Extraction of the Information on the Support System of Ladies’ Wear Selection Using a 3D-Body Shape and Garment Simulations for Adult Women’s Garments

Part 1: Classification of 3D-Body Image Type

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Abstract

To set the garment purchasing system using the network and cellular phone in IT, authors investigated 3-dimensional body (referred to as 3D-body hereinafter) shape images for well-suited garment selection for adult women. In this study, authors extracted the evaluated information to show the relationship between the expression of body image key-words and the representation of the 3D-body modeling simulation. In order to select women’s garments well-suited for 3D-body image, 72 subjects of the 3D-body model were adopted from a broad range of women ranging in age from the late 20’s to 70’s.

In this first part of the study, the five principal components of the 3D-body shape images were extracted based on evaluation scales with values from 1 to 5 for full-length 3D-body images A1 to A6 and partial 3D-body images B1 to B19 (number of evaluation respondents = 81). The 3D-body shape image were classified into six clusters i.e., Ideal figure, Underweight figure, Overweight figure, Slightly masculine figure, and other image types, using those 4 principal components scores.

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Key words: 3D-body measurement, 3D-body shape image types, adult women, cluster analyses, design selection support, principal component.

1. Introduction

In accordance with new garment-purchasing systems using IT, we have proposed the construction of a 3-Dimensional Fashion Factory or Boutique ordering system (denoted by 3D-FFB). The 3D-FFB consists of two parts. One is 3D-body shape measurement and a 3D-garment design system, and the other is the research of garment selection support information for communication between consumers and retailers. This should be promoted as a method of selling and selecting garments which fulfill individual needs. In previous papers, we had studied young women’s garments for 3D-FFB. Different types of young women’s 3D-body shape images and garment images were extracted. The support items of 3D-body shape and 3D-garment design images for garment selection were investigated and the garment’s design image was judged according to those items.

In the previous paper, specific key image words describing a form were extracted in order to classify the 3D-body shape images for garment selection of women. Though we found numerous papers on body image from different disciplines such as clothing science, health science, psychology, and human engineering, in most papers, 2D-dimensional body silhouette images were reported using specialized words from each field research on images of 3D-body shapes and words used to select individualized garments for consumers was limited. We aim to investigate 3D-body shapes and corresponding image words in order to design a 3D-simulation model for future use in a 3D-FFB-like system. Therefore, in the previous paper, 200 image words pertaining to body shape for garment selection were collected.
from magazines, journals, and a questionnaire survey. The total of 25 key image words describing the 6 full-length and 19 partial 3D-body shape for communication between consumers and retailers were selected, and the 3D-body shape image type of young women were extracted.

In the next reports, our goal is the construction of a 3D-FFB for adult women from their late 20's to 70's in age with the exception of university students. The method of research is as follows: 1) First in this paper, 72 3D-body shapes were measured using an automatic non-tactile 3D-body measurement system. Those 3D-body shapes were categorized by means of image evaluation using specific key image words of full-length and partial body[1]. 2) In the next paper, we will extract the distinctive ages and body measurements of adult women in each categorized 3D-body shape image type. The particular main images of the full-length 3D-body shape will be predicted from the physical body measurements which can be obtained easily by means of multiple regression analysis. 3) In the final papers, we hope to extract the key words for evaluating the garment design image from numerous image words published in fashion magazines. The garment designs were selected according to appropriate key image words. The 3D-garment rotating simulations for each design were modeled on 3 selected model body surfaces from the categorized 3D-body image types. These 3D-garment designs were evaluated for their design image using key image words, favorable or unfavorable impressions on a person, and their occasion for wear, etc.

In this part, we selected adult women from a broad age range as the object of the 3D-body shape models for collecting useful information of ladies' garment design. When we shop or order a garment using the internet, we want to easily select a well-fitting and well-suited garment design for our body size and shape type. However, for 3D-body size and shape, there is little intelligible information for ease and useful communication between consumers and retailers. In particular, expressible image words for 3D-body shape should be provided for consumers on internet shopping systems.

