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Exploring the Integration of Multimodal Data and CAD Collaborative Design Technology in Art Design

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Abstract. The purpose of this paper is to explore the integration of multimodal data and CAD co-design technology in the field of art design. Firstly, the background and significance of this research field are introduced. Traditional art and design still face significant issues in terms of design communication and efficiency management. In order to solve the problem of CAD collaborative design in the multimodal field, an accuracy analysis of multimodal collaborative applications was conducted. Data semantic analysis was constructed by integrating deep learning and computer vision processing, and the analysis of data modal feature extraction was explored through the interactive vision of CAD models. In the construction of the experimental platform, it was evaluated by a professional designer. The results indicate that combining visual algorithms with image information in videos can achieve good model interactivity. Greatly enhancing the flexibility and innovation of artistic design modal data. This method has significant effects in strengthening communication in art and design, as well as in the integration of collaborative effects in art.

Keywords: Art Design; Multimodal Data; CAD Collaborative Design (CAD Co-Design); Integration Exploration
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1 INTRODUCTION

In the field of art and design teaching, workshops are an innovative, practical teaching method. Asadi et al. [1] broke the traditional single-teaching form of teaching and learning, achieving interdisciplinary collaboration. Currently, this teaching method has become a trend. However, due to the sudden impact of the epidemic, traditional offline art and design workshops have faced unprecedented challenges while also accelerating and catalyzing the combination of online and offline workshops for teaching. The teaching methods of workshops in the new form are limited by time and physical space. Resulting in scattered workshop resources, difficulties in workshop teaching management, and a low level of collaborative creation among teams. Therefore, in the normalization of the digital media era, it is necessary to explore innovative paths for collaborative art and design workshops in order to achieve sustainable development. Multimodal digital interaction has developed from the theory of multimodal discourse and gradually extended to the field of art and design to achieve its innovative applications. Cabero et al. [2] analyzed the digital multimedia teaching mode of art and design. It mainly stems from the comprehensiveness of the art and design discipline, which helps to form interdisciplinary development with other disciplines. Cross-disciplinary cooperation between different disciplines helps to generate new innovations. As a carrier of innovative development, digital multimedia in the field of art and design integrates various disciplines to establish innovative teaching spaces, effectively leveraging the cross-disciplinary advantages of different disciplines and forming complementary resources. At present, there is no relatively complete system construction and organizational model for art and design workshops, and there is still a lot of room for exploration. The introduction of this technology not only improves the efficiency of artistic creation but also provides artists with more creative inspiration and possibilities. In artistic creation, hybrid reality technology can combine virtual works of art with real scenes, making the audience seem to be in a dreamy art space. The application of this technology not only enriches the form of artistic expression but also brings more profound artistic feelings to the audience. However, traditional CAD design methods still have certain limitations, especially in design communication and creative expression, which are difficult to meet the needs of designers. With the development of artificial intelligence, art image style transfer technology stylizes images to give them the desired artistic style. Convolutional neural networks based on deep learning can be used to extract and fuse the content and style features of input images, resulting in corresponding stylized images. The difference between supervised and unsupervised neural networks is the presence or absence of labelled data for input and output. The pre-training of unsupervised networks does not require labelled data, only analyzing the regularity of the dataset itself. Cao [3] discussed the unsupervised CycleGAN network to reduce issues such as noise textures, transition transitions, and image distortion in generating artistic images. It proposed an art-style image transfer model and conducted experiments on relevant datasets to verify the effectiveness of the model. Therefore, how to combine multimodal data with CAD collaborative design technology, to improve the efficiency and quality of art design and enhance communication and cooperation among designers.

