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Children's Education APP Color Matching Design Method Based on ACGAN

Ying Nie[1,*], Xian Zhou[2], Yongzheng Tie[1]
[1]*School of Mechatronic Engineering, Xi'an Technological University, Xi'an, Shaanxi, China*
[2]*School of Design, Xi'an Technological University, Xi'an, Shaanxi, China*
**Corresponding Author.*

Abstract: To achieve automated color scheme generation and enhance design efficiency and creativity, a method utilizing Auxiliary Classifier Generative Adversarial Networks (ACGAN) is proposed to assist designers in creating color schemes for early education APP interfaces. Firstly, interface samples from multiple successful early education APPs are collected, ensuring they are representative in terms of color pairing and thematic styles, and an excellent color scheme dataset is established. Secondly, the actual needs and preferences of children towards color schemes are identified, resulting in a target color sample set with six basic hue categories as labels. Then, an ACGAN model is constructed and trained on this target color sample set to obtain an automated color scheme generator that can produce color designs for early education APP based on the selected hue.

Keywords: Auxiliary Classifier Generative Adversarial Network; Early Education App; Color Psychology; Child Psychology

1. Introduction

With the promotion of the Internet and other new technologies, the State has introduced a series of policies to encourage the development of the new business mode of "Internet + Education". In today's digital era, early education apps have become an important tool for many children's enlightenment education due to the diversity of topics covered and the innovative content. International studies have shown that using smart mobile devices and their accompanying educational apps can revolutionize the learning experience of young children [1]. Interface color scheme plays an important role in children's early education apps, directly affecting children's mood, attention, learning effect and user experience. Traditional color matching design methods are often based on designers' subjective experience and aesthetic concepts, and lack of scientific and systematic nature. The ACGAN model combines the advantages of generative adversarial networks and auxiliary classifiers, and is able to generate more creative color matching schemes. By introducing the ACGAN model, the color scheme design of children's early childhood education APP can get more inspiration and choices to enhance user experience and learning effect.

2 Relevant Research

2.1 Research Status of Color Research on Children's Early Education Apps

Children's education APP covers children's learning, entertainment, life and other aspects, is an important way to guide children's cognitive development, has become the main way of their extracurricular life, learning and entertainment. In recent years, several scholars have conducted research on the application of color in the APP interface. Bi et al. [2] believe that education APP, as a new type of teaching resource, presents unique advantages in teaching with its features of intelligence, convenience and real-time interaction. For example, Fu [3] argued that the design of the interactive interface of early education APP has the greatest correlation with the visual aspect of preschool children's perception. Wang et al. [4] found that the application of children's preferred colors and combinations can stimulate the motivation and initiative to use the APP. Yu et al. [5] combined color and games to develop children's color discrimination, cognitive ability and color matching ability.

As can be seen from related studies, more and more scholars have studied the influence of color on children's cognition, but there is a relative lack of research on the design method of color matching for the interface of early education APP. For preschool children, the use of color can increase the efficiency and accuracy of information communication. Color can improve the reproduction of early education content in the real world and reduce children's cognitive obstacles and learning burden.

2.2 Research Status of Color Matching Design Methods

The research of color matching design methods mainly focuses on the operational techniques of evaluation, decision-making and generation of color matching schemes, in which various types of intelligent algorithms are widely used in this field. Zhang et al. [6] proposed a color matching evaluation method for the interface of ASD child intervention APP based on the PCCS color system, which improves the objectivity and scientificity in the design evaluation process. Lyu et al. [7] applied the ACGAN model to generate a color scheme for an animated character, and the results showed that the color matching degree of this model was higher than that of other models.

Through the above research, it is found that the ACGAN model has significant advantages in the field of improving the quality of image generation as well as image recognition, and has potential application value in the field of color matching generation. Therefore, this paper will apply the ACGAN model to color matching design for early education APP, aiming to improve the design efficiency and quality. Scientific and systematic guidance is provided for designers to ensure the quality and effect of the interface design of the early education APP.

3. Research Method

ACGAN is a new variant of Conditional Labeling GAN based on GAN proposed by Odena A et al. [8], which aims to add labeling constraints to improve the quality of the generated images. This property makes ACGAN very suitable for generating image data with class-specific attributes, and the main color phase of the interface color scheme of the Early Learning App is multiple classes. Therefore, the ACGAN model is adopted as the basic framework, as shown in Figure. 1. The framework mainly consists of a generator G and a discriminator D. The generator receives random noise vectors and category labels as inputs and outputs a color combination. The discriminator receives two kinds of inputs: a fake color combination and its label from the generator, and a color combination and its label from the real data set. After the discriminator determines whether it is true or false, the result is fed back to the generator, which modifies the model parameters and eventually generates a more realistic color combination to fool the discriminator. The discriminator needs to determine both whether the input color combinations are real and which category they belong to.

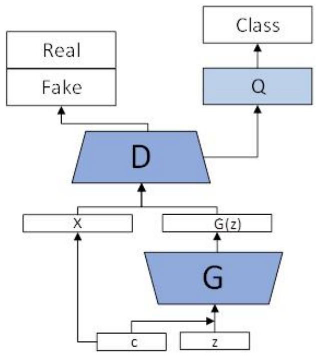

Figure 1. ACGAN Network Model

The output of the generated model G constitutes a matrix containing 9 color arrays, each of which further consists of values representing the red (R), green (G), and blue (B) channels, resulting in a 9x3 array structure. This can be visualized as a 3x3 pixel picture where each pixel is defined by its corresponding RGB value.

