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CUSTOMIZED GARMENT DESIGN SUPPORTING SYSTEM FOR AGED PEOPLE USING DIGITAL DRESS FORM MODEL

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ABSTRACT: The aging society is rapidly increasing in Japan, and the percentage of middle-aged and older people are becoming over fifty. In senior citizens, the physique and posture varies remarkably being affected by reduction of muscle strength, osseous deformity and attrition, lack of physical activity, reduction of metabolism, increase of body fat, etc. Thus, they have to pay close attention to a matter of details such as the weight of the garments and compatibility which were never taken so seriously in their early days. The main objective of our study is to develop a customized garment design supporting system (CGDSS) for individual aged people using a Digital Dress Form Model. With this system, the customer is able to get comfortable garment only by measuring several parts of the body. There are two characteristic features in this system. The first is that considerable experience and expertise of dressmakers is embedded in the software, i.e., (1) estimation of body types, (2) allocation basis of ease, (3) appropriate drafting variations of panel lines or construction lines, etc. The second is a distinguished flow of garment design. We have previously measured the body shape of 52 aged females three-dimensionally and have extracted 8 body types in addition to body size variation. In the CGDSS, a suitable body type of customer is determined from among the 8 body types. Then Digital Dress Form Model of selected body type is deformed into personal model applying customer's body measurements and proper quantity of ease. The measurements of the body which is used for customization are as follows; "posterior length", "height of cervical from the level of hip line", "neck base line", "shoulder length", "bust circumference", "waist circumference", "hip circumference", etc. By using construction line and applying spring-mass model to the curved surface of the Personal Dress Form Model, the surface is automatically developed into plans as a garment pattern. In order to examine the validity of the system, we performed a trial production and evaluation test. The test result showed that our new system provided enough performance for garment pattern arrangement.

Keywords: Garment design, Geometrical modeling, Body types, Digital Dress Form Model, Aged individual

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1. INTRODUCTION

The tastes and activities of the elderly are in a state of change, and particularly amongst elderly women there is a rising demand for comfortable ready-made clothing [5]. In order to meet this demand, it is necessary to fuse technological skills with information technology and innovate established production processes. Traditionally in the field of ready-made clothing production, the method has been to create three-dimensional garment pattern data such as creating a garment pattern from a three-dimensional model [8],[11]. However, as a certain amount of ease has to be introduced after two-dimensional development, it has been impossible to confirm whether

there is an appropriate amount of ease without actually making a prototype garments. In response to this problem, Kakinuma [2],[3] ,[7] has proposed a technique for adding ease to a three-dimensional dress form model. However, as the size changes were made only by similar deformity, there were cases in which an appropriate amount of ease was not added to the proper parts of body. Thus although ease is an important factor in the manufacture of comfortable clothing, it is difficult to automatically set ease.

In order to accommodate changes in the body types of the elderly and design clothing which eliminates restraints to the body, we propose a clothing design system which (1) creates a Personal Digital Dress Form Model based on a personal body type of the elderly. This system should be capable of adding "ease" in advance by using methods newly proposed in this study; (2) this system should be able to develop garment patterns semi-automatically. Based on these capabilities, it is conceivable that a new system for selecting clothing from body types will be introduced in clothing markets where only traditional sizes have been available, and it may become possible to provide clothing corresponding directly to customers' orders.

In this study, in order to meet requirement (1), an investigation was conducted into the professional designers' clothing production processes and knowledge. We sought to clarify the current state and problems in the design and tailoring of clothing, learn what reference points are measured by experts, and understand the relationship between the garment pattern and the allowance of ease when creating garment patterns.

In order to accommodate individual variations in the figures of aged people, body figures were classified into eight typical body types using three-dimensional data taken from the elderly subjects, as proposed by Tsutsumi et al [9],[10], in the research on "Analysis of Human Figures by using Cross Sections of Aged People" in this Proceeding. Then we developed eight "Digital Body Type Models (hereafter, Body type Model)" from those typical body figures. Furthermore, we developed "Digital Dress Form Model (hereafter, Dress Form Model)" which is generated from the Body type Model. As a result, the Dress Form Model makes it possible to set construction lines and ease for each body type. [1],[4].

