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An Efficient Method for Relating Various Human Impressions to Physical Features

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***Abstract*: An important topic of Kansei engineering is to associate humans' impressions with physical features characterizing certain objects. Recently, such relationships have been applied to impression-based information systems that aim to retrieve/recommend objects suitable for users' impressions. However, such systems restrict the use of various expressions concerning each individual's image, because the selectable impression words are fixed. To achieve information systems based on individuals' Kansei, it is important to provide a flexible human interface to deal with a greater diversity of impression words. In our previous study, we proposed a method for associating various impression words with physical features by introducing a new class of impression words called "meta-impressions." A meta-impression was defined as an impression whose relationship to physical features has been revealed in past studies. In the method, an M-I dictionary that describes the relationship between meta-impressions and various impression words was constructed using a text-mining technique. Using the dictionary, various impression words were translated into physical features through meta-impressions. However, the accuracy of translation using the dictionary was not sufficient because the dictionary contained unnecessary or redundant relationships. In this study, we provide a new method for associating a large variety of impression words with physical features by implementing a function that filters out unrelated or redundant relationships in the M-I dictionary on the basis of the modification structures obtained by dependency parsing. Using the method, we try to construct a more accurate and exact M-I dictionary than that with the previous method. In the experiment, we show that our method improves the construction accuracy of the dictionary compared with our previous method.**

***Keywords*:** Kansei engineering, Impression, Physical feature, Thesaurus, dependency parsing, Text-mining.

I. Introduction

Kansei engineering, which was proposed by Nagamachi, has been attracting attention as a methodology to develop customer-oriented products suitable for customers' feelings and demands [1, 2]. "Kansei" is a Japanese word that signifies an individual's impressions/images evoked by external stimuli through the sensory organs. An important issue in Kansei engineering is to correlate humans' impressions to physical features characterizing objects, such as music, pictures, clothes, and furniture.

Recently, Kansei engineering has been applied to impression-based information systems that aim to retrieve/recommend objects that are suitable for users' impressions [3-14]. In these systems, the user is required to input a search query using several predefined impression words. Kumamoto et al. associated 20 impression words with particular physical features of music [3] and developed an impression-based music retrieval system [4]. However, such systems restrict the use of a variety of expressions concerning each individual's image because the selectable impression words are fixed. To achieve information systems based on individuals' Kansei, it is important to provide a flexible human interface to deal with the greater diversity of impression words.

To solve the above issue, our previous study [15] proposed a method for associating various impression words with physical features by introducing a new class of impression words called "meta-impressions." A meta-impression is an impression word that mediates the relationships between impression words and particular physical features. In the study, a meta-impression was defined as an impression word whose relationship to physical features has been experimentally or statistically revealed in past studies. In the method, an M-I dictionary that describes the relationship between meta-impressions and various impression words was constructed by collecting a large variety of impression words from electronic texts such as review comments and by automatically associating them with meta-impressions. Using the M-I dictionary, various impression words were translated into physical features through meta-impressions. However, the accuracy of translation was not sufficient because the dictionary contained unnecessary or redundant relationships.

This study aims to provide a new method for associating a large variety of impression words with physical features by improving on the previous method. A novel feature of this method is to implement a function that filters out unrelated or redundant impression words in the M-I dictionary on the basis of the modification structures obtained by dependency parsing. Using this method, we attempt to construct a more accurate and exact M-I dictionary than with the previous method. In this study, an M-I dictionary specialized for the "music domain" is

