ORIGINAL ARTICLE

Spatial Evaluation Method of Impression Considering Vagueness of Kansei and its Characteristics

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Abstract: This paper proposes a method of evaluating impressions using a space containing impression words. The impression of an object is specified by circling impression words that match its impression. The degree of matching of the impression is expressed by the darkness of the color used to paint the circled area. This method is called the Impression Evaluation Method by Space (IEMS). The IEMS considers the vagueness of Kansei. The IEMS poses few restrictions to users evaluating an impression, while the semantic differential (SD) method evaluates an impression in a predefined range for enabling statistical processing. A prototype system is implemented to evaluate the IEMS. This system enables a subject to evaluate their impression of a picture by using the IEMS. An impression evaluation experiment is carried out on several pictures to compare with conventional methods, such as the SD method. Various results of evaluation are obtained from this experiment, and consideration is conducted. Finally, it is shown that the proposed method can evaluate the aspects that other methods cannot. The IEMS enables users to express the degree that they feel in the continuous manner, the opposite feelings at the same time, and the feeling among several impression words. It also enables them to add the impression words that they want to use, and not to enforce the evaluation through all of the impression words.

Keywords: *Kansei, Vagueness, Impression, Evaluation, Space*

1. INTRODUCTION

In recent years, in addition to functions and convenience, Kansei topics such as design have become important. Kansei is a word that means how people feel. Since Kansei is vague, it is difficult to precisely capture and quantify it. Moreover, Kansei is difficult to evaluate because Kansei differs for each person.

The semantic differential (SD) method [1] is often used to evaluate Kansei. Since the SD method digitizes impressions, it enables statistical processing and makes it possible to perform various analyses. However, to enable statistical processing, it requires that the evaluation be performed in a predefined range. The arbitrary elements might exist. For example, all pairs of the impression words used in evaluation are selected for the convenience of experimenters. As a result, it is difficult to evaluate vague aspects of Kansei. A method enabling the evaluation of the vagueness of Kansei is required. However, while various research efforts concerning the expression of Kansei have been conducted [2-4], such an evaluation method has not yet been established.

This paper proposes an impression evaluation method that takes into account the vagueness of Kansei. This method uses a Kansei space containing impression words [5]. The impression of an object is specified by circling the areas that match its impression. The

degree of matching to the impression is expressed by the darkness of the color used to paint the circled area. The proposed method is called the Impression Evaluation Method by Space (IEMS). In order to verify the effectiveness of the proposed method, an impression evaluation experiment is carried out on several pictures. Here, the IEMS is compared with other methods, such as the SD one. It will be shown that the proposed method can evaluate aspects that the other methods cannot.

This paper is organized as follows. Section 2 provides a summary of the SD method and outlines problems associated with it. Section 3 introduces the concept of the Kansei space. Section 4 proposes an impression evaluation method that takes into account the vagueness of Kansei. The baseline Kansei space is obtained in Section 5. Section 6 describes an impression evaluation system based on the IEMS. In Section 7, the impression evaluation experiment is conducted. Finally, Section 8 gives the conclusion to this paper.

2. SEMANTIC DIFFERENTIAL METHOD

The SD method is a technique used to clarify an impression that people feel [1]. It uses a large number of pairs of impression words. For each pair, impression is evaluated usually in five or seven steps. By gathering the results evaluated by many subjects, general tendency of the impression could be obtained. Moreover, by applying

the factor analysis to the data obtained, potential factors could be obtained. These factors make the interpretation of the results easy.

However, it is difficult to evaluate vague aspects of Kansei using the SD method, due to the following problems:

1. Discrete level evaluation:

Although the SD method evaluates a vague quantity called Kansei, it produces discrete scores. In other words, the evaluation results in predefined scores, and does not allow for the notion of vagueness. Of course, it is difficult to quantify Kansei.

2. Opposite impressions:

The SD method cannot express opposite impressions. For example, the impression of a picture of a starry sky may feel to a person as both dark and bright.

3. Interpretations of an impression word:

The interpretation of an impression word may vary for each person and/or scene. When an impression word has multiple meanings, it is not understood which meaning is used.

4. Selection of pairs of impression words:

The SD method uses the pairs of the impression words selected by an experimenter. These pairs may be selected according to some purpose. For instance, they may not include the pairs of the impression words that are needed for a particular subject. Moreover, the SD method for evaluation uses all pairs of words.

5. Discrete relations between pairs of impression words:

The SD method independently evaluates all pairs of the impression words. Moreover, certain impressions cannot uniquely be expressed by words, such as an impression for the words “cute” and “beautiful.”

