Quantitative assessment for tailored jacket appearances with bonding different adhesive interlinings

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The aim of this study is to propose a quantitative assessment method for jacket appearances with bonding adhesive interlining. Four tailored jackets made with the same pattern and fabric, and different three adhesive interlinings were prepared for experimental samples. Characteristics and criteria for determining the quality of jacket appearance were investigated by paired comparison regarding both entire and various evaluation parts of the jackets. It was found that the number and amount of wrinkle and the constriction of the waist are important criteria among the characteristics for assessment of jacket appearances. To evaluate the jacket appearance quantitatively, 3D scanned data of jackets were examined. The calculating methods for *smoothness value* and *waist constriction value* were developed using the obtained 3D scan data. Using multiple regression analysis with two explanatory variables, the *waist constriction value* and *smoothness value*, the prediction equation was proposed to predict the jacket appearance. The *smoothness values* from the front body and the *waist constriction values* showed good agreements with corresponding results of sensory tests. The appearance evaluation in the sensory test considered both waist constriction and smoothness agreed with the predicted jacket appearance. Therefore, it was found that the proposed criteria are effective for assessment of jacket appearance with bonding adhesive interlining. It will be also able to predict the jacket appearance quantitatively using the proposed method.

Key words: quantitative assessment method, jacket appearance, adhesive interlining

1. Introduction

In garment design, adhesive interlining is usually used to make up the mechanical properties of face fabric for improving the garment appearance and stability. By bonding adhesive interlining, the bending rigidity and shear stiffness are able to be controlled. Selecting suitable adhesive interlining is important stage to make an adjustable and beautiful appearance for garments. However, the selecting is still depending on a manufacturer's previous experiences, and a result of trial laminating with actual samples which needstime and cost. Some researchers studied about the mechanical properties of laminated fabric with adhesive interlining. Kim et al. [1-4] investigated the prediction methods for bending rigidity of laminated fabrics. They[5] also researched about the effects of adhesive mass on shear stiffness of laminated fabrics. C. Ball et al. [6] investigated the difference between objective measurement and consumer perception on men's tailored jackets considering the laminated fabric with adhesive interlining. They reported that there are differences between both results and asked the necessary of

assessment method for jacket appearances which they did not propose. In previous study [7], we proposed a quantitative evaluation method for tailored jacket appearances with bonding different adhesive interlinings. It was found that people feel the changes of jacket appearance by bonding different adhesive interlining and the roughness was an important evaluation factor for jacket appearances. However, in the result of the sensory test, the criteria to judge the garment appearance were not clear and the quantified method for specified evaluation parts was not proposed.

It is still necessary to investigate the characteristics and the criteria to judge the garment appearance for determining the quality of jacket appearance as well. Thus the purpose of this study is to investigate a quantitative assessment method for jacket appearances with bonding adhesive interlining taking into account the characteristics and the criteria for determining the quality of jacket appearance. To investigate those, sensory tests were carried out and a prediction method for a quantitative assessment of the apperance using three dimensional data was proposed.

