Human Body Shape Imaging for Japanese Kimono Design

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Abstract *– A yukata is a type of traditional Japanese kimono. An alignment of its texture pattern is an important factor of the yukata design. The wearing condition of the yukata is affected by the wearer's body shape and the way of wearing the yukata. Accordingly, three dimensional display of the yukata is necessary for designing the yukata. In this paper, we developed human body shape imaging system for yukata design. At first, we developed an algorithm to measure the wearer's upper half of the body that is important to display the wearing condition of the yukata. Secondarily, we developed an algorithm to map the texture pattern of the kimono cloth on the wearer's body shape. The designer and the wearer can make sure the condition of the texture alignment exactly because the yukata is displayed three dimensionally on the wearer's body shape.*

Keywords *– Japanese kimono, Yukata, Apparel CAD, Image processing*

I. INTRODUCTION

A yukata is a type of traditional Japanese clothing. An alignment of its texture pattern is an important factor of the yukata design. The wearer has difficulties to know about the impression of the ordered yukata. Therefore, three dimensional display of the yukata is necessary for the designer and the wearer to evaluate the result of the texture alignment. We have developed a CAD system for Japanese kimono and the measurement system for the wearer's body shape[4], [5], [6], [7] .

The most important area of the yukata design is the front side. The measurement of the wearer's upper half of the body and the outline of the body is important to display the wearing condition of the yukata. In this paper, we describe about the human body shape imaging system for the yukata design. At first, a imaging system for the wearer's body shape is developed. Secondarily, three dimensional display method of the yukata based on the yukata design is developed.

II. METHODS

A yukata is one of the kimonos. The yukata consists of several parts; a right body, a left body, a right sleeve, a left sleeve, a right overlap, a left overlap and a collar. There is traditional wearing way of the yukata. At the wearing of the yukata, the wearer adjusts the positions of the yukata parts to the specific positions of the wearer's body. The back center of the yukata and the wearer's body is adjusted each other. The height of the yukata hem is adjusted to the wearer's ankle. The woman folds the kimono cloth at the waist when she wears the yukata. The folded area is called a tuck. The tuck makes her look tall. In this way, the positions of the texture patterns are changed by the wearer's body shape and the wearing method. Accordingly, measurement of wearer's body shape is necessary for achieving the three dimensional display of the yukata.

A. Imaging system for the wearer's body shape

We developed an imaging system for the wearer's body shape as shown in Fig.1. The imaging system consists of two CCD cameras, a LCD(Liquid Crystal Display) projector and a computer. To measure the wearer's body shape, a color pattern is projected to the wearer's body using the LCD projector. The color pattern is a green circle and taken by two CCD cameras that are placed in parallel to the measurement system. The wearer's wears colorless cloth by the measurement and the circle pattern has a color. The subtraction image between the green color components and the blue color components of the circle pattern is obtained. The region of the circle pattern in the subtraction image is detected using thresholding. Then, the center position of the circle pattern is used as corresponding

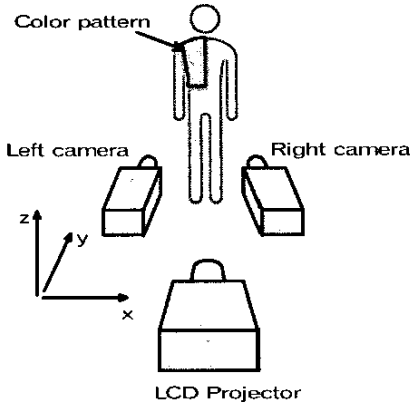


Fig.1. Imaging system for wearer's body shape.

points of the left camera and the right camera to measure a distance between the camera and the body of wearer.

Fig.2 shows the ROI(Region of interest) area of the wearer's body. We measure the right half of the wearer's body because the human body is symmetrical. At first, the 5 points ①,②,③,④ and ⑤ are manually pointed out on the wearer's body outline. The outline of the wearer's body is approximated by the straight lines ①-②,②-③,③-④ and ④-⑤. Next, 3 regions of interest(ROI) are set. (m+1)×(n+1)points of circle pattern are set on each ROI. Fig.3 shows the positions of the circle pattern in ROI2. The circle pattern is projected on a grid pattern that is (m+1) in row and (n+1) in column. The (n+1) of circle patterns are projected from the center of the body to the outline on the line i=3.

