3D interactive design of wedding dress

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ABSTRACT – REZUMAT

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Based on the human torso point cloud, this paper proposes a method from the 3D design of the corset to the 2D pattern expansion. The point cloud of the human body is obtained through 3D scanning. The human body model for research is constructed, and the 3D basic style design of the corset is carried out, based on the same style and different structural line design, and through the curved surface flattening platform to convert 3D into 2D patterns. The verification was made through a virtual simulation platform and physical production methods. This study enriches the application prospect of digital technology in clothing design. Our proposed solution provides a more intuitive wedding dress design method and improves fit and comfort. It can significantly reduce the difficulty of wedding pattern-making and improve the efficiency of wedding design. In addition, our proposed method is not only suitable for wedding dress design, but also other styles of clothing design.

Keywords: *interactive design, wedding dress, pattern-making, try-on, fashion design*

Design 3D interactiv al rochiei de mireasă

Pe baza conturului punctat al trunchiului uman, această lucrare propune o metodă de la proiectarea 3D a corsetului până la generarea tiparelor 2D. Conturul punctat al corpului uman este obținut prin scanare 3D. Se construiește modelul corpului uman și se realizează designul de bază 3D al corsetului, bazat pe același stil, dar design diferit de linii structurale și utilizând platforma de aplatizare a curbei suprafeței pentru a converti modelele 3D în tipare 2D. Verificarea s-a realizat cu ajutorul platformei de simulare virtuală și metodelor de producție fizică. Acest studiu îmbogățește perspectiva de aplicare a tehnologiei digitale în designul vestimentar. Soluția noastră propusă oferă o metodă mai intuitivă de proiectare a rochiei de mireasă și îmbunătățește gradul de potrivire și confortul. Poate reduce semnificativ dificultatea modelării rochiei de mireasă și poate îmbunătăți eficiența designului acesteia. În plus, metoda noastră propusă nu este potrivită numai pentru designul rochiei de mireasă, ci și pentru alte stiluri de design vestimentar.

Cuvinte-cheie*: design interactiv, rochie de mireasă, construcție de tipare, probare, design vestimentar*

INTRODUCTION

The wedding dress industry is constantly changing along with people's lifestyles. In recent years, its sales model has developed from a traditional rental type to individual customization. The dressing occasions have gradually moved from being worn on the wedding day to a dinner party and daily routine. At present, a few South Korean and Italian scholars have conducted research on wedding gowns, but they usually focus on certain aspects such as materials, pattern innovation, marketing and detailed design [1, 2]. Funduk and Pavko-Čuden explored the structure, performance and social characteristics of contemporary Slovenian wedding dresses [3]; Kwon designed a new wedding dress pattern through the study of the structure and details of the wedding dress and the analysis of existing basic patterns [4]; Tu and Hu researched the construction of wedding photography and clothing product system indicators, and provided a substantial reference and basis for the business strategy of wedding photography companies [5].

3D body scanning technology is widely used in various fields of the textile and apparel industry to obtain accurate body size data for design customization and virtual prototyping [6, 7]. Daanen and Hong proposed a customization model based on 3D human body scanning, linking 3D scanning technology with manufacturing technology to achieve mass customization of clothing [8]. For clothing with special functions such as protective clothing, body posture is more important for computers for computer simulation and prediction of clothing drape [9]. Jolly et al. developed jacket and trouser patterns based on the four postures of motorcycle riding, flattened the 3D clothing model to obtain a 2D pattern, and then performed a virtual fit analysis of the clothing [10]; Liu et al. developed garment pattern by using surface unfolding technology and evaluated the comfort based on clothing pressure [11–16]. Wu and Kuzmichev simulated classic swimming postures and dynamic underwater

postures and optimized the design of diving suits based on 3D body scanning technology and virtual fitting technology [17]. For tight-fitting clothing, more significant material properties and pressure comfort should also be considered [18], Cheng et al. proposed a new method to evaluate and test the pressure and comfort of male underwear [19].

