Using VR Technology Combined with CAD Software Development to Optimize Packaging Design

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Abstract. There are still many problems to solve in the development of virtual design. The first is the problem of data exchange. The current manufacturing industry often uses CAD systems, but the data of the virtual design system cannot have directly transmitted to CAD. In addition, this obstacle restricts the application of virtual reality in many enterprises. Second is the hardware problem. The current virtual design hardware needs to improve, such as the resolution of the helmet display and the sensitivity of the feedback system. The transmission speed of the network and the reduction of data all restrict the development of virtual design. At present, the manufacturing industry has shown three major trends: globalization, networking, and virtualization. Although virtual reality is still very young, virtual reality has still regarded as VR interface. This paper proposes that the use of VR combined with CAD software to optimize packaging design and the application of virtual reality in packaging design can achieve complete digitalization of products. It is foreseeable that in the future industry, virtual reality (VR) and its applications will become more extensive, and virtual reality will certainly play a more human advantage.

Keywords: CAD; Virtual Reality; Packaging design; digitalization
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1 INTRODUCTION

Commodities are indispensable in people's lives. As people's living standards continue to improve, the packaging of goods has become increasingly high. Among various commodity-packaging containers, the application of packaging products takes the first place. Well-designed cardboard boxes can help logistics and circulation play an advantageous role. With the progress of science, computer applications have become increasingly widely. There are more and more surprises [1]. The application of computers to the production field is no longer a manifestation of its innovation, but the software development technology of packaging design based on network is an important manifestation of it in the field of packaging design. The software packaging design is an important

auxiliary function of computer network system. It can better provide services for product packaging, which can optimize the application of manual packaging design software. Rahman, et al., [2] find that not only can the packaging effect have more favored by people, but also the packaging staff reduces the workload, and improves the quality of workers. At the current stage, the visual shock of packaging is getting stronger by Natephra, et al., [3]. Only by perfecting the combination of computer technology and packaging design, and improving the application of software development technology, the packaging effect appear to be getting better.

Various new technologies have emerged endlessly, and the integration of various disciplines has created many new discipline technologies. Product design is one such discipline. Every innovation will bring new development and changes to the way of product design. Serafin, et al., [4] said that CAD has developed rapidly. A large number of commercialized CAD software goes to various fields. However, what does not match this is that until today, the user's interaction with the CAD system has hardly changed, and still uses standard keyboard/mouse input. The two-dimensional interface is used to deal with the 3-D modeling environment, and lacking three-dimensional interactive equipment. Song, et al., [5] urged to solve the human interaction. The emergence has adopt VR 3D equipment to improve the interface of GUI, which has led to the CAD research. Virtual reality was born in the 1940s and gradually developed and perfected in the 1990s. Now it has applied swords in many fields such as manufacturing, military industry, medicine, aerospace, and construction, and has achieved great success.

The application of virtual reality to product design will reflect many of its advantages and bring new ideas and methods to the design industry. Packaging products have many advantages by Liu, & To [6]. First, it has a lower price. It has certain rigidity and strength, good elasticity and toughness, and good protection for the contents. Secondly, compared with other packaging containers, it is lighter in weight and relatively less in transportation costs. Finally, packaging products can be recycled and reused. As waste, the disposal method is very easy and does not cause pollution. Therefore, we have designed a CAD system for packaging products to facilitate the automated packaging of packaging products. In this article, our team completed the establishment of a computer-aided matching system from technical support to VR, which collected the data of the main packaging products, and established a database of packaging products to obtain information about the biological characteristics, ornamental characteristics and uses of the packaging products of alternative plants that meet user needs. Through computer technology, remote sensing images, and so on.

