10 The Development of a Glasses Design Support System

Wei-Ming Shih and Ming-Chuen Chuang

Institute of Applied Arts, National Chiao Tung University, 1001,Ta-Shuei Rd., Hsinchu City, Taiwan

While looking at glasses, we will have various sensation on their forms, colors, textures etc. These feelings direct us to decide which pair of glasses to buy. This study tries to find out the relationship between human sensation and glasses design; that is, to figure out what kinds of forms will excite what kind of human sensation. By adopting this relationship, we also propose a computer support system which can automatically generate appropriate glasses forms in response to the expectation of consumers.

In this study, we first collect several adjectives which can express the human sensation on glasses designs. Then, in an experiment, subjects are asked to evaluate a set of glasses in order to acquire the ratings of those adjectives. We further analyze the formal elements included in different glasses. multivariate analysis and the neural networks are used to decide which design of each element are more likely to excite a specific human sensation.

These results then are built as a knowledge base of a support system which includes an inference engine to assist a designer to produce new glasses design. By receiving the input of desired adjectives, this system will find out the most preferred elements for each adjective and integrate them into some appropriate design prototypes for further modification.

KEYWORDS: *glasses design, human sensation, multivariate analysis, neural networks, design support system*

INTRODUCTION

This study intends to apply the concept of 'design automation' in the eye-glasses design. The goal is to inspire the designers and to stimulate their creativity; at the same time, it will allow the customers using the same mechanism to select a pair of eye-glasses that matches their own personal prestige. As the marketing strategy has shifted from 'manufacturer-oriented' to 'customer-oriented', the design focus has migrated from simple mechanical functionalism to complex sensational personalism. The core of this study will include how to analyze the customers' preference and forecast the market trend with the scientific tools, and how to utilize the computer technology to help the designers.

When the customers encounter a product, they will generate a collective feeling from its shape, color, texture, functionality, manipulation, value, and etc. This is usually the major factor that affects the customers' decision on buying a product. The core concept of eye-glasses design is to create sensational stylish frames that bring the sense of custom-designed or custom-made to each individual. An in-depth research on the relationship between the customs' feelings and the product design can help qualify the degree of customer satisfaction on expression of self-image. Coupling the concept of eye-glasses design and the understanding of the relationship between the customers' feelings and product design, we would like to propose the framework of the Glasses Design Support System (GDSS), and use the neural networks to perform a pilot test on finding of the relationship between the customers' feelings and design features of eye-glasses.

1.0 BACKGROUND

Some studies have indicated that 'style' can be classified, evaluated, and cognized, and will be influenced by the amount and the importance of the design features. Genetic algorithms (Katsuyama, Yamakawa, 1990) and neural networks, fuzzy reverse reasoning theory (Y.M. Chang, 1992) have been explored and used to analyze the customer satisfaction with the products based on design preference and their needs. As a result of those experiments, a procedural mechanism of transforming from conceptually abstract descriptions to perceptibly concrete geometric shapes was developed. It can assist the designers to create the product forms according to the demanded images.

The so-called 'Kansei Engineering' theory was proposed by Nagamachi in 1986. This theory was based on analyzing the sentimentality of the customers with the aid of statistics and computer techniques. With the application of this theory, many intelligent CAD systems had developed successfully.

From the above experiments and researches, we conclude that if the 'style' of a specific product can be classified, and its possible corresponding customer feeling that can be arouse by each different form features are known, then we can design a product to stir up a certain sense or emotion. In the following of this report, we will use the eye-glasses as our target product and propose an Intelligent CAD System.

2.0 MODEL OF GLASSES DESIGN SUPPORT SYSTEM

This Glasses Design Support System (GDSS) is based on the theory of 'Kansei Engineering' and exploits further. After numerous interviews with customers and glasses designers, we find that the front part of a pair of eye-glasses draws most of people's attention. Therefore, the GDSS will focus at the front frame design of optical eye-glasses.

The first step is selecting image adjectives and eye-glasses samples; then establish the 3D parts database and the image-sense database. In Fig. 1, a flowchart is shown to depict all the necessary steps to build the above two databases. By using the method of semantic differential (SD) we gather the subjects' impressions for every eye-glasses sample in order to pinpoint the relationship between the design features and human feeling and thus further establish the image-form database. The next section will elaborate the process of collecting image adjectives, establishing the 3D parts database and image-form database.

