The Research on 3D Numerical Control Modeling Method of lapel Collar

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Abstract

Rolled collar is formed by the stand collar connected with top collar and the lapel, taking special attention to the folding ease on shoulder. Its overall appearance and clothing comfort play a vital role in clothes. Neck connects the head and the body.it is one of the body parts be covered by collar. In the basic female human body model, the key data is extracted to establish wire-frame model of rolled collar. The research uses model measurement function in the CLO Enterprise OnlineAuth software to set up the wire-frame model of lapel model. There are two aspects mainly in solving problem of digital control. The one is the structural changes caused by the neck key point changes in human body. The other is using the wire-frame model is to describe spatial geometrical shape and topological relationship of lapel collar. And to solve the digital simulation of lapel collar.

Key Words: Lapel Collar; Key points data analysis; Neck Model; Lapel collar Model

1. Introduction

Computer aided design (CAD) of garment is the production of combing of science technology and clothing technology. This new garment technology includes Fashion design, Clothing structure design, Put the code, Cloth discharging, Computer graphics, data base, Network communication, etc. It is used for garment product development and engineering design.

At present in China, the main research fields of garment digital technology include: 1. Digital garment products development; 2.Electronic Made to Measure (EMTM), The theory of garment design and production technology, Measurement and analysis of 3D human body scanning, 3D human body modeling, Clothing Virtual Design, Flattening the curved surface of 3D garment; 3.The development of garment CAD system; 4. business process management system of digital clothing.

The research focuses on the personalized template generation technology in the EMTM system. In this paper, researches focus on the above second part based on the garment digital technology. Main contents include: neck feature morphological analysis and establishing a 3D lapel Collar model on the basis of this. How to construct 3D collar? It is one of the key technologies of garment EMTM system. Collar is garment component, and it is around the neck of the human body and visual center of garments. It is one of the key points in clothing design. The Collar is one of the key marks of clothing structure and plate making technology level.

In the existing pattern making technology, two methods are used to design collar structure, which were planar structure and spatial structure [2-6].Due to the importance of the collar. Many researchers according to the structure of the human neck and its movement characteristics [7-8].The collar structure is studied from the view of human engineering [9-14]. Reference [15-16] develops manual 3D garment design software for general fashion designers, and establishes fashion design method based on virtual human platform. In this paper, it was built personalized neck model used 3D data of personal neck instead of two-dimensional data. Put forward a kind of method: Collar 3D Construction based on made-to-measure.

In this paper, clothing digital system is looked as the background. The research focuses on the personality collar model. From ergonomics perspective to study 3D human neck measurement, neck feature shape is analyzed to the establishment of a personalized 3D collar model.

2. Method and Material

Adult women in the southwest area were scanned by 3D scanner, and generated human body model. Measure the key parts' data of the neck, and use the factor analysis function in SPSS software to analysis of measurement data. The specific analysis method is principal component analysis of maximum variance rotation.

Get 3 neck shape characteristic factors: Girth factor, width factor and thickness factor. In order to provide more shape of the neck comprehensively .The leading content involves the 3D human body model system. The neck data were obtained by scanning the human body, and the 3D neck model was constructed by analyzing the data characteristics. In order to meet the establishment and production of the virtual model of human neck in 3D human body model system. As shown in Figure 1.

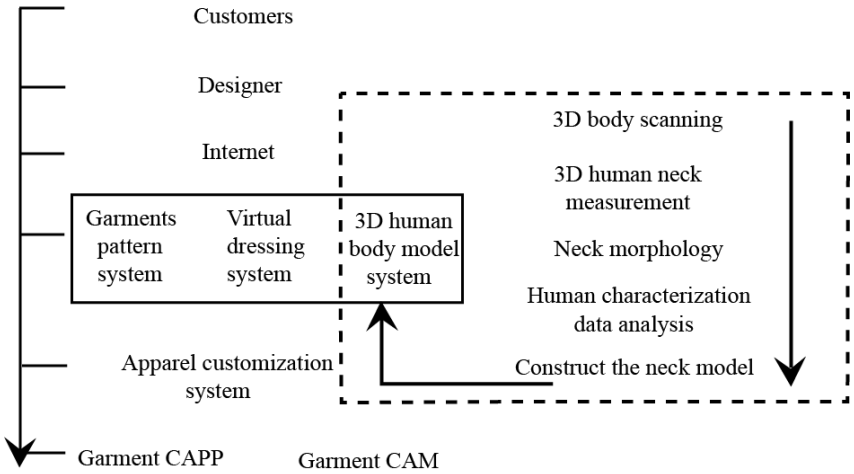


Figure 1: Research methods and routes

Measurement environment: The survey selecting 20 mental health adult women aged 20-25 years. Measured relative temperature is 270-290; the humidity is 65%-70%.Using 3D scanning equipment to input body data.