The production of wedding dress with traditional manual plate making method can no longer meet today's personalized consumer needs. Tao and Bruniaux directly conceived virtual clothing on the human body model adjusted the clothing shape, and tried on the 3D virtual software to save the process of two-dimensional plate design [20]; Yao et al. through three-dimensional scanning technology and curved surface modelling technology, a personalized female girdle model is generated, and the dividing line can be flexibly designed according to needs [21]. In the same way, this method can also be used for prototyping other tight-fitting garments, such as personalized custom-made cheongsams and wedding dresses. Digital-based clothing production models are urgently required. Combining customization with digital technology is the future development trend of the clothing industry.

In this experiment, digital clothing technology is used to 3D scan the body size of the experimenter, and the body point cloud is used to construct the surface of the wedding corset. Based on the constructed surface, the plane pattern of the wedding corset is obtained, and the change design is carried out based on the basic shape. It is a precise plate-making concept and the development trend of the times. It can reduce the gap between the body shape and the national standard, which is gradually becoming obese with the development of The Times but also meet modern people's pursuit of personalized customization.

METHOD

Technical roadmap

The technical roadmap of this study is shown in figure 1. Step 1, collect the point cloud data. Step 2, build the human model according to the point cloud. Step 3, build the clothing model on the human model. Step 4, design the clothing structure line on the clothing model. Step 5, expand the surface surrounded by the clothing structure line, and obtain the clothing pattern. Step 6, virtual fitting with the pattern. Step 7, virtual wedding dress design.

Point cloud data processing

The surface of the human body is an irregularly changing curved surface, and the curved transition parts such as armpits, inner thighs, and pleural sulcus will not be scanned. The human body point cloud obtained by scanning is purified in ANTHROSCAN human body data analysis software to automatically repair the holes in the transition part. The generation of noise is an inevitable objective factor. After the scanning experiment, the human point cloud is denoised, which lays a more accurate experimental data foundation for point cloud extraction, curve fitting, surface reconstruction and other experiments. Figure 2 is the completed picture of denoising.

Construction of a basic model 1 of corset

The basic model 1 construction is the three-dimensional surface construction of the vest. When constructing a basic surface, it is necessary to intercept the point cloud of the required part. The upper boundary of the basic model 1 is the upper boundary taken through the cross-section parallel to the shape of the human neck through the seventh cervical vertebrae point, with a slight inclination; the left and the right boundary are taken longitudinally with the cross-section passing through the end of the shoulder and the

