Journal of American Science

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# Research on the restoration of modern children's clothing structure based on CLO 3D technology

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**Abstract** Modern children's clothing breaks the feudal concept and reflects the characteristics of the era when the west wind is gradually moving from the east to the east and the east are integrated. Taking the big red jacquard silk children's jacket and the cyan lotus pattern crotch pants collected by Hebei Yongqing Clothing Museum as the research object, the relevant data of two pieces of modern children's clothing were obtained through the plane contact measurement method and holographic data collection, the 2D plate restoration was carried out by using CorelDRAW software, the CLO3D virtual fitting technology was used to establish a modern children's clothing wearing model, and the clothing deformation rate and clothing pressure were evaluated and analyzed. The results show that the feasibility of using CLO3D virtual fitting technology for the restoration of modern children's clothing structure, as well as the structural design of modern children's clothing, have certain limitations, which is conducive to the scientific, effective, intuitive and convenient study of modern children's clothing, and open up ideas for the restoration and inheritance of traditional clothing.

[WANG Yi, HOU Dongyu, DENG Tianyuan, ZHAO Bo. **Research on the restoration of modern children's clothing structure based on CLO 3D technology.** *Am Sci* 2023;19(9):57-64]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org 06.doi: 10.7537/marsjas190923.06.

**Keywords:** Modern children's clothing; CLO 3D; Virtual fitting; Clothing structure; Virtual resiliency

After the Opium War, China ended the situation of "seclusion", and Western textiles and kimono ornaments were constantly introduced into China, which had a drastic impact on the change of clothing. The change of men's wear is manifested as the gradual emergence of suits, the change of women's wear is manifested as the gradual emergence of cheongsam, and the change of children's wear is similar to that of adults. Under the modern "parent-oriented" thought, the development of children's clothing is relatively limited, and the phenomenon of "adult clothing" is common [1]. At the end of the Qing Dynasty, children wore above and below the skirt, above and below the trousers and gown vests. In the early period of the Republic of China, children's clothing changed from complex to simple, horse-face skirt gradually changed to one-piece skirt, and the wide and complicated edge of the neckline, cuffs and hem also changed to relatively narrow and simple edge. Western dresses were relatively common in the middle and late period of the Republic of China, but traditional Chinese patterns were still retained [2].

Compared with a small number of children's clothing relics left in ancient times, modern children's clothing materials are rich, and the research can be more perfect. He Beilu and Zhang Jingqiong et al. took the animal forms and embroidery patterns of modern children's wear in the National Dress Hall of Jiangnan University as their research objects, explored their artistic representations, and innovatively applied them in the design of modern children's wear [3-4]. Deng Haijuan studied the shape and function of children's belly pocket and applied it to modern children's clothing [5]. At present, the research on modern children's clothing is confined to patterns and techniques, and the research on structure is not mature. 3D restoration research mainly relies on data support to make plates to restore the overall style of clothing. Ji Zihui used DC-Suite3D fitting technology to establish a parametric model of modern Hanfu, which is worth learning in the field of clothing restoration [6]. Zhang Weimeng used CLO 3D software to restore the Ming Dynasty Hanfu with verified data based on the plane cross structure theory [7]. Liu Dongsheng et al. carried out 3D virtual fitting after actual measurement and structural analysis of traditional Mongolian robes, providing methods for the digital inheritance of traditional Mongolian robes [8].

Through the field investigation of Hebei Yongqing Fashion Museum, the actual investigation measured and sorted out more than 60 pieces of modern men's wear, more than 70 pieces of modern women's wear and more than 30 pieces of modern children's wear. Modern children's clothing includes children's robes, children's jackets, children's coats, children's pants, children's skirts and children's shoulders six categories, involving

Zhejiang, Hebei, Shanxi and other regions. This paper takes the matching of bright red jacquard silk children's padded jacket and blue lotus pattern open-backed pants in Baoding area of Hebei Province as the research object, carries out 2D structural restoration and 3D virtual fitting, summarizes the structural characteristics of modern children's clothing, and widens the idea for the digital inheritance of modern children's clothing.