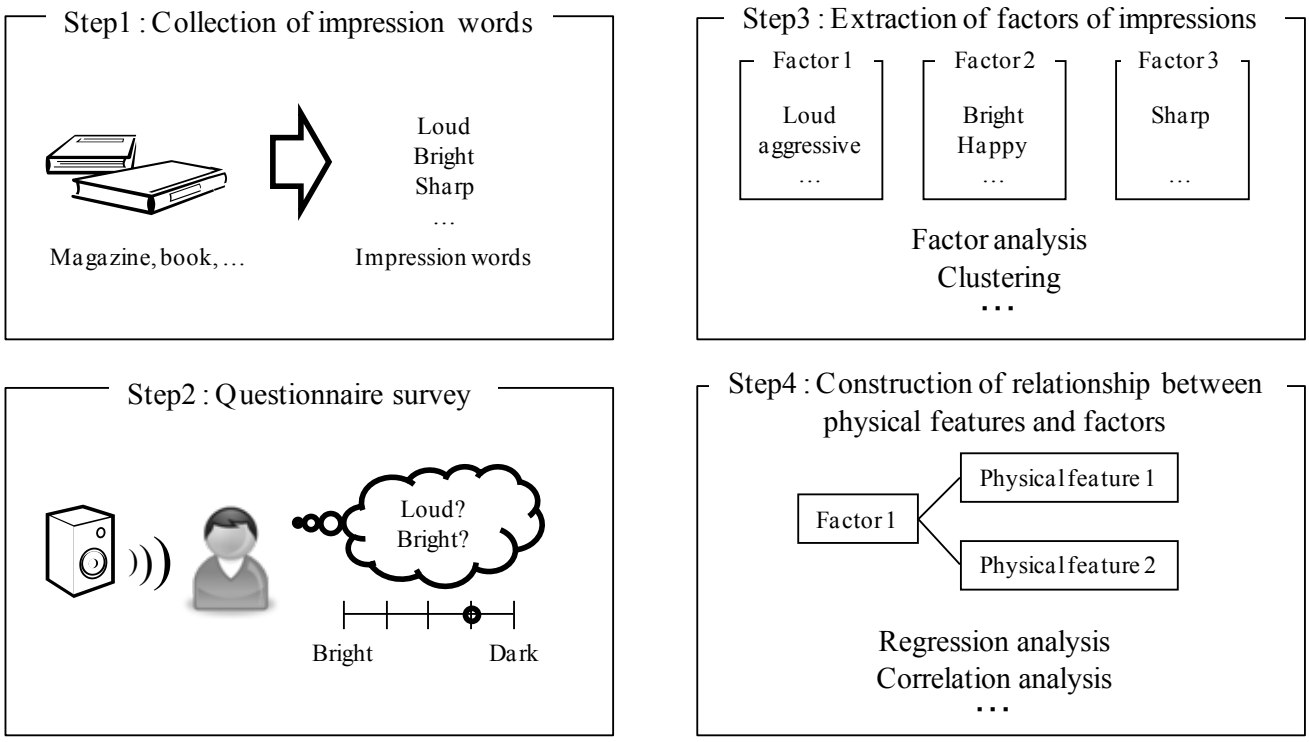

Figure 1. Typical procedure to associate impressions with physical features in Kansei engineering

constructed on the basis of the proposed method. In the experiment, we show that the proposed method improves the accuracy of translation of the dictionary compared with the previous method.

This paper is organized as follows. Section 2 describes the traditional Kansei engineering approach and its limitations. Section 3 explains the new procedure for constructing the M-I dictionary. Sections 4 and 5 show the comparative evaluation between the proposed method and the previous method. Finally, Section 6 summarizes our conclusions and suggests future work.

II. Traditional Approach for Kansei Engineering and its Limitations

The typical procedure for associating impressions with physical features consists of four steps, as shown in Figure 1. Step 1 collects as many impression words as possible in a certain domain of interest, such as music [3] and clothing designs [2]. Subsequently, redundant impression words with similar meanings are unified to a single representative word. In Step 2, a questionnaire survey is performed to obtain information from the subjects about the images of the respective objects in different physical feature quantities (e.g., velocity in music). Here, the objects are rated using a multi-grade evaluation for each impression word obtained in Step 1. In Step 3, multivariate analysis methods such as factor analysis and clustering are applied to group the impression words with similar trends (rating patterns) in the answers of the questionnaire survey. Step 4 identifies the physical features characterizing the factor of each group of impression words using regression or correlation analysis.

Typically, Step 1 requires much effort by the experimenters in collecting many impression words, and Step 2 requires much effort by the subjects in rating them in the questionnaire survey. In contrast, our method can automatically collect impression words from electronic texts using text mining. In addition, the impression words are associated with certain physical features through the meta-impressions; thus, the subjects are not required to perform the laborious impression evaluation.

III. Method

Figure 2 shows an outline of our method, in which the shaded area is the process of constructing the target M-I dictionary in this study. In this section, we construct an M-I dictionary specialized for the "music domain" as an illustrative example. The M-I dictionary is constructed by the following three steps:

A. Extraction of Meta-impressions

We extract meta-impressions that are impression words whose relationships to certain physical features have already been elucidated in the published literature. Kumamoto et al. associated 20 impression words with several physical features (e.g., tone color, pitch variation, volume variation) using multiple regression analysis [3, 4]. In this study, we employ these 20 impression words as meta-impressions (Table 1).