2 APPLICATION AND USE OF VR

CAD (Computer Aided Design) application to the packaging industry will greatly shorten the design cycle of packaging products and improve design quality. Computer technology in packaging industry started late, which has a large gap with developed countries. Some domestic packaging design manufacturers use traditional manual design and processing techniques. Dr. Boitelle, et al., insisted that the CAD/CAM technology to realize the modernization of packaging design is particularly important [7]. A man-machine interface technology highly realistically simulates human behaviors such as audiovisual movements in the natural environment. It uses multimedia computer simulation technology forms a special environment. With the development of computer software and hardware technology, CAD technology has developed into a design technology for each stage of the whole process of product design (including conceptual design, scheme design, detailed design, analysis and optimization design, simulation test and other stages). As a great achievement of engineering technology, CAD technology has been widely used in various fields of engineering design, especially in the field of microelectronics. CAD technological progress and innovation can always be reflected in the field of packaging design in a short time, and greatly promote its technological progress. In turn, the continuous development of packaging design also drives the development of computer software and hardware technologies that CAD depends on. Compared with other computer systems, VR system can provide real-time interactive operations, three visual spaces and human-machine interface in Figure 1.

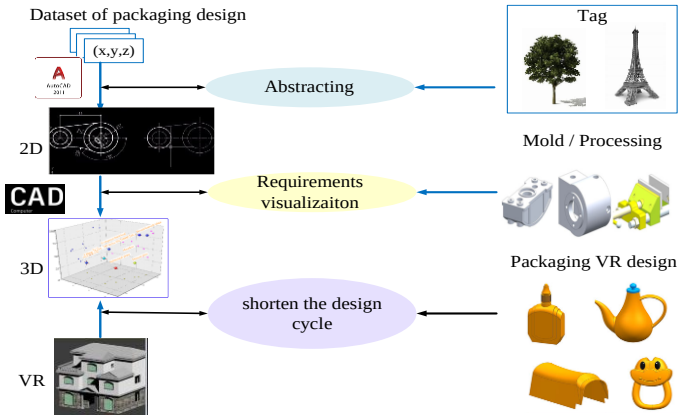

Figure 1: Schematic diagram of VR system.

2.1 Application in Product Design

VR application to product development and design is called virtual design, which based on VR for mechanical products. Essentially, virtual design is the virtual realization of the entire process of conceptual design to use in a virtual environment constructed on a computer. The goal is not only to simulate and visualize the material form and manufacturing process of the product, but also to Predict, evaluate, and optimize the performance, behavior, and functionality of your product, as well as the implementation at all stages of product realization by Weiss, et al., [8]. There are many aspects of the application of virtual design in reality, Because of its advantages. The following is the current application of virtual design in Figure 2.

(1) Virtual prototypes visualize and replace physical prototypes. For example, in 1992, the United States NASA established a digital model of the space shuttle and a virtual wind tunnel to observe the streamline distribution of the aircraft and verify the rationality of the design of the aircraft.

(2) Immersive virtual environment is interconnected with the design. By establishing a 3-D model, the designer uses virtual reality equipment to guide the manipulation of the model in the virtual environment. At each stage of product development, the structure, function, performance, production organization and other aspects are simulated in a virtual design.

(3) Virtual assembly. In traditional design methods, this error cannot have discovered until the final assemble software. With virtual design, interference can have detected early. By assembling simulation software, designers can experiment with virtual prototypes; analyze stresses and deformations, and more. If the design does not meet the standards, you can easily change the model and regenerate the model. Virtual Assembly uses computer simulation and virtual reality technology. Zhang, et al., insisted that simulation assembly performed on the computer through the simulation model to achieve product process planning, manufacturing, assembly and debugging [9]. At present, as far as its technology is concerned, although there is no commercial virtual assembly system, and it has not applied to the analysis and evaluation of new product development. The first step of virtual assembly is to create a virtual product model in the CAD system in Figure 2, and then enter and use the Virtual Assembly Design Environment system. Product developers work in the VADE system. With the help of the virtual assemble design environment, designers can use various assembly tools in the virtual environment to perform assembly inspection on the design mechanism, who help designers find assembly defects in the design in time, fully grasp the assembly process in virtual manufacturing. Experiments show that the improvement of virtual assembly design will effectively accelerate the introduction of advanced design methods and technologies, improve the reliability of new product.