4 Experiments and Analysis of Results

4.1 Constructing the Target Color Sample Set

4.1.1 Collecting data

The purpose of this paper is to build a model that can quickly generate an early education APP interface color scheme according to the color preference selected by the designer. The palette provided by the model contains 9 colors, and the algorithm model for the coloring part will use a generative adversarial network to learn from existing early education APP interface color schemes. Therefore, a large number of visually organized color palettes with high color quality and sorted by color preference should be used as learning samples, and the number of colors in these palettes should be no less than 9.

Through investigation of Huawei App Store, Xiaomi Store, Apple App Store, Google and other app stores, it was found that there are mainly language training apps, knowledge-guided apps, nursery rhyme training apps, and educational games apps for early education. 200 popular early education apps such as "Song Duoduo" and "Hongen Pinyin" were selected because the homepage interface colors are the most representative and determine the initial impression of users before use. Therefore, the homepage interface colors of the software were extracted, and some interfaces, as shown in Figure 2, were used. The color of the picture was obtained using an online picture color picker tool and saved locally for easy data access.

Figure 2. Interface of Early Education APP

4.1.2 Obtaining stencil colors that describe color tendencies

Preschool is a key stage in children's growth and development, and color enlightenment education is particularly important currently. Aiming at the visual development and cognitive characteristics of children aged 3 to 6, in order to promote their sensitivity and recognition of color, the color design of early education APP is crucial.

Jiang [9] found that preschool children showed interest in bright, varied colors, such as bright blue, green, yellow, and orange. Yang et al. [10] found that children aged 3-4 years preferred colors in the following order: red, yellow, orange, green, blue, and purple; there was no significant difference between boys' and girls' color preferences. Zhao et al. [11] showed that the order of color preference of 4–6-year-old children was red, blue, yellow, purple, orange and green. Based on the color preferences of children aged 3-6 years and previous literature studies, red, orange, yellow, green, blue and purple were finally identified as the six basic primary hues, as shown in Figure 3.

Figure 3. Color Tendency Template Color

4.1.3 Reclassification of data

After obtaining the color tendency of the template color, by comparing the CIEDE2000 color difference with the template color reordering, which is based on the color difference with according to the color difference with the initial letter and the color difference with the previous color according to a certain mathematical relationship to add up to get a color difference and the final combination of the color bar obtained, as shown in Figure 4.

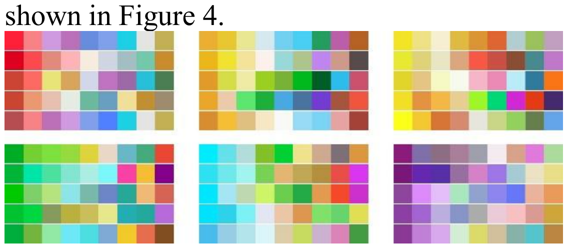

Figure 4. Color Bar Combination

4.2 Training the Color Matching Generation Model

To better compare the generation results of the two models after training, the training of the color matching model adopts the form of adversarial alternate training. For each batch of data, the discriminative model D is trained first, and then the trained discriminative is used to train the generative model G. Therefore, the respective training functions of the two models will be defined separately. The size of the training batch is set to 50, so for each batch of training, 50 color samples will be sampled from the real data as the real dataset and 50 color samples will be generated from the generative model as the fake dataset, so the amount of data passed to the discriminative model for each batch is 100.

The training process of the generative model G will combine the generative model G and the discriminative model D into a Combined Model, and then train this combined model. To ensure the dynamic balance of capabilities between the generative model and the discriminative model, the generative model is trained without training the discriminative model. The forward propagation stage is the same as the generative model, for a random vector z of length 100 and a randomly generated color category c. To ensure that the amount of data for discriminative model training is relative to that of the generative model, the amount of training samples for each batch is set to be 100, which is twice the batch size.

4.3 Analysis of Results

The generated color bar combinations of the trained generative model generate 10 sets of palettes for each color tendency, respectively, as shown in Figure 5. It can be seen from the observation that the uniformity of the generated color palettes is good.

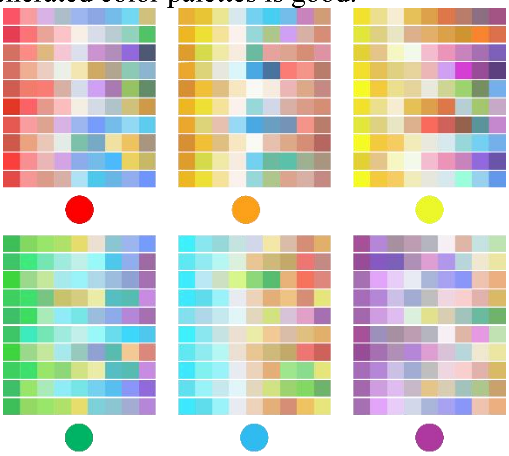

Figure 5. Color Bar Combination Generation Results

5. Conclusion

This paper explores the application of the ACGAN model in the color matching design of children's early education APP. By constructing a color sample set and training the model, various color schemes that meet children's preferences are generated, which enhances the visual appeal of the APP and optimizes the user experience and learning effect. Compared with the traditional color matching design method that relies on designers' subjective experience and aesthetic judgment, the ACGAN model shows a higher scientific and systematic nature. Looking ahead, more advanced network architectures, optimization algorithms, and richer color datasets will be explored with the aim of further expanding the application potential of the model while maintaining its scientific and systematic nature.

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