2. Extraction
2.1 Measuring 3D-body shape

The 3D-body shapes of 72 adult women were measured for 6-10 seconds using the non-tactile 3D-body color measuring instrument (Voxclan LFL-1800. Hamano Engineering Co. Ltd.). Permission was granted from all 3D-body models in this study. However, three of the models are the 20's, 40's, and 70's figure samples of a Japanese female made by the Nanasai Corporation based on measurements of HQL (1992-1996) as shown in Fig. 1. For extracting the design images of ladies' garments of adult women in future parts of studies, the 3D-body models were selected by random sampling from a wide age range that excludes university students. Therefore, the number of models in each age group are; late 20's to 30's models = 17, 40's to 50's models = 35, and 60's to 70's models = 20. The means (standard deviations) of all models ages and their fundamental body measurements are as follows: mean age = 50.07 years old (SD = 12.67), stature 154.51cm (6.47cm); posterior waist length 37.79cm (2.18cm); neck-base girth 37.90cm (1.57cm); bust girth 87.61cm (6.23cm); waist girth 70.39cm (7.17cm); hip girth 90.89cm (4.88cm); posterior shoulder length 36.59cm (2.18cm); sleeve length 51.68cm (2.23cm); upper arm maximum girth 27.74cm (2.36cm), and body weight 52.25kg (6.28kg) of the mean values from the data of the 20's, 40's, and 70's figure samples mentioned above age, body weight, upper arm and maximum girth were adopted from the data of the Ningen Seikatsu Kouguaku Kenkyu Center. Due to the broad age range including elderly model bodies, the measurements of some body features differ from the mean values set by the Ningen Seikatsu Kouguaku Kenkyu Center. For example, in our models body length is lower and girth items are larger.

2.2 Simulating 3D-body shape

The method of the 3D-body measurement is as follows: 1) the underwear worn during measurement consists only of a flesh-colored brassiere and panties, and a bathing-like cap. 2) The 3D-body surface mesh of each person is created, and the crude front and back depth images are obtained using the Voxclan 3D-body measurement. Each crude 3D-body image is classified as “body”, “background”, “garbage”, or “hole in the body” 3) The outline of the body is rectified to form a smooth curve; front and back body regions are organized as triangular 3D mesh surfaces and boundaries are also connected by

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triangles. 4) The 3D-body mesh, as a closed polygon surface, is constructed from the generation of triangular 3D mesh by means of semi-automatic execution using our original program ("Obm").

Front, back, and lateral views of the mesh surface, painted with the same flesh color and magnification, are generated by this program as well. Adobe Photoshop ver.6 was used to gather the four views of the 3D-body surface at approximately a 1/10 reduction. All flesh-colored 3D-body figures in Fig. 1 were printed as sample cards using the Illustrator ver.10 and an Epson 2000.

2.3 Image evaluation method of 3D-body shape

The 3D-body image evaluation key words were adopted from our previous paper1). The detail evaluation items of the 6 full-length 3D-body image key words (As: A1 to A6) and the 19 partial 3D-body image key words (Bs: B1 to B6) are shown on the left side of Table 1. The scale values of the 6 image items for the As are: Strongly Disagree (1) - Slightly Disagree (2) - Neutral (3) - Slightly Agree (4) - Strongly Agree (5). The scale values of the 19 image items for Bs used the SD (Semantic Differential) method. For example, B1. Leg thickness: Thin Very (1) - Slightly (2) - Average (3) - Slightly (4) - Very (5) Thick. The remaining 18 items were evaluated using the same scale. (B2. Arm size: Thin - Thick, B3. Height: Short - Tall, B4. Leg length: Short - Long, B5. Trunk length: Short - Long, B6. Head size: Small - Large, B7. Bust size: Small - Large, B8. Hip circumference size: Small - Large, B9. Shoulder inclination: Sloping - Square, B10. Shoulder breadth: Narrow - Wide, B11. Spinal curvature: Stooped back - Straight back, B12. Posture: Forward leaning - Backward leaning, B13. Leg shape: Bow-legged - Knock-kneed, B14. Trunk width: Narrow - Wide, B15. Abdominal appearance: Flat - Protruding, B16. Buttock appearance: Sagging - Firm, B17. Chest thickness: Thin - Thick, B18. Proportion: Poor - Good, B19. Body shape: Square - Round). These image words were extracted using 106 women from cards which contained 200 body image words categorized into similar image word groups1).