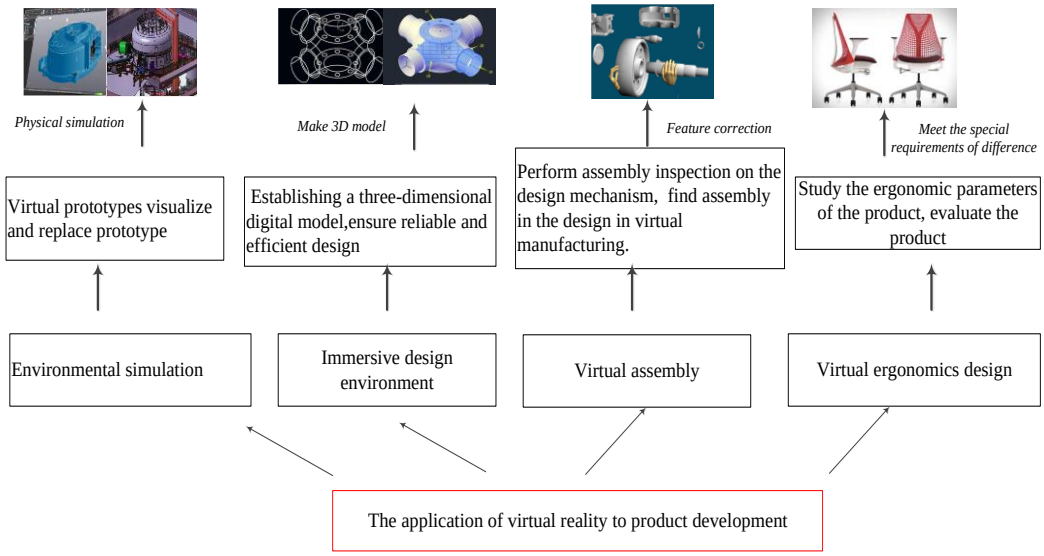

Figure 2: The current application of virtual design.

(4) Virtual ergonomics design. Virtual ergonomics design is based on a virtual prototype system, which is also called a virtual environment. It has introduced into a virtual evaluation system, and designers can accurately study the ergonomic parameters of the product. In addition, if necessary, modify the position of the virtual part and redesign the structure of the entire product.

2.2 The Role of VR in Product Design

The visual design of packaging design has been improved compared to the CAD system, but the specific construction effect is still in the initial stage of the three-dimensional effect, and the visualization ability is limited. In the specific construction, the construction department may still not be clear about the specific location of each component in the drawings. If equipped with VR technology, the BIM system can provide an immersive experience, thereby effectively improving the ability of resource integration and product competitiveness. Integration has not only integrated various CAD tools, but also CAD and CAM (Computer Aided Manufacturing), CAE (Computer Aided Engineering), CAPP (Computer Aided Process), VR, ERP (Enterprise Resource Planning Management) and other systems are integrated. If these systems are independent of each other, it is difficult to give full play to the overall benefits of packaging design. The core problem of system integration is data sharing. The system must ensure that the data is valid, complete, unique and can be updated in a timely manner. Even within the CAD system, sharing data among various parts is also a core issue of integration. To solve this problem, the data format needs to be standardized. Currently there are many analysis software that can directly input CADSAT format data. Intelligent design (Intelligent Design) and knowledge-based system (Knowledge-based System) engineering are new trends that appear in the development of product processing. The development of database technology to data warehouse (Data Warehouse) and further development to knowledge base (Knowledge Repository), from simple data sets to the application of certain rules for knowledge mining from the data, and to let the data itself have the ability to learn and accumulate step by step process of data processing and application. Because of the development of database technology, it is possible to make the software system highly intelligent. The two-dimensional graphic design method has been unable to meet the design requirements of the new generation of packaging products, and CAD tools based on the overall three-dimensional design began to develop. The hypervariable geometry technology began to be used in CAD,

making the 3D product design more intuitive and real-time, which makes the CAD software easier to use and more efficient. Virtual reality (Virtual Reality, VR) technology has also begun to be applied in CAD, which can be used for various visual simulations (such as electrical performance, thermal performance analysis, etc.) to verify the correctness and feasibility of the design.

