

# Color Matching Method of HCI Interface Design Driven by Aesthetic Perception

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## ABSTRACT

A method of human-computer interface color design based on aesthetic feeling is proposed, which provides a basis for the design practice in accordance with users' aesthetic preference. Taking the mobile interactive terminal interface of intangible cultural heritage display as an example, the color matching of Cloisonne, a traditional Chinese craft, was selected as the primary color, and the colors were extracted by *k-means* clustering algorithm to form four groups of color matching samples. Secondly, the interface element model is constructed, and the matching relationship between color matching samples and interface interaction elements is established and applied. Thirdly, the network text analysis method ROST was used to extract the perceptual image semantics of interfaces, and the four groups of interfaces were subjectively evaluated to obtain the optimal scheme and verify the effectiveness of the proposed color matching method. The results show that the aesthetically driven color design method is beneficial to improve the information transfer and aesthetic experience of human-computer interaction, and promote the creative transformation of intangible cultural heritage in digital mobile media.

**Keywords:** Human-computer interface, Ergonomics design, Color design method, Perceptual image, Aesthetic evaluation

## INTRODUCTION

Mobile media interactive interface is an important carrier to display cultural heritage, and users put forward higher requirements for the visual effect and user experience of interactive interface design. The interface design that conforms to human visual cognition and operation habit can improve operator's pleasure. Color scheme has a strong influence on aesthetic experience, and color matching style consistent with content is the key factor to realize users' emotional needs. Taking cloisonne intangible cultural heritage display interface as an example, this paper studies the hierarchical color combination, analyzes the optimal color scheme combined with perceptual image, and applies it to the visual expression of mobile terminal media human-computer interaction interface.

## LITERATURE REVIEW

As for the influence of human-computer interface color on visual perception, scholars at home and abroad have studied different color matching methods. Ahlstrom and Arend (2005) used hierarchical lightness coding to improve the design and analysis of the display interface of aviation fighters. Dennis (2008) pointed out that the perceptual hierarchy of color structure can constitute visual superiority, and the hierarchical color combination of lightness, hue and saturation can promote visual attention to information capture and importance ranking. In terms of the influence of the color coding method of the human-computer interaction interface on the user's visual cognitive performance, Xue et al. (2015) found that on a black background, with the increase of the color difference between the target and the background, the reaction time showed a trend of slowing down. The current research are mainly focused on digital interfaces in complex industrial systems, while the display of intangible cultural heritage needs to considering aesthetics functionality.

## CHARACTERISTIC ANALYSIS OF CLOISONNE COLORING STYLE

Cloisonne, a kind of utensil, is the essence of China's intangible cultural heritage, which contains strong traditional Chinese color characteristics and coloring styles. The main color characteristics of cloisonne is bright and gorgeous, with the traditional Chinese five colors: blue, yellow, red, white and black as the main color changes. Classical cloisonne is mostly saturated color with high purity and light color substrate, mostly blue and yellow contrast colors and less green and red, then use other colors with high brightness and purity to decorate the picture, widely distributed and dense in a small area (Kırmızı, Colombari and Quette, 2010). Cloisonne color has the richness of color contrast relationship under the pursuit of uniform color structure, giving people a lively sense of color (Quette, 1999), enhancing people's visual experience and aesthetic experience, it provide a good paradigm for the human-computer interaction interface color matching method.

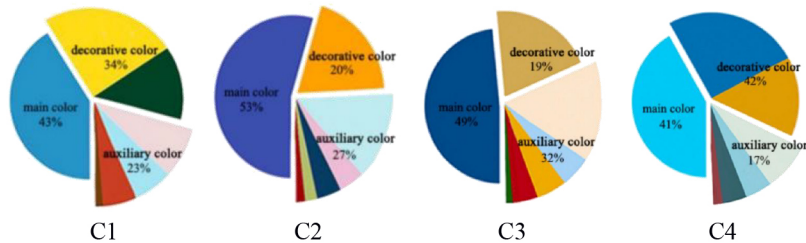
## COLOR SCHEME EXTRACTION AND CLASSIFICATION

Four typical blue-based low-black and medium-color cloisonne samples are selected, contained enamelled eight lion pattern in copper tire (C1), enamelled four-seas life bottle (C2), enamelled Domu kettle with copper tire (C3), and drawing of enamelled mountain penholder (C4). Each group has rich hues and 7–8 different color biases. The k-means clustering algorithm is used to extract the coloring styles and distribution statistics of cloisonne cultural relics, pre-determined K value to achieve the main color extraction needs (Mignotte, 2008)  $K = 7$  (see Figure 1).

