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COMPUTER AIDED DESIGN OF INDIVIDUALIZED BEST FITTING PANTS

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ABSTRACT

An automated design system for making the best fitting pants considered personal figures was developed. The best fitting pants means fitter pants for individual body than ready-made clothes in this study. It would be more comfortable to wear than ready-made clothes and not restrict persons' movement. Three-dimensional body shapes of wearing persons were obtained by 3D scan of the persons or by a deformable virtual body which reflected a person's measurements. Then, we made a three-dimensional pants model which wrapped the virtual body. Appropriate allowance was added to the measured body shape from the waistline to the hip line to make the three-dimensional pants model. In making a pants model, the most important configuration, which should be controlled, could be the crotch line of pants. The crotch line is a line of intersection for median plane in the pants model. In our previous study, the crotch line was extracted from the body shape before deformation. In this study, the crotch line of pants was made by connecting second order B-spline curve from determined node points. Abdomen protraction point or pubic symphysis point, intersection of median line and gluteal fold line were selected as the node points in the front part. The stuck out point of buttocks part, intersection of median line and gluteal fold line were selected as the node points in the back part. Allowance to the crotch line was given by moving the bottom node of spline curve down. The entire model shape was changed according to the deformation of crotch line. The leg parts of pants model were obtained by deforming the leg shape of the body model straight. The allowance for legs parts was given by magnifying the hip line. The patterns were made by the automatic draping system which we developed with a previously mentioned pants model. As a result of wearing the pants which we made by this system with three dimensional measurements of wearing persons, it was able to make pants that reflected individual figures. The made pants contained appropriate allowances for movement such as sitting down at seat, bending and stretching of legs, and walking. Furthermore, the buttocks part of those did not swell out and had better shapes than those made by the method of our

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previous study. In this study, it was possible to make the best fitting pants which reflected the shape of individuals by the presented method.

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Keywords: **Pants, Individualize, Pattern making, Clothing design**

1. INTRODUCTION

Wearing clothes is the most basic method to express a person's personality. Most people choose ready-made clothes which could fit ones personality and preference. However, the kinds of size are limited in ready-made clothes, and most people cannot wear clothes desired by being the fittest state. Haute couture or tailor making is an ideal method for making clothes for individuals. However, these custom-made clothes are expensive and take time. Furthermore, the results mostly depend on the tailor's skill.

In clothes producing process, a designer designs image of clothes and then a patterner makes a pattern of clothes according to the designer's design. Finally, a tailor sews cloth following the pattern. In pattern making, patterners draw paper patterns according to the measurements of body and design of clothes. They fit clothes to the personal figures of customers in custom-made processing. Due to the fitting process, custom-made clothes could fit customers.

With improving computer technology, the apparel CAD was used for drawing patterns. Recently, by adoption of three-dimensional simulation and 3D pattern making [1], it has been possible to simulate a humans body dressed in clothes [1]. However, it is not possible to create individualize patterns promptly and automatically because those pattern making systems make patterns out of consideration of individual body sizes, body silhouettes and three-dimensional characteristics for body.

Therefore, computerized 3D body models of the human have recently attracted attention in the apparel industry. And the development of making a 3D body model for better fitting clothing has been continuing. Although there are a number of research efforts in the field of 3D body modeling, almost none of those are focused on creating crotch lines of pants for an individual body shape.

In our early study, to make patterns for individuals, we changed a master pattern by adjusting clothes measurements to body measurements for each corresponding parts [2]. The virtual human body models for personal figures were also developed in our previous studies [3, 4]. We also developed a virtual fitting system afterwards [5]. By the system, we were able to cover 3D clothes model with a flexible cloth considering shearing deformation and make a pattern by cutting the 3D clothes model covered with cloth on a computer. We succeeded in production of tight skirts for individuals using the system and a 3D body scanner. Furthermore, we made a