3 VR COMBINED WITH CAD SOFTWARE FOR DEVELOPMENT AND OPTIMIZATION IN PACKAGING DESIGN

3.1 VR Technology to Support Design

As packaging design matures, a large number of packaging designs emerge. Taking Suzhou as an example, different units in different industries in Suzhou have produced many packaging design models for buildings, road networks, pipelines, and transportation, and the three-dimensional scenes produced are very realistic. If these built models are integrated to form a data model library for packaging design, is it not what we call the concept of intelligent packaging design? The maintenance and construction of various facility packaging can be extracted from the intelligent packaging design database to avoid It has done a lot of repetitive work of modeling in packaging products, and can provide accurate and intuitive data for packaging design [11]. The modeling process requires many low-level operations in Figure 3. In this way, a non-professional CAD person cannot use it. To build a product model, it must have coordinated by the designer and CAD staff. To support the conceptual design of the product, a large number of scholars have made long-term efforts. Techniques such as sketch design, parametric design, and feature-based product design provide conditions for supporting conceptual design in Figure 3. The use of VR technology makes it possible to produce a CAD system that supports conceptual design in the true sense.

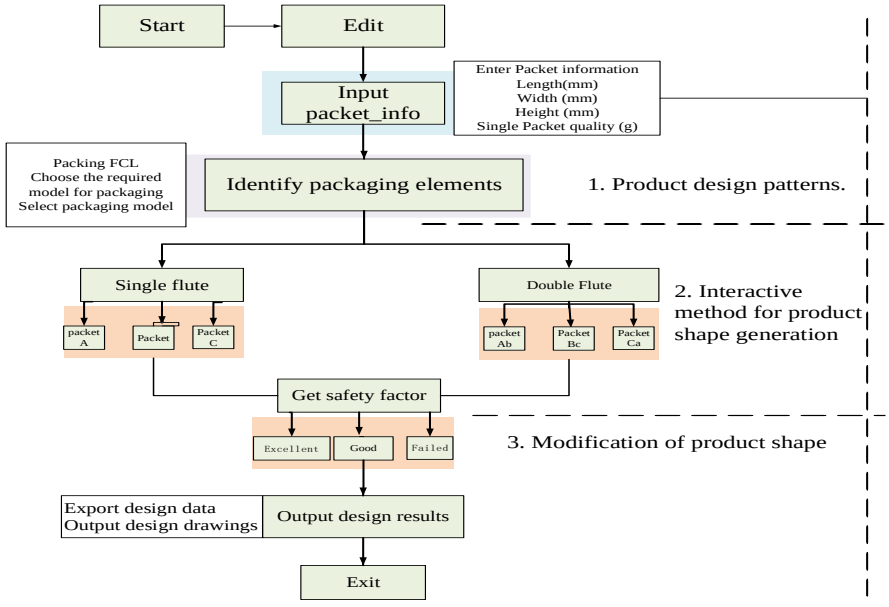

Figure 3: The workflow of the VR Packaging products.

The conceptual design of products using VR technology mainly solves the following problems.

(l) Product design patterns. There are many ways to represent products, and two of them are commonly used. VR used to generate standard geometric shapes such as cubes, cylinders, spheres. Users can use advanced commands to generate parameters by determining parameters. The

freeform surface can have given the preliminary shape of the surface by the hand's motion trajectory, without generating the vertex.