B. Collection of Candidate Impression Words

We collect synonymous words (only adjectives) of each meta-impression as candidate impression words by referring to

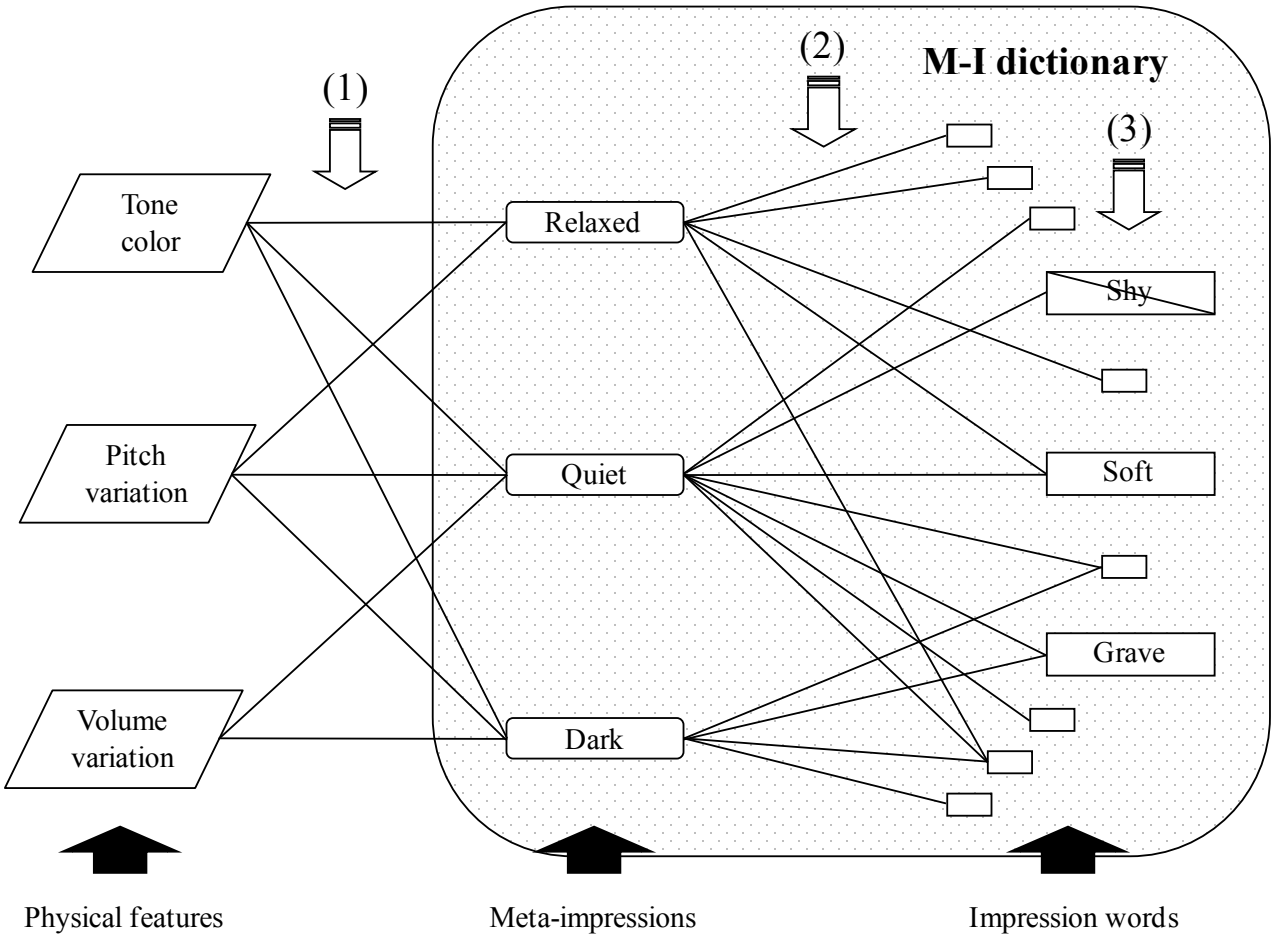

Figure 2. Outline of proposed method

Quiet, Aggressive, Tranquil, Busy, Refreshing, Somber, Bright, Dark, Solemn, Flippant, Relaxed, Tense, Beatutiful, Dirty, Funny, Sad, Calm, Exciting, Healing, Sorrowful

Table 1. Twenty meta-impressions.

