Pattern Remaking System of Dress Shirt Using 3D Shape Measurement

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Abstract: Apparel manufacturers have been struggling to meet the wants and needs of their customers without sacrificing the efficiencies and profits gained through mass production. While order-made clothes are ideal one, they are expensive because the processes involved are complicated and far from automatic. In order to establish interactive apparel pattern making using CAD at a reasonable cost for customizing clothes, it is essential to employ three-dimensional pattern. In this research, we focus on the development of a clothes measurement system using three-dimensional digitization of the shape of wearing clothes. Moreover we attempt to develop a pattern-remaking system that is three-dimensionally interactive, using measurement data from a given model to provide accurate information for individual pattern design. The three-dimensional measurement data was converted by coordinate column to build cross section line model. We created a human body model with ten control points, and which were capable of being deformed by scaling magnification. A clothes model can be modified interactively and suitably with a body model. Pattern fitted size information from the three dimension shape was created, thus allowing us to simulate clothes pattern fitting for individual body shapes.

The following results were obtained;

1.The bodice and sleeve sizes of shirt obtained from three-dimensional measurement data were almost identical to those of the original paper patterns. This fact suggests the potential usefulness of our process.

2. The use of the three-dimensional pattern-remarking system, featuring interactive modeling with a cross section line view and duplication pattern view, could be used to easily accommodate any individual’s body requirements.

Application of this pattern-remaking system using apparel CAD realizes the automatic customization of clothes and more efficient.

Key word: *Pattern remaking system, Apparel CAD, Three-dimensional measurement*

1. Introduction

With an increased standard of living and an increased awareness of fashion and design, the current generation has been called the “generation of personality” and one that places a high priority on clothes design. Therefore order made clothes are ideal to cater to these demand. However, order made clothes are expensive because the process involved are complicated and far from automatic.

Fortunately with improving computer technology and information processing, customers can order clothes using the internet or network systems. Clothes ordered in these ways can cater to customers’ individual preferences and such process has been referred to mass customization [1].

In order to mass-customize clothes, it is essential to take into account individual body shapes and three-dimensional patterns. In the past the apparel CAD was used for the development two-dimensional patterns.

Recently, by employing three-dimensional simulation, it is possible to simulate body models and create suitable two-dimensional patterns [2][3]. However to date, it has not been possible to create such patterns promptly and automatically that suit individual body sizes, silhouettes and three-dimensional characteristics [4][5].

Adjustments to clothes in order to suit body shapes have mechanical limitations because of the difficulty in creation patterns for curved surfaces. At present, it is not possible to easily create patterns for curved surfaces using three-dimensional apparel CAD. Therefore, in this research, we developed methods for making patterns promptly with three-dimensional adjustments to suit individual body shapes and silhouettes at will.

In accordance with such method, body models wearing clothes are represented on screen so for customers as to be able to modify patterns to suit their individual body shapes and sizes and then to view the results instantly on screen.

We developed the pattern remaking system, which can modify patterns to suit to body contour and shape three-dimensionally. This system is capable of producing individually adjusted patterns in real time using interactive three-dimensional modeling.

In this research, we used a dress shirt as a sample for the development of our pattern remaking system.

The following are our research objectives;

(1) To obtain three-dimensional measurement data of the shape of clothes being worn for the construction of automatic three-dimensional clothes models.

(2) To make patterns using size information from clothes as obtained from their three-dimensional shape. We used knowledge of pattern construction instead of a developing system for curved surfaces.

(3) To examine the potential usefulness of our process by comparing our results with the pattern used to make the original sample pattern. We assumed it possible to develop clothes without pattern size information using this process.

(4) To obtain information of the length dimension that is common to both the original pattern and the three-dimensionally modeled shape.

(5) To determine which parts and methods to enable contouring of three-dimensional body shapes using scaling formulae.

(6) To determine the way to make corresponding pattern adjustments between the clothes model and the body model. Pattern fitted size information from the three dimension shape was created, thus allowing us to simulate clothes pattern fitting for individual body shapes.

