Development of a measuring garment for a woman’s upper body shape

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Abstract: We have developed a measuring garment for the shape of a woman’s upper body for personalized garment design. A stretch sensor with a linear relationship between the elongation and capacitance was used. Twenty one measurement locations were determined based on the required measurements to make a basic pattern. Twenty one sensors were sewn on a long-sleeved T-shirt corresponding to the measurement locations. The capacitance of each sensor was measured while a subject was wearing the measuring garment. We estimated the measurements owing to short length of the sensor compared with the measurement gauge. Because there were linear relationships between the measured dimensions by the three-dimensional (3D) scanner and the capacitance values from the sensors at all of the measurement locations, we used the linear regression equations to estimate the measurements. An upper garment pattern for the subject was successfully created using the obtained measurements. To confirm the fit of the pattern, a wearing simulation was performed using a 3D apparel simulation system. It fitted well on the subject without wrinkles and redundant ease. Therefore, it is possible to measure a woman’s upper body using the proposed measuring garment.

Keywords: Measuring garment, woman’s upper body shape, body dimensions

1. INTRODUCTION

In the apparel industry, the need for personalized clothing has increased. To make an article of personalized clothing, it is necessary to measure individual body dimensions and shapes. These are related to not only wearing comfort, but also Kansei. Three-dimensional (3D) scanners have been used to measure individual body dimensions and shapes [1]. However, a stationary-type scanner with high precision is still expensive and requires a skilled operator. Measuring garments for body dimensions have been proposed, such as the Zozo suit [2]. Although they can measure body dimensions, the effectiveness of the measured dimensions for making clothing has not been verified. Iguchi et al. [3] proposed measuring clothing for a man’s shoulder shape using stretch sensors. However, the shape of the upper body differs greatly between women and men, especially in the shape of the bust. In this study, we developed a measuring garment for the shape of a woman’s upper body for personalized garment design. We also investigated the effectiveness of the developed measuring garment by creating a garment pattern using the measuring garment.

2. EXPERIMENTAL METHOD

To measure the body shape, twenty one measurement locations were determined based on the required measurements to make a basic pattern (Figure 1) [4]. A stretch sensor (Stretch Sensing Element, Stretch Sense Ltd., effective gauge length 70 mm × 26 mm) with a linear relationship between the elongation and capacitance was used. Twenty one sensors were sewn on a long-sleeved T-shirt (81% polyester, 19% polyurethane) corresponding to the measurement locations. The capacitance of each sensor was measured while subjects were wearing the measuring garment. Because the length of the sensor was short compared with the measurement gauge, we compared the relationships between the measured dimensions obtained with a 3D scanner (Bodyline Scanner, Hamamatsu Photonics Co., Ltd.) and the capacitance values from the sensors at all of the measurement locations. We then obtained regression equations to estimate the measurements. The subjects were 10 female university students in their 20s.

The validity of the proposed method was confirmed by creating a basic pattern of the upper body using the
obtained values from the regression equations. To create the pattern, it was necessary to determine the bust dart amounts and angles. We calculated the required bust darts amounts and angles from the measurements using the cosine theorem. To confirm the fit of the pattern, a wearing simulation was performed using a 3D apparel simulation system (CLO enterprise, CLO Virtual Fashion LCC).

3. RESULTS AND DISCUSSION

The relationships between the measured dimensions obtained with the 3D scanner and the capacitance values from the sensors for locations ③ and ④ are shown in Fig. 2. For all of the measurement locations, there were linear relationships between the measured dimensions and the capacitance values from the sensors. Therefore, we were able to estimate the measurements using the regression equations and capacities. The differences were less than 1 cm at most of the measurement locations, except some locations of particular subjects. For sensors ⑬, ⑭, and ⑮ in the bust area, the differences between the estimated measurements and the actual dimensions were about 1 to 2 cm for only two subjects. For sensor ⑭ of subject 7, the measured dimension was 2.3 cm shorter than the actual dimension. Regarding sensor ⑭ of subject 7, the sensor did not extend to the armpit owing to the subject’s large bust. A pattern for subject E was created using the measured values. Because sensors ③ and ⑤ were located at symmetrical locations, ③ was used for pattern creation. For locations ⑬ and ⑭, and ⑬ and ⑭, ⑬ and ⑭ located on the right side were used to create the pattern for the waist dart positions. A wearing simulation was performed on the 3D scanned body of subject 5 (Fig. 3). It fitted well on the subject without wrinkles and redundant ease. Therefore, a woman’s upper body was able to be measured using the proposed measuring garment and the validity was confirmed.

4. CONCLUSION

We have developed a measuring garment for a woman’s upper body for personalized garment design using a stretch sensor. We also propose a pattern-making method for a basic upper pattern. An upper garment pattern for a subject was successfully created using the obtained measurements from the developed garment. The clothing fitted well on the subject without wrinkles and redundant ease. Therefore, it is possible to measure a woman’s upper body using the proposed measuring garment. In the future, we will make patterns for more subjects to verify the effectiveness of the proposed measuring garment.

![Figure 1: Locations of the sensors on the front bodice](image1)

![Figure 2: Relationship between the actual dimensions and the capacitance for sensors (a) ③ and (b) ④](image2)

![Figure 3: Wearing simulation of the created pattern on subject E](image3)

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