrict the results of subsequent optimization. In the detailed design process of 3D modeling of cultural creativity products, VR and 3D animation technology are applied to the appearance sketch design and layout design of products. By combining cultural creativity product design with VR and 3D animation technology, the overall design effect can be improved and the practicality of design can be promoted. In this article, the collected data are classified and preliminarily processed. Real-time data: classify this data function and check the accuracy of the data. Texture data: Optimize the texture picture and edit it with software, including removing noise, tone adjustment, stretching deformation, cutting and so on. Redundancy often exists when building a solid model. In the process of determining the appearance sketch of cultural creativity's product design, 3D space can be modeled by 3DSMAX technology, and the coordinates of 3D space can be set up, and then detailed design and rendering can be carried out by VRML, so as to improve the efficiency of appearance sketch design. The 3D space modeling of cultural creativity product design is shown in Figure 3.

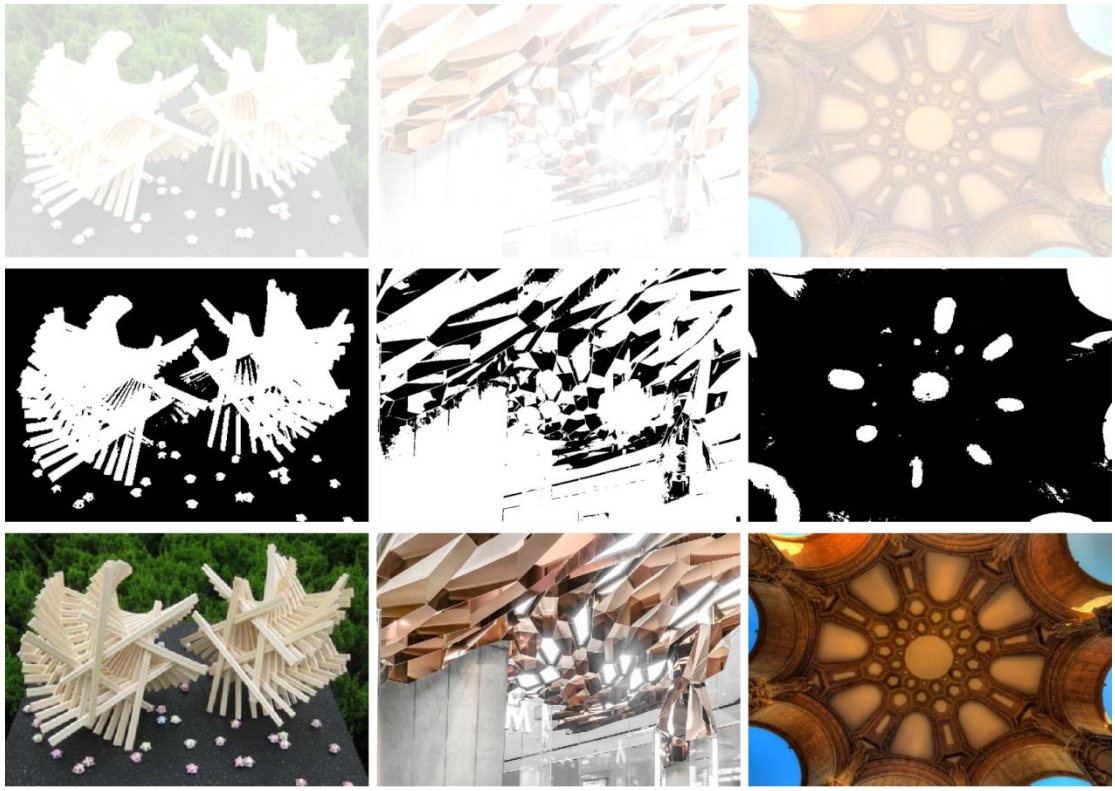

Figure 3: 3D space modeling of cultural creativity product design.

The construction of cultural creativity product entity includes the model construction of dynamic and static entities. The construction of static model mainly obtains its three views, dimensions, texture information, etc. through product drawings, and then uses software to integrate all the split parts to form a complete static thing model. Dynamic solid model is to show the basic characteristics of things mainly through images and video materials, and then deal with their changing movements in the environment according to actual needs. In the process of model creation, there will be a lot of cutting fragments, and static mesh optimization algorithm can be

used at this time. Modeling in the form of model+map is a modeling technology that combines image and geometry to maximize the potential of modeling technology. Mapping high-fidelity images to simple object models can greatly reduce the quantity of meshes in the model without sacrificing the authenticity of 3D models. Fusion technology is used to eliminate the color difference, light intensity difference and image ghosting of adjacent images caused by illumination change, dynamic scene and image distortion caused by geometric correction, so that multiple images can be fused into a seamless transitional panoramic image. In addition, in the process of modeling, product functional design needs people to exert the value of creative thinking and speculate and analyze the design content.

