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A product configuration analysis method for emotional design using a personal construct theory

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ABSTRACT

Identifying emotion-related product attributes (perceived by consumers) is no easy task in the realm of emotional design. Conventionally, this process relies heavily on the researchers who conduct the Kansei experiments selecting product attributes such as color, form, and texture for Kansei studies. However, in so doing, other product attributes that also play a vital role in product-emotion associations might be neglected by the researchers. More importantly, the identification of product attributes should be based on consumer's point of view (and feelings). Accordingly, a personal construct theory based product configuration analysis method is proposed in this work. The method develops the customer's mind map for each Kansei tag in order to capture replications of candidate products. A means-value chain is used to generate targets which are later compared with candidate products by consumers. The comparison results could suggest product attributes that are relevant to the desired Kansei. The proposed approach is presented and illustrated using a case study of Graffiti designs on notebooks. Results obtained are discussed. It appears that the proposed method is promising in identifying product attributes with desired Kansei impacts.

Relevance to industry: This study presents a method to address product attributes with emotional impacts in new product development. It appears that the proposed method can be utilized to analyze product configurations according to consumers' Kansei needs as well as to facilitate decision-making in practical industrial design cases.

1. Introduction

Product design and development becomes strategically important to the continuous success of modern businesses (Chen et al., 2009a,b). Industries are not only required to satisfy traditional function-focused customer needs, such as faster speed and lower oil-consumption, but also demanded to deliver excellent users' experiences gained from the interaction with the products (Norman, 2008). The study of users' experiences may tackle different problems in various perspectives. Amongst them, emotional design is of great importance due to its ability to handle consumer's emotional requirements in new product design (NPD), which in turn increases competitive edge significantly. The Kansei engineering, a philosophy of emotional product design, proposed by Nagamachi (1995, 1999, 2002, 2008) is considered as the most useful methodology in handling consumer's emotional requirements (Chen et al., 2008). Numerous products have been successfully developed based on it, e.g. car crash pad (Bahn et al., 2007), camera form design (Chang, 2008), home appliances (Demirtas et al., 2009), domestic commodity (Hsiao et al., 2010), and toiletry application (Ishihara et al., 2000).

To date, many approaches have been proposed in Kansei engineering. For example, Nagamachi proposed six types of Kansei engineering, i.e. category classification, Kansei engineering (expert) system, hybrid Kansei engineering system, Kansei engineering modeling, virtual Kansei engineering, and collaborative Kansei engineering designing (Schütte, 2005). Petiota and Yannou (2004) suggested a general approach to assess product semantics based on usability tests and several classical methods in marketing and decision-making theory. Yang et al. (1999) emphasized on the importance of inference algorithms in Kansei engineering systems and proposed a rule-based inference model that is able to satisfy the requirements. Yan et al. (2008) suggested a target-oriented decision analysis method to quantify how well a product meets consumer's Kansei preferences using three types of fuzzy targets. Schütte (2005) proposed an overall framework of Kansei

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engineering to address the correlations between the Kansei domain and the product domain using various statistical methods. Although these approaches adopt different procedures, in essence, they have to deal with the same three major problems. First, consumer's emotional requirements for a product should be identified. They are fundamental inputs of emotional product design. Second, relationships between products and the emotional requirements have to be established. Based on them, it is possible to differentiate products in the perspective of consumer's emotional acceptance. Third, ways to improve product parameters have to be addressed so that the new product is able to fulfill consumer's Kansei needs.

Handling of the first problem requires thorough knowledge on human emotions. However, because human emotions are extremely subjective, circumstance-related, and highly individual (TenHouten, 2006), accurately measuring consumer emotions is impractical. Nevertheless, Kansei engineering advocators suggested an effective way to represent human emotions: the use of Kansei words or adjectives (Ota and Aoyama, 2001). It shows that consumers can be guided to express their affective needs, feelings, and emotional states successfully using Kansei adjectives (Jiao et al. 2006). To facilitate Kansei experiences in later stages, numerous Kansei adjectives are clustered into several Kansei tags using various methods, e.g. principal component analysis (Chen et al., 2009a,b), factor analysis (Ou et al., 2004), fuzzy nuance function (Kobayashi and Ota, 2000), adaptive resonance theory in self-organizing neural networks (Ishihara et al., 1997), and design structure matrix (Huang et al., 2010, 2012a).