Art and design is a comprehensive discipline that covers a wide range of artistic creation and design activities. Its purpose is to create both aesthetic and functional works through various means of artistic expression, such as painting, sculpture, graphic design, etc., in order to enrich people's aesthetic experience and quality of life. In the field of digital art, image watermarking technology is an important means of intellectual property protection. By embedding specific information (watermark) into the image, the tracking and protection of image source, copyright and other information can be realized without affecting the visual quality of the image. Therefore, Dhaya [4] proposes a convolutional neural network (CNN) to solve the above problems. By combining encryption and obfuscation technologies, the security and robustness of watermarks can be improved. Finally, the scheme is suitable for various art image types and has high universality and practicality. With the continuous development of society and the rapid progress of science and technology, the field of art design is gradually moving towards the trend of digitalization and intelligence. CAD technology provides designers with efficient and accurate design tools with its powerful drawing, modelling and editing functions. In art and design teaching, CAD software can help students quickly master the basic principles and skills of design, and deepen their understanding of design concepts through practical operation. At the same time, CAD technology also supports parameter design, which makes the design scheme flexible to adjust and optimize, and cultivates ability. In the teaching of artistic creation and design, Feng [5] Uses virtual reality technology to let students feel the spatial effect of design firsthand and understand the details and proportions of design more intuitively. In addition, virtual reality technology supports online collaboration among multiple people, allowing students to create, discuss and modify designs together in a virtual environment. It improves teamwork and communication efficiency. In this context, computer-aided design technology has become an indispensable and important tool in the field of art design. With its powerful functions and flexible operation, computer-aided design technology provides art designers with new design ideas and working methods. Through CAD technology, designers are able to use computer software to carry out design, drawing and simulation, and realize the digitalization, automation and visualization of design.CAD technology makes the design process more efficient and precise, and also greatly expands the means of expression and creative space of design. In the field of steganalysis, a classification algorithm based on image texture features is an effective detection method. However, the traditional texture feature extraction methods often can not fully capture the unique texture features in art images, resulting in poor steganalysis results. Therefore, Hammad et al. [6] Proposed a steganalysis classification algorithm based on unique artistic image texture features to achieve accurate detection of steganography information in artistic images. Through the pre-processing steps, the art image is de-noised and enhanced to improve the quality of texture feature extraction. It is not only limited to the field of two-dimensional design but also covers a variety of aspects such as three-dimensional modelling, animation design, virtual reality and so on. Designers can use CAD software for three-dimensional modeling to achieve a three-dimensional representation of the design object, so as to understand the design effect more intuitively. At the same time, CAD technology is also combined to provide designers with a richer design experience and interaction. The development of computer-aided design technology not only improves the efficiency and accuracy of art design but also enriches the means of expression and creative space of design. It provides powerful tools and resources for art designers, enabling them to better realize their design concepts and create more creative and infectious works.

Multimodal data is a collection of data that contains multiple types of information, which can be in the form of images, sounds, videos, etc. Compared with traditional single-modal data, multimodal data has richer information expression ability and wider application areas. The original teaching mode of art and design is no longer able to meet the existing needs, and reshaping the workshop process and innovating workshop collaboration methods are its internal motivations. But it also causes difficulties in teaching management and team cooperation in different fields. It needs to try to expand online educational resources for art and design workshops, in order to achieve a reasonable match between online education and offline teaching experiences. Attempting to utilize continuously iterating network applications to assist in the development of online art and design workshop teaching activities, and exploring a more comprehensive operational model for art and design workshops. Secondly, in the process of sustainable social development, combined with the transformation of social relationships between people in the post-pandemic era. Based on exploring ways to meet the needs of today's society and creating new relationships and cooperation models. View the current new form from a systematic, sustainable, and innovative perspective. To summarize, by combining multimodal data with CAD technology, we can expect to open up new possibilities and innovative paths in the field of art design. This integration will not only improve design efficiency and accuracy but also expand the dimensions of design expression and enhance communication and collaboration among designers. Through this paper, this research will introduce a new way of thinking and technical means for the field of art design, and provide designers with richer and more flexible tools and methods, so as to promote the field of art design to digitalization and intelligent development to take a greater step forward!

2 PROGRESS OF RELEVANT RESEARCH AT HOME AND ABROAD

Hu et al. [7] proposed a mask r-CNN generation model. Firstly, the position normalization and dynamic moment shortcut modules are added to the generator to better preserve and transmit the feature information extracted from the input image. Secondly, the multi-scale structural similarity loss function and regularization loss function are simultaneously applied to the reconstructed image to strengthen the constraints on image brightness, colour contrast, and structure. The image generation results of the mask r-CNN model can better preserve the integrity of image content feature information and strengthen the constraints on image colour contrast. Firstly, the position normalization and moment shortcut modules are inserted into the encoder and decoder to improve the stability of image content feature information transmission. Secondly, combining mask r-CNN loss with the regularization loss function can effectively optimize the quality of generated images.