(2) Interactive method for product shape generation

User-generated shapes can be used in two ways, which are implicitly and explicitly. Virtual reality is the use of computer simulation to generate a virtual world in a three-dimensional space, providing users with visual, auditory, tactile and other sensory simulations, so that users can observe things in the three-dimensional space in a timely manner and without restrictions. AR Augmented Reality (Augmented Reality, AR for short): Augmented reality AR, which uses computer technology to apply virtual information to the real world. Real environments and virtual objects are superimposed on the same screen or space in real time. It is not necessary to use strict dimensions here, as strict dimensions are not required during the conceptual design phase. This is implicit generation. Explicit generation can be performed as follows, issue a voice command "produce a cube with a length of 20mm, a width of 10mm, and a height of 5mm".

(3) In the parameterized mode, the method of product shape modification and generation is similar. It is easy to add a hole, slot, elongate an object, etc. or resize it with sound and gestures. It is more difficult to modify the design, and a set of advanced abstraction methods should be provided when modifying. Such as using material types, surface features, virtual tools to complete the modification work.

3.2 Industrial Design Based on Virtual Technology

The shape design of packaging products adopts the shape design of Sichuan virtual reality technology, which can have modified, evaluated, and modeled after the solution is determined. In a virtual environment, establish a three-dimensional CAD model (virtual model) of surrounding scenes, structural members and packaging design, etc., to form a computer-based simulation system with certain functions, so that the model in the system has dynamic performance, and The model is virtually assembled, and based on the results of the virtual assembly, the construction plan is modified in the visual environment of human-computer interaction. Meanwhile, using virtual reality technology can do a lot of analysis on different programs in a short time, so as to ensure the optimization of the construction program [12]. The size of the package calculated as follows.

$$\begin{aligned} L' &= L0 + 5mm; \\ B' &= B0 + 5mm; \\ H' &= H0 + \Delta X0; \end{aligned} \tag{1}$$

Manufacturing size calculation is as follows.

$$\begin{aligned} L1 &= L' + \Delta X \\ L2 &= L' + \Delta X \\ B1 &= B' + \Delta X \\ B2 &= B' + \Delta X \\ B' &= B0 + 5mm; \\ H' &= H0 + \Delta X0; \end{aligned} \tag{2}$$

The external dimensions of the package are calculated as follows.

$$\begin{aligned} L'' &= L + \Delta X; \\ B'' &= B + \Delta X; \\ H'' &= H + \Delta X \\ B' &= B0 + 5mm; \\ H' &= H0 + \Delta X0; \end{aligned} \tag{3}$$

In the formula, L means the length of the package, B means the width of the package, and H means of the package. The coordination of movements in various links on the cattle production line is relatively complicated. Using Sichuan simulation technology, you can intuitively configure and

design to ensure the coordination of work. The slogan of packaged products Roaming Product advertisements made with virtual reality or two-dimensional animation technology have realistic effects, which can not only display the shape of the product, but also the product's internal structure, assembly and maintenance process, use method, work process, and so on. In particular, the product introduction using the Internet is vivid and intuitive, and the advertising effect is very good. Online roaming technology enables people to roam in cities, factories, cars, machines, even drawings and parts, and obtain information intuitively and conveniently. Virtual products provide convenience for online shopping.

3.3 Manipulating Objects in a Virtual Environment

People naturally take advantage of VR to design. However, when operating on objects, various problems will have found. A simple example, if you want to decorate a room, you need to put many chairs, tables, lamps, etc. In VR, you can grab an object directly and place it in the desired position. However, if you need to install a lamp on the ceiling, you can see the ceiling, but you cannot reach it. This requires corresponding operating technical support. Another example is that placing a chair can restrict the chair to move on the ground (two-dimensional movement) and make the operation more accurate. It can be seen that the operation of objects under VR has its own characteristics in Figure 4. If these characteristics have not fully understood, it will be difficult to operate objects in VR. Several operation techniques described below.

