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□期中進度報告

電腦輔助色彩味覺與嗅覺意象之調和配色研究（I）

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計畫主持人：蔡宏政
計畫參與人員：許毓君、曾鐘慧

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中　華　民　國　九十七　年　七　月 三十一 日

電腦輔助色彩味覺與嗅覺意象之調和配色研究（Ⅰ）

Computer-Aided Color-Combination Design on the Images of Taste and Olfaction with Color Harmony (I)

計 畫 編 號：NSC 96-2221-E-343-005
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中文摘要

民以食為天，「食」在生活中是不可或缺的要項，與人類最主要的 5 種感覺系統中的味覺與嗅覺最為相關。而食材的色澤，乃至外包裝色彩設計的良窳，不僅會影響人們的食慾，亦將影響實際的味覺感受[1]。本研究旨在探討色彩味、嗅覺意象感知程度，並透過三角模糊數、模糊整體效用值與模糊效用相似度進行量化計算，進而建立一個色彩味、嗅覺配色之意象評價配色模式。研究結果顯示：(1)受測者對於色彩與味覺語彙意象感知，大多經由食物本身的色彩繼而產生食物味道的聯想。(2)單色與雙色色彩於味、嗅覺語彙感知程度具有相當之一致性。(3)多色彩配色會降低對色彩之味、嗅覺感知程度。

此外，本研究針對單色、雙色與三色配色進行味、嗅覺意象評價實驗，以驗證所提出之評價方法之有效性。最後以三個實務個案，進行味覺、嗅覺、味覺+嗅覺之商品色彩計畫實作評價。

關鍵詞：色彩、共感覺、味覺、嗅覺

Abstract

Foodstuff is all-important to people. Food is a necessary part in our daily life that has a close relationship with taste and olfaction in our five sense systems. Besides, color of food, even the color design of the apparent package would not only affect our appetites, but the sense flavor [1]. This study aimed at exploring color psychological perception about taste image and olfaction image. Through the quantitative methods of fuzzy numbers, fuzzy total utility values and fuzzy utility similarity, a color-combination evaluation model was built based on the taste/olfaction image perception. The experimental results indicated the following assumptions. (1) The subjects mostly associate the taste of food with the food's colors. (2) The image perceptions of single colors and two-color combinations on taste and olfaction are highly identical. (3) Multiple color combinations decrease the perceptual degree of taste and olfaction images.

The study proceeds with the taste and olfaction image evaluation experiments on single colors, two-color combinations, and three color combinations to demonstrate the effectiveness of the proposed method. Finally, three packaging cases were designed based on the evaluation of 'taste', 'olfaction', and 'taste + olfaction' images.

Keywords: Color, Synesthesia, Taste, Olfaction

1. Introduction

Eighty percentage of our daily received information is conveyed by the visual system [2]. The overall image perception of a product's style is generally induced by its form and by its color. Tsai *et al.* [3] investigated the overall image of a product, and the results showed that the overall image perception was dominated by the product's color rather than by its form.

Many color design researchers keep their attentions on the synesthesia induced by color stimuli. The senses of taste and olfaction in synesthesia are of better consensus and practical utility. Nowadays, the hardware and software of computers has reached mature development. Computer-aided color simulation has become the dominant method for color design and the parameterized color systems are adopted for color presentation [4]. Thus, it is appropriate to quantify the relationship between color and its synesthesia for the studies on synesthesia of taste and olfaction.

Traditional color image-related researches were usually limited in the discussion issues of single conceptual image or color-usage suggestion. They didn't include the construction of the objective quantitative relationship between color and its image. Therefore, this research focused on computer-aided color design with the chromaesthesia of taste and olfaction. It constructed the quantitative relationship between colors and its image evaluation of taste and olfaction. The method integrated with fuzzy numbers, fuzzy total utility values and fuzzy utility similarity [5,6] were utilized to build a color-combination evaluation model based on the taste/olfaction image perception. Three case studies of color designs were individually evaluated through the proposed method.

2. Implementation Methods

Seven linguistic variables (VL: very low, L: low, ML: medium low, M: medium, MH: medium high, H: high, VH: very high) were used to indicate the color perception degrees on taste-image and olfaction-image. These variables can be viewed as fuzzy linguistic sets and quantified using triangular fuzzy numbers. The implementation procedures used in this study include the following steps:

Step 1. Quantify the subjects' judgements using triangular fuzzy numbers.

$$LV_T = [lvt_{ijk}]_{216\times5\times53} \quad (1)$$

$$LV_O = [lvo_{ijk}]_{216\times5\times53} \quad (2)$$

where LV_T and LV_O denote the linguistic judgement matrix and the triangular number lvt_{ijk} represents the fuzzy judgement value of the *i*th color sample and the *j*th taste adjective of the *k*th subject. So that lvo_{ijk} represents those about olfaction judgements.