(7) To develop the pattern-remaking system using the interactive model such as cross section model and section of pattern estimation which could be used to easy accommodation of the individual body.

2. Measurement of dress shirt shape and body shape

We gained three-dimensional(3D) measurement data of the shape of clothes being worn using light section method. From this data, we extracted size information for pattern construction. The 3D shape measurement using light section method obtains to data without physical contact with the subject. Therefore, this method is most suitable for measuring body shapes. It is also most suitable for measuring clothes shapes without deforming the clothes through contact.

We used a dress shirt as a sample, manufactured by Flex Japan Co. who also provided us with the original pattern for the shirt. The sample information from the original pattern is shown in Table 1.

Table1. The size(cm) and material of dress shirt

Length of neckline	Sleeve length	Shoulder length	Length of bust line	Length of waist line	Hem length	Full length	Material
39	82	46	114	106	108	81	Polyester 55%, Cotton 35% Other 10%

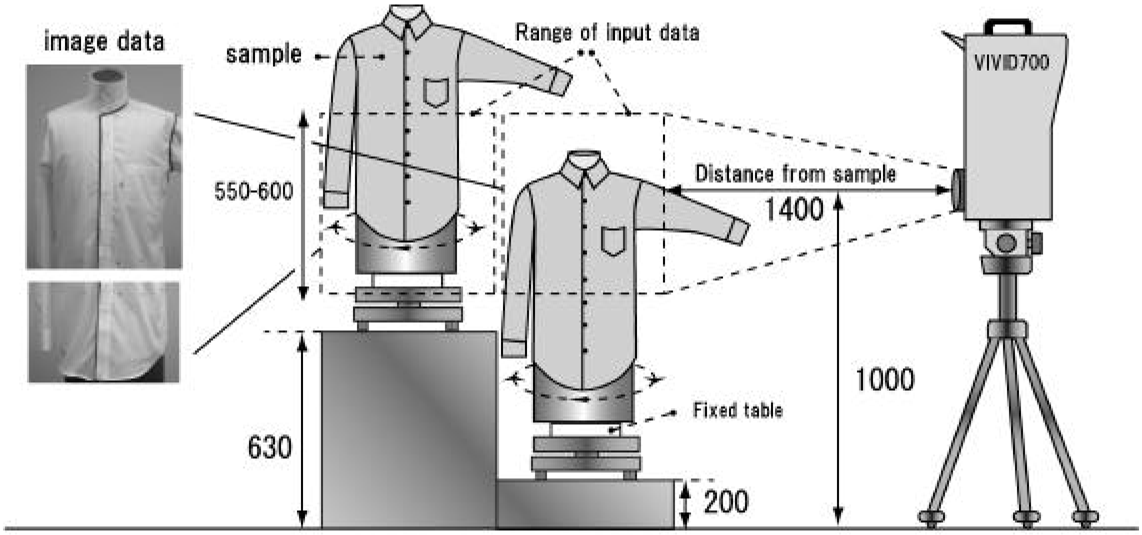
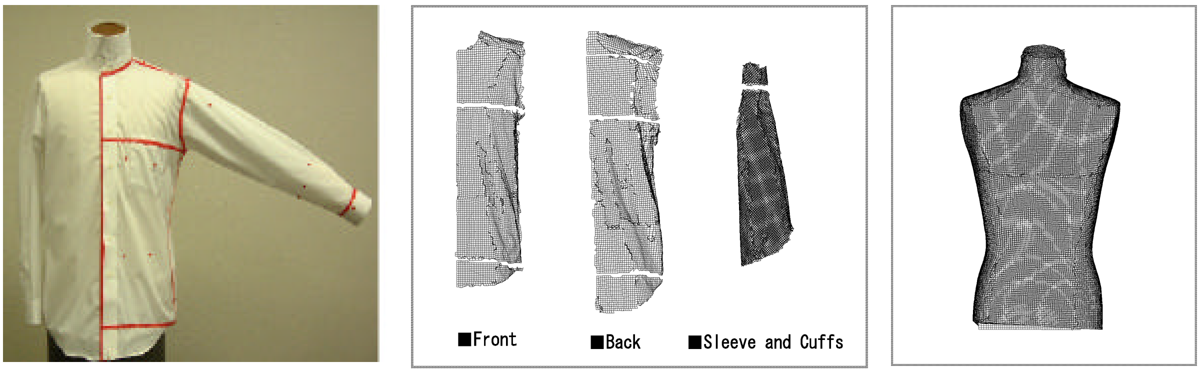


