Research on the Design of Smart Pension Product Modeling Based on Brand Image

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Abstract. With the deepening of trend and degree on China's aging, the demand of pension services is expanded further. Thus contents about pension services which come from the needs of more families and society are being introduced in the pension industry, and a multi-support system of the old is being formed. Meanwhile, the existing high-technology promotes the conversion of traditional elderly products and convenient smart products under the design idea of "human-oriented". In the development process of smart pension product, apart from the basic functional requirements of the product, the emotional needs of the elderly are needed to parse through the image cognitive process which containing the psychological, experiential, emotional and other aspects, so as to meet the needs of the elderly for the use of functional and kansei image truly. The brand image of product modeling is the brand impression in the minds of users which exists in the concept of consumers', and all the features and beliefs that are imposed upon a product style, being formed in the process of users' cognitive experience after interacting with the product. So it is necessary to grasp the brand image of product form accurately by reading and extracting through the cognitive process for effectively assisting the designers to upgrade the brand value of product modeling quickly. As the information of product modeling is diverse, complex and fuzzy, the image information will appear a dissipation phenomenon during the delivery process. For the sake of the validity to pick up the image information, the theory and method of Kansei Engineering and Information Entropy are used to analyze the brand image of smart pension product modeling in this paper, and also taking the smart bracelet styling as an example to obtain the design factors who can affect the brand image identification of it. Firstly, two methods named KJ method and interview method are used to ensure the research samples and the adjective vocabularies which can describe the image of smart pension product modeling. Secondly, the SD method is needed to grab the consumer's kansei image needs, and an image cognitive space is constructed to count the weight of each target image for analyzing the brand image of smart product modeling. Then, the research samples are deconstructed by using the morphological analysis. Finally, the coupling and the attribute of game between product and design elements as well as design elements and design elements are parsed by the information entropy for gaining the design factors that can affect the brand image identification. Those design factors are also called product design elements which can provide guideline and development ideas for the design of smart pension product.

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1 Introduction

With deepening of the aging trend and the rapid development of high technology in China, traditional products of the elderly are converted to the facilitation of smart products. While in the research process of the smart pension products, besides considering the basic functional requirements of the product, it also needs to start from the emotional needs of the elderly to analyze the perceptual information of the elderly cognitive process effectively. Cognitive ability is the most important psychological condition for people to successfully complete their activities, which refers to the ability of the human brain to process, store and extract information. In other words, it is the ability to grasp the relationship between them, the driving force of development, the direction of development and the basic law. However the cognitive ability of people will decline when they are in the old age, and mostly may also decay the ability to extract information, which means can not know the performance of objects [1]. Therefore, this study aims to pick up the image information of the elderly for guiding the design of smart pension product development, the theory and method of Kansei Engineering and Information Entropy are used to analyze the brand image of smart pension product modeling in this paper, and also taking the smart bracelet styling as an example to obtain the design factors who can affect the brand image identification of it.

2 Background

2.1 Aging Society

In the 21st century, the aging of the population has become a common problem facing by the world. The United Nations defines an aging society as a country over the age of 65 with a population of more than 7%. Then, in 2016, the China's elderly population is about 1.1883 billion, accounting for 11.9% of the total population [2]. According to the standards of the United Nations, China has been listed as an aging society, and it makes the silver wave to promote the development of silver-haired market which becoming the hotspot in the future consumer market. Meanwhile, an interpretation of the concept of "People Oriented" is the attention and love from the society for elderly needs, which means not only to provide their physical level of satisfaction, but also should take into account their inner real needs. This study realizes to meet the needs of elderly people to use function and perceptual image by analyzing the image cognition process of the elderly, which includes psychological, experience and emotion.

2.2 Brand Image Needs

People's consumption concept has also changed greatly with the improvement of material and cultural life level. The emotional demand has become diversified and

individualized, which reflects people's pursuit of emotional quality and satisfaction of self-realization. The brand image of product modeling is the brand impression in the minds of users which exists in the concept of consumers', and all the features and beliefs that are imposed upon a product style, being formed in the process of users' cognitive experience after interacting with the product. Kansei engineering is a kind of theory and method of using engineering technology to explore the relationship between kansei needs of cognition subject and design elements [3]. In the field of product design, the technical method of Kansei engineering is used to excavate and reveal the potential emotional needs of "human" perception "objects", so as to find the correlation mechanism between the product's emotional images and design elements [4]. Hsin-Hsi Lai used the semantic difference method and the multidimensional evaluation method to explore the relationship between the style and the styling elements of the car side profile [5]. And Ke Shanjun put forward the research method of brand image based on logistic regression, which is aimed at the demand of automobile brand [6]. This study can accurately grasp the brand image of product modeling, through the effective extraction and interpretation of kansei information in "human" cognition process. That is, assisting designers to quickly enhance the brand value of product modeling effectively, and meeting the "people" brand image needs of personalized product development.

