Analytic Study of Acquiring KANSEI Information Regarding the Recognition of Shape Models

Shao-Chi Wang†, Hiroshi Kubo‡1,
Hiromitsu Hikita‡2, Takashi Uozumi‡1 and Tohru Ifukube†

†: Laboratory of Sensory Information Engineering,
Research Institute for Electronic Science,
Hokkaido University, Sapporo 060-0812, Japan
{wsc, infukube@sense.es.hokudai.ac.jp}
‡1: Satellite Venture Business Laboratory
Muroran Institute of Technology,
Mizumoto-cho 27-1, Muroran 050-8585, Japan
{kubo, uozumi@csse.muroran-it.ac.jp}
‡2: Mechanical System Engineering
Muroran Institute of technology
Mizumoto-cho 27-1, Muroran 050-8585, Japan
{hikita@mondo.mech.muroran-it.ac.jp}

Abstract

This paper explores a fundamental study of acquiring the users' KANSEI information regarding the recognition of shape models. Since there are many differences such as background differences and knowledge differences among users, they will produce different evaluations based on their KANSEI even when an identical shape model is presented. Cluster analysis is proved to be available for catching a group tendency and for constructing a mapping relation between a description of the shape model and the KANSEI database.

In order to investigate an analogical relation and a mutual influence in our consciousness, first, we made a questionnaire that asked subjects to represent images having different colors and shape cones by using 4 pairs of adjectives (KANSEI words). Next, based on the cluster analysis of the questionnaire using a fuzzy set theory, we proposed a hypothesis showing how the analogical relation and the mutual influence work in our mind while viewing the shape models. Furthermore, how the properties of KANSEI depend on their descriptions was also investigated by virtue of the cluster analysis. This work will be valuable to construct a personal KANSEI database regarding the Shape Model Processing System.

Keywords: KANSEI, KANSE information, Cluster analysis, Fuzzy set theory

1. Introduction

Recently, much more great notices have been poured into KANSEI information processing and a new field regarding KANSEI Engineering has been attracting many researchers to launch themselves into this research field. One of the social backgrounds of this field is a need that requires shifting the machine-centered to the human-centered products considering human's feeling 'KANSEI'. It is hypothesized that the activities of our right brain have many properties, such as polysemy, ambiguity and subjectivity that are difficult to obtain an integrated description among a group of persons. This is a reason why KANSEI strongly depends on individual perception behavior even when an identical object is presented. However, as a supplement of developing a novel product for the specified targets, it is available to investigate the conscious tendency and to acquire the feedback of users' evaluation. We intend to develop a Shape Model Processing System (SMPS) that the 3D primitives are designed as reconfigured shapes to adapt user's KANSEI by using a learning-machine algorithm. However, the decision of initial values and the solution of the mutual properties of a KANSEI database firstly need to be solved in the system. In this paper, we address a fundamental study for acquiring the users' KANSEI information when they evaluate a shape model and discuss a potential application of this study in the SMPS. Based on a questionnaire in which 4 pairs of KANSEI words are used to evaluate a reconfigured cone, we carry out a cluster analysis with respect to the questionnaire by means of the fuzzy set theory. The present work is useful to: (1) establish a methodology for investigating the perception behavior when we perform the recognition of shape models and (2) decide the initial values in the SMPS and solve the mutual influence problems in the construction of a personal KANSEI database.

In the next part, we will introduce the questionnaire and give a description of the cluster analysis in the third part. A discussion for applying the results to the SMPS is addressed in the fourth part. In the last part, we will conclude this paper.

2. Description of the Questionnaire

Although it is compelled to classify the ambiguity feeling to a distinct description, the SD method is generally adopted in the conscious survey since it can at last obtain the psychology tendency of perception behavior of the survey targets. In our study, we also employ the SD method to serve the purpose to evaluate a group of different shape and color cones by using 4 pairs of opposite adjectives, i.e., "Bright-Dark", "Soft-Hard", "Warm-Cold" and "Flashy-Plain". 7 levels are set up between these opposite adjectives (Fig. 1) and used to evaluate the reconfigured cones.