Finally, an attention mechanism module and spectral normalization operation are added to the discriminator. The former improves network performance by adjusting the interdependence of feature channels, which can effectively assist the model in fine-tuning. The latter makes the network more stable for training. The results generated by the mask r-CNN model significantly reduce the problems of noise texture, colour distortion, and boundary blur, resulting in a certain degree of improvement in image quality. This immersive experience not only enhances the perception of designers but also improves the innovation and practicality of design. In the art of image denoising, the application of a convolution neural network has unique advantages. Artistic images often have rich details and complex textures, which make traditional denoising methods difficult to deal with. Through multi-layer convolution and pooling operations, convolution neural networks can extract deep features in the image, and then achieve more accurate noise reduction. Ilesanmi and Ilesanmi [9] discuss the art image denoising method using a convolutional neural network and explain its application in complex and intelligent systems. The complexity of the model is high, which requires longer training time and higher computing resources. In addition, for some complex artistic styles or details, convolutional neural networks may still be difficult to completely remove noise without affecting the original artistic effect.

As an art form, painting carries rich cultural and historical connotations. Different painting styles reflect the artist's unique aesthetic and creative ideas. However, the traditional analysis of the painting style mostly relies on artificial experience and subjective judgment, which makes it difficult to achieve objective and quantitative evaluation. Jiang and Yang [10] simulated the hierarchical processing of the human brain's visual system, abstracting and extracting features layer by layer. In the extraction of painting style features, a convolution neural network can learn the deep feature representation of different styles of paintings, so as to achieve objective description and quantitative analysis of painting style. Art texture is an important part of art design, and its feature extraction and application are very important to improve the quality and uniqueness of design works. Keyvanpour et al. [11] Analyze the application of CAD collaborative design technology in art texture feature extraction, which brings new development opportunities to the field of art design. Based on artistic texture feature extraction, designers can further use these feature data for creation. By applying the extracted texture features to design works, we can enrich the details and layers of design, and enhance the quality and uniqueness of design. For example, in architectural design, designers can use the extracted natural texture features to simulate the texture of materials such as stone and wood, so as to make the appearance of buildings more vivid and realistic. In fashion design, designers can use texture features to create unique patterns and texture effects to enhance the sense of fashion and the art of clothing.

Khaldi et al. [12] Compared the fusion of CAD collaborative design technology, in order to provide theoretical support and reference for design practice. The colour co-occurrence matrix reflects the distribution and variation of pixel grayscale values in grayscale images. These two matrix features have important application value in image processing and analysis, providing designers with in-depth information about image structure and content. Traditional art pattern defect detection mostly relies on manual visual inspection, which is not only inefficient but also vulnerable to human factors. Image style transfer based on texture synthesis is a traditional method of image style transfer, which involves texture synthesis on the input image to achieve style transfer. This method can directly use the pixel information of style images as texture information, and can also be achieved through methods such as wavelet analysis and statistical learning. Extract texture information from the style image and synthesize a texture image corresponding to the style based on this texture information. Li et al. [13] solved the following problem through a slow neural style transfer algorithm based on image iteration: (1) dependence on input images. If the generated image differs significantly from the expected synthesized image, the algorithm will require more iterations to generate the desired image. (2) The global semantic style feature display of the generated image is not rich. (3) The generated image has a single style and cannot adapt to any image style. It inputs content images and style images separately into a pre-trained deep neural network to obtain their semantic, texture, and shape information. Secondly, random noise images are introduced into the model for iterative optimization, and the quality of these noisy images is also improved. Finally, generate a graph that satisfies both content and style constraints. To address the issues of transition transition, boundary blur, noise texture, and semantic information loss in the CycleGAN model, and further improve the constraints of the model during training. The superiority of the proposed method has been confirmed through qualitative and quantitative experimental results through the bidirectional generation of image data, resulting in higher perceptual visual effects in the generated images. Therefore, it is of great significance for Ouyang et al. [14] to study an efficient and accurate colour segmentation method for multicolour art images. A colour segmentation method for multicolour art images based on node growth self-organizing mapping. First of all, art images need to be pre-processed, including colour space conversion, noise suppression and other operations, in order to improve the quality of images. Then, the pretreated image data is input into the GSOM network, and the colour data are clustered through the self-organizing learning process of the network. In the process of clustering, the GSOM algorithm will automatically adjust the structure of the network according to the similarity and difference of colours, so as to achieve the segmentation of different colour regions. Zhu et al. [15] Analyzed interactive art design, with the help of these advanced technical means, which not only broke the limitations of traditional art design but also brought a new aesthetic experience to the audience. As a product of modern information technology, intelligent sensors have the characteristics of high sensitivity and fast response. Smart sensors play a crucial role in interactive art design. They can capture the audience's movements, sounds, expressions and other information in real-time, convert this information into digital signals and transmit them to the information processing system. In this way, art and design works can make real-time feedback according to the behaviour of the audience and interact with the audience.

