Research on Cell phone Appearance Image Models Based on BP

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Keywords: Kansei engineering, cellphone modeling, BP neural network, Appearance image.

Abstract. Kansei engineering provides a new idea for perceptual quantitative analysis. This paper targets in quantitative description the relationship between cellphone appearance design and consumer subjective felling, eventually builds a mathematical model through BP neural network. This research start with collecting a large number of perceptual image vocabularies, then transforms subjective assessment to quantitative evaluation by SD method and builds BP neural network mode. Thus analyzes the result of BP Model, the foundation is established by summary of the relationship between product appearance and objective feeling. It can be used to know the rule of how modeling elements affect perceptual image through the complete BP mode. This research provides a scientific method for engineer to process emotional design problem.

Introduction

A brief summary of relevant concepts in Kansei engineering is presented in this section. Product appearance is one of the most direct ways to reflect these perceptual factors. Form image design has become an important competitiveness to many companies [1]. In Japan, many commodities will be designed by Kansei Engineering Method (KE) before processing. Nowadays, it has been successfully applied in vehicle, cellphone, packaging, electrical appliances, clothing and website fields over the world. KE theory provides a new way for Industrial Design, it converts the invisible image into visible data, make designers and consumers become closer. BP artificial neural network is a kind of theoretical mathematics model, simulate the human`s brain neural network processing. Training use error back propagation algorithm. It realizes the simulation of prediction result by processing the nonlinear relationship between the input signal and the output signal.

This paper is based on KE method, using mobile phone as an example. Thus through morphological character to analyzing the product components, and finally builds a prediction model which can handle those perceptual design problems. (Fig. 1 cellphone samples)

Fig. 1: cellphone samples

Shape elements analysis and ascertain feeling image vocabularies

Cellphone's modeling factors analysis. First to analyzing the cellphone samples, selects those representative samples to deconstruct. Then based on focus group discussion and analysis, get the representative cellphone`s shape elements, like edge horn shape, thickness (continuity datum can be directly recorded). The discrete attribute such as section style, button shape, should in the category of options to represent. Thus, get six mobile phone modeling features include three continuous attributes and three discrete attributes. So generalizes the relationship between these effects about

morphological characteristics of cellphone and other perceptual evaluations (Table 1).

Table.1: Mobile phone sample shape elements analysis

Project	Category					Variable type
A. edge horn shape	0-5mm fillet					Continuous type
B. side section style	 b1	 b2	 b3	 b4	 b5	Discrete type
C. style of cross section	 c1	 c2	 c3	 c4	-	Discrete type
D. form of function keys	 d1	 d2	 d3	-	-	Discrete type
E. screen size	3 inches to 6.44 inches					Continuous type
F. thickness of the fuselage	6.5 mm - 10 mm					Continuous type

Sensory image vocabulary scale. This section discusses some problem about the perceptual words, accesses to relevant information in preliminary stage, finds out 264 words to describe mobile phone's modeling image. Then gets six pair of representative adjective phrases after screening analysis (durable-delicate, rigid-soft, beautiful-ugly, professional-amateur, unique-ordinary and simple-tedious), so that to provide adjective image for establishing the feeling characteristic. The central issue is how to build feeling characteristic assessment scale for six pairs of phrases and to assess the obtained datum which can be reflected the intention of consumers' feeling characteristics. Then it provides a basal subsequent intention model by Semantic Differential Method (SD).

Construction of BP Network Model

Network structure. Some important issues in developing a BP model system are discussed in this section. The basic framework of artificial neural network can be divided into three levels: Processing Element (PE), Layer and Network. Artificial neural network algorithm is simulated by artificial neuron. Through each fan of artificial neuron node output, it could be converted to other input processing unit. Its relation can be expressed in the following function:

$$Y_j = f(\sum_i W_{ij} X_i - \theta_j), \quad i = 1,\ldots p; j = 1,\ldots, n \tag{1}$$

X_i ——Input variables;
Y_j ——Output variable;
f ——Conversion function;
W_{ij}——Connection weights;
θ_j ——The threshold value.

This research makes product structural elements as input datum, each input data source is presented in input layer of neural node method. There are 15 (5+4+3+1+1+1) input factors that affect cellphone's modeling image, including side section style (5), style of cross section (4), function keys' form (3), edge horn, the screen size and the thickness of the fuselage.

The result of the network forecast is the output layer, is the information output[2]. Output layer

exports the perceptual image's subjective evaluation of product modeling. Six pairs of adjectives about perceptual image modeling elements have been got through the previous research (durable-delicate, rigid-soft, beautiful-ugly, professional-amateur, unique-ordinary and simple-tedious). So the evaluation of 6 pairs of perceptual vocabularies from 20 mobile phone modeling samples is regarded as the target output value, one node corresponds one pair of perceptual image , that is , the output layer has 6 nodes.

Combined with the characteristic of input layer data structure, the hidden layer has S tangent tan-sigmoid function as activation function. If chose output layer type S function, then the output would be limited to interval (0, 1). So output value (-2, 2) adopts KE fraction. The output layer uses linear activation function purelin. Model BP network structure is constructed as shown in the following figure. (Fig.2).

