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Computer-Aided Design and Applications

Design and Visualization of Arts and Crafts Based on Simulated Annealing Algorithm

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Abstract. CAD technology, with its high precision and efficiency, is gradually becoming a powerful assistant for designers. It is worth mentioning that with the help of 3D modelling and rendering technology, CAD enables the visual presentation of design effects, greatly facilitating communication between designers and clients. The core of this study is to explore in depth the best application methods and optimization methods of CAD in the design of arts and crafts. To this end, we creatively integrated the simulated annealing algorithm (SAA), striving to achieve new heights in design accuracy and efficiency. In addition, the study also conducted visual CAD and art design research in the field of education. By analyzing the accuracy of the SAA algorithm and the visual effect of visualization, the accuracy and efficiency status results that customers can understand were constructed. Thus, achieving the application strategy effect of the algorithm, this art field provides a reference value for algorithm design concepts. Thereby strengthening effective communication between designers and customers. At the same time, in the field of education, by introducing visual teaching methods, CAD technology has been successfully used to enrich teaching content, improve teaching quality, and open up a new path for the teaching of arts and crafts design.

Keywords: Arts and Crafts; CAD; Visual Teaching; Simulated Annealing Algorithm
DOI: https://doi.org/10.14733/cadaps.2024.S27.131-144

1 INTRODUCTION

Arts and crafts, as treasures of human civilization and art, have long held a pivotal position in people's daily lives. They not only embellish our living space but also serve as carriers of history and culture. In this era of rapid technological advancements, the design methods of traditional arts and crafts face unprecedented challenges. In exploring how information technology can inject new vitality into traditional ink painting creation, Amri et al. [1] designed and optimized an ink painting rendering algorithm based on deep learning frameworks and convolutional neural network models. This program can simulate the flowing and haloing effects of ink on rice paper, making computer-generated images closer to real ink paintings. Firstly, we utilized Python, a powerful programming language, to develop an ink rendering program. The goal of this technology is to leverage the power of computer science to combine the essence of traditional ink painting with modern technology, in order to create ink painting works with unique charm. Specifically, the VGG and Figure 2Vec models based on the Caffe architecture were successfully ported to the TensorFlow architecture. Through the combination of deep learning frameworks and convolutional neural network models, we have successfully achieved the function of rendering images in ink style. Then, they delved into deep learning techniques and applied them to the rendering of ink painting styles. These two models have excellent performance in the field of image processing, accurately capturing and simulating the style characteristics of ink painting. In addition, to facilitate user use and interaction, we have also built a server-side program for image ink-style rendering based on Node.js. Users only need to access our server through a browser to easily upload their images and see their effects converted into ink style in real time. With the help of Express, an excellent web framework, we have achieved the construction and display of front-end pages. This algorithm not only accurately identifies various elements of an image, but also vividly presents these elements in the form of ink painting, truly achieving a perfect combination of technology and art. This innovation not only breaks the limitations of traditional ink painting creation but also brings infinite possibilities to ink painting art. This program can receive images uploaded by users, perform ink-style rendering through algorithms, and return the results to the user. At the same time, he also adopted Express as the web framework and designed a simple and easy-to-use front-end page, through which users can easily upload images, view rendering results, and perform other operations [2].

The combination of artificial intelligence and computer-aided art design not only provides new creative tools and ideas for art designers but also promotes the deep integration and common development between the two. Deng and Chen [3] learned from artificial intelligence algorithms and models that computers can more accurately understand the intentions of designers, assisting in complex image processing, colour matching, and pattern design work. The combination of arts and crafts and computer-aided art design has further expanded the application scope of artificial intelligence in the field of arts and crafts design. Specifically, artificial intelligence can extract patterns and patterns hidden in a large amount of data through analysis and learning, providing designers with more accurate and scientific design suggestions. Traditionally, arts and crafts design mainly relies on the personal experience and inspiration of designers, and the design process is often full of uncertainty and subjectivity. Digital video is growing rapidly at an unprecedented pace and becoming an indispensable part of our lives. This transformation not only reflects the rapid development of technology but also demonstrates people's demand and pursuit of visual information. Guo and Li [4] proposed a revolutionary method of directly extracting I frames in arts and crafts videos. This method breaks through the limitations of traditional video retrieval algorithms that require decompression of video files before processing, greatly improving the efficiency and accuracy of video processing. From the perspective of the scene, this method also discusses how to use art and craft frames to obtain the smallest computer-aided unit in the video. By directly extracting frames, we can obtain key information in videos more quickly and directly, providing strong support for subsequent art design and creation. This not only helps to improve the quality of art and design but also promotes the information transformation of art and design activities, providing strong theoretical support for the extension of digital networks to art and design.