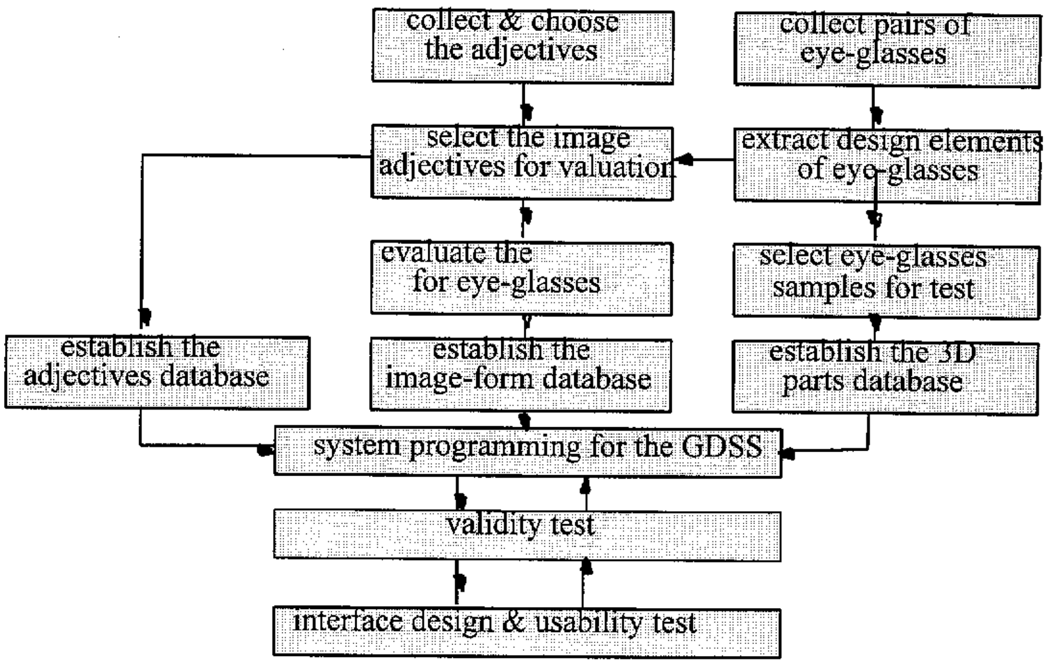

Fig. 1 Flowchart of constructing the GDSS.

2.1 Collect & select the image adjectives

Comprehensively collect image adjectives which are expressive to the consumer's feelings, and remove the inappropriate adjectives which contain material, usage, and jargons. The adjectives left then are paired in comparison form. Then ask the consumers and designers to rank some adjectives which are frequently used to evaluate eye-glasses. And take the first 30 higher rank pairs to be used in the next stage.

All adjectives are paired in comparison form on the semantic differential (SD) 5 grade scale. The evaluated data are analyzed by Factor Analysis. These adjectives are narrowed down to about 10 pairs while maintaining a good balance with respect to their arrangement in that factor space.

2.2 Establish the 3D parts database

Subjects are asked to sort these comprehensively collected eye-glasses samples into several groups according to the similarity between eye-glasses. These data are analyzed by Multi-dimensional Scaling Analysis (MDS), to identify some significant groups. We can select some representative samples from each of these groups for further analysis. On the other hand, we classify these representative eye-glasses samples by the method of morphological analysis based on some design features, shapes, materials, colors, and other parameters. An integrated morphological analysis table is built, and the 3D model of each category are built in the parts database.

2.3 Establish the image database

The subjects are asked to evaluate each pair of eye-glasses sample by the SD scale on the basis of the impressions they perceive. The evaluated data are analyzed by neural networks and multiple regression analysis to figure out the relationship between human feeling and the form features of eye-glasses design. According to this relationship, we build a image-form database in the system.

All these databases will be linked by the object-orientated concept, and an inference engine will be built. Finally we will configure the operations and interface design of the system. For examining the feasibility of this approach, we has made a pilot study for finding the relationship between the design features and human feeling.

3.0 PILOT STUDY

Since 1943 Warren McCulloch & Waiter Pitts proposed ü the first paper about the artificial neural networks, there are many developments and applications in this domain. In fact, the artificial neural networks are based on the simulation of human nerve neuron. On receiving stimuli or signals from outside or other neurons, a neuron will decide whether to process the information or not according to strength of the stimuli, and then transmit the output into outside or other neurons. Fig. 2 is the framework of the artificial neural networks.

Fig. 2. The framework of the Artificial Neural Networks.

In this pilot study, we had chose 16 pairs of eye-glasses and 10 pairs of adjectives for SD evaluation (Table 1), and made a integrated morphological analysis table of the eye-glasses (Table 2).

1. Masculine						Feminine
2. Vivid						Quiet
3. Complicated						Simple
4. Pliant						Formidable
5. Modern						Classic
6. Unique						Popular
7. Deluxe						Inferior
8. Wild						Neat
9. Light						Stable
10. Warm						Cool

Table 1. The representative pairs of adjectives for SD evaluation.

Item \\ Category	C 1	C 2	C 3	C 4	C 5	C 6	C 7
I1. Lens shape							
I2. bridge							
I3. Frame shape							
I4. Frame thickness	thick	thin					
I5. Color	silver	brown	white	light-golden	dark-golden		
I6. Texture	yes	no					
I7. Material	metal	non-metal	partial metal				
I8. Pad	separated	integrated					

Table 2. The morphological analysis table of glasses

We first collected the evaluated data and analyzed them by the artificial neural networks. There are 2 approaches to analyze these data. One of them is to use the evaluated data (10 nodes) as input and the design features (30 nodes) as output, in order to predict the eye-glasses design, corresponding to the specific image adjective. There are 30 nodes in the hidden layer, and the learning rate is set as 0.075. While the total error is less than 0.005, the learning period ends. The second approach is to use the design features (30 nodes) as input and the evaluated data (10 nodes) as output, in order to predict what kind of feeling will be excited by the specific design. There are 20 nodes in the hidden layer, and the learning rate is set as 0.05. While the total error is less than 0.001, the learning period ends. After several times of learning, the results are accurate enough to further apply to practical design of eye-glasses.