## 1 Structure analysis of modern children's clothing

### 1.1 Style Features

Figure 1 is the real picture of the back side of the bright red jacquard silk children's jacket, and the style diagram of the back side is shown in Figure 2. Big red jacquard silk children's lined jacket for the Chinese Han traditional shape of the collar right skirt, sleeve type, along sleeve sleeve, ordinary cuffs. The main body of the fabric adopts jacquard fabric, the ground organization is plain weave organization, the jacquard organization is three up and one down left twill organization, the change of the warp float line is jacquard pattern, the pattern has mountain pattern, fish pattern and so on. The interior is made of plain printed cotton fabric, comfortable and breathable. In the cross collar, cuffs, hem and slit edge, inlaid with different width, different styles of edging, for different colors of butterfly flowers and flower patterns. The right skirt is fixed with a tie, the width is 1.5cm, the two disc buckle is fixed, the two sides are short slit, which is a typical short jacket style in the early Republic of China.

Fig. 1 Large red jacquard silk children's jacket

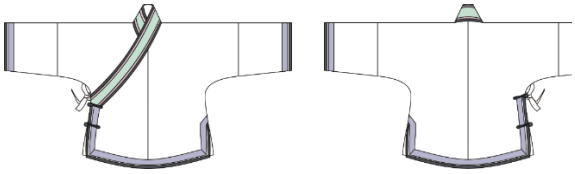


Fig. 2 Large red jacquard silk children's jacket style picture

Figure 3 is the real picture of the back of the green lotus pattern open-crotch pants, and the style diagram of the back is shown in Figure 4. Green lotus pattern open-crotch pants are a kind of clothing often worn by children in modern times. They are designed with wide waist, silk fabric and embroidered lotus pattern on the side of pant leg. In traditional Chinese culture, they symbolize many children and happiness, and their descendants are extended and exquisite, and are mostly worn by rich children [9]. The waist and inner material are made of printed cotton fabric, which is comfortable, breathable and sweat-absorbing, suitable for children. There is a cross at the front center of the pant leg, and the crotch at the back center of the pant leg is opened from the waist head, and only the children's calves and ankles are wrapped. There is a long tie at the waist, fixing the waist, and pink fringe lace at the bottom of the pants, which plays a decorative role.

Fig. 3 Cyan lotus pattern crotch pants

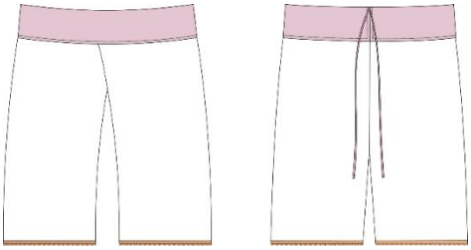


Fig. 4 Cyan lotus pattern crotch pants style diagram

### 1.2 Structural Analysis

The data were measured by plane contact method. The data collected by children's lined jacket with bright red jacquard silk were shown in Table 1. According to the actual measurement data, draw the structure diagram as shown in Figure 5, check the position data, determine the direction of the yarn and the name of the plate, determine the buckle position and the vent point. Children's lined jacket for a flat cross structure, cuffs, hem, and around the collar have black piping, in addition to the decorative role, but also to protect children's skin, to avoid being edged scratches, protect the raw edge of the fabric is not exposed, increase the edge fastness [10]. Sleeve and lower flanging have 0.5cm gap from black piping, which is different from the complicated and wide flanging in the Qing Dynasty, the flanging is narrowed to make the dress simple [11]. The lower hem of the inner flap is 6 cm shorter than the lower hem of the back piece, which can ensure that the inner flap is not exposed and maintain a beautiful appearance. There is a tie at the collar end to fix the front flap, and there are two groups of disc buckle on the right side to play a decorative and fixed role. The lined jacket retains the characteristics of the Han traditional dress of turning over the right skirt, sleeve and binding, but it also has the characteristics of

the Manchu dress button, edge and slit, which is caused by the political background of the integration of Manchu and Han in the Qing Dynasty [12].