Jiang and Yang [5] proposed a painting-style feature extraction method based on convolutional neural networks to address the issue of low accuracy in traditional painting-style feature extraction methods. Firstly, quantify the parameters in the digital images of the artwork. Then, fusion technology is used to fuse feature parameters as input information. In order to further enhance the flexibility and scalability of the teaching mode, Liu and Yang [6] adopted the principle of modular design and constructed a contemporary art computer-aided design teaching mode based on the B/S mode MVC three-layer architecture mode. In order to extract the wind fusion features of artworks more accurately, they adopted a deep hash encoding method with a triple recombination structure. The experimental results show that regardless of how the recall value changes, the accuracy value of this method always remains at a high level, even above 0.7, while the AP value remains stable above

0.9. In this teaching mode, they chose Microsoft's ASP NET technology has been used as a development language to construct an information service-oriented creative teaching model based on IIS servers. This architecture pattern not only makes system maintenance and updates easier but also allows for flexible configuration and adjustment according to teaching needs. This model aims to inject new vitality and possibility into art design education through the open learning platform of the Internet. Artistic feature image classification is a challenging task in the multimedia field, with the core goal of accurately classifying images based on the emotional features triggered by the images. The artistic feature emotion image classification algorithm proposed by Liu et al. [7] undoubtedly injects new vitality into the field of image processing. This method fully utilizes the gradient information of all individuals in the population, optimizes the parameters of SuperNet, and achieves a more efficient architecture search. It not only accurately captures visual features closely related to emotional expression from images, but also breaks through the constraints of traditional image processing techniques, achieving an organic combination of visual features and semantic annotation. This algorithm is deeply inspired by art theory and has demonstrated outstanding innovative capabilities in feature extraction. In another study, Liu et al. [8] proposed a revolutionary direct encoding strategy. Meanwhile, they also proposed a new method for automatically designing CNN architectures, particularly suitable for hyperspectral image (HSI) classification tasks. In this innovative approach, Liu et al. cleverly encoded the CNN architecture as particles, each inheriting the parameters of SuperNet. Through this innovative algorithm, Liu et al. successfully achieved precise classification of image emotions. They conducted a series of complex calculations and analyses to explore the emotional information in the image deeply and ultimately obtained satisfactory emotional classification results. This not only improves the accuracy of the algorithm but also greatly shortens the calculation time, providing great convenience for practical applications. This method can automatically adjust and optimize the CNN architecture based on the characteristics of HSI, thereby better adapting to complex image classification requirements. This not only requires designers to have profound professional knowledge but also requires a lot of time and effort to make fine adjustments and optimizations.

The unique advantages of CAD technology in the design of arts and crafts are increasingly prominent. Its high-precision measurement and calculation capabilities effectively reduce errors in manual drawing and enhance the feasibility of design. Meanwhile, through 3D modelling and rendering, the designer's design philosophy is perfectly demonstrated. Moreover, CAD technology has brought great convenience to the production of arts and crafts. Related studies have also shown that CAD technology can assist in completing tedious and repetitive tasks, generating visual and touchable handicraft models, inspecting product appearance and structural design, and thus shortening product launch time.

However, to fully tap into the potential of CAD technology in the design of arts and crafts, further optimization methods need to be sought.

The core of this study is to explore CAD-based design methods for arts and crafts and optimize them in conjunction with SAA. Firstly, we will conduct an in-depth analysis of the current application status of CAD technology in the design of arts and crafts, clarifying its role and positioning. Then, through specific cases and practical experience, extract a set of effective design methods. In the optimization design phase, the principle and implementation steps of SAA will be elaborated in detail, demonstrating its specific application in the design of arts and crafts. In addition, we will also explore how to integrate CAD technology into the teaching of arts and crafts design, using intuitive visual teaching methods to stimulate students' interest in learning and improve their practical abilities. The innovation of this study lies in:

(1) This article delves into the application of CAD technology in the design of arts and crafts. We have designed core functions such as visualization using its precise modelling and efficient rendering characteristics. Significantly improved the efficiency and quality of arts and crafts design.

(2) In the optimization stage of arts and crafts design, this article innovatively introduces the SAA algorithm. This algorithm can locate the global optimal solution in a complex solution space, bringing an innovative optimization method, and promoting the intelligent process of design.

(3) A new visual teaching method based on CAD technology is proposed for the field of arts and crafts design education. This method utilizes intuitive and engaging teaching methods to help students master CAD technology more easily and effectively stimulate their learning enthusiasm and practical abilities.

In the opening section, the key and application background of CAD technology in the design of arts and crafts are first outlined. Furthermore, crafts based on CAD technology were elaborated in detail, and optimized through the SAA algorithm. Subsequently, the visualization teaching methods for the design of arts and crafts were discussed. Finally, the effectiveness of the proposed method and strategy was verified through experimental data, and the research results were summarized. At the same time, future development directions were also discussed.

