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Computer-Aided Design AND APPLICATIONS

Development and Implementation of a Colour Matching Teaching System for Art Design

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Abstract. The traditional art design colour matching teaching mode is simple, teaching resources are scarce, and collocation skills are backward, which limits students' innovation ability. Therefore, this paper combines the theory of colour space and computer-aided technology to develop the art design colour matching teaching system. In the system, the k-means algorithm is used to calculate and optimize colour matching, and personalized teaching resources can be recommended for students based on data analysis. The experimental results show that compared with other systems, the proposed system has a higher peak signal-to-noise ratio and structural similarity, the colour ratio is more in line with the actual situation, and the overall performance stability is good. Therefore, in the application experiment, the system in this paper shows a better integration degree and output rate of colour matching information, can show more main colour information, and improve the harmony and unity of colour, to obtain a better colour matching scheme. At the same time, the system can effectively help students improve the learning efficiency of art design colour matching, realize personalized teaching, and greatly improve learning results.

Keywords: Art Design; Colour Matching; Computer Aided; K-Means;; Genetic Algorithm; Deep Learning
DOI: https://doi.org/10.14733/cadaps.2025.S4.138-152

1 INTRODUCTION

At present, the teaching of colour matching in art design still adopts traditional teaching methods to a large extent, focusing on the teaching of colour theory knowledge and the training of colour matching skills. In such colour-matching teaching, there is often a disconnect between theory and practice. Teachers pay too much attention to the teaching of theoretical knowledge while ignoring the cultivation of students' practical abilities [1]. At the same time, due to the lack of opportunities for students to apply theoretical knowledge to practical design projects in the learning process, it is difficult for them to flexibly apply what they have learned in the face of specific design tasks. In addition, teaching resources are one of the important factors affecting the teaching effect of colour matching. However, some schools have the problem of lack of teaching resources, such as old textbooks, cases of lack of innovation and practicability. This makes it difficult for students to access the latest colour-matching concepts and techniques in the learning process, which affects their learning effect and innovation ability [2]. The teaching methods adopted by some teachers in colour-matching teaching are relatively simple and lack diversity and innovation. As a result, the classroom atmosphere is dull and students' interest in learning is not high. In terms of teaching methods, they often use unified teaching standards and requirements to evaluate students' learning outcomes, ignoring students' individual differences and strengths [3].

Facing the challenges brought by the complexity of the environment and the richness of landscape colours, objectively and accurately measuring and analyzing garden colours is particularly important in art and design education. The model utilizes a colour clustering algorithm to decompose complex colour landscapes in traditional Chinese gardens such as Xiangshan Temple into several theme colours and their associated networks [4]. By introducing machine vision and advanced image processing techniques, the CADT Color system can efficiently extract, recognize, classify, and quantify colour information from photos in the building environment. These visual tools provide art and design students with intuitive and in-depth learning materials, helping them understand the role and laws of colour in landscape design. To this end, the combination of machine vision, image processing algorithms, and computer-aided teaching of colour matching in art and design (CADT Color) has brought revolutionary changes to this field [5]. This process is not limited to simple colour recognition, but can also deeply analyze the distribution, intensity, saturation, and relationships between colours, thereby generating detailed colour maps and hierarchical networks. Students can learn the principles and applications of colour clustering through the system, and master how to flexibly use colours in design to create harmonious and layered works. This quantitative analysis method not only reveals the deep-seated rules of colour matching but also provides a scientific teaching basis for the CADT Color system [6]. The CADT Color system can provide students with a virtual design platform, allowing them to preview the effects of different colour combinations before actual operation, greatly reducing design costs and risks. Meanwhile, by comparing and analyzing historical colours with modern aesthetic trends, the system can also provide valuable reference opinions for innovative design of garden colours. Applying the above techniques and methods to the colour design and restoration projects of classical gardens such as Xiangshan Temple not only achieves precise restoration of the original colour style but also injects new design inspiration and vitality into them [7].