2. Experimental

2.1 Experimental samples

Four jackets made with the same pattern, the same fabric (a satin woven fabric) and different adhesive interlinings(poly 100% woven fabrics, dot type of adhesive) were prepared for experimental samples as shown in Figure 1. The pattern and parts where interlining used are also shown in Figure 1. One was made without adhesive interlining (denoted by none) and the others (soft-c, normal-c and hard-c) were made of different three adhesive interlinings which were made of different cloth and adhesive mass. To confirm the effects of adhesive interlining only, linings were not used in the jackets. The jacket patterns were made for JIS 9AR size for Japanese women (Bust 83, Height 158, and Hip 91). Four jacket samples were made by an expert who has worked in the clothing field. Ironing treatment was carried out in some parts such as waist and dart lines under the same condision. Bonding interlining to face fabric was treated by a press machine (KOBE DENKI KOGYOSYO, BP-V4812D) and the bonding condition was at 150°C, under 0.3kgf/cm² load and for 10s of pressing time.
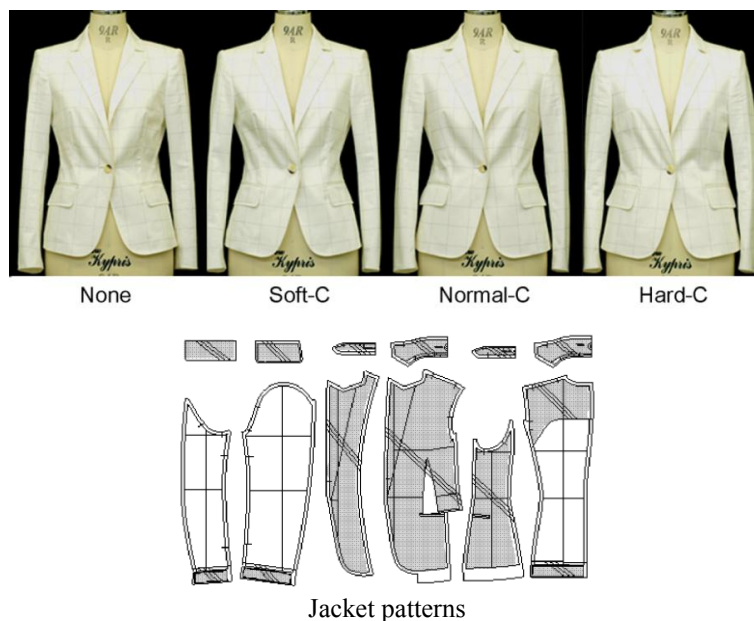

Jacket patterns
Figure. 1 Jacket pictures and jacket patterns and parts where interlining used (gray parts)

2.2 Sensory tests

To investigate the characteristics and criteria to judge the garment appearance, the first sensory test was carried out. The four jackets were worn on dummies (Kiiya Co., Ltd, 9AR) for the test. The front style of jackets appearances worn on dummies were compared entirely and partially using paired comparison as shown in Figure 2. Ten 20's male (three) and female (seven) university students, who were considered as potential customers and were not practiced to evaluate the appearance of garments, participated in the sensory test as subjects. By watching two jackets at the same time, a subject answered that 1) which jacket appearance is better on a designated part, 2) what is the view points (multiple answers allowed), and 3) what is the characteristic (open question). The test was carried out in a temperature of 20±1℃, a relative humidity of 65±5% and under the same light condition of fluorescent lamps.

After clarifying the characteristics and criteria of each evaluation parts, the second sensory test for jacket appearances taking into account the criteria focusing on the evaluation part was also carried out. The second sensory test was carried out to evaluate the appearances of the designated parts in jacket appearance which are lower left and right parts and waist line in front direction style. Those parts were selected because they showed significant differences from the results of the first sensory test for criteria. The subjects were asked to evaluate the appearance of each part taking into account wrinkle, waist constriction and the both respectively. The subjects watched and evaluated the right and left body seperatly and also together. Twenty three 20's male (thirteen) and female (ten) university students who were not practiced to evaluate the appearance of garments, participated in the sensory test as subjects. They are different subjects with the previous sensory test. The experimental environment was the same as mentioned above. Each jaket was covered with a board and only evaluation part was shown to the subject to avoid the effects of the other parts as shown in Figure 3. The subjects watched the evaluation parts of four jackets on dummies in the front direction at the same time through a window in the bord and ranked the order of good or bad. Tie was not allowed. The subjects were not informed of the difference of the interlining. The normal scores of the sensory test results were calculated.