Measuring posture：Each person is measured in a light colored bra, wearing a rubber cap to cover the hair and shorts. The measure posture is upright, Feet shoulder width apart，Two sides of the upper arm and trunk 15-20 degrees。The neck relaxed, look at the front horizontally.

Measuring points: In this paper, we select the 12 key points of the neck for data measurement, as shown in table 1:

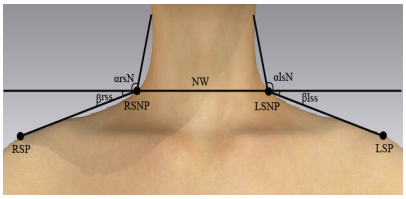
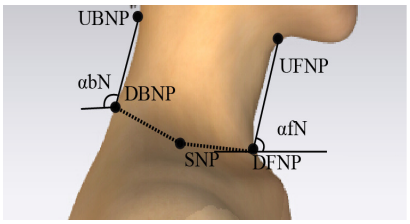
Number	Measurement project		Specific location
1	Neck Girth	NG	
2	Neck Width	NW	
3	Front Neck Length	FNL	
4	Back Neck Length	BNL	
5	Neck Thickness	NT	
6	Left Shoulder Slope Angle	LSSA	**The front of Neck**
7	Right Shoulder Slope Angle	RSSA	
8	Front Neck Angle	FNA	
9	Back Neck Angle	BNA	
10	Left Side Neck Angle	LSNA	
11	Right Side Neck Angle	RSNA	
12	Level Neck Angle	LN	**The Side of neck**