Comprehensive development status at home and abroad, it can be seen that in the integration of multimodal data and CAD co-design technology in art design, foreign countries have made more significant progress than domestic. In some developed countries abroad, academia and industry have established a more mature research system and practical applications, including research projects involving virtual reality (VR), augmented reality (AR) and other technologies, and the introduction of CAD software to support multimodal data. The development of these technologies makes the design interaction more intuitive and flexible, and at the same time provides richer design tools and resources, which helps to improve the design efficiency and quality. Comparatively speaking, domestic research in this field is still in its infancy, and although some universities have already offered relevant courses, there is still a big gap between the overall research level and application scope. At the same time, the country also faces some challenges, including insufficient technical level and insufficient depth of applied research. This research will be devoted to remedying these deficiencies and proposing innovative methods and techniques to meet the current challenges through in-depth research on the integration of multimodal data and CAD co-design techniques. Specifically, this study will try to explore the fusion method based on deep learning and computer vision and verify its effectiveness with experimental design and analysis. At the same time, this research will focus on the actual needs of the domestic art design field and propose targeted solutions to make positive contributions to the development of the domestic art design field.

3 MULTIMODAL LEARNING

3.1 Multimodal Machine Learning

Multimodal machine learning is a technique to learn and enhance its own algorithms from data in multiple modalities, which is not a single algorithm but a general term for a class of algorithms. This form of composite data presents a high degree of heterogeneity and diversity and requires specific techniques for processing and analyzing. Mining and analyzing heterogeneous data from multiple sources can be understood as part of multimodal learning. Through multimodal learning techniques, information from different modalities can be effectively utilized to enhance the effectiveness of data mining and analysis, thus revealing the potential laws and knowledge in the data. This comprehensive learning approach helps to deeply understand the intrinsic correlations and features behind the data, providing support for further applications and decision-making. For the specific process, this paper draws the following figure Figure 1.

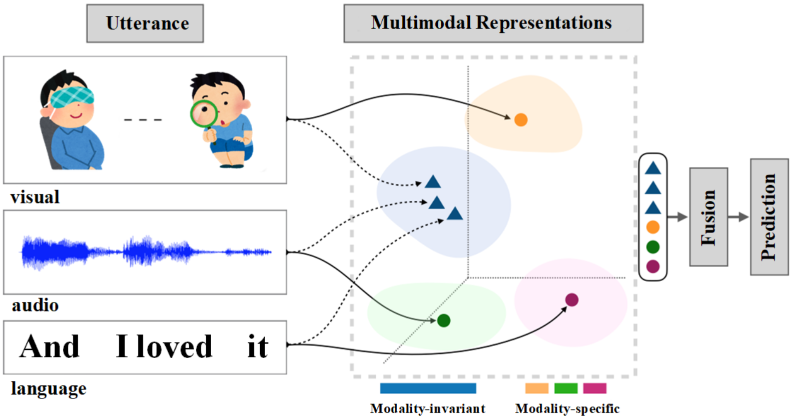

Figure 1: Multimodal learning flowchart.

3.2 Selection of Multimodal Algorithms

The design of multimodal dynamic models aims to integrate multiple modal information in the art and design process. This model first collects basic information about designers through a CAD system, such as educational background and work experience, as well as project information related to art and design, such as design sketches, color matching, material selection, etc. After preprocessing, this information is input into the random forest algorithm for training. During the training process, the random forest algorithm learns the relationship rules between different art and design projects by constructing multiple decision trees. Based on the research on the concept of integrated thinking, it can be concluded that the development of integrated thinking theory is relatively mature. However, the theoretical application of integrated thinking is mainly in the fields of architectural design and industrial design, and it currently has significant space exploration and research value in other fields. Secondly, this article believes that the current changes in the characteristics and needs of art and design workshops require the use of collaborative thinking methods to solve them. The integrated thinking approach in integrated thinking comprehensively considers the relationships between various elements. This has good applicability for the systematic research of applying integrated thinking theory to art and design workshops in this article.

$$S(Y,Z) = P(Y,Z) = \frac{num(yz)}{num(allsamples)} \tag{1}$$

$$C(YZ) = P(y|Z) = \frac{P(yz)}{P(z)} \tag{2}$$

In this process, we may find that some subsets of data do not significantly improve model performance, so we can consider removing these subsets from the training set. After data pruning, we can input the optimized multimodal data into the random forest algorithm for training. Due to the reduction in data volume and feature selection, the training speed of the model will be faster, and the predictive performance will also be improved. This will make the application of multimodal dynamic models in the field of art and design more efficient and accurate.