Step 2. Calculate the fuzzy average judgement values.

$$\overline{LV}_T = [\overline{lvt}_{ijk}]_{216\times5\times53},$$

$$\overline{lvt}_{ij} = \left(\sum_{k=1}^{53} lvt_{ijk}\right) / 53 \quad (3)$$

$$\overline{LV}_O = [\overline{lvo}_{ijk}]_{216\times5\times53},$$

$$\overline{lvo}_{ij} = \left(\sum_{k=1}^{53} lvo_{ijk}\right) / 53 \quad (4)$$

where $\overline{lvt}_{ij}$ denotes the fuzzy average judgement value of the *i*th color sample and the *j*th taste adjective, and $\overline{lvo}_{ij}$ represents those about olfaction judgements.

Step 3. Search for the nearest upper and lower color samples based on the specified color parameters.

Step 4. Calculate the weights (*w*) for the

relationship between the specified color and color samples using the RMSE method.

$$w = 1/RMS = 1/\sqrt{\frac{1}{3}\sum_{k=1}^{3}([c_k^{up}]-[c_k^{low}])^2} \quad (5)$$

where c_1, c_2 and c_3 represent the color parameters R, G and B, respectively.

Step 5. Calculate the image evaluation for the specified single colors.

$$F_{ij} = \frac{F_i \times w_i + F_j \times w_j}{w_i + w_j} \quad (6)$$

where F_i and F_j represent the image values for the ith upper and the jth lower color samples, respectively.

Step 6. Calculate the total image evaluation F_{total} for the specified color combination.

$$F_{ml} = (\sum_{i,j=1}^{m,n} F_{ij})/(m \times n) \quad (7)$$

$$F_{total} = \frac{\sum_{i=1}^{n}(F_{mli} \times A_i)}{\sum_{i=1}^{n} A_i} \quad (8)$$

Step 7. Calculate the total utility values of the specified color combination.

$$U_T(F_{total}) = [\frac{d_t - x_{min}}{(x_{max} - x_{min}) - (a_t - d_t)} + 1 - \frac{x_{max} - c_t}{(x_{max} - x_{min}) + (a_t - c_t)}]/2 \quad (9)$$

Step 8. Calculate the utility similarity.

$$S_T(A,B) = \frac{U_T(A) \times U_T(B)}{\max(U_T(A) \times U_T(A), U_T(B) \times U_T(B))} \quad (10)$$

Step 9. Choose the corresponding best linguistic adjective for the taste-image and the olfaction-image.

To check the reliability of the proposed evaluation model, the RMSE values between the evaluated results and the experimental data were obtained, shown in Figure 1.

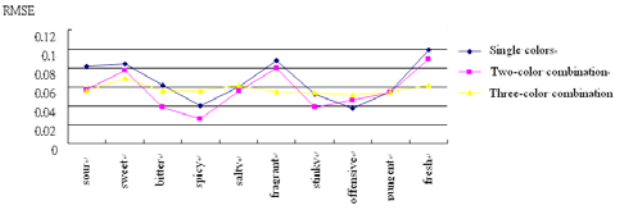

Figure 1 RMSE values between the evaluated results and the experimental data

3. Color Design Examples

3.1 Case 1: color design for the package of taste-related food

A two-color pickle gift package was taken in the current study as the color-design example of the taste-related merchandise. Two colors of the green/pink tone with their RGB parameters, C_1(177, 216, 86) and C_2(219, 81, 109), were specified for this design (shown as Figure 2). Designer A intended this design felt sour, sweet and a little spicy for the accordance with the real pickle inside. The color area ratio of C_1 and C_2 is 0.4 versus 0.6. Through the proposed image evaluation model, the taste-image similarity result was calculated in Table 1. It shows that the sour and sweet images is nearest to medium degrees (the corresponding intensities 0.90 and 0.87), and the spicy image is nearest to medium low degree (intensity 0.86). Therefore, the designer might check whether the evaluation meets his/her image goal and modify the color setting.