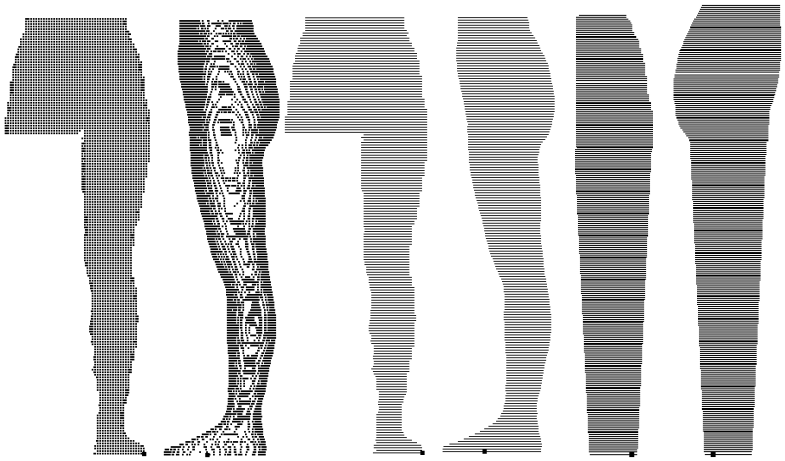
pants model and its patterns, but there was a problem that unseemly wrinkles (see Figure 1) were occurred when subjects worn those [6].

In this paper, we developed a 3D pants model adding allowance and constructing crotch line depending on various hip shapes. In order to investigate our methods, we tried to make basic pants patterns using 3D human body shapes.

Figure 1: Unseemly wrinkles on crotch line.

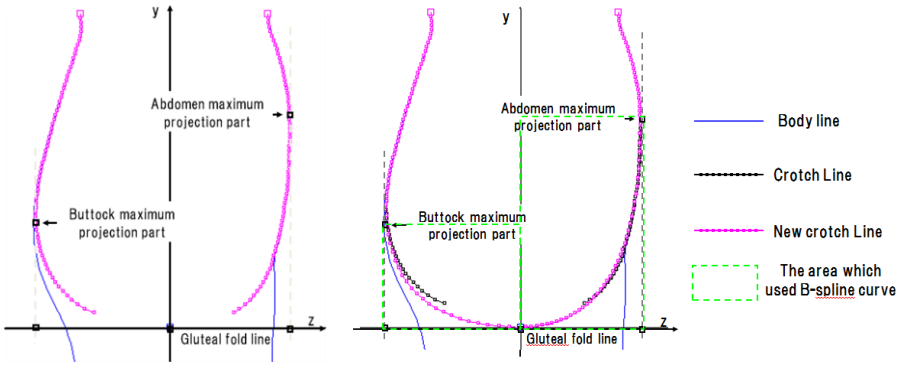
2. CONSTRUCTION OF PANTS MODEL

A three-dimensional body shape of a subject was obtained by 3D scan of a human body or by a deformable virtual body[3,4] which reflected person's measurements. Then, we made a three-dimensional pants model which wrapped the virtual body. Appropriate allowance was added to the body model from the waistline to the hip line to make the three-dimensional pants model. Figure 2 shows scanned body shape (a), horizontal line model (b), and pants model. We used horizontal line model as the virtual body because it was convenient to deform. Considering symmetry of a body shape, we used a single leg for making the pants model. Waist, stomach and hip shape express unique characteristics of an individual shape. Thus these factors were needed to be considered when we reconstructed 3D body shapes with allowances. We lengthened the hip line 4 cm more for body movement without changing the waist circulation. Other allowance for upper part was increased by a linear function from the waistline to hip line.