The targets are 30 teachers of high school whose ages are between 20 and 40. The reconfigured cones are produced with changing the geometry parameters and color of a standard cone. (Fig. 2)

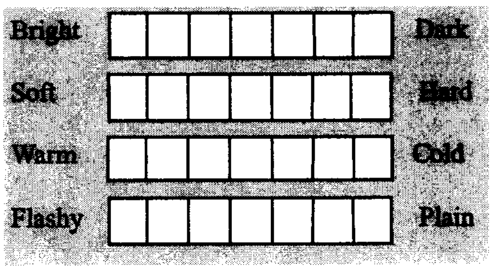

Figure 1. KANSEI Words

Figure 2. Reconfigured Cones

It was reported that the adjective words can be dividied into subordinate and superordinate concepts while the superordinate adjective words can be considered as the combination of some subordinate ones[1]. Moreover, the superordinate adjectives relate our high-level of our KANSEI while the subordinate ones relate the low-level KANSEI. The former two pairs of words in figure 1 are considered as the subordinate adjectives while the last two pairs are the superordinate adjectives. As a result of the questinnaire, the following statement have been addressed yet in reference [2].

- We usually use our higher-level KANSEI in the evaluation of an object rather than using our intuition. The judgment by using our lower-level KANSEI easily produces relatively great difference.

3. Analysis of the Questionnaire

It has been shown that fuzzy set theory is available to the sociogram analysis of consciousness [3]. In order to elucidate the perception behavior and investigate the analogical relation and mutual influence regarding the recognition of shape models, we also use this fuzzy set theory to analyze the above questionnaire in this part. With exploring the questionnaire, the cluster analysis of KANSEI is carried out and consequently the dependent relation of KANSEI description is explained.

3.1. Evaluation Matrix

	B-D	S-H	W-C	F-P
1	0.43	0.43	0.71	1.00
2	0.29	0.57	0.14	1.00
3	0.86	0.57	0.43	1.00
4	0.14	0.86	0.57	1.00
5	0.57	0.57	0.57	0.71
6	0.43	0.71	0.14	1.00
7	0.71	0.71	0.57	1.00
8	0.14	1.00	0.14	1.00
9	1.00	0.57	0.43	0.71
10	0.14	1.00	0.14	1.00
11	1.00	0.86	0.57	0.86
12	0.14	0.86	0.14	1.00
13	0.71	0.86	0.57	0.71
14	0.43	0.29	0.71	1.00
15	0.29	0.29	0.86	0.86
16	0.57	0.71	0.71	0.86
17	0.71	0.71	0.29	1.00
18	0.57	1.00	0.14	1.00
19	0.57	0.71	0.29	0.86
20	0.57	0.86	0.29	1.00
21	0.14	1.00	0.14	1.00
22	0.57	0.86	0.14	1.00
23	0.14	0.86	0.43	1.00
24	0.28	0.71	0.29	0.71
25	0.43	0.71	0.57	1.00
26	0.57	0.57	0.57	0.57
27	0.57	0.57	0.14	1.00
28	0.57	1.00	0.14	1.00
29	0.71	0.86	0.43	1.00
30	0.71	1.00	0.43	1.00

Table 1. Evaluation Matrix

7 level evaluations of the aforementioned 4 pairs of KANSEI words can be translated into the

numbers "0.14, 0.29, 0.43, 0.57, 0.71, 0.86, 1". Evaluations of 30 persons to the first one cone in figure 2 can be represented as a 30×4 matrix by using these numbers. This matrix is called an evaluation matrix and described as in the table 1. Where "B-D", "S-H", "W-C and "F-P" represent the abbreviations of the 4 opposite adjectives (KASNEI words).