Computer-assisted technology is the theory, method and technology that the computer is the tool to assist people in completing tasks in a specific application field [8]. It emphasizes the leading role of humans, and computers and users constitute a system of close interaction between humans and machines. In the teaching of colour matching in art design, the application of computer-aided technology can intuitively display the effect of colour matching, and help students understand colour theory and application skills more quickly and accurately. Compared with traditional colour-matching teaching, computer-assisted technology can provide students with a digital platform and allow students to practice colour matching, modify and adjust at any time, and get immediate feedback, thus improving learning efficiency [9]. Computer-aided technology can also provide a wealth of teaching resources, including online colour libraries, case studies, teaching videos, etc. These resources not only cover basic colour theory knowledge but also contain the latest colour-matching trends and practical skills, which help students broaden their horizons and enhance their innovation ability [10]. At the same time, computer-aided technology can provide personalized learning paths and recommended resources according to students' different levels and needs, providing students with broader creative space and freedom [11]. Therefore, this paper developed an art design colour-matching teaching system combined with computer-aided technology and combined K-means algorithm and genetic algorithm to realize art colour matching and corresponding optimization on the basis of colour space. After that, a personalized recommendation module for art design colour-matching teaching resources is built through a deep learning algorithm, and personalized learning resources and paths are recommended according to students' historical learning data and interest preferences.

2 RELATED WORK

The adaptive extraction model for the main colours in images further simplifies the colour analysis process, enabling students to quickly master the skill of extracting key colour information from complex images, and laying a solid foundation for subsequent colour-matching practices. Exploring smarter and more efficient colour-matching methods is particularly important in the field of computer-aided instruction for art and design colour matching (CADT colour). Luo et al. [12] proposed an improved K-Means algorithm based on contour coefficients and innovatively designed an adaptive extraction model for image-dominant colours, aiming to provide students with a more intuitive and scientific colour learning tool. This improvement not only provides strong technical support for CADT colour systems but also enables students to have a clearer understanding of the composition and distribution patterns of colours during the learning process. By introducing contour coefficients into the K-Means clustering algorithm, Shen et al. [13] effectively improved the accuracy and stability of colour clustering, making the extraction of main colours in images more accurate. This method simulates the human eye's perception process of colour and combines similarity measurement techniques to objectively and comprehensively evaluate colour schemes. The application of the Pix2Pix network model based on visual aesthetics has pushed the CADT colour system to a new height. In order to cultivate students' colour aesthetic ability and innovative thinking, Tembine [14] introduced an art colour scheme evaluation method based on visual perception and similarity measurement. This not only helps students continuously optimize colour schemes in practice but also guides them to deeply understand the aesthetic principles of colour matching and improve their overall design level. Meanwhile, through comparative experiments, it was found that the Pix2Pix model, which integrates visual aesthetics, performs well in terms of average palette similarity, comprehensive evaluation indicators, and colour scheme calculation efficiency, significantly better than traditional methods that do not integrate visual aesthetics. This model can automatically generate colour schemes that conform to visual aesthetic principles based on students' design needs, greatly improving design efficiency.

The application of computer-aided technology in teaching colour matching in art and design is becoming increasingly widespread, greatly improving the efficiency and accuracy of colour matching. Xu and Wang [15] used Adobe Photoshop, Color iMatch, and other software during the color-matching process. Through the powerful performance and tools of the software, accurate measurement and analysis of colour data can be achieved. At the same time, the real-time preview function allows designers to intuitively see the effect of colour changes and make fine adjustments accordingly. Ensure colour matching meets design requirements. With the development of artificial intelligence technology, machine learning-based colour-matching algorithms have gradually become a research hotspot. These algorithms learn and extract effective colour-matching rules by analyzing the colour-matching rules of a large number of excellent design works. In practical applications, designers only need to input design themes or keywords, and algorithms can automatically generate a series of colour schemes that meet the requirements based on the learned rules for designers to choose and optimize. Xu [16] believes that colour matching is a designer's emotional expression, so he combines colour psychology with intelligent colour-matching algorithms to recommend colour schemes that better meet psychological expectations. In order to enhance the colour-matching experience, some designers have constructed a colour virtual space through virtual reality technology. Designers can freely colour-match colours in the virtual environment and observe the effects of different colour combinations in specific scenes. This method not only improves the intuitiveness and accuracy of colour matching but also reduces actual production costs and time. Some designers use VR technology to directly overlay virtual colours onto real objects or scenes for real-time preview. This method is particularly suitable for product design, interior decoration, and other fields. Designers can intuitively see the actual effect of color matching before product production or decoration, and adjust and optimize the design plan in a timely manner. The application of computer-aided technology in teaching colour matching in art and design not only improves the efficiency and accuracy of colour matching but also expands the possibilities of colour-matching teaching. By applying colour management software, intelligent colour-matching algorithms, and virtual reality and augmented reality technologies, designers can more easily create colour schemes that meet requirements, injecting new vitality into the development of art and design.