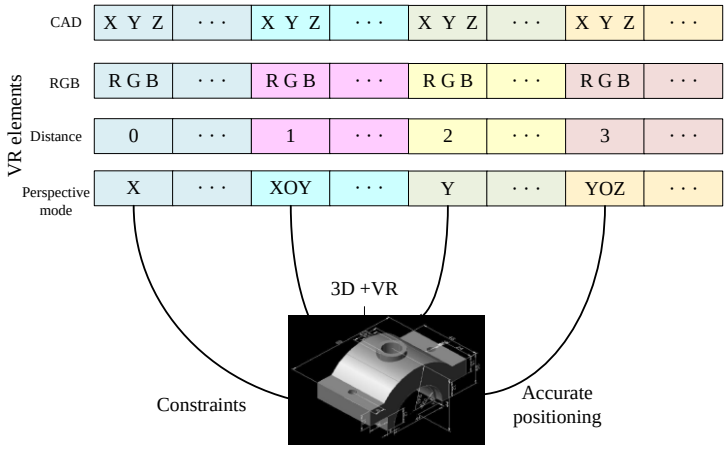

Figure 4: Manipulating objects in a virtual environment.

First, it is difficult for customers to imagine the design results through drawings. Customers who have not been trained in professional graphics cannot imagine and understand the result of the decoration based on the floor plan and elevation. And many low-cost packaging designs cannot provide renderings. Even if there are renderings, in most cases the perspective ratio of the static renderings will be different from people's visual habits. From time to time, people can misjudge at the spatial scale. In addition, the low-cost renderings are all ready-made furniture in the model library, the style of these models may not be what the customer wants.

The second is the cultural and professional differences between designers and clients. There are sometimes certain cultural differences between designers and clients, and language expression and aesthetic judgment may not be on one level. Customers often cannot describe what they want in professional language very accurately. And what designers do according to their own ideas may not be recognized by customers.

The advent of VR glasses has made some people in the industry see a more effective means of customer communication. If the customer wears VR glasses connected to a smart device, they can immediately walk into the space designed by the designer. Feel the scale of the space, the light in

the room and the texture of the furniture more realistically, and experience the stimulation of the senses of virtual reality in all directions. Then, the customer can truly intuitively understand the designer's design and may give more accurate feedback. There is no need to imagine the designer's plan through drawings and renderings. At the same time, it will greatly reduce the misunderstanding of language description caused by the cultural and professional differences between the client and the designer.

From this perspective, future VR glasses and related technologies are bound to improve the designer's work efficiency. The packaging design industry will naturally generate demand for VR glasses and related technologies. With this demand, the development of VR glasses and related technologies in the design field has a driving force. In modern society, economic interests often determine the direction of technological development. Manufacturers in the IT industry must also be willing to invest money in this profitable direction.

3.4 Virtual Assembly Using VR Technology

Virtual assembly, referred to as VA, is an important leader in the application of VR in CAD. VA is also a key part of virtual manufacturing. It can have described as follows: computer tools instead of building used an actual model of the product, which help engineers make engineering decisions on assembly relationships through analysis, visualization, and data representation techniques. In general, the virtual assembly technology is not very mature at present, and the degree of practical application in the industry is not high. Some key technologies need to resolve. Therefore, there is still a long way to go before it can have applied in industry. The key development directions in the future mainly reflected in the following aspects. As shown in Figure 5, by presetting appropriate packaging three-dimensional parameters and VR parameters, the effect of immersive scenes in virtual reality can have improved to a certain extent. Based on the initial parameters, the method obtains the texture to render and submits it. It supports computing device poses to predict the texture rendering delay of packaged products, thereby improving the stability of the entire scene in the packaged products.

