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ASSESSMENT OF VISUAL IMPRESSION OF FABRICS WITH CURVED SURFACES

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ABSTRACT

When a sample fabric is tested for the assessment of visual impressions, a flattened fabric is mostly used with a fixed distance from the respondents. However, the visual impressions of respondents to the flattened fabrics often vary with the conditions of lighting-angle, brightness, and the viewing angle to fabric. Moreover, the visual impressions assessed in practical forms differ from the visual impressions of the flattened fabrics. These problems are often pointed out because, in reality, fabric is hardly used in a flattened state. In this research, a novel technique is proposed and simple/lucid equipment is developed in order to enable a sample fabric to simulate the visual impressions of the fabric used in a practical scene. The method allows respondents to evaluate the complex impressions of fabric in three-dimensional vision even though the sample fabrics, which sizes are only 20 centimeter squared, are used in the sensory test. In our previous studies, the image features were extracted from the fabric images captured in flattened state in order to describe the relation between these image features and human's visual impressions. A few methods for relating the assessment of fabrics' visual impressions using the new equipment to the quantified image features of the fabrics captured in various illumination conditions are proposed. Furthermore, this research shows that the new method and the simple equipment enable us to develop the assessing method for complicated visual impression of fabric that usually forms unstable shape in actual space.

Keywords: *Apparel, Sensory test, Visual impression, Fabric assessment, Multivariable analysis*

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1. INTRODUCTION

The visual impressions of clothing materials have been investigated using various objective mechanical parameters and energetic properties. It shows the quality of texture of those materials has a considerable effect on the visual impression, and is closely related to the beautiful appearance and elaboration of the surface. Therefore, in order to develop the '*Kansei-rich'* fabric, it is important to explore the effective element of texture by the viewpoint of *Kansei* engineering, which is an approach to connect human sensibility with scientific/engineering applications.

We have been interested in the effects of texture on its impressions. As a part of the study, the relationship between some visual impressions for the textural characteristics of fabrics and image features has been investigated [1-3]. Meanwhile, effective image features that are related to human visual identification of those textures have been explored using image processing techniques [4-6]. Several images were captured for fabrics under varied illumination conditions in our studies. Various image features were also extracted in order to find the suitable combinations of the features for describing the integrated relationship to the visual impressions of fabrics. When these fabrics were evaluated by respondents in a fixed distance while the images were captured by digital photography, the sample fabrics were often used in flattened state as the conventional studies. However, the visual impressions of respondents to the flattened fabrics often vary with the conditions of lighting-angle, brightness, and the viewing angle to fabric. Moreover, the visual impressions assessed in practical forms differ from the visual impressions of the flattened fabrics. These problems are often pointed out because, in reality, fabric is hardly used in a flattened state.

In this research, a novel technique is proposed and simple/lucid equipment is developed in order to enable a sample fabric to simulate the visual impressions of the fabric used in a practical scene. The method allows respondents to evaluate the complex impressions of fabric in three-dimensional vision even though the sample fabrics are used in the sensory test. A few methods for relating the assessment of fabrics' visual impressions using the new equipment to the quantified image features of the fabrics captured in various illumination conditions are proposed. Furthermore, this research shows that the new method and the simple equipment enable us to develop the assessing method for complicated visual impression of fabric that usually forms unstable shape in actual space.

2. EXPERIMENT

2.1. New Equipment for Sensory Test

We have been developing new and simple/lucid equipment for visual sensory test as shown in Fig.1. This is expected to enable a sample fabric to simulate the visual impressions of the fabric used in a practical scene. Fig.2 shows an example of a fabric state on the equipment in the visual sensory test. The method allows respondents to evaluate the complex impressions of fabric in three-dimensional vision including the conditions of lighting-angle, brightness, and the viewing angle to fabric; nevertheless the size of sample fabrics used in the sensory test are only 20 centimeter squared represented in the figure.

