A concept network method based on analysis of impressions formation

Color schemes of uniforms from impressions of seasons

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Abstract: Our aim is to develop a method to capture the formation of impressions of design by using network analysis. We carried out a design evaluation experiment in which nine hospital uniforms (three groups) were selected for examination. Thirteen participants were administered a set of questionnaires to determine their impressions of each uniform. We then conducted centering resonance analysis. The free description data were automatically computed onto visualization files using methods based on the associative concept dictionary, and 98 depth images were extracted from the words in each file. A structure of concept networks for each uniform was visualized using “Pajek.” Through a correspondence analysis, nine uniforms were placed in different semantic spaces. We found significant high central concepts related to the concept networks of design impression. There was a clear difference between the three groups. The results confirm the effectiveness of the proposed method to understand impressions of design.

Key words: Impression forming, Network analysis, Associative concept, Design evaluation, Seasonal colors.

1. Introduction

1.1 Impressions of designed artifacts

In this study, we propose a new method to capture human impressions of products (designed artifacts). We first discuss the previous methods for capturing human impressions and our original method to understand the structure of impressions. Krippendorff emphasized design as a creative work that makes sense of an artifact [1]. He developed his knowledge of design with a view to inventing meanings for users’ experiences. Accelerated by his study, there are an increasing number of design methodologies based on users’ interpretations of their experiences. We consider that people ascribe many interpretative meanings to designed artifacts. Interpretative meanings not only include usage aspects (e.g., “how to use”) but also impressions (e.g., feelings). The true impression formed after using an object serves to evoke deeper impressions, which differ from the surface impression because the user has learned about the object and cultivated a deeper understanding of the object. This deeper understanding is regarded as a remarkable feature of the human mind [2] that constructs interpretations of the things and semantics. According to Roseman & Gero, 1993, and Cross, 2006, the first principle, which is one of the characteristics of creative design respects this deeper understanding of objects [3, 4]. Their principle illuminates the key features of cognition in creative design. One outstanding designer actually uses a method that is based on the first principle [5]. He stated that he had visualized a clear image of the “archetype of the object” (that is, a deeper impression) even before he had begun designing it. Indeed, human impressions form images of objects which are activated from “depth images.” We consider that depth images have strong conjunctions with the first principles. Therefore, understanding the impressions of objects (designed artifacts) is essential in the development of both design creativity and design methodology.
1.2 Previous studies on design impression

There are numerous methods to understand people’s impressions of objects. One of the most popular is the kansei evaluation method, which adopts the semantic differential (SD) method. Kansei means feelings, emotions, and sensitivities. The SD method was proposed by Osgood, Suci, and Tannenbaum [6] to measure the connotative meaning of concepts. The respondent is asked to choose where his or her position lies on a scale between two bipolar adjectives. Thus, human sensitivities to objects are evaluated through scoring sheets with a set of two bipolar adjectives, for instance, bright and dark (scales range from 1 to 5 or 7); the factors involved are determined by using mathematical analyses to form a semantic map. There are many advantages of using the kansei evaluation method in design [7]. For example, Ohtomi [8] used the SD method to survey product sound quality and verify the design of worth. Since the SD method contributes quantitative analytic results, it has become a popular method for investigating the sensibility related with design impression [9].

On the other hand, certain studies in the past have reported a limitation of kansei evaluation when using the SD method. One limitation is with respect to the scoring method used to collect data. The scoring procedure seems to analyze the tentative, shallow impression or the surface impression of participants on the basis of the exterior of the stimuli presented [10]. The “rough sets method” has been proposed on the basis of fuzzy logic to overcome this limitation and analyze the collected impressions using flexible integration [11]. However, even with this method, it is difficult to capture the deeper impressions or the “depth images” (described above). This limitation is deeply related to a dynamic process of human cognition. We paid close attention to the human cognitive process in the process of association. The protocols in the design process have been investigated as the association process by Nagai and others [12]. They used a conceptual combination task to determine the factors involved in the creative design process. The focus was on the number of concepts associated with the concepts presented during the task and the use of action concepts in the design process. In their experiment, the protocol data were analyzed by automatic methods using the associative concept dictionary [13]. The feasibility of capturing such associative concepts and identifying the process involved has increased the understanding of human thought and impressions. In this study, we focus on the association process in a network structure in order to understand the impressions (see, Figure 1) of designed artifacts.