2 RELATED WORK

The introduction of CAD technology in arts and crafts teaching provides new possibilities for visual teaching. Through CAD software, teachers can easily present complex processes and design principles to students in an intuitive way, helping them better understand and master relevant knowledge. In the ceramic design course, teachers can use CAD software for 3D modelling and rendering, presenting the shape, structure, and texture of ceramics realistically. CAD technology can also assist students in creative design. By learning and mastering CAD technology, students can have more freedom to create and design, and express their ideas and ideas in a more precise and intuitive way. Art iconography is a discipline that specializes in studying the visual content of artworks, delving into the themes and connotations of artworks, and exploring their ways of expression. Researchers in art iconography are committed to interpreting the deep meaning of artworks, tracing their historical origins, and analyzing the mutual influence between artists and artworks. Milani and Fraternali [9] introduced a brand new painting dataset designed specifically for image classification, aimed at application in art image recognition. Their classifier demonstrated excellent performance. The new possibilities for the research and education of art imagery. Digital technology field of arts and crafts, existing technologies have not yet fully met the requirements of participatory design. Currently, simulation software mostly focuses on technical-level simulation, while neglecting the friendliness and ease of use of the user interface. Regarding this issue [10]. Participatory design emphasizes close collaboration between designers and users, continuously improving design solutions through user feedback and suggestions. They defined the basic requirements for software tools aimed at effectively conducting computer-aided participatory arts and crafts design through practical cases and data analysis. Study the visual content of a work by considering the themes and their expressions depicted in the work. Pinciroli et al. [11] exposed through neural models that the appropriate classification method relies on image regions that contribute the most to classification. Computer vision technology has shown its unique charm and potential in the field of art in recent years. Researchers have successfully utilized this technology to identify image themes in paintings, providing a new perspective for in-depth analysis of artistic works. The salient regions calculated through the CAM algorithm have been cleverly applied to estimate object-level bounding boxes, providing precise tools for object localization in artworks. The prominent image regions generated by it are not only wider and more continuous but also more effective in covering large image symbols, allowing us to capture key information in painting more comprehensively. In addition, it achieved a 31% success in mAP (mean average precision), demonstrating the broad application prospects of this technology in the field of art recognition.

The automatic recognition of neural network scripts, as a technological challenge, has long attracted the attention of many researchers. In practical operation, it usually requires manual intervention from experts in the professional field, from data preprocessing to model tuning, each step needs to be carefully designed and adjusted. To verify the effectiveness of this method, Sharma et al. [12] conducted computational experiments on eight different datasets. Compared to traditional machine learning algorithms, deep neural networks have shown impressive results in script recognition tasks, undoubtedly bringing new breakthroughs to related fields. They proposed a neural structure search method based on metaheuristic quantum particle swarm optimization (QPSO), which brings new possibilities for script recognition technology. The research goal of Xu et al. [13] is not to explore new theories or technological breakthroughs. This is not only an in-depth study and innovative expression of traditional patterns but also injects new vitality and concepts into the field of architectural design. However, it is dedicated to exploring the formal possibilities of cultural symbols in existing digital technologies. Through experimental attempts on existing buildings, Xu et al. successfully achieved the collision and integration of culture and technology, and the results of this collision were often unimaginable in the past. Their focus is on cleverly integrating these possibilities into existing buildings while maintaining spatial coherence. By combining digital technology with traditional architectural models, new vitality can be injected into traditional culture, making it shine with new brilliance in modern society. At the same time, it highlights its heterogeneity and highlights the uniqueness of the project. The profound significance of this study lies in its attempt to inject new concepts into traditional Chinese architectural models and create an innovative digital expression for them.

The application of art education is becoming increasingly widespread and in-depth. As an auxiliary teaching technology, computers not only greatly enrich the teaching content of art classes, but also provide students with more accurate and personalized learning suggestions. In this context, Yi [14] proposed a deep learning model system. This system has effective systematic educational technology segmentation for the decomposition and classification of educational art images. The recognition accuracy of its decomposed graphics is as high as 84.65%, which improved the performance by 26.29% compared to the traditional standard classification model. Through this design, the model can more accurately capture the complex features of artistic images, thereby achieving more accurate classification. Large-scale automatic painting analysis, as an outstanding representative of the integration of contemporary art and technology, is leading the research in the art field to a new stage. Painting is not only a visual presentation, but also contains rich emotions, thoughts, and cultural connotations. In the past, computer vision technology was the main tool for analyzing painting works. This technology can accurately extract and process the image features of painting works, enabling computers to understand and express artistic content. In this context, Zhao et al. [15] proposed a groundbreaking method. Graph convolutional networks can learn the deep relationships between words and documents, thereby extracting richer semantic information. It aims to leverage the powerful power of machine learning technology to perform deep classification and efficient retrieval of massive painting works, thereby opening a new window to the world of art for us. In this way, computers can not only understand the visual effects of painting but also the cultural connotations and emotional expressions behind it.

