Innovative Application of Recombinant Traditional Visual Elements in Graphic Design

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Excellent graphic design can enhance the attractiveness of promotional products. This paper briefly introduces traditional visual elements and their main application methods. Three graphic designs used for promoting Fengxiang painted clay sculpture were analyzed using the analytic hierarchy process method, and a convolutional neural network (CNN) was used for auxiliary analysis. The results showed that the performance of the trained CNN was initially verified in the training set. The comparison between the evaluation results of the three graphic designs and the manual evaluation results further verified the performance of the CNN in aiding the evaluation of the graphic design. All three graphic designs proposed in this paper effectively deconstructed and recombine the traditional visual element, "painted clay sculpture", enhancing its attractiveness.

Povzetek: Za iskanje atraktivnih grafičnih predstavitev so uporabili metodo konvolucijskih globokih mrež.

1 Introduction

In our daily life, we often come into contact with things related to graphic design, such as product packaging, magazine covers, posters and advertisements [1]. The visual experience of these things is the result of careful design, and the ultimate goal is to attract the attention of the public and to convey the designer's intention contained in the graphic design. Through the expression of their intentions to empathize with the audience, new things or concepts can be widely accepted. Graphic design is the combination of text and images in a two-dimensional space according to certain rules, i.e., typography, and then the results of the combination are shown through printing and other means [2]. With the development of technology and design fields, the elements that can be filled in graphic design become more and more diverse. As a form of artistic expression that focuses on visual communication, visual elements are the focus of graphic design. The ultimate goal of graphic design is to make something compelling, so the design process needs to guarantee that the work is unique, especially the visual elements that are directly related to visual communication [3]. China's traditional culture has a long history, and various traditional arts contain visual elements worthy of reference. These visual elements not only provide a new development direction for graphic design, but also facilitate the creation of graphic design works with national characteristics. Shen et al. [4] proposed a method that can measure color harmony and verified the effectiveness of the method through experiments. Yuan et al. [5] proposed a method based on Kansei engineering (KE) and interactive genetic algorithm (IGA), and the results of example analysis showed that the method could obtain a satisfactory color design. Carlos Velasco et al. [6] proposed an experimental method capable of assessing the response of customers to changes in the orientation of various design elements on product packaging, such as food images. The results highlighted the complex relationship between preferences and willingness to pay and raised some questions about the role of orientation in visual aesthetics, preferences and perceived value. The paper briefly introduced traditional visual elements and the main ways they are used and analyzed three graphic designs used for promoting the Fengxiang painted clay sculpture.

2 Traditional visual elements and reorganization

2.1 Visual elements

Visual elements are an important part of visual communication in graphic design. Visual elements have various types, but they can be generally categorized into three types: composition and pattern, color, and text [7]. Composition and pattern reflect the style of graphic design. Graphic designs will use abstract means to express the specific product content [8]. Especially now that computer technology is commonly used, it is possible to build abstract visual effects through various irregular geometric texture patterns to visualize the connotation of goods that are difficult to describe with words. In addition, graphic design will also use painting, cartoon and exaggerated deformation to enhance the expressiveness of the pattern [9]. Color matching highlights the spirit of a graphic design program. When a viewer appreciates or

stumbles upon a graphic design, the color of the graphic design will first come into the scope of observation. Reasonable color matching can first attract the attention of the audience [10]. Text description directly reflects the essential content of a graphic design. Texts can play a decorative role. Chinese calligraphy, in particular, is inherently artistic and can be used to decorate graphic design through a variety of calligraphic variants, thus resonating with the audience's imagination [11].

2.2 Application of traditional visual elements

The application of visual elements in graphic design is closely related to market competition. The uniqueness of visual element design can effectively distinguish one's products from other products. Traditional culture with a long history provides a new direction for selecting visual elements in graphic design, adding a unique national character to graphic design [12].

Traditional visual elements are visual elements extracted from traditional culture and have distinctive characteristics of Chinese culture. Traditional visual elements with specific images include dragon, Kylin, Chinese painting, facial makeup, pottery, etc. In addition, there are also many visual elements without specific images but with distinct Chinese cultural contexts. The traditional visual elements with specific images often have been processed before applications [13].

The application method of traditional visual elements is shown in Figure 1, including the simplification, deconstruction and reorganization, replacement and isomorphism of traditional visual elements. The simplification of traditional visual elements is a common means in graphic design. The simplified traditional visual elements can reflect the designer's ideology more intuitively, which is not only in line with the eye-catching purpose of modern graphic design but also can be more compatible with other elements [14]. The deconstruction and reorganization of traditional visual elements are to rearrange and combine different visual elements to obtain new visual elements. Since the deconstruction and reorganization are based on the original elements, they give the audience a new visual impact while preserving the traditional cultural context. The replacement of traditional visual elements means replacing the original visual elements with other visual elements in nature according to some connection in the structure of graphic design [15]. Isomorphism of traditional visual elements and modern visual elements is to connect similar traditional visual elements and modern visual elements to obtain a more logical imagination effect [16].

