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# Study on digital protection and innovative design of Qin opera costumes

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## Abstract

Qin opera culture has a long history in China for thousands of years. It is the ancestor of Chinese opera. However, with the development of modern technology and the rise of new media, the protection and inheritance of traditional Qin opera culture is facing a new challenge and opportunity, its costume culture is the same. This paper analyzes the style and structure of Qin opera costumes, extracts the colors of the costumes, summarizes the costume patterns, and then uses the three-dimensional (3D) virtual visualization technology to virtually restore the Qin opera costume, and innovates the Qin opera costume. In this paper, twelve sets of traditional Qin opera costumes are virtually restored, and on this basis, the digital protection and innovative design of Qin opera series costumes are carried out, and all the restored costumes are displayed digitally in an all-round way. The combination of Qin opera costume and digital protection extends the application scope of virtual visualization technology and enriches the transmission mode of Qin opera costume. This study inherits and protects the traditional Qin opera costume culture better.

**Keywords:** Qin opera costumes, Virtual visualization, Innovative design, Digital protection

## Introduction

Cultural heritage is composed of intangible cultural heritage (ICH) and material cultural heritage [1]. ICH is an important part of Chinese national culture. It is an important carrier to carry forward the Chinese national spirit. ICH is intangible, but any intangible culture takes tangible culture as the carrier. There are three kinds of tangible carriers of ICH: the carrier with people as the core, the carrier with national traditional festivals as the time, the specific space carrier with museums and other institutions. With the rapid development of China's economy, the Chinese people have gradually deepened their sense of recognition and respect for traditional culture and traditional ideological value system. ICH refers to various traditional cultural expressions handed down from generation to generation by people of all ethnic groups and regarded as an integral part of their cultural

heritage, as well as physical objects and places related to traditional cultural expressions [2]. Opera is a small part of ICH. As one of the ancient Chinese operas, Qin opera is the first batch of national ICH approved and released by the State Council of China. It was officially listed in China's national intangible cultural heritage list in 2006. It is mainly a vocal opera produced by the combination of local folk music and Guanzhong Dialect. With the development of history and the progress of the times, Qin opera has gradually formed its own unique style, which is mainly popular in Shaanxi, Gansu, Ningxia and other northwest regions [3]. Although Qin opera belongs to the intangible cultural heritage in the cultural heritage, Qin opera costumes, as the external image of opera, are tangible and belong to the material Cultural Heritage [4]. Material cultural heritage refers to tangible cultural heritage, such as historic sites, architectural complexes, sites, etc. In recent years, the economy has grown rapidly, people's entertainment methods have gradually increased, the frequency of opera stage has become lower, and the sense of atmosphere for the development of Qin opera is lack, which leads to the stagnation of Qin opera. This

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problem of losing the market from the public is more worthy of us to promote the prosperity and development of Qin opera and clothing in the future.

As an artistic treasure of the Chinese nation, the beauty of Qin opera is now the external dress modeling and very exquisite dress patterns of its artistic performance. Moreover, Qin opera contains Chinese traditional morality, which mainly educates and affects the viewers through opera storytelling. Qin opera costumes can not only render the stage effect of opera performance, but also reflect the specific era background, living habits and specified situation of opera. The role status, character characteristics, age and occupation in opera can be distinguished by clothing [5]. The research on opera costumes mainly starts from the development history of costumes, opera costume culture and aesthetics, the application of opera costume elements to modern costumes. It is very important to better inherit the Qin opera culture and protect the material and intangible cultural heritage. It is very important to better inherit the opera culture of Qin opera, so that the intangible cultural heritage such as the singing of Qin opera and the material cultural heritage such as the costumes of Qin opera can be better protected. Therefore, this paper realizes the digital protection and inheritance of Chinese Qin opera costumes with the help of digital technology.

Cultural heritage can be protected through digital technology, virtual visualization technology and so on. As a product of the development and dissemination of the Internet, digital technology is widely used in architecture [6], culture [7], tourism [8], clothing [9], archaeology [10, 11] and so on. Digital technology can improve work quality and efficiency and reduce the damage probability of Cultural Heritage [12]. As a means of protecting cultural heritage, this technology provides tourists with more opportunities to contact Cultural Heritage [13], greatly promotes the inheritance of cultural heritage, opens up a new path for cultural transmission and is conducive to the preservation of Cultural Heritage [14]. The three-dimensional (3D) virtual fitting technology can simulate the touch, smell and hearing in the virtual environment, combine the virtual environment with the real environment, and greatly improve the reality of the virtual environment. This technology has now been widely used in the field of clothing. Compared with the traditional physical clothing display, the virtual clothing display system can achieve the expected wearing visual effect faster, more accurately and more efficiently [15]. In the virtual environment, the size of the virtual model can be adjusted according to the needs of the designer, the clothing size can be changed flexibly, the clothing design process can be simplified, the clothing cost can be reduced and the clothing production cycle can be shortened [16].

At present, there are many researches on the digital protection and innovative design of clothing, but few researches on the digital protection and innovative design of Qin costume. There is no high-quality literature on the research of integrating artificial intelligence, virtual reality and other technologies into the digital protection and innovative design of Qin costume. There have been relevant studies on the restoration and protection of costume by using pattern-based 3D modeling and human-computer interaction technologies [9–11], and some progress has been made. 3D innovative design based on costume elements is a new research field. The innovative design of clothing style and structure combined with artificial intelligence algorithms, such as genetic algorithm [17, 18], neural network [19], fuzzy logic [20], is a research hotspot. Scholars have studied the restoration of historical costumes [21, 22] and confirmed that digital technology can more effectively realize the digital protection of traditional clothing. There are many cases of clothing digital protection, but there is little research on the digital protection and pattern design of opera clothing. As a key link in clothing design, the efficiency of pattern design and production is very important. There are two methods of pattern production. The first is the traditional manual pattern-making. This method requires designers to have 3–5 years of clothing pattern-making experience, which is time-consuming and difficult to promote. The second is the garment pattern-making software. With the help of pattern-making software, designers can quickly and efficiently complete the pattern-making [23]. The new 3D pattern making method of graphic coding can generate clothing pattern more intuitively, accurately and quickly. The design ability of clothing pattern determines the final effect of clothing innovative design. At present, the latest method of costume digital restoration is to apply the virtual stitching technology of custom pattern to quickly construct a realistic 3D costume model by simulating the mechanical properties of fabric in the physical simulation environment such as virtual gravity and virtual wind. The pattern development is a necessary part of costume digital restoration [10, 11]. The three-dimensional interactive pattern-making method provides technical support for pattern-making of ancient costumes [24]. At present, fashion design is only to meet people's psychological and physiological needs, not to carry forward a certain culture or promote the dissemination of culture. Combining digital technology with clothing pattern-making to restore ancient famous paintings, and comparing the effects of clothing models made of different patterns in the virtual visualization environment to reconstruct ancient Chinese clothing, which has relative reference value for studying ancient Chinese clothing and carrying forward Chinese clothing culture [9].