Table 1: Key points of the neck

2.1.Key points data analysis of the neck

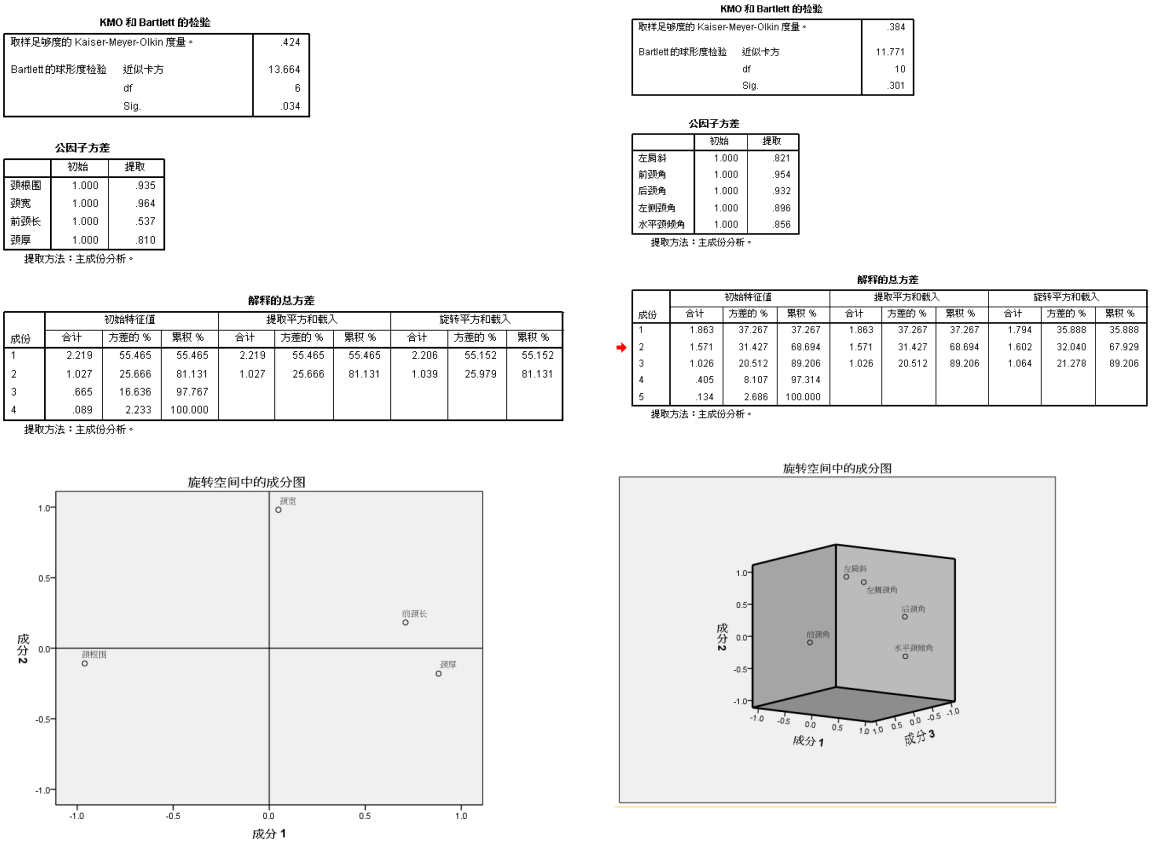
2.1.1 Human neck model extraction

Neck connects the head and the body.it is one of the body parts be covered by collar. Neck can be regarded as an elliptic platform. But in the strict sense there is a certain difference on neck shape for different people. The difference factors are thickness, length and tilt angle, etc.

In the field of clothing human engineering, the Method for describing human shape is divided in two aspects：3D human body scanning measurement and Manual direct measurement. In the actual measurement process, those data of the key points on the left and right sides of the neck are different and similar (such as: Neck Angle and Slope Angle).At the same time the structure of the human body are symmetrical structure. In the actual garment design, the left structure and the right structure of the garment adopts the symmetrical design to increase the production efficiency, which makes the garment more beautiful simultaneously. So in the analysis of the neck data, this paper used the average value of the Neck angle and the Slope angle.

2.1.2 key point data processing

The human neck data processing uses the method named factor analysis. Its main effect is to reduce the variable quantity and extract factors. In this paper, we used the maximum variance rotation to get the best factor group, and got the neck characteristic factor.as shown in Figure 2.



KMO 和 Bartlett 的检验

取样足够度的 Kaiser-Meyer-Olkin 度量。		.424
Bartlett 的球形度检验	近似卡方	13.664
	df	6
	Sig.	.034

公因子方差

	初始	提取
颈根围	1.000	.935
颈宽	1.000	.964
前颈长	1.000	.537
颈厚	1.000	.810

提取方法：主成份分析。

解释的总方差

成份	初始特征值			提取平方和载入			旋转平方和载入		
	合计	方差的 %	累积 %	合计	方差的 %	累积 %	合计	方差的 %	累积 %
1	2.219	55.465	55.465	2.219	55.465	55.465	2.206	55.152	55.152
2	1.027	25.666	81.131	1.027	25.666	81.131	1.039	25.979	81.131
3	.665	16.636	97.767						
4	.089	2.233	100.000						

提取方法：主成份分析。

旋转空间中的成分图

KMO 和 Bartlett 的检验

取样足够度的 Kaiser-Meyer-Olkin 度量。		.384
Bartlett 的球形度检验	近似卡方	11.771
	df	10
	Sig.	.301

公因子方差

	初始	提取
左局斜	1.000	.821
前颈角	1.000	.954
后颈角	1.000	.932
左侧颈角	1.000	.896
水平颈倾角	1.000	.856

提取方法：主成份分析。

解释的总方差

成份	初始特征值			提取平方和载入			旋转平方和载入		
	合计	方差的 %	累积 %	合计	方差的 %	累积 %	合计	方差的 %	累积 %
1	1.863	37.267	37.267	1.863	37.267	37.267	1.794	35.888	35.888
2	1.571	31.427	68.694	1.571	31.427	68.694	1.602	32.040	67.929
3	1.026	20.512	89.206	1.026	20.512	89.206	1.064	21.278	89.206
4	.405	8.107	97.314						
5	.134	2.686	100.000						

提取方法：主成份分析。

旋转空间中的成分图

Neck characterization data **Neck Angle**

Figure 2: Human characterization data analysis

The KMO value is low in the factor analysis. The main reason is that the data acquisition area on the neck because the measurement items are less, so the variable correlation coefficient is small and have large partial correlation coefficient.The data are collected in the neck. There is a certain relationship in those characterization data (the width data, the girth data and the angle data)

2.2. 3D structure model of garment collar

2.2.1 Coordinate system setting and the Neck mathematical model

Right-handed coordinate is used in this paper. In the coordinate system, each point of 3D model can be described by 3 components (x, y, z).

According to the data analysis results in the first part. Those parts for the neck model with greater significance are Neck Width, Neck Girth, Shoulder Slope and Front Neck Angle.