The 3D-body shapes of 72 adult women, displayed in Fig. 1, were evaluated on a scale of 1 to 5 using the total 25 items of As and Bs by 81 respondents (mean age = 46.4 years old, 20's to 30's: 27%, 40's to 50's: 59%, 60's to 70's: 14%).

2.4 Data analysis method

The mean values of the 25 image items (number of respondents = 81) were evaluated using Principal Component Analysis (hereafter PCA) in a part of Factor Analysis with the SPSS statistics program to extract the PCA scores. Next, the image type of the 3D-body shape was categorized using these PCA scores by method of Cluster Analysis (Ward Styles using squared euclidean distance).

3. Results and discussion

Although we obtained permission to create a real individual's 3D-body for this research, we used linear silhouettes of the 3D-body shape in consideration of the Privacy Protection Law, except the standard 3D-body models of Fig. 1.

3.1 Extraction of principal components of 3D-body images

The evaluation mean results of A1 to A6 and B1 to B19, calculated by means of the PCA according to the mutual correlation coefficients, are shown in Table 1. The five principal components with the 3D-body image eigenvalues of 1.00 or more are presented and comprise 82.14% of cumulative contribution ratio. Each item's value for each PC was determined using factor loading (Varimax rotation) in accordance with the SPSS statistics program.

![Fig. 1 3D-body shapes of Japanese woman in their 20's, 40's, and 70's - made by the Nanasaki Corporation based on measurements of HQL (1992-1996)](329)
PC1 involves higher or slightly higher negative values of three full-length image items (A1. Underweight figure, A3. Ideal figure, and A4. Standard figure) and two partial image items (B3. Height and B18. Proportion). On the other hand, the items with higher or slightly higher positive values include one full-length image of A6. Overweight figure and eight partial images (B2. Arm size, B6. Head size, B7. Bust size, B8. Hip circumference size, B14. Trunk width, B15. Abdominal appearance, B17. Chest thickness, and B19. Body shape). Furthermore, the factor loadings of B1. Leg thickness and B4. Leg length are approximately 0.5 or -0.4. PC1’s eigenvalue is 9.83 and accounts for 39.33% of the contribution ratio. PC1 contains more than one third of the body images.

Each correlation coefficient between A6 and A1 or A3 or A4 is between -0.98 and -0.78, the correlation coefficient between A6. Overweight figure and A1. Underweight figure represents the negative highest value. For the three full-length and the two partial 3D-body images of the positive PC1, A1, A3, and A4 are more strongly linked to B18. Proportion (A1 and B18: r = 0.79, A3 and B18: r = 0.98, A4 and B18: r = 0.88). For the negative PC1, A6 is more strongly linked to size, thickness, and shape items (B2. Arm size: r = 0.91, B6. Head size: r = 0.85, B8. Hip circumference size: r = 0.86, B17. Chest thickness: r = 0.80, B19. Body shape: r = 0.88). Therefore, the higher PCA score is mainly due to combining A1, A3, and A4 with partial 3D-body images of Good proportion. In the lower PCA score, A6 with Large size and Round body shape is indicated. PC1 represents a general 3D-body size image of large or small.

PC2 involves higher or slightly higher positive or negative values of the five partial images from B1, B3 to B5, and B16 for height, length, appearance of the legs, trunk, and buttock etc., regardless of the full-length 3D-body image items. Particularly, the PC2 values of B4. Leg length and B5. Trunk length represent higher positive or negative values. The correlation coefficient between B4 and B5 show a negative value (r = -0.89). Therefore, B4 is slightly more positively linked with B3 (r = 0.76) and B16 (r = 0.65), while B5 has a negative correlation coefficient with them (B5 and B3: r = -0.55, B3 and B16: r = -0.50). The correlation coefficients between B4 or B5 and B1 represent the opposite results, B4 and B1 (r = -0.76), and B5 and B1 (r = 0.59).

However, the loading factors of A3. Ideal figure and B18. Proportion approximately show a 0.4 value of the correlation coefficient with B1. Leg thickness or B4. Leg length. PC2’s eigenvalue is 3.86 and its contribution ratio is 15.42%. The higher PCA score indicates Long length and thin legs and Short trunk, and vice versa. PC2 represents the factor of balance between the length of Legs and Trunk. The factor of vertical length proportion were extracted from PC2. Therefore, B1. Leg thickness (r = -0.53) and B4. Leg length (r = 0.60) have slightly higher correlation coefficients with B18. Proportion. Good proportion is confirmed by the Long length and Thin legs in the partial 3D-body images.