When there are many objects with the same geometry and attributes but different positions in the 3D complex model, instantiation technology can be used. The geometric transformation matrix of objects in 3D space can be $\mathrm{T}_{3\mathrm{D}}$. Representation, translation, rotation and scaling can be expressed as a unified matrix multiplication form. The specific expression is as follows:

$$\mathrm{T}_{3\mathrm{D}}=\begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \tag{1}$$

$\mathrm{T}_{3\mathrm{D}}$ is divided into four sub-matrices from the transformation function. Among them, $\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$ produces geometric transformations such as proportion and rotation; $\begin{bmatrix} a_{41} & a_{42} & a_{43} \end{bmatrix}$ produces translation transformation; $\begin{bmatrix} a_{14} \\ a_{24} \\ a_{34} \end{bmatrix}$ generates projection transformation; $\begin{bmatrix} a_{44} \end{bmatrix}$ produces an overall proportional transformation. From this, each transformation matrix can be derived: if the object position is point $P(x,y,z)$ and the object is translated by $\mathrm{T}x$, $\mathrm{T}y$ and $\mathrm{T}z$ in three axial directions, then the translation transformation matrix is:

$$\begin{bmatrix} x' & y' & z' & 1 \end{bmatrix}=\begin{bmatrix} x & y & z & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ T_x & T_y & T_z & 1 \end{bmatrix}=\begin{vmatrix} x+T_x & y+T_y & z+T_z & 1 \end{vmatrix} \tag{2}$$

If the scaling ratio is (Sx,Sy,Sz) and the reference point of scaling transformation is (Xf,Yf,Zf), its transformation matrix is:

$$\begin{bmatrix} x' & y' & z' & 1 \end{bmatrix}=\begin{bmatrix} x & y & z & 1 \end{bmatrix}\begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{3}$$

Let the coordinates of the lower left corner of the rectangular window be w_1 and w_2, and the coordinates of the upper right corner be w_3 and w_4; The coordinates of the two corners of the rectangular view area are iv_1, iv_2 and iv_3, iv_4 respectively. The point (x, y) in the window has the following relationship with the corresponding point (ix, iy) in the view area:

$$\frac{ix - iv_1}{x - w_1} = \frac{iv_3 - iv_1}{w_3 - w_1} \tag{4}$$

$$\frac{iy - iv_2}{y - w_2} = \frac{iv_4 - iv_2}{w_4 - w_2} \tag{5}$$

Derived from the above formula:

$$ix = iv_1 + (x - w_1)sx \tag{6}$$

$$iy = iv_2 + (y - w_2)sy \tag{7}$$

Where the scaling factor is:

$$sx = \frac{iv_3 - iv_1}{w_3 - w_1} \tag{8}$$

$$sy = \frac{iv_4 - iv_2}{w_4 - w_2} \tag{9}$$

If the scaling factor is $sx = sy$, the objects remain similar. Otherwise, the objects in the window area will be stretched or compressed in x or y direction when displayed on the output device.

In this article, a hierarchical simplification algorithm based on k_dop is proposed to optimize the model in the region. Among them, dop stands for "k discrete direction polygons" and k_dop stands for "discrete direction polygons". The precondition of the optimization algorithm is to ensure the accuracy of real objects and the authenticity of the scene. The hierarchical simplification algorithm based on k_dop has a slow display speed at first, because structural optimization is needed first, but the time interval between models is short, and the models in the region can be optimized in parallel, and the total delay time between regions is obviously less than that between models. The algorithm steps are as follows: ⊖ For each vertex, calculate its k nearest neighbors. ⊜ For each surface, calculate its normal, and determine its projection in all directions according to the normal. ⊛ For each face, calculate its dop error, that is, the sum of the absolute values of the differences between the faces and k nearest neighbors. ④ Sort the dop errors of all faces. ⑤ Starting from the face with the largest dop error, delete the faces in turn until the required simplification is achieved. ⑥ Repeat steps 2-5 until the required simplification level is reached. Among them, the value of k can be adjusted as needed. Generally, the larger the value of k, the better the simplification effect, but the amount of calculation will increase accordingly.