The color composition of the four samples can be classified into three types: main color, auxiliary color and decorative color. The main color affects the color style of the whole picture, accounting for about 50 % of the whole picture color. Usually, high saturation color is more suitable for use as



**Figure 1:** Samples color extraction.



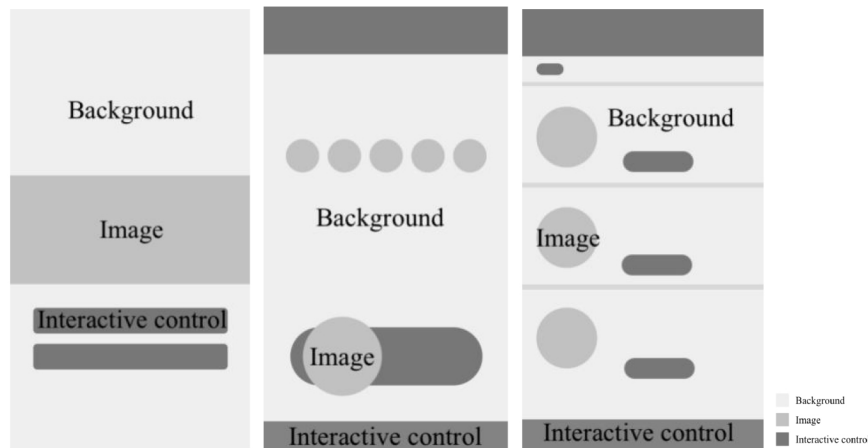
**Figure 2:** Hierarchical color combination in cloisonné samples.

the main color. The auxiliary color has a slightly higher brightness than the main color, which usually accounts for about 30 % of the picture. Decorative color usually accounting for less than 20 % of the picture (Peter, 2003). The observation samples can draw the following conclusions. The four groups of samples are composed of blue system as the main color, bright gray and other colors as auxiliary colors, yellow green and blue as decorative colors. Among them, auxiliary colors and decorative colors are more flexible. According to this classification method, four groups of sample colors are classified (see Figure 2). Hierarchical color combination is an effective method to integrate complex color information, which is helpful for the rational arrangement of interface information levels (Van, 2001).

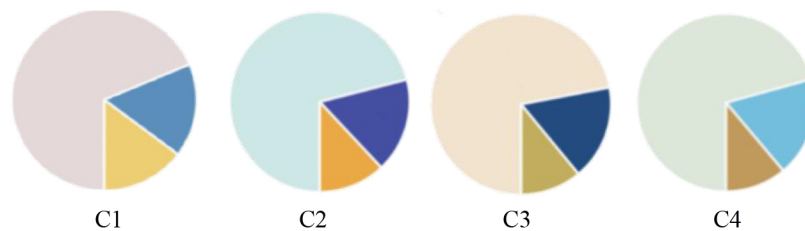
## DESIGN OF INTERFACE MODEL

Human-computer interface interaction elements include background, interactive controls, and image views, the layout of relevant elements is designed according to the content displayed by Cloisonné (see Figure 3). It is concluded from the figure that the amount of background color of the interface is about 69% or more of the whole. The color consumption of image view is divided into two categories: picture and text, which should be controlled within 18% of the whole interface, while the amount of interactive control color is usually 13%.

The background color of the cloisonné interface is bright gray or white, with the function of harmonizing and unifying visual elements. Interactive control with high saturation high black, eye-catching color, conducive to



**Figure 3:** Cloisonne interactive interface layout design.



**Figure 4:** Interface color scheme.

interaction, image color lightness between background and interactive control. According to the requirements of the interface design elements and sample color matching relationship. The color of interactive controls in the interface should be consistent with the primary color in the sample, and the background color in the interface should be consistent with the auxiliary color in the sample. The image color is required to match the decorative color in the sample. According to the uniform principle of interface coloring, the main colors of the interface are no more than three tones (Van Den Broek, Kister and Vuurpijl, 2004). Therefore, the color scheme is adjusted according to the above analysis (See Figure 4). Each group selects three colors that conform to the color characteristics. The amount of background color, image, and interactive control color is 69%, 18%, 13% respectively.

Apply the color scheme to the cloisonne interface to form four sets of interface samples (see Figure 5). Although the four schemes show differences in hue, they all use a bright color as the background color. The interactive controls use highly saturated colors, and the images use bright and gorgeous decorative colors to highlight the traditional coloring style and aesthetic characteristics.



Figure 5: Cloisonne interface color matching model.

## AESTHETIC EXPERIENCE TEST OF INTERFACE COLOR

Interface color beauty is an important index to measure aesthetic experience. Interface color beauty image reflects users' perceptual cognition and demand, but perceptual demand has the characteristics of fuzziness, dynamics, complexity and induction (Bertelsen, Petersen and Pold, 2004). Therefore, the test extracted six color perceptual image semantics through the analysis of network text data, established the mapping relationship between image semantics and interface color and scored them, and used Pearson coefficient correlation analysis to select the optimal color scheme.