(a) (b) (c)

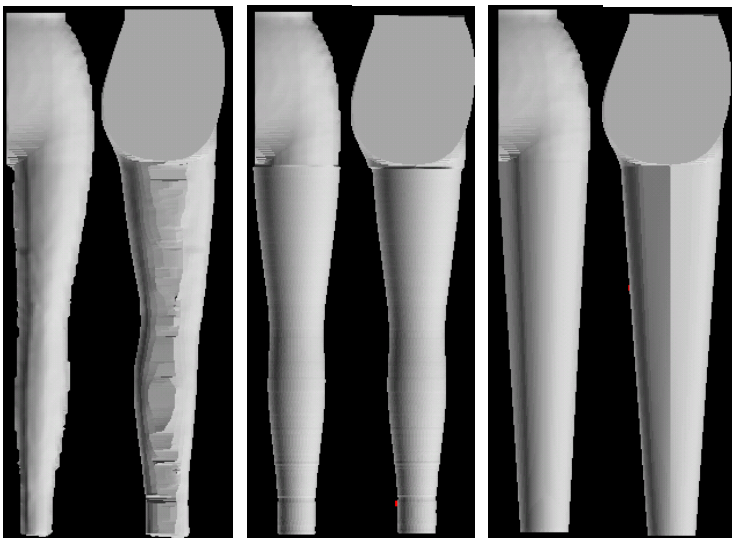
Figure 2: Construction of pants model from scanned body shape, (a) scanned body shape, (b) horizontal line model of body, and (c) pants model.



(a) (b)

Figure 3: Construction of crotch line, (a) crotch line obtained from body model, (b) new crotch line.

The crotch line is a line of intersection for median plane in the pants model. The most important configuration, which should be controlled, could be the crotch line of pants. Unseemly wrinkles could be occurred on pants if the crotch line was not appropriate. Figure 3 shows the construction of the crotch line. In our previous study, the crotch line (a) was extracted from the body shape before deformation. In this study, the crotch line (b) of pants was made by connecting second order B-spline curve from determined node points. Abdomen protraction point or pubic symphysis point, intersection of median line and gluteal fold line were selected as the node points in the front part. The stuck out point of buttocks part, intersection of median line and gluteal fold line were selected as the node points in the back part. Allowance to the crotch line was given by moving the bottom node of spline curve down. The entire model shape was changed according to the deformation of crotch line.



(a) (b) (c)

Figure 4: Construction of leg part of pants model, (a) scanned shape, (b) smoothed model, and (c) final pants model after reconstruction of crotch line and leg line.

Figure 4 shows the construction of the leg part. For the leg part of the pants model, we removed the noise in the scanned shape (a) and changed the cross section circumferences to circles with keeping the length of circumference and arranged the center of the figure (b). We chose two lines, crotch and ankle line and then reconstructed leg shape having allowances from the crotch part to the ankle part by 20% expanded circulation of ankle line and deformed the leg shape of the body model straight after reconstruction of the crotch line(c).

The patterns of those pants model were made by the automatic draping system [5] which we developed.

3. EXPERIMENT

Table 1: Measurements of subjects

Subject No (Sex).	Height [cm]	West [cm]	Hip [cm]	Thigh [cm]	Knee [cm]
1 (M)	167	74	88	52	34
2 (M)	170	69	87	49	34
3 (F)	155	70	87	53	34
4 (F)	158	71	90	55	30
5 (M)	169	81	96	59	40
6 (F)	167	67	93	55	33
7 (F)	157	64	87	50	31
8 (F)	156	65	85	47	29