3.2. Questionnaire Analysis with Fuzzy Set Theory

According the reference [3], an analogical fuzzy matrix $\boldsymbol{S}$ and a mutual fuzzy matrix $\boldsymbol{T}$ can be expressed as in formulas (1) and (2). Elements of Matrices $\boldsymbol{S}$ and $\boldsymbol{T}$ are named analogical and mutual coefficients and express the degrees of analogical relation and mutual influence of the KANSEI evaluations. For instance, the analogical degree between the evaluations of "Bright-Dark" and "Soft-Hard" are represented by element $\boldsymbol{S}_{12}$ and its value is 0.69. Moreover, the dependent degree of KANSEI evaluation "Bright-Dark" relating to " Soft-Hard" is 0.91 ($=t_{12}$) while the degree of the converse relation is 0.56.

$$\boldsymbol{S}=\begin{pmatrix} 1 & 0.69 & 0.75 & 0.54 \\ 0.69 & 1 & 0.56 & 0.8 \\ 0.75 & 0.56 & 1 & 0.46 \\ 0.54 & 0.8 & 0.46 & 1 \end{pmatrix} \qquad (1)$$

$$\boldsymbol{T}=\begin{pmatrix} 1 & 0.91 & 0.67 & 0.95 \\ 0.56 & 1 & 0.42 & 0.99 \\ 0.84 & 0.87 & 1 & 1 \\ 0.38 & 0.68 & 0.3 & 1 \end{pmatrix} \qquad (2)$$

Therefore, the larger the values of the elements of these 2 matrices are, the closer the analogical relation is and the stronger the dependent degree is. With the matrix $\boldsymbol{S}$, an analogical fuzzy graph can be described as figure 3.

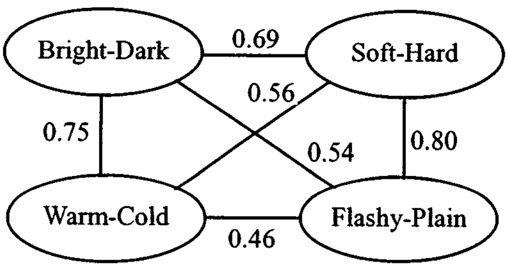

Figure 3. Analogical Fuzzy Graph

Furthermore, we perform the cluster analysis in which each element of matrix $\boldsymbol{S}$ is used as thresholds to filter itself and a graph can be obtained as figure 4. Where ①, ②, ③ and ④ respectively express the aforementioned adjective pairs "Bright-Dark", "Soft-Hard", "Warm-Cold" and "Flashy-Plain". This graph can explain the analogical relation as follows: namely, KANSEI evaluation with using "Soft-Hard" and "Flashy-Plain" exposes the analogy when the analogical coefficient is 0.8 and also analogical relation of "Bright-Dark" and "Warm-Cold" is exposed when the coefficient is 0.75. There

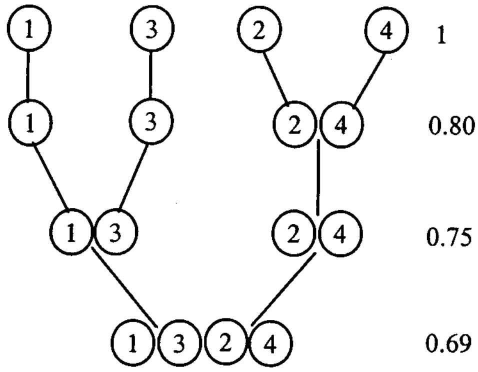

Figure 4. Graph of Cluster Analysis

is no analogical relation each other between these adjectives when the coefficient is 1. If the analogical coefficient is 0.69, however, 4 pairs of adjectives have analogical relations reciprocally.

On the other hand, a mutual fuzzy graph can be obtained by virtue of the matrix $\boldsymbol{T}$ (Fig. 5).

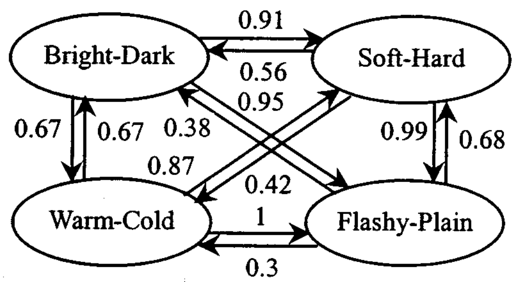

Figure 5. Mutual Fuzzy Graph

Then, filtering this figure with the following formulas

$$t_{ij}=\begin{cases} 1 & t_{ij}>0.5 \\ 0 & t_{ij}<0.5 \\ 0.5 & t_{ij}=0.5 \end{cases} \qquad (3)$$

a simplified graph can be described as in figure 6. Numbers 1s are omitted in figure 6.