![Figure 1: Differences between affective meanings and associative meanings](image)

1.3 Aims

The central issue addressed in this study is how to capture human impressions of designed artifacts. We aim to use semantic networks and develop a method that captures the impressions of designed artifacts (“design impression”). The design methodology is expected to be related to in depth human sense based on semantics. For this purpose, we define impression as a cognitive process dynamically structured in the human mind. Thus, we paid particular attention to the association process that connects concepts in the human mind.
2. Methods used in the study

A series of experimental investigations are employed in this study. We conduct a case study questionnaire to collect data, and we perform association analysis. Two different analysis techniques are employed in association analysis: corresponding analysis (CA) and centering resonance analysis (CRA). With a view to capturing design impression on the basis of an investigation of freely expressed impressions, we propose a methodology with which to capture human impressions as a semantic (conceptual) network. Network analyses are based on the network theory, which involves the graph theory as a representation of either symmetric or asymmetric relations between discrete objects. When considering a method to capture impressions, we focus on the common depth images of individuals. To detect these images, the semantic network structure applied in the psychological approach provides a framework of the nodes and link structure. On the basis of this network structure, we position the words gathered from the free style descriptions and extract the depth images from within the network to clarify the structure.

2.1 Survey of seasonal colors: preliminary study

In our investigation of design impressions, we first conducted a preliminary study to propose a framework for our study. The participants were 22 adults. We investigated people’s impressions of seasons using 3,800 colors, according to JIS-Z-8721. To identify design impressions, we surveyed the basic structure of human impressions elicited by designed artifacts (color impressions of seasons and uniforms) in comparison with a general impression of the object (color impressions of seasons). The key stimuli selected for investigating the impressions were seasons and colors because these concepts are well known and popular in Japan, and it was assumed that they would encourage participants to use their imaginations. As an exemplar of designed artifacts, we selected a particular kind of medical uniform. We analyzed the results of this survey and assumed six typical colors corresponding with each season: two colors for spring (cherry pink and young green), one for summer (light blue), two for autumn (apricot yellow and grass green), and one for winter (pale pink).

2.2 Investigation settings

On the basis of the results of our survey, we prepared stimuli uniforms to investigate the impressions elicited by colored uniforms. The colors of the stimuli uniforms were cherry pink (U6), young green (U7), light blue (U9), apricot yellow (U8), grass green (U3), pale pink (U2), white (U4), red (U5), and ultramarine (U1). Our investigation target was a structure of association networks using these nine uniforms. Figure 2 shows the nine colors, categorized as A, B, and C, as stimuli for the investigation. The selected six colors of our preliminary study are shown in the frame of group A (on the left) and the vivid colors are in group C (on the right). We compare the impression structure of the colors in group A with that of the standard color in group B (only one color in this group), which was strongly associated with a hospital uniform, and the other colors in group C, which were not at all associated with a hospital uniform.

![Figure 2: Nine uniforms used in the experiment (Munsell scale color number is below each uniform).](image-url)
2.3 Association analysis

Semantic network analysis is a method that analyzes colored uniforms as an example of designed artifacts in order to investigate the structure of human impressions by focusing on association processes. The association process is defined as a “mental connection between concepts or things.” Therefore, we investigate this process as a mental connection between concepts that form design impressions. We conducted a set of questionnaires to understand the impressions elicited by color uniforms for a hospital. The 8 male and 5 female participants (not the same as preliminary study participants) ranged from 22 to 70 years old and were all from the same country. The words expressed by the 13 subjects in free description were collected in text files for each stimulus (uniform). The data obtained from the association analysis were first normalized as words using “Chasen,” a morphemic analysis tool, and after deleting the overlapping words, 735 words were determined. Of these, 397 were extracted and used for further association analysis as follows. For every word, we calculated the probability of its occurrence in the responses.