Fig.1 Arrangement of sample and measurement equipment



(a) (b) (c)

Fig.2 Color tape used to divide the shirt into different sections (a) Shape data after dividing (b) Body model (c)

Height limitation of object in three-dimensional measure equipment (VIVID700/MINOLTA) is around 550mm-600mm. However, the total height of the dress shirt exceeds this limitation. Therefore, we measured the sample in two stages for upper and lower parts. The arrangement of sample and measurement equipment is shown in Figure 1.

When the size information of the pattern is extracted, various point must be identified, as the yoke joint point, the end of side line point, bust line point, joint point of sleeve and joint point of cuffs. Therefore, we extracted data from sections defined and divided them by these reference points. The data from these sections was subsequently combined in the pattern remaking system.

A colored tape was used to enable the VIVID software to recognize the divisions between parts. As a result of this process we obtained 9 distinct files such as 3 parts of the front bodice, 4 parts of the back bodice, a sleeve part and a cuff part. Figures 2(a) and (b) show the colored tape used to divide the shirt into the parts.

Figure 2(c) shows the body model obtained using the VIVID700.

3. Establishment of size information of clothes and of pattern construction

The traditional method for making two-dimensional pattern for three-dimensional objects is based on area measurement [6]. On the other hand we attempted to achieve size information of clothes for pattern construction by identifying each corresponded point between the pattern and the three-dimensional data. Information needed for pattern construction are length dimensions such as full length, length of bust line, etc. To gain length information we developed formulae that are able to calculate corresponding pattern points using knowledge of traditional pattern construction. We constructed patterns using these formulae. Paper patterns are geometrical figures determined by the type of clothes. The dress shirt pattern used in this research is based on the Bunka pattern for men [7].

Knowledge of traditional pattern construction is used to calculate relationships between lengths when a certain length is altered. Traditional grading knowledge was extremely useful in developing our method for pattern construction. After calculating representing points using formulae as mentioned before, we connected these points by straight line or spline line for making pattern construction [8].