Music, Number, Track, Tune, Sound, Song, Melody, Performance, Lied, Instrumental, Harmony, BGM, Phrase, Tone

Table 2. Words with meaning similar to music.

a thesaurus. Next, the synonymous words are linked to the corresponding meta-impressions.

C. Pruning of Unnecessary Candidates

In this step, a pruning process based on a text-mining approach is conducted to eliminate unnecessary candidate impression words that are not generally associated with the music domain. First, we collect 46,178 review comments for a variety of audio CDs from amazon.co.jp [16]. Second, a dependency parsing tool [17, 18] is used to obtain the part of speech and modification structures of words in the comments. Third, adjectives that modify "Music" and its synonyms (Table 2) are extracted by referring to the parts of speech and modification structures. That is, the extracted adjectives are impression words that are generally used in the music domain. Next, their frequencies of appearance across all the comments are counted. Finally, by referring to the appearance frequencies, we prune the candidate impression words that occur two or fewer times. The M-I dictionary is provided as a set of links between the meta-impressions and the candidate impression words. In this dictionary, every impression word can be represented with a combination of multiple meta-impressions. That is, an impression word can be translated into some physical features using those meta-impressions.

D. Difference between Proposed Method and Previous Method

As shown in Section 3.3, the proposed method extracts only the impression words used in the music domain from the review comments by using the dependency parsing tool, and it prunes the candidate impression words based on their appearance frequencies. In contrast, the previous method simply extracts all adjectives that appear in the comments, and