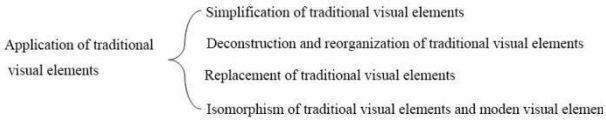

Figure 1: The way of applying traditional visual elements.

Figure 2: Three graphic designs.

3 Example analysis

3.1 Object of analysis

Fengxiang painted clay sculpture is a traditional folk art in Fengxiang District, Baoji City, Shaanxi Province, also known as clay goods by the locals. The craft of clay sculpture can be traced back to the Spring and Autumn Period and the Warring States Period when clay sculptures were used as funerary objects. Fengxiang painted clay sculptures are mainly produced in the Sixth Battalion Village of Chengguan Town. A story is going around that soldiers from the sixth battalion of Zhu Yuanzhang's army in the Ming Dynasty were stationed in a place and turned to be residents and they were engaged in the craft of pottery making and developed pottery as a local specialty. Fengxiang painted clay sculpture has become a unique fine art of folk art in modern times. Fengxiang clay sculptures are exaggerated in shape and colorful.The ornamentation of Fengxiang clay sculpture draws on stone carving, paper cutting and other arts. It was included in the Chinese intangible cultural heritage list on May 20, 2006. In order to better promote this folk craft and better inherit and protect it, it is necessary to promote Fengxiang clay sculpture accordingly. Figure 2 shows the three graphic designs of the brochure and poster for Fengxiang clay sculptures.

3.2 Evaluation methodology

The evaluation of graphic design is a rather subjective personal feeling. Even the same work may give different feelings to different people at different times. In addition, when facing a large number of designs, it is inefficient to rely on one person alone to evaluate and select, but the participation of multiple people will reduce the credibility of the evaluation due to the subjectivity of personal feelings. Intelligent algorithms have high processing efficiency and can imitate human thinking patterns. The imitation can be regarded as a single individual's evaluation of a large number of designs.

This paper uses the CNN algorithm that has a wide application in image recognition to evaluate graphic designs. The basic structure of CNN includes the input layer, the convolutional layer, the pooling layer and the output layer [17], as shown in Figure 3. The graphic design was input into the input layer. The convolutional layer convoluted the graphic design with convolution kernels to extract characteristics of graphic images. The pooling layer compressed the convolutional feature map by pooling to reduce the number of operations. After

repeating the convolution and pooling operations several times, the evaluation results were output in the output layer.

Before evaluating graphic designs with the CNN algorithm, the algorithm was trained with training samples. The flow of the algorithm in the training was almost the same as described in the last paragraph, and the difference between them was that the output results were compared with the expected results of the training samples. The gap between the output results and expected results determined whether to stop the training or reversely adjust the algorithm parameters [18]: when the gap converged to within the set range, the training was stopped; when the gap exceeded the set range, the algorithm parameters were adjusted reversely in accordance with the gap, and the stochastic gradient descent method was used in this paper.

The relevant parameters of CNN are as follows. Its structure was two convolutional layers, one pooling layer, two convolutional layers and one pooling layer. There were 16 convolution kernels in a size of 2 × 2 in the convolutional layers. There were mean-pooling boxes in a size of 2 × 2 in the pooling layers. Sigmoid was used as the activation function. The size of the image input to the input layer was 800 × 600. The training samples and test samples were in the format of jpg.

Among the samples used for training and testing, in addition to the graphic design, every design had a corresponding evaluation label. These labels were manually labeled. Graphic designs within the samples used for training and testing came from various promotional schemes for local painted clay sculptures in the market. One thousand samples were collected, of which 70% were used as training samples and 30% as testing samples. The formula for measuring the performance of the algorithm using the test samples is:

$$\begin{cases} P = \dfrac{TP}{TP + FP} \\ R = \dfrac{TP}{TP + FN} \\ F = \dfrac{2PR}{P + R} \end{cases}, \quad (3)$$

where P is the precision rate, R is the recall rate, F is the average accuracy after blending the precision rate and recall rate, TP denotes the number of positive samples that are judged as positive by the algorithm, FP denotes the number of negative samples that are judged as positive by the algorithm, FN denotes the number of positive samples that are judged as negative by the algorithm, TN denotes the number of negative samples that are judged as negative by the algorithm.