Based on the pictures of Qin opera stage, this paper carries out digital restoration of Qin opera costume, and then carries out innovative practice of Qin opera costume. Firstly, we analyze the shape, fabric, pattern and color of 12 Qin opera costume. On the base of completing the study on stage costumes, the two-dimensional photo is transformed into 3D costumes by using digital technology, and the digital restoration of 12 sets of Qin opera costume and the innovative design of 10 sets of Qin opera costumes are completed. Under the technical background of unrestricted time and space, we can modify and design the restored costumes at any time, which not only inherits the costume style of 5000 years of Chinese civilization, but also integrates history and modernity, reproduces the characteristics of the historical times, and highlights the gorgeous, simple, exquisite and life characteristics of Qin opera costume. The virtual restoration of Qin opera costume has accelerated the construction of Digital Costume Museum, better inherited the ancient costume culture, and protected and developed the intangible cultural heritage.

## Method

### General scheme

This paper mainly includes two parts. The first part discusses the digital restoration and protection of Qin opera costumes, and the second part describes the 3D fashion design based on Shaanxi opera clothing elements. The technical road map studied in this paper is shown in Fig. 1. The research of this paper is divided into seven steps. The first step is to collect 12 main Qin opera costumes. The second part is to draw these Qin opera costumes' flats with AI tool. The third step is to make pattern with Fuyi CAD tool according to these costume flats. The fourth step is to use Clo3D software to restorage Qin opera costumes. The fifth step is to carry out the innovative design of the costumes according to the elements of Qin opera costumes.

### Costume style of Qin opera costume

The costume of Qin opera consists of three parts: crown dress, body costume and shoes. The crown dress is the hat and decoration worn by the character's head, such as crown, hat, forehead, towel (cap, hat), pheasant tail, beard etc. Body costumes are costumes to wear, including court robe, armor, robe (Pei), cloak, costume, robe (pao), casual coat etc. Foot costume is boots, shoes and socks etc. The costumes described in this paper are body costumes. At first, opera costume was divided into two categories: costumes for civilian and costumes for military. Then, costumes were divided into court robe, robe (Pei), casual coat, armor, and costume, as shown in Fig. 2.

Style 1 and 2 are casual coats, which are worn by commoner. White casual coats are mourning costumes; As the status of commoner children is humble, the pattern of the casual coat they wore was a diagonal continuous pattern (a bipartite continuous pattern).

Style 3 and 4 are robes (Pei). The women's flower casual robe is the costume worn by married young women, and the symmetrical pattern is used for maiden or married young women.

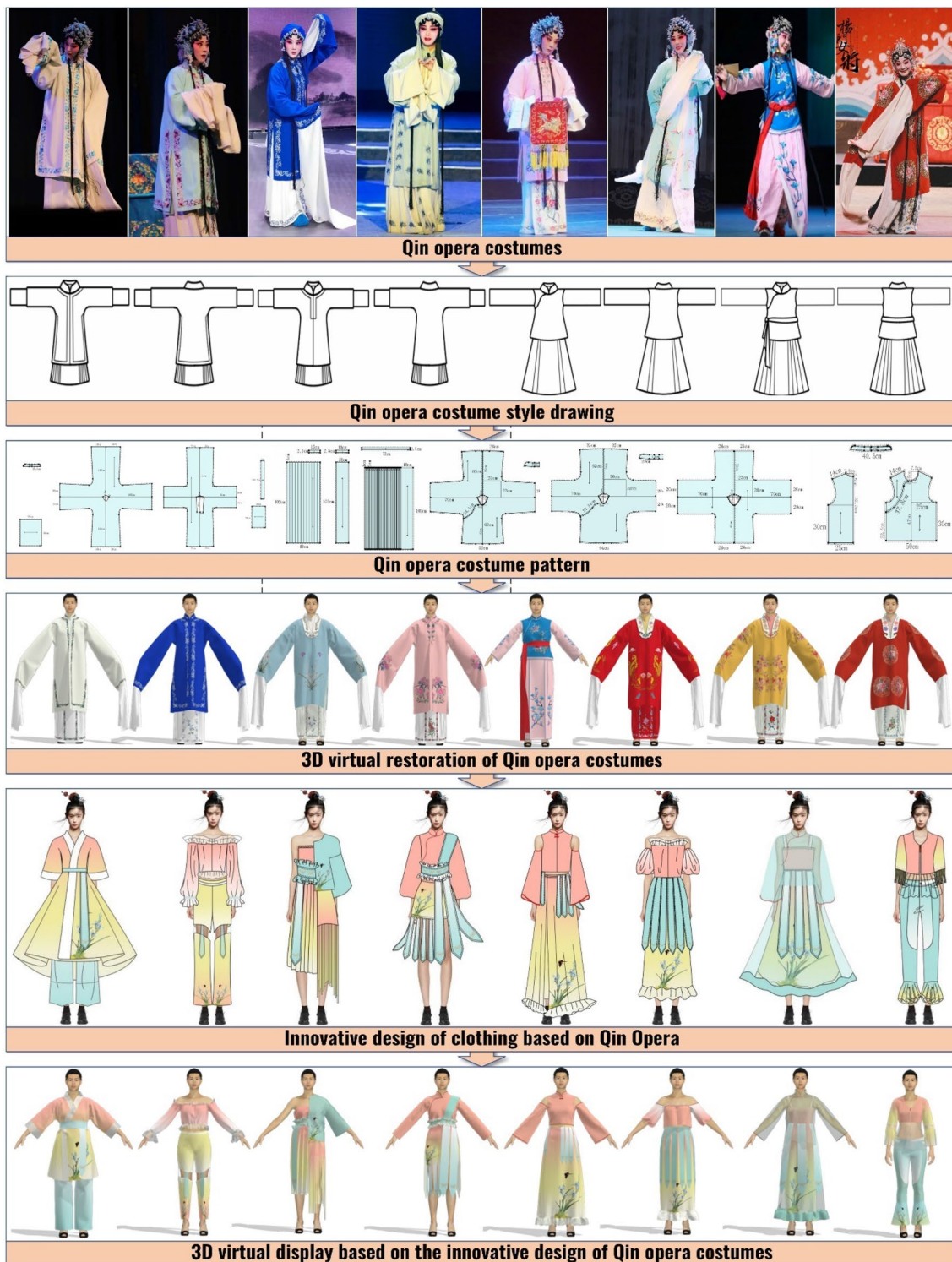
Style 5 is jacket and skirt, jacket is stand-up collar and oblique lapel, the cuffs are relatively tight. Jacket is worn on the inside of the robe. The skirts are divided into large folded skirt and pleated skirt. The jacket and skirt were worn by Huadan (a role of Qin opera) and originated from women's costume in the Qing dynasty. They are light and generous. The collar, lapels, and cuffs of the jacket and skirt are edged at the hem.