In this article, after determining the market standards and technical standards for evaluation, the designed products are finally processed and displayed through VR, and the rationality of the products is comprehensively analyzed under each standard. For some cultural creativity products with sports factors, to determine the range of their sports, the following formula is generally used to determine the range:

$$\frac{\text{benefit}(\text{ob ject}, \text{lod}, \text{r})}{\text{cost}(\text{objec t}, \text{lod}, \text{r})} \tag{10}$$

After the evaluation of technical standards and market standards, products should also be put into the market for evaluation, and consumer experience data should be recycled to optimize the performance of products through VR. In this article, the virtual cultural creativity product is divided into smaller units by unit division method. When rendering, only the solid model of cultural creativity product in the current perspective is rendered, and the solid model of cultural creativity product outside the perspective is ignored, thus improving the processing speed of rendering. In addition, this article strengthens the ability of program module in parameter model construction and optimizes the effect of CAD function module, so that it can better serve Cultural creativity product design.

5 CULTURAL CREATIVITY PRODUCT MODELING 3D MODEL AND ALGORITHM TEST

The quality of modeling will affect the quality of the whole VR system. Generally, the effect of 3D modeling will be evaluated by the display speed of the applied model, the accuracy, ease of use and the operational efficiency of the model. This section tests and analyzes the 3D model and algorithm of cultural creativity product modeling. In the evaluation process, not only the design of cultural creativity products should be presented in VR, but also the display background of the designed products should be designed to highlight the characteristics of cultural creativity products. Firstly, according to the collected information, according to the demand orientation of the model, combined with the current actual software and hardware conditions, the collected data should be preliminarily processed by using modern advanced technology. Firstly, the experiment in Table 1 illustrates the influence of file block size on data processing. The details are shown in Table 1.

Slave number	*Block size*	*Number of processed records (10000)*	*Execution time (seconds)*
4	5M	90	11
4	72M	95	26
4	4M	920	58
3	12M	1000	179
5	58M	800	59
6	58M	800	48
6	84M	1100	72

Table 1: Experimental results of file block size.

In this article, in the process of modeling the display background of cultural creativity products, 3DSMAX technology is used to build the overall background model, and then the 3D graphic background and dynamic content are generated and rendered by VR and 3D animation technology. At the same time, the use of instantiation can greatly reduce the quantity of polygons in the scene and save a lot of memory.

The hierarchical simplification algorithm based on k_dop belongs to the combination of serial optimization and parallel optimization, which is more focused on parallel optimization. Therefore, the hierarchical simplification algorithm based on k_dop has high manipulation efficiency. Figure 4 shows the 3D modeling speed of the algorithm. Figure 5 shows the accuracy of the algorithm.

The model-based optimization algorithm is relatively slow, and the hierarchical simplification algorithm based on k_dop is relatively fast, reaching 0.201s at the fastest. In addition, the hierarchical simplification algorithm based on k_dop has better accuracy, which is more than 90%. The k_dop hierarchical simplification algorithm based on is slow at first, because the structure must be optimized first. However, the time interval between models is small, and the models in the region can be optimized in parallel, and the total delay time between regions is obviously less than that between models. Generally speaking, the hierarchical simplification algorithm based on

k_dop considers the optimization efficiency from a global perspective, and it is block-optimized, clear-cut, and the purpose of model optimization is clear.

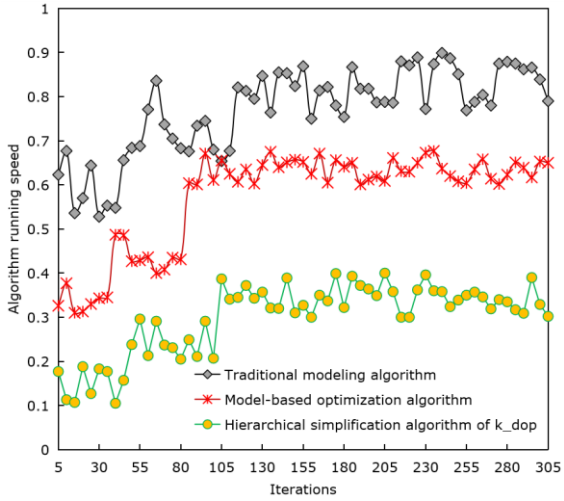

Figure 4: 3D modeling speed.

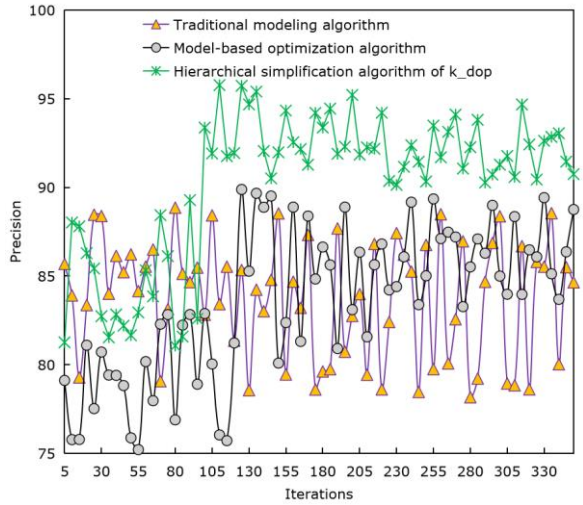

Figure 5: Algorithm accuracy.