**Tab. 1 Size table of children's jackets with large red jacquard silk**

| position | Size (cm) | position | Size (cm) | position | Size (cm) |
|---|---|---|---|---|---|
| Clothes length | 42 | Neck drop front | 9.5 | Vent height | 8.5 |
| Chest circumference | 68 | Collar length | 62 | Placket length | 36 |
| Through sleeve length | 82 | Collar hem wide | 5 | Cuff trim | 1.5 |
| Hem width | 80 | Cuff width | 13 | Black piping | 0.8 |
| Hem lift | 2.5 | Sleeve extension | 15.5 | Buckle length | 4 |

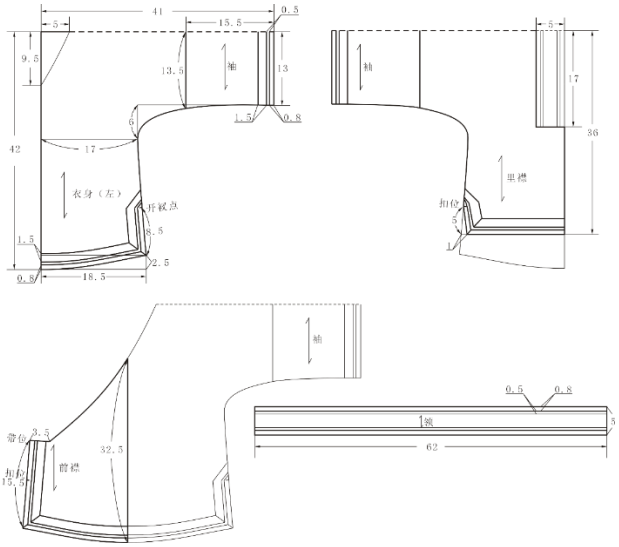


Fig. 5 Structure diagram of a large red jacquard silk children's jacket

The data collected for green lotus pattern open-crotch pants are shown in Table 2, and the structure diagram drawn according to the actual measurement data is shown in Figure 6. Before the Qing Dynasty, open-crotch pants were mostly worn by aristocratic adults, and after the Qing Dynasty, open-crotch pants were mostly worn as children's clothing [13]. This type of open-crotch pants is a half-girth type of open-crotch pants, fixed at the waist by a tie, a single pant leg is cut, and the opening is directly from the waist to the inner thigh. The printed fabric of waist and inner material is influenced by the introduction of western chemical dyes and printed cloth. The overlap part of the front and middle is 3 cm, which plays the role of strengthening the crotch and hiding the shame, and the overlap is small, which basically does not affect the straight cutting of the trouser leg. Pant length of 40 cm, presumed to be a height of 90 cm three-year-old children wear, three-year-old children can walk independently, and the crotch has no excess space, not suitable for children's activities, so in the late period of the Republic of China, the crotch of the crotch will leave a suitable margin for children's activities, its curve design is also borrowed from the Western three-dimensional cutting, this crotch pants and modern children's crotch pants similar, It can be inferred to be the precursor of modern open-crotch pants. [14]

**Tab. 2 Cyan lotus pattern crotch pants size table**

| Part name | Size (cm) | Part name | Size (cm) |
|---|---|---|---|
| waistband | 40 | Frenum length | 47 |
| waistline | 66 | Set band width | 2 |
| Hem circumference | 66 | Waist width | 7 |
| Amount of front center overlap | 3 | Lace width | 1 |
| Crotch length | 29 | | |