The style 6 is a short sleeveless jacket Since The 18th which is usually worn by maid. The short sleeveless jacket is stand collar, large flaps, with left and right forks, and the lower body is matched with a large folding skirt. The waist of the skirt is tied with a waist band, and the hem of the skirt and horse face are decorated with lace. The overall color of the short sleeveless jacket and large folded skirt are more vibrant color.

### Costume color and pattern of Qin opera costume

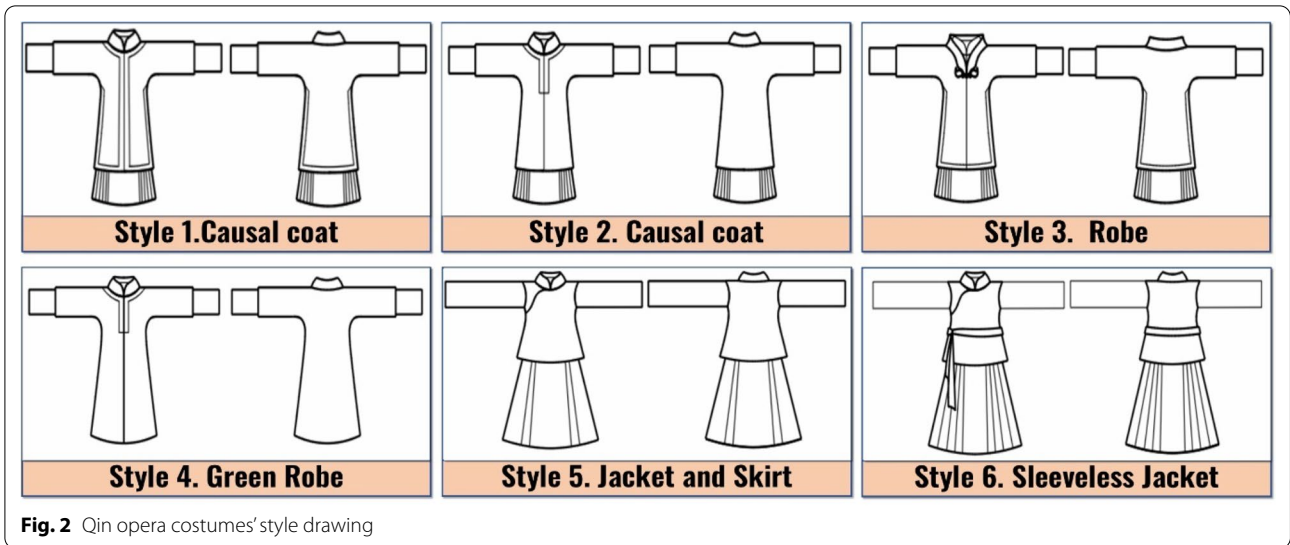
The color of Qin opera costume is an important part of Qin opera art. Costume color has a great impact on the shaping of characters in the play. Five colors are the core content of Qin opera wearing regulation, which has the stylized characteristics of distinguishing roles, symbolizing identity, indicating age, highlighting personality and setting off anger. Five colors represent the basic aesthetic style of Qin opera, which can be divided into upper five colors and lower five colors. The upper five colors refer to the five colors of red, yellow, green, white and black. The lower five colors refer to blue, purple, pink, lake and fragrance. The lower five colors can supplement the upper five colors, and the upper five colors can also replace the lower five colors. For example, red symbolizes dignity and value, yellow symbolizes kingship and dignity, green symbolizes solemnity, white symbolizes beauty and elegance, and black symbolizes integrity and poverty. The colors of Qin opera costume selected in this paper are extracted, as shown in Fig. 3.

Figure 3a is Snow in Summer, the casual coat, jacket and skirt are all white, and the patterns are composed of dayflower color, cyan and bright greenish blue. Figure 3b is the Unicorn Purse, the casual coat is dark blue, the skirt is white, and the pattern is composed of sky-blue, water and cyan. Figure 3c is a Flame-foal, the robe (Pei) is light blue. The skirt is white and the patterns are composed of



**Fig. 1** The general scheme of this paper





tender pink, peach and willow. Figure 3d is the Unicorn Purse. The causal coat is peach red and the skirt is white. The patterns are composed of rose color, coral color,

peach color, grass green, willow and pea green. Figure 3e is a Flame-Foal. The short sleeveless jacket is blue, the jacket and large folded skirt are pink. The pattern is

composed of cyan, blue, brown. The waist band is red. Figure 3f is the Unicorn Purse, the robe (Pei) and the pleated skirt are all red, the jacket is yellow, the patterns are composed of watermelon pink, purple and blue. Figure 3g is the Unicorn Purse. The robe (Pei) is lemon yellow, the jacket and skirt are all peach pink, the patterns are composed of water blue, dark green, peach, peony red and bright red. Figure 3h is the Young's Female Warrior. The robe (Pei) is red, the jacket and skirt are all white. The patterns are composed of peach pink, light pink rose pink, carmine red, cochineal, pine leaf, willow and dark green. Figure 3i is Exploration the Kiln. The causal coat is sky blue; the jacket is lemon yellow and the skirt is white. The patterns are composed of celeste, cyan, sky blue and water blue. Figure 3j is Snow in Summer. The causal coat is water blue, the jacket and skirt are all white. The patterns are composed of dark purple, orchid, light purple, purple-pink. Figure 3k is the costume Xiao Ruolan wore during her lifetime, which is middle jacket and large folded skirt. Both jacket and skirt are all bean green, the piping is dark reddish purple. The patterns are composed of peach pink, rose pink and purplish red. Figure 3l is robe (Pei) which is dark green and the sleeves are white. The piping is mauve and the patterns are composed of yellow and light yellow.

