Engineering

Industrial & Management Engineering fields

Okayama University *Year* 2001

Computer aided design system for Japanese kimono

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IEEE Instrumentation and Measurement
Technology Conference
Budapest, Hungary, May 21–23, 2001

Computer Aided Design System for Japanese Kimono

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Abstract – ***A yukata is a type of traditional Japanese clothing. An alignment of its texture pattern is an important factor of the yukata design. The calculation of the size, texture alignment and the creation of the cutting pattern are manually performed. Especially, the texture alignment depends on the experience and intuition of the skilled person. In this paper, we describe about a CAD system for the yukata. First, we developed a measurement system for the wearer's body shape. Second, we developed an algorithm for performing garment simulation of Japanese yukata. The designer can understand the condition of the texture alignment exactly because the yukata is displayed three dimensionally on the wearer's body shape. As a result, designers can tailor easily the yukata.***

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

I. INTRODUCTION

A yukata is a type of traditional Japanese clothing. There are a wide variety of texture patterns for the yukata. An alignment of its texture pattern becomes an important factor for the design of the yukata, because the yukata is the same shape regardless of the wearer's height or weight. However, designers have difficulty in drawing its cutting pattern with texture alignment.

Yamamoto et. al. developed a database of the kimono design and a database of the cutting pattern of the kimono. The CAD system that supports the drawing of the cutting pattern of the kimono is also developed[3]. Sano et. al. developed a CAD system that supports the texture alignment of the yukata[4].

Traditionally, texture alignment is performed in two dimensionally. However, there are some differences between a two dimensional image of the yukata and an actual image of yukata wearing. Garment simulation system and measurement system for the human body shape are developed[2]. However, there is a peculiar style in wearing the yukata. These garment simulation systems are not designed for the yukata. Measurement systems are generally much expensive and a user must pay attention in handling it.

Therefore, the garment simulation system and for the yukata are needed. In this paper, we describe about a method of the garment simulation of the yukata. At first, we developed a measurement system for wearer's body shape. Secondarily, we describe about the algorithm for the display of the yukata on the wearer's body surface.

II. CAD SYSTEM FOR JAPANESE KIMONO

A. Basic of the kimono

Figure 1 a) shows the basic kimono pattern. The kimono consists of a right body, a left body, a right sleeve, a left sleeve, a right overlap, a left overlap, and a collar. The most important data of the kimono are wearer's body shape, such as height A, hip B, and sleeve plus shoulder length C as shown in figure 1 b). The size of the various yukata parts such as left body, left sleeve and so on is determined by these data[1].

B. CAD system

Figure 2 shows the display of the CAD system. A front view, a rear view of the yukata is displayed. The size of the yukata is calculated automatically from the wearer's body data. We design the body sections, the sleeves and the left overlap. A texture pattern of the kimono cloth is shown in figure 2 b). The designers can arrange the cutting pattern with the simple mouse operation. The cutting pattern is automatically estimated by this CAD system[4].

This system performs automatic texture alignment with a striped yukata or with a yukata with stencil patterns. As

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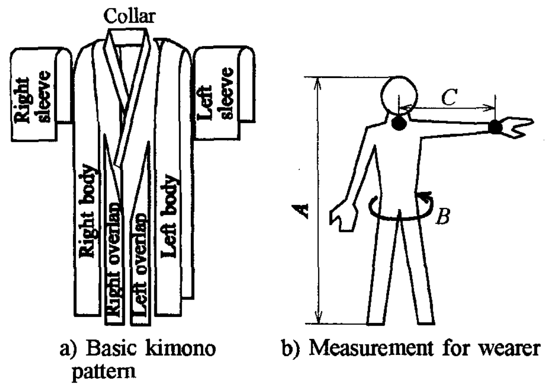


Fig. 1. Basic kimono pattern.

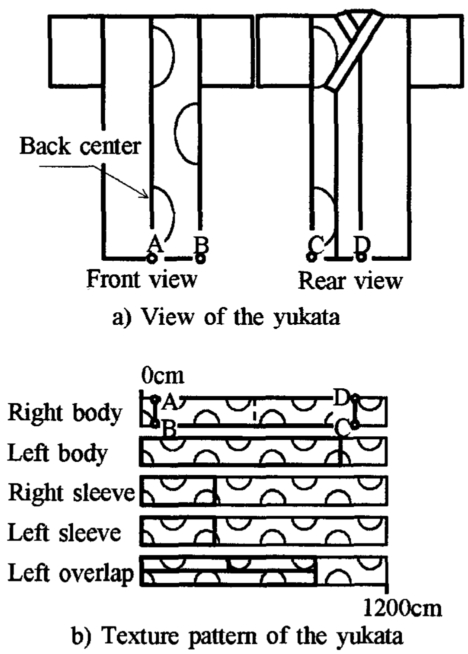


Fig. 2. CAD system.