In order to deepen the understanding and optimization of cultural and creative product colour matching, explore its potential application in computer-aided teaching of art and design colour matching (CADT colour). Zhang and Deng [17] proposed a comprehensive colour-matching design method that not only combines traditional colour theory with modern visual aesthetic analysis but also cleverly combines the advantages of computer-aided teaching. Using semantic differentiation methods, users conducted a preference survey on 30 carefully selected image semantic words to explore the subtle relationships between colours, emotions, and images in depth. Through factor analysis, six key colour image factors were further extracted, which are the core elements of colour matching and provide a scientific guidance framework for subsequent teaching and design. Subsequently, an interactive genetic algorithm was developed that can automatically optimize and generate various colour schemes based on the aesthetic calculation formula and subjective image evaluation mentioned above. In terms of colour visual aesthetics, some scholars have innovatively derived calculation formulas for aesthetic attributes such as harmony, balance, and symmetry, achieving quantification and standardization of colour aesthetic evaluation. This process not only enhances the emotional resonance of colour selection but also provides a theoretical basis based on user preferences for subsequent colour matching. Subjective image evaluation is represented by interval numbers to reflect the uncertainty and diversity of the evaluation. This breakthrough not only helps designers to more accurately grasp the aesthetic effects of colour matching but also provides operational evaluation criteria for computer-aided teaching systems. This system can not only provide personalized colour suggestions and learning paths based on students' colour preferences and aesthetic cognition. Integrating the above colour-matching design methods into an art design colour-matching computer-aided teaching system can significantly improve teaching effectiveness and learning experience. Simultaneously utilizing grayscale methods to quantify this uncertainty further enhances the robustness of the algorithm. By simulating real design scenarios, students can also master the skills and rules of colour matching in practice. In addition, through real-time feedback and iterative optimization, the system can continuously adjust teaching strategies to ensure that each student can access the most suitable learning resources for themselves.

3 CONSTRUCTION OF ART COLOUR-MATCHING SYSTEM

3.1 Colour Matching Theory System

The common colour representation system includes RGB colour space, CMYK colour space, HSV colour space and CIE-Lab standard colour space. Each colour space is unique in the range of colours that can be displayed, and they can be converted to each other to adapt to different application needs. RGB colour space, as the most commonly used colour model in computer graphics, generates a wide range of colours through different intensity combinations of the three basic colours red, green, and blue. It is the basic colour representation of digital display devices (such as monitors, televisions, etc.).

Figure 1 shows that segmentation complementary color matching is an advanced color matching method based on the principle of complementary colors on the color wheel. However, unlike direct complementary colors (such as blue and orange), segmentation complementary colors select a color on the color wheel and then take the adjacent complementary colors on both sides as the matching, forming a more delicate and soft color relationship. For example, if red is chosen as the main color, computer-aided design software can help quickly locate cyan (instead of direct green) and magenta as auxiliary colors. This combination maintains contrast tension and increases the richness of color layers. DIADIC color matching, also known as dual adjacent color or adjacent color matching, refers to selecting any color and its adjacent colors on the color wheel for combination. This combination can create a harmonious and smooth visual effect, which is very suitable for creating a warm and comfortable atmosphere. Computer aided design software can easily achieve this color matching process by adjusting color proportions and saturation, helping designers explore the best combination of adjacent colors in different contexts.

Figure 1: Intelligent color matching in art and design.

Figure 2: Color range structure matching of intelligent color matching.

Figure 2 shows the color range structure of the color scheme. When the design requirements expand to use four or more colors, the complexity of color matching significantly increases. The tetrahedral color matching method is a creative color matching approach based on three-dimensional color spaces such as HSV, HSL, etc., which allows designers to explore a wider range of colors freely. Computer aided design software can construct three-dimensional color models, allowing designers to intuitively see the positional relationships between different colors making it easier to achieve the matching of tetrahedral or other complex color structures. In addition, the software can also provide intelligent recommendation functions, automatically generating multi-color color schemes based on design themes and target audiences, greatly improving design efficiency and the possibility of color innovation.

HSV colour space provides a colour representation method that is more in line with human intuitive feeling. It consists of three parameters: hue, saturation and lightness. Among them, hue represents the basic property of colour, its value varies from 0° to 360°, covering all colours in the visible spectrum; Saturation indicates the purity of a colour, ranging from 0% (colourless) to 100% (fully saturated); Brightness controls the brightness of the colour, which also varies from 0% (black) to 100% (white). This colour space is visually closer to human colour perception. CMYK colour space is mainly used in the printing industry, composed of four colours blue, magenta, yellow and black, working through the principle of the subtractive colour method, and RGB colour space in the principle of colour generation is completely different. CIE-Lab colour space is a device-independent colour system that aims to provide a uniform colour space, so that the perceived difference of colour is proportional to the distance in the colour space, and is widely used in the field of colour management. Figure 3 shows the colour space of the different systems.