3 APPLICATION OF SAA

Traditional design methods often face many limitations, which not only suppress the innovative potential of design but also greatly reduce the diversity of design. In the practice of arts and crafts design, the SAA algorithm has shown a wide range of application prospects. The SAA algorithm can optimize the design process, improve design efficiency, reduce design costs, and inject new vitality into the development of the field of arts and crafts design. Introducing the SAA algorithm to optimize the process of arts and crafts design is an innovative attempt. It can be applied in various aspects such as shape adjustment, material selection, colour combination, etc., helping designers to design more flexibly and create more diverse and innovative works.

Taking form adjustment as an example, designers can transform design challenges into optimization tasks by clarifying. The objective function can be set based on specific design requirements, such as aesthetics, structural stability, or manufacturing costs. Constraints may involve elements such as geometric configuration and physical characteristics of the design. Subsequently, using the SAA algorithm, search for a design solution in the solution space that satisfies both constraint conditions and maximizes the objective function.

In addition, this study also adopted Convolutional Neural Networks (CNN) as the key architecture for designing image feature extraction. Through multi-level convolution and pooling operations, we can accurately capture the unique features of art and craft design (as shown in Figure 1), laying a solid foundation for further optimization of design.

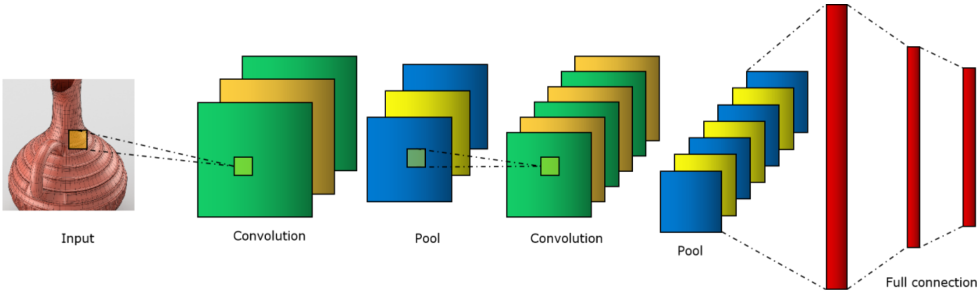

Figure 1: CNN model.

The introduction of the Structural Adaptive Algorithm (SAA) provides a possible solution to this challenge. Combined with CNN models, SAA can fully utilize the advantages of CNN in feature extraction and representation learning. However, even on the basis of such powerful algorithms, there is still a challenge of improving model accuracy further while maintaining efficiency. By integrating SAA into CNN models, the depth, width, and connectivity of network layers can be dynamically adjusted according to the characteristics of training data to meet the needs of different design optimization tasks. However, in the field of arts and crafts design, its fixed network architecture and parameter configuration may make it difficult to capture the subtle changes and innovative elements of design fully. Combined with actual design requirements, the concept of the objective function and adjacent solutions is defined. SAA can gradually explore the best design strategy, thereby improving the efficiency and accuracy of arts and crafts design. The application of this method helps to break free from the constraints of local optimal solutions and find the global optimal solution. The probability here can be explained as:

$$p = \exp\left(\frac{-\Delta E}{kT}\right) \tag{1}$$

The selection of initial temperature needs to consider the complexity of the design and the size of the search space to ensure that the algorithm can fully explore various possibilities. The objective function is the standard for evaluating the quality of a design scheme, which can be set based on factors such as design objectives, user needs, aesthetic standards, etc. The cooling coefficient determines the rate of temperature decrease and affects the convergence speed and quality of the algorithm. Adjacent solutions represent possible alternative solutions in the design space, and their variations can reflect the diversity and innovation of the design.

$$I\begin{bmatrix} a_1 & a_2 & \cdots & a_n \\ b_1 & b_2 & \cdots & b_n \\ c_1 & c_2 & \cdots & c_n \end{bmatrix} \tag{2}$$

$$\Delta f = f\ \ j\ - f\ \ i \tag{3}$$

Which need to calculate their expected and variance values separately. This process is a crucial step in data analysis, which helps us gain a deeper understanding of the distribution characteristics and degree of variation of the data and provides important references for subsequent optimization designs.

$$avg\ \ X\ \ a_i\ \ = \frac{1}{g_i}\sum_{j=1}^{g_i} a_{ji} \quad i = 1,2,\ldots,m \tag{4}$$

$$std\left(X\left(a_i\right)\right)=\sqrt{\frac{1}{g_i-1}\sum_{j=1}^{g_i}\left(x_i\left(a_i\right)-avg\left(X\left(a_i\right)\right)\right)^2}\quad i=1,2,\ldots,m \tag{5}$$

$$x_j\left(a_i\right)=\frac{x_i\left(a_i\right)-avg\left(X\left(a_i\right)\right)}{std\left(X\left(a_i\right)\right)} \tag{6}$$

The sample data follows the normal distribution $N\left(0,1\right)$, and the dimensional differences between each attribute have been eliminated.