2.3 Entropy and Application

Entropy is defined as the degree of system chaos, which also means a measure of the probability that the system is in a certain macro state. Greater the entropy of the system is, more probability that the system is in this state [7]. Claude Elwood Shannon who is an American engineer proposed the concept of information entropy, which is a measure of the amount of information used for the negative entropy, indicating the order of a system [8]. Entropy theory will be applied to the objective analysis of complex image problems in this study. Arnheim who was the earliest person introducing the theory of entropy to the art field studied the perceptions of art works, basing on the Gestalt psychology and Entropy theory [9]. France explored the relationship between the entropy and the system which means an art work, and demonstrated that the chaos of this system can be measured by entropy [10].

3 Methods

As the information which transfers form product modeling is diverse, complex and fuzzy, image information will appear dissipative phenomenon in the transmission process [11]. In order to ensure the validity of the extracted image information, this study uses the theory and method of the kansei engineering and the information entropy to analyze the brand image of smart pension product modeling and evaluate the design elements of the product. The study flow is shown in Fig. 1.

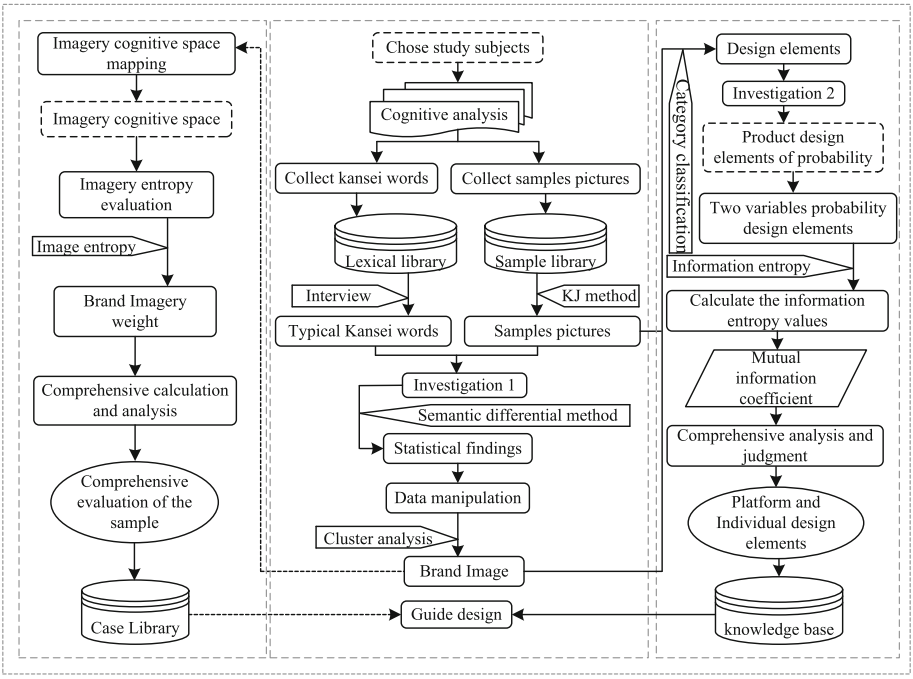

Fig. 1. Study flow

The study flow and steps are described below in five stages:

1. Identify the study samples and the kansei images. The KJ method and Interview are used to screen samples and sensible vocabulary, getting the typical kansei words and the samples pictures.
2. Establish a brand image cognition space basing on the emotional needs of the elderly. The Semantic Differential method is used to evaluate the cognitive performance of the samples, and the images are clustered to draw the brand image collection and image evaluation matrix. Then, constructing a cognitive space of brand image about old people, which takes the elements of brand image as the coordinate axes of spatial model and the image evaluation value as the coordinate value of the sample.
3. Evaluate the brand image entropy of the elderly. According to the image evaluation matrix, the image entropy model [12] is applied to analyze the entropy of brand image in the cognition process of elder image, then getting its weight value. In order to composing an excellent case library which is used to guide product design, weighting is then used to calculate the composite brand image evaluation value of the study samples.

$$I_j = -k \sum_{i=1}^{m} P_{ij} \ln P_{ij} \tag{1}$$

Where I_j is the image entropy value that is calculated from probability P_{ij} which is about the j item target image of the i sample, among these i indicates the study sample which is from 1 to m and j refers to the brand image that is from 1 to n, and the interval of P_{ij} is in [0, 1]. While k is a constant, its value is 1/ln m.