After training and testing, the three graphic designs proposed in this paper were evaluated, and the evaluation results were compared with the manual evaluation results. The evaluation labels of the training and testing samples were labeled in the same way as the manual evaluation, i.e., using the analytic hierarchy process (AHP) method [19]. The hierarchical structure of the evaluation of the reorganization effects of traditional visual elements in graphic designs is shown in Figure 4. The highest layer was the reorganization effect of traditional visual elements

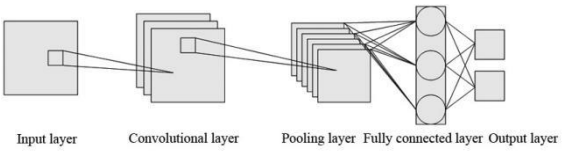

Figure 3: The basic structure of CNN.

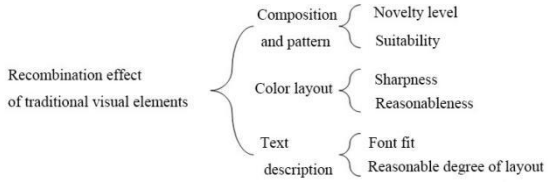

Figure 4: Hierarchy for evaluating the effect of reorganization of traditional visual elements.

in graphic design, i.e., the final evaluation result. The intermediate layers were composition and pattern, color layout and text description, and the target layers under the intermediate layers are shown in Figure 4. In the AHP method, in addition to collecting the scores of the target layer items through questionnaires, it was more important to set the weight of the layers. This paper constructed hierarchy weights by information entropy, and the corresponding formulas are as follows:

$$\begin{cases} E_j = -\dfrac{\sum_{i=1}^{n} p_{ij} \ln p_{ij}}{\ln n} \\ p_{ij} = \dfrac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \\ \omega_j = \dfrac{1 - E_j}{m - \sum E_j} \end{cases}, \quad (2)$$

where E_j stands for the information entropy of indicator j, x_{ij} stands for the standardized data of the j-th indicator of sample i, p_{ij} stands for the proportion of sample x_{ij} in all the data of indicator j, n is the number of samples, ω_j is the weight of indicator j, and m is the number of indicators. The above indicators are six indicators in the target layer in the AHP method.

After the weights of the layers were determined, the survey content of the questionnaire was designed according to the items of the target layers. Ten experts who had been engaged in graphic design for more than five years rated the graphic designs using a ten-point scale. The average score was used as the final result of the evaluation.

3.3 Analysis results

The test set was tested using the trained CNN algorithm, and the final evaluation performance is shown in Figure 5. The CNN algorithm had a precision rate of 97.6%, a recall

rate of 97.3%, and an F-value of 97.5% for scoring the graphic designs. The analysis of the precision rate, recall rate and F-value of the CNN algorithm in Figure 5 showed that the CNN algorithm had good accuracy, i.e., a high precision rate and a recall rate for evaluating graphic designs, and the high F-value further illustrated the stable comprehensive performance of the CNN algorithm for evaluating graphic designs.

The scores of the three graphic designs for promoting the Fengxiang painted clay sculpture were collected from the ten experts. The average scores are shown in Table 1, which also includes the scoring results of the CNN algorithm. The final decision layer of the AHP method was the final score of the graphic packaging design. The final score of design (1) given by manual evaluation was 7.18, and the final score of design (1) given by the CNN algorithm was 7.02. The final score of design (2) given by manual evaluation was 8.25, and the final score of design (1) given by the CNN algorithm was 8.09. The final score of design (2) given by manual evaluation was 7.58, and the final score of design (1) given by the CNN algorithm was 7.73. The reason for the small difference in the final scores between the three graphic designs is that they were all designed to promote the local painted clay sculptures, i.e., the difference in the overall composition was small. In addition, the comparison of scores between the manual evaluation and the CNN algorithm showed that the CNN algorithm only differed from the manual evaluation in one aspect, and the final score given by the CNN algorithm was similar to the actual score of the manual evaluation, which further verified the effectiveness of the CNN algorithm for graphic design evaluation.

3.4 Discussion

This paper describes the application of the reorganization of traditional visual elements in graphic design and presents an analysis of three graphic designs for promoting the Fengxiang painted clay sculpture. The AHP method was used in the example analysis. The recombinant traditional visual elements to be evaluated in the graphic design were divided into three intermediate layers: composition and pattern, color layout and text description. Every intermediate layer was divided into two target layers, and the target layers were scored using questionnaires. Finally, the evaluation scores were summarized. In addition, in order to improve the evaluation efficiency of graphic designs and reduce the consumption of manual evaluation, the CNN algorithm, an intelligent algorithm, was used to assist in the evaluation. The obtained results were compared with those of manual evaluation, and the final results have shown above. The CNN algorithm trained with the training set got good test results, which initially verified the evaluation effect of the CNN algorithm on recombinant traditional visual elements in graphic design. After that, the CNN algorithm was applied to evaluate three graphic designs, and the results were compared with the results of manual evaluation. The final results further verified the evaluation effectiveness of the CNN algorithm on recombinant traditional visual elements in graphic design.