<table>
<thead>
<tr>
<th></th>
<th>PC1</th>
<th>PC2</th>
<th>PC3</th>
<th>PC4</th>
<th>PC5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Underweight figure</td>
<td>-0.589</td>
<td>0.298</td>
<td>-0.216</td>
<td>-0.075</td>
<td>-0.051</td>
</tr>
<tr>
<td>A2 Female figure</td>
<td>-0.374</td>
<td>0.066</td>
<td>0.806</td>
<td>0.239</td>
<td>0.123</td>
</tr>
<tr>
<td>A3 Ideal figure</td>
<td>-0.269</td>
<td>0.386</td>
<td>0.224</td>
<td>0.189</td>
<td>0.040</td>
</tr>
<tr>
<td>A4 Standard figure</td>
<td>-0.622</td>
<td>0.167</td>
<td>0.264</td>
<td>0.142</td>
<td>0.070</td>
</tr>
<tr>
<td>A5 Muscular figure</td>
<td>-0.196</td>
<td>0.200</td>
<td>-0.246</td>
<td>0.177</td>
<td>0.031</td>
</tr>
<tr>
<td>A6 Overweight figure</td>
<td>0.824</td>
<td>-0.294</td>
<td>0.147</td>
<td>0.037</td>
<td>0.062</td>
</tr>
<tr>
<td>B1 Leg thickness</td>
<td>0.451</td>
<td>-0.592</td>
<td>0.397</td>
<td>0.004</td>
<td>0.246</td>
</tr>
<tr>
<td>B2 Arm size</td>
<td>0.851</td>
<td>-0.252</td>
<td>0.243</td>
<td>0.152</td>
<td>0.114</td>
</tr>
<tr>
<td>B3 Height</td>
<td>-0.506</td>
<td>0.673</td>
<td>-0.046</td>
<td>-0.012</td>
<td>0.291</td>
</tr>
<tr>
<td>B4 Leg length</td>
<td>-0.359</td>
<td>0.899</td>
<td>-0.124</td>
<td>-0.124</td>
<td>0.031</td>
</tr>
<tr>
<td>B5 Trunk length</td>
<td>0.143</td>
<td>-0.800</td>
<td>0.040</td>
<td>0.075</td>
<td>0.113</td>
</tr>
<tr>
<td>B6 Head size</td>
<td>0.811</td>
<td>-0.361</td>
<td>0.081</td>
<td>0.154</td>
<td>0.076</td>
</tr>
<tr>
<td>B7 Bust size</td>
<td>0.589</td>
<td>0.105</td>
<td>0.450</td>
<td>0.439</td>
<td>-0.116</td>
</tr>
<tr>
<td>B8 Hip circumference</td>
<td>0.732</td>
<td>-0.317</td>
<td>0.373</td>
<td>-0.108</td>
<td>0.099</td>
</tr>
<tr>
<td>B9 Shoulder inclination</td>
<td>-0.214</td>
<td>0.082</td>
<td>-0.210</td>
<td>0.819</td>
<td>0.105</td>
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<tr>
<td>B10 Shoulder breadth</td>
<td>0.292</td>
<td>0.034</td>
<td>0.076</td>
<td>0.817</td>
<td>0.142</td>
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<tr>
<td>B11 Spinal curvature</td>
<td>-0.261</td>
<td>-0.353</td>
<td>0.241</td>
<td>0.676</td>
<td>0.247</td>
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<tr>
<td>B12 Posture</td>
<td>-0.184</td>
<td>-0.080</td>
<td>-0.098</td>
<td>0.321</td>
<td>0.732</td>
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<tr>
<td>B13 Leg shape</td>
<td>0.234</td>
<td>0.065</td>
<td>0.156</td>
<td>0.055</td>
<td>0.772</td>
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<tr>
<td>B14 Trunk width</td>
<td>0.856</td>
<td>-0.140</td>
<td>-0.082</td>
<td>-0.126</td>
<td>0.098</td>
</tr>
<tr>
<td>B15 Abdominal appearance</td>
<td>0.820</td>
<td>-0.118</td>
<td>-0.156</td>
<td>-0.214</td>
<td>-0.029</td>
</tr>
<tr>
<td>B16 Buttock appearance</td>
<td>-0.307</td>
<td>0.660</td>
<td>0.038</td>
<td>0.184</td>
<td>0.057</td>
</tr>
<tr>
<td>B17 Chest thickness</td>
<td>0.842</td>
<td>-0.026</td>
<td>0.220</td>
<td>0.365</td>
<td>-0.090</td>
</tr>
<tr>
<td>B18 Proportion</td>
<td>-0.826</td>
<td>0.405</td>
<td>0.185</td>
<td>0.287</td>
<td>0.037</td>
</tr>
<tr>
<td>B19 Body shape</td>
<td>0.773</td>
<td>-0.225</td>
<td>0.541</td>
<td>-0.040</td>
<td>0.069</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eigenvalues</th>
<th>9.83</th>
<th>3.86</th>
<th>2.72</th>
<th>2.64</th>
<th>1.48</th>
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<tbody>
<tr>
<td>Contribution ratios (%)</td>
<td>39.33</td>
<td>15.42</td>
<td>10.90</td>
<td>10.56</td>
<td>5.92</td>
</tr>
<tr>
<td>Cumulative contribution ratios (%)</td>
<td>39.33</td>
<td>54.76</td>
<td>65.65</td>
<td>76.21</td>
<td>82.14</td>
</tr>
</tbody>
</table>
PC3 features higher or slightly higher positive values of A2. Feminine figure and B19. Body shape or higher negative values of A5. Masculine figure. The A2 and A5 are generally recognized as referring to opposite full-length 3D-body images of the sexes (r = −0.58), while Square or Round B19 affect the partial 3D-body image for the physical characteristic of the sexes (B19 and A5: r = −0.65). However, the correlation coefficient between B19 and A2 is low (r = 0.40). Its eigenvalue is 2.72, which accounts for 10.90% of the contribution ratio. PC3 represents Feminine or Masculine figure images. A higher PCA score indicates the A2. Feminine figure image with slightly Round body image, while a lower PCA score indicates the A5. Masculine figure image with Square body image.