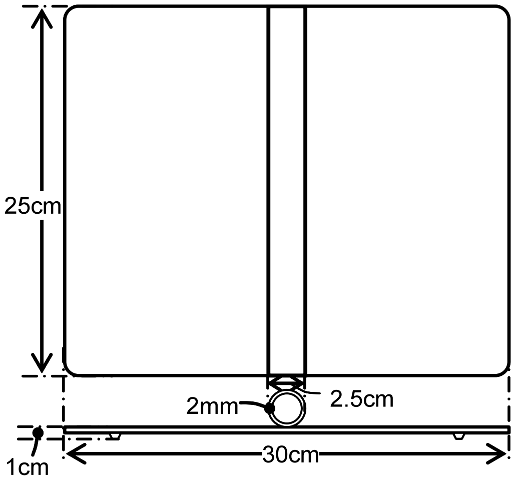

Figure 1: New developed equipment

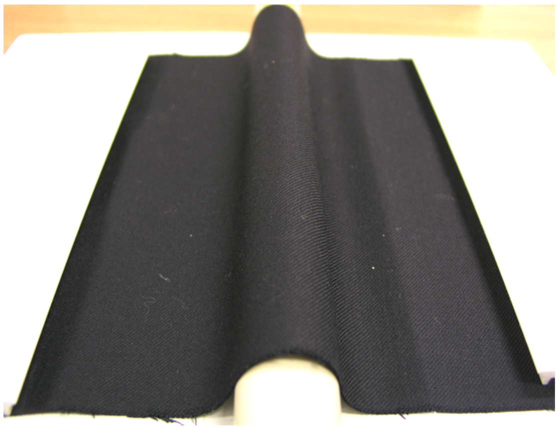

Figure 2: Example of a fabric on the equipment

2.2. Assesment of Visual Impression and Samples

Sensory tests were carried out using the fabrics shown in Table 1. It shows 7 black sample fabrics that were used in our previous studies. Black fabrics were often used as the sample in our research because of the following two advantages: The first reason is that black material allows us to investigate the impressions of textures independently of colors, which strongly affect human visual impressions. The second advantage is their fibrous and textural structure, which directly produces the delicate differences of visual impressions of clothing materials, even if fabrics have equivalent blackness. This enables us to investigate the complicated impressions of the materials and the delicate differences of textures.

Table 1: Title of the table

Sample	Material (%)	Weave	Weight (mg/cm^2)	Thickness (mm)	Bulk Density (g/cm^3)	Volume Fraction (%)	L-Value (Lightness)
B4	PET(Fil) 100	Satin	9.54	0.32	0.298	21.6	20.42
B6	Base: Cupra 100 Pile: Rayon 100	Velveteen	19.70	1.29	0.153	11.1	4.53
B9	Wool 100	Woolen	25.97	1.51	0.172	13	14.20
B10	Wool 100	Doeskin	26.82	0.82	0.326	24.7	15.20
B11	Wool 100	Doeskin	25.79	0.82	0.316	24	14.94
B12	Wool 100	Twill	29.92	0.89	0.338	25.6	14.61
B13	Wool 100	Twill	30.12	1.02	0.295	22.4	14.10

Figure 3 shows micrographs of these samples taken for observing and analyzing the micro-components of fabric surface characteristics. Close-up images of these fabrics were also captured from about 30cm away by digital camera for analyzing the relationship between the global structures of fabrics and the visual impressions.

The sensory test by visual impression and identification of fabric was experimented. The respondents for this evaluation test were over twenty consumers. The sample fabrics sized were arranged on the new equipments although the fabrics in previous studies were used to arrange on white paper. In this assessment, the five grade semantic differential method was employed comparing with the ranking method. Since an opposite evaluation may be derived in response influenced by sample arrangement, the order of the arrangement was changed complying with the ranking by each respondent and confirming his/her assessment. Several pairs of impression words were evaluated by the respondents. In this study, blackness, formality, and warmth are pointed up.

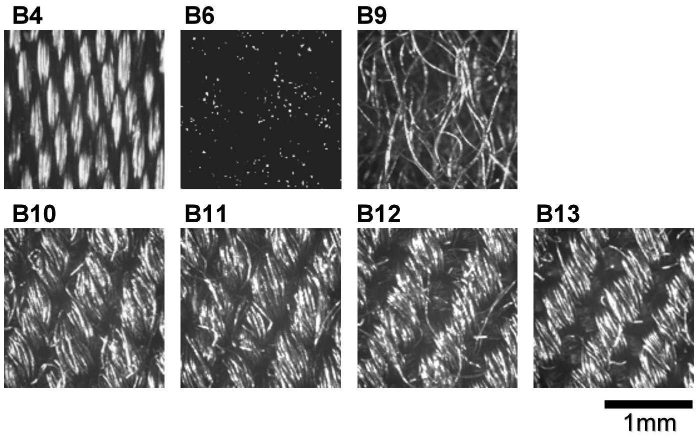

Figure 3: Micrographs of the sample fabrics

2.3. Mechanical Properties

A few mechanical and thermal properties of these sample fabrics were measured using Kawabata's Evaluation System to compare with the subjective assessment by the visual impressions. L-values, which were represented by lightness, were also measured using colorimeter of MINOLUTA CR300.

2.4. Extraction of Image Feature

We have applied image processing techniques to extract various image features of black fabrics. The visual impression on black fabric is not influenced by color effect, but is affected by delicate differences of texture caused by fiber and/or textile structures. We have recently investigated an evaluation method of human visual impression and the objective discrimination and evaluation by employing textural image features. The evaluation method of fabrics based on digital image processing has an advantage that it is reproducible because of the stability of captured images, contrarily to the instability of physical measurements of fabrics. The proposed method in [4] was applied experimentally to the exploration of the most effective ones from these textural features for describing human visual impressions of black fabrics. These novel features were employed to analyze quantitatively and evaluate objectively the visual impressions of materials. The following feature sets were employed for the analysis of the subjective assessment: texture anisotropy [7] expressing orientation distribution of textural elements contained in an image, texture segment features [4] expressing several geometrical characteristics of texture elements extracted by image segmentation using clustering of its intensity histogram, and periodic structures, which express frequency elements of textures with discrete Fourier transform [8]. These image features of the fabrics captured in various illumination conditions were quantified to analyze statistically the assessment of sensory test.