Compared with the colors of Qin opera costume, the costume patterns are not only beautiful, various, but also complex and exquisite. The patterns also reflect the personality characteristics of each character. They are divided into animal patterns, plant patterns, natural landscape patterns, text patterns and other patterns that symbolize beauty and auspiciousness. Among these patterns, animal patterns include dragon and phoenix, crane, butterfly, etc. Each pattern has its own meaning, and they are full of longing for beautiful things. There are peony in plant patterns, and four gentlemen patterns which named plum blossom, orchid, bamboo, chrysanthemum and lotus, etc. These plant patterns are mostly from tough and noble plants with rich meanings. Natural landscape patterns include cloud, sea water river cliff, etc. Text patterns, such as hui, fu, shou and ruyi, which symbolizes auspiciousness. This paper analyzes and draws the patterns of the restored 12 opera costume, as shown in Fig. 4.

#### Costume fabric of Qin opera costume

The fabrics of traditional Qin opera costume include satin, crepe, damask, silk, cloth, etc. The 12 style of Qin opera costume restored in this paper are mainly made of crepe, damask and silk fabrics. These three fabrics are light, elegant and have good drapability. When used with cotton, they can better reflect the softness and elegance of female roles. Satin has smooth surface, luster, softness

and heavy; it is mostly used for robe (Pei) and causal coat. The surface of crepe fabric is irregular concave and convex, and the fabric surface is rough, light and thin, which makes it cool to wear; damask belongs to twill silk fabric, with light and thin texture; damask is light, thin and soft, with a wide range of applications; cloth is cotton. Cotton is comfortable to wear, has good moisture absorption and air permeability, and it is lower price and cost. Cotton is mostly used in humble figures. When using different garment fabrics, the visual feeling expressed by the garment is different. Female opera costumes in Danjue are mostly used in crepe, silk and silk fabrics, supplemented by cotton fabrics. Taking the garment fabric as an example, this paper uses silk fabric as the fabric of fabric and cotton fabric as the fabric of water sleeve. Silk fabric is soft and glossy, giving people the feeling of high-end luxury. Cotton fabric has light material, strong sense of movement and better stage effect.

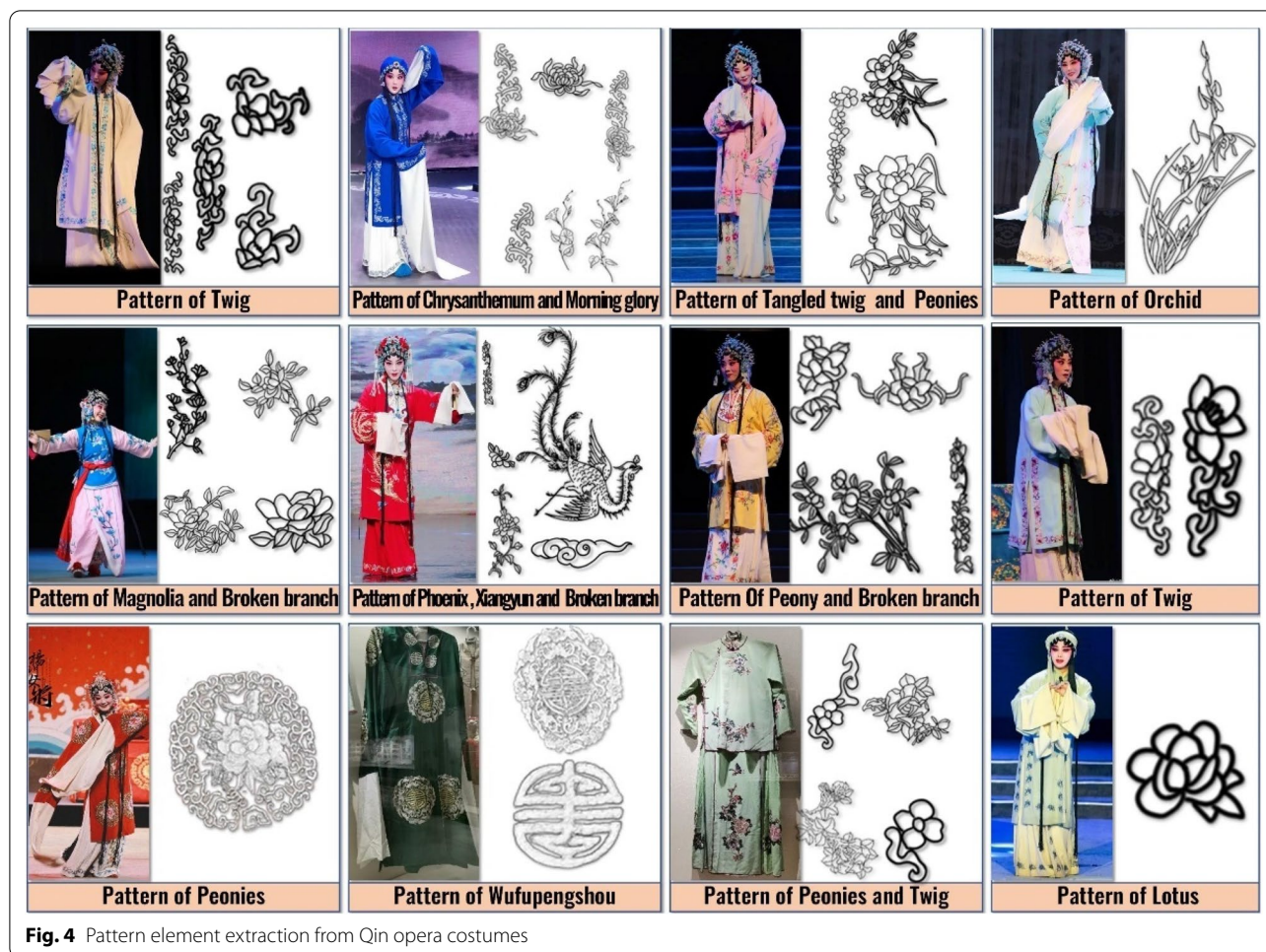
#### Pattern making of Qin opera costumes

When the 3D virtual restoration of Qin opera costume is carried out, firstly, the corresponding costumes pattern must be drawn with computer software. According to the data from the Internet, the height of Qin opera Danjue (a role of Qin opera) is generally between 160 and 170 cm, which is generally not too high. Therefore, the size of 165/88A in Chinese women's costume size is selected for parameter setting. This part determines the size of the main parts of the costume, as shown in Table 1.