3. KANSEI SPACE

The Kansei space is the space that is imagined when the impression of an object is evaluated. For example, when the impression of a landscape is evaluated, this can be expressed with words such as “beautiful.” In addition, similar to the SD method, the degree of fitness to an impression word can also be expressed. It is believed that people have in their minds some impression expression items, and they compute the degree of fitness of each item to the impression of an object.

In this paper, impression words are used as impression expression items because words can easily express an impression (something considered by the authors to be

very important). In the Kansei space, the more similar the impressions of two impression words are, the closer these impression words are.

The characteristics of the Kansei space are as follows:

1. Dissimilarity between impression words:

When two different impression words are presented, one can determine how similar they are. That is similarity or dissimilarity between impression words. It is considered that there are dissimilarities between the impression words.

2. Growth characteristic:

The Kansei space changes (grows) by experience and learning.

3. Dynamic characteristic:

The impression of an object changes according to the current feeling. In addition, temporary changes are restored with time. Therefore, the Kansei space always changes.

4. Personal characteristic:

The Kansei space depends on the person; this is clear from Items 2 and 3. Persons with common attributes, such as twenty-year-old Japanese university students, tend to have similar, but not identical, Kansei spaces. The impression words in the Kansei space also depend on the person. For example, some people evaluate an impression using the word “cute,” while others evaluate it using “pretty.”

4. IMPRESSION EVALUATION METHOD BY SPACE

4.1 Summary of the IEMS

The IEMS uses as the Kansei space a plane containing impression words. The impression of an object is specified by circling the areas matching its impression. The degree of matching the impression is expressed by the painting color. In other words, the more closely matched the impression is, the darker the color is. The color gray is used for these areas. A special brush is used to paint the areas darker.

As it is difficult to create the Kansei space mentioned above from scratch, the IEMS provides to users a commonly used baseline Kansei space. Users can modify this baseline space as needed.

4.2 Evaluation rules of the IEMS

The evaluation rules used in the IEMS are as follows:

- The impression words selected to express the impression of an object are circled.

- One or more impression words can be circled in a single area.
- One or more circled areas can exist.
- If the impression points-of-view are different, the circled areas are different.
- If a user does not agree with the position of an impression word, that impression word can be moved.
- If the space does not have a desired impression word, an impression word can be added.
- Two or more Kansei spaces can be used when users cannot sufficiently evaluate impressions through one Kansei space. In other words, when users want to evaluate different impression points-of-view by using the same impression word, or when the areas overlap, users can evaluate an impression through two or more Kansei spaces.

4.3 Evaluation Example

An example of a Kansei space is shown in Fig. 1(a). Impression words are placed according to their similarity. For example, the word “bright” is placed near the word “beautiful,” and far from the word “dark.” In other words, in the Kansei space, the more similar the impressions are, the closer the impression words are.

An evaluation example for this Kansei space is shown in Fig. 1(b), which depicts that the impression of an object is beautiful, bright, and wide. In addition, the degree of darkness of a color expresses how much it matches an impression. Using this approach, a user can also evaluate the impression between impression words. A vague impression can be evaluated by expressing the degree of darkness of a color. In addition, even if a matching impression word cannot be imagined, the impression words that have similar meanings can be used. Furthermore, two words with opposite meanings at the same time can also be used. Such cases cannot be evaluated using the SD method.

Figure 1: Kansei space: (a) example of a Kansei space, (b) evaluation example using the IEMS.

5. BASELINE KANSEI SPACE

5.1 Constructing the Baseline Kansei Space

To obtain the baseline Kansei space, the impression words commonly used must be decided. Next, they are placed in a space using multi-dimensional scaling (MDS). MDS uses the distances between items to place them in a space [6]. The dissimilarities between the impression words are determined by computing the distances. These dissimilarities are experimentally obtained. These steps are described in detail below.

5.2 Choice of Impression Words

All impression words required for evaluation are wanted to be included in the baseline Kansei space. However, numerous impression words exist. In addition, when a large number of impression words are placed in the Kansei space, it is difficult and time-consuming to evaluate them all. Therefore, it is undesirable to choose too many impression words for a baseline Kansei space. The impression words used for the baseline Kansei space are required to be properly chosen. In this paper, the impression words that are often used for the evaluation of Kansei are chosen.

Ozawa *et al.* proposed a hierarchy of Kansei containing six levels [7, 8]. At the highest level is the absolute Kansei, and at the lowest level is the basic Kansei. One hundred impression words often used to evaluate Kansei were chosen. These impression words were used to verify the validity of the hierarchy. Therefore, the impression words were divided into six levels. In this paper, 37 fundamental impression words, which are obtained by selecting several words from each level, are used for the baseline Kansei space. Table 1 shows the 37 impression words chosen, and their levels.