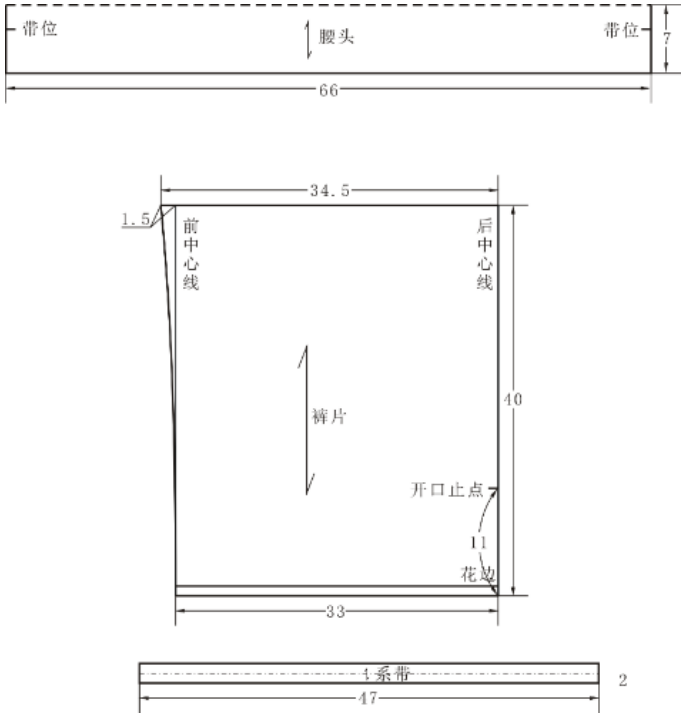



Fig. 6 Structure of cyan lotus pattern crotch pants

## 2. 3 D virtual simulation of modern children's clothing

### 2.1 Establishment of virtual models

The virtual boy model in CLO3D is adopted, and the model standard refers to the dimensions of each control part in the national standard GB/T 1335.3-2009 "Clothing Type Children", and the dimensions of key control parts are input into the virtual model editor to adjust the model's body shape, as shown in Table 3. Accurate model size is the premise for adjusting model body shape, and appropriate model body shape is the basis for effectively displaying the overall appearance of clothing [15]. In the mode of "X-Ray junction", the posture of the model can be adjusted by rotating each node of the human body, so that the clothing can be accurately worn on the human body during the simulation. The four views of the virtual model are shown in Figure 7.

**Tab. 3 Mannequin dimensions**

| position | Size (cm) | position | Size (cm) | position | Size (cm) |
|---|---|---|---|---|---|
| height | 90 | 背长 | 23 | Top crotch length | 16 |
| Chest circumference | 50 | Abdominal girth | 47 | Thigh circumference | 29 |
| Neck length | 3 | waistline | 45 | Calf circumference | 20 |
| Neck base girth | 26 | Hip circumference | 52 | Upper arm circumference | 16 |
| Shoulder breadth | 24 | Waist height | 52 | Wrist circumference | 11 |

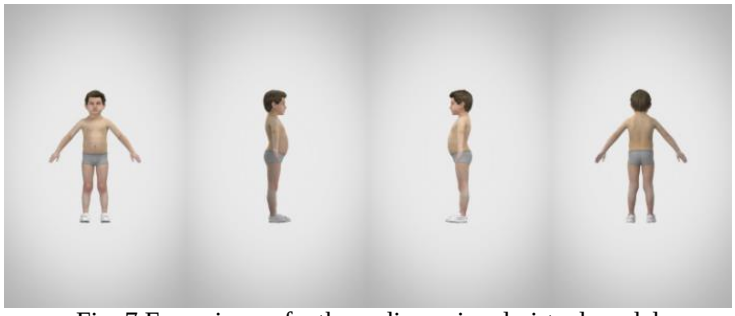
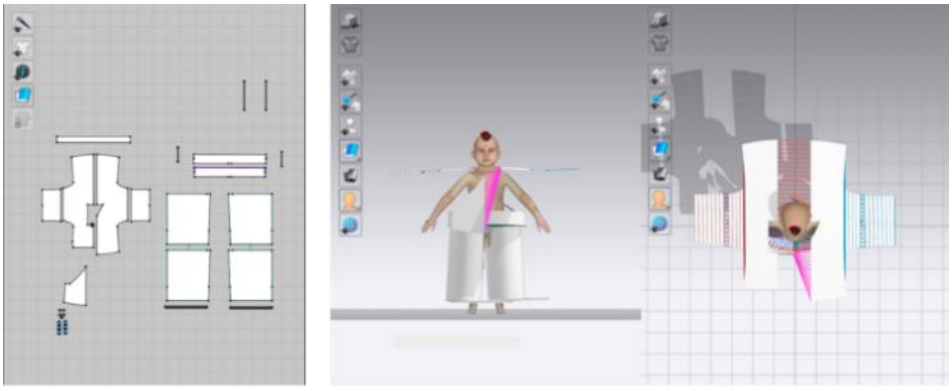