In the process of cultural creativity product design, if the structural model is made, Pro-E, UG and Solidworks are needed. In this process, the structural model is more designed by the structural designer. Figure 6 shows the comparison results of user satisfaction of cultural creativity product modeling constructed by different modeling methods.

The experimental results show that the hierarchical simplification algorithm based on k_dop is suitable for the complex modeling of cultural creativity products and has achieved good results. The algorithm is fast and accurate, and the user satisfaction of cultural creativity product modeling constructed by this modeling method is high, which has been recognized by the public and provided support for the research and growth of cultural creativity products.

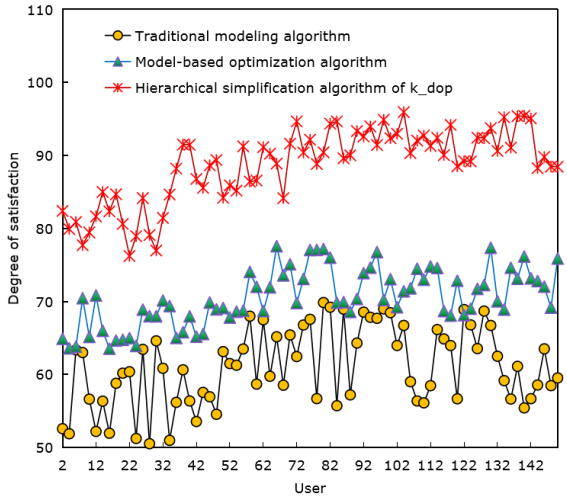

Figure 6: Satisfaction result.

In this article, after the model is created in 3DS MAX, the corresponding simulation system import and export plug-ins are used to convert the model into a simulation model format that can be recognized by the simulation system, and then it is imported into the simulation system for real-time simulation browsing. In this article, VRP3D interactive simulation platform is used as the driving engine, and the scene model is integrated in 3DS MAX software, and then the model is exported to VRP format through VRP export plug-in. Then, you can import, edit and set the model in the VRP platform editor. The method in this article can help designers to optimize the appearance of products and choose the best scheme that best meets the design requirements. In the design process of cultural creativity products, the quality of products can be verified and the completion period of product design can be effectively shortened. As shown in Figure 7, the 3D modeling of cultural creativity building products constructed by VR and CAD is shown.

Figure 7: Cultural creativity building products 3D modeling.

It can be seen that the 3D modeling renderings of cultural creativity products are more intuitive than engineering drawings, and the effect of attracting customers' attention can be achieved by rendering the renderings. In the design of cultural creativity products, CAD is more important, which plays an important role in the design and production of cultural creativity products. In the product design of cultural creativity, the design scheme of computer program software can make the work fast and convenient.

In the R&D and design of cultural creativity products, the introduction of VR and CAD not only enriches the carrier form and communication means of cultural creativity products, but also objectively relates the two fields of cultural creativity industry and VR industry, which stimulates the consumption demand of cultural creativity products and makes the total value of cultural creativity products and cultural creativity industry continuously improve.

6 CONCLUSIONS

To a certain extent, the public's demand for the diversity of cultural creativity products has promoted the application of VR and 3D animation technology in cultural creativity products. The development and application of CAD function has fundamentally changed the traditional manual design mode, greatly improved the success rate and efficiency of product design, shortened the product design cycle, improved the product design quality and reduced the production cost. Based on this background, this article mainly discusses the use of VR and CAD in cultural creativity product development, and puts forward a 3D modeling method of product modeling based on VR and CAD. This article focuses on 3D modeling optimization process, structure optimization, model optimization and hierarchical simplification algorithm based on k_dop. The results show that the accuracy of the proposed algorithm is high, and it is basically stable above 90%. The fastest running speed can reach 0.201s. It provides better technical support for the design of cultural creativity products. Generally speaking, the 3D modeling method of product modeling based on VR and CAD not only improves the efficiency and accuracy of product design, but also opens up a new road for the research and growth of cultural creativity products. The popularization and application of this method will have a far-reaching impact on product design, cultural creativity industry and related fields. In the future, in the process of applying computer-aided technology, cultural creativity industry should make new attempts and adaptive adjustments based on the new growth of technology, so as to fully absorb the usefulness of technology and promote its own better development.

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