4. Deconstruct the design elements. Category classification is used to analyze the design elements of the study sample, obtaining the design elements set and the modeling feature set of them.
5. Measure the amount of information. By investigating the design elements of the concentration of various design elements of the probability of different shapes, the probability of each modeling feature is the statistics. Then, the information entropy model is applied to calculate the information entropy of a single design element.

$$H = -\sum_{g=1}^{q} p_g \ln p_g \tag{2}$$

Where H is the value of information entropy, and P_g is the probability about the appearance of the q modeling feature which is in the g element. Meanwhile, the relationship between multiple design elements can be explored based on the calculated result, for example, the mutual information entropy between the two design elements named I and II is:

$$H_{I\,II} = \sum_{g=1}^{q} \sum_{g^*=1}^{q^*} p(I_g II_{g^*}) \ln p(I_g II_{g^*}) \tag{3}$$

In the evaluation of product design elements, the mutual information coefficients of the two design elements can be defined by the information entropy of the single design element and the mutual information entropy of the two design elements:

$$\begin{aligned} o_{I\,II} &= \frac{H_I + H_{II} - H_{I\,II}}{H_{II}} \\ o_{II\,I} &= \frac{H_I + H_{II} - H_{I\,II}}{H_I} \end{aligned} \tag{4}$$

The O is the size of the impact between two design elements which named the information coefficient in this paper, containing two aspects. By calculating the mutual information coefficient, we can compare the design elements of the product modeling with each other and obtain the relative importance of each design element, thus can identify the individual design elements and platform design elements of the product modeling, which is conducive to understanding and tapping the individual needs. Finally we may design the product which in line with the people's brand image needs.

4 Case Study

4.1 Identify the Study Samples and the Kansei Images

In this paper, an example of smart bracelet is studied for research. Firstly, collect 86 product pictures from the website, journals and product brochures and other channels. Secondly, obtain the study sample set as shown in Fig. 2 containing the 16 samples that are discussed about 86 cards of the smart bracelet from the experts by using the KJ method. Because this study is to analyze the relationship between product modeling and image cognition, the images are grayscale processed in order to avoid the impact of color on the process of image recognition. Finally, the methods of interview and cluster analysis are used to determine the target image set consisting of five kansei adjectives named comfortable, succinct, slap-up, facile and distinctive.

Fig. 2. Study sample set

4.2 Establish a Brand Image Cognition Space

In order to further determine the brand image of the elderly on the bracelet shape, the semantic differential method is used to analyze the image cognition process of the elderly bracelet modeling, and the SD questionnaire is generated from 16 study samples and 5 target images which have been known in the previous step. Then each participant who is the elderly population scores the study samples for each image, it is means that as the kansei image "Comfortable" for example, "5" is very comfortable, "4" is comfortable, "3" that comfortable, "2" that the general comfort, and "1" that is not comfortable. Finally, we get the evaluation value of the target image of the elderly in each study sample. The results are given in Table 1.

A total of 30 questionnaires have been distributed, of which 26 questionnaires were valid. Then, the cluster analysis is used to analyze the results for reducing the evaluation error. While the representative vocabularies are clustered into three categories which Combined with the image of cognitive space attributes, and the brand images of the bracelet are selected by choosing the nearest image from the cluster center for each

Table 1. Target image evaluation results

Sample	Comfortable	Succinct	Slap-up	Facile	Distinctive
1	3.8	3.5	4.3	3.8	3
2	3.1	3.1	2.4	2.9	2.5
3	3.3	3.1	2.9	2.7	3.6
…	…	…	…	…	…
14	2.9	2.1	2.4	2	2.4
15	2.5	1.6	2.4	2.5	3.7
16	3.5	3.4	2.9	4.1	3.8

Table 2. Lexical classification of target images

Classification	Result	Brand images
1	Comfortable Succinct Slap-up	Comfortable
2	Facile	Facile
3	Distinctive	Distinctive