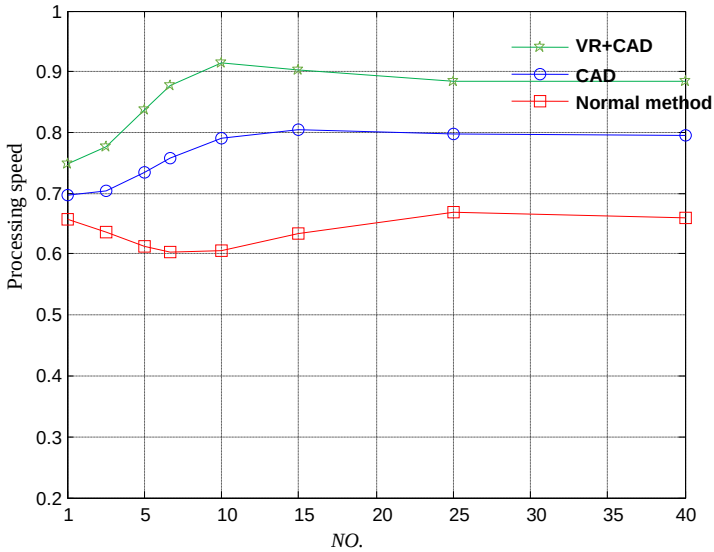

Figure 5: Processing speed in the different methods.

(1) The virtual assembly system should be able to accept the model information of the CAD system and achieve seamless integration with mainstream CAD systems. At present, the virtual assembly system developed by each unit customizes the CAD interface and implements

information conversion according to its own situation. There is no unified standard and specification in terms of data extraction and expression, information storage and management.

(2) People are an important factor in the process of product assembly/disassembly. Taking full advantage of human subjective initiative, enthusiasm and creativity, and truly embodying human-centered design are the keys to improving product assembly quality and efficiency. The combination of technologies such as ergonomics and virtual assembly technology is a hot research topic at this stage, which can solve technical problems that cannot have solved in automated assembly.

(3) In industrial-grade complex products (such as airplanes, ships, rocket engines, etc.), due to the small space and compact structure, various rigid pipes and flexible cables, cables, etc. are intertwined, which brings great difficulty to the assembly operation. Become the key to affect the quality of product assembly. Existing virtual assembly systems lack effective tools in this regard, limiting their application in industrial production.

(4) The current virtual assembly systems are based on ideal part models, without considering the impact of specific processing and assembly environments on part shape accuracy and dimensional errors, resulting in the actual produced parts not being assembled or the assembly performance not meeting the requirements. For example, due to the influence of factors such as machine tools, tools, and residual stress in actual processing, the shape accuracy and design dimensions of parts are not completely consistent. Figure 6 shows the assembly efficiency by VR+CAD method, due to factors such as ambient temperature and assembly stress, the parts will also elastically deform. All factors have an impact on product assembly accuracy and assembly performance.

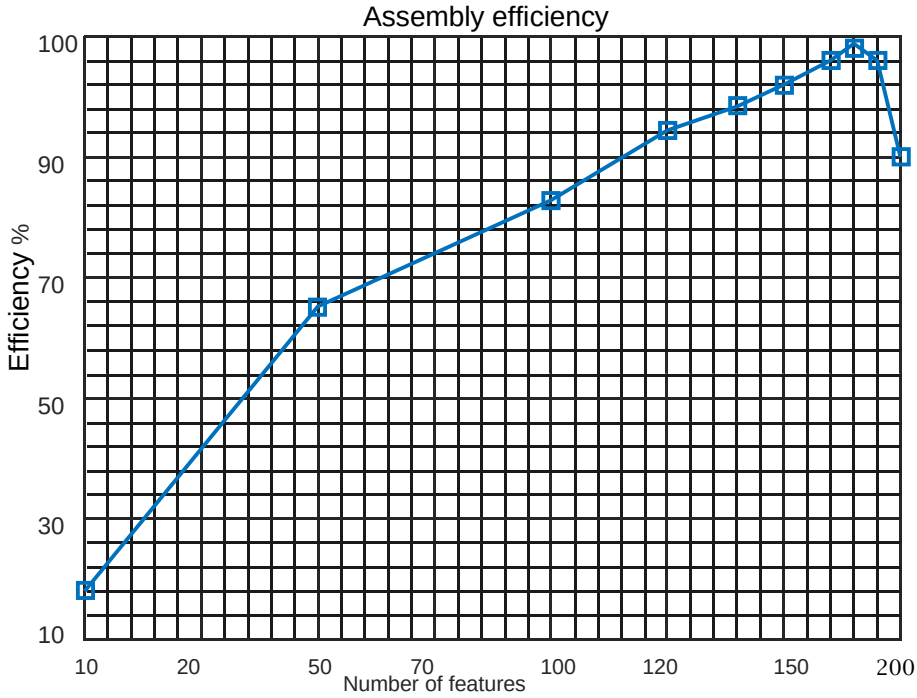

Figure 6: Assembly efficiency by VR+CAD method.