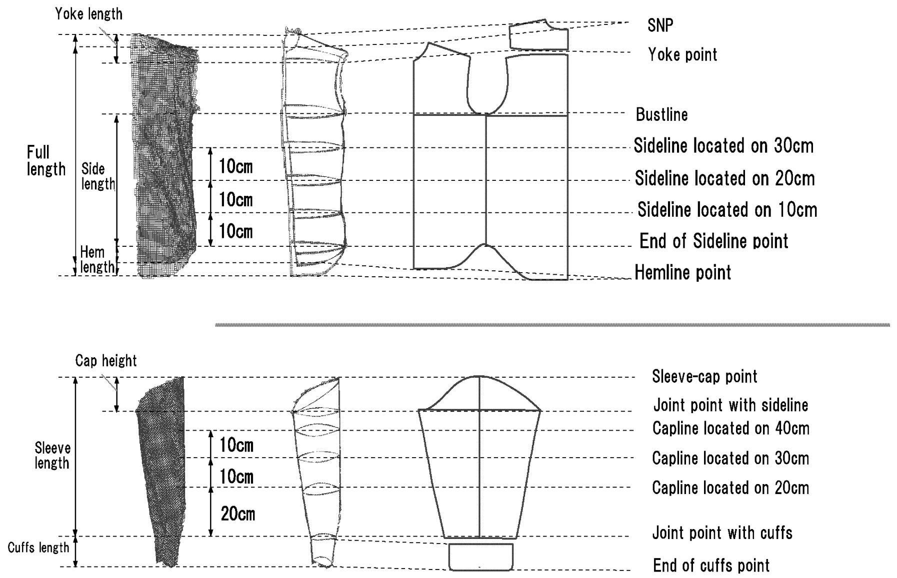


Fig.3 The extraction items for dress shirt construction

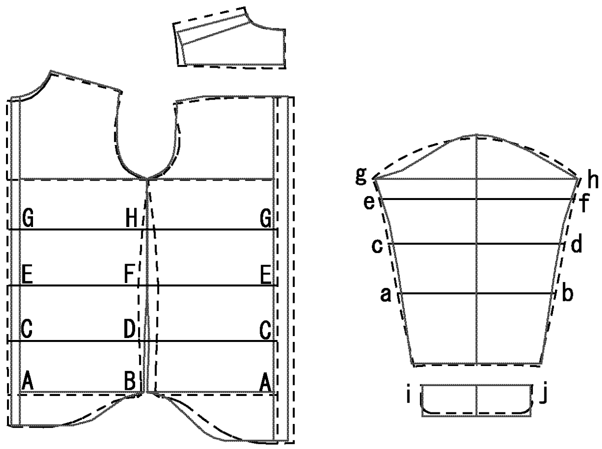
At first, the identification of corresponding point between pattern and three-dimensional data, we determined which point was essential for pattern construction. Figure 3 shows corresponding essential points of dress shirt between pattern and three-dimensional data.

Three-dimensional data consists of cross sections of the model arranged at intervals of 10mm at the Y-coordinate. Each dimension was calculated using the distance between adjacent points on the cross section of the line model. Therefore, horizontal length dimensions were based on the distance between two points on the X, Z plane. On the other hand, vertical length dimensions were based on the distance between two points on the Y, Z plane. SP(shoulder point), curve line of pattern such as AH(armhole), neckline and capline were also calculated using formulae from traditional knowledge of pattern construction and original pattern. Front and back neckline curves were calculated from the SNP (shoulder neck point). Front and back hemline curves were calculated between the end of sidelines and hemline points. The yoke part was calculated from SP and SNP. SP was worked out using SNP, AHP and bust line length. The capline was calculated from sleeve-cap point and joint point of sideline by calculating the AH curve length. Also the AH curve length was calculated from bust length and SNP. Representing points for pattern construction were connected to each other by a straight lines or spline lines.

4. Comparison of our results with original pattern

Figure 4 shows a comparison of the original sample pattern with our results. The extracted size information from three-dimensional data was compared with the original patterns' size in Table 2.

Our results for bodices and sleeve were almost identical to those of the original patterns. The errors were quite small thus demonstrating the potential usefulness of our process. If there were three-dimensional data but no pattern information, clothes could still be constructed by this process.



(a) bodice part (b) sleeve & cuffs

Fig. 4 Comparison of the original sample pattern with our results

(----- original pattern, —— constructed pattern)

Table2. Comparison of size information from 3D extraction and original pattern

Object		Front bodice			Back bodice			Object		Sleeve & Cuffs		
Dimensions		M	A	E	M	A	E	Dimensions		M	A	E
Measuring point	Full length	766	770	-0.5	824	817	0.9	Measuring point	Sleeve length	520	515	0.9
	Hem length	80	73	9.6	117	107	9.3		Cap height	100	92	8.7
	Side length	440	457	-3.7					Cuffs length	70	63	11.5
	Yoke length				82	82	0.0		Length of sleeve opening	295	284	3.8
	Length of hemline	114	81	40.8	104	74	40.1		Length of a-b	354	374	-5.3
	Length of A-B	264	286	-7.7	269	259	3.9		Length of c-d	387	410	-5.5
	Length of C-D	265	268	-1.1	261	256	2.0		Length of e-f	431	456	-5.5
	Length of E-F	271	264	2.7	269	254	5.9		Length of g-h	460	473	-2.7
	Length of G-H	271	269	0.7	269	258	4.3		Length of i-j	245	253	-3.2
	Length of bustline	271	286	-5.2	269	275	-2.2		M=measured value(mm) A= actual measurement(mm) E=margin of error(%)			

