Products classification in emotional design using a basic-emotion based semantic differential method

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A R T I C L E   I N F O

A B S T R A C T

Consumer's emotional requirements, or the so-called Kansei needs, have become one of the most important concerns in product design nowadays. In this regard, the semantic differential (SD) method has been widely used in emotional product design and Kansei engineering to address the relationships between emotions and products. However, the conventional SD method assumes that the survey participants' understandings on Kansei adjectives or tags are consistent, which might not be true for all design cases. As a result, classification of products using Kansei tags may not reflect a consumer's genuine opinions. Accordingly, a basic-emotion based semantic differential method is proposed in this work. The proposed method improves the conventional SD method by taking variances of Kansei tags into consideration for better products classification in emotional design. It incorporates basic-emotion systems to identify Kansei variance and mapping functions in determining transformed values on Kansei-tag dimensions. Therefore, the adjusted Kansei mean values, which help classify products using Kansei tags, are obtained. The proposed approach is presented and illustrated using a case study of perfume bottle design. The results reveal that the proposed method is promising for handling product classifications in emotional design.

Relevance to industry: This study presents a generic method to establish the relationships between consumers' Kansei needs and products for new product development. The knowledge gained from the method is beneficial in assisting the mapping of product domain into Kansei domain when applying Kansei engineering. Especially it helps to suggest a quantified range of each Kansei tag for product designers so that the links between products and Kansei requirements can be more clarified to them. It appears that the proposed method can be utilized to better classify products under Kansei tags as well as to facilitate decision-making in practical industrial design cases.

1. Introduction

Product design and development nowadays aim at providing high-quality products and services to global consumers with reasonable cost. By high-quality, it not only refers to traditional function-focused consumer needs, such as reliability and multi-purpose usages, but also concerns with the users' experiences gained from the interaction with the products (Norman, 2008). The studies of users' experiences, or the so-called user-centered design, may tackle different problems in various perspectives. In this regard, the Kansei engineering approach proposed by Nagamachi (1995, 1999, 2002, 2008) and Nagamachi et al. (2006) has been widely advocated by researchers in handling consumer's emotional requirements (Chen et al., 2008). It has been successfully applied in various design domains, such as domestic commodities (Hsiao et al., 2010), seat comfort (Goonetilleke, 1998; Goonetilleke and Song, 2001), home appliances (Demirtas et al., 2009), and booth show (Huang et al., 2011).

A large number of approaches, which are more or less relevant to Kansei engineering, have been proposed to date (some examples are Nagamachi, 2008; Schütte, 2005; Yan et al., 2008; Yang et al., 1999). Although adopt different procedures to address different problems, basically these methods deal with the following three important issues: 1) how to capture human emotions so that consumer's emotional requirements can be identified; 2) how to identify the relationships between products and the emotional needs; and 3) how to improve products in such a way that new products better fit consumer's emotional needs.

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Thorough knowledge of human emotions is required for tackling the first issue. In this respect, a number of studies have been conducted to investigate into emotions in psychological realm. For example, based on four basic components, viz. cognition, evaluation, motivation, and feelings, Aaron (2000) suggested that emotions are an integrated and complex process that involves human intentional activities as well as a feeling domain. In other words, a cognitive-psychology perspective on emotions was adopted. Based on the theories of Darwin, Plutchik, and Izard, TenHouten (2006) established a socio-evolutionary theory of emotions, in which emotions are described from a decomposed perspective. This theory can be used to explain some human psychological phenomena; however, it is not fully applicable to deal with product design problems. Grimm et al. (2007) evaluated emotions in speech using Kehrein's three emotion primitives model (Kehrein, 2002). Nonetheless, using this method, reliability of the emotional requirements obtained depends heavily on the feasibility of the emotional model based. Therefore, selection of emotional models determines the nature of consumer's emotional requirements in this case.

Owing to the fact that human emotions are extremely subjective, circumstance-related, and individual, an accurate measurement of consumer emotions is generally impractical. In this regard, to consolidate consumer's emotional requirements, Kansei engineering advocators suggested a new perspective on human emotions, i.e. the use of Kansei words or adjectives to represent various emotions (Ota and Aoyama, 2001). Using Kansei adjectives, consumers can be guided to express their affective needs, feelings and emotional states (Jiao et al., 2006). Compared with other emotions examining methods, such as cognitive evaluation, social and evolutionary assessment, and emotional models based analysis, the use of Kansei adjectives provides good efficiency and satisfactory accuracy (Chen et al., 2006).

