3D CAD Hanfu Design Based on Virtual Reality Technology

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Abstract. with the improvement of computer science and technology, modern fashion design has become the product of the combination of designers, computer application and art design. 3D CAD design based on virtual technology has become a technical means and is widely used in the field of fashion. This paper mainly studies how to apply virtual technology to 3D CAD Hanfu design. Starting from the principle of garment CAD, this topic first introduces the function and application method of 3D virtual design LookStailor X, the establishment of 3D human model, the establishment of garment model, style line drawing, the conversion from 3D garment piece to 2D garment piece, etc. Then, the virtual design of Hanfu is carried out through parametric 3D human modeling, 3D garment generation and physical simulation. Finally, through the actual research, this paper compares and analyzes the clothing under the three modes, demonstrates the advantages of 3D virtual clothing design with specific research figures, and predicts the market prospect and economic contribution of 3D virtual clothing design.

Keywords: virtual reality technology; Hanfu; 3D CAD;
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1 INTRODUCTION

Virtual reality technology, also known as spiritual environment technology, is a technology concerned by the scientific and engineering circles in the 1990s [1]. Its rise has opened up a new research field for the development of human-computer interaction interface; It provides a new interface tool for the application of intelligent engineering; It provides a new description method for large-scale data visualization of various projects. If computer application is the source of virtual technology, the development of virtual technology will inevitably promote the improvement of computer application technology and promote the prosperity of virtual culture under the condition of mutual influence and promotion [2]. The birth and development of virtual culture is the

inevitable product of high-tech development and the derivative of scientific and technological culture. Detailed explanation of virtual: the virtual situation that does not or does not necessarily conform to the facts is a thing fabricated by imagination and a technology of imitating or pseudo physical objects realized by high technology [3]. In short, it is the behavior of imagining things and ideas, which do not exist in the real objective world. Virtual technology has obviously changed human's perception of the world and created a new method of human life practice. Virtual culture is basically divided into two parts: one part is simulation, which is the reproduction of the real world. Some historical film and television art is the visual persuasion of analog art, and the other part is imitation, which presents the things of the virtual world in the real world. Virtual clothing design is the combination of these two parts. Simulation can continue the popularity of clothing, reduce the investment in design and quickly put into the market; Imitation is to increase the personalization and differentiation of design, and echo with the customized purchase mode of the public [4].

The common shapes and systems include Han system, Tang system, song system, Ming system and so on. It cannot be simply understood as the restoration of traditional clothing. It can be said that contemporary Hanfu is a kind of clothing with the characteristics of traditional clothing, which is based on the design prototype of Chinese traditional Han clothing and combined with the aesthetic, technical level and production technology of contemporary people [5]. Aesthetics, comfort and economy are the core attributes of traditional clothing accessories. As a special kind of clothing, Han clothing also requires both culture and art in addition to daily clothing needs. Such as whether the dress contains a certain etiquette culture and historical connotation, whether it shows the traditional aesthetic concept, whether the pattern design and production technology are excellent, etc. In addition, the collocation, use occasion and frequency of Han clothes and daily clothes are also the focus of clothing wearers and designers. Garment CAD is the product of the combination of computer graphics and garment design. The applications of modern computer-aided garment design include creative design, sampling, coding, layout and so on. The advent of garment CAD aided design brought a new design concept to the garment industry at that time. With the help of computers and software, designers could save a lot of time and experience. Therefore, it was a new vision and brought a lot of shock to the garment industry at that time. With the passage of time, garment CAD is also advancing bravely in the tide of history, and has developed many types of design software, which adds color to the development of garment. With the development of the times, human beings are constantly creating new vitality in the field of fashion design. The vitality of computer application has brought us new challenges, brought us all kinds of convenience in work, study and life, helped us remember huge information, reduced the complexity of work, and brought us convenient and fast information control ability and information exchange ability; The development of computer also brings new vitality to the garment industry. With the development of computer and its network technology, computer-aided garment design began a series of development, and two-dimensional garment CAD and three-dimensional garment CAD came out one after another. The content of 2D garment CAD mainly includes garment style design system, garment fabric design and simulation system, garment pattern design system, garment code pushing and layout system, etc.; 3D garment CAD includes 3D anthropometry and data processing system, 3D human modeling, 3D cutting, 3D virtual fitting and 3D garment effect display.