Next, in order to achieve requirement (2), we developed a method for providing eases to Dress form Model and as well as a method for elaborating a surface developments of Dress Form Model, employing a method by Mitani [6]. With this technique, a garment pattern plan can be obtained from a three-dimensional model directly.

Employing garment pattern plan described above, a system for the clothes design was constructed, and an evaluation of the results was conducted.

Below, in section 2, we describe research on the topics concerning the current state of clothing design in general as well as the specifics of clothing design for the elderly. In section 3, we give an outline of the proposed clothing design system and elucidate the relationships amongst the various parts of the system. In section 4, we explain the Body Type Model used in this system, and in section 5, we discuss the production of the Personal Dress Form Model which sets ease, thereby allowing for the changes in shape that the Digital Dress Form Model undergoes in order to match the body types of individual customers and to create garment patterns. In section 6, we show the development technique used to make a garment pattern with the Personal Dress Form Model. Next, in section 7, we present clothing design using the proposed system, a trial production and evaluation. Finally, in section 8, we summarize the results of this study.

2. A NEW APPROACH TO CLOTHING DESIGN

Traditional clothes ordering system follows the process laid out in Procedure A of Figure 1. After measuring the customer and using the measurements taken to become familiar with his or her body type, a two-dimensional garment pattern is created and localized corrections are made if necessary. Then, basting is done with actual cloth, and corrections are made to fit the customer's body type. Finally, clothing appropriate for the customer's figure is produced. The main point here is that the clothes are fitted to the body type when they are reconstructed three-dimensionally from the garment pattern (at the time of basting). It is difficult to produce comfortable clothing using the two-dimensional garment pattern presently in use, because the clothes are produced from standard body types and do not fit the body types of the majority of elderly people.

Therefore, to design clothing which fits the customer's body type, it is desirable rather to take three-dimensional information from a customer, feed it into a computer, and create a garment pattern based on the information, as laid out in Procedure B of Figure 1. In this study, we construct a system capable of performing Procedure B.

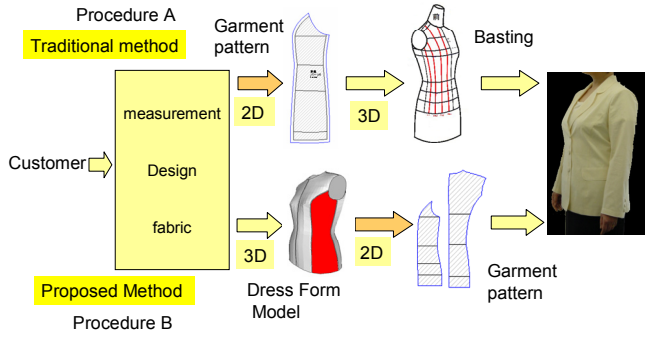

Figure 1: Traditional system and proposed system for customized garment design.

3. OUTLINE OF CLOTHING DESIGN SYSTEM

In this study, we propose a two-stage process for creating the Digital Model that will serve as the base for the garment pattern in the computer. The first stage is "Body Type Models" rendered from the classed body types of aged people. The other stage is the "Personal Dress Form Model" that has been adjusted using measurements taken from the customer and tempered with the appropriate ease.

The system's functions are divided roughly into three parts. The first function is the ability to create a Dress Form Model tailored to an individual. The second function is the ability to create a Personal Dress Form Model which provides ease, and the third is the ability to develop a surface of the Personal Dress Form Model and create plans for a garment pattern.

