Mapping functions between image features and KANSEI and its application to KANSEI based clothing fabric image retrieval

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Abstract: KANSEI is a Japanese term which means psychological feeling or image of a product. KANSEI engineering refers to the translation of consumers' psychological feeling about a product into perceptual design elements. Recently several researches have been done for image indexing or image retrieval based on KANSEI factors. In this paper, we propose a new technique for clothing fabric image retrieval based on KANSEI (impressions). We first learn the mapping function between the fabric image features and the KANSEI and then the images in the database are projected into the KANSEI space (psychological space). The retrival is done in the psychological space by comparing the querry impression with the projection of the images in database.

1. Introduction

Recently a growing interests has been seen in KANSEI engineering or emotion design. KANSEI is an individual subjective impression from a certain artifact, environment or situation using all the senses of sight, hearing, feeling, smell, taste, recognition and balance [1]. KANSEI engineering refers to the translation of consumers' psychological feeling about a product into perceptual design elements. KANSEI can "measure" the feelings and shows the relationship to certain product properties. In consequence, products can be designed to bring forward the intended feeling. KANSEI is the integrated functions of the mind, and various functions exist in during receiving and sending. Filtering, acquiring information, estimating, recognizing, modeling, making relationship, producing, giving information, presenting and etc. are the contents of KANSEI. A person's KANSEI will be expressed through physiological functions. There are 4 ways of measuring the KANSEI: (1) words; (2) physiological response (heart rate, EEG); (3) people's behaviors and actions; (4) Facial and body expressions [2]. The most common way of measuring the KANSEI is through the words. Recently several researches have been done for image indexing or image retrieval based on KANSEI factors (impression words) [3-5]. In our previous studies, we have significantly estimated the mapping functions from the image feature space to the KANSEI space for four groups with different ages [6]. In this paper, we propose a new technique for clothing fabric image retrieval based on KANSEI (impressions). We first learn the mapping function between the fabric image features and the human KNASEI factors. We use the semantic differential (SD) method to extract the KANSEI factors (impressions) such as bright, warm from human while they viewing an fabric image. A neural network is used to learn the mapping functions from the image feature space to human KANSEI factor space (psychological space) and then the images in the database are projected into the psychological space. The retrival is done in the psychological space by comparing the querry impression with the projection of the fabric images in the database.

2. Mapping Function

In order to make a quantitative study on the relationship between the image features and KANSEI factors, we construct an image feature space and a KANSEI factor space (psychological space) as shown in Fig.1. One fabric image has one point in the image feature space and has a corresponding point in the KANSEI factor space, which is an impression (KANSEI) of the subject to the image, just like a projection of the image feature to the psychological space. The relationship between the image features and the KANSEI can be described by the mapping function from the image feature space to the psychological space. The input of the mapping function is the image features and the output of the function is the KANSEI factors (impressions). The mapping functions (relationships) can be learned by finding the corresponding points in the image feature space and psychological space.

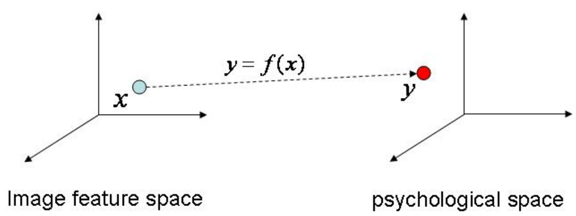

Fig.1 Mapping Functions from image feature space into psychological space.

3. Psychological Features (Impressions)

In order to find a corresponding point in psychological space, we use the semantic differential (SD) method to extract the KANSEI factors (impressions) such as bright, warm from 8 adults while they viewing an image (material). In this research, we use words (adjective pairs) to measure the KANSEI. By careful selections, we chose 23 pairs of adjectives, which are shown in Table 1, as measures of KANSEI. We chose 168 clothing fabric images as shown in Fig.2 for learning of mapping functions and validations. We asked 8 college students to rate the impression with 23 pairs of adjectives in 7-level scales (-3,-2, -1, 0, 1, 2,3).