Table 1: 37 impression words selected.

Level	Description	Impression words
6	Absolute Kansei	mysterious, natural, pure
5	Artistic Kansei	tired, refreshing, cool, stylish, excellent
4	Emotional Kansei	cute, simple, leisurely, sad, loose
3	Satisfactory Kansei	flashy, sober, plain, greasy, sharp, smooth, strong, weak
2	Comfortable Kansei	noisy, quiet, beautiful, dirty, soft, hard, wide, narrow
1	Basic Kansei	bright, dark, hot, cold, heavy, light, big, small

Figure 2: The baseline Kansei space.

5.3 Questionnaire

The distances between the chosen impression words were experimentally obtained; Japanese words were used in the experiment. Subjects judged the dissimilarities between the pairs of impression words using a scale of 1 to 10. The number of the pairs was 666. The pairs were presented to the subjects in a random order. Eleven subjects participated in the experiment: ten were males, and one was female. All subjects were university students in their early twenties, majoring in Information Science.

5.4 Constructing the Baseline Kansei Space

A matrix expressing the dissimilarity between the impression words was constructed using the data obtained from the experiment. The impression words were placed in the plane by applying MDS to the matrix. As the dissimilarity measure was used, the non-metric version of MDS was applied. Figure 2 shows the Kansei space obtained by averaging the scores obtained from all subjects. Similar impression words were placed near each other in the space. It appears likely that the impression words were properly placed in the space. This space is used as the baseline Kansei space.

6. IMPRESSION EVALUATION SYSTEM

Next, the impression evaluation system based on the IEMS was implemented. This system enables a subject to evaluate their impression of a picture. Figure 3 shows the initial screen of the system. The Kansei space is in the center of the screen and a picture is on the right side. Pictures are presented to subjects in a random order. A subject evaluates their impression of a picture in the space by using the buttons and text boxes available in the left and bottom sides of the screen.

Figure 3: The initial screen of the impression evaluation system.

The evaluation process followed by the subjects is as follows. First, the subject uses the pencil (by pressing the “pencil” radio button) to circle the area matching their impression of the picture. Next, the subject uses the brush to color the area to express the degree by which the area fits their impression. The brush, which makes the color of the area darker, is used by pressing the “brush (darker)” radio button. In addition, the subject can move or add an impression word by pressing the “move/add” radio button. Finally, by pressing the “next” and “return” buttons, subjects can evaluate the impression of a picture through two or more spaces.

7. IMPRESSION EVALUATION EXPERIMENT

7.1 Experimental Method

Pictures were evaluated using the IEMS, and then compared with the following two methods: unipole and SD ones. In this experiment, Japanese words were used in all methods.

In the unipole method, subjects evaluate impressions of pictures by using the impression words that have five scores, 1 to 5. When a subject feels that an impression word does not match a picture at all, he or she scores the impression word with 1. When they feel that an impression word matches a picture very well, he or she scores the impression word with 5. For this method, the 37 impression words in the baseline Kansei space were used.

In the SD method, subjects evaluate impressions of pictures by using the pairs of the impression words that have five scores (25 pairs are used). The pairs of the impression words used are shown in Table 2. When the left-side impression word is “A” and the right-side impression word is “B,” the five scores used are: “very A,” “a little A,” “neither A nor B,” “a little B,” and “very B.” Out of the 37 impression words contained in the baseline Kansei space, 24 impression words were 12 pairs of

Table 2: 25 pairs of impression words used in the SD method.

No.	Pairs of impression words		No.	Pairs of impression words	
1	mysterious	ordinary	14	plain	greasy
2	natural	artificial	15	sharp	dull
3	pure	impure	16	smooth	coarse
4	tired	refreshing	17	strong	weak
5	cool	uncool	18	noisy	quiet
6	stylish	unstylish	19	beautiful	dirty
7	excellent	awful	20	soft	hard
8	cute	massive	21	wide	narrow
9	simple	sticky	22	bright	dark
10	leisurely	restless	23	hot	cold
11	sad	happy	24	heavy	light
12	loose	tight	25	big	small
13	flashy	sober			

words. The remaining 13 words are combined with antonyms to produce 13 pairs of impression words. The original 37 words are shaded in Table 2.