Figure 2 Taste-based color design for the package of pickle

Figure 3 Olfaction-based color design for the package of Taiwanese high mountain tea

Table 1 Taste-image similarity of case 1

Linguistic variables	sour	sweet	bitter	spicy	salty
Very Low	0.10	0.11	0.17	0.16	0.20
Low	0.38	0.39	0.64	0.59	0.75*
Medium Low	0.74	0.77	0.80*	0.86*	0.68
Medium	0.90*	0.87*	0.54	0.57	0.45
Medium High	0.68	0.65	0.40	0.43	0.34
High	0.54	0.52	0.32	0.35	0.27
Very High	0.47	0.45	0.28	0.30	0.24

3.2 Case 2: Color design for the package of olfaction-related merchandise

The second case was the color design for olfaction-related package. The Taiwanese high mountain tea was chosen as the subject. Three-color combination is required for this design. The B designer specified these three colors with the RGB values as (221,233,187), (163,206,81) and (56,52,49), shown as Figure 3. Then the olfaction-image similarity was calculated and the result indicated that the images of fragrant and fresh are higher (medium intensity) than those of the other three olfactory adjectives, stinky, offensive and pungent (medium low, low, and medium, respectively).

3.3 Case 3: color design for the food package considered with its taste and olfaction

The third color design considered both taste and olfaction images. An durian gift package with the three-color combination was chosen as the objective product. The present RGB setting are (233,170,77), (225,252,200) and (110,71,44), shown in Figure 4. The C designer intended the color design felt sweet and fragrant images. The calculated result showed that the fragrant image is the highest, but the sweet image is medium low. Therefore, it revealed that the current color design should be appropriately modified to meet the sweet image requirement.

Figure 4 Taste and olfaction based color design for the durian gift package

4. Conclusion

Color plays a key role for customers in determining what they like or dislike. Although many of the tasks performed by a designer at the color-planning design stage involve the consideration of user's perception of the package's color, very few computer-aided design systems are available to support these design activities. A quantitative evaluation method based on the RGB (i.e. R(Red), G(Green) and B(Blue)) color system is proposed in this article. The proposed model helps designers to diagnose their color design and to recognize the tendencies about the taste and olfaction images. Thus, the color scheme might be redesign for several times towards the desired taste and olfaction images.

5. Reference

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6. 成果自評

(1) 本研究完成色彩味覺與嗅覺之意象調查，並建立單色與多色色彩之味、嗅覺語彙意象之模糊評價模型，續應用此方法於三個味、嗅覺產品的模擬配色案例，藉由可靠度實驗，以驗證其應用之可行性。研究成果符合原計畫第一年之預期目標。

(2) 具色彩配色需求之味、嗅覺相關商品可適用之。

(3) 本年度研究成果擬於 2009 年 9 月在澳洲雪梨舉辦之四年一度的 AIC (International Colour Association) Congress 中發表。亦擬於 2008 年底投稿至設計相關之 SCI 期刊。

附件二

可供推廣之研發成果資料表

□ 可申請專利　■ 可技術移轉　日期：97年7月31日

國科會補助計畫	計畫名稱：電腦輔助色彩味覺與嗅覺意象之調和配色研究（I） 計畫主持人：　蔡宏政 計畫編號：NSC 96-2221-E-343-005 學門領域：人因工程與工業設計
技術/創作名稱	色彩味、嗅覺意象評價系統
發明人/創作人	蔡宏政
技術說明	中文： 本研究旨在探討色彩味、嗅覺意象感知程度，並透過三角模糊數、模糊整體效用值與模糊效用相似度進行量化計算，進而建立一個色彩味、嗅覺配色之意象評價配色模式。因此，本研究所架構之自動化設計系統，將可以協助設計師快速模擬產品色彩組配並評價其整體色彩之味、嗅覺意象值。
	英文： This study aimed at exploring color psychological perception about taste image and olfaction image. Through the quantitative methods of fuzzy numbers, fuzzy total utility values and fuzzy utility similarity, a color-combination evaluation model was built based on the taste/olfaction image perception. The experimental results indicated the following assumptions. The automatic design system proposed in this study enables designers to rapidly simulate the designed colors of a product and then obtain its corresponding taste and olfaction image evaluation.
可利用之產業及可開發之產品	具色彩配色需求之味、嗅覺相關商品。(例如，包裝色彩設計、產品色彩設計、企業形象設計、展示設計設計、或室內色彩設計等)
技術特點	1. 可結合 3D CAD 軟體進行配色模擬。 2. 以「語彙意象」與「色彩味、嗅覺」為基礎的配色評價系統。
推廣及運用的價值	優良的產品色彩味覺與嗅覺配色，可增加消費者對產品內容的瞭解與滿意度，強化產品的競爭力。

※　1. 每項研發成果請填寫一式二份，一份隨成果報告送繳本會，一份送　貴單位研發成果推廣單位（如技術移轉中心）。

※　**2. 本項研發成果若尚未申請專利，請勿揭露可申請專利之主要內容。**

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