As Qin opera costume is composed of robe (Pei), sleeveless jacket, causal coat, jacket, large folded skirt and pleated skirt, we draw the patterns of different styles of costumes according to the dimensions of the main parts, as shown in Fig. 5, and match them to obtain the expected effect.

#### Digital restoration of Qin opera costume

Digital restoration of Qin opera costume is carried out according to make the costume pattern. Before the virtual restoration of costume, the costume pattern style should be drawn with the help of CAD software, output to DXF file format and imported into the 3D virtual design system. To avoid the influence that the fabric is difficult to sew due to too many layers of costume, it is necessary to set the number of layers of the patterns. Before virtual stitching in the 3D window, arrange each costume pattern through the arrangement points. In this process, ensure that every pattern is close to the virtual model and that the sutures of the corresponding parts do not cross. After all patterns are sewn and all parts are checked to be smooth, set the color, fabric and pattern attributes of all patterns in the physical attribute window according to the previous study. Finally, the virtual opera costumes



**Fig. 4** Pattern element extraction from Qin opera costumes

**Table 1** Restore Qin opera costume's size (Unit: cm)

Position	Height	Cervical point height	Arm length	Waist height	Chest Width	Neck Width	Cross Shoulder	Waist Width	Hip Width
Length	165	140.0	52.0	101.0	88	34.4	40.4	72	93.6

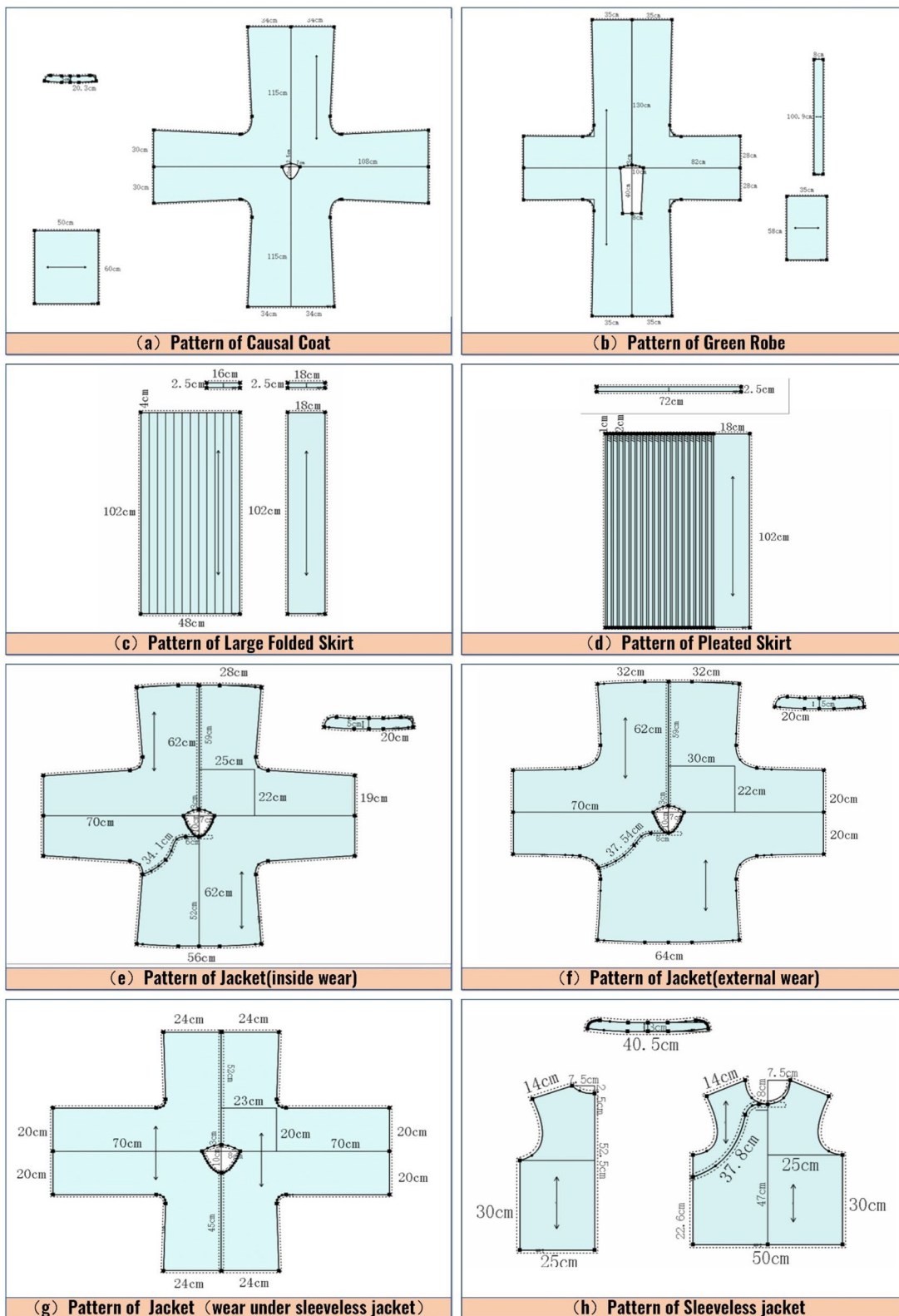
that meet the requirements are obtained through adjustment. The main process is shown in Fig. 6.