2 RELEVANT RESEARCH

Lee et al. [6] entitled "ultimate display" has become the birth language of virtual technology, and has put virtual technology on the agenda of historical development since then. Today's virtual design is consistent with its bold ideas decades ago, which shows its foresight and predictability. In the 21st century, the garment industry has entered the era of information manufacturing, virtual manufacturing and intelligent manufacturing.

Various countries have successively developed or are developing three-dimensional garment virtual design software, among which the world advanced virtual garment design software is LookStailor X software system developed by Japan Toyo Textile Group for ten years. The system establishes a parameterized electronic model, which can modify the characteristic data of each part according to different body types to obtain the virtual model configuration of various body characteristics in the normal range, so as to convert the three-dimensional and n-dimensional structure. Vitali and Rizzi [7] have developed a fitting system for the transformation from two-dimensional pieces to three-dimensional clothes. After the designed two-dimensional plane pattern is sewn, three-dimensional clothes are generated and worn on the virtual model, so that we can inspect the drape, texture and overall effect of the design of the fabric at any time, as well as the different external effects displayed when changing the performance of the fabric Wrinkles and gloss changes caused by human movement. With the development of computer network, clothing virtual design has also entered the network environment with the trend. Many countries have launched many virtual clothing design websites. On the one hand, online design is carried out through the network. The more successful is the VirtuOsi system developed by Chen et al. [8] in the UK. The customer and designer jointly design, use the customer's size to establish a three-dimensional garment model, design the garment style, generate a two-dimensional idea, and sew the garment pieces on the three-dimensional manikin to let the customer see the wearing effect. This move has been welcomed by Internet lovers. On the other hand, it is the online virtual model. The website scans the customer's body, and then obtains the 3D electronic model with data such as skin tone and hairstyle characteristics. The website establishes a database of all clothes for the customer's virtual model to choose. 3D virtual garment design makes the design, production and trade of the whole garment industry fully reflect the characteristics of globalization. As a major garment country in the world, China is under the background of network virtualization. Although facing many difficulties, such as the high cost of VR technology, the imperfection of the system itself, the fact that there are many unpredictable situations in actual production, the few fields that actually get benefits, and the industry insiders still hold a conservative attitude towards the introduction of new things, garment virtual design is an inevitable development trend.

3 3D VIRTUAL HANFU DESIGN METHOD

3.1 Parametric 3D Human Modeling

There are many methods to establish virtual human models. The commonly used methods are: wireframe human modeling method using points, lines and curves; solid human modeling method using voxels; Curved human modeling using points, curves and surfaces; Physics based human modeling method, etc. Wireframe human modeling method is the basis of solid human modeling and curved human modeling. Wireframe human modeling is to construct a three-dimensional object frame by using several points, lines, arcs, curves and other information. It can be said to establish a skeleton model, which has simple structure and convenient and fast computer operation. However, the details are insufficient, the sidelines are uneven, the treatment of small parts of clothing is unsatisfactory, and the sense of reality is poor. The characteristic dimensions of key parts such as height, shoulder width, chest circumference, waist circumference and hip circumference are selected as reference data for human parametric surface modeling. Using the form of geometric accumulation and according to the structural characteristics of human body, 18 key curves are established on the human platform, and then curve interpolation is carried out between each two layers of key curves to obtain 86 layers of curves and 85 interpolation points. The adjacent points are connected in turn to form a simple triangle, and each point is connected to form a three-dimensional surface to obtain a curve parameterized human platform. Human parametric surface modeling can show the external smoothness of human body, can only reflect the external characteristics of human body, cannot truly show the internal structure of human body, and the operation is relatively simple and easy to understand. The obtained human model can also

reflect the external performance of real human body, which is suitable for the auxiliary operation of clothing design software. 3D clipping software mostly adopts the way of surface modeling.

3.2 Virtual Design Operation Process

3D cutting software is a form of computer-aided virtual garment design system, which integrates the advantages of three-dimensional cutting and plane plate making. A more scientific and reasonable method has been adopted in the transformation of 3D and 2D fashion design, setting off a trend in the era of machine electronics industry that saves more time and efficiency in the field of fashion. The operation steps of the three-dimensional virtual cutting software operating system are shown in Figure 1.