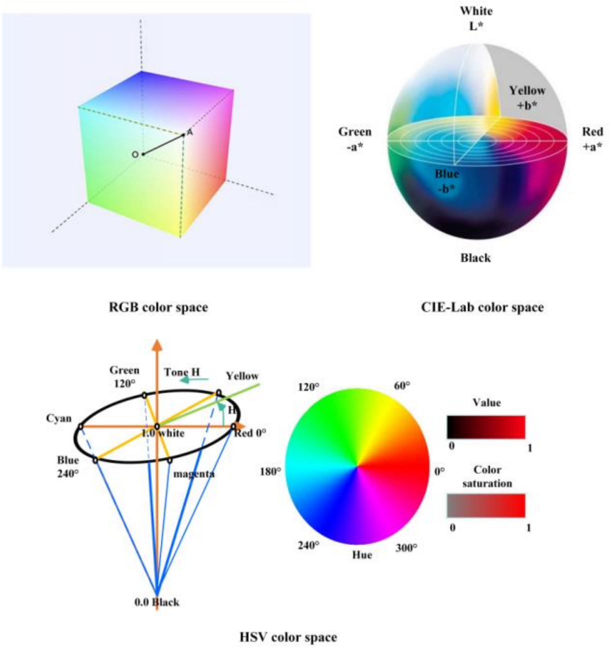

Figure 3: Colour space diagrams of different systems.

In the art design colour matching teaching, in order to make colours closer to the visual perception effect, the colour space of different systems will be transformed accordingly, as shown in formula (1) - (3), which is the conversion formula between RGB colour and HSV colour:

$$H=\begin{cases}\arccos\dfrac{2R-G-B}{\sqrt[2]{(R-B)^2+(R-B)(G-B)}} & (B\le G)\\ 2\pi\text{-}\arccos\dfrac{2R-G-B}{\sqrt[2]{(R-B)^2+(R-B)(G-B)}} & (B>G)\end{cases} \tag{1}$$

$$S=\frac{\max(R,G,B)-\min(R,G,B)}{\max(R,G,B)} \tag{2}$$

$$V=\frac{R+G+B}{3} \tag{3}$$

Among them, $R,G,B\in[0,255]$ $H\in[0,360]$ $S,V\in[0,1]$.

Artistic design colour matching requires more stringent colour rendering effects, but there will be a certain colour difference between colours and many colour differences are difficult to detect through human vision, which needs to be detected by professional instruments and calculation of colour. The colour difference is expressed as ΔE Its definition is shown in (4):

$$\Delta E = \sqrt{(L_2 - L_1)^2 + (\alpha_2 - \alpha_1)^2 + (\beta_2 - \beta_1)^2} \tag{4}$$

Where the brightness of the colour is expressed as The colour component is expressed as α, β.

In order to shorten the difference between the colour difference value and the visual effect of human eyes, the colour difference evaluation formula CIEDE2000 was adopted in this paper for correction. Its definition is shown in (5):

$$\Delta E_{CIEDDE2000} = \sqrt{(\frac{\Delta L}{K_L S_L})^2 + (\frac{\Delta C_{\alpha\beta}}{K_C S_C})^2 + (\frac{\Delta H_{\alpha\beta}}{K_H S_H})^2 + R_T(\frac{\Delta C_{\alpha\beta}}{K_C S_C})^2(\frac{\Delta H_{\alpha\beta}}{K_H S_H})^2} \tag{5}$$

Where, the brightness difference of the colour is expressed as ΔL The saturation difference is expressed as $\Delta C_{\alpha\beta}$, The colour difference is expressed as $\Delta H_{\alpha\beta}$ And the corresponding weighting coefficients are expressed as S_L, S_C, S_H, the parameter factor is denoted as K_L, K_C, K_H, and The calculated variable is denoted as R_T.