Figure 2 shows the random forest algorithm tree pruning diagram After pruning the raw data, because the data directly from the CAD system is heterogeneous, it also needs to be normalized. The data were first arranged in a preliminary categorization using the matrix formula (3).

$$D_T = \begin{bmatrix} d(y_1,y_1) & \cdots & d(y_1,y_T) \\ \cdots & \cdots & \cdots \\ d(y_T,y_1) & \cdots & d(y_T,y_T) \end{bmatrix} \tag{3}$$

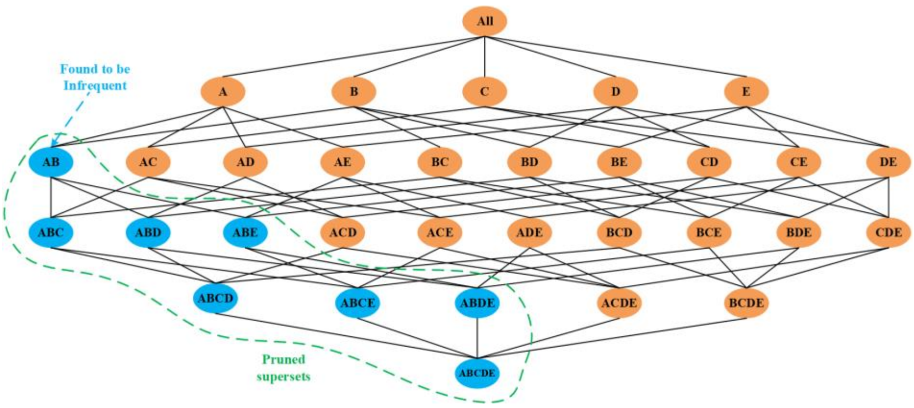

Figure 2: Random forest algorithm tree pruning diagram.

Where T denotes the total number of all the data and then the data is used to get the average value using equation (4).

$$\overline{R} = \frac{\sum_{i=1}^{T} R_i}{T} (i = 1,2,\cdots,T) \tag{4}$$

The $\overline{R}$ above formula indicates the average of R_i of the total number of T, and finally, the data will be weighted according to the classification of the upper error to achieve the normalization of the data, which needs to be used to the following formula.

$$R = \overline{R} + d_{\min}(y_i,y_j) \tag{5}$$

After the pruning operation and normalization, the unified structure of the data makes it easier to perform multimodal mining and modeling afterward.

3.3 Dynamic Multimodal Modeling

In order to explore the synergy between multimodal data and CAD systems, data mining is performed using the Random Forest algorithm. In the construction of the model, the data localization state prediction vector is considered for the classification of different items in art design:

$$\alpha = (\alpha_1,\alpha_2,\cdots,\alpha_n) \neq 0 \tag{6}$$

Transmit the diversified art design data to the application server and refer to it with a feature vector when scheduling the data as:

$$y^{(k)} = \left[y_1^{(k)}, y_2^{(k)}, \cdots, y_{N_{k-1}}^{(k)}\right]^T \tag{7}$$

$$s^{(k)} = \left[s_1^{(k)}, s_2^{(k)}, \cdots, s_{N_k}^{(k)}\right]^T \tag{8}$$

$$z^{(k)} = \left[z_1^{(k)}, z_2^{(k)}, \cdots, z_{N_k}^{(k)}\right]^T \tag{9}$$

Where $y^{(k)}$ and $z^{(k)}$ denote the linear horizontal and vertical inputs to the system and $s^{(k)}$ denotes the reversible invariant output.