2.3.1 Correspondence analysis (CA)

Correspondence analysis (CA) is a multivariate statistical technique similar to the principal components analysis used in kansei evaluation. However, this technique scales data, which should be situated in positive positions such that rows and columns are treated equivalently. CA decomposes the Chi-square statistic associated with this table into orthogonal factors. We cross-calculated the emergence frequency scores (0 to 13) of all the 397 words expressed by the 13 participants. Dual scaling [14] was used to analyze the correspondences among these words in order to determine the key properties of all the words (Table 1). We then plotted the 397 words on a two-dimensional map with axes 1 and 2 representing the first two properties. This map expresses a semantic map of the nine colored uniforms (explained in section 3.1).

2.3.2 Centering resonance analysis (CRA)

To investigate the structure of the impressions elicited by the nine colored uniforms, we categorized them into three groups using network analysis to facilitate a comparison. We adopted a CRA on the association network in order to not only capture the depth images of participants’ impressions of the nine colored uniforms but also construct a semantic meanings map of the hospital uniforms. CRA is a new text analysis method that has a broad scope and can be applied to large quantities of written text and transcribed conversations [15]. It differs from the traditional word frequency-based approach to modeling text. CRA is based on the linguistic theory that deals with how people create coherence in their communication. Thus, CRA employs natural language processing to create a network model of text. Networks via CRA accurately present the concept map that emerges when a person reads the text. Word influence values are calculated on the basis of the structural position of each word within the CRA network. In this research, we calculate the out-degree centrality for each concept network file (every file for which we carried out the sensitivity evaluation of each product). The following phases describe the procedure followed.

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Table 1: Part of the cross-table of words associated with stimuli uniforms (U1 - U9).

<table>
<thead>
<tr>
<th></th>
<th>U1</th>
<th>U2</th>
<th>U3</th>
<th>U4</th>
<th>U5</th>
<th>U6</th>
<th>U7</th>
<th>U8</th>
<th>U9</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-shirt</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Iced(1)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bright</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Warm(3)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hot(3)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Animation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Healing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glad</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Phase 1: On the basis of the words expressed by the 13 participants, we classify the text file into nine groups as per each uniform. These words are normalized and thought to be impression words (section 2.3).

Phase 2: We calculate the emergence frequency of all the impression words and erase the ones that overlap. The probability of occurrence was recorded for each of the expressed words and duplicated words were deleted. To detect the stimulus words, we use the Associative Concept Dictionary of the impression words [13]. This dictionary was constructed in a large-scale association experiment and applies the most common basic nouns (Japanese language at the elementary school level).

Phase 3: The free description data obtained in the sensibility evaluation experiment were automatically computed (Figure 3), on the basis of the associative concept dictionary, into visualization files to extract the latent image as the depth image from the impression words for each of the nine uniforms (see phase 6).

Phase 4: We analyze the nodes in all text files from Phase 3 and calculate the out-degree centrality score using "Arc" counting for each concept network corresponding to the nine uniforms.

Phase 5: On the basis of the following determination rule, we transfer the text files onto the vector graphs using weights.

\[
A = (a_{ij})
\]

\[
\begin{pmatrix}
    a_{11} & a_{12} & \cdots & a_{1n} \\
    \vdots & \ddots & \vdots \\
    a_{n1} & \cdots & a_{nn}
\end{pmatrix}
\]

Out-Degree Centrality: 
\[
D_i = \frac{\sum_{j=1}^{n} a_{ij}}{n-1}
\]

(Note: \( n \) is the number of nodes)

Phase 6: We choose only over 0.0012 out-degree centrality scores and erase the words that overlap from among the 161 words. Ninety-eight words (Table 2) were extracted and thought to be depth images of the impressions formed for the nine uniforms.

Phase 7: We represent the nine files of impressions and the associations of only the over 0.0012 out-degree centrality scored words in nine independent network structures (obtained in Phase 6). In connection with Phase 5, nine text files of depth images were visualized using "Pajek 1.24" [16] with the algorithm of "Fruchterman Reingold" (Figure 4). The node size was set to 300 so that the file was readable.

Phase 8: The latent concepts that represent the depth images were extracted from the words collected from each concept network file. For the final visualization of the analysis in this study, we present a two-dimensional map and distribute the extracted words (Table 2) of the depth images to investigate the relationships among the nine uniforms.

3. Results

3.1 CA results
Table 2: The extracted depths image.

The depths image for 9 stimuli uniforms (98 words). (1) is the first, (2) is the second semantic of the word.