Fig. 7 Four views of a three-dimensional virtual model

**2.2 Virtual fitting of modern children's clothing**

The structure drawing is drawn with CorelDRAW software, exported in png format, and imported in CLO3D software by adding background pictures in a proportion suitable for 2D window models, which can be completely reproduced, and the template processing can be completed by copying and symmetrical plate tools, as shown in FIG. 8 (a). Adjust the position of the template in the 3D view. Since the garment is easy to pass through or fall during the simulation of wearing, it is necessary to adjust the posture of the model when adjusting the position of the jacket plate, rotate the shoulder joint and raise the arm flat, and turn over the parts on the jacket plate and collar that need to be turned by using internal lines and turning tools to make the plate fit the human body; When adjusting the position of the crotch pants plate, open the human body arrangement point, arrange the pants sheet and waist at the appropriate arrangement point in a curved state, so as to facilitate the pants leg and waist to wrap the human body, and then connect the corresponding sutures, as shown in Figure 8 (b). In the simulation state, the clothing is easy to skew or distort, so the tool is needed to continuously drag and adjust the shape. The four views of the model virtual fitting are shown in Figure 9.



（a）2D样板处理 （b）3D样板安排与缝合

Fig. 8 2D sample processing and 3D sample stitching

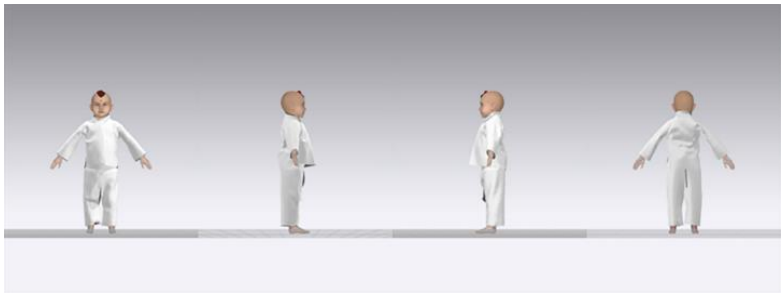


Fig. 9 Four views of virtual fittings

**2.3 Virtual simulation of fabric and embroidery pattern**

Photoshop software was used to process the original image, as shown in Figure 10. Use the filter function and stain repair function to remove wrinkles from the fabric and improve the fabric clarity by adjusting the brightness and contrast saturation. Use the free cut tool and Matting tool to work with edging, embroidery pattern and trouser lining prints, and adjust the edging Angle through perspective to get a continuous edging and print pattern. Adjust the fabric of jacket and pants to silk/stain, and adopt red and turquoise color respectively. Import the treated fabric into the corresponding sheet with texture, and approach the real fabric by adjusting physical properties such as the strength of warp and weft yarn and surface roughness of the fabric. Import the edging and embroidery pattern into the corresponding position in the form of a map, adjust the direction and size of the map, so that it is consistent with the physical pattern. Finally, the scarlet jacquard silk children's jacket and green lotus pattern open-crotch pants modeled by CLO3D software are shown in Figure 11.