The SAA algorithm demonstrates strong global search capability, which can accurately locate the global optimal solution in a complex parameter space, effectively avoiding the dilemma of falling into local optima. This advantage enables the model to explore various possibilities of design more deeply and discover more creative design solutions. By adopting SAA, we can flexibly adjust the optimization process according to different design requirements and objective functions, thereby achieving more precise design optimization. When SAA is combined with CNN models, the design optimization process can be automated, greatly reducing reliance on manual operations. However, as shown in Figure 2, due to the influence of lighting conditions and reflectivity, the obtained images of arts and crafts often have problems.

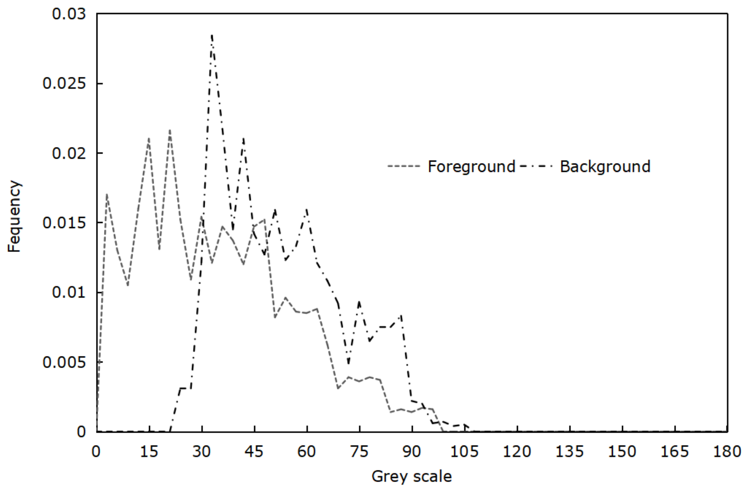

Figure 2: Grayscale distribution.

Under this setting, the maximum classification spacing is defined as $\frac{2}{\|w\|}$. Seeking to maximize the classification interval is actually equivalent to pursuing the minimization $\|w\|$. Therefore, the original problem can be transformed into the following form:

$$\begin{cases}\min\frac{1}{2}\|w\|^2\\ s.t.y_i\left(w^Tx_i+b\right)\geq 1,i=1,2,\cdots,n\end{cases} \tag{7}$$

In the classification task of machine learning, the setting of classification hyperplanes plays a crucial role. This hyperplane is actually a decision boundary that divides the feature space into different regions, each corresponding to a category. In classification tasks, we usually use a set of labelled sample data to train the model. Each sample has an index that identifies its position in the dataset. In addition, the Local Phase Quantization (LPQ) method is a commonly used feature extraction technique in image processing. By calculating the relationship between the position of the sample in the feature space and the classification hyperplane, we can determine the category attribution of the sample.

It is based on the fuzzy invariance of the Fourier phase spectrum and can effectively extract local phase information from images. Through this method, we can capture some important texture and structural features from the image, providing strong support for subsequent classification or recognition tasks. In addition to the classification hyperplane itself, we also need to consider two classification boundaries located on either side of the hyperplane. Another one is located on the other side of the hyperplane and belongs to another category; The area located between two boundaries is considered an uncertain area, by selecting a rectangular area around each pixel in the image and calculating a two-dimensional Short Time Fourier Transform (STFT). When implementing LPQ, it checks the local neighborhood N_x of each pixel x in image $f(x)$ to extract the corresponding phase information:

$$F(u,x) = \sum_{y \in N_x} f(x-y) \exp(-j2\pi u^T y) = W_u^T f_x \tag{8}$$

In the given expression, W_u is used as the fundamental constituent element of the two-dimensional discrete Fourier transform, and it is a key component. At the same time, f_x is not just a simple vector, it actually carries information on all grayscale levels in the N_x neighbourhood, forming a complete set of grayscale values.