The colour selection guided by the multimodal concept is used as a time-frequency feature, which is calculated as the time-mean and frequency-mean of the gain indices in the design as the following equations (10) and (11), respectively

$$t_m = \frac{1}{E}\int_{-\infty}^{+\infty} t\left|y(t)\right|^2 dt \tag{10}$$

$$v_m = \frac{1}{E}\int_{-\infty}^{+\infty} v\left|Y(v)\right|^2 dv \tag{11}$$

Based on this model, a dynamic fractal of the index information storage tree structure is performed using principal component analysis to calculate the variance matrix of this storage structure : C

$$C = \frac{z+1}{N}\left[Y-\overline{Y_i}\right]\left[Y-\overline{Y_i}\right]^T \tag{12}$$

A linear dynamic system fitting multiple art design level influencing factors is established to realize the fitting of diversified data in the dynamic model, which the following equation can express:

$$R_\beta Y = U \;\; E \in U / R\left|c(E,Y) \le \beta\right. \tag{13}$$

$$bnr_\beta(Z) = R_\beta Z - R_\beta Z_1 \tag{14}$$

Through the above dynamic fractal design, this experiment realizes the multimodal modelling of art design in a collaborative CAD system.

4 INTEGRATION TESTING OF MULTIMODAL MODELING AND CAD COLLABORATION TECHNIQUES

Each art design task can be viewed as a collection of multiple subproblems. The multimedia model built by the Random Forest algorithm then jointly solves these related subproblems using multi-task optimization, thus finding an optimal set of models in a unified algorithmic process. Each subproblem provides a Pareto-optimal model, i.e., it is no longer possible to improve any solution to solve a problem without sacrificing solutions to other problems. This multimedia model is characterized by its ability to find a balance between different trade-offs when solving complex art design tasks and to obtain the best design solution from them. These different Pareto-optimal models reflect the different trade-offs between tasks, thus making the art design process more flexible and efficient.

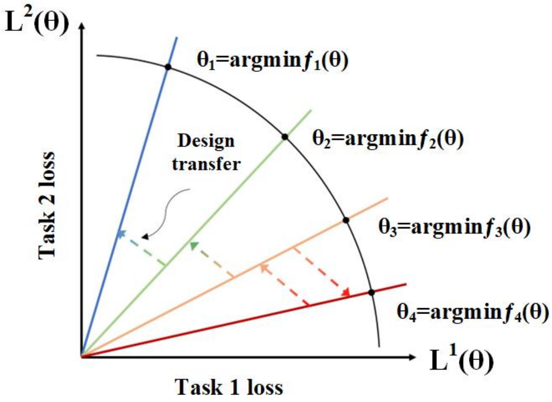

Figure 3: Multimodal modelling to solve art design subproblems.

Figure 3 shows the sub-problems divided by the multimodal model to solve a large problem, and it can be seen that it provides optimal solutions for each sub-problem, and passes and connects the design directly to each sub-problem. This makes it possible to get the needed results more accurately and efficiently in art design.

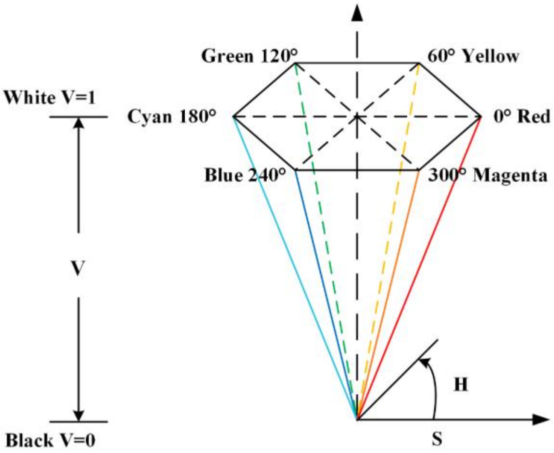

Figure 4: Hue, saturation, lightness, and darkness spatial structure diagram.

The degree of integration between the multimodal data model created by the Random Forest algorithm and the CAD system directly affects the speed of project processing. Therefore, this experiment aims to assess the degree of integration between flat and three-dimensional art design through the study of the two. The degree of integration will directly reflect the capability of the overall collaborative technology. The results obtained are shown in Figure 5 below.