The procedure for creating a development plan for garment patterns using this system is as follows (Figure 2):

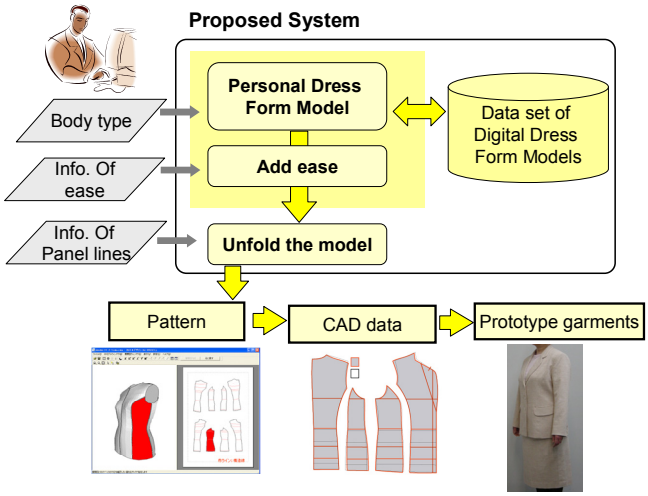

Figure 2: Overview of our system.

Step.1 The expert selects the appropriate Body Type Model for the customer's body type, and takes some basic body measurements. Using these measurements, a corresponding Personal Dress Form Model is created.

Step.2 After selecting the article of clothing to be made, a Personal Dress Form Model with an appropriate amount of ease added for that particular article of clothing is created. The article of clothing may be a jacket, blouse, skirt, dress, a pair of pants, etc.

Step.3 A panel line is input into the Personal Dress Form Model, and the plans for the garment pattern are created.
Based on the three procedures mentioned above, a CAD system creates the garment pattern using the plans, and a prototype garment is created.

The important functions of this system, namely (1) the procedure for creating a Body Type Model using actual body type measurements, (2) the procedure for creating a Personal Dress Form Model by using customer's measurements and adding ease, and (3) the procedure for creating plans for a garment pattern by adding a panel line will be discussed in sections 4, 5 and 6.

4. GENERATING A BODY TYPE MODEL

In this section, we will discuss the procedure for creating the Body Type Model as well as how to set the construction lines on the model.

4.1 The construction lines for creating a Body Type Model

With help from specialists and designers, we examined the Body Type Model's construction lines, which are needed to create a garment pattern. Because the construction lines serve as reference lines, when developing the surface of Dress Form Model as garment pattern, their position is highly important. As shown in Figure 3, construction lines include several horizontal and vertical lines. Each of the Body type Models are rendered along these horizontal and vertical lines. The total number of construction lines is set at 36, with 9 base construction lines, 19 horizontal lines, and 8 vertical lines.

For women, plural horizontal lines are necessary for the chest area. A number of construction lines correspond to the positions of the horizontal cross-section taken for the classification of various body types [9,10].

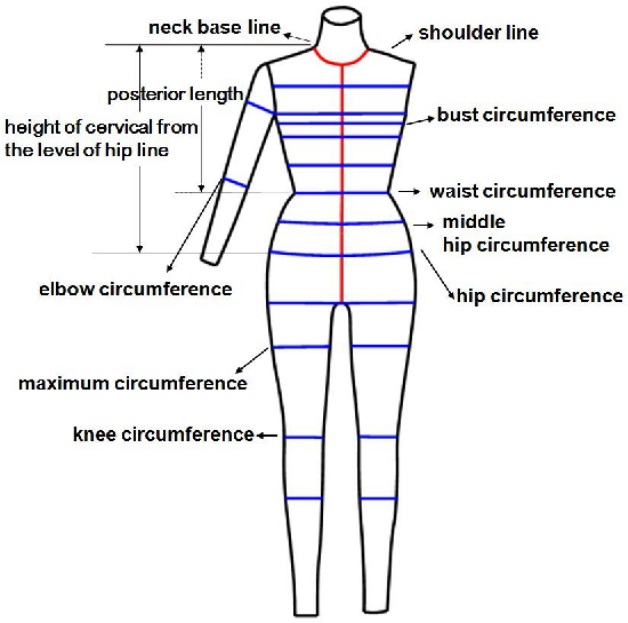

Figure 3: Anterior mesh construction lines.