a first step of alignment, the designer decides the yukata texture of the right body section. The left body section and the right sleeve are aligned to the right body section. The left sleeve and the left overlap are aligned to the left body section. As a result of automatic texture alignment, the yukata with stencil pattern is designed so that its stencil patterns are with well-balanced location. A yukata is made of a kimono cloth. The kimono cloth is 1200cm in length and 36cm in width. The cutting pattern is automatically arranged by using this CAD system[4], [5].

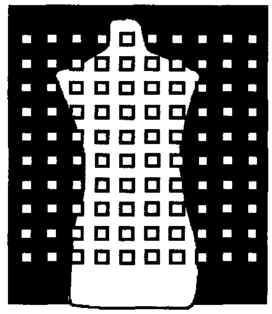


Fig. 3. Color pattern.

III. GARMENT SIMULATION OF THE YUKATA

The kimono is designed in accordance with classical Japanese's body shape. Recently, when a yukata is worn, the wearer binds theirs waist with a cotton cloth. Unlike the western clothes, the wearing of kimono is comparatively flexible in putting on clothes.

A. Measurement system for wearer's body shape

The system consists of an overhead projector, two CCD cameras, and a personal computer. The wearer stands in front of the wall. The color patterns as shown in figure 3 are projected to the wearer. The color patterns consist of green small regions. The color of the background is red. The body shape of the wearer is derived as a matrix data of the distances between the corners of the color patterns and the camera.

First, the noise reduction is performed with the median filter. Second, RGB to YUV conversion is performed. The pixels of color patterns are extracted by adaptive thresholding. Though the wearer's body shades color patterns, the color pattern can be detected clearly from V color components. Third, the sides of each color pattern are detected by hough transformation. The corner positions of the color pattern is estimated by estimating the cross point of sides of the color pattern. The color patterns are numbered from lower left to upper right. The color patterns that are the same number in the left image and the right image are corresponded to each other.

Figure 4 shows the principle of stereovision method. The distances between each color patterns and the camera are estimated by the stereovision method. The Y axis is perpendicular to the wall. The X axis and the Z axis are parallel to the wall. The x_l and x_r represent the points which are the position of the color pattern $\mathbf{P}$ to be projected to the left and right CCD. The distance y_p is estimated by the stereovision method as follows.

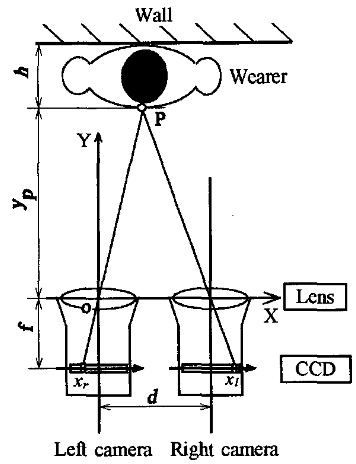


Fig. 4. Principle of stereovision method.

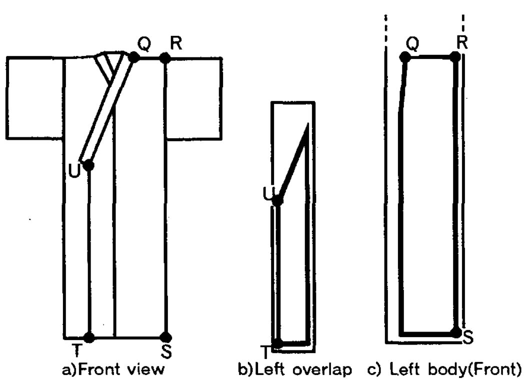


Fig. 5. Sewing line of the left overlap and the left body.

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

where the f is the focal distance of the cameras and the d is the distance between the left and the right cameras. The values of f and d are estimated from the actual measurement. The distances between the camera and each center of the color patterns are estimated.

B. Algorithm of wearing the yukata

Figure 5 shows the sewing line of the left overlap and the left body. The right body, the right overlap, the left body, the left overlap, the right sleeve, the left sleeve, and the collar are displayed. The most part of the right body and the right overlap are hidden by the left body and the left overlap. An algorithm for 3D display of the yukata is as follows.