Setting the human body is completely symmetrical and established 3D coordinate system of the neck. In the neck model, we only need to establish half of the neck model. Make the X axis through the two side neck point, forward through the left neck point to the right neck point. Take the midpoint as the coordinate origin. Z axis ran through the origin and perpendicular to the X axis in the horizontal plane. So we can get the XOZ plane. The Y axis is passed through the origin and is perpendicular to the XOZ plane. The mathematical model of the neck and the coordinates of the key points are set, as follows Figure 3:

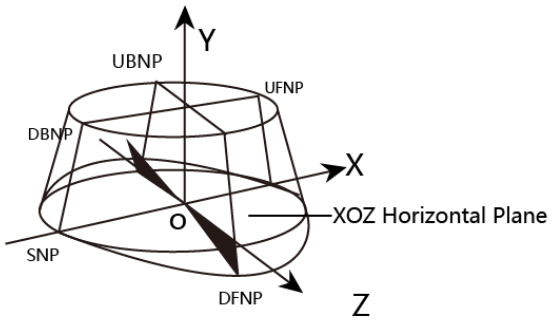


Figure 3: The mathematical model of the neck coordinate system.

As shown in the chart, DBNP, SNP and DFNP are located on a curve. Therefore, the equation of the curve of the front neck is set to

$$f(\theta)=(a\cos\theta,b\sin\theta,c\sin\theta),\theta\in\left[\pi,\frac{3}{2}\pi\right]$$

When $\theta=\pi$; the point is $SNP(x,0,0)$; when $\theta=\frac{3}{2}\pi$; the point is $DFNP(0,y_f,z_f)$;

the above equation can be solved: $a=-x,b=-y,c=-z_f$;.

The equation of the curve of the back neck is set to $f(\theta)=(d\cos\theta,e\sin\theta,k\sin\theta),\theta\in[\frac{\pi}{2},\pi]$.

When $\theta=\pi$; the point is $SNP(x,0,0)$; when $\theta=\frac{\pi}{2}$; the point is $DBNP(0,y_b,z_b)$;

the above equation can be solved: $d=-x_s,e=y_b,k=z_b$.

So we can get the parameter equation of the half neck.

$$f(\theta)=\begin{cases}(-x_s\cos\theta,-y_f\sin\theta,-z_f\sin\theta) & \theta\in[\pi,\frac{3}{2}\pi]\\(-x_s\cos\theta,-y_b\sin\theta,-z_b\sin\theta) & \theta\in[\frac{\pi}{2},\pi]\end{cases}.$$

In the up neck circumference, making two points: $UFNP(0,y_f,z_f)$ and $UFNP(0,y_f,z_f)$.

The equation of the curve of the up neck circumference is set to:

$g(\phi)=(R\cos\phi,p\phi+q,t+R\sin\phi),\phi\in\left[\frac{\pi}{2},\frac{3}{2}\pi\right]$ and $\phi=\frac{\pi}{2}$; the point is $UBNP(0,y_b,z_b)$.

Into the above equation can be solved:

$$R=\frac{z_b-z_f}{2}, p=\frac{y_f-y_b}{\pi}, q=\frac{3y_b-y_f}{2}, t=\frac{z_b+z_f}{2}$$

So we can get the parameter equation of the up neck circumference.

$$g(\phi)=(\frac{z_b-z_f}{2}\cos\phi, \frac{y_f-y_b}{\pi}\phi+\frac{3y_b-y_f}{2}, \frac{z_b+z_f}{2}+\frac{z_b-z_f}{2}\sin\phi) \quad \phi\in\left[\frac{\pi}{2},\frac{3}{2}\pi\right]$$

2.2.2. Collar 3D mathematical model

In the traditional clothing system Lapel Collar is an important part of the suit. The design quality of the lapel collar plays a vital role on the overall appearance of the suit. For the modern clothing design, the design style of lapel collar becomes diversified gradually. In this paper, we use data of the prototype lapel collar. Using the wire-frame model is to describe spatial geometrical shape and topological relationship of lapel collar. And to solve the digital simulation of lapel collar.

According to the principle of spatial segmentation, any complex shapes in an object can be simulated by finite number of simple shapes. A complicated structure can be divided into a number of simple plots.

The skeleton of lapel collar is supported by the turning line and the border line. And it is an aggregate constrained by all skeleton and various plane. So the topological relationship of lapel collar can be described by collar skeleton. And the complex relation between surface and surface is described by the skeleton relation.

Suppose that each of the lapel collar entities is made up of the boundary and the turning line. So the wire-frame model consists of several simple plane elements. Hypothetical surface are expressed by S, the boundary is represented by ∂S, then the whole wire-frame model of lapel collar can be expressed as $\partial S_{ik}=\partial S_u \cup \partial S_b \cup \partial Sc$. S_u、S_b and S_c are plane elements forming wire-frame model of lapel collar. The common edge of those planes uses reference technology. It is not only ensures the accuracy of data, but also reduce the redundancy data.