**Innovative practical design of Qin opera costumes**

The main content of this chapter is to carry out 3D innovative design based on Shaanxi opera clothing elements. The specific operation process is shown in Fig. 7. To further inherit Chinese culture and carry forward China's intangible cultural heritage, based on the virtual restoration of Qin opera stage costumes, and using 3D digital protection technology as a tool, we choose Armour in Qin opera costume as the main costume pattern of this practical design. Based on the Armour

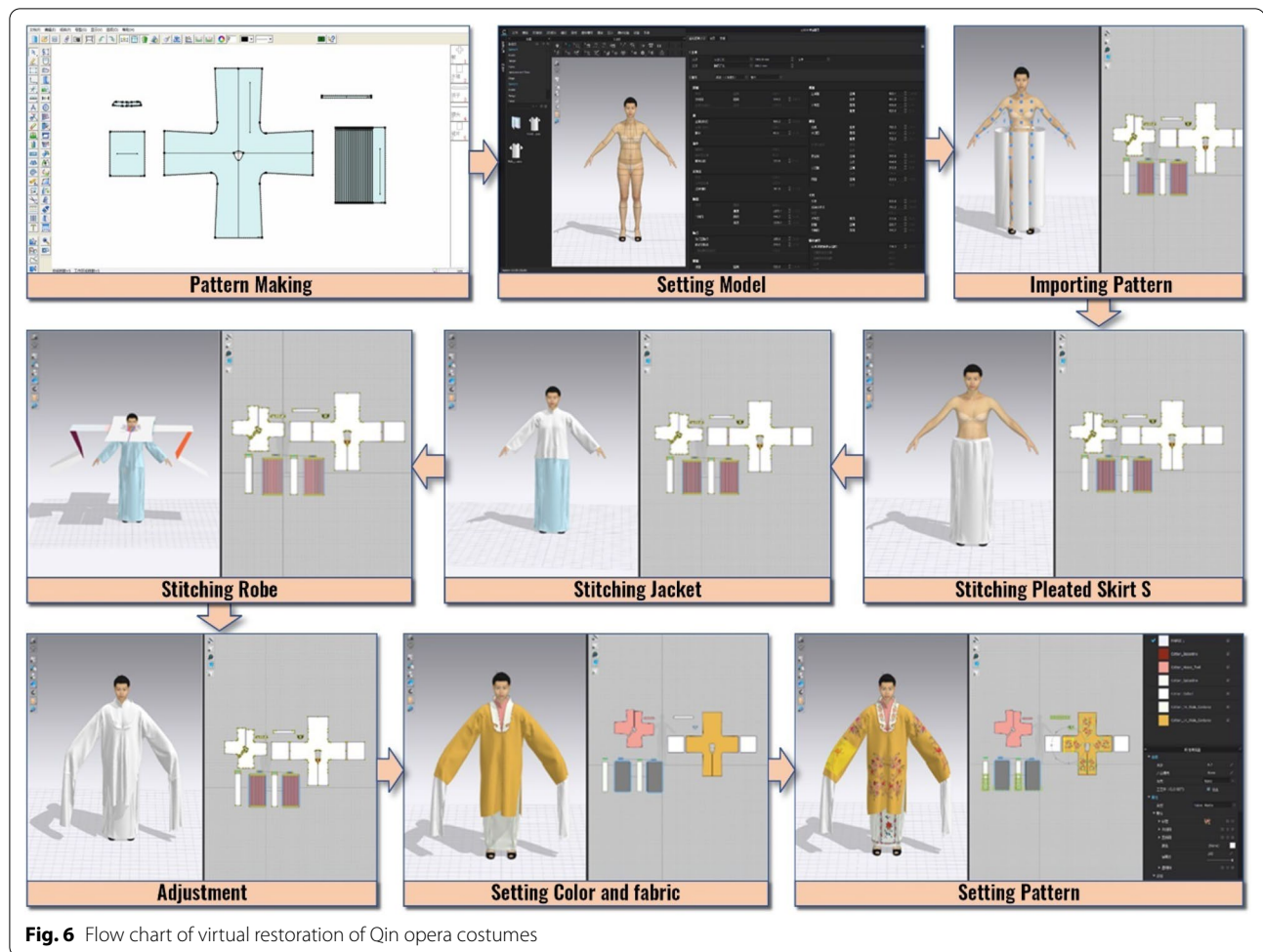
costume structure, the traditional Qin opera costume is improved and innovated, in which the butterfly pattern in the animal pattern and the orchid pattern in the plant pattern are selected. In ancient China, the Butterfly of the Hu was homophonic with the Blessing of Fu, and was also considered to symbolize fortune and auspiciousness. At the same time, the rebirth of a butterfly from its cocoon indicates that it has changed from ugly to beautiful and symbolizes freedom. Orchid is a gentleman among flowers. It is an elegant, noble and represents noble personality. Therefore, the selection of butterfly pattern and orchid pattern as the patterns of improved Qin opera costume expresses the author's lofty praise and expectation for Chinese women.





**Fig. 5** Patterns of Qinq opera costumes





**Fig. 6** Flow chart of virtual restoration of Qin opera costumes

In the process of innovative design of Qin opera costumes, we use digital technology as a tool, combined with the aesthetic needs of modern Chinese people, and choose three light color systems of red, yellow and blue to set off the softness of modern Chinese women. Based on retaining the elements of tassel, stand collar, oblique placket and pleat in Qin opera costume, some modern designs are added, such as lantern sleeves, splicing, pleating and other elements and processes. Completed the virtual design of the improved version of modern Qin opera women's costume. Based on the design drawing, fill and add the color and pattern, and complete the drawing of innovative costume effect drawing. The effect drawing, flat and pattern of the innovative design of Qin opera costumes are shown in Fig. 8.