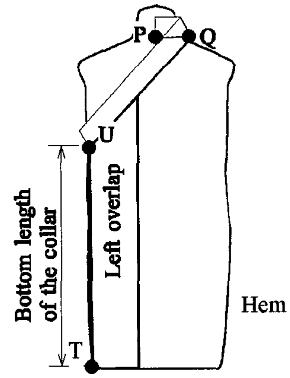


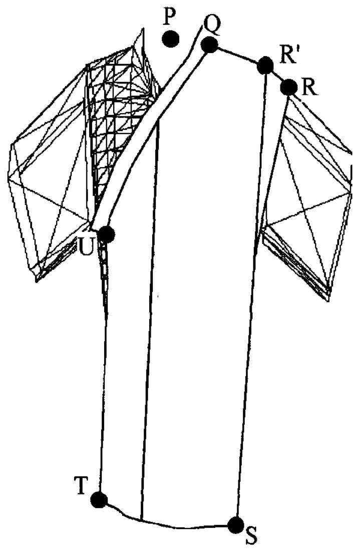
Fig. 6. Base position of the collar.

Figure 6 shows the base position of the collar. The body, the overlap and the collar of the yukata are worn so that a nape, the position of the hem and the collar may be suitable. At first, the nape line is made to be coincident with the lapel line of the body. The contour of the human body is detected from the camera image. Points **P**, **Q**, **U** and **T** are decided on the contour of the body. The point **P** is the nape of the neck. Point **Q** is intersection of the horizontal line from the point **P** and contour of the body. Point **T** is intersection of the right side of the body and the hem. **U** is the end of the collar. The distance between **T** and **U** is the bottom length of the collar. The bottom length of the collar is accommodated so that the length from **P** to **U** may become equal to $\frac{1}{2}$ of the length of the collar.

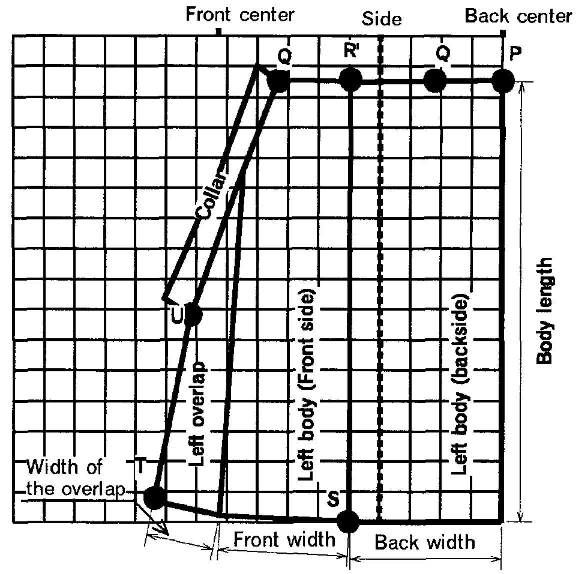
Figure 7 a) shows the correspondence points between the left body and the wearer's body. **R′** is decided on the end of the wearer's shoulder. **P**, **Q**, **R′**, **S**, **T**, **U** correspond to the backside of the neck, left end of the neck, end of the shoulder, the left hem, the right hem and the end of the collar respectively.

Figure 7 b) shows the sewing pattern of the left body, the overlap and the collar connected each other. Squares mean the wearer's body data. Each cross points presents vertexes of the body shape. Distance between each cross point indicates the distance between the measurement points. The backside and the front side of the left body and the left overlap are connected. First, the backside of the left body is positioned to the **P**. Second, the vertexes in the area that is surrounded by contour of the left body is selected as the vertexes that presents the shape of the left body.

The vertexes $\mathbf{p}_i$ on the contour of the left body are estimated as shown figure 8. The d_1, d_2, d_3 and d_4 show the distance between the $\mathbf{p}_i$ and the vertexes $\mathbf{C}_1$, $\mathbf{C}_2$, $\mathbf{C}_3$ and



a) Left body.



b) Sewing pattern of the left body, the left overlap and the collar.

Fig. 7. Correspondence points between the left body and the sewing pattern.

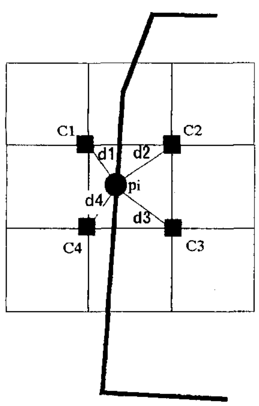


Fig. 8. Bilinear interpolation.