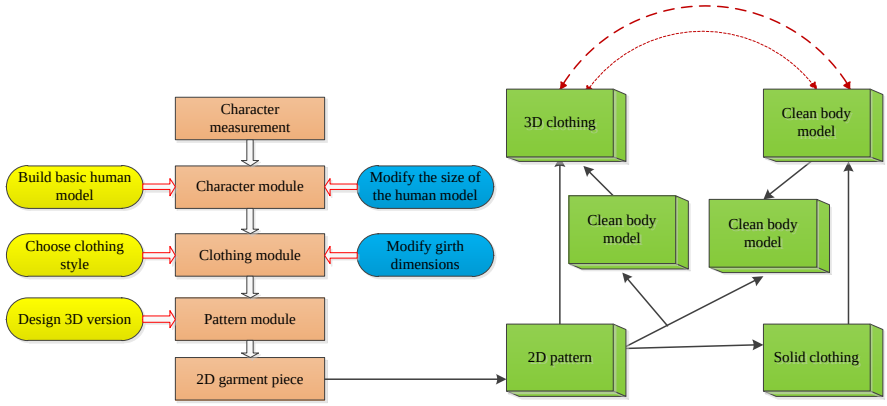

Figure 1: Virtual design operation flow chart.

3.3 3D Garment Generation and Physical Simulation

After formulating the specific data parameters of clothing pieces, the subsequent operation is to quickly generate the corresponding clothing piece model. The step of garment generation is not only used in the simulation stage, but also needs to generate garment information in real time in the 2D sketch drawing stage for timely adjustment. Therefore, the whole 3D garment generation can be divided into multiple stages and handed over to different modules. At the same time, different modules are reused in many stages. The first step of garment piece digitization is to process the garment piece in 2D plane CAD system into a data structure that can be used for physical simulation and real-time rendering. There are many methods of physical simulation. Generally, the physical simulation is carried out through finite element analysis. At this time, the clothes need to be discretized. This step will directly affect the physical characteristics of subsequent simulation and the display effect in the actual display. Silva et al. [9] developed a classical method for the physical simulation of textile fabrics, namely the mass spring model. Figures 2 and 3 are the reference diagrams of his proposed model.

The mass spring model takes the physical structure of textile fabric as a quadrilateral grid structure with m and n units. Nodes are regarded as particles, and the particles between the same mesh will be affected by the interaction between them. This quadrilateral mass spring model divides the spring system into three categories: structural spring, flexible spring and shear spring. The structural spring acts on four adjacent particles to restrict the force on the particles in the quadrilateral of the minimum element. It is the basic way to control the motion of the particles. The flexible spring acts on adjacent cells to simulate the effect of flexible movement between cells. Without this force constraint, the extension of clothing cannot be simulated. The shear spring is

used to stabilize the whole quadrilateral mesh. Without this constraint, the quadrilateral mesh will collapse and cannot be simulated normally.

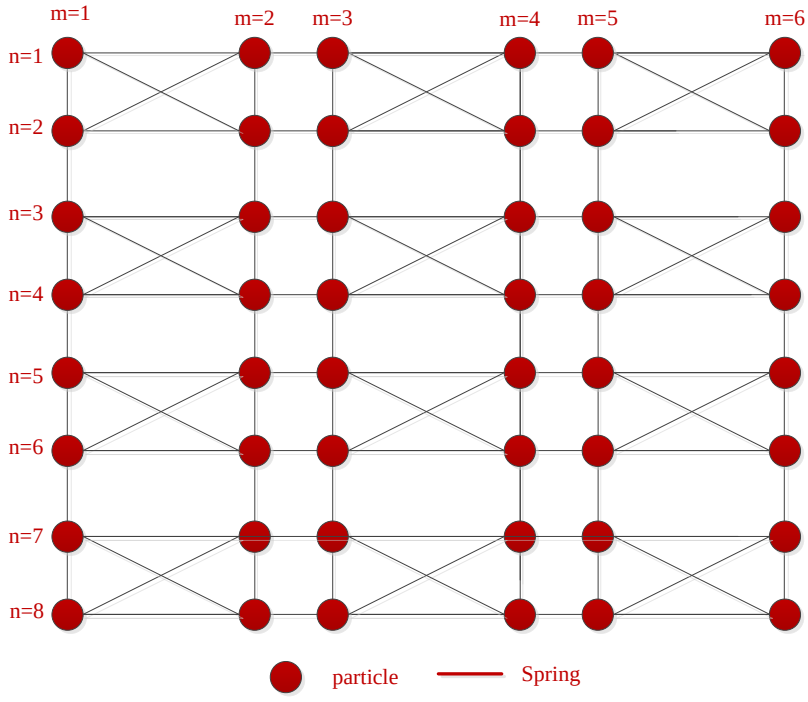

Figure 2: Mass spring model.