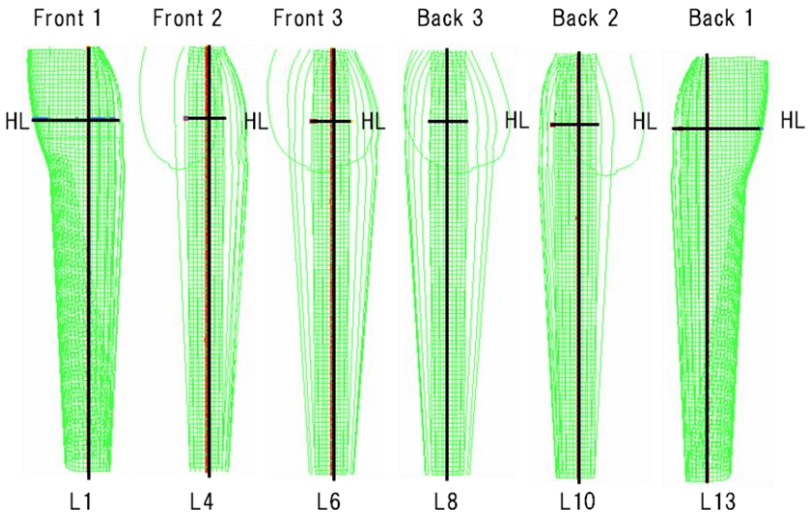


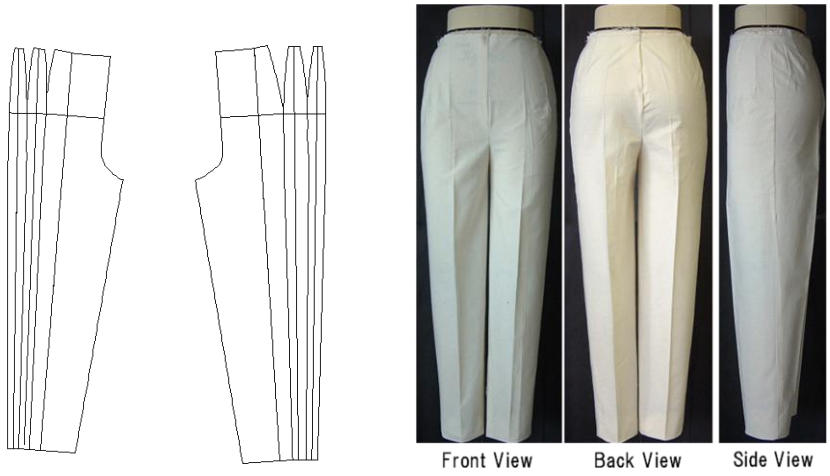
Figure 5: Pattern making process for dummy model

In order to verify our methods, we made pants patterns using 3D dressmaker's models and human body shapes. We chose a lower part body of dressmaker's model

(Kiiya Ladies', Waist: 63cm and Hip: 91cm) and eight 20's subjects. Table 1 shows the measurements of subjects. Each shape was scanned by a three dimensional scanner (Hamano Engineering Co. Ltd. VOXELAN) and each pants model was made by the method as previously described. There were five processes to produce the pattern. Those were as follows; (1) determining the number of panels and regions in the pants model to cover each panel, (2) setting grainlines of each panel, (3) covering pants model with the cloth model and cutting it according to cutting lines, (4) pattern development from 3D to 2D, (5) composition of panels. Figure 5 shows the process (3) for the dressmaker's model. Although setting grainlines and cutting lines is arbitrary in this system, we were able to obtain the pants pattern. Moreover the fabric characteristic (shear property) was taken into consideration on developing process.