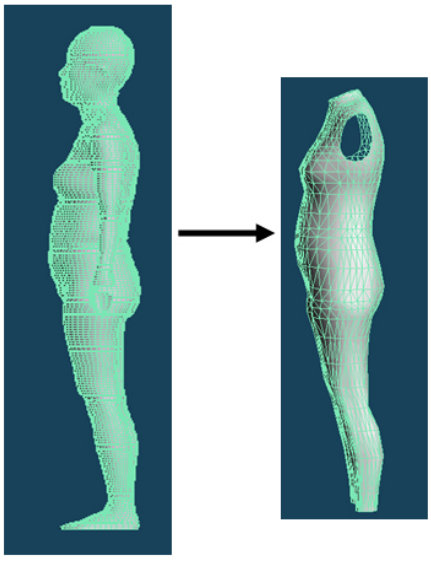

Figure 4: Creating a Body Type Model.

4.2 Creating the Body Type Model

The Body Type Model used is a triangular mesh model, which allows the construction lines discussed above to be clearly displayed, at the same time decreasing the number of polygons from the measurement results (Figure 4). On the basis of the results of the body type classification, 8 different Body Type Models have been created (corpulent//slim, "round body//flat body", "Straight back// Stoop" and "forward-leaning//backward-leaning").

5. GENERATING A PERSONAL DRESS FORM MODEL

When creating a Personal Dress Form Model for an individual customer, the first step is to select the Body Type Model which most closely resembles the body type of the customer.

Next, basic measurements are taken from the customer, and corresponding regions of the Body Type Model are altered to reflect these measurements. There are 36 basic measurements, including posterior waist length, posterior hip length, neck baseline, posterior shoulder width, posterior shoulder girth, upside bust girth, bust girth, underbust girth, waist girth, middle hip girth, hip girth, etc.

Thirdly, appropriate quantities of ease for each part of the customer's body are provided.

5.1 Importance of ease

Ease for the purpose of creating apparel means that there is a good amount of space between the clothing and the wearer. No matter the silhouette, ease is necessary. There are three reasons for providing ease: (1) for freedom of movement (wearability), (2) to maintain the clothing's lines and (3) to satisfy the wearer. When providing "ease" for the purpose of producing a garment, the workman usually decides the optimum quantity of ease for each part of the customer's body, taking into account both the customer's body type and her tastes. This process requires an expert's skill and knowledge, and in the past was it very difficult to load this process into a computer.

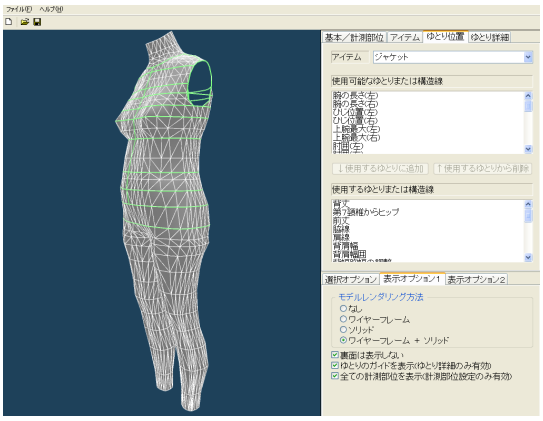

Figure 5: Reading the personal dress form model.

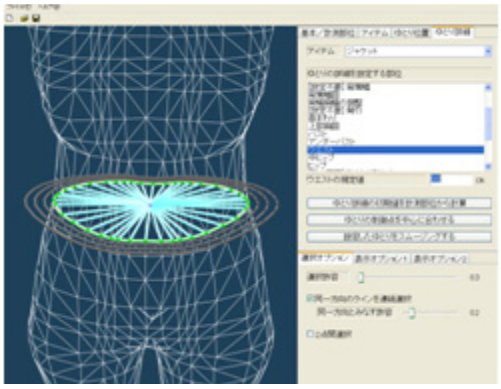

Figure 6: Setting ease.