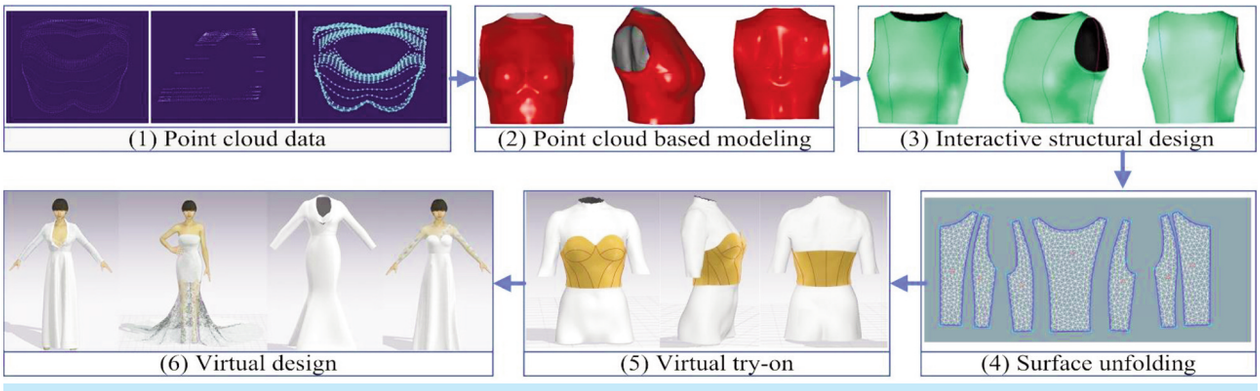

Fig. 1. The technical roadmap of this study

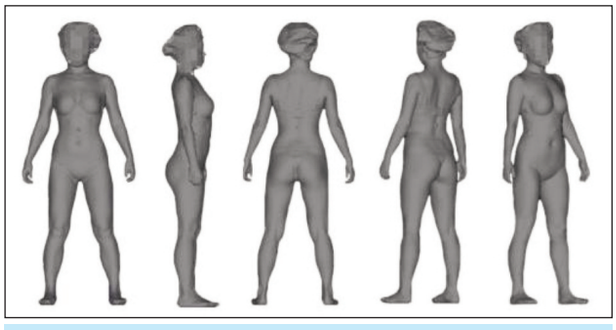

Fig. 2. Denoising complete picture

axillary point as the cross-section; the lower boundary is a horizontal cross-section cut based on the thinnest part of the waist of the human body, that is, the navel.

After observation, the basic model 1 can be divided into three parts: the neckline to the shoulder endpoint, the shoulder endpoint to the bottom of the sleeve, and the bottom of the sleeve to the waistline for the extraction of key point clouds. According to the change of the human body surface from the neckline to the shoulder endpoint, this part uses the parallel intercept point cloud method to intercept the point cloud. From the neckline to the shoulder endpoint, the point cloud is extracted with equal gradients (viewing the human body from the side the back neck is higher than the front clavicle, gradually transitioning to the level of the shoulder point). The area from the end of the shoulder to the bottom point of the sleeve cage can be divided into two parts: the front chest area and the back area for surface construction, and the front chest key point cloud and the back key point cloud are respectively intercepted horizontally. The point cloud distribution from the bottom point to the waistline of the sleeve cage is approximately columnar, so the key point cloud is intercepted horizontally to obtain a uniform key point cloud that is approximately elliptical.

Complete the interception of different key point clouds in the three regions, perform curve fitting, and adjust the number of nodes and order of the fitted curve to make the starting point of each fitted curve consistent, and generate the lofted surface according to the fitted curve. The surface construction of the basic model 1 of the corsets is completed, as shown in figure 3.

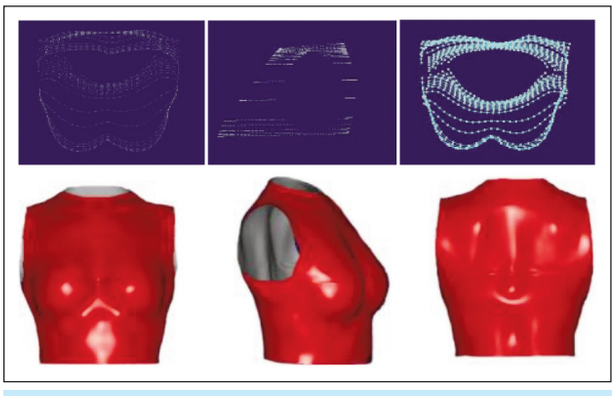

Fig. 3. The basic model 1

Construction of the basic model 2 corset

The basic model 2 corset is the cup type. When determining the basic position and shape of the upper boundary line, it is necessary to ensure its beauty and smoothness of the upper boundary line. Because the front middle and upper boundary of the cup-shaped corset is heart-shaped, the upper boundary of the front chest and back are not on the same horizontal plane, and the scanned human body is in a three-dimensional state, the basic position and shape of the upper boundary of the cup-shaped corset can be determined by rotating the purified human body point cloud in different angles and dimensions according to the needs of the style. Further precise the upper boundary, the shape of the location to meet the requirements, as shown in figure 4, the basic model of 2.