Yang and Lee [10] also uses this modeling method in CAD system design. Although this configuration meets the basic mechanical requirements, in order to ensure the efficiency and diversity of physical simulation, it is difficult for a simple quadrilateral mesh to simulate all kinds of clothing pieces. Therefore, the simple use of Provot's particle model is not enough to meet the actual needs.

3.4 Design of Virtual Matching System for Fashion Design

In the process of designing the virtual matching system of fashion design, the most important thing is to build the system model according to the demand analysis. In the demand analysis, the connection form, interface effect, image processing and background database of clothing virtual collocation system have been analyzed in detail. Below, the detailed design of each part will be carried out according to the above.

For the design of system architecture, the most popular multi-layer model is the three-layer structure. The multi-layer model has the following advantages: (1) Good flexibility. It can be widely used in LAN and WAN (2) High network efficiency. Designing a reasonable layout in advance can greatly reduce the amount of data transmitted through the network and greatly improve the efficiency of the network (3) Easy to manage. Since the modification of business logic will not affect the use of the customer layer, it only needs to focus on the management of the application logic layer. This design can basically realize the "zero management" of system users (4) Reusable. The component pattern is object-oriented. These components can be reused, and a variety of components constitute services. Applications are constructed according to the required services, and each application can reuse different applications, so the whole system reflects good reusability

(5) Superior security. The three-tier B / S mode system can clearly divide the system into three different levels of application functions: the first layer is the presentation layer (user layer); The second layer is the business logic layer; The third layer is the data layer. These three levels are three units separated independently. See Figure 3 for details.

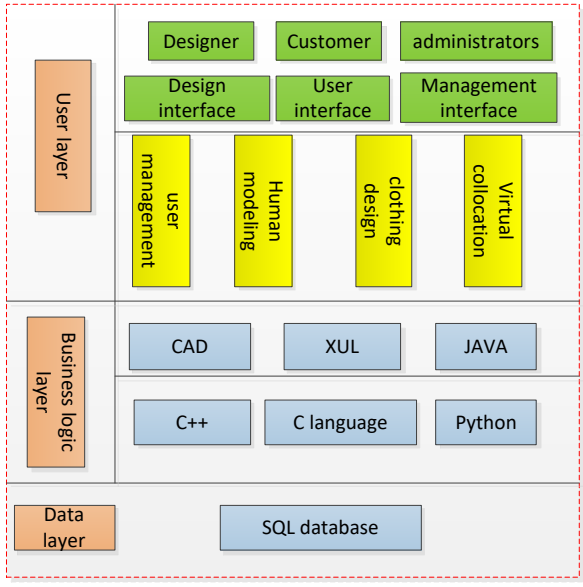

Figure 3: Four architectures of virtual collocation system.

The user layer, also known as the presentation layer, is located at the client side in the three-tier structure, that is, the user interface. It is a web browser based on TCP/ IP protocol. In addition to displaying data results, it is also responsible for submitting user requests. Then, the business methods provided by the business logic layer can be freely called by the user layer.

The business logic layer is in the middle of the three-tier structure, that is, between the data layer and the presentation layer. It is the core layer of the system, in which the main components are web server and application server. This layer will process the business logic, including HTTP requests from the interface, provide business functions to the user interface layer, and read and write the database through access to the data layer. The specific process is as follows: the web server receives the HTTP request from the client, then analyzes and converts the request, and then calls the corresponding logic handler; The data layer will communicate with the logic processor, then read and write access to the database, and then transfer the processed results to the web server. Finally, the web server will return the results to the browser on the client side in the form of HTML or XML as the results. The data layer is located in the third layer. The main component is the database server. Its main function is to convert the content from relational database to object database, access, maintain and update data, and realize communication with the database server. To sum up, the virtual collocation system adopts a three-tier B/S mode architecture. The system architecture is shown in Figure 4.

According to different functions, the system is divided into clothing design system, human body modeling subsystem, fitting room subsystem and system management subsystem. Figure 4 shows the basic functions of the system.