The distances between the points of the wearer's body and the camera are calculated by the stereovision method. The distance y from a measurement point to the camera is given with the following equation.

$$y = \frac{f \times d}{x_l - x_r} \tag{1}$$

where the x_l is the position of the measurement point in the left image and x_r is the of the measurement point in the right image. The f is the focal distance of the left camera and the right camera. The d is the distance between the left camera and the right camera. However, it has difficulties to obtain the value of f and d . The measurement range is very close. Accordingly, the measurement y is obtained following equation.

$$y = A(x_l - x_r) + B \tag{2}$$

The value of A and B are experimentally determined.

In this way, the wearer's body data is derived as the distances between the camera and the measurement points.

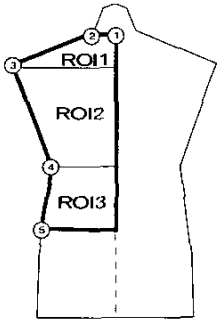


Fig.2. ROI areas for the wearer's body.

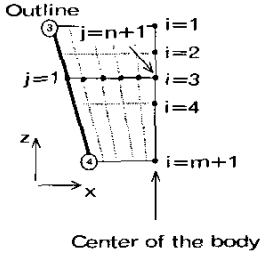


Fig.3. Measurement points for the ROI2.

B. Human body shape imaging for the yukata

Fig.4 shows a basic shape of the human body. Three data of the wearer's size, that is, height A, hip B and shoulder plus sleeve length C are measured. The shoulder plus sleeve length is the length from the wrist to the base of the neck when the wearer horizontally stretches one arm. The wearer's body shape of the wearing condition of the yukata is roughly approximated by the elliptical column. The size of the elliptical column is determined by the wearer's sizes. After the obtaining the upper half of body shape, the basic shape of the yukata is replaced by the wearer's body shape. The outline of the upper part of the body is represented by 5 straight lines. A point e shows a point of the basic shape of the yukata. The position in z axis is interpolated by the measurement data c1, c2, c3 and c4 that are near to the v in x-y plane. d1, d2, d3, and d4 are the distance between the e and c1, c2, c3 and c4 in x-y plane. The position of the e in y axis are derived by following equation.

$$y = \frac{\frac{y1}{d1} + \frac{y2}{d2} + \frac{y3}{d3} + \frac{y4}{d4}}{\frac{1}{d1} + \frac{1}{d2} + \frac{1}{d3} + \frac{1}{d4}} \tag{3}$$

where, the y1, y2, y3, and y4 are the positions of the c1, c2, c3 and c4 in y axis.

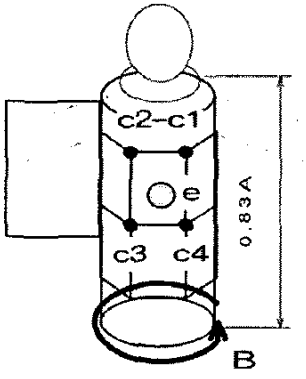
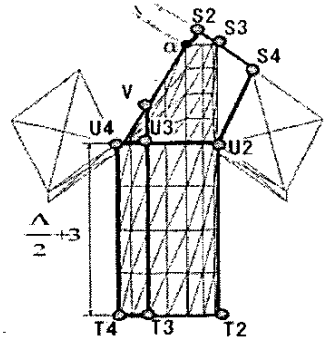
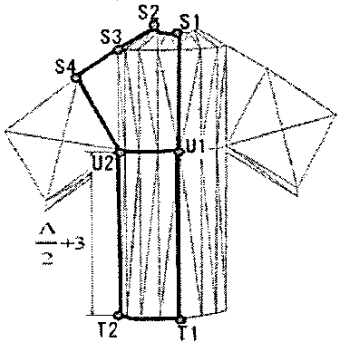


Fig.4. Basic shape of the human body.

Fig.5 shows the texture arrangement of the yukata to the wearer's body. The back center, the left ankle, the right ankle, and the ridge of the shoulder become the corresponding points between the wearer's body and the yukata when the texture pattern of the yukata is mapped on the wearer's body. Fig.6 shows the kimono cloth of the yukata. The sizes of yukata parts are calculated using data of the wearer A, B and C by traditional yukata making method. The shape of the left body is a rectangle. The left body is folded at the center. The left part is the backside of the left body and the right side is the front side of the left body. The gray area shows the tuck. The size of the tuck decided so that the left body is suited on the wearer's body shape. Therefore, it is important the method of positioning of the left body. Corresponding points between the wearer's body shape and the kimono cloth such as S1, S2, T1 and U1 are set by the wearing method of the yukata as shown in Fig.5 and Fig.6. Points S1, S2, S3 and S4 can be set at the fold line of the left body in Fig.6. The point S4 in Fig.5 is decided so that the length of a curve S1, S2, S3 and S4 is equal to the width of the left body shown in Fig.6. The position of the tuck is slightly longer than a half of the wearer's height. Therefore, the position of the points U1, U2, U3 and U4 are calculated by the wearer's height. The wearer's body shape is represented by triangles as shown in Fig.5 a). The point α in Fig.6 is set so that the distance between the point S2 and the point α is equal to the distance d that is derived in Fig.5 a). The texture pattern in the triangle S2, α, S3 in Fig.6 is mapped to the triangle S2, α, S3 in Fig.5 a). In the same way, the other part of the texture pattern is divided into triangles corresponding to the wearer's body shape and mapped to the wearer's body. The texture patterns of the right body, the right sleeve, the left sleeve and the left overlap are mapped on the wearer's body in similar way.