The mutation step in the SAA algorithm is actually a fine coding adjustment process. In this process, each sample point is assigned multiple potential encoding values. Mutation is not just a random replacement process, it is based on the preset mutation probability P_i, replacing the current encoding value with other optional encoding values at a specific encoding position of the sample point. This process requires each sample point to be operated on one by one. Based on an accurately calculated probability P_i, a new encoding value is selected from the existing category encoding of the sample points to replace the original encoding, thus forming a brand new individual representation. The probability of this mutation, we call it P_i, is defined in a unique way that ensures the flexibility and controllability of the mutation process.

$$P_i = \frac{1.5 \times d_{\max}(x_i) - d(x_i - c_k) + 0.5}{\sum_{k=1}^{k} \left[1.5 \times d_{\max}(x_i) - d(x_i - c_k) + 0.5\right]} \tag{9}$$

In this context, $d(x_i - c_k)$ represents the spatial straight-line distance between the sample x_i and the centre point c_k of the kth cluster, which is the Euclidean distance.

For consumers, the quality, appearance design, and market acceptance of arts and crafts together shape their overall impression and selection preferences for the product (see Figure 3 for details).

In order to minimize the impact of errors generated during feature extraction on recognition performance, it is necessary to satisfy a condition for the fuzzy distribution. When the difference in features is large, the distribution curve can quickly decline. The expression of this fuzzy distribution function is as follows:

$$\mu(x) = \frac{1}{2} - \frac{1}{2}\sin\frac{\pi}{a_2 - a_1}\left(x - \frac{a_1 + a_2}{2}\right) \tag{10}$$

Technical factors	Appearance factors	Market factors
Including material selection, material treatment and manufacturing technology	Material, color and shape	Economic development, government policies, consumer market demand, knowledge resource endowment, industry competition pattern

Figure 3: Product factors.

This formula x represents the degree of feature difference. Based on the fuzzy distribution function, a membership matrix μ was constructed to represent the correlation between features of the same dimension:

$$\mu = \begin{bmatrix} \mu_{11} & \mu_{12} & \cdots & \mu_{1Q} \\ \mu_{21} & \mu_{22} & \cdots & \mu_{2Q} \\ \vdots & \vdots & \ddots & \vdots \\ \mu_{M1} & \mu_{M2} & \cdots & \mu_{MQ} \end{bmatrix} \tag{11}$$

The distribution of product characteristics on pixel value $H\ v$ is as follows:

$$H\ v = L_{xx}\ x,\sigma + \frac{1}{\sqrt{L_{yy}}}\exp\left(\frac{j\pi}{4}\right)\exp\left[\frac{-j\pi}{L_{yy} S\ t}\right] \tag{12}$$

Especially in the feature decomposition process of product design images, we can obtain high-frequency and low-frequency coefficients through wavelet transform. An excessively high annealing temperature may lead to premature convergence of the algorithm to the local optimal solution, while a temperature that is too low may cause the convergence speed of the algorithm to be too slow. However, despite the enormous potential of Structural Adaptive Algorithm (SAA) in the field of industrial and artistic design optimization, its actual performance and effectiveness are still constrained by various factors. This measurement indicator not only reflects the degree of blurriness of images at different scales but also provides key reference information for subsequent image-processing tasks. When delving into the application of multi-scale transformation in image processing, we note that ambiguity measurement plays a crucial role. The coefficients not only reveal the detailed information in the image but also provide us with a deeper understanding of the overall structure of the image.

4 RESULT ANALYSIS AND DISCUSSION

In the progress of this study, a critical stage underwent meticulous revisions and improvements to ensure the accuracy of the experiment and the robustness of the results. Observing the actual scene test results shown in Figure 4, the technology proposed in this study significantly improves the quality of artistic product images and successfully preserves rich details.

Noise, as an unnecessary and random interfering element in an image, can weaken the overall quality of the image and damage the visual experience. The method of this study has made significant progress in this regard, resulting in clearer and purer visual effects in artistic images.