The pictures used in the experiment are presented in Fig. 4. Each subject evaluated these five pictures using the three methods mentioned above. Each picture was evaluated in the order of (1) the IEMS, (2) the unipole method, and (3) the SD method.

The order of the impression words in the unipole method and the pairs of the impression words in the SD method presented to the subjects was random. Moreover, the order of presenting pictures was also random.

Figure 4: The five pictures used in the experiment: (a) cherry blossoms [9], (b) Veronica persica [9], (c) lightning [10], (d) Christmas tree [11], and (e) Neuschwanstein Castle [12].

Twelve subjects participated in this experiment. Ten subjects were males, and two were females. All subjects were university students in their early twenties, majoring in Information Science.

7.2 Result

The results of the experiment are the impression evaluations of the five pictures (Fig. 4) obtained from the 12 subjects. Due to space limitations, the evaluation results of only a few subjects are presented. The evaluation results of the IEMS are shown in Fig. 5 to 7 (these results are obtained from different subjects). The evaluation results of the unipole and SD methods are presented in Tables 3 to 5. The evaluation scores of the SD method range from 1 to 5 in Tables 3 to 5. The meanings of the scores are as described in Section 7.1. The score 5 means “very A,” while 1 means “very B,” where A (B, respectively) is the left-side (right-side) impression word. For example, the impression of Picture (a) is “very cute” because the score of the “cute – massive” pair is five as shown in Table 3 (b), while it is “a little light” because the score of the “heavy – light” pair is two.

The impression words with the evaluation scores using the unipole method equal to 1 are omitted because the subjects do not feel any impression to the pictures. The pairs of the impression words with the evaluation scores equal to 3 using the SD method are also omitted because subjects do not feel any impression to the pictures. The impression words and the pairs of the impression words evaluated by the IEMS are shaded in Tables 3 to 5.

In summary, the evaluation results obtained are very similar for all methods tested. However, there exist a few small differences.

The average times required in the evaluations are shown in Table 6. The IEMS requires about two times longer time than the other methods. The SD method requires slightly more time than the unipole method on the average, while the number of the impression words in the unipole method is 37 and that of the impression word pairs in the SD method is 25.

7.3 Discussion

In Fig. 5, the words “beautiful” and “dirty” are circled in different places. Using the unipole method, the evaluation scores of the words “beautiful” and “dirty” are both equal to 4, as shown in Table 3. Hence, the subject feels both “beautiful” and “dirty” at the same time. Using the SD method, the evaluation result obtained is “a little” beautiful. In other words, the impression “dirty” is not felt. In the SD method, it is impossible to evaluate an

Figure 5: Results for the picture shown in Fig. 4(a) using the IEMS.

Figure 6: Results for the picture shown in Fig. 4(c) using the IEMS.

Figure 7: Results for the picture shown in Fig. 4(e) using the IEMS.

Table 3: Results for the picture shown in Fig. 4(a) using (a) the unipole method and (b) the SD one.

(a) Unipole method		(b) SD method		
Impression word	score	Impression word pair		score
beautiful	4	cute	massive	5
refreshing	4	bright	dark	5
dirty	4	natural	artificial	4
noisy	3	pure	impure	4
cute	3	excellent	awful	4
soft	3	leisurely	restless	4
natural	3	loose	tight	4
pure	3	plain	greasy	4
excellent	3	beautiful	dirty	4
simple	2	soft	hard	4
stylish	2	mysterious	ordinary	2
plain	2	tired	refreshing	2
leisurely	2	smooth	coarse	2
loose	2	heavy	light	2
strong	2			
weak	2			
small	2			
quiet	2			
bright	2			

Table 4: Results for the picture shown in Fig. 4(c) using (a) the unipole method and (b) the SD one.

(a) Unipole method		(b) SD method		
Impression word	score	Impression word pair		score
tired	5	strong	weak	5
noisy	5	noisy	quiet	5
dark	5	wide	narrow	5
strong	5	heavy	light	5
wide	5	big	small	5
heavy	5	mysterious	ordinary	4
big	5	natural	artificial	4
sharp	4	tired	refreshing	4
cold	4	stylish	unstylish	4
hard	4	loose	tight	4
flashy	4	flashy	sober	4
mysterious	3	sharp	coarse	4
excellent	3	beautiful	dirty	4
sad	3	leisurely	restless	2
stylish	2	soft	hard	2
beautiful	2	bright	dark	1
loose	2	hot	cold	1
natural	2			
pure	2			
bright	2			

Table 5: Results for the picture shown in Fig. 4(e) using (a) the unipole method and (b) the SD one.