a) Front view.



b) Rear view.

Fig.5. Texture arrangement of the yukata to the wearer's body.

III. RESULTS

A woman who is 150 cm in height, 63 cm in the shoulder plus sleeve length and 94 cm in the hip designed herself her own yukata.

The wearer sits on the chair in front of the measurement system. The system is set so that the distance between the wearer's body side and the camera is 90cm. The distance between the left camera and the right camera is 30cm. The distance is calculated by following equation.

$$y = -2(x_l - x_r) + 19 \qquad (4)$$

Fig.7 shows the measurement data of the wearer's body shape. The measurement area is from the wearer's throat to the wearer's waist. Fig.8 shows the wire frame display of the

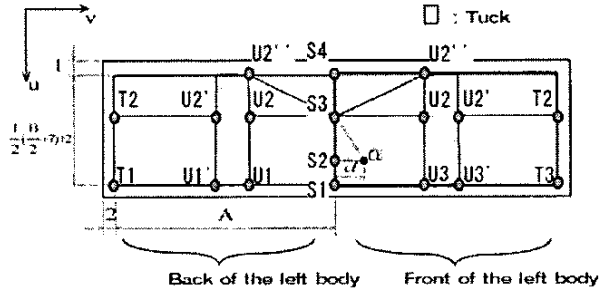


Fig.6. Kimono cloth of the left part.

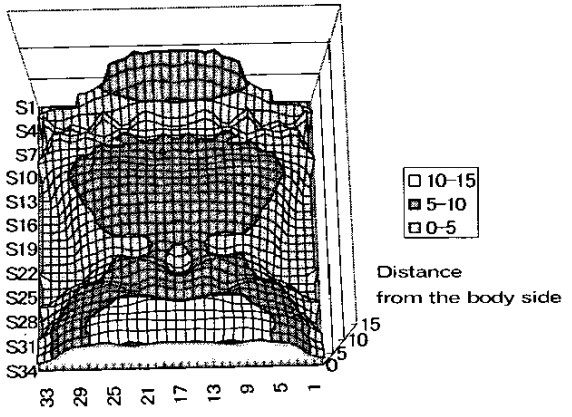


Fig.7. Wearer's body shape.

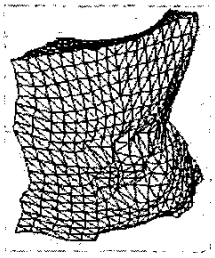


Fig.8. Wire frame display of the wearer's body shape.

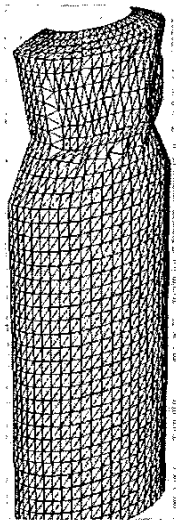


Fig.9. Wire frame display of the yukata.

measurement points. We use measurement data of the wearer's breast. Fig.9 shows the wearing condition of the yukata. The outline of the upper part of the yukata body and the breast shape are replaced by the measurement data. The texture pattern of the left body, the right body, and the left overlap is mapped on the yukata body that is shown in Fig.10. The designer and the wearer can make sure the texture alignment of the yukata from all angles with this display.

IV. CONCLUSIONS

In this study, we developed a human body shape imaging system for the yukata. At first, the human body shape at the yukata wearing is approximated by the elliptical column. Secondarily, the outline and the breast shape data of the wearer, which is the most important data for the yukata design, is measured using proposed method. In this way, we can obtain the wearer's body data that represents the wearing condition of the yukata. The texture pattern of the yukata is mapped on the wearer's body based on the yukata design. By the proposed

Fig.10. Three dimensional display of the yukata.

system, the wearer and the designer can make sure the impression of the yukata. The design support system could assist her retried and confirmed texture alignments if necessary. In this way, the designer can make the yukata, which fitted the wearer's taste.

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