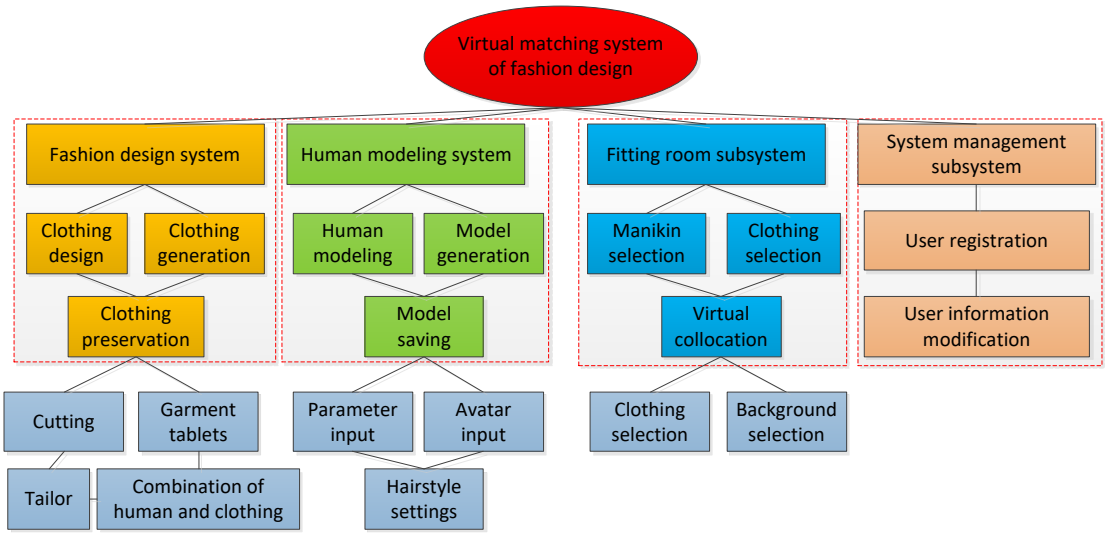

Figure 4: System function module diagram.

4 RESEARCH ON COMPREHENSIVE EVALUATION SYSTEM OF VIRTUAL DESIGN HANFU

In order to test the popularity of Hanfu, reflect the market economy and artistic value, and obtain real economic benefits, this subject accepted 10 undergraduate garment students, 10 structural design teachers and 10 garment designers, who were divided into three groups for comprehensive market evaluation. Students are highly sensitive to fashion, deeply influenced by fashion factors and many perceptual factors. Teachers have a good professional foundation and can make a more perfect and reasonable evaluation of plate shape and contour.

In the study, three different types of clothes were made in three different ways, and round neck robes, deep robes and Taoist robes based on plate type comparison were selected as evaluation samples. Three production modes of manual plate making, vertical cutting and three-dimensional vertical cutting are used to demonstrate the influence of their production methods on clothing, and the corresponding subjective evaluation is made. The score is set to 10 points. The representatives with higher scores have higher comprehensive evaluation, and the representatives with smaller scores have lower comprehensive evaluation. The specific scores are shown in Figure 5, Figure 6 and Figure 7, and a comprehensive summary of the scores is made in Table 1.

Through the analysis of the results of subjective evaluation (Figure. 5), for the different shapes of round neck robes, deep clothes and Taoist robes made by manual plate making, the round neck robes have the highest score and the deep clothes have the lowest score. The traditional manual plate making is a plate type drawn by adding a certain amount of relaxation through the size of the national standard and using the formula. This method is simple and suitable for mass production. However, because the plate type calculated by the formula and data is only suitable for standard production, it is difficult to achieve the fit degree suitable for every human body.

Through the analysis of the results of subjective evaluation (Figure 6), for the different shapes of round neck robes, deep clothes and Taoist robes made by three-dimensional cutting, the Taoist robe has the highest score and the deep clothes has the lowest score. Three-dimensional cutting is to use paper and white cloth to make the preliminary modeling of clothing on the platform. After modeling, draw the contour line with a marking line or pen, make marks, remove the white cloth from the platform for false sewing and try on.

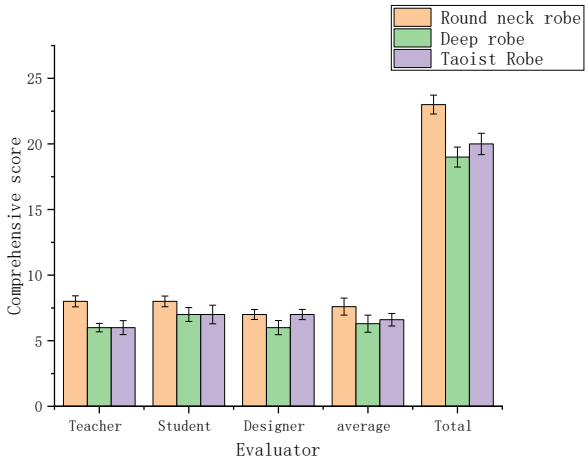

Figure 5: Score chart of three kinds of clothing for manual plate making.