Fig. 10 Photograph of the original fabric (left) and PS-treated fabric and pattern (right):(a) Large red jacquard silk children's jacket; (b) Cyan lotus pattern crotch pants

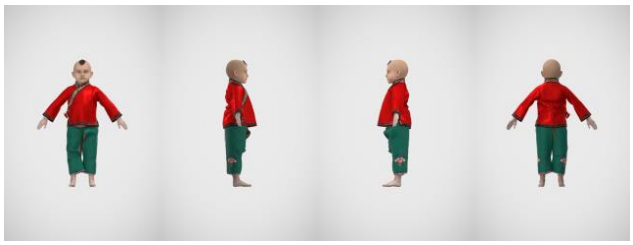


Fig. 11 The overall effect is shown

**3 Dress effect evaluation**

Clothing pressure is one of the important indexes for evaluating clothing comfort [7]. CLO3D was used to evaluate and test clothing pressure and deformation rate. The pressure parameters of key parts were shown in Table 4 and the pressure figure was shown in Figure 12. The main pressure point of the jacket is concentrated on the shoulders and neck, indicating that the cross-collar style will produce a little restraint on the shoulders and neck of children. The pressure point of the open-backed pants is mainly concentrated on the waist to ensure that the open-backed pants will not slide. There is no pressure on the arms, chest and abdomen. The test results of clothing deformation rate are shown in Figure 13. Shoulder and neck clothing deformation rate reached 118% ~ 125%, it can be seen that the traditional style of cross-collar will cause children's shoulder and neck wrinkles, not suitable for neck activity. The deformation rate of the clothes in the armpit and the front crotch reaches 112% ~ 119%, indicating that the plane cross cutting can not meet the activity of the armpit, and the front crotch is easy to pull and deform during the walking process of children. Therefore, the modern children's clothing design is mostly colarless, the armhole is dug deep, and the crotch is generally cut with curves. The deformation rate of the remaining parts is 95% ~105%, basically no deformation. To sum up, the clothing pressure value and deformation rate of this modern children's wear are mostly low values, good fitting, and can be used for reference in modern children's wear design after the improvement of the cross-collar structure.

| Dorsal cervical point center | Shoulder point | | Arms (sides) | | Bust line (side) | | Waist line (side) | |
|---|---|---|---|---|---|---|---|---|
| | left | right | left | right | left | right | left | right |
| 23.55 | 14.40 | 13.23 | 6.29 | 4.56 | 11.27 | 10.12 | 19.38 | 16.84 |


Fig. 12 Stress test results for virtual fittings

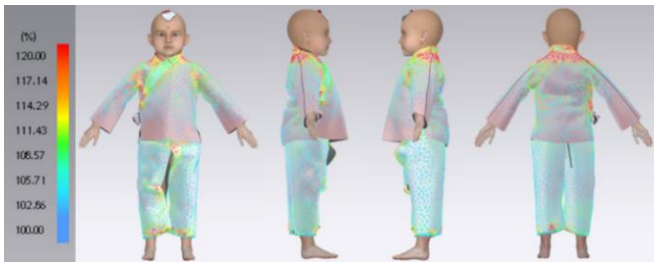



Fig. 13 Deformation rate test result of virtual fitting

**4 Conclusion**

In this paper, based on the structural analysis of the bright red jacquard silk children's padded jacket and blue lotus pattern crotch pants collected by Hebei Yongqing Clothing Museum, the structure diagram is restored. With the help of CLO3D software, a virtual fitting model is established for two modern children's clothes, and the clothing pressure value and deformation rate are tested. This paper objectively evaluates the problems existing in the structure of modern children's wear and the feasibility of virtual fitting, explains the inevitability of the development of modern children's wear from the perspective of clothing comfort, and expands the thinking for the research of modern children's wear and provides the direction for the design of modern children's wear. The traditional plane cross structure in ancient China is an important part of costume culture. It is an inevitable trend of cultural inheritance to promote the development of costume culture with the help of science and technology.

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9/22/2023