Only a significant variation between 3D extracted data and the original pattern was present in the length of hem and hemline. This variation resulted from difficulties in measuring these dimensions due to looseness of the garment in these areas. Therefore, we tried to predict the shape of the hemline with a traditional knowledge of pattern construction. Nevertheless, it was difficult to estimate the shape of the hemline because of variations in hemline shapes as determined by the type of dress shirt. Hem shape and dimension however are not critical in determining the bodices shape of the dress shirt. Therefore the hem shape was not considered too important.

At present, our system is only capable of constructing patterns for the S shape sleeve capline. Further development will be necessary to enable to construct the rounded sleeve capline. Cuffs length had a variation because of including darts parts.

5. Extraction of length dimensions in product measurements

If length dimensions of product measurement are attained by this system immediately, it could be helpful for making a purchase more efficiently and quicker. There are 5 length dimensions in size information that length of neckline, cervicale to wrist, shoulder length, length of bust line and length of waistline. The length of neckline is same as the length of neckline curve. The length of cervicale to wrist is calculated by the distance from back neck point to the back shoulder point in the X coordinate and added to sleeve length and cuffs length. The shoulder length is calculated by distance from the back neck point to back shoulder point in the X coordinate. The length of bust line is a length of cross section of line model of bust part file in the lowest point in the Y coordinate. The length of waistline is the shortest length of cross section of line model in the waist part file.

6. The development of pattern remaking system

In order to alter clothes model and patterns to contour individual body shape interactively, we used a scaling of point group using a grading method in the horizontals and in the verticals. Grading method of the horizontals was determined in accordance with the ratio of increase or decrease of bust line length. Grading of the verticals was done in full length according to length of the waist in back. The scaling formulae are in the following;

$$fkSbai = \frac{sShuuBD[bust]/2 + 8(cm)}{ShuuFB[bust] + ShuuBB[bust]} \qquad fkHbai = \frac{\frac{sBDy[\max y]}{sBDy[0]} + SH + 35(cm)}{Mtake}$$

$fkSbai$; scaling magnification of horizontals

$fkHbai$; Scaling magnification of vertical

$sShuuBD[bust]$; length of bust line after contoured body

$ShuuFB[bust]$; length of front bust line of original data

$ShuuBB[bust]$; length of back bust line of original data

$sBDy[\max y]$; the top point in Y coordinate on body

$sBDy[0]$; the bottom point in Y coordinate on body

SH ; distance of hipline and length of waist in the back

$Mtake$; full length of original data

New coordinates for pattern construction are determined by multiplying scaling magnification of horizontals (fkSbai) to the X, Z coordinate of original data. Scaling magnification of verticals (fkHbai) is multiplied by Y coordinate of original data. We constructed the pattern remaking system enabling to alter the clothes model interactively using these formulae and individual body model [9][10].

This system has 5 GUI panels that represent three-dimensional clothes model (Fig.5a), the cross section model (Fig.5b), the section of pattern estimation (Fig.5c), the section for indicating size information (Fig.5d) and section enabling to control 3point of waist parts and full length (Fig.5e). According to the change of clothes model, the cross section model and pattern are changed automatically in this system.

Moreover this system includes dialogs for the body model that consists of height selection (155-164, 165-174, 175-185)(Fig.6B) and type of body shape (slim, moderately slim, average, moderately fat, fat)(Fig.6C). To operate these dialogs, customers choose their own height and their body shape. The three-dimensional body figure then appears on the screen and customers can alter 4 variables; length of neckline, shoulder length and length of waist line and bust line at will. Operating this system is easy using the scroll bars.