Fig.2 Some examples of colothing fabric images for training

Table 1. 23 pairs of adjectives

1.	strange - familiar
2.	unique - usual
3.	bright - dark
4.	Interesting - uninteresting
5.	scary - not scary
6.	pretty - ugly
7.	western - eastern
8.	gorgeous - quiet
9.	natural - artficially
10.	clear - indistinct
11.	fine - rough
12.	adult - childlike
13.	refresing - messy
14.	gentle - indifferent
15.	deep - faint
16.	regular - irregular
17.	modern - classical
18.	warm - cool
19.	transparent - opaque
20.	simple - complex
21.	jaunty - placid
22.	manly - womanly
23.	like - dislike

4. Image Features

In this paper, color, texture and shape features are used as image features.

4. 1 Color Features

We first transform the color image from the RGB space to the HSV space and the Hue value (from 1 to 360) is used as color features. The gray lavels (R=G=B) are reresented by four bins. So the dimension of color feature vetors is 364. Two typical color images and their color feature vectors are shown in Fig. 3. In order to find an efficient representation of color features, we use pricipal component analysis (PCA) to reduce the dimension of the color feature space. The 364-dimentional color space is reduced into 30-dimention.

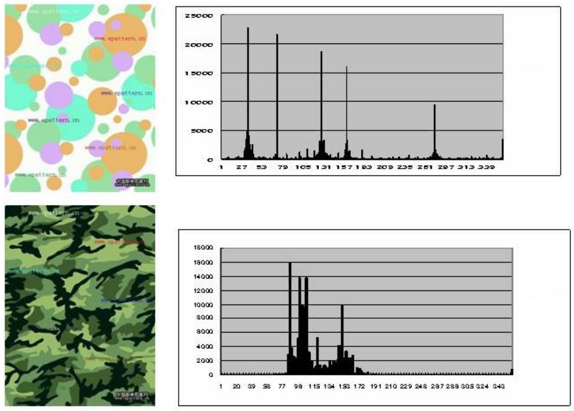

Fig.3 Two typical color fabric images and their color features

4. 2 Texture Features

The texture features are represented by the use of Fourier transform power spectrum P(r,θ), which express a periodic pattern of image in polor coordinate, where r is the amplitute of the frequnecy and θ is the direction angle of the frequency. Following two features with dimentions of 50 and 180, respectively, are used for texture representation:

$$p(r) = \sum_{\theta=0}^{\pi} P(r,\theta) \qquad (1)$$

$$q(\theta) = \sum_{r=0}^{w/2} P(r,\theta) \qquad (2)$$

The typical fabric image and its features are shown in Fig.4. The dimention of the texture feature vector, which is composed of $p(r)$ and $p(\theta)$, is 230 and it is reduced into only 2 by the use of PCA.

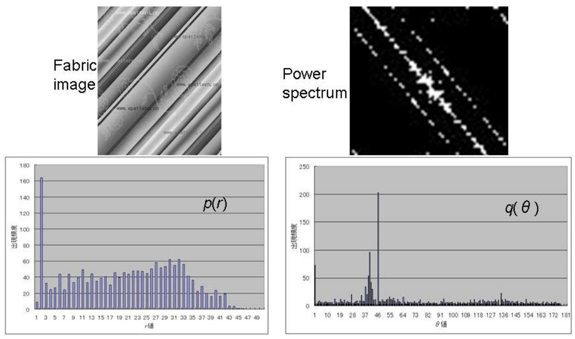

Fig.4 A typical fabric image and its texture features

4. 3 Shape Features

We use Gabor filters to extract shape features. A directional Gabor filter can be expressed as

$$F(x,y) = e^{-\pi(x^2a^2+y^2b^2)}\cos(ux+vy) \qquad (3)$$
$$u = f\cos\alpha, v = f\sin\alpha$$
$$f : frequency$$

where α is the direction of the filter. Four directional Gabor filters with angles of 0, π/4, π/2, π3/4, respectively, are used for shape feature extractions. Each filtered image is divied into 10×10 subimages and the mean value of each subimage is used as shape features. Thus the dimension of the shape feature vector is 400 and it is reduced to 15 by the use of PCA. A typical image and its Gabor filtered image (α=π/2) are shown in Fig. 5. It can be seen that the horizontal features are extracted.