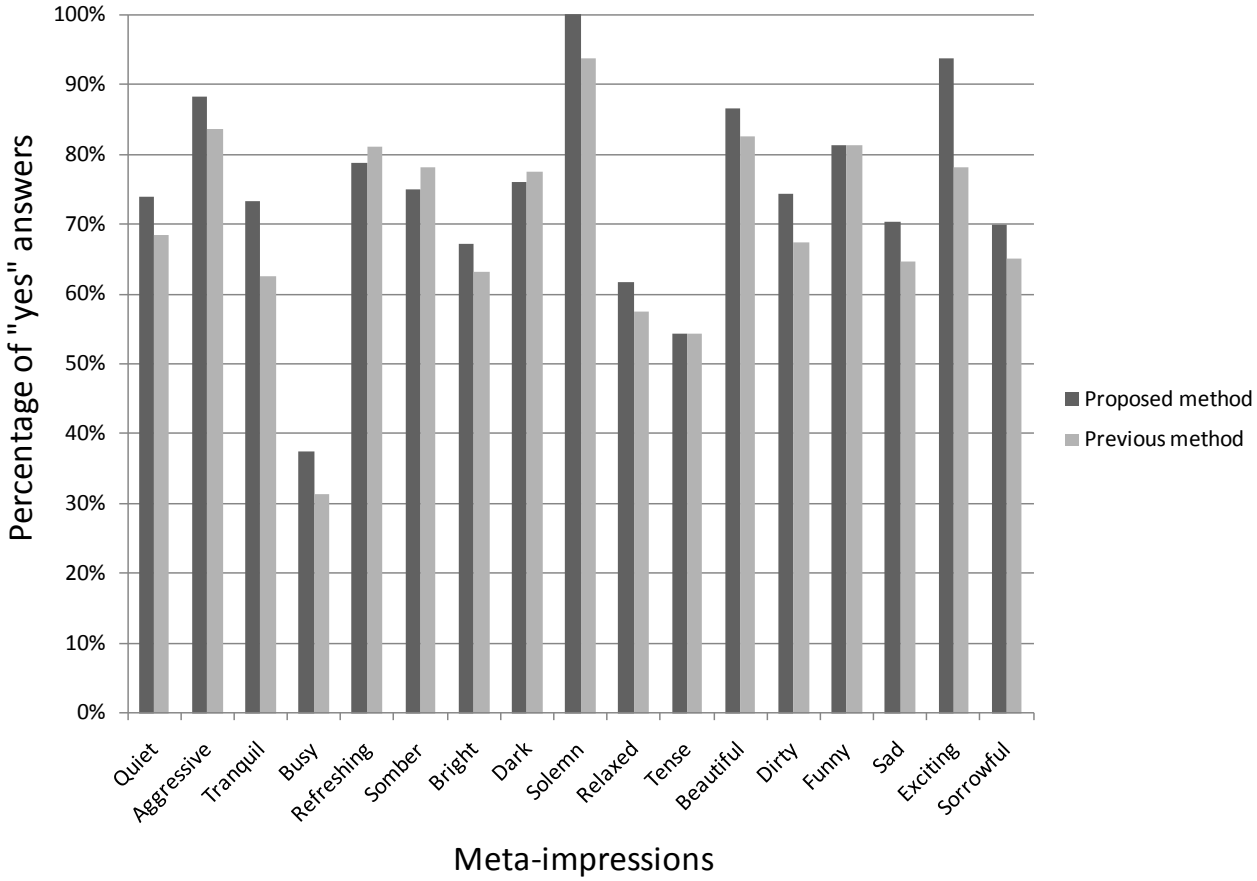

Figure 3. Results of questionnaire for proposed method and previous method

it prunes the candidate impression words based on these appearance frequencies. In the previous method, many impression words unrelated to the music domain are extracted from the comments when the comments contain many topics unrelated to the music domain (such topics can often be found in the review comments). Consequently, the pruning accuracy of the previous method is lower than that of the proposed method. We solve the problem by introducing dependency parsing. The use of this procedure is a clear difference between the proposed method and the previous method.

IV. Evaluation

Based on the above method, we obtain an M-I dictionary that includes a total of 253 impression words linked with their meta-impressions. Similarly, we obtain an M-I dictionary that includes a total of 399 impression words based on the previous method (see our previous study [15]). To compare the adequacy of these M-I dictionaries, we conduct a questionnaire that requires a yes/no answer regarding whether each link between an impression word and a meta-impression is adequate as a synonymous relationship of the music domain. The subjects are eight students. In this evaluation, 3 out of the 20 meta-impressions are eliminated because there are no impression words connected to them in the M-I dictionary constructed by the proposed method. For each meta-impression, we count the number of "yes" answers for the connected impression words across the eight subjects.

V. Results and Discussion

Figure 3 shows the percentage of "yes" answers for each meta-impression in the M-I dictionaries constructed by the proposed method and the previous method. We can see that more than half of the meta-impressions (proposed method: 15/17, previous method: 14/17) present scores of more than 60% in both M-I dictionaries, implying that these M-I dictionaries characterize the music domain well. On the other hand, the proposed method shows a higher score than the previous method in more than half of the meta-impressions (12/17), implying that the proposed method can reduce unnecessary relationships in the M-I dictionary compared with the previous method. In other words, the proposed method can construct a more adequate and accurate M-I dictionary than the previous method.

In contrast, one meta-impression "busy" shows scores under 50%, implying that the meta-impression links with impression words unrelated to the music domain. Table 3 shows the number of impression words that relate to each meta-impression before and after pruning in the proposed method. The number of impression words related to the meta-impression "busy" shows relatively small values before pruning. In addition, we could not find impression words clearly related to the music domain when investigating

	Quiet	Aggressive	Tranquil	Busy	Refreshing	Somber	Bright	Dark	Solemn
Before pruning	101	63	37	24	52	42	243	224	26
After pruning	14	16	7	1	9	6	57	49	2

	Relaxed	Tense	Beautiful	Dirty	Funny	Sad	Exciting	Sorrowful
Before pruning	89	139	99	176	3	44	11	32
After pruning	16	27	13	18	2	9	2	5

Table 3. Number of impression words before and after pruning in proposed method.

impression words before pruning. Consequently, this problem is attributable to the lack of variety of impression words that are collected by referring to the thesaurus. We will solve this problem by combining the use of multiple thesauruses and a collection of synonyms of synonyms (i.e., a collection of synonyms of the candidate impression words).

VI. Conclusions

We proposed a new method to automatically construct an M-I dictionary that associates a large variety of impression words with fewer meta-impressions by improving our previous approach based on text mining. In this study, we constructed an M-I dictionary that was specialized for the "music domain," and evaluated its adequacy by comparing the proposed method with our previous method in the experiment. We believe that our method is a promising approach for not only creating flexible user interfaces for an impression-based information system, but also for reducing laborious and time-consuming tasks in Kansei engineering, such as the collection of impression words and the use of a questionnaire survey.

In our future study, we will further improve our method and the M-I dictionary. In addition to the music domain, we will apply our method to different domains, such as pictures and clothing and will develop flexible Kansei-based information systems that implement M-I dictionaries.

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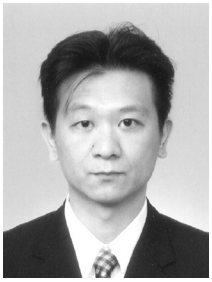

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