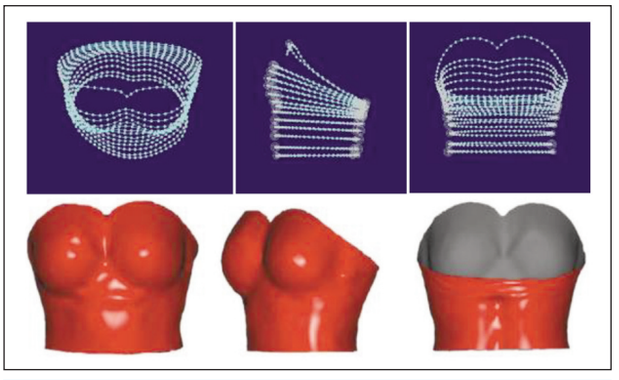

Fig. 4. The basic model 2

Construction of the basic model 3 corset

The basic model 3 corset is the wipe chest. To construct the curved surface model, the upper boundary is first determined. According to the scanned human body, first, determine the upper bound of the wipe chest style, and then determine the position and shape of the upper boundary (front chest, back) and lower boundary of the basic three bra style on the processed human body point cloud, and adjust to the required style.

Because the upper boundary line of the wipe chest style is slightly higher than the back, the point cloud extraction in the upper and lower boundary area needs to be intercepted from the point cloud with a certain angle in the front and back of the upper boundary line, and gradually transition to parallel. The point cloud is intercepted at the level of the waistline.

Select the upper boundary or lower boundary as a reference, fit each key curve and adjust its order, starting point position and several nodes to make the surface construction smooth and accurate, as shown in figure 5 for the basic model 3 corset.

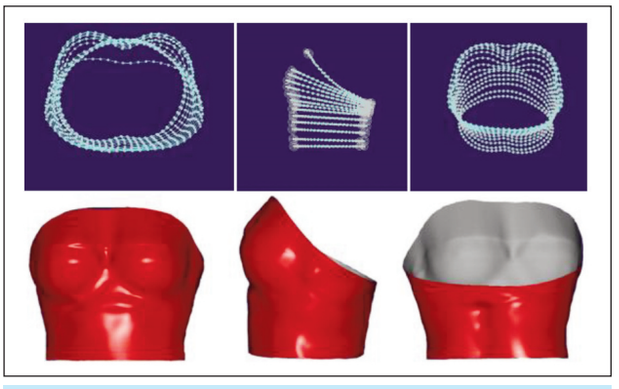

Fig. 5. The basic model 3

Style expansion and curved surface expansion

After the three basic types of corsets are constructed, save them in obj. format and import them into the Design Concept Auto platform for segmentation design. Basic section 1 has a variety of division methods. The general division method is adopted for structural line positioning, and the principle of beautiful and reasonable structure is followed. The basic common structure lines are divided by the back seam at the front and rear sleeves, the front and back shoulder seams are divided by the back seams, and the back of the front sleeve (front shoulder seam) is combined with the back of the back-shoulder seam (rear sleeve), V sub-neckline, as shown in the three divisions of basic model one in figure 6.