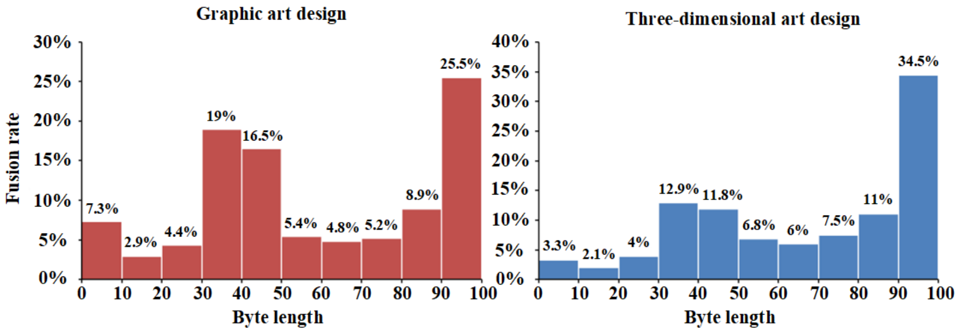

Figure 5: Effect of fusion rate of the multimodal data model and CAD system on the processing speed of projects.

In Fig. 5, it is observed that in the case of planar art design and three-dimensional art design, the fusion rate reaches its highest value of 25.5% and 34.5% when the number of project bytes is between 90 and 100, respectively. This means that in this range, the multimodal data model is most closely integrated with the CAD system, i.e., the highest efficiency is achieved. A high integration rate at this point means smoother collaboration between the two and a corresponding increase in project processing speed. It is worth noting that in both the left and right figures, the fusion rate in the range of 30 bytes to 90 bytes exceeds 4%. This suggests that the experimentally developed model is scientifically reliable and effective across a wide range of item sizes. These results validate the feasibility and practicability of combining multimodal data models with CAD systems and provide strong support for further research and application. When and in the figure, the trend of item processing speed under different fusion rates can be clearly observed. The processing speed tends to be faster under high fusion rates, while the processing speed is relatively slower under low fusion rates. These results provide an intuitive understanding of the impact of the degree of fusion between multimodal data models and CAD systems and provide an important reference for further optimization of collaboration techniques.

With the continuous development of modern technology, the field of art design has gradually ushered in more subtle changes. Through the application of multimodal models, designers can make fine adjustments to the colour blocks at the pixel level, so as to achieve more accurate and personalized design effects. In this paper, for the two pixels of blue and white, different design experiments are carried out by using synergetic technology, and the results are shown in Fig. 6 below.

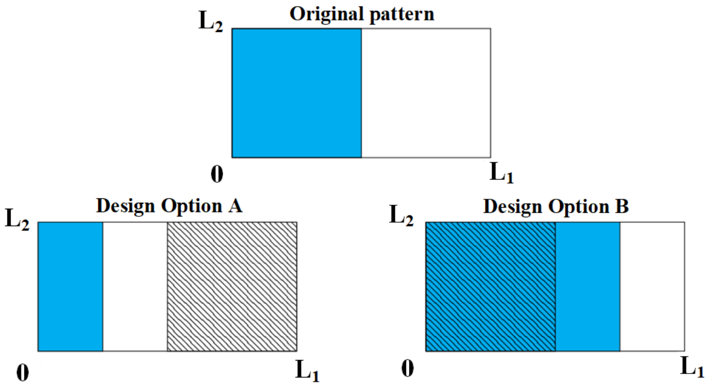

Figure 6: Multi-modal modeling for art design pixels.

In Figure 6, different design effects for blue and white pixel points based on the synergy technique are shown. In scheme A, the blue colour is halved and a shadow of wavy lines is added to the white area. In scheme B, the blue colour was added with a shadow and half of the white part was changed to blue. Both scenarios increase the richness of the design, add variation to the design from the pixel dimension, and enhance the texture in general. With the fine-tuning of the multimodal model, it is possible to observe the trend of blue and white pixel points in the design, showing different aesthetics and visual effects. These results highlight the potential application of multimodal modelling and collaborative techniques in art design, providing designers with richer and more flexible design tools.

This article mainly elaborates on the training process of the human-machine collaboration model, including the application process of the interaction module in the generator. Elaborate on the relevant details and parameter settings of the channel-based mechanism in the discriminator. The attention mechanism can effectively assist the model in focusing on certain key pixel positions in the generated image. Secondly, the specific process of the AMS CycleGAN model was described, and a brief introduction was given to the loss functions and related weight settings included in the AMS CycleGAN model. Finally, to demonstrate the superiority of the proposed model, quantitative and qualitative experimental comparisons were conducted with existing methods on the photo2monet and photo2vangogh datasets, as well as on the monet2photo and vangogh2photo datasets. The results of the model satisfaction questionnaire are shown in Figure 7.