**Table 1.** Words frequency analysis of image semantics on interface.

Serial number	Words	Frequency
1	Elegant	156
2	Sophisticated	148
3	Ordered	140
4	Color	104
5	Charming	100
6	Creative	84
7	Aesthetic	60
8	Interface	53
9	Succinct	52
10	Tradition	46

### Image Semantic Selection

The representative intangible cultural heritage mobile interface is selected as the design example, and the network text analysis software ROST is used to capture the data of the core nodes of “ interface color matching “, “ Chinese traditional color “, “ emotion “ and “ aesthetics “. A total of 89 effective image semantics are extracted and the word frequency is analyzed (see Table 1). The six characteristic words with the most frequency are selected, namely Elegant, Sophisticated, ordered, charming, Creative, and Succinct, to form the typical color perceptual image semantics of the cloisonne interface, Since the experiment was conducted in Chinese, the above terms are generalized and don't cover all these definitions. Then we carry out subjective evaluation for target users, and obtain the consistency between the interface color and the user's aesthetic cognition degree.

At the same time, four industry experts were invited to conduct open-ended interviews, and combined with relevant literature and materials, they made authoritative interpretations of these six terms (see Table 2). In order to facilitate subsequent experiments, testers will be familiar with the following information before the experiment starts.

### The Mapping Relationship Between Image Semantics and Interface Color

The subjects selected fifty-one adults aged 20-60 who were healthy and had normal color vision. Subjects were asked to subjectively evaluate the interface from six aspects: Elegant, Sophisticated, ordered, charming, Creative, and Succinct, SPSS 22.0 was used for data analysis (see Table 3). The Pearson correlation coefficient values between image semantics and color samples.

When the correlation coefficient is between 0.1 and 0.3, it is generally considered that there is a weak correlation between variables; when the correlation coefficient is between 0.3 and 0.5, it is generally considered that there is a moderate correlation between variables; when the value of the correlation coefficient is greater than 0.5, it is generally believed that there is a strong

**Table 2.** The interpretation of image semantics

semantic	Description example (Explanation)
Elegant	Use the aesthetic characteristics of Chinese art to show the beauty
Sophisticated	Analyze the complexity and advocate the integration of simplicity
Ordered	Standardize the arrangement and respect the principles of design
Charming	Consider human factors and focus on empathy to enhance interactivity
Creative	Solve conflicts according to needs and design products satisfied users
Succinct	Abandon unnecessary decorative to reduce visual redundant information

**Table 3.** Correlation values between image semantics and color samples.

Sample	Elegant	Sophisticated	Ordered	Charming	Creative	Succinct
C1	0.454*	0.334*	0.193	0.343*	0.287	0.264
C2	0.368*	0.289	0.527**	0.427*	0.114	0.291
C3	0.502**	0.452*	0.284	0.518**	0.334*	0.222
C4	0.446*	0.403*	0.253	0.365*	0.268	0.213

**Figure 6:** Final optimization scheme.

correlation between the variables. The degree of influence of the correlation coefficient is indicated by \*.

Sample C3 has the largest number of correlations with image semantics, and has a positive correlation with 4 image semantics, and has a significant correlation with the feature words “elegant” and “charming”. It shows that the combination of yellow and blue colors of sample C3 can better highlight the color characteristics of cloisonne, and at the same time, neutral and warm colors can make people feel warmer and satisfy users’ psychological feelings.

Sample C3 has no correlation with the imagery words “ordered” and “Succinct”, indicating that sample C3 should also pay attention to the overall color coordination when color matching. The correlation between sample C2 and the semantic “order” of imagery is significant, which means that the same color can be selected in the color matching of the interface, so as to reduce the mixed use of different colors, and ensure that the color scheme has a sense of clarity and information hierarchy.

In order to ensure the accuracy of the test results, the arithmetic mean of the image semantic evaluation values of the four groups of samples is taken. The arithmetic mean values of C1, C2, C3 and C4 are 0.312, 0.336, 0.385 and 0.325 respectively. The average order of the obtained color scheme is basically consistent with the above analysis, namely  $C3 > C2 > C4 > C1$ . Therefore, according to the test results, sample C3 is most in line with the public aesthetics. In summary, the final optimization of sample C3 is carried out (see figure 6).

## CONCLUSION

In order to satisfy users' emotional needs and aesthetic experience, the method of cloisonne interface color design is proposed. The color matching scheme is designed by color extraction and color stratification combination, and the rationality and validity of the color matching scheme is verified by establishing the mapping relationship between perceptual image and color sample. The scheme summarizes the interface coloring methods in line with the public color aesthetics, and realizes the digital protection, inheritance and activation of intangible cultural heritage.

## ACKNOWLEDGMENT

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