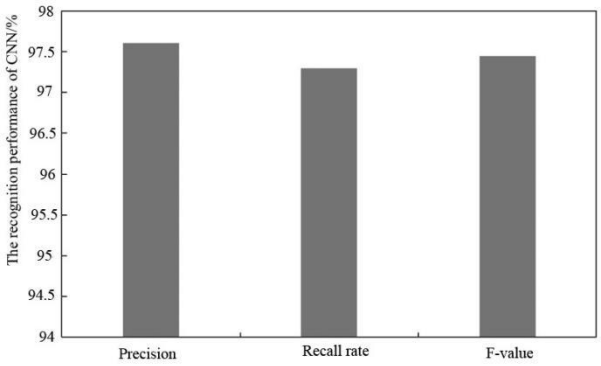

Figure 5: Performance of the CNN algorithm for evaluating graphic designs.

Middle layer	Composition and pattern		Color layout		Text description	
Weight	0.3		0.4		0.3	
Target layer	Novelty level	Suitability	Sharpness	Reasonableness	Font fit	Reasonable degree of layout
Weight	0.4	0.6	0.4	0.6	0.5	0.5
Design (1) (Manual)	7	8	7	7	8	6
Design (1) (CNN)	7	8	6	7	8	6
Design (2) (Manual)	8	8	9	9	9	6
Design (2) (CNN)	8	8	8	9	9	6
Design (3) (Manual)	9	8	8	7	8	6
Design (3) (CNN)	9	8	8	7	8	7

Table 1: Questionnaire results of three graphic designs.

According to the results of the questionnaire survey in the AHP method and the evaluation results of the CNN algorithm, the three graphic designs were analyzed in detail. Design (1) used red as the main color, which was quite eye-catching in tone. In terms of composition and pattern, the background of design (1) adopted the fish scale pattern of pottery decoration, which increased the sense of depth and strengthened the impression of "porcelain". The non-background composition appeared to be a mask at first glance, but it was actually an abstraction of the head front of a painted clay figure in the shape of a rooster. The main element, the head front of the

painted clay sculpture of a rooster, was retained. The flattened head front instead of the entire shape of a rooster was used as the main composition and filled with other clay sculpture-related elements. As to the text description, there were three text strings in a vertical layout, one was "Fengxiang painted clay sculpture" in "SimYou" font, one was the pinyin of "Fengxiang painted clay sculpture", and one was "Fengxiang clay sculpture" in Hui font, and a cloud was added to the right of the word "Xiang" as a decoration. The three text strings in vertical layout directly indicated the content of the graphic design, and "Fengxiang clay sculpture" in Hui font also served as an attractive decoration.

In terms of composition and pattern, design (2) also used the fish scale pattern in the background, which had the same effect as described above. The non-background composition also appeared to be a mask at first glance, but it was an abstraction of the head front of a "dog" in the painted clay sculpture. Similar to design (1) described above, the flattened head of a "dog" was used as the main composition and filled with some other elements. In terms of color, this design used the color of green tile as the main color, which was not as eye-catching as red, but this color gave people a sense of bluestone. In terms of textual description, it was consistent with design (1).

In design (3), the background also used the fish scale pattern. The non-background composition was not the same as the animal clay sculpture used in the above two designs, but a traditional visual element, "kite", was used and filled with the element of painted clay sculptures. In terms of color, the light cyan color was chosen to match the "kite" element. The textual description was the same as that of design (1).

Fengxiang painted clay sculptures have a variety of shapes, the most common of which are the twelve Chinese zodiac signs. Since they are "painted", they are colorful in appearance. The three graphic designs analyzed in this paper deconstructed and recombined the traditional visual element, "painted clay sculpture". Designs (1) and (2) deconstructed the frontal images of the head from rooster and dog sculptures and recombined them by filling some colors. The main image in design (3) did not apply the head shape of the clay sculpture, but adopted "kite" as the main composition and filled it with the color and composition elements of the painted clay sculpture, realizing the reorganization of two traditional visual elements, "kite" and "clay sculpture".

4 Conclusion

This paper briefly introduced the traditional visual elements and their main applications and analyzed three graphic designs used for promoting the Fengxiang painted clay sculpture. The AHP method was used, and the CNN algorithm was used for auxiliary analysis. The results are as follows. The trained CNN algorithm had a precision rate of 97.6%, a recall rate of 97.3% and an F-value of 97.5% in evaluating the samples in the test set. The difference between the scores obtained using the CNN algorithm and the AHP method was not significant, which verified the effectiveness of the CNN algorithm in assisting graphic design analysis. The analysis of the three graphic designs by manual evaluation and the CNN algorithm showed that the three graphic designs effectively deconstructed and recombined "painted clay sculpture", which improved the attractiveness of painted clay sculptures.

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