In addition, the virtual product design has digitally connected with other design processes, which can realize the integration of new product development processes, so that Concurrent Engineering

can have fully reflected and implemented. This shortens development time, reduces development costs, and brings out the creative potential of designers.

1) Improving the intuitiveness and authenticity of the design

Virtual design systems are different from general computer-aided design systems. Computer-aided design, which is commonly used now, has not fundamentally and conceptually changed the original design method, but the Sichuan display, mouse, and keyboard have replaced the design of Yazhi pen. The designers in the virtual design system do not have to be subject to the various constraints of these external devices, and can freely use Baiji's imagination and creativity in the virtual space through the virtual devices.

2) Shorten the design process and improve design efficiency

After the virtual design is applied to the process, the original prototype trial production can be omitted, and the product experiment (trial) is completed virtually, thereby shortening the product design cycle and improving efficiency. Figure 7 shows the CAD coordinate and VR+CAD coordinate fitting accuracy. Many large international manufacturers are vying to introduce virtual technologies into their designs.

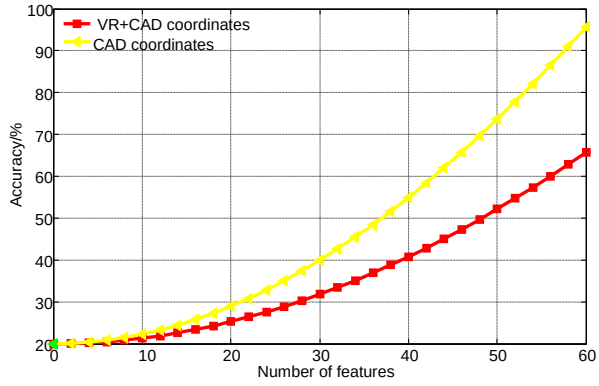

Figure 7: CAD coordinate and VR+CAD coordinate fitting accuracy.

3) Reduce design costs and improve product competitiveness

In today's increasingly competitive market, for any manufacturer, reducing product costs is undoubtedly one of the first considerations. In the past product design, the production of physical models and prototypes cost a lot of manpower and material resources, as well as the time-consuming and labor-intensive experiments on products. When Boeing designed the cabin of the 707-passenger plane, Zeng Shan paid 500,000 US dollars and completed a 1: 1 cabin model.

4 CONCLUSIONS

In recent years, China's packaging design has become more and more popular, the industry has become more concentrated, packaging design technology has been continuously improved, and its dependence on modern technology has become more and more obvious. Modern packaging design generally improves assembly technology and management level. Among them, the application of Internet of Things technology can realize environmental monitoring of packaging design, making the project implementation process more intuitive. All departments can coordinate and unify, not only to improve engineering efficiency, but also to avoid duplication of labor and control cost risks. Improve the quality of prefabricated processing, promote the development of prefabricated assembly engineering, and reduce processing costs. Reduce pollution caused by construction. VR applications have brought new leaps to the development of packaging design. Because of its unique

characteristics, VR technology will strongly promote the integration of CAD and greatly accelerate the development of CAD/CAM. In addition, the development of computers has made the development of packaging design software more and more modern, its application fields have become more and more extensive, and its functions have become more diverse. Designers can make comprehensive use of current software and continuously explore the advantages of software. Developers should also continuously improve the software, make the software more humane, enable it to better communicate with users, and let it better assist the completion of packaging technology.

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