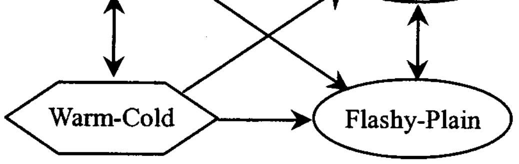

Figure 6. Simplified Analogical Fuzzy

Consequently, the dependent relation of conscious tendency on the recognition of models can

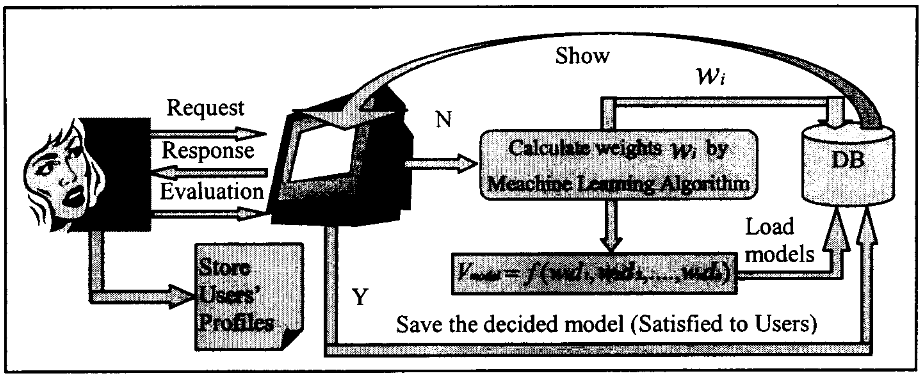

Figure 7. Shape Model Processing System

be shown by the direction of the arrows in figure 6. Combining the aforèmentioned statement in part 2, we can acquire the following perception sequence when we perform the recognition of shape models by using these KANSEI words, i.e., "Flashy-Plain" => "Soft-Hard" => "Bright-Dark" => "Warm-Cold". Meanly, the perception like "This cone is flash" or "This is a plain cone" is the common standpoint and firstly comes to conscious for plenty of persons to evaluate the cone.

4. Further Discussions

The questionnaire, in fact, is the prepared work of a project for developing a SMPS. The purpose of the project is to construct a part supporting the "3D Object Design System"[2]. The SMPS is described as figure 7 and its specification is stated as follows:

(1) Provide 3D primitive objects and the basic operations.
(2) Reflect the users' evaluation in real time.
(3) Correct the trial errors according to the users' evaluation and match users' KANSEI by virtue of the machine-learning function.
(4) Store the KANSEI information together with the users' profiles for constructing a personal database.
(5) Implement the User Interface (UI) between users and a computer.

The acquired result in the above part is available to the following functions:

(1) Solve the mutual properties of KANSEI description on the construction of KANSEI database.
(2) Contribute to decide the initial value of the SMPS.

In the system, a primitive object is initially shown as a response and evaluated by users' KANSEI. According to the feedback of user's evaluation, the primitive object will be modified until a reconfigured model can satisfy users' demands. Modification of the models depends on the adjustment of the weights of KANSEI evaluations by using a Reinforcement Learning Algorithm. As an index to load the physical arguments from a database, a value V_{model} is expressed in the formula (3) and can be obtained by the machine-learning algorithm.

$$V_{model} = f(w_1 d_1, w_2 d_2, .., w_n d_n) \tag{3}$$

With the loaded arguments, a reconfigured model as a response will be rendered on the screen. Finally, the satisfied model together with the user's profiles will be saved in a database. The weights will keep the following relation, i.e.,

$$w_1 + w_2 + \ldots + w_n = 1 \tag{4}$$

and the initial values are given by referring the results obtained in the part 3.

5. Conclusions

For the purpose of how to acquire the users' KANSEI information on the recognition of shape model, a questionnaire and the fundamental analysis were addressed in this paper. With the obtained results, i.e., the analogical relation and dependent degree, not only the perception behavior and process on the recognition of shape models can be elucidated, but also the work is available to develop the SMPS. As the perspective, we also simply discuss a potential application of the current study. The statement in the part 4 is expected to obtain a real operation and estimation through the further development in future.

Reference

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