In the exploration of colour matching in art design, deepening the extraction and application of colour features is a crucial link. In order to enrich the colour expression and enhance the visual level and emotional communication of the design, two characteristic dimensions, GY (yellow and green feature) and F (bright colour frequency), based on the HSV colour model, are introduced into the system. GY features focus on capturing and quantifying the intensity and distribution of yellow-green tones in the image. Through the extraction and enhancement of GY features, the proportion and depth of yellow and green colours in the works can be precisely regulated, creating a harmonious and intense visual effect. F-feature is a profound insight into the vividness and distribution frequency of an image. In colour matching, the application of the F feature is crucial, because it is directly related to the first visual impact and emotional transmission efficiency of the work. By increasing the F-eigenvalue, designers can create brightly coloured, vibrant designs that draw the viewer's eye and inspire emotional resonance. On the contrary, properly reducing the F feature value can create a quiet and restrained atmosphere, which is suitable for design scenes that need to express calm and high-end texture. The calculation is shown in formula (6):

$$GY = \frac{H}{150}, when\ H\ in[0,150] \tag{6}$$

In addition, in the process of the art design, it is also necessary to calculate contrast and colour temperature, as shown in formula (7):

$$C = \sum_{\delta} \delta(i,j)^2 P_{\delta}(i,j) \tag{7}$$

Where the grey difference between adjacent pixels is expressed as $\delta(i,j)$ moreover $\delta(i,j) = |i - j|$, moreover $P_{\delta}(i,j)$ Indicates that the grey difference between adjacent pixels is δ The distribution of pixels.

Chrominance is calculated as shown in formula (8):

$$IS = \frac{N_p}{N} \times 100\% \tag{8}$$

Where, the number of pixels whose colour saturation is higher than the threshold is represented as N_p, the total number of pixels is expressed as N.

The above colour attribute values can be considered objective colour attributes, and colour can be accurately expressed through calculation and numerical values. However, colour matching in art design has strong subjective images, that is, there is an important correlation between colour expression and emotional expression. Therefore, on the basis of the above scientific expression of colour matching, this paper also adds the subjective colour image coordinate system to realize the construction of the correlation between objective colour image and subjective colour image. Figure 4 shows the scale diagram of a colour image that is not affected by subjective perception differences.

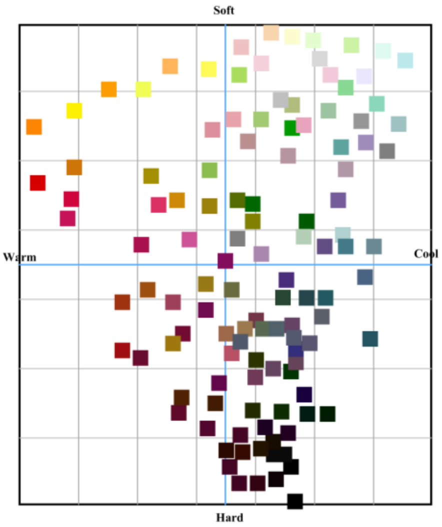

Figure 4: Schematic diagram of colour image scale that is not affected by subjective perception differences.

On the basis of the above figure, the system realizes the construction of a subjective image colour quantization model by analyzing the corresponding laws of cold and warm, soft and hard, pure turbidity, and H, S and V.

3.2 Colour Matching Algorithms

There is uncertainty in the number of main colours extracted in the past colour matching. If the number of the best main colours can be determined, the efficiency of main colour extraction can be improved, and it is conducive to the optimization of colour matching. In this paper, the K-means algorithm is used to extract the main colour. Its core idea is to express the clustering result of the sample set through the cluster centre of the preset number of targets. It is based on the distance of the aggregation centre and the data object to realize the set partitioning algorithm. In this algorithm, the parameter is K The set of sample points described $M=\{m_1,m_2,...,m_i\}$, from which select a quantity of k As the initial aggregation centre, the data samples are classified into clusters. The clustering division is based on the minimum error, and the similarity evaluation criterion is the distance between clusters. Set cluster through cluster centroid e_i Means, in the cluster x and e_i The formula for calculating the distance difference between them is shown in (9):

$$d(x_i,e_i)=d(x_i,x_j)=\sqrt{(x_{i1}-x_{j1})^2+...+(x_{ip}-x_{jp})^2} \tag{9}$$

The measurement of cluster quality is realized by using the error square and SSE as the objective function, which can reflect the tightness of each sample and cluster centre in each cluster, and the SSE value is negatively correlated with the similarity. The SSE calculation formula is shown in (10):

$$\begin{cases} SSE = \sum_{i=1}^{k} \sum_{x \in E_i} d(x_i, e_i) \\ e_i = \frac{1}{n_i} \sum_{x \in E_i} x \end{cases} \tag{10}$$

Where the cluster centre set is represented by E_i, the sample data object x and $x \in E_i$ The number of its attributes p. The sequence number is i The quantity of sample data expressed as n_i.