1. upper collar
2. lower collar
3. shoulder
4. front body(upper)
5. front body(middle)
6. front body(lower)
7. hemline
8. flap
9. side line
10. sleeve cuff
11. entire front style
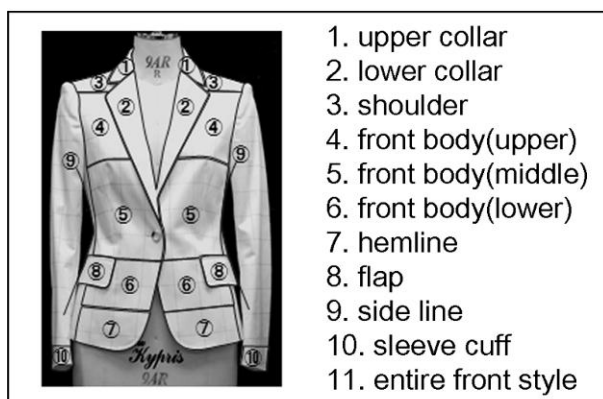
Figure. 2 Evaluation parts of a jacket for quantitative assessment for jacket appearances

a) Left part evaluation

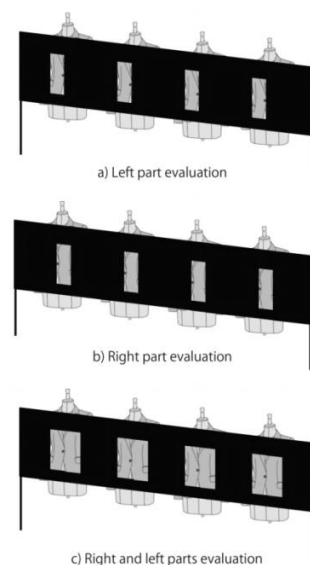b) Right part evaluation

c) Right and left parts evaluation

Figure. 3 Sensory test with blind

2.3 Quantitative assessment method for jacket appearances

Using three-dimensional (3D) shape data, quantitative assessment for jacket appearances were performed. 3D data of each jacket were scanned by a 3D scanner (Konica Minolta Holdings Inc., VIVID 700, resolution 0.6 mm) and were processed by utility software (Konica Minolta Holdings, Inc., VI-S1)(See Figure 4). The horizontal (Figure 4-b) and vertical (Figure 4-c) cross section data for each jacket were extracted and compared respectively. Horizontal cross-section curve around the hemline of each sample in the front direction, which showed significant difference between samples in the second sensory test results, were obtained and compared. Eleven vertical cross-section lines on the right and left hemline part of each sample in the front were obtained and compared. The curvature and variance of the curvature of cross sections for each part were calculated and named as *smothness value* [7]. The value is representative of the wrinkle level. The average smoothness values of both horizontal and vertical crosssections were also compared to the sensory test results.

The obtained vertical lines of the sides (Figure 2-9) represent a waist lines of the jacket. However it is different from the waist line which subjects watch while evaluating jackets. To evaluate the waist line, it is necessary to obtain the waist line which subjects watch in front direction. Thus, in this study, "combination of the outermost points of the same height" of vartical cross-sections were supposed and the obtained line considered as the waist line which subjects watch for evaluating jacket appearances. As shown in figures 4-d and 5, the waist lines were obtained from four vertical cross-section curves by 10mm intervals in left and right separately for each sample. For the waist line, the degree of constriction was calculated using the vertical line '*a*' and horizontal line '*b*' as shown in Figure 6. '*a*' is the distance of the side waist line from designated waist and hip position, '*b*' is the distance from '*a*' to the most constricted line in waist. The degree of constriction in waist (named *constriction value of waist*) was obtained by averaging the calculated degree of constriction of the left and right parts. The obtained data were also compared to the sensory test results.