Table 3. Brand image evaluation matrix

Sample	Comfortable	Facile	Distinctive
1	3.0	3.8	3.9
2	2.5	2.9	2.9
3	3.6	2.7	3.1
4	2.4	4	3.6
5	3.6	2.4	3
6	3.3	2.9	3.9
7	2.9	3.9	2.8
8	3.3	3.8	3.5
9	4.4	3.4	2.4
10	3.4	3.1	3.5
11	3.2	2.5	2.9
12	2.7	2.4	3
13	3.4	3.7	3.3
14	2.4	2.0	2.5
15	3.7	2.5	2.2
16	3.8	4.1	3.3

type of representative. At last, we can get the brand image set and its evaluation matrix, the results are shown in Tables 2 and 3.

Form Tables 2 and 3, the brand image cognition space is set up by Matlab, which is based on the emotional needs of the elderly, as is shown in Fig. 3.

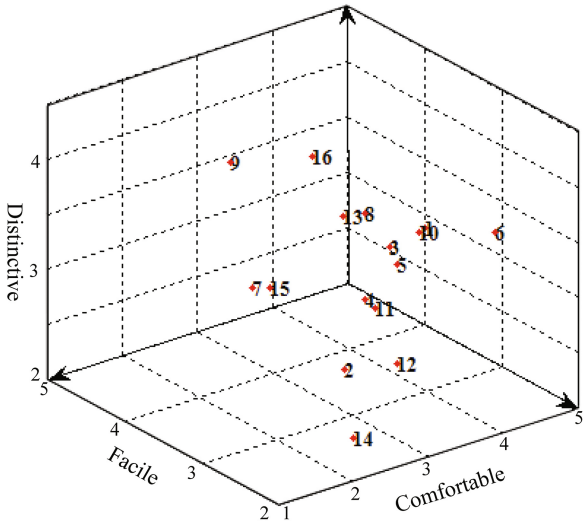

Fig. 3. The brand image cognition space of the elderly

4.3 Evaluate the Brand Image Entropy of the Elderly

Basing on the normalized data from Table 3, the brand image entropy of the elderly is evaluated by Eq. (1). The results are shown as follows:

$$I = [0.9027,\ 0.9271,\ 0.9367]$$

It should be noted here that, when $p_{ij} = 0$, it is shifted to the right by 0.0001 to ensure the validity of the results to minimize the effect of the extreme value 0 on the evaluation results.

4.4 Deconstruct the Design Elements

On the basis of the Table 2 and the Fig. 2, the expert group uses the category classification to deduce the design elements influencing the bracelet image modeling, and determines six design elements which are the material, shape, complex, overall volume, concavity and surface treatment. After that, the modeling features of each design element are analyzed, as shown in Table 4.

4.5 Measure the Amount of Information

In order to know the probability of different modeling characteristics of statistics, designing a questionnaire from Table 3 and Fig. 2, and then having the research. The occurrence probability of the single-design element and two-by-two design elements is obtained by collating the findings, as shown in Tables 5 and 6.

Table 4. Design elements and features

Brand image	Design elements	Design features
Comfortable facile distinctive	*(I)* Material	*I(1)* Hard *I(2)* Soft
	(II) Shape	*II(1)* Square *II(2)* Organic shape *II(3)* Arc-shaped
	(III) Complex	*III(1)* Simple *III(2)* Medium *III(3)* Complex
	(IV) Overall volume	*IV(1)* Small *IV(2) IV(3) Big*
	(V) Concavity	*V(1)* Small *V(2)* Medium *V(3)* Big
	(VI) Surface treatment	*VI(1)* No *VI(2)* Yes

Table 5. The single design element

Design elements	Occurrence probability
(I) Material	$P_{I(1)} = 7/16$ $P_{I(2)} = 9/16$
(II) Shape	$P_{II(1)} = 6/16$ $P_{II(2)} = 6/16$ $P_{II(3)} = 4/16$
(III) Complex	$P_{III(1)} = 7/16$ $P_{III(2)} = 6/16$ $P_{III(3)} = 3/16$
(IV) Overall volume	$P_{IV(1)} = 10/16$ $P_{IV(2)} = 6/16$
(V) Concavity	$P_{V(1)} = 6/16$ $P_{V(2)} = 5/16$ $P_{V(3)} = 5/16$
(VI) Surface treatment	$P_{VI(1)} = 8/16$ $P_{VI(2)} = 8/16$