According to the above calculation results, the data samples are divided into the most similar sets according to the nearest neighbour method, and a new class cluster is obtained. The new cluster centre is calculated, as shown in formula (11):

$$e_i = \frac{1}{n_i} \sum_{j=1}^{n_i} x_j \tag{11}$$

When the cluster centre does not change, it indicates that the algorithm reaches the termination state and outputs the final result. If the cluster centre changes, the cluster is re-divided to obtain a new cluster until the cluster centre no longer changes.

In order to improve the effect of the colour-matching scheme, this paper introduces a genetic algorithm to optimize the colour-matching scheme. GA algorithm needs to encode the individual features contained in the population and initialize the population. After that, the fitness of individuals in the population is evaluated, and the calculation formula is shown in (12):

$$F = k[\sum_{i=1}^{n} abs(y_i - d_i)] \tag{12}$$

Among them, the individual adaptation degree is expressed as F, the individual output value is expressed as y_i, The target output is denoted as d_i the Parameter is denoted as k and The output quantity is expressed as n.

The selection formula is shown in (13):

$$\begin{cases} f_i = k/F_i \\ p_i = \frac{f_i}{\sum_{i=1}^{n} f_i} \end{cases} \tag{13}$$

Where individual fitness is expressed as F_i f_i The relation between and is reciprocal; p_i The probability represented is the individual selection probability.

After selecting outstanding individuals, the new populations will be crossed, as shown in (14):

$$\begin{cases} a_{ij} = a_{ij}(1-b) + a_{nj}b \\ a_{nj} = a_{nj}(1-b) + a_{ij}b \end{cases} \tag{14}$$

Formula, a_{ij}, a_{nj} For individuals with good genes, b Yes parameter.

$$\begin{cases} a_{ij} = \begin{cases} a_{ij} + (a_{ij} - a_{\max}) \times f(g) & r > 0.5 \\ a_{ij} + (a_{\min} - a_{ij}) \times f(g) & r \le 0.5 \end{cases} \\ f(g) = r(1 - g/G_{\max})^2 \end{cases} \tag{15}$$

Shizhong $r \in (0,1)$, g Refers to the number of iterations completed so far, $G_{\max}$ Refers to the maximum number of iterations.

On the basis of the above K-means algorithm, this paper constructs the art design colour-matching resource library and realizes the mining of relevant data according to the model's own functions. Considering that there are category differences among the data of art design colour matching in practical applications, the prediction vector for data positioning in this paper is shown in (16):

$$\alpha = (\alpha_1, \alpha_2, \cdots, \alpha_n) \neq 0 \tag{16}$$

Use feature vectors to refer to data for adjustment, as shown in (17):

$$\begin{cases} y^{(k)} = \left[y_1^{(k)}, y_2^{(k)}, \cdots, y_{N_{k-1}}^{(k)} \right]^T \\ z^{(k)} = \left[z_1^{(k)}, z_2^{(k)}, \cdots, z_{N_k}^{(k)} \right]^T \end{cases} \tag{17}$$

Formula, $y^{(k)}$ and $z^{(k)}$ Indicates the linear horizontal and vertical input of the system.

After obtaining the index system of students' art design colour matching level, the principal component analysis method is used to store the dynamic fractal of the index information tree structure, establish a linear dynamic system fitting various influential factors of art design colour matching, and achieve data fitting. The formula (18) can be used:

$$R_\beta Y = U \quad E \in U / R \middle| c(E, Y) \leq 1 - \beta \tag{18}$$

Finally, through the above dynamic fractal design, this paper realizes the establishment of the horizontal model of student art design colour matching based on the K-means algorithm. After several iterations, personalized recommendations can be made according to these data.

4 EXPERIMENTAL ANALYSIS

4.1 Experimental Analysis Results of System Performance

To test the performance of the system's main colour extraction and the system's colour matching, a comparative experiment is carried out. In the main colour extraction performance experiment, this paper selected other two algorithms for comparison, and the number of main colours in the experiment was 4, 5, and 6 respectively, and the results are shown in Figure 5. As can be seen from the results in the figure, the peak-to-noise ratio and structural similarity of the proposed algorithm model are significantly higher than those of the other two algorithms when the number of principal colours is the same. With the increase in the number of main colours, the peak signal-to-noise ratio and structural similarity of the proposed algorithm maintain a steady growth state, while the other two algorithms have a certain range of changes. This shows that, compared with the other two algorithms, the proposed algorithm can achieve a better reconstruction effect of artistic design colour images, can show the main colour information of design colours, and has strong performance stability.