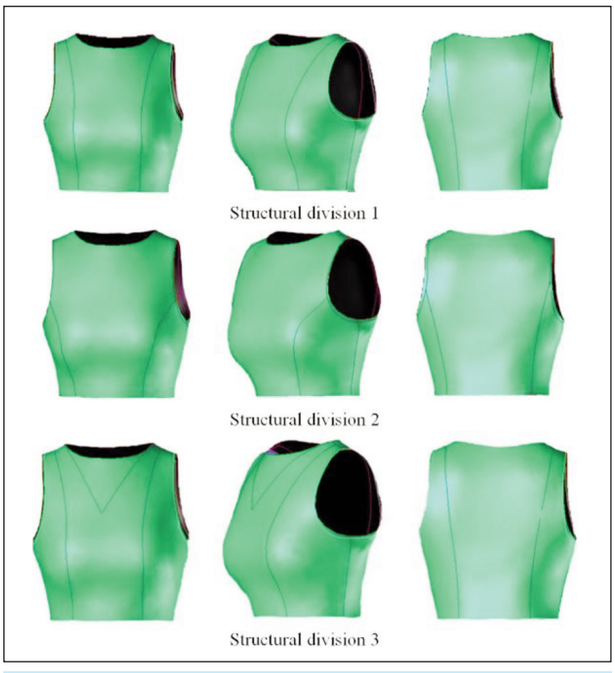

Fig. 6. Division of basic model 1

Basic model 2 is closely related to basic model 1. At this stage, certain segmentation changes will be carried out, and the changes will focus on factors such as conforming to the female body shape and highlighting the curvilinear beauty of the female chest and waist. Including the horizontal and vertical division of the cup, the horizontal division with a certain oblique angle from the bottom of the bust to the waist, and the horizontal division with a certain oblique angle from the shape of the human ribs, reflecting the beauty of women's torso; the vertical division of the cup, from the bottom of the bust to the waist for a certain angle of longitudinal division, the objective female chest and waist difference is divided into an equal longitudinal diagonal line, which is in line with human aesthetics and human body structure; the whole body of the body is divided into equal parts longitudinally with a certain angle, which is simple and generous, similar to a person holding a love heart in both hands, as shown in figure 7, the basic model 2 can be divided into three parts.

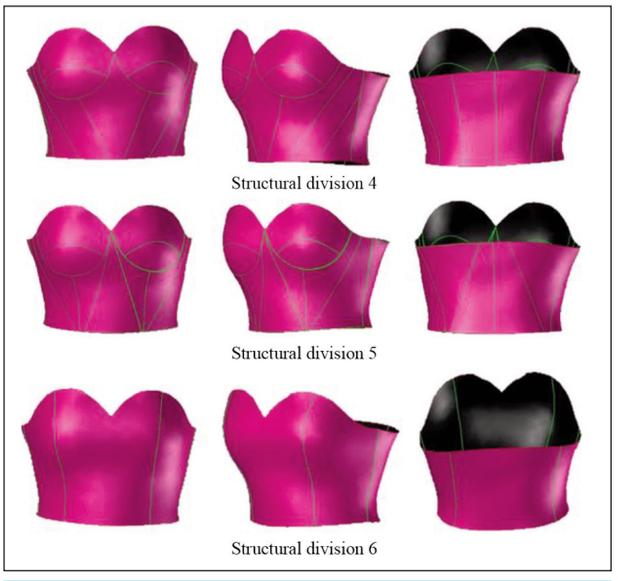

Fig. 7. Division of basic model 2

Basic model 3 is closely related to basic model 2. Basic model 2 has already been explained, then model 3 will be explained by ordinary division. When performing the common three kinds of segmentation, it is necessary to pay attention to the setting of the structural segmentation line to conform to the law of curvature of the human body surface. As shown in figure 8, the two divisions of the basic model 3.

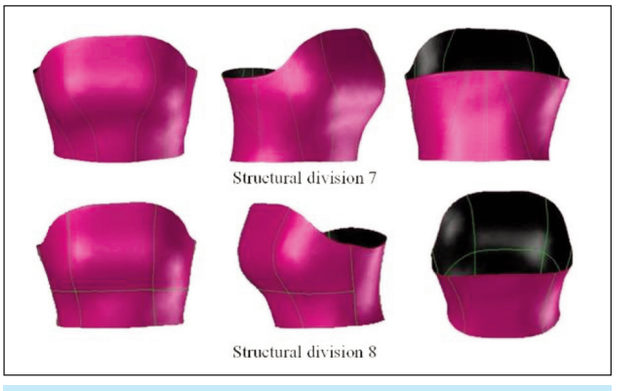

Fig. 8. Division of basic model 3

Curved surface development

After accurately positioning the basic structure dividing line in the Design Concept Auto platform, it enters the stage of unfolding the corset surface. After the three basic types of corsets are set, there are a total of 8 divisions. According to the 9 segmentation methods, select six of them for surface expansion. Two points should be made before expansion: First, the curved surface of each expansion area must be a closed contour curve; second, the lines cannot overlap each other. Figure 9 is a split and expanded view.