Fig. 4 is the result of inputting adjective 'feminine'. And after receiving the input of the form of eye-glasses illustrated on Fig. 5, the GDSS can acquire the masculine, classic, and stable feelings in the output layer. The validity test showed that the result of this pilot study can fit the specific needs and feelings of consumers very much. So we believe that this approach is able to match the research goal.

Fig. 4

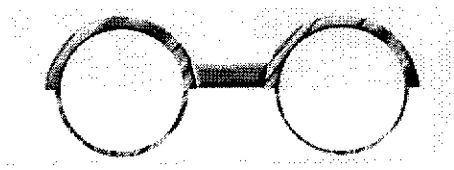

Fig. 5

CONCLUSION

In this study, we intend to propose a overall framework of the Glass Design Support System, which can benefit both product designers and consumers. It not only provides designers a relationship between human feelings and the corresponding design features, but also assists consumers to select a product which fits his feeling from a lot of products. To build an integrated and more creditable CAD system, we will conduct a broader image evaluation survey, and compare the analysis result of the multivariate analysis and that of the neural networks.

Besides, consumers always select several pairs of glasses which fit the image they want at first, then decide which pairs of glasses to buy after the examination by putting the selected glasses on their faces one by one. The shape of faces, eyes, and the colors of skin will affect the overall images and feelings; therefore, all of these factors should be considered in the future study. Glasses is a kind of fashionable product, people's feelings and images will be changed with different cultures, areas, and generations, so it is necessary to build the system with an open structure for updating or modifying the data at anytime. We also have to construct the professional knowledge rules which can remove the inappropriate or absurd designs into this system to increase the integrality of the system.

REFERENCES

Allen, M S 'Morphological creativity: the miracle of your hidden brain power.' Prentice Hall Inc. (1962).

Chan, C S 'Exploring individual style in design' Environment and Planning B Vol 19 (1992) 503-523.

Chan, C S 'How an individual style is generated' Environment and Planning B Vol 20 (1993) 391-423.

Chang, S S, and Lin, S C 'SPSS for Windows: statistical analysis' Song-Kang, Taiwan (1994).

Chang, Y M, Mori, N, and Sumio, Y 'Analysis of a preference model for car styling, Using concept of cognitive segment union' Bulletin of JSSD No 94 (1992) 43-50.

Chang, Y M, and Mori, N 'A design support system for cars using fuzzy inverse reasoning integrated by neural-network' Journal of Japan Society for fuzzy theory and systems Vol 5 No 5 (1993) 1223-1245.

Chen, S E, and Parent, R E 'Shape averaging and its applications to industrial design' IEEE Computer Graphics & Applications' (Jan. 1995).

Jindo, T, Hirasago, K, and Nagamachi, M 'Development of a design support system for office chairs using 3-D graphics' Industrial Ergonomics Vol 15 No 1 (1995) 49-62.

Katsuyama N, and Yamakawa H 'A study on Heredity and Evolution of designs considering KANSEI by using genetic algorithms' Waseda University, Japan.

Liu, Y T 'Restructuring shapes: a study of symbolic and connectionist computation in design' Ph.D. Dissertation Harvard University.

Liu, Y T 'Some phenomena of seeing shapes in design' Design Studies Vol 16 No 3 (1995) 367-385.

Luger, G F, and Stubblefield, W A Artificial intelligence and the design of expert system. The Benjamin/Cummings, Redwood city, CA (1989).

Mastandrea, S, and Bove, G 'Meaning of industrial design objects: from designers to users' Environment and Planning B Vol 19 (1992) 307-319.

Nagamachi, M 'Kansei Engineering' KAIBUDO, Japan (1989).

Nagamachi, M 'Kansei Engineering: a new ergonomic consumer-oriented technology for product development' Industrial Ergonomics Vol 15 No 1 (1995) 3-11

Norris, K W 'The morphological approach to engineering design' Conference on Design Methods Pergamon Press (1963).

Shiau, K A and Chuang, M C 'Exploring style operation of product design - using Ming-style chairs as examples' Master Thesis, NCTU, Hsing-chu, Taiwan (1995).

Stiny, G 'Introduction to shape and shape grammars' Environment and Planning B (July 1980) 343-351.

Stiny, G, and Mitchell, W J 'The Palladian grammars' Environment and Planning B Vol 5 (1978) 5-18.

Wallace, D R, and Jakiela, M J 'Automated product concept design: unifying aesthetics and engineering' IEEE Computer Graphics & Applications (July 1993) 66-75.

Winston, P H Artificial intelligence (2nd edn) Addison-Wesley, Taipei, Taiwan (1984).