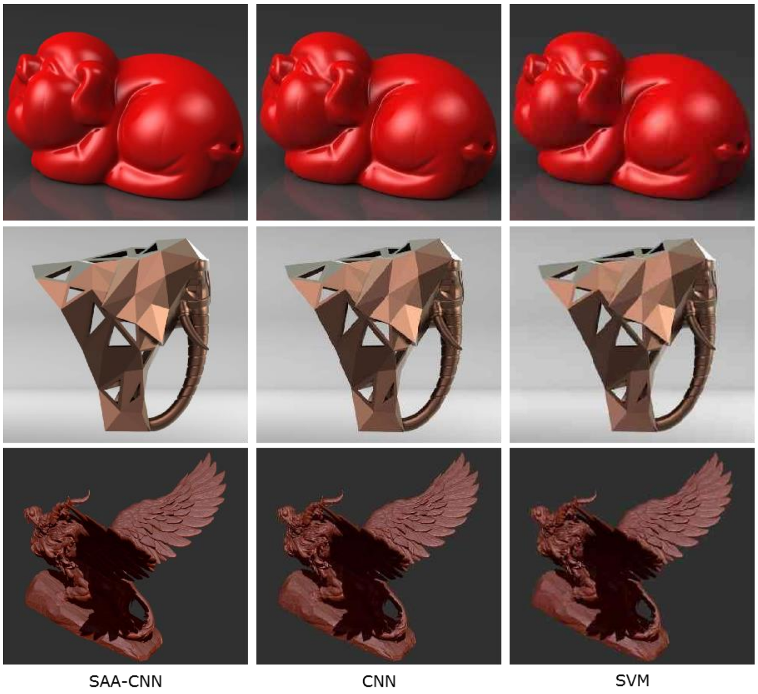

Figure 4: Visual effects example.

In the field of image processing, preserving details is crucial for maintaining the integrity and realism of images. Traditional image enhancement techniques often inevitably damage the delicate layers of the image while removing noise, which may weaken the three-dimensional sense and texture of the image. The new method in this study not only effectively suppresses noise but also successfully maintains the fine details of texture in artistic works. These details are crucial for the beauty and artistic expression of artistic works, and their preservation is of great significance for improving the overall quality of images.

The test results in actual scenarios have confirmed the effectiveness and reliability of this research method. In real-world applications, methods that can adapt to the complexity of different environments are truly valuable. Through practical application and evaluation in the environment, this study confirms the stability and practicality of the proposed method, providing a solid foundation for its widespread adoption in the fields of art and handicraft design.

The significantly reduced error rate means that in practical applications, the algorithm proposed in this study can more accurately recognize and classify images, reducing the occurrence of erroneous judgments and omissions.

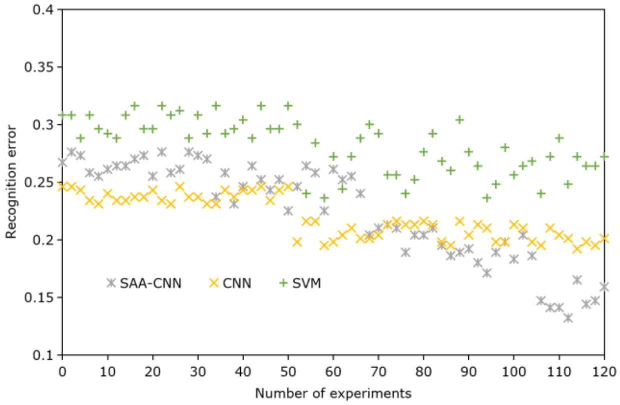

Figure 5: Feature extraction error.

Figure 5 shows the result of feature extraction errors. Traditional CNN may encounter performance bottlenecks when dealing with highly complex visual information. This is mainly because they rely on filters to capture local features of the image and reduce the dimensionality of these features through subsampling steps. In dealing with ever-changing textures, shapes, or colours, such frameworks often struggle to accurately capture subtle distinguishing elements, which may lead to a decrease in accuracy in classification or recognition tasks.

To overcome this challenge, this study introduces a method combined with SAA, which aims to more comprehensively analyze image data. As a global optimization technique, SAA can search for the best solution in complex solution spaces. When applied to image analysis, SAA assists the algorithm in overcoming the limitations of locally optimal solutions and extensively exploring characteristic domains to discover more representative and recognizable image attributes.

Normalization of grayscale is a key preprocessing step in the image processing process. Its goal is to scale the grayscale values of an image to a specific range, in order to reduce grayscale fluctuations caused by different lighting conditions or shooting environments. The advantage of grayscale normalization is to make objects or regions in the image appear more consistent at the grayscale level. This provides a more robust data foundation for subsequent processing steps such as feature extraction and classification.

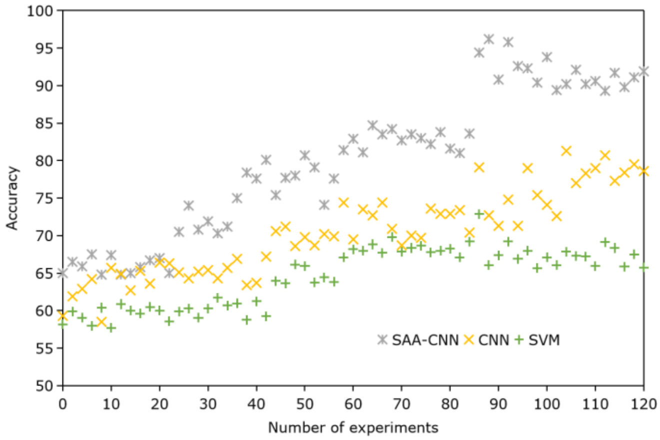

Figure 6: Normalization effect of grayscale.