PC4 involves three higher or slightly higher positive values for the shoulder and spinal shape images on the back surface, B9 to B11. B9 and B10 show the correlations with other full-length or partial body shape images. The main correlation coefficients are as follows: B9 and B10 or B11 or B12 or B18; r = 0.37 to 0.55, B10 and A1; r = −0.36, B10 and A6; r = −0.33, B10 and A1; r = −0.36, B10 and B7 or B17; r = 0.46 to 0.47, B11 and B12; r = 0.41. PC4's eigenvalue is 2.64 and its contribution ratio is 10.56%. Their values are approximately the same values as PC3. A higher PCA score indicates the Square and Wide Shoulder with Straight back, and vice versa. PC4 represents the Shoulder and Back curved surface shape images.

PC5 involves two slightly higher positive values for B12. Posture and B13. Leg shape images. However, PC5's eigenvalue (2.64) and its contribution ratio (5.92%) are low. B12 and B13 do not appear to correlate with any other full-length or partial 3D-body shape image. PC5 represents Posture and Leg shape. The lower PCA score indicates a slight Forward leaning Posture and Bow-legged Leg shape.

As compared to the young females' 3D-body images in our previous paper, the PC items are approximately the same regardless of the number of PCs and grade of the items. As for the main differences, the previous paper on young females included PC1 to PC6, and PC5 for A4. Standard figure and B3. Height were extracted as separate factors.

### 3.2 Classification of 3D-body images

On the left side of Fig. 2, the 72 3D-body images are categorized into 6 clusters at dissimilar branching level of the dendrogram by method of the Ward Style using the PCA scores (denoted PCS) of PC1 to PC4 (cumulative contribution ratio: 76.21%). The factor loadings of PC1 to PC4 show the features of all 6 full-length 3D-body images and over 10% of the contribution ratio. The bar graph on the upper right side of Fig. 2 show the mean values of the PCS in each cluster.