The second and third problems are the main concerns by conventional Kansei engineering studies. Various techniques and approaches have been used to investigate how products and product parameters can be correlated to Kansei needs. For example, Jiao et al. (2006) proposed a framework which applies data mining techniques to improve the mapping of customer's affective needs to design elements or product parameters. Demirtas et al. (2009) considered that traditional conjoint analysis (CA), which is commonly used to analyze the relations between products and Kansei adjectives, is subject to certain drawbacks, e.g. the interaction effects of them are neglected or cannot be calculated. They proposed a model based on ordinal logistic regression (OLOGREG) to identify the relations. Zhai et al. (2009) took non-linearity and uncertainty of raw design data into consideration and suggested a decision support approach based on principles of dominance-based rough set theory for the study of interactions between consumer affective needs and product features. Nishino et al. (2006) considered that the use of statistical methods in finding the relationships between Kansei and design specifications is problematic because Kansei is not primarily in linear form. They proposed an approach based on Bayesian rough set (BRS) and variable precision Bayesian rough set (VPBRS) to extract design rules between Kansei and products. Huang et al. (2012b) proposed a basic-emotion based semantic differential (SD) method which improves the conventional SD method by taking variances of Kansei tags into consideration for better products classification. All of abovementioned approaches are able to address the relationships between Kansei and product parameters. However, reliability of the resulting relations is, to a great extent, subject to the ways of representing product configurations, i.e. how to decompose products into product parameters. There could be many ways to analyze a product. For example, a product can be viewed by its color, overall shape, and size. It could also be analyzed according to its front part, middle part, and rear part. Obviously, different product configurations will result in different or even contradictory correlations which in turn affect the decision making in later design stages.

Barone et al. (2007) suggested a procedure for identifying important product parameters or attributes based on participants' choice time in controlled interviews. They gave a weight to each product parameter. The estimated weights are used as correction coefficients in a regression model. However, the participants' choice time to the same product attribute may vary with each individual. In addition, similar to human emotions, the choice time is also circumstance-related. Therefore, by the choice time alone, important product attributes may not be fully addressed. Yan et al. (2008) noticed that consumer's preferences on Kansei relevant product attributes vary from person to person. They suggested a fuzzy target based method to handle vagueness and uncertainty of consumer's preferences. However, the membership functions for Kansei linguistic variables were assumed to be triangular which might not be true in all design cases. Schütte (2005) proposed a model, which consists of three steps, viz. collection, selection, and compiling, for spanning the space of product properties or attributes. To select the product attributes with highest importance, customer representatives and one-to-one interviews are used. For determining the importance, Schütte suggested that Pareto diagrams can be useful. Schütte's model is able to capture some product attributes based on consumer's opinions. However, the interviews are not guided or supported by any theoretical basis and the results might not be reliable. As a consequence, product attributes obtained may be influenced greatly by the selection of interview participants.

Other researchers analyze product configurations in a simplified way, i.e. according to researchers' or designers' intuition. For example, Bahn et al. (2009) considered that product attributes should be selected based on the design practitioners' expert knowledge and design guidelines. However, consumers may look and think differently from industrial designers. Therefore, a method which is able to reflect genuine consumer's opinions on product configurations is needed. In addition, a sound theoretical backup is necessary if interview experiments are involved.

George Kelly's personal construct theory (PCT) (Kelly, 1955) provides a solid fundamental for eliciting and organizing people's cognition. Kelly (1963) claimed that a person's processes are psychologically channeled by the ways in which he anticipates events. In other words, everyone is an incipient scientist: he is continuously making and refining his own theories and models about the world so that he can anticipate events. All of these theories are built up from a system of constructs with two extreme points, such as happy–sad. A construct is a way in which some things are construed as being alike and yet different from others (Kelly, 1963). For example, we place people at either extreme or at somewhere in between friendly–unfriendly. The idea is exactly the same as Osgood's semantic differential (SD) method (Osgood, 1962; Osgood et al. 1957), which plays a fundamental role in conventional Kansei engineering. Compared with the SD method, PCT is more systematic and has many advantages. From the theory, Kelly derived a technique called the repertory grid interview that helped to uncover the patients' own constructs, or possibly antonyms in the SD method and Kansei adjectives in Kansei engineering applications. In addition, one corollary in PCT suggests that a person anticipates events by construing their replications (Kelly, 1963). Based on the corollary, a consumer could be said to anticipate or evaluate products by construing similar products. Replications, or similar products, bring similar feelings to consumers. To achieve a given Kansei, designers might have to address the replications that deliver the Kansei need in the first place. If the newly designed product has similar characteristics to those of the replications, it should deliver the same Kansei to consumers. Comparison between replications and product could be made to identify similar product characteristics or attributes. Doing so could address emotion relevant product attributes.