Figure 6 shows the comparison results between the colour-matching ratio of the three algorithms and the actual matching ratio. In the experiment, three fixed main colours were selected for different proportions. The results in the figure show that among the three algorithms, the colour-matching ratio of the algorithm in this paper is the closest to the actual matching ratio, and shows good stability. In addition, there is a large gap between the colour-matching ratio of the two algorithms and the actual matching ratio in most cases, and the overall performance is not stable. This indicates that the artistic design colours presented by the system in this paper are more consistent with the actual visual effects of human eyes, can reduce the colour difference between different colour Spaces, and can provide more accurate colour data for system applications and more realistic colour visual effects for teaching.

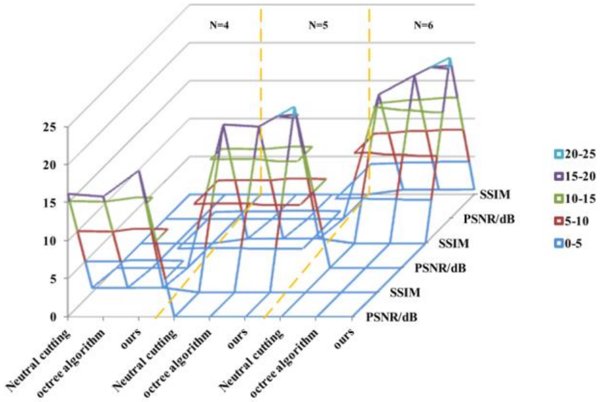

Figure 5: Peak signal-to-noise ratio and structural similarity extracted by three main colours.

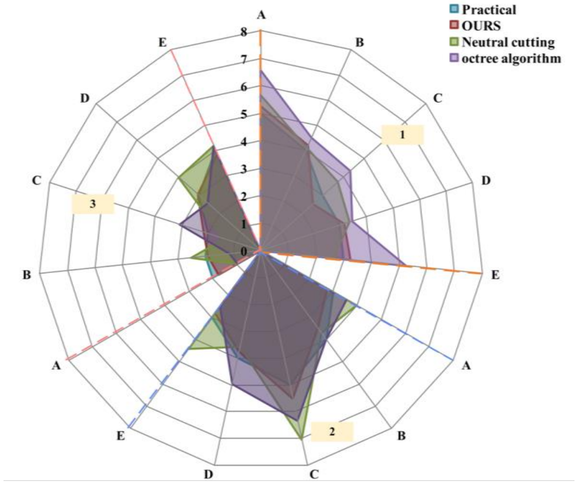

Figure 6: Comparison results between the colour matching ratio of the three algorithms and the actual matching ratio.

4.2 The Results of the Systematic Application

The integration degree of colour-matching information in artistic design is an index to measure the degree of mutual coordination, unity and harmony of colours in the design. Therefore, the information integration degree of the system in this paper is compared with the traditional colour-matching method in the application experiment, and the results are shown in Figure 7. The results in the figure show that among the three colour-matching methods, the integration degree of principal component analysis is the lowest, and its integration degree shows a large fluctuation within a certain range with the increase in the number of iterations. The information integration performance of the system in this paper is much higher than that of the other two algorithms, and with the increase in the number of iterations, the stability of the information integration performance is good. This shows that the system can show better integration of colour-matching information in the process of application, and can effectively improve the coordination and unity of colour matching in design.

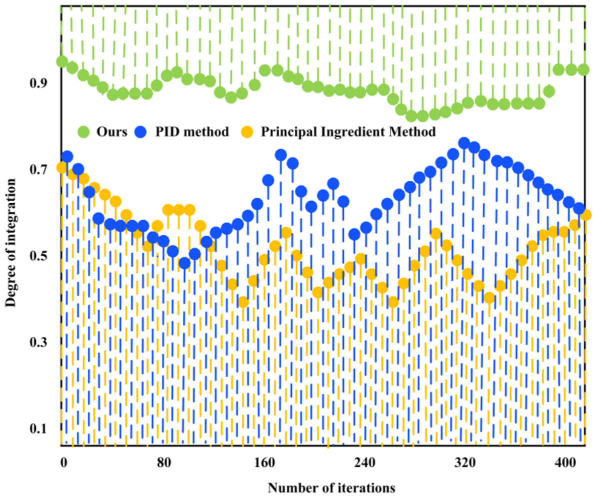

Figure 7: Integration degree of colour-matching information of the three systems.