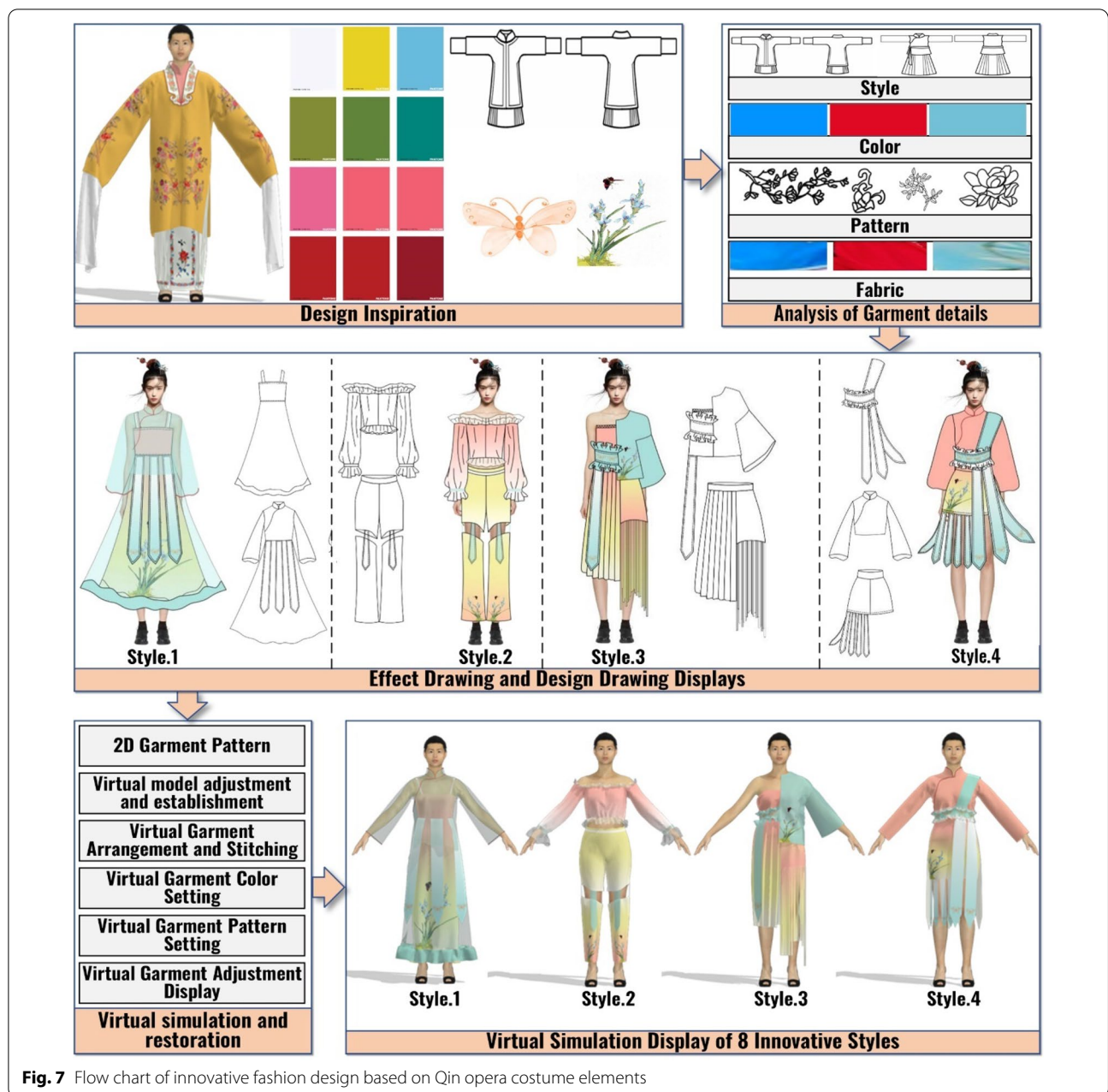
## Result

After pattern-making of Qin opera costume samples, the virtual try-on technology is applied to build Qin opera costumes' 3D models, and then colors and patterns are added to the models to finally restore Qin opera costumes

realistically (as shown in Fig. 9). Finally, a series of 3D innovative designs are carried out according to the elements of Qin opera costumes (as shown in Fig. 10). These digital Qin opera costumes can export different formats, such as OBJ, FBX. These formats of digital Qin opera costume files can be used in most 3D modeling software and virtual reality development environment. They can be further used to make virtual reality display systems.

## Discussion

This paper systematically analyzes and draws the style and pattern of Qin opera costumes, constructs the 3D digital models of Qin opera costumes, and then carries out a series of 3D innovative designs of Qin opera costumes according to the elements of Qin opera costumes. The results show that the 3D Qin opera costume model contains more detailed original information of the costume. The style of 3D Qin opera costume model is more intuitive, the structure of 3D Qin opera costume model is clearer and easier to understand, the patterns of 3D Qin opera costume model are richer, and the colors of



**Fig. 7** Flow chart of innovative fashion design based on Qin opera costume elements

3D Qin opera costume model are more diverse and gorgeous. Because the 3D Qin opera costumes can rotate 360 degrees, every small detail of style, color, pattern, structure, etc. can be clearly displayed, and even can be zoomed in and out from different angles to display the Qin opera costumes culture in an all-round way, so that visitors can have a deeper understanding of Qin opera costumes culture.

The previous research on the protection, restoration and innovative design of Chinese Qin opera costumes has two ways: (1) physical restoration and innovative

design; (2) Digital restoration and innovative design. With the continuous updating of computer-aided design technology, the digital restoration and innovative design of Chinese Qin opera clothing occupy the mainstream position. However, the current research mainly focuses on the two-dimensional digital design and storage of Qin opera clothing style, color, pattern and structure. There are few studies on the 3D digital restoration, restoration and innovative design of Chinese Qin opera traditional costumes, and the corresponding references have not been retrieved for the