RESULT

Import the previously built human body model into the virtual fitting platform in the obj. format, and

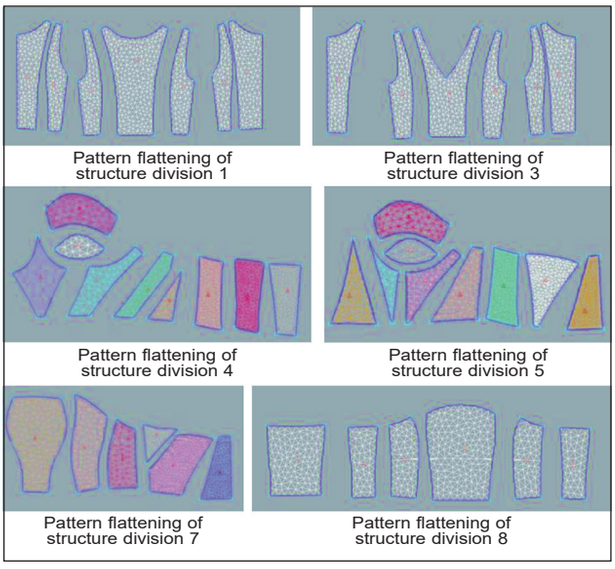

Fig. 9. Split expansion

import the two-dimensional pattern of the unfolded surface into the virtual fitting platform in the DXF. format, adjust the position of the human body model, and perform a virtual fitting. First, the two-dimensional pattern is positioned around the human body according to the stitching position in three dimensions; second, the stitched part is stitched with a sewing thread tool; finally, the stitched pattern is hardened to check whether the stitching position of each side is correct to simulate, the virtual effect after completion is shown in figure 10.

Fig. 10. Virtual rendering

The virtual fitting platform equipment includes the distribution of body surface pressure after the human body is dressed. In the pressure mode, it can be observed that the pressure between the garment and the human body is greater. That means the bust is closer to the garment and the pressure on other parts such as the shoulders and waist gradually decreases. From the pressure effect analysis diagram in figure 11, the green area indicates that the clothing fits

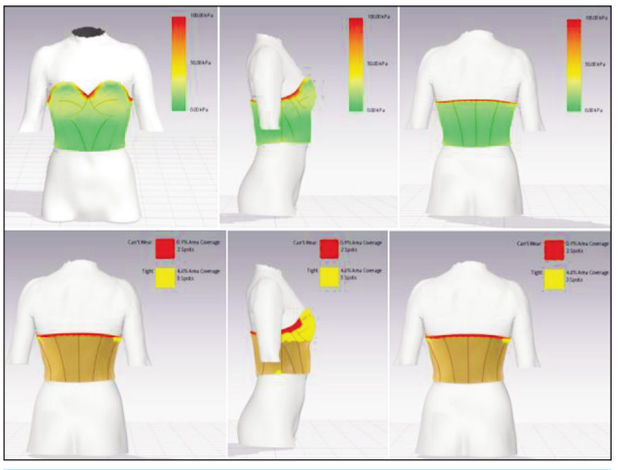

Fig. 11. Pressure effect analysis diagram

the human body, and the yellow area indicates that the clothing fits the human body.

Import the two-dimensional pattern of the unfolded surface into the PGM clothing CAD system in DXF. format to complete the pattern, and then import it into CLO3D for virtual simulation design. By adjusting the parameters of each part of the female human body in the platform to the scanned human body value, that is, the bust circumference is 88 cm, the waist width is 68 cm, the hip width is 90 cm, and the height is 162 cm. The shape and design method of the wedding dress is divided into three parts: corset, skirt, and decoration. The paper pattern is adjusted according to the three-dimensional display effect until it meets the requirements. Figure 12 is a simulation effect diagram.