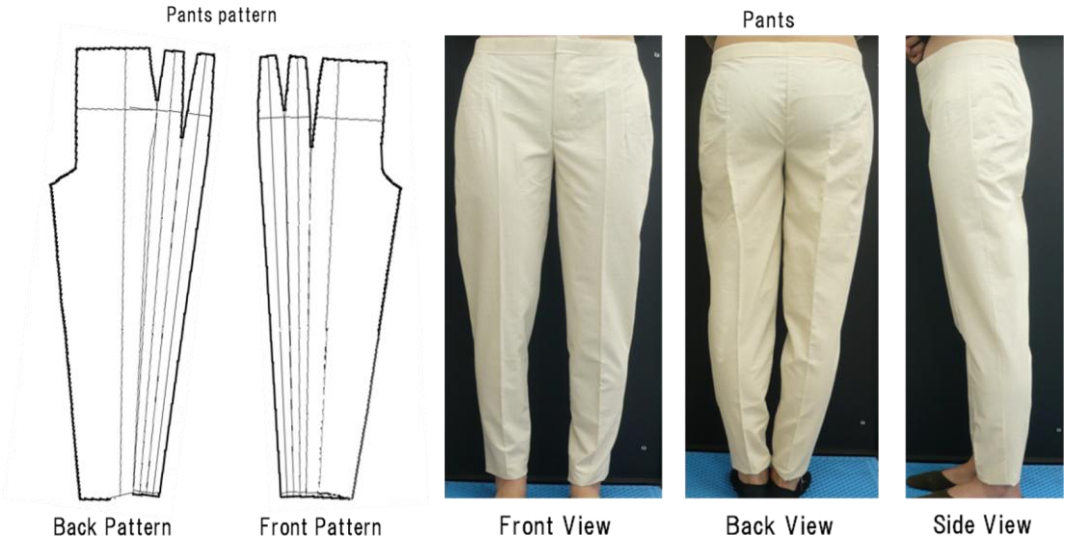
4. RESULTS

Figure 6 shows the produced pants pattern for dummy shape. We used 100% cotton fabric for making those pants. As shown in (a), complexly curved lines such as waistlines and dart lines were created automatically. The pants made with these methods showed a good appearance. Figures 7 and 8 show obtained the pants pattern for subject No. 6 and No.7 using our pattern making system. The subjects wore their pants and were satisfied with allowance for movement such as sitting down at seat and walking. Furthermore, the crotch line individually constructed depending on their hip shapes was fitted for their body shapes.



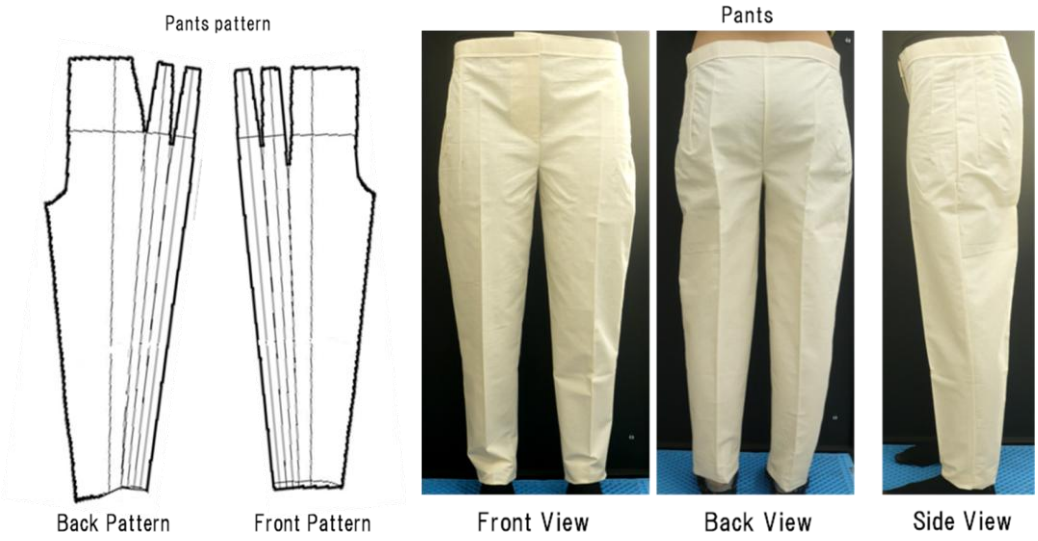
(a) (b)

Figure 6: Obtained pants pattern (a) and completed pants (b) for dummy body.



(a) (b)

Figure 7: Obtained pants pattern and completed pants for subject No.6.



(a) (b)

Figure 8: Obtained pants pattern and completed pants for subject No.7

5. CONCLUSION

We developed a computerized pattern making system for pants considering an individual body shape. We obtained pants patterns using reconstructed 3D body shapes by computerized pattern making system. In our pants patterns, complexly curved lines such as waistlines, dart lines and crotch line were created automatically using the developed method. We successfully used our methods to add allowance and reconstruct crotch line on the 3D human body shape for pants. As a result of wearing the pants, subjects were satisfied with ease allowance for movement such as sitting

down at seat and walking. In this study, it was able to make fitting pants which reflected an individual body shape. For the next step of our research, this method will be able to be used for pants of various designs.

ACKNOWLEDGMENTS

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