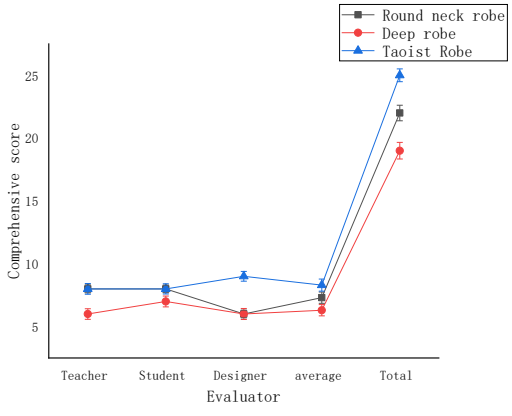

Figure 6: Score chart of three kinds of three-dimensional cutting clothes.

After fitting, remove the white cloth and expand the paper template. Because the three-dimensional cutting is directly aimed at the platform, it has a high degree of coincidence with the platform in terms of relaxation and shape contour, and the shape worn on the human body can better reflect the beauty of curve.

Through the analysis of the results of subjective evaluation (Figure 7), for the different shapes of round neck robe, deep robe and Taoist robe made by three-dimensional cutting, the round neck robe has the highest score and the Taoist robe has the lowest score. Three-dimensional vertical cutting combines the advantages of plane cutting and three-dimensional cutting. It can not only have the simplicity and practicability of plane cutting, but also have the beautiful shape of three-dimensional cutting, and has strong market development strength.

In the software operation of three-dimensional vertical cutting, first establish a virtual human model, establish the overall garment profile on the human model, and then draw the garment structure line on the three-dimensional garment profile.

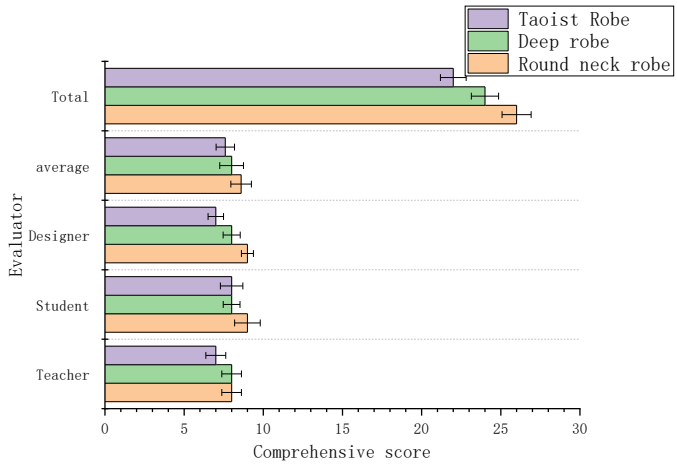

Figure 7: Score chart of three kinds of clothes cut in three dimensions.

The three-dimensional garment structure lines are used to generate planar garment pattern. Therefore, in the subjective evaluation, the scores of the three costumes are relatively high, the modeling design and plane plate development are time-saving and labor-saving, and the fit degree is more in line with the human body.

Manufacturing method	Round neck robe	Deep robe	Taoist robe
Manual plate making	7.6	6.3	6.6
Vertical cutting	7.3	6.3	8.3
Three-dimensional vertical cutting	8.6	8	7.6

Table 1: Summary of average score.

5 CONCLUSION

Based on 3D garment CAD, this paper focuses on the technical method of 3D virtual garment design. After consulting a large number of literatures on garment CAD and virtual design technology, learning the principle of 3D virtual CAD technology, this paper discusses the application method of the representative 3D design software LookStailor X. Taking Hanfu as an example, the style and model are designed, and finally the ready-made clothes are made. The operation process of 3D virtual garment design is more time-saving, simple, resource saving, more intuitive modeling effect, and has great market promotion advantages. Three-dimensional virtual fashion design is the inevitable result of the development of fashion design and computer science and technology. Its technical principle is a new mode extended through the development of CAD technology on the basis of three-dimensional cutting, which realizes the mutual conversion of 2D and 3D. Three-dimensional virtual garment design is more intuitive and efficient than plane cutting. After the style design is completed, the paper pattern can be produced automatically. Compared with three-dimensional cutting, it can save fabric, higher efficiency, save time and resources, and meet the needs of the industry. Any fashion design method will have its advantages and disadvantages. 3D virtual design is an advanced technical means extended and developed under

the three-dimensional cutting method. It has strong foresight of the times, market promotion and exploitability. At present, it is not suitable for the design of some products with high precision.

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