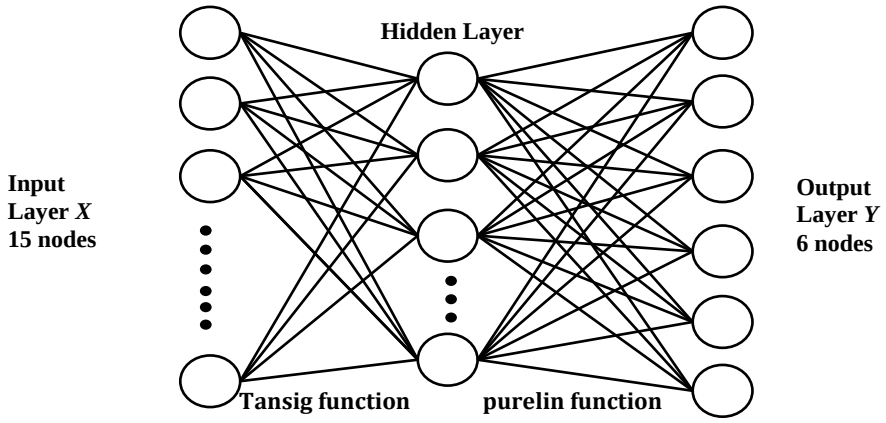

Fig. 2: shape image BP artificial neural network structure diagram

Hidden layer structure selection. Attempts to resolve this dilemma have resulted in the development of hidden layer structure. Generally, it should give priority to add neural nodes in the hidden layer. If it still couldn`t improve the performance of neural network, the designer should consider two hidden layer condition [3]. LinY-C[4] and others through research thought, if the neural nodes number of hidden layer is half of input layer and output layer nodes` sum, the root means square error become smaller[5]. A single hidden layer structure can satisfy any form of discriminant classification problem[6]. In this study the input layer has 15 nodes, output layer has 6 nodes, according to this conclusion this research will select 10 neural nodes as hidden layer.

Implementation of BP artificial neural network model. This experiment uses MATLAB neural network toolbox to building the BP artificial neural network model. The training number sets for 1000 times, training target is 4-10, choose the training function TRAINLM, using Levenberg-Marquardtt (LM) and the numerical optimization algorithm to achieve the error back propagation algorithm. When can't improve neural network performance, consider two hidden layer[7]. After training times, the network error would converge to a predetermined target (Fig. 3 network training process). It is necessary to test the network model after training. The absolute value error should be within a reasonable error range (less than 0.1). It shows that the established model is effectively and it has a good generalization ability. So it can be applied to help engineers design job.

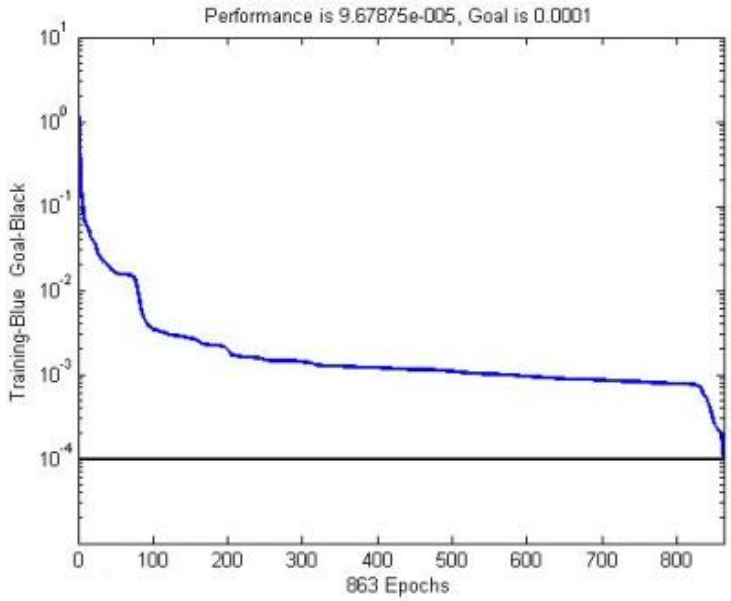

Fig. 3: network training process

Modelling elements feeling imagery influence rule analysis

Applying the BP artificial neural network model to give an analysis of the cellphone side section forms with the modeling image effects, select cross section of category B4, style selection button to select C2, and set the fillet 2mm, the screen size is 4.3 inches, the thickness is 8.5mm, other variables unchanged, Selected side section style category a1 , a2 , a3 , a4 , a5， observe the side section style changing from the image of BP neural network model， predict the effects of output value. With the input layer to hidden layer weights w1 and hidden layer to output layer weights w2 supports the entire network (Fig. 4 evaluating weight of factors w1 , Fig. 5 evaluating weight of factors w2).