<table>
<thead>
<tr>
<th>Uniform</th>
<th>Depth Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U2</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U3</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U4</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U5</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U6</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U7</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U8</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
<tr>
<td>U9</td>
<td>Marsh, Rain, Climate, Seashore, Beach, Climate, Feeling, Bridge, Scene, Lake, Harbor, Sight, Moisture, Waterside, Blue, Pacific Ocean, Pond, Bottom, Wave, White, Evening, Wind, Night</td>
</tr>
</tbody>
</table>

Figure 4: Network structure of the depth images for each uniform U1-U9. (Large nodes: the higher central concepts)
As per the CA results of the impressions elicited by the nine uniforms, Figure 5 presents the relationships among the associations. Axis-1 represents feelings (strong/mild) and axis-2 represents temperature (warm/cool). The positions of the typical associations for the nine uniforms are as follows.

1. The first quadrant indicates warm and mild. U2; U3; U6; U8; and the words “pretty,” “tree,” “gentle,” and “honest” are closely positioned for each uniform.

2. The second quadrant indicates warm and strong. U5 and the words “activity,” “crying,” and “fire” are closely positioned for each uniform.

3. The third quadrant represents cool and strong. U1, U7, and the words “quiet” and “fresh” are closely positioned here.

4. The fourth quadrant represents cool and mild. U4, U9, and the words “doctors” and “clean” are closely positioned for each uniform.

3.2 CRA results

The 98 extracted words (Table 2) represent depth images from the integration of seasons, colors, and uniforms. We distributed the 98 depth images on the semantic map. Thus, we obtained visualized concept networks from the nine colored uniforms and a semantic map of the season-colored uniforms. Axis-1 represents temperature (warm/cool) and axis-2 represents stability (excited/relaxed). The positions of the nine typical associations for the nine uniforms are as follows.

1. The first quadrant indicates warm and mild. U1; U4; U9; and the words “water,” “babul,” and “surface” are closely positioned for each uniform.

2. The second quadrant indicates relaxed and cool. U1; U4; U9; and the words “water,” “babul,” and “surface” are closely positioned for each uniform.

3. The third quadrant represents excited and warm. U3; U5; U7; and the words “children,” “light,” and “bright” are closely positioned for each uniform.

Figure 5: Correspondence analysis results (Square U1-U9 is uniform), Cumulative contribution rate is 30.47%.
4. Discussions

4.1 Findings: Characteristics of the impressions elicited by the season-colored uniforms

From the results of the analyses, we identified the characteristics of the impressions elicited by stimulus group A (U2, U3, U6, U7, U8, and U9) of the season-colored images as compared to stimulus group B (U4: standard white) and stimulus group C (U1 and U5) of the vivid-colored images. In the CA, four uniforms in group A (U2, U3, U6, and U8) fell in the “warm and mild” quadrant, separated from group B (U4) and group C (U1 and U5). Three of these (U2, U6, and U8) fell in the “warm and relaxed” quadrant in the CRA. The colors of these uniforms (pale pink, cherry pink, and apricot yellow) are considered to evoke the impression of “warmth” or “healing.” On the other hand, the standard color white was strongly associated with the image of “closed.” In other words, the white uniform, which evoked the image of a “hospital,” was associated with being “confined in a room,” and therefore, it was difficult to feel “warm.” The impressions elicited by the white uniform showed conflicting feelings of “stability” and “anxiety.” The pale pink, cherry pink, and apricot yellow uniforms might cause the human mind to feel more free because of the associated images of “seasons,” which symbolize the “gentle dynamics of nature.” These images are considered to be closely related to the image of “healthy.” Moreover, unlike the “facilities in a hospital” evoked by a white uniform, the season-colored uniforms evoked images of “family,” which is associated with intimate relationships rather than the physical image of a “house”. In the CA and CRA, the grass green uniform (U3) was located closest to the center point and in between the cherry pink (U6) and
young green (U7) uniforms. Grass green is thought to be a well-balanced color that evokes images of “yards,” “flowers,” and “mothers.” The features of the pale blue uniform (U9) were most similar to those of the white uniform in group B. On the other hand, the vivid-colored uniforms of red and ultramarine evoked feelings of “vitality” and “nature”; these are far from “healing” images and “mild” feelings, suggesting that they have clearly distinct features from the season-colored uniforms. Firstly, the vivid colors were connected to the image of the “force of nature,” which is more powerful and harsh than the “gentle dynamics of nature.” Secondly, unlike the season-colored and white uniforms, the vivid-colored ones evoked the depth image categorized “outdoors.”