Table 6. The two design elements about *I and II*

Design elements	*I(1)*	*I(2)*
II(1)	$P_{I(1)\ II(1)} = 5/16$	$P_{I(2)\ II(1)} = 1/16$
II(2)	$P_{I(1)\ II(2)} = 1/16$	$P_{I(2)\ II(2)} = 5/16$
II(3)	$P_{I(1)\ II(3)} = 1/16$	$P_{I(2)\ II(3)} = 3/16$

Table 7. The information entropy

Design elements	*I*	*II*	*III*	*IV*	*V*	*VI*
H	0.6853	1.0822	1.0434	0.6616	1.0948	0.6931

According to the probability, the information entropy and the mutual information entropy of design elements are computed by Eqs. (2) and (3), and results are shown in Tables 7 and 8. Then, the mutual information coefficient between the design elements are obtained by Eq. (4) and the results are in Table 9.

Table 8. The mutual information entropy

Design elements	*I*	*II*	*III*	...
I				
II	$H_{I\ II}$ = 1.5607			
III	$H_{I\ III}$ = 1.5438	$H_{II\ III}$ = 2.0140		
...	…	...	...	

Table 9. The mutual information coefficient

Design elements	*I*	*II*	*III*	*IV*	*V*	*VI*
I		0.3018	0.2698	0.0947	0.0380	0.1070
II	0.1911		0.1031	0.1048	0.1808	0.0498
III	0.1772	0.1070		0.0715	0.3206	0.0348
IV	0.0981	0.1714	0.1128		0.0355	0.0001
V	0.0133	0.1788	0.3055	0.0215		0.0607
VI	0.1058	0.0778	0.0524	0.0002	0.0959	

Finally, the mutual information coefficient map of the bracelet's design elements is drawn by reading the information in Table 9. As shown in Fig. 5.

5 Results and Discussion

We can conclude from the previous research results about the Fig. 4 that "Comfortable" which is the brand image of the elderly has the highest weight, following by facile and distinctive. The weight values are 0.4167, 0.3122 and 0.2711, that determining the more inclined to care the elderly a sense of comfort in the design process of a bracelet shape. Then, according to the higher composite evaluation value, a case library is also composed from the calculation results are shown in Fig. 4. As shown in Fig. 6.

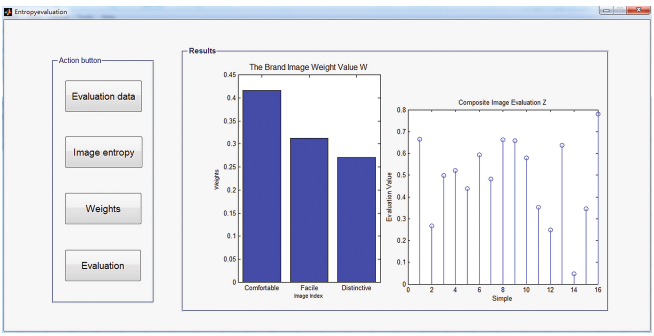

Fig. 4. The calculation results

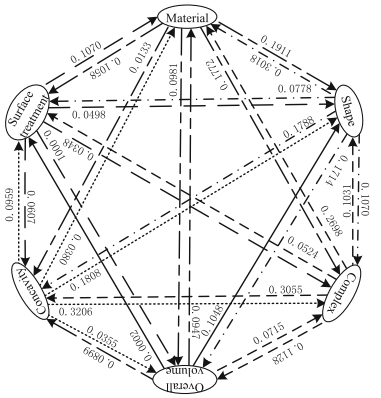

Fig. 5. Map

Fig. 6. The case library

At the same time, from Fig. 5, the weight values of the design elements are calculated for ranking in the design process that the design factor with larger information coefficient should be given priority in decision-making. And the ranking results named the knowledge base are the concavity, complex, shape, surface treatment, material, and overall volume. Thus the formation of a knowledge base and the case library are used to provide the design idea and direction for the follow-up bracelet design.

6 Conclusion

In this study, we use the kansei engineering and information entropy to analyze the brand image of smart pension product modeling, and we make more consideration for the elderly on the comfort of the heart needs in the design process. While, we also obtain the platform design elements and individual design elements of the smart pension product modeling which affect the brand image that can instruct the follow-up product image design effectively.

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