By examining the points of positive or negative mean values of PCS1 to PCS4, we can recognize the general differences between the features of each cluster. In the upper Clusters 1 to 4 of dendrogram, PCS4 (the diagonally striped bar graph) consists mostly of negative mean values, regardless of the small positive mean values of Cluster 2, indicating a Narrow shoulder, Sloping shoulder, and/or Stopped back. In the lower Clusters 5 and 6 of dendrogram, the PCS4 consists of positive mean values representing opposite features, Square shoulder, Wide Stopped shoulder, and Straight back.

Furthermore, in Clusters 1 to 3 the mean value of PCS1 (the dotted bar graph) is negative corresponding to the A1. Underweight, A3. Ideal, and A4. Standard figure image groups, while in Cluster 4 the mean value is large and positive corresponding to the A6. Overweight figure image group.

In the first three clusters, the mean value of PCS2 (the horizontal striped bar graph) is positive in Clusters 2 and 3 indicating B1. Thin Leg thickness, B3. Tall Height, B4. Long Leg length, B5. Short Trunk length and B16. Firm Buttock appearance, while in Cluster 1 the negative mean value represents the opposite partial 3D-body images.

Lastly, the different images of PCS3 (the checkered bar graph) are extracted by examining mean values between Clusters 2 and 3 or Cluster 5 and 6 are extracted. The Clusters 2 and 5 are evaluated as A2. Feminine figure groups, while Clusters 3 and 6 are evaluated slightly high or high A. Masculine figure image groups. Similarly, there are not so high values of A2. Feminine figure image in Clusters 1 and 4.
Fig. 2 Dendrogram obtained from factor loading using cluster analysis and bar graph of PCS1 to PCS4 in Clusters 1 to 6.

Fig. 3 Mean values of each item (As and Bs) in Clusters 1 to 6.

As and Bs: A1 to A6 and B1 to B19 in Table 1. The labeled items on bar graphs of clusters 1-6 have significant differences (P: 0.01% or 0.05%) with the total mean values (number of total models =72).

Each 3D-body shape main image of the 6 clusters are described using the features of these 4 PCS in Fig. 2 and the mean values of the As and Bs of the 6 clusters in Fig. 3.

The A3. Ideal, A1. Underweight, A4. Standard, and A2. Feminine figure images are represented in Cluster 2 (n=7). These desirable images are based on the partial 3D-body shapes in PCS1 and PCS2;

On the other hand, the 3D-body images in Cluster 3 (n=13) are slightly similar to the A1, A6, and B1 to B6 images in the above Cluster 2. The different features of the 3D-body images extracted in this cluster are the slight A5. Masculine figure of PCS3 with B19. Square Body shape, Small B7. Bust size and B8. Hip circumference size, and B17. Thin Chest thickness of PCS1. However, there are the slight B9. Sloping Shoulder, B10. Narrow Shoulder breadth, and B11. Stooped back of PCS4 as well as in Cluster 3 that have the distinctive 3D-body shape images for Underweight and slightly Masculine figures with Narrow and Sloping shoulders and Stooped back area.

In comparison to the previous Clusters 2 and 3, the 3D-body features of Cluster 1 (n=13) are B4. Short leg length within B5. Long Trunk length delineated by a large negative PCS2. The full-length 3D-body images are A2. Feminine figure regardless of A5. Masculine figure with slight B7. Small Bust size and B17. Thin Chest thickness in PCS1 and slight B9. Sloping Shoulder and B10. Narrow Shoulder breadth due to a small PCS4.


Cluster 6 (n=18) has the A5. Masculine figure image in PCS3 with B8. Small Hip circumference size, B9. Square Shoulder, and B19. Square Body shape in Fig. 3. A large number of models belong in this cluster. Therefore, the total mean values of PCS1 to PCS4 in Fig. 2 and the As and Bs in Fig. 3 are small and those bar graphs are short in length.

In the relationship between the full-length images As and the partial images Bs in all of the model body (n = 72) images, the majority of the image As have higher positive or negative values with B18. Proportion or B19. Body shape. In particular, the A5. Masculine figure in the above mentioned Cluster 6 show the slightly negative correlation coefficient (r = - 0.65) with B19.

In a rough classification of the body of the adult feminine 3D-body shape images in all clusters regarding Shoulder inclination and breadth, item images were distinguished between the Sloping or Normal and Small breadth Shoulder of clusters 1 to 4 (62.5%) and the Square and slightly Wide breadth Shoulder of Clusters 5 and 6 (37.5%). The next classification of Clusters 1 to 4 and Clusters 5 and 6, were the two image types of Overweight or slightly Overweight figure image types of Cluster 4 and Cluster 5 (29%) and the Non Overweight figure image type of Clusters 1 to 3 and Cluster 6 (71%).