$\mathbf{C}_4$. $\mathbf{p}_i$ is approximated as follows.

$$\mathbf{p_i} = \frac{\frac{\mathbf{C}_1}{d_1} + \frac{\mathbf{C}_2}{d_2} + \frac{\mathbf{C}_3}{d_3} + \frac{\mathbf{C}_4}{d_4}}{\frac{1}{d_1} + \frac{1}{d_2} + \frac{1}{d_3} + \frac{1}{d_4}} \tag{2}$$

In the same way, the vertexes of the left overlap and the collar are derived from the vertexes of the wearer's body shape.

IV. RESULTS

A wearer's height is 165cm, and the sleeve plus shoulder length is 64cm, and the hip is 85cm. The yukata with stencil patterns is automatically designed as shown in figure 11. A cutting pattern of the yukata is derived automatically as shown in figure 12.

Figure 9 a) shows the mannequin having the same as the wearer. The distance between the left camera and the mannequin is 150cm. The distance between the left camera and the right camera is 17cm. The color pattern consists of green squares that are arranged 10 in row and 10 in column. By the image processing, the squares are detected as shown in figure 9 b). Measurement is performed intervals of 4.2cm in row and in column. The resolution of measurement is from 0.90cm to 1.08cm at the wearer's chest. It is enough to present the garment simulation of the yukata. The shape of the mannequin is derived as the depth map as shown in figure 10. The garment simulations of the designed yukata is performed as shown in figure 13.

V. CONCLUSIONS

We developed a CAD system for the yukata. Achievements are as follows.

(1) The wearer's body shape is measured by a simple measurement system.

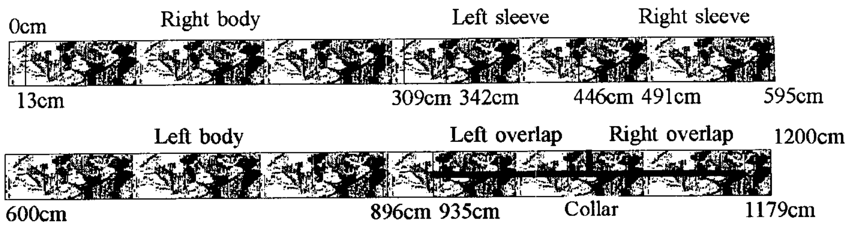


Fig. 12. Cutting pattern of the yukata with butterfly patterns.

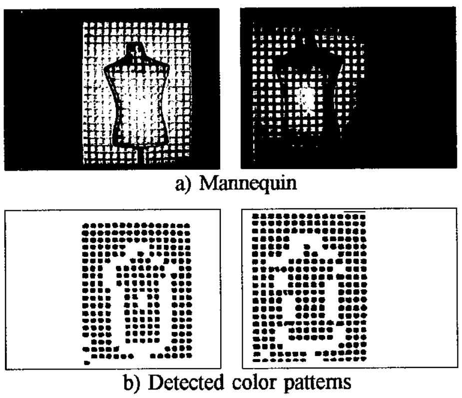


Fig. 9. Result of image processing.

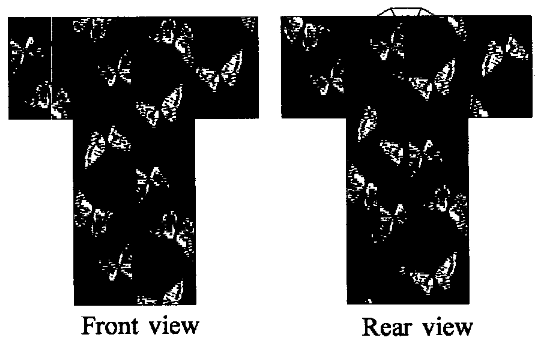


Fig. 11. Yukata with butterfly patterns.

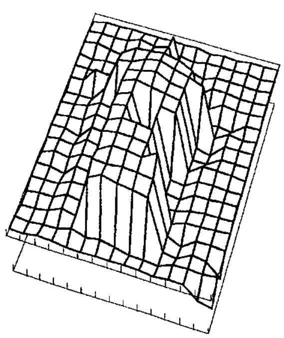


Fig. 10. Display of the body shape.

(2) A garment simulation is performed with a simple algorithm.

As a result, designers tailor easily the yukata regardless of their skill by using this CAD system.

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Fig. 13. Garment simulation of the yukata with butterfly patterns.

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