Kansei adjectives are collected from various resources, e.g. magazines, reviews, consumer feedbacks (Schütte, 2005). Usually, number of words may reach hundreds depending on the design cases (Nagamachi, 1999). Meanings of Kansei adjectives may overlap and similar words should be grouped together. Using clustering methods (Xu and Wunsch, 2008; Gan et al., 2007), several Kansei clusters, or the so-called Kansei tags, can be formed. The Kansei tags can then be used to represent a consumer's emotional requirements. In previous studies, design structure matrix (DSM) was used to generate Kansei tags (Huang et al., 2010). This work proposes a classification method to establish the relationships between Kansei tags and products using the Kansei tags identified.

In general, there are four approaches to tackle products classification in emotional design, viz. physiological methods, questions and interview, card sorting, and semantic differential. Amongst these approaches, semantic differential is the most widely used method in Kansei engineering.

Physiological methods measure such consumer physiological signals as facial patterns, heart rate changes, and electroencephalogram scanning, and use those as objective indexes of emotions for product classification. Although these methods have an edge over non-physiological methods in terms of objectiveness, however, conducting relevant experiments can be very burdensome and unnatural. For example, participants have to put sensors on their fingers for monitoring pulse and electro-dermal activity, as well as equipment on their heads for measuring electroencephalograms (Jeong, 2007). In addition, the relationships between emotions and human nervous system reaction are difficult to identify (Prkachin et al., 1999). A smile can stand for a happy feeling but it could also be found on the face of a polite person. Furthermore, the types of physiological signals that are measured are indeterminate. Pattern recognition of facial expressions can be used for emotion analysis, but it cannot be the only measurement on emotions because there are huge amounts of emotional information besides that elicited on human faces (Schmidt and Stock, 2009). In a nutshell, physiological methods lack consistency in explaining emotions and usually require high-cost equipment. Therefore, these methods are usually used as complementary tools in Kansei studies.

The interview method refers to conversations between consumers and interviewers, where an ordered series of questions is asked to obtain Kansei information on products. Sample questions could be 'How would you describe this car? How would you describe the owner? What words describe your vehicle? What are important factors in the vehicles character?' (Rutherford, 2004). The interview method is fast and convenient and requires no expensive hardware, e.g., experimental equipment. Useful interview results depend heavily on well-designed questions, however, they are also greatly affected by such factors as interviewer's skills, ways of perceiving consumer's responses, and experience, which are difficult to address and standardize. Therefore, the results might vary depending on the interviewer.

A more standardized product classification approach in emotional design is a series of card sorting methods. One typical method is the affinity diagram, which is simple and straightforward. Llinares and Page (2008) used an affinity diagram to group semantic descriptions according to their affinity. A major shortcoming of the method is that it provides no quantification on consumer emotions, e.g. the degree of like or dislike is unknown. Similar to the affinity diagram, knowledge organization systems (KOS) also classify or index products using Kansei tags. However, in using KOS, it has to assume a high degree of inter-indexer and intra-indexer consistency (Schmidt and Stock, 2009) and the indexing process is usually quite inconsistent (Markkula and Sormunen, 2000). Manual indexing also suffers from low tag agreement across indexers, as well as between indexers and user queries (Jörgensen, 1998). Another similar card sorting method is called social tagging or folksonomy tagging. It is basically a method of indexing documents using uncontrolled tags by a large number of participants. Unlike KOS, this method has no indexing rules and no authority controls the terminology. Social tagging represents an authentic use of language and it allows multiple interpretations (Schmidt and Stock, 2009). However, in addition to a lack of quantification of consumer Kansei, it also suffers from such disadvantages as lacking of precision, existence of spam or user-specific tags, and use of misleading keywords.

The fourth type of products classification approaches in emotional design is semantic differential (SD) proposed by Osgood (Osgood, 1962, Osgood et al., 1957). It is a self-report method using Likert scale (usually 7 points scales). The SD method has been widely used in Kansei engineering to address the relationships between emotions and products due to: 1) it is relatively easy and low-cost to conduct experiments; 2) it demonstrates a high reliability and validity; and 3) it provides a unified platform to quantify subjective assessments such as emotions. Many sophisticated methods and models have been established based on the conventional SD method in Kansei engineering. For example, Luo et al. (2012) proposed a two stage integrated perceptual matching procedure which features a classification task and a semantic differential experiment to acquire the subjects' perceptions of stimuli so as to measure perceived qualities. Nonetheless, the SD method has a critical limitation where it assumes that the Kansei words used in an experiment should be understood consistently by all the participants. For instance, a pair of Kansei words, hot and cold, is used to associate with the feelings of different colors of a product. To most designers and consumers, they are able, based on their experience, to associate hot with those colors that resemble the feeling of