3. RESULT AND DISCUSSION

Fig.4, Fig.5 and Fig.6 show the results of the assessment for the fabrics set on the new equipments compared with the previous assessment of those flattened fabrics. Fig.4, Fig.5 and Fig.6 show the results of the assessment for the fabrics set on the new equipments compared with the previous assessment of those flattened fabrics.

While the little differences are found in the relationship of warmth, the remarkable differences are recognized in the assessment of blackness as shown in those figures. The assessment of blackness on the curved surface, which significantly differed from that of fabric in flattened state, was related strongly to the prominent edges and dominant element of periodic structure. The relationship between the blackness of fabric on the equipment and the L-value of it also decreased. The assessment of warmth on the curved surface hardly differed from flattened state. It was recognized that there is a relationship to the elliptic intensity of small segment and inconspicuous element of indication of periodic structure.

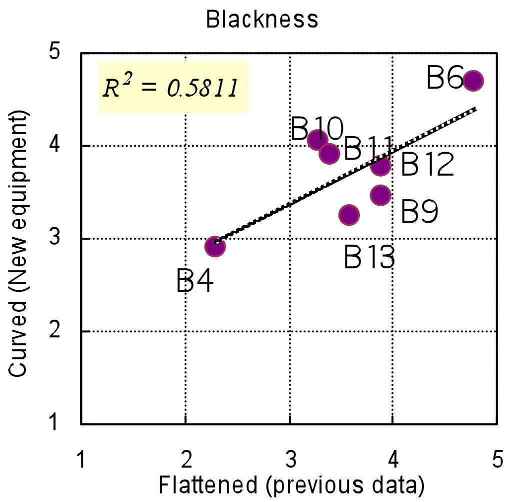

Figure 4: Assessment of blackness

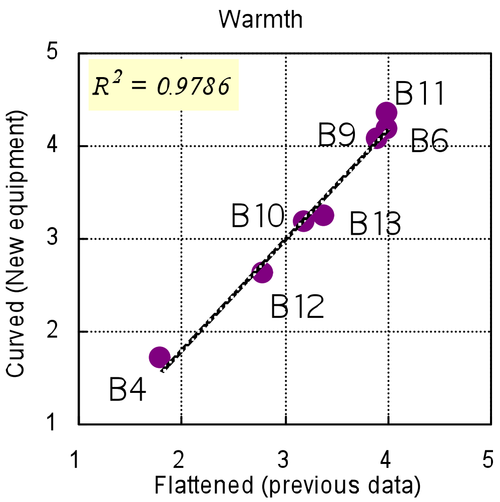

Figure 5: Assessment of warmth

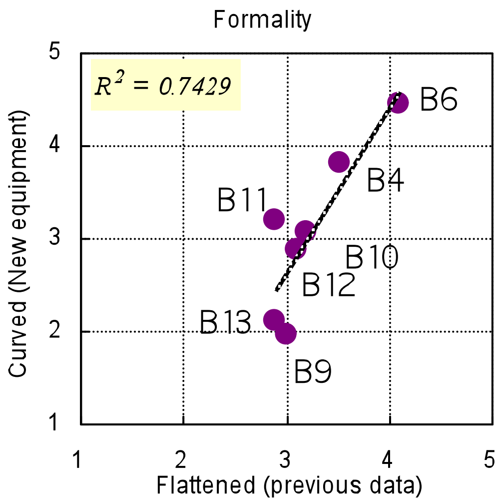

Figure 6: Assessment of formality

4. CONCLUTION

Simple/lucid equipment is developed in order to enable a sample fabric to simulate the visual impressions of the fabric used in a practical scene. A novel technique is also proposed and these allows respondents to evaluate the complex impressions of fabric in three-dimensional vision even though the sample fabrics, which sizes are only 20 centimeter squared, are used in the sensory test. Fabrics set on the curved surface produced significant variation in human visual sensibility and the visual assessment. The remarkable differences of the visual impressions between the fabrics flattened and those arranged on the curved surface were recognized in the assessment of blackness because the blackness of fabric is often influenced by lighting conditions. Little differences were found in the visual impression of warmth. These differences were analyzed by the proposed method using the selecting technique of image features. The results show that which features or characteristics of fabrics closely relate to the human sensitivity when we recognize some impressions to the fabrics in three-dimensional vision. This study also presents fundamental knowledge for constructing an objective evaluation system of human visual impressions, which requires reproducibility in real usage.

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