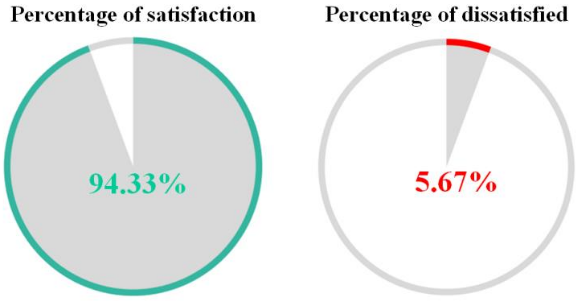

Figure 7: Model Satisfaction Questionnaire Results.

5 SUMMARY

This research project starts from the perspective of multimodal interaction and proposes a design optimization method that aligns perception channels with functional interaction modes. In specific functional design, more emphasis is placed on the matching degree between "perception channels" and behavioural research. From the combination of user psychology and product design in outdoor offices to extracting the interaction path between people and products as one of the innovative points. And then guide users to achieve their target behaviour. Ultimately, a more comprehensive perspective was achieved to consider office activities carried out in situations with significant scene limitations. It has certain application value in the direction of integrating visual and auditory touch modes, which correspond to the visual and auditory channels and touch and colour modes. By analyzing the results of the questionnaire of the cooperative experiment, the feasibility and effectiveness of multimodal modelling and collaborative technology in fine art design were verified, and the following conclusions were drawn: the fusion of multimodal data and CAD collaborative design technology can improve the efficiency and quality of fine art design, and enhance the communication and cooperation among designers. Multimodal data enriches the expression of design information and makes the design process more flexible and efficient. Domestic and foreign-related research shows that the progress of foreign countries in multimodal data and CAD co-design technology is relatively more significant, but the country has also gradually increased its research efforts, which is expected to narrow the gap with the foreign technology level. Dynamic multimodal model based on random forest algorithms brings new possibilities for art design, solving related sub-problems by multi-task optimization to find a set of optimal models, making the design process more flexible and efficient. The results of cooperative experiments show that the multimodal model and collaborative technology have been recognized and affirmed by a large number of students in practice, and 94.33% of the students are satisfied with the multimodal model, which further verifies the feasibility and practicality of the research results. In summary, the results of this research have introduced a new way of thinking and technical means for the field of art design, provided designers with richer and more flexible tools and methods, and promoted the field of art design to take a greater step towards digitalization and intelligent development. In the future, the research on multimodal data and CAD co-design technology can be further deepened to explore more application scenarios and optimization schemes, so as to make greater contributions to the development of the field of fine art design.

Although this study has made some progress in exploring the fusion of multimodal data and CAD co-design techniques in art design, there are still some shortcomings. First, this study mainly focuses on the establishment and fusion testing of multimodal dynamic models based on the Random Forest algorithm and lacks a comparative analysis of other machine learning algorithms or deep learning methods, so there may be limitations in terms of model performance and efficiency. Secondly, the scope of cooperation in this study is limited, only with the art school of a university to conduct cooperative experiments, for other schools or organizations of the practical application has not yet been explored in depth, so in terms of practicality and universality is yet to be further verified. In addition, this study used both offline and online methods in the distribution and collection of the questionnaire, and although the questionnaire coverage is as broad as possible to ensure the questionnaire coverage, there may still be some sample bias and insufficient data collection. In view of the above shortcomings, future research can be carried out in several ways. First, the scope of cooperation can be further expanded to cooperate with more art colleges or design organizations to collect more practical application data and verify the applicability and effect of multimodal data and CAD co-design technology in different environments and scenarios. Secondly, more advanced machine learning algorithms or deep learning methods can be explored for comparative studies in multimodal data processing and CAD co-design to improve the performance and efficiency of the models. In addition, the research and analysis of the actual needs in the field of art design can be strengthened, and solutions can be targeted to provide designers with richer and more flexible tools and methods. Finally, the theoretical research on multimodal data processing technology and CAD co-design technology can be further deepened to explore their potential applications in art design innovation and expression and to promote the digital and intelligent development of the art design field. Through continuous improvement and refinement, the multimodal data and CAD co-design technology can be applied to the actual art design practice and make greater contributions to the development of the art design field.

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