**Fig. 8** The effect drawing, flat and pattern of the innovative design of Qin opera costumes

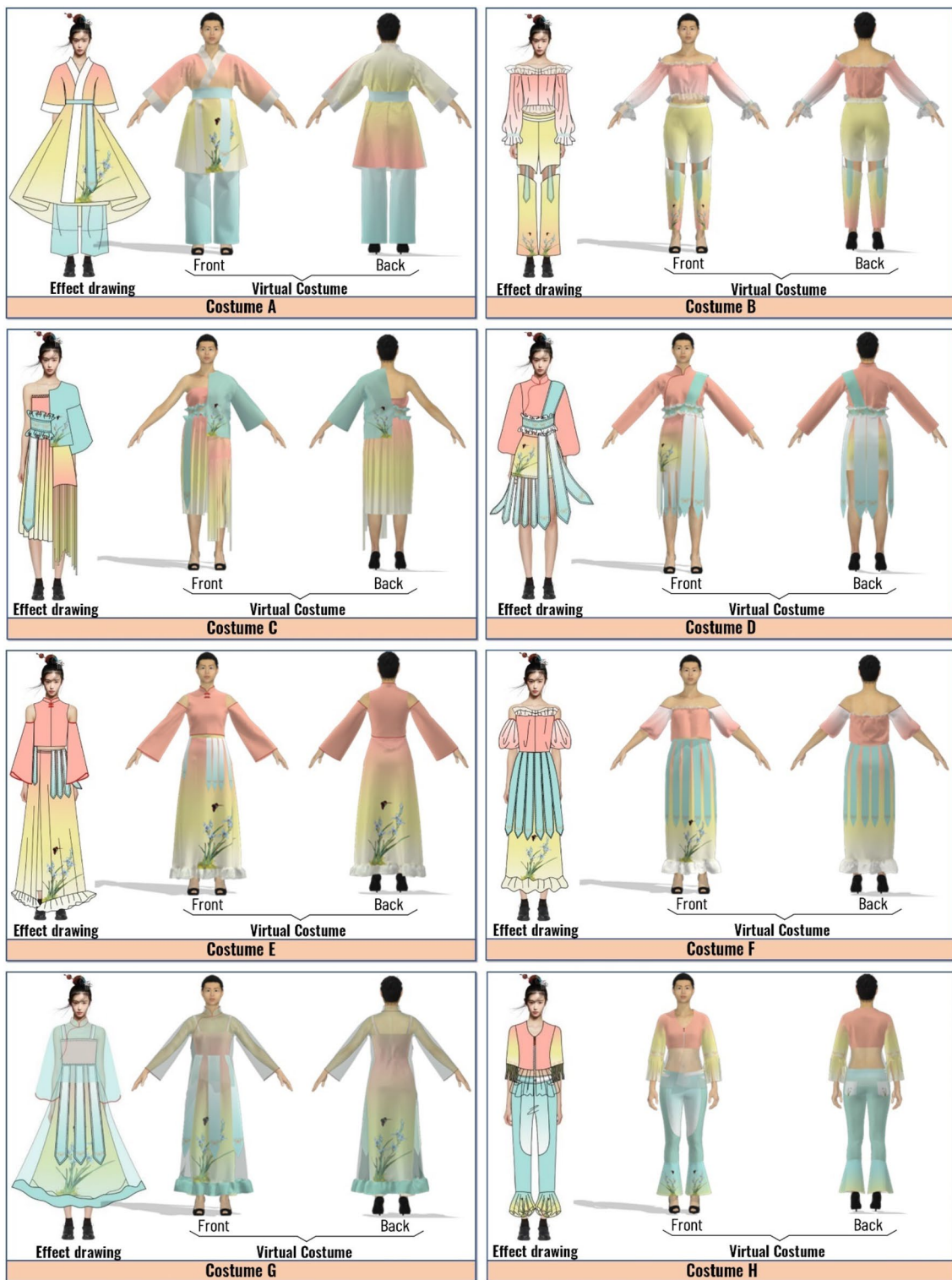




**Fig. 9** Digital restoration display of Qin opera costumes

research on the 3D digital protection, restoration and innovative design of Chinese Qin opera costumes. The 3D model of Qin opera clothing can contain more clothing information. For example, the two-dimensional Qin opera clothing image can only show the clothing style, color, pattern and structure information from a certain angle, while other angles cannot be shown. The 3D Qin opera costume model can more completely represent all the styles, colors, patterns and structural information. Therefore, 3D Qin opera clothing model has more obvious advantages than two-dimensional clothing pictures in terms of digital protection of Qin opera clothing. In the process of Chinese traditional Qin opera clothing design, the pattern maker makes the clothing pattern according to

the design drawing after the designer draws the clothing effect drawing of Qin opera clothing. Because the design drawings are two-dimensional pictures, they can only show the style, color, pattern and structure information of Qin opera clothing from a certain angle, and cannot show all the costume information, which leads to the misunderstanding of the design ideas of costume designers by costume pattern makers. Qin opera costume designers need to communicate with pattern makers repeatedly in order to finally realize the design and production. The process is extremely time-consuming and costly. Because the 3D costume model displays the costume style, color, pattern and structure information from 360 degrees, the pattern maker can completely and clearly understand the designer's design



**Fig. 10** 3D virtual display of Qin opera costume innovative design

works. The 3D Qin opera costume design better solves the understanding error between the costume designer and the pattern maker.

The construction of 3D Qin opera costume model takes several hours to several days, which mainly depends on the difficulty of style, pattern, color, structure and technology. Whether it is a complex or simple style, the time for digital 3D modeling of Qin opera dress is significantly less than the time for its physical production. Three-dimensional Qin opera clothing model can be exported in OBJ, FBX and other formats. The OBJ format belongs to the 3D file format without bone data, and the file size is generally between tens of MB and hundreds of MB. The FBX format belongs to 3D file format with bone data, and the file size is generally between hundreds of MB and thousands of MB. Both Obj and FBX 3D models of Qin opera clothing can be applied to most 3D modeling software and 3D game engine platforms in the current market. The physical and virtual display of costumes is the main means of the dissemination of Qin opera costume culture. The 3D Qin opera costume model can better display the Qin opera costume culture. The Qin opera costume model in this paper can be imported into game engines such as unity 3D or ue5 to develop VR, MR and AR display platforms for Qin opera costumes, so that visitors can experience Qin opera costume culture more immersivity.

## Conclusion

Through the study on the costume culture of Qin opera, such as the shape, fabric, pattern, color and so on, this paper selects 12 kinds of Danjue costumes in six different plays of Qin opera for digital restoration. On the basis of understanding the Qin opera costume culture, this paper selects the Qin opera costume elements and applies them to modern garment, and completes the innovative design and digital display of Qin opera costume. In this process, we use computer-aided software for pattern design, and realize the modeling and virtual visualization of Qin opera costumes in the virtual visualization environment. This method has the following advantages: (1) 3D Qin opera costume model contains more style, color, pattern and structure information, which is the best digital storage carrier of Qin opera costume at present; (2) 3D innovative design of Qin opera costumes can better solve the understanding deviation between fashion designer and pattern maker, and can effectively realize the design of Qin opera costumes; (3) The 3D digital data of Qin opera costumes can be directly used as the material for the development of VR, AR and MR costume display systems; (4) The 3D model of Qin opera costumes can be modified at any time according to needs, which is significantly better than the physical objects modification

and picture modification of Qin opera costumes; (5) The innovative design of Qin opera costume can integrate Chinese traditional elements into modern clothing design, which is conducive to the protection and inheritance of Chinese cultural heritage.

In the future, the 3D static display and dynamic display system of Qin opera costumes can be developed based on the 3D model of Qin opera costumes produced in this paper and combined with artificial intelligence technology by using 3D game engine, such as Unity 3D, UE5. Visitors can watch Qin opera performances through VR and MR glasses. This is a very practical way to inherit and carry forward the traditional Chinese Qin opera culture.

## Author contributions

KL developed the study idea. YG made style drawings, patterns and 3D garments. CZ collected clothing information and data. JZ wrote part of the manuscript. All authors read and approved the final manuscript.

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## Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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