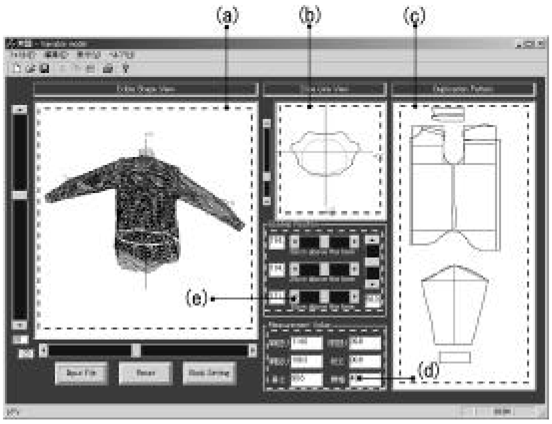


Fig.5 Pattern remaking system

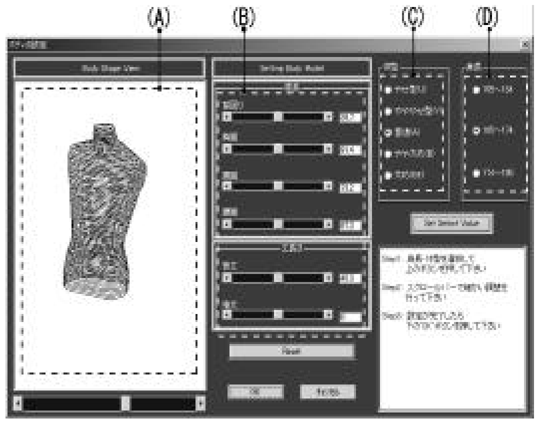


Fig.6 Dialog of body model

7. Conclusion

In this research, we attempted to establish the pattern duplication system using the three-dimensional data of the shape of clothes being worn, especially based on the knowledge of pattern construction. Moreover we tried to develop an interactive pattern remaking system, which can modify patterns to suit to body contour and shape three-dimensionally.

We verified the potential usefulness of our process by comparing our results with the original pattern. At first, the bodice and sleeve sizes of shirt obtained from three-dimensional measurement data were almost identical to those of the original paper patterns. This fact supports the potential usefulness of our process. Secondly, the use of the three-dimensional pattern-remarking system, featuring interactive modeling with a cross section model and section of pattern estimation, could be used to easy accommodation of individual body shapes.

Application of this pattern-remaking system using apparel CAD is expected to automatically customize clothes and be more efficient. In the future, it may be possible for customers during the buying process, to not only modify the pattern to match the contours of their own body shape, using this system on the internet or catalogs, but also for apparel manufacturers to communicate with their customers by describing the clothes model to fit on the screen while in the ordering process.

Reference

1. Cynthia L. Lstook. Enabling mass customization; computer-driven alteration methods. International Journal of Clothes Science and Technology, Vol.14, No1 (2002)
2. Makabe haruko. The pattern making idea in the future. Textile research journal, Vol.33, No3 (1992)
3. Yasuo Watanabe. Ordering your cloth to fit yourself; A custom-clothes system by using virtual environment. Pattern measurement symposium (1996)
4. Haruki Imaoka, Atsuo Shibuya. Recent Technology of CAD system for Garment Design. Textile research journal, Vol.46, No.3 (1990)
5. Yoshiyuki Sakagukhi. PARTY: An Numerical Calculation Method for a Dynamicaly Deformable cloth Model. The journal of the IEICE, D-Ⅱ Vol.J77-D-Ⅱ No.5 (1994)
6. Akira Shinohara: Ihukunokikagaku, kouseikann, pp24-72 (1997)
7. Bunka fashion kooza (Shinshi- fuku): Bunka Shuppankyoku (1989)
8. Farin, Gerald E: Curves and surfaces for computer aided geometric design. A practical guide,4th ed. (1996)

9. Kiyoshi Minemura, De-Zhong Wang. Interactive Pattern-Making for Dress or Suit Based on Measurements of a Body Form. Construction and Drafting, Vol.24, No.10 (1989)
10. Mingjie ZHANG, Masayoshi KAMIJO. An interactive pattern making and 3D simulation system of collars. Kansei Engineering International, Vol.1, No.4, pp1-10 (2000)