Comparing the obtained *smoothness value* and *waist constriction value,* and the results of sensory tests, the validity of the values were examined.
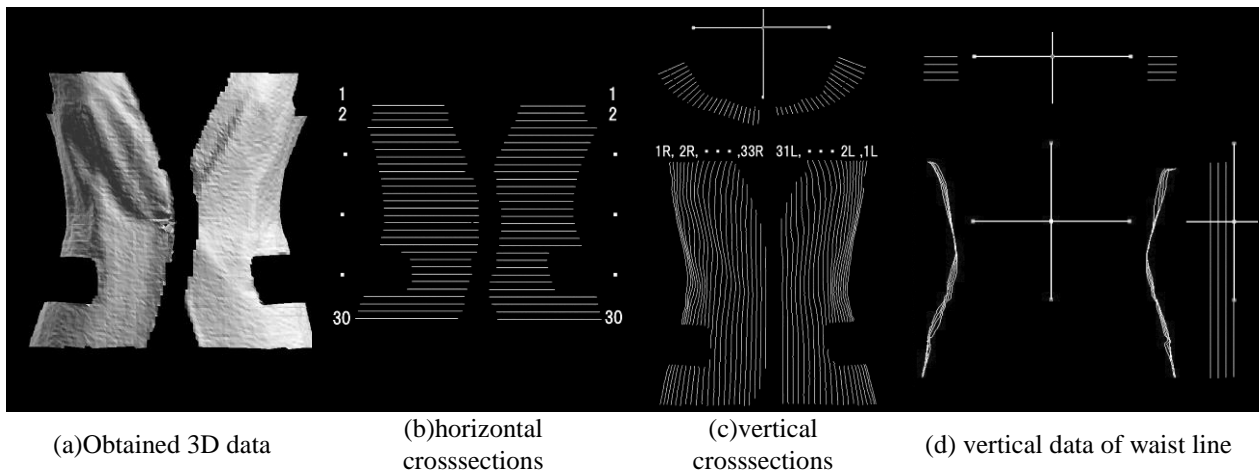

| (a)Obtained 3D data | (b)horizontal crosssections | (c)vertical crosssections | (d) vertical data of waist line |

Figure. 4 Example of obtained 3D data and crosssection data for evaluation

Figure. 5 Visible vertical waist line in the front direction from cross-sectional shape data

Figure. 6 Obtaining method of waist constriction value

2.4 Prediction method for garment appearance using smoothness value and waist constriction value

Using multiple regression analysis with *smoothness value* and *waist constriction value* as explanatory variable, a prediction equation of garment appearances was derived. The objective variable, which named as evaluation value *V*, is the result of the sensory test taken into account the both wrinkle and waist constriction. The *V* was assumed by Equation (1). The *V* represents the garment appearance entirely. The higher value is the better appearance.

$$V = a_1 + a_2 \times smoothness\ value + a_3 \times constriction\ value\ of\ waist \qquad (1)$$

where a_1, a_2 and a_3 are the coefficients of the multiple regressions.

3. Results and Discussions

3.1 Criteria and characteristic for evaluation of jacket appearances

From the first sensory test, the results of characteristics and the criteria for quantitative assessment of jacket appearances are shown in Table 1. It was found that there are several characteristics to evaluate jacket appearance as shown in Table 1. Among the characteristics, wrinkle in front lower parts (5 and 6 in Figure 2) and waist constriction in side parts (9 in Figure 2) showed over 70% respondents rate. Therefore it was found that waist constriction and wrinkles were considered to be major factors when evaluating the jacket appearance. Based on the results, the sensory evaluation parts, front lower parts and waist curves, were selected for the second sensory test. The other parts for evaluation such as collar and sleeve were neglected due to the low respondents rate.

Based on the second sensory test, normal scores of results were calculated. Normal scores of order of wrinkle acceptability of each sample is shown in Figure 7. In the wrinkle, normal-c showed the highest values. Normal scores of order of constriction acceptability of each sample is shown in Figure 8. In the constriction, soft-c showed the highst value. Normal scores considered both constriction and smoothness of each sample is shown in Figure 9. In the results considered both, normal-c showed the highest values. This values will show the 'quality taken into account both constriction and smoothness values'. Fgures 7, 8 and 9 showed different results. Thus, it was found that it is necessary to consider both wrinkle and waist constriction for evaluating jacket appearance.