The colour-matching output of art design is the final visual effect and emotional transmission presented by the designer through careful selection and matching of colours in the process of art creation or design. The higher the colour-matching output rate of the system, the better the effect of its art design colour matching. Figure 8 shows the comparison of the output rate of art design colour matching of three different systems. The results in the figure show that among the three systems, the colour-matching output rate of the proposed system is the best, which is much higher than the other two algorithms, and shows good application stability. This shows that in the teaching and colour-matching effect, the system in this paper can present different colour-matching effects at a higher level, and output better colour-matching schemes according to the corresponding goals to help students improve the colour-matching effect.

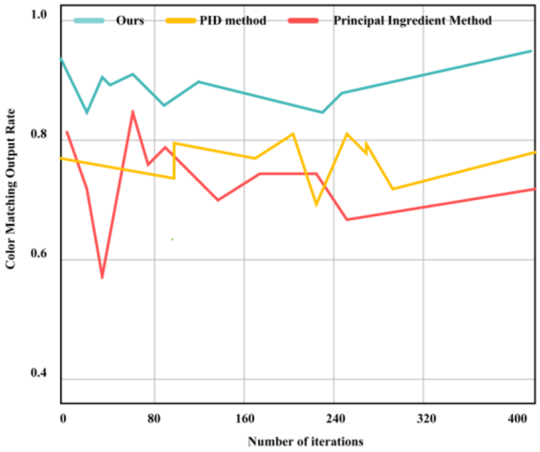

Figure 8: Comparison of output rate of colour matching in art design of three different systems.

As shown in Figure 9, the color matching output effect of the model in this article in actual art design is demonstrated. The results in the figure show that the model can effectively match colors selected by the art designer, and adjust the color matching output rate reasonably based on the visual design of the design, making the design more harmonious in color effect presentation and visual aspects, meeting the requirements of the designer.

Figure 9: Color matching output effect in actual art design.

In order to verify the application effect of this system in teaching, this paper randomly selected two classes of art design to conduct a comparative experiment, the experiment lasted for one month. In the comparison experiment, class A is the experimental class, and the art design colour matching teaching is carried out through this system in one month, Class B is the contrast class, which adopts the traditional teaching method. Figure 10 shows the comparison results of the scores of the two classes before and after the comparison experiment. The results showed that before the comparison experiment, the scores of the two classes were almost the same, indicating that there was no obvious difference between the two classes. Judging from the results after the experiment, Although the scores of the two classes have improved, the score of class B has improved relatively little, and the score of class A has greatly improved, especially in the harmony of colour matching, visual impact and emotional expression. This shows that this system can effectively improve the quality of art design colour-matching teaching, provide students with personalized teaching resource recommendations, achieve differentiated teaching, and help students improve their performance.

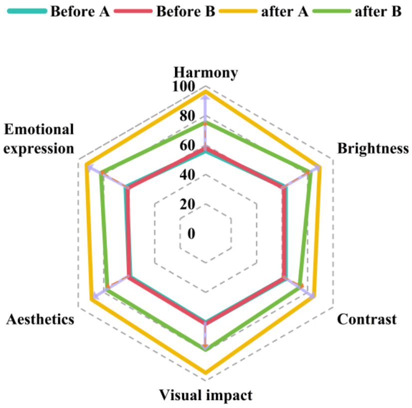

Figure 10: Comparison results of scores of two classes before and after the comparison experiment.

As shown in Figure 11, the design results of Class A's experiment on the theme of "different animal colors" are presented. The results indicate that the model proposed in this paper can help students optimize design effects, improve color matching in artistic design, and achieve color matching optimization according to different design styles in practical applications, demonstrating good performance.

Figure 11: Design Results of Class A's Experiment on the Theme of "Animals+Rainbow."

5 CONCLUSIONS

The colour matching of the art design has strong subjectivity, and the traditional teaching mode mostly adopts a unified standard for teaching, which limits the innovation of students. At the same time, in the past teaching mode, teaching resources are scarce, and it is difficult for students to obtain new colour-matching skills and ideas. Therefore, this paper combines computer-aided technology to develop an art design colour-matching teaching system, combines k-means algorithm and colour space theory to carry out colour matching and optimization, and realizes personalized recommendations of teaching resources through the analysis of relevant data. The experimental results show that the system in this paper has the highest performance of peak signal-to-noise ratio and structural similarity when the number of main colours is the same, and their values increase with the increase of the number of main colours. At the same time, compared to the other two algorithms, The colour-matching ratio of this system is more in line with the actual situation. This shows that the system has good performance in colour extraction and colour matching, and can show more main colour information and provide more real colour effects. It can be seen from the experimental results that the system in this paper has a higher integration degree of art design colour-matching information, a significantly higher output rate than the other two algorithms, and good stability.

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