The lapel collar data base on wire-frame model using those elements: Point, Node-Point, Edge, Triangle, Plane and Wire-frame. The specific topological relationship is shown in Figure 4:The wire-frame model not only stores the relationship of boundary lines, but also stores the planes number. The plane is a set of triangular mesh, and the constraint boundaries are provided by the line box. If dividing the component elements of the part is 3D lapel collar, will get 4 elements, those are location, boundary, representative elementary volume, and wire-frame model of lapel collar. According to its corresponding relationship with the topological elements, the topological representation and model representation of the Lapel collar model can be achieved.

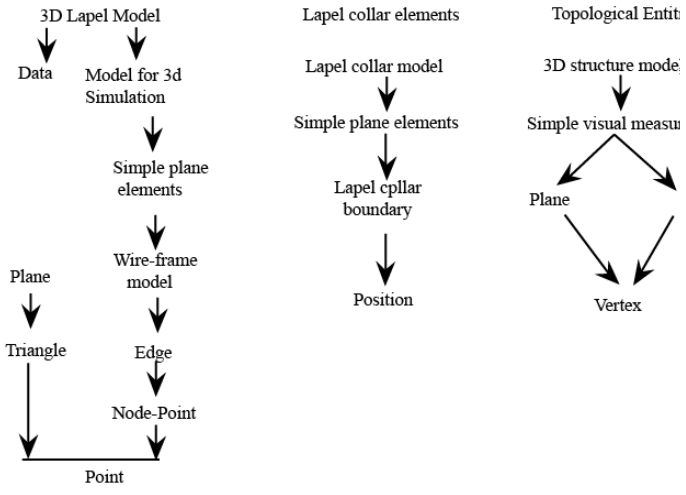


Figure 4:3D neck wire frame model and topological grape

The method proposed in this paper can be achieved in VC+ +6.0, Open GL graphics library and MapGIS TDE platform in the PC machine. As shown in Figure 5.

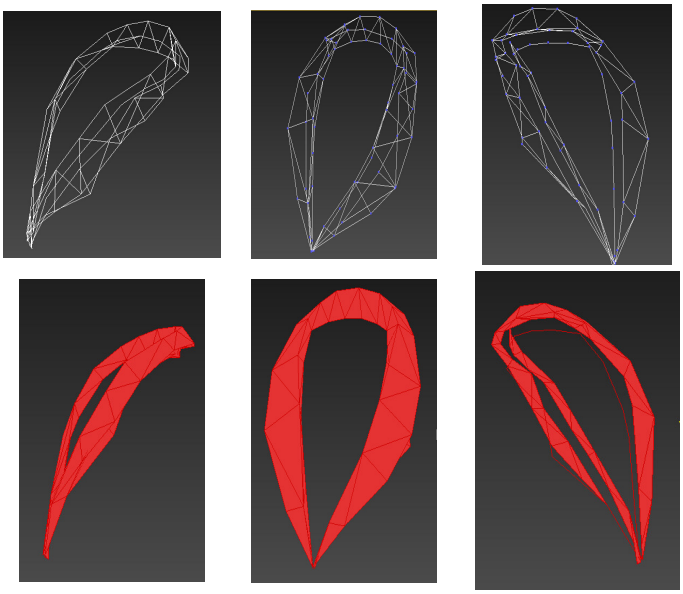


Fig. 5: The wire-frame model of lapel collar

3. Conclusion

Clothing personalized customization is the trend of the clothing development. The main characteristic of this paper is that the human body model is collected from the human body model in the southwest region. For the data analysis of the model is conducive to establish neck model that conforms to the characteristics of the human body in China southwest. It has practical significance for garment collar production in the area. Clothing personalized customization is the trend of the development of clothing.

Based on the measurement experiment, we have studied the subdivision method of the neck morphological characteristics. SPSS software was used to analyze and gets 3 factors of neck characteristic. Those are Girth factor, Width factor and Thickness factor.

The construction of the outer frame is the key technology to simulate 3D structure. The wire-frame model not only can accurately reflect the basic shape, but also can explain the topological relationship between the collar surfaces. The method of constructing lapel collar based on wire-frame model can solve the staggered and complex problems between lapel and peak lapel, collar band and collar top. In order to lay the foundation for different collar types when analyzing the construction of model.

The gradient data of lapel collar has directly affects to the fit of lapel collar in the lapel collar structure. The lapel roll ease and lapel appearance are restricting the aesthetics property of lapel collar. In the further study, the gradient data of lapel collar will be considered in 3D lapel collar model. And providing the basis to simulate lapel collar more accurate .

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