Observing the data shown in Figure 6, it is evident that the success rate of image classification and recognition has been significantly improved after grayscale standardization. This result confirms the positive effect of grayscale standardization on improving the performance of image recognition systems. The enhancement of accuracy may be due to the effective suppression of lighting differences and grayscale fluctuations in the image by grayscale standardization, which often has a negative impact on the discriminative ability of the recognition system. After standardization, the system can more accurately focus on key visual attributes such as shape and texture, and Figure 7 shows the accuracy evaluation results under different viewing conditions. As the number of experiments increases, the recognition accuracy not only gradually improves but also tends to stabilize. This growth trend indicates the continuous optimization of algorithms in the learning process. More trials provide the algorithm with a richer dataset, enabling it to more effectively adapt to and identify various angle changes.

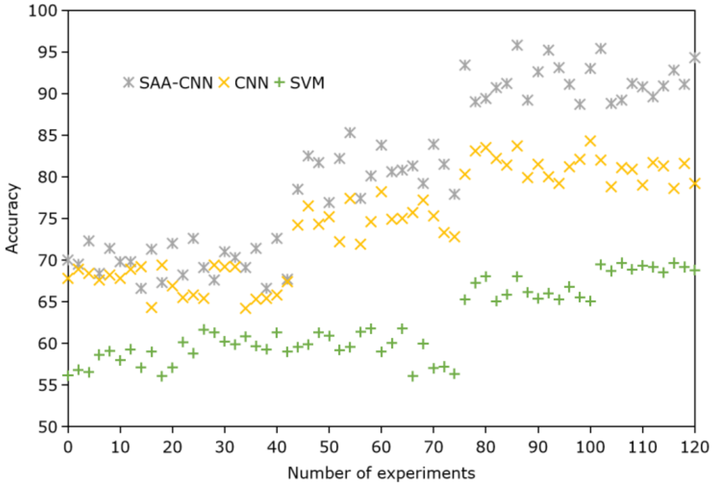

Figure 7: Accuracy under multiple perspectives.

In real-world scenarios, the perspective of objects often varies greatly, which undoubtedly poses a serious challenge to the stability of testing algorithms. In the field of traditional art and handicraft design training, the teaching mode often focuses on imparting theoretical knowledge and training manual painting skills. With the introduction of CAD technology, teaching modes have undergone profound changes. This vivid and concrete teaching method greatly stimulates students' interest and ignites their enthusiasm for exploring arts and crafts design. With the help of CAD technology, teachers can dynamically demonstrate the entire design process, enabling students to intuitively observe every specific step from creative conception to the final product. From Figure 7, we can clearly see that the testing algorithm has demonstrated excellent performance in multi-angle recognition, which undoubtedly enhances its practicality in practical applications. However, this abstract teaching method often confuses students and makes it difficult to truly grasp the essence of design. For robust algorithms, adapting to these common angle changes is an indispensable ability. Only in this way can it maintain stable performance in complex and ever-changing real-world environments.

By personally operating CAD software, students can simulate the real design process, from conceptualization to modelling, and then to adjust details, each step is full of challenges and fun. In addition, CAD software also provides a convenient platform for communication between teachers and students. Teachers can remotely view students' design progress through online platforms and provide timely feedback and guidance. The real-time feedback function provided by the software allows them to see the design effect in real time and make adjustments and optimizations as needed.

This complementary online and offline teaching method not only improves teaching efficiency but also provides students with a more flexible learning experience. This interactive learning method not only helps students to have a deeper understanding of design principles and technical points but also invisibly exercises their practical and problem-solving abilities. It can be said that the emergence of CAD software has injected new vitality into design education. It enables students to learn through practice, grow through exploration, and lay a solid foundation for their future design journey.

5 CONCLUSIONS

This article elaborates on the recognition of artwork images designed specifically for the art field. In order to comprehensively evaluate the performance of the model, this article also conducted additional tests on a set of images related to the exhibits. This makes the task more similar to an out-of-distribution detection problem, further increasing the difficulty and practicality of the benchmark. This benchmark dataset not only has a large scale, but also contains many challenges, such as high similarity between various artworks, long tail data distribution, and a large number of categories covered. In the experiment, we found that effectively combining self-supervised and supervised contrastive learning to train backbone networks for non-parametric classification is a highly promising and promising research direction. The design of this benchmark dataset follows the paradigm of similar datasets in other fields in recent years, such as level recognition in different fields, aimed at encouraging researchers to develop more domain-independent methods. This method not only fully utilizes unlabeled data for pre-training and improves the model's generalization ability but also further fine-tunes the model through supervised learning to achieve better performance on specific tasks. Looking ahead to the future, further exploration and improvement of relevant algorithms will help address more complex image-processing challenges and promote the sustained development of this technology.

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