Fig.5 A typical image and its Gabor filtered image (α=π/2)

5. Learning and validation

In this paper, we use a neural network as a model of mapping function as shown in Fig.6. The neural network can be used to approximate any nonlinear functions. The neural network or the mapping function can be learned by finding the corresponding points in the image feature space and psychological space. The input of the neural network is the image features and the output is the corresponding impression. The number of input neurons is 47 (30+2+15), the number of the output neurons is 23 (the number of the pairs of adjectives) and the number of the neurons in middle layer is 67.

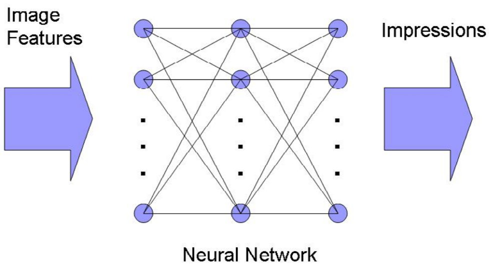

Fig.6 A neural network used as a model of mapping functions

We choose 165 images as training images to train the neural network. Once the neural network is trained, we use remianed 3 images, which are not included in the training images, as test images for validations. We compared the outputs (estimated impressions) of the test images with real impressions obtained by SD method and calculate the mean squre error (MSE) between the estimated impression and real impression. The experimental process is shown in Fig.7. The experiments are repeated 56 times with different training and test images. Averaged MSE of each impression is shown in Fig.7. Since the value of the impression is -3~3, the estimation error is less than 10%. The overall MSE of each image is shown in Fig.9.

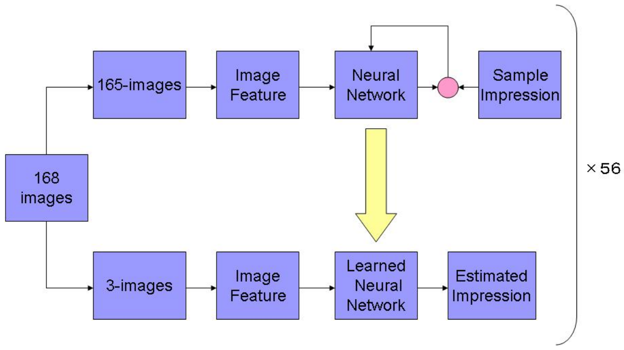

Fig.7 Experiment process for training and validation.

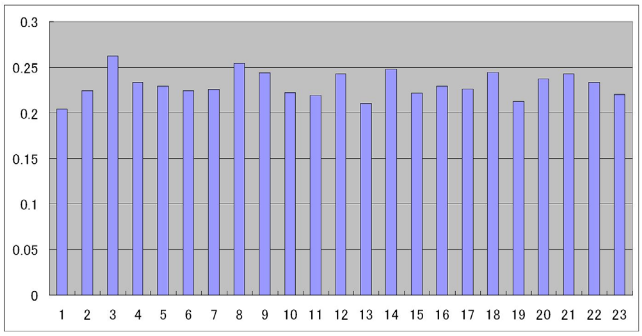

Fig.8 Averaged MSE of each impression

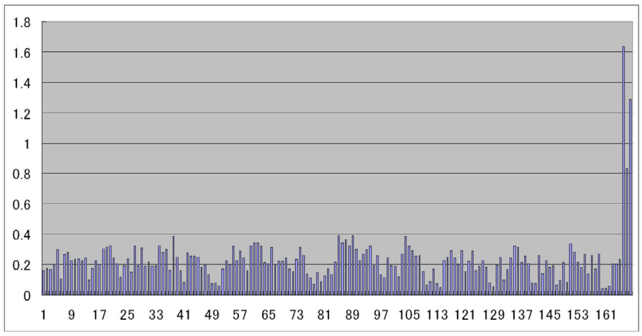

Fig.9 Overall MSE of each image

6. KANSEI based Image Retrieval

As an application, we developped a KANSEI based clothing fabric image retrieval system. The flowchart of the system is shown in Fig.10. The input quarry is KANSEI words (impressions). The image feaures (color, texture and shape features) of fabric images in the database are first extracted by use the methods, which are shown in Sec.4) and then the image feature vector is projected or transformed into the psychological space (impression vector) by the mapping function (trained neural netowork). We calculated the Euclide distance between the quarry impression vector and the each transformed fabric image impression vector. The image with minimum distance is retrived as an output. The examples of the retrieval results are shown in Fig.11 and Fig.12. The retrieval results for qurry impressions of "bright", "fine", and "faint" are shown in Fig.11 and the retrieval results for the qurry impression of “dark”, “rough” and “deep” are shown in Fig.12. It can be seen that the retrieval images are marched with the qurry impressions.