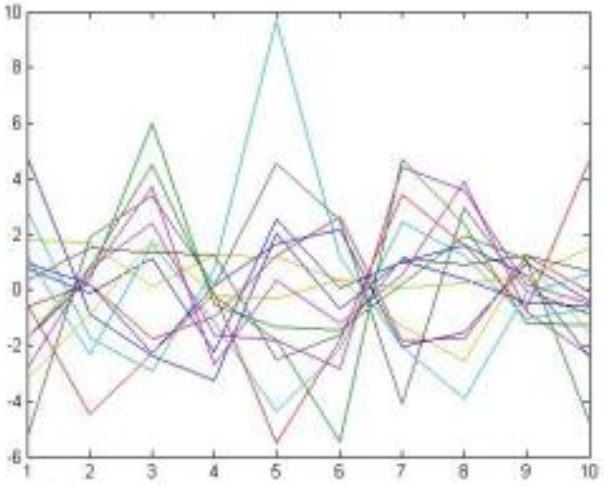

Fig. 4: evaluating weight of factors w1

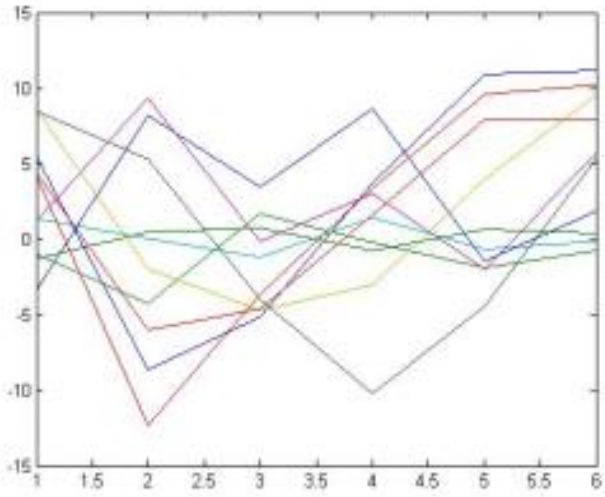

Fig. 5: evaluating weight of factors w2

Then picture 6 perceptual image influence rule figure (Fig.6). It can be seen that for “durable-delicate”, “rigid-soft” imagery, side section a 3 has the biggest influence on the negative image of “durable”, side section a1 has the biggest impact on the negative image of “delicate”. As to “beautiful-ugly” and “professional-amateur” imagery, side section style a2 has the greatest impact on the positive image. Side section style a4 is the most negative image.

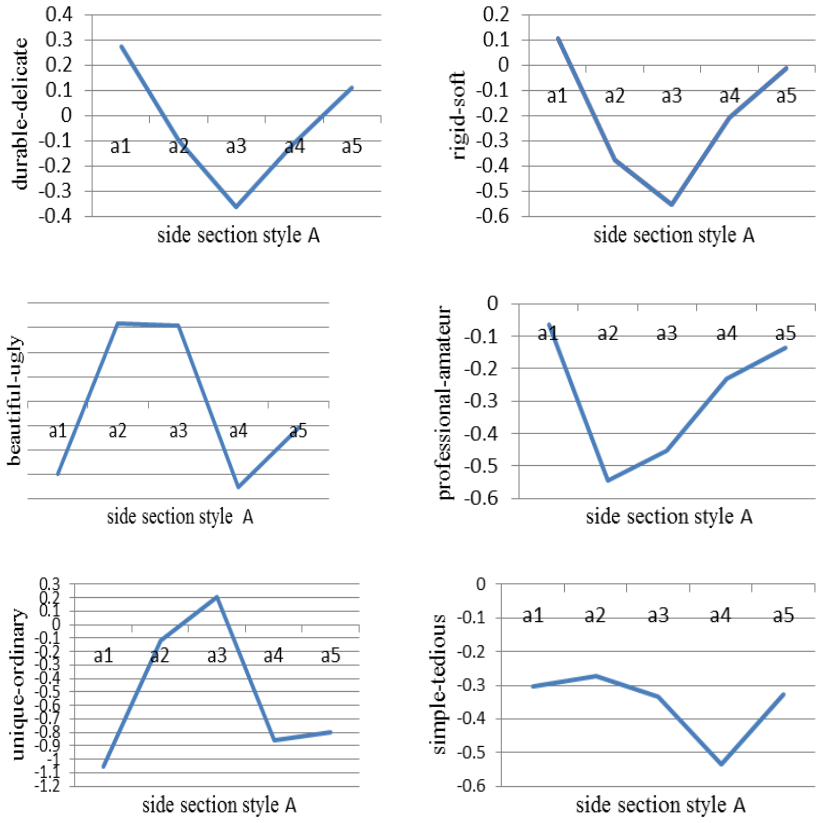

Fig. 6: Perceptual image influence rule

Conclusions

Finally, conclusions and future work are summarized in this section. Employ BP artificial neural networks in Kansei Engineering to obtain the structure model of customers’ preferences for product image and then verify it. BP artificial neural network model analyzes the mutual influence between style and shape intention with mobile phone side section styles. It shows that this model predict

feeling imagery and modeling elements well, provides a scientific method for engineer to process emotional design problem. The next step is based on the theory of product form, combined with point, line, surface structure, refined product modeling method of deconstruction. So that to deal with more complex product modeling and to improving the model prediction.

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