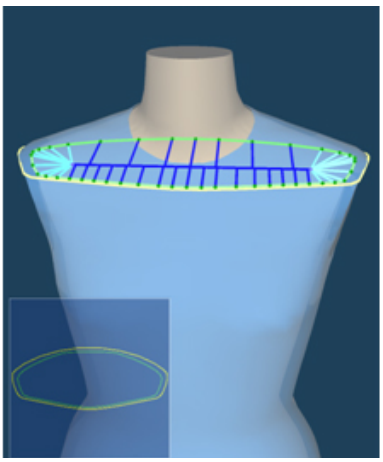

Figure 7: Setting ease for a flat portion of the garment.

5.2 Procedure for providing ease

In order to provide ease, the Body Type Model is being read (Figure 5), and the article of clothing is being selected. Then ease will be provided, and a Personal Dress Form Model will be completed.

There are two ways to provide "ease": (1) scale the entire profile line almost uniformly, by radially expanding out from the position of the figure's center toward the cross-sectional outline (Figure 6), and (2) when chiefly scaling in the direction of the width, to specify two places on the right and left sides of the outline, and scale by radially expanding out from the position (Figure 7). The former procedure applies when cross-sectional outlines are almost perfectly circular, such as the case with the waist area, and the latter applies when the cross-sectional outlines are flat, for example, with shoulders.

6. METHOD OF MAKING THE GARMENT PATTERN PLAN USING PANEL LINES

In order to make the plans for a garment pattern, the user sets the panel lines to the Personal Dress Form Model. The garment pattern cut using these panel lines can be output to an apparel CAD program in a compatible format.

As is shown in Figure 8, this system reads the three-dimensional mesh model displaying the personal dress form shape, and displays it on the screen. At the same, the user sets the panel lines on the model surface. To set the panel lines, four different methods were implemented: moving the mouse cursor, the shortest route on the mesh that connects two points, a straight line, or a Bezier curve. The procedure proposed by Mitani [6] was used for the topological operation which actually cuts the mesh model with the set panel lines. After setting the panel lines, the system automatically generates the pattern plans.

Basically, a Dress Form Model takes its shape from curved surfaces, and because it has undevelopable surface, it is impossible to develop the surface without warping it. With this system, a spring-mass model is used in which the vertices of the mesh model are replaced with mass points and edge lines are replaced with springs. By repeating simulations in which energy from expansion and contraction of the spring is minimized, a garment pattern plan with low warpage was developed from the original mesh. The construction line from Dress Form Model is mapped onto the garment pattern, and then the garment pattern can be edited and processed in the following process. Once the garment pattern has been developed the construction lines are displayed over the plans in red.

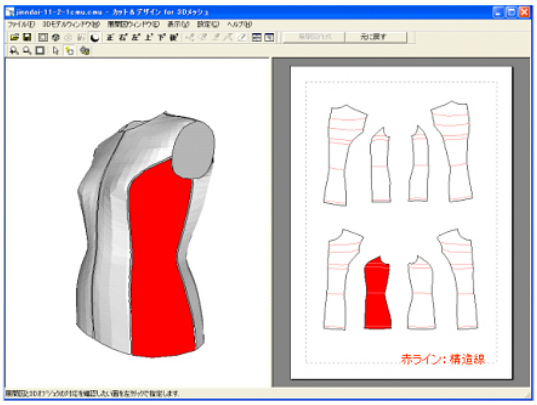

Figure 8: Plans for generating a garment pattern.

7. CLOTHING TRIAL PRODUCTION AND EVALUATION

In this section, we will discuss trial production based on this system. The purpose of the trial run was to examine the fit of clothing produced by this system. In the trial, a jacket was created for an individual, and the fit of the jacket was evaluated using a garment pattern plans (Figure 8). A jacket which was designed using the same design, size, ease and cut, made for the same individual, by a professional designer, using traditional methods, was used for comparison.