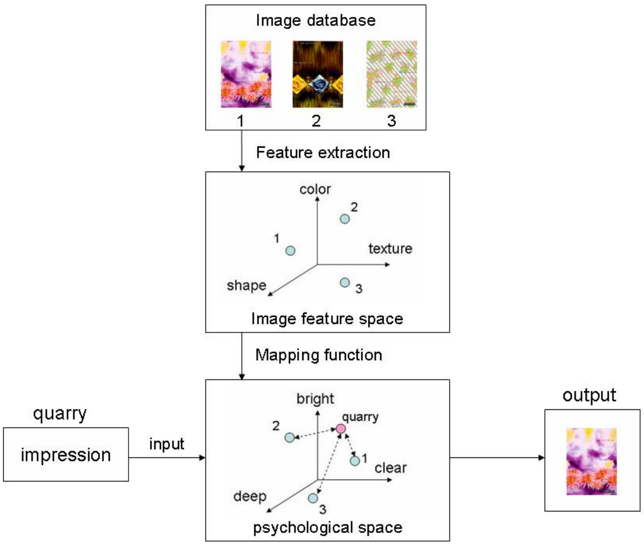

Fig.10 Flowchart of KANSEI based fabric image retrieval system

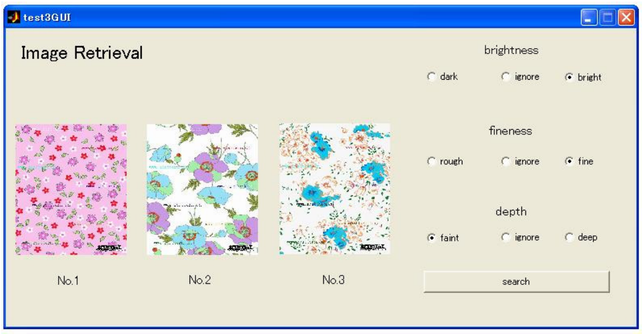

Fig.11 The retrieval results for qurry impressions of “bright”, “fine”, and “faint”

Fig.12 The retrieval results for the qurry impression of “dark”, “rough” and “deep”

6. Conclusions

We proposesd a new approach to learn the mapping function from the image features space to the human KANSEI space (psychological space) using a multi layer neural network The experimental results show that for a given image, the KANSEI (impressions) estimation error is less than 10%. As an application, we also developped a KANSEI based clothing fabric image retrieval system. Significant positive results have been obtained. We can retrive the desired clothing fabric images from the detabase by using only some KANSEI words (impression words).

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References

[1] S. Schwte, J. Eklund, J.R.C. Axelsson, M. Nagamachi: “Concepts, methods and tools in Kansei Engineering,” Theoretical Issues in Ergonomics Science, Vol.5, pp.214-232, 2004.

[2] K.Grimsæth: “Linking emotions and product features,” KANSEI Engineering, pp.1-45, 2005.

[3] J. Black, K. Kahol, P. Tripathi, S. Panchanathan: “Indexing natural images for retrieval based on Kansei,” Proc. of Human Vision and Electronic Imaging conference, 2004.

[4] H. Takagi, T. Noda: “Media Converter with Impression Preservation Using a Neuro-Genetic Approach,” International J. of Hybrid Intelligent Systems, Vol.1, pp.49-56, 2004.

[5] H. Takagi, T. Noda, S. Cho: “Psychological Space to Hold Impression Among Media in Common for Media Database Retrieval System,” Proc. of IEEE International Conference on System, Man, and Cybernetics (SMC'99), Tokyo, Japan, vol.VI, pp.2630268, 1999.

[6] X. Huang, S. Sobue, T. Kanda and Y.-W. Chen: “Linking KANSAI and Image Features by Multi-layer Neural Networks,” Lecture Notes in Artificial Intelligence, Springer, (Proc. of KES2007), Springer, LNCS 4693, pp.318-325, 2006