Table 1. The Questionnaire results of characteristics and criteria for quantitative assessment for jacket appearances

Characteristics	criteria
Wrinkle	a few wrinkles -many wrinkles
Shape	good looking-not good looking
Floating from body	not floating-floating
Fitting to the body	fitting-unfitting
Symmetricalness	symmetrical-unsymmetrical
Tense	tens – not tens
Angulation	not angulated- angulated
waist constriction	constricted-not constricted good looking-not good looking
Swelling	not swelled- swelled
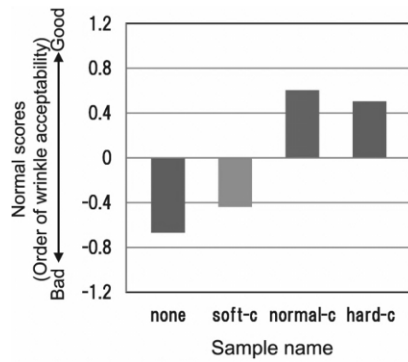
(a)
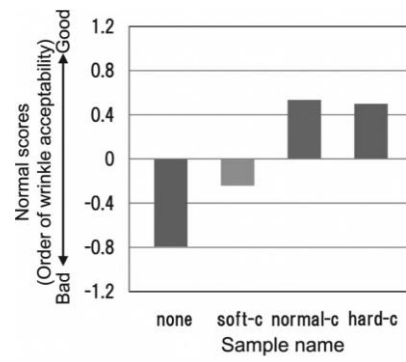
(b)

Figure. 7 . Normal scores of order of wrinkle acceptability of each sample
(a) left part of lower front body (b) right part of lower front body
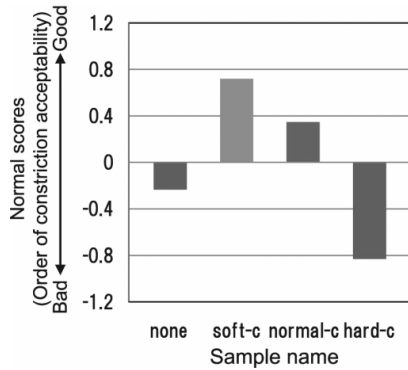
Figure. 8 . Normal scores of order of constriction acceptability of each sample
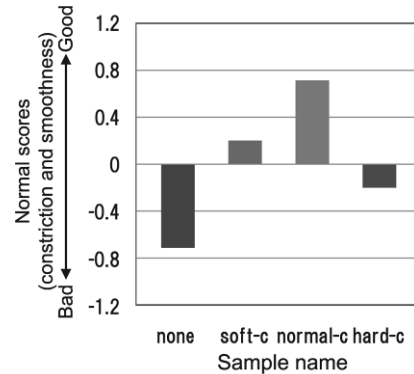
Figure. 9 . Normal scores considered both constriction and smoothness of each sample

3.2 Relationship between data for quantitative characteristics and sensory test results

Figure 9 shows the relationship between the normal scores of the order of the number of wrinkles and the horizontal *smoothness values* of body part both left and right. Relationship between normal scores of order of construction of waist line and the *waist constriction value* was shown in Figure 10. In Figure 10 (a) and Figure 11 showed linear ralaionships. Therefore, it was found that *constriction values of waist* and *smoothness values* are effective as evaluation values for evaluation of jacket appearance.
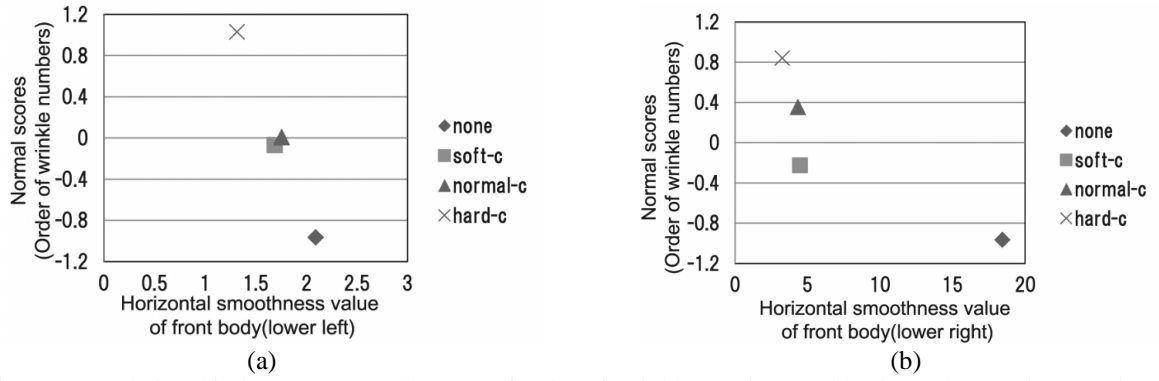
(a) (b)