Fig. 12. Wedding dress virtual effect

The final paper pattern can be directly drawn after the details are perfected, and the model for physical production. Figure 13 is the style drawing of the wedding gown. According to the style drawing, physical production and try-on are carried out. The subject of the three-dimensional scan and the test-wearer of the finished product should be the same person to ensure the rigour and scientific nature of the research. When trying on, the invisible zipper or strap should be opened first, and the waist of the wedding dress should be supported by the hand. The staff should assist the subject to try on (because the garment is more complicated and has many layers) from bottom to top. Figure 14 shows the actual picture of the wedding dress.

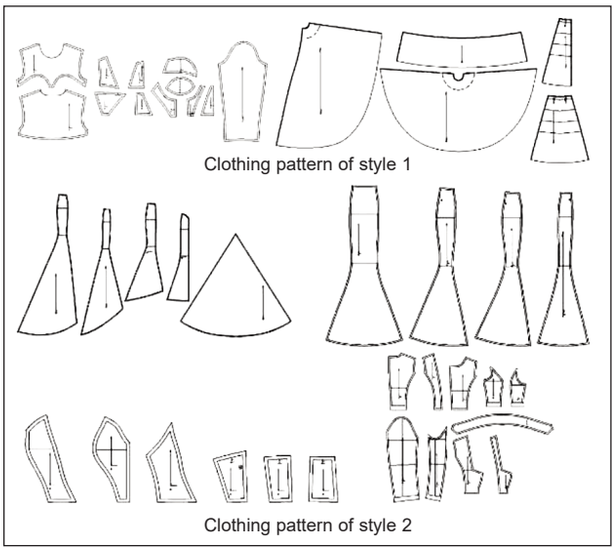

Fig. 13. Style drawing

Fig. 14. Wedding dress physical map

DISCUSSION

The method is feasible and reasonable according to the comprehensive evaluation of 5 technicians engaged in the wedding dress industry, combining static pressure, dynamic pressure and practical standards of wedding dress design. Subjective evaluations of the wearers showed that the chest and waist of the garment fit better with themselves, without discomfort, chest compression, or dyspnea. When the subjective performed the horizontal arm forward movement (bouquet), there was no looseness or falling of the top; when the arms are bent at 45° and the palms are moved inward (arms in arms), there is no huge deformation or slippage of the top.

Compared with traditional wedding dress production, the clothing adopts 3D visualization technology, obtains the human body point cloud through 3D scanning, constructs the human body model and 3D clothing style model, transforms the 3D style into a 2D pattern, and adjusts the virtual simulation version. All these operations are carried out on the computer, which greatly saves the time of traditional wedding dressmaking, and reduces manpower and cost. It is a new practical fashion design method with strong operability and realizes real accurate plate making.

CONCLUSION

This research focuses on “the structural design of female western-style wedding dress based on the point cloud of the human torso”, and designs the basic corset. The research of wedding dress design methods through a virtual simulation platform verifies a new three-dimensional visual clothing design method, which meets the expectations of pre-study.

1. Achieved a two-dimensional pattern acquisition method based on the torso point cloud. The human body point cloud is obtained through 3D scanning, and the 3D surface model of the human body with arms is constructed according to the surface characteristics of the female human body, which prepares for the verification of the 3D style design method of the corset.

2. Completed the curved surface construction of the basic three-dimensional style of the corset in the reverse platform, and obtained the style expansion of the same style with different structures.

3. The three parts of the corset, skirt, and decoration are designed in the computer for a virtual simulation of the wedding dress, and the layout is adjusted according to the design requirements. The final design and the two-dimensional pattern can be completed at the same time, which can directly reflect the lack of design, improve the design, and improve work efficiency, shorten the cycle of clothing from design to shipment.

This method is valuable for enterprises from the acquisition of human body point cloud data to the surface construction and expansion of basic corset model, to the 3D virtual fitting and the final sample fitting. Compared with traditional wedding design, the method can improve work efficiency, shorten the work cycle, and customers can interact in time, so it is more scientific and operable.

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