On the models in their 20's to 70's in this study, the Square and slightly Wide breadth Shoulder image type accounts for 37.5% while the Normal Shoulder image type accounts for approximately
62.5%. In addition, the Overweight figure image type accounts for 29% and Non-Overweight figure image type account for approximately 71%.

4. Conclusion

For the well-suited garment selection using IT etc., we investigated the 3D-body shape images in adult women in their 20's to 70's (number of models = 72, mean age = 50.07 years old). The four profiles of the 72 3D-body models were evaluated on a scale of 1 to 5 using 25 key image words (As of full-length and Bs of partial 3D-body image items) by 81 female respondents (mean age = 46.4 years old).

The 5 principal components of the 3D-body shape images (cumulative contribution ratio: 82.14% of PC1 to PC5) are extracted. Using these scores of PC1 to PC4 (PC1: Overweight figure - Ideal figure within Underweight and Standard figures, PC2: Vertical length proportion images, PC3: Feminine - Masculine figure images, PC4: Shoulder size and shapes images), the 3D-body shapes of the models are categorized into 6 image types by means of cluster analysis. The 6 clusters are as follows.

In Japanese adult women in their 20's to 70's, the Sloping or Normal and Small breadth Shoulder image type of Clusters 1 to 4 (62.5%) were categorized as Non Overweight figure image type (Clusters 1 to 3: 46%) and Overweight figure image type (Cluster 4: 16.5%). The Square and slightly Wide breadth Shoulder type of Cluster 5 and 6 (37.5%) were categorized as Non-Overweight figure image type (Cluster 6: 25%) and Overweight figure image type (Cluster 5: 12.5%). The ideal figure image type of Good Proportion occurs in only a few models in Cluster 2 (10%). The images of Cluster 3 (18%) indicate an Underweight and slightly Masculine figure with Square Body shape; although, it is smaller in size and proportional to the Underweight figure. The images in Cluster 1 (18%) are Short-legs and Long-trunked with Small size image type.

In the next paper, we will investigate the relationship between the 3D-body shape images and the ages or the body measurements from our own population sample.

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成人女子の3次元体形とデザインのイメージ評価を用いた婦人服選択支援情報の抽出（その1）

3次元体形のイメージによる体型分類

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要 旨

IT を利用した衣服の購入がより盛んになりつつある。個々の消費者の要求するデザインと体形のイメージを含むサイズに対応した服を確実に提供する必要があり、3次元人体モデルに着装シミュレーションなどで具体的に提示できるシステムの確立が望まれる。本研究では、衣服購入時の消費者がサイズだけでなく個々の体形のイメージを容易に示すことで、販売側がそれを正確に捉えるための3次元体形イメージ情報を（その1）で、次の研究で体形のイメージを予測し、それに適した服の3次元着装シミュレーションによるデザインのイメージに関してさらに検討したいと考えている。

高齢社会を迎えて幅広い年齢の成人女子に適した婦人服購入支援のため、数値ではない感性的な体形のイメージ用語による3次元体形のイメージ分類と、各イメージのタイプ別の特徴をサイズで捉え予測できるようにしたい。本報では、20代後半から70代の平均年齢50歳の成人女子72名の3次元体形イメージを、全身（A1〜A6）と部位（B1〜B19）を示す体形のイメージ用語を用いて5段階評価を行った。評価者はほぼ同年代の成人女子81名である。主成分分析の結果抽出された4つの主成分（PC1: 肥満体形 〜 瘦身・標準的体形を含んだ理想体形、PC2: 垂直距離のプロポーション、PC3: 女性的体形〜筋肉質の男性的体形、PC4: 肩部の大ささと形状のイメージ成分）の得点を用いてクラスタ分析を行い、6つの体形イメージのクラスタ（理想体形、瘦身体形、肥満体形、やや筋肉質で男性的体形などのイメージタイプ）に分類した。

キーワード：3次元人体モデル、体形イメージ用語、3次元体形イメージ分類、成人女子、主成分分析とクラスタ分析。