Figure. 10 Relationship between normal scores of order of wrinkle numbers and horizontal *smoothness values* of front body (a)lower left (b) lower right)
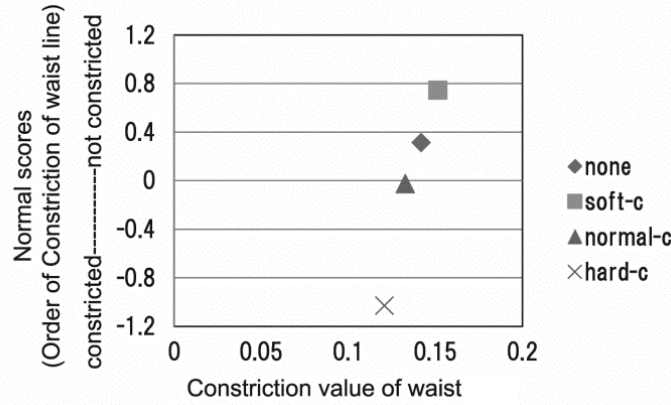

Figure. 11 Relationship between normal scores of order of construction of waist line and *constriction value of waist*

3.3 Quantification of prediction values

As mentioned above, the *smoothness value* from the front body and the *waist constriction values* showed good agreements with the normal scores from sensory tests. However, some case showed disagreements as shown in Figure 10 (b). Thus, it is still difficult to evaluate the jacket appearance taking into account both the constriction and wrinkles. It was found that the wrinkle and the waist constriction are important characteristics for assessment of jacket appearances. Using multiple regression analysis with two explanatory variables, the *waist constriction value* and *smoothness values*, a new prediction equation was proposed to expresses the jacket appearance.

$$V = -4.12 - 0.11 \times smoothness\ value + 38.74 \times constriction\ value\ of\ waist \qquad (2)$$

Figure 12 shows a plot of evaluation value, *V* and the results of sensory test taken into account both waist constriction and wrinkle. They showed high correlation with each other ($R^2 = 0.82$). Therefore, it was found that the quality of jacket appearances was able to be predicted using the proposed prediction method. Consequently, the proposed characteristic values are effective for assessment of jacket appearance with bonding adhesive interlining.

4. Conclusion

A quantitative assessment method for jacket appearances with bonding adhesive interlining was propose. It was found that the wrinkle and the waist constriction are important characteristics for assessment of jacket appearances. The *smoothness value* from the front body and the *constriction values in waist* were obtained from 3D data to predict the quatitative evaluation of jacket appearance. They.showed good agreements with both sensory test

results. A prediction equation for jacket appearance using both *smoothness value* and *constriction values* was proposed. The evaluation value, *V* showed high correlation with the results of sensory test taken into account both wrinkle and waist constriction. Therefore, it was found that the proposed values are effective for assessment of jacket appearance with bonding adhesive interlining. It will be able to predict the jacket appearance quantitatively using the proposed equation.
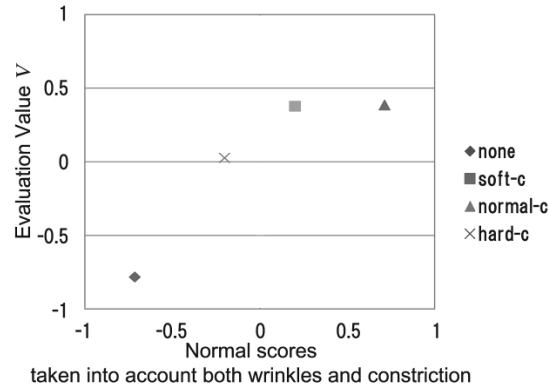

Figure. 12 Relationship between evaluation value *V* and normal scores taken into account both wrinkle and waist construction of each sample

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