Figure 9 shows the result drawings of the garment pattern using a CAD system.

Figure 10 shows the garment pattern generated in the trial and the one based on the designer's jacket, using the bust line as a reference line. In the garment pattern made by the system for this trial, the following differences were observed: (1) the position of the waist and hipline was high, (2) the front portion of the collar stand wide, and (3) the slope of the posterior shoulder was different. The difference in shoulder slope originated from problems during the three-dimensional measurement of the individual.

Figure 11 show the trial participant wearing the test jacket and the designer-tailored jacket. The participant's impression was that there was no noticeable difference in the fit. In regard to wearing, observer also couldn't find any wrinkles or stretching that reveal poor fit. Based on these test evaluations, it can be said that clothing created using the Personal Digital Dress Form Model is not haute couture, but there is no doubt that it fits the customer and is comfortable to wear.

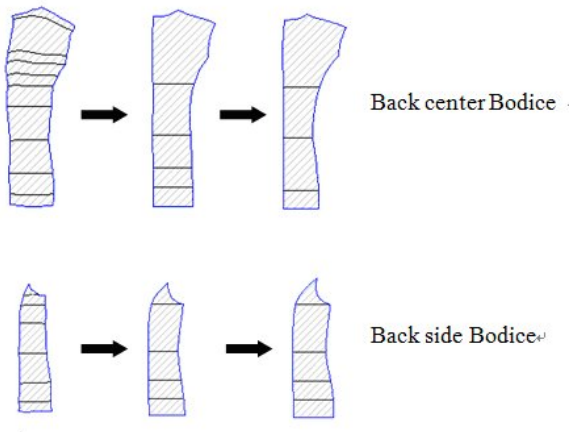

Figure 9: Back Panel pattern manufacturing step.

8. CONCLUSION

In this study, in order to design clothing which accommodate changes in the body

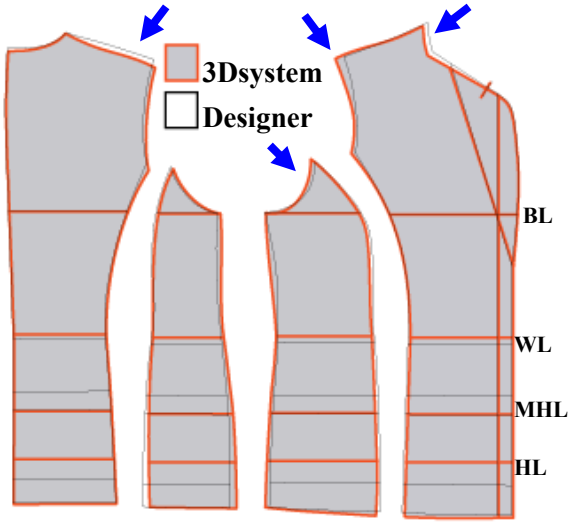

Figure 10: Comparison of a pattern.

(a) Trial production (b) Designer's

Figure 11: Comparison of trial jacket and designer-tailored jacket.

types of the elderly and eliminates restraints to the body, we created and evaluated a clothing design system in which (1) we creates a Body Type Models based on body types of the elderly. It is able to make Personal Dress Form Model providing "ease" and customer's size; (2) the system develops garment patterns semi-automatically. The following results were observed:

(1) By using a Body Type Models classed by body type, it is easy to produce clothing

which accommodates the body type of a customer.
(2) By having proposed a method for setting ease, we were able to create a Personal Digital Dress Form Model for garment pattern development which accommodates changes in the body types of the elderly and eliminates restraints to the body.
(3) By setting the panel lines which serve as design lines on the Personal Digital Dress Form Model, it was also possible to develop garment patterns with high design characteristics.
(4) In terms of test production however, clothing could only be produced for one individual, and though it did not reach the level of high-class ladies' tailoring, the item of clothing produced using the Body Type Digital Dress Form Model was no doubt easy to wear and had a good fit for the person it was made for.

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