(a) Unipole method		(b) SD method		
Impression word	score	Impression word pair		score
strong	5	excellent	awful	5
wide	5	wide	narrow	5
big	5	big	small	5
mysterious	4	mysterious	ordinary	4
beautiful	4	natural	artificial	4
natural	4	loose	tight	4
excellent	4	flashy	sober	4
cold	3	sharp	dull	4
heavy	3	strong	weak	4
quiet	3	beautiful	dirty	4
bright	3	bright	dark	4
stylish	2	heavy	light	4
refreshing	2	tired	refreshing	2
dark	2	noisy	quiet	2
sharp	2	hot	cold	2
hard	2			
flashy	2			

Table 6: Average times required in the evaluations.

Picture	IEMS[min]	Unipole[min]	SD[min]
Picture(a)	3.5	1.8	1.8
Picture(b)	3.2	1.4	1.6
Picture(c)	2.9	1.5	1.7
Picture(d)	3.1	1.4	1.8
Picture(e)	3.7	1.7	1.9
Average	3.3	1.6	1.8

impression with words of opposite meanings at the same time. Conversely, it is possible in the proposed and unipole methods.

In Fig. 7, the area between the words “cold” and “quiet” is darkly colored. In the unipole method, the evaluation scores of these words are equal to 3. Using the SD method, the evaluation score is “a little” cold and “a little” quiet. The subject feels as their impression of the picture an impression between the words “cold” and “quiet” rather than these words themselves. This type of vague evaluation is not possible using the unipole and SD methods. In contrast, the IEMS enables such vague evaluations.

The addition of an impression word is considered. If the baseline Kansei space does not include the impression words a subject desires, the IEMS allows the subject to add impression words. For instance, in Fig. 6, the area around the word “scary” is darkly painted; “scary” was added by the subject. Impression words added by the subject are important to the subject. The word “scary” cannot be evaluated using the SD and unipole methods because they do not allow for the addition of impression words.

Therefore, it is said that the IEMS enables evaluation of impressions that other methods cannot.

It was expected that the impression words evaluated by the SD and the unipole methods would be circled in the IEMS. However, in many cases, such words were not circled. In some cases, even the impression words with the evaluation scores equal to 5 in the unipole method were not circled. It was also expected that the areas near an impression word evaluated highly in the SD and the unipole methods would be darkly colored. However, such places were often lightly colored instead. This result is believed to be influenced by the fact that in the SD and the unipole methods, the evaluation took place using a predefined set of impression words and a fixed range of scores. In other words, enforcing the evaluation of all items in a predefined range may affect the evaluation. The subjects do not feel such enforcement in the IEMS. They circle and paint areas that they want to.

In the IEMS, subjects have to circle and color areas. It takes more time in the IEMS than in the other methods. The amount of the work required must be taken into account. However, the experience obtained from the evaluation using the IEMS may make the evaluation fast.

8. CONCLUSIONS

This paper proposed an impression evaluation method that takes into account the vagueness of Kansei. The proposed method is called the Impression Evaluation Method by Space (IEMS). This method evaluates impressions by circling an area in the Kansei space that fits the impression, and painting a color according to the degree of matching to the impression. The baseline Kansei space is obtained by using the results of a questionnaire about the dissimilarity between impression words, and applying multi-dimensional scaling. Next, a prototype system based on the proposed method was implemented. This system enabled the evaluation of impressions of pictures using a computer. An impression evaluation experiment on several pictures was conducted using three methods: the IEMS, the unipole method, and the SD method. The results showed that the IEMS enabled the evaluation of the impressions that the other methods could not. In other words, using the other methods, subjects may not be able to evaluate impressions the way they would like. The IEMS enables users to express the degree that they feel in the continuous manner, the opposite feelings at the same time, and the feeling among several impression words. It also enables them to add the impression words that they want to use, and not to enforce the evaluation through all of the impression words. Using the IEMS can therefore obtain information that is more useful. The IEMS enables users to express sensitive feelings. This is an advantage of the IEMS. On the other hand, the IEMS requires long time in evaluating the impression. Therefore, the IEMS will be used when delicate impressions are wanted to be obtained even if it may require time in the evaluation.

Analyzing the evaluation results of the impressions obtained from multiple subjects using the SD method is straightforward. Conversely, it is not so straightforward to analyze the evaluation results obtained by many subjects using the IEMS. Although we are trying to compare the results evaluated only in the baseline Kansei space [13], it is not possible to compare all of the evaluation results. We have to compare the results evaluated in the Kansei space where impression words are moved and/or added. Establishing a method of analyzing results obtained by multiple subjects using the IEMS is in future work.

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