4.2 Feasibility and validity of the method
The results of the network analyses have confirmed the applicability of our method and approach to capture design impressions. We successfully obtained the differences in the responses to stimuli by carrying out a case study on colored uniform design, described above. The results of the analyses showed that in the natural order of things, the standard uniform (white) is closely related with the impressions of “doctors,” “hospitals,” and “cleanliness.” These results support the validity of our study, and therefore, our method of analysis can be considered appropriate. Moreover, the results showed that the season-colored uniforms were closely related to a milder nature. The impressions elicited correspond with the answers of the preliminary study participants, who were different members of this investigation. This confirms the reproducibility of data in the proposed method to successfully capture design impressions. A plus point of the proposed method is that the data were obtained from free descriptions in natural language; therefore, it is completely different from the SD method. It will facilitate wider applications for design research because it is based on impression evaluation, which is closely related to understanding users at the depth level. For example, this method might contribute to the evaluation of future products having a compound element, that is, higher complex artifacts used in divergent situations.

4.3 Open issues in studying design impression
There are some issues that must be addressed in the future. First, we have studied a case of colored uniform designs from the perspectives of visitors (patients, family members of patients, or guests at a hospital). We chose to determine visitor perspectives with a view to capturing mental impressions. However, in order to discuss uniform designs, it is necessary to also consider the people wearing the uniforms. Perhaps in their case, functional requirements would dominate over mental impressions. Therefore, we would need to develop integration methods for mental (visual) and functional image impressions. Second, the dynamic feature of impressions should be strongly considered. Our method eases restrictions because impressions are gathered by using free descriptions rather than the scoring techniques of the SD method; however, human impressions are dynamic, unstable, and easily susceptible to outside influence. People in the real world are rather diverse, hailing from different cultures, nations, races, and so on. To account for these differences, future data collection techniques need to be more advanced. Third, the participants’ impressions could have been based on their motivations. The proposed method does not provide participants with a strict condition like the SD method does. However, in the future, we expect to develop a technique that will encourage participants.

4.4 Contributions to future design theory and methodology
At the beginning, we described how artifacts are considered to be the result of users’ experiences with a product, which, in turn, are the results of the endeavors of designers in society [17]. This has directed designers’ attention toward the users’ understanding of a product via experience, and therefore, design methods have begun to include more social views [18]. This view on the understanding of users drives design methodology, which is expected to develop further. However, there are some theoretical contradictions with designer creativity. The methods suggest that the understanding of users must always be behind the users. As discussed, an outstanding designer can foresee the image of an artifact to be produced, perhaps corresponding with the users’ understanding. In previous studies, this has been discussed as an issue of design creativity, and it is considered
“the first principle” of creative design [3, 4]. It is based on understanding of depth images, which are impressions at the depth level of cognition. The findings in this paper shed some light on depth images through an analysis of the network structure of impressions. The method proposed in this study will increase the knowledge about depth images and facilitate the development of a method that approaches design impressions at the depth level.

5. Conclusion
We have proposed a new method to capture design impressions by focusing on the associative concept networks represented in concept networks. In order to build a method that captures design impressions, we investigated the detailed structure of human impressions within associative concept networks by carrying out a case study on colored uniform designs. The findings of this study show that the impressions of season-colored uniforms are more significantly related to the depth image of “warm and mild” than the impressions of the other colors are, and season-colored uniforms can evoke feelings of “healing,” symbolizing the “gentle dynamics of nature”, that forms a high central concept of an ideal medical uniform. The validity of our proposed method to capture design impressions was demonstrated through the case study. The advantages of this method, such as, the possibility of approaching depth images and the method’s applicability with adopting free description data, were addressed. Future work will involve a trial of analysis of design impression on a larger scale. Further examination of the proposed method will be required continuously.

Acknowledgment
The research on color uniforms in this paper is supported by KOMATSU SEIREN Co., Ltd.

References