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Computer-Aided Design AND APPLICATIONS

Style Conversion of Fine Arts Based on Deep Learning Algorithms and CAD Technology

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Abstract. The data of artworks is highly complex and unstructured, and effectively representing and processing this data is a challenge. Computer-aided design (CAD) technology can be used for precise modeling and rendering and to assist artists in creating and modifying virtual environments. The combination of deep learning (DL) and CAD not only helps to transform the style of artworks but also enables deeper data mining (DM) and analysis of artworks. By separating the content and style representation of images and using DL technology for style recognition and transformation, this study verifies the effectiveness of this method in art creation and research. The method based on Convolutional Neural Networks (CNN) has higher accuracy in style recognition. The style recognition and transformation method of artworks based on DL provides new possibilities for art creation and research and an innovative means for protecting and inheriting traditional culture.

Keywords: Deep Learning; CAD; Art Works; Style Conversion; Data Mining
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1 INTRODUCTION

Due to the rapid development of information technology, people are in an era of data explosion. These potential values also bring many challenges. Extracting useful information from these data, identifying hidden patterns, and providing support for decision-making have become important issues facing today's society. CAD technology converts artistic style into color language, converting and adjusting the style and color of design works. This technology can transform one design style or color language into another, making design work more personalized and innovative. Cao [1] uses CAD technology to adjust the colors in design works, including achieving better visual effects and artistic expression. CAD technology can convert one design style into another, such as converting modern style into classical style or converting minimalist style into complex style, etc. This transformation can increase the diversity and innovation of design works. Through the interactive design function of CAD technology, designers can interact with the audience and adjust design

elements and color language in real time based on audience feedback. Looking forward to seeing more innovative works that integrate traditional and modern art elements, showcasing unique charm. At the same time, designers have also adapted to constantly changing market demands and audience aesthetics. DM is the stage of extracting useful information hidden in a large amount of data. It combines theories and technologies from disciplines such as statistics, computer science, mathematics, and data science to process and analyze large amounts of data through specific algorithms, discovering correlations, trends, and patterns between data.

As an important branch of traditional art, arts and crafts have a long history and rich cultural connotations. Deng and Chen [2] explored the artificial intelligence interaction research between deep learning algorithms and CAD technology in the style transformation of arts and crafts, providing new ideas and methods for the inheritance and innovation of arts and crafts. Deep learning algorithms can extract style features from a large amount of image data and apply them to the transformation of artistic and craft styles. In the style transformation of arts and crafts, identifying and extracting the style features of different arts and crafts works helps designers to carry out style transformation and innovative design. At the same time, deep learning algorithms can also provide inspiration and guidance for designers, helping them create more unique and creative arts and crafts works. CAD technology is a digital design tool that can assist designers in modeling, rendering, animation production, and other operations. In the transformation of art and craftsmanship styles, CAD technology can help designers design and produce their works. Through CAD software, designers can design and produce more efficiently, achieving more refined and realistic design effects. Meanwhile, CAD technology can also provide a digital way for designers to save and display their works, promoting their dissemination and promotion. It utilizes deep neural networks to simulate the learning stage of the human brain, automatically extracting features from data and processing complex nonlinear relationships. Deep learning technology is a 3D point cloud data processing method based on deep learning algorithms. Point cloud data processing based on deep learning can accurately replicate and reconstruct artworks. Artists can use this feature to explore different creative possibilities or provide more accurate references when creating new works. Through deep learning techniques, unique features or styles of artworks can be extracted and transferred to other works. This provides artists with an innovative way to integrate different artistic styles and create unique and innovative works. Improve the quality and efficiency of art creation. Art style transformation refers to the process of transforming an image from one style to another. In 3D point cloud data processing, artistic style transformation can help artists transform one form or structure of artwork into another form and structure of artwork. Through deep learning techniques, it is possible to extract the formal or structural features of an artwork and apply them to the creation of another artwork, achieving style transformation of the artwork. Thus guiding the creation of artworks. Through deep learning techniques, useful information and knowledge can be extracted, providing guidance and inspiration for the creation of artworks [3].

As an important base for cultivating future artistic talents, universities need to explore how to apply intelligent virtual reality technology and CAD technology to artistic creation and achieve a transformation of artistic style. Feng [4] combines intelligent virtual reality technology with CAD technology to explore its application in the transformation of artistic style in university art creation. Intelligent virtual reality technology provides a new way of creation and display for artistic creation. By manipulating elements in virtual space, achieve more realistic artistic effects. In college art creation, students can use intelligent virtual reality technology for experimental creation and explore forms of expression. Virtual reality technology can also provide an immersive display method for artworks, allowing viewers to deeply experience the artistic charm of the works. CAD technology is a digital design tool that can assist artists in modeling, rendering, animation production, and other operations. In college art creation, CAD technology can be used to assist in design, prototype production, and other aspects. Through CAD software, students can design and produce more efficiently, achieving more refined and realistic design effects. Meanwhile, CAD technology can also provide digital storage and display methods for artistic works, facilitating their dissemination and promotion. In the digital age, the integration of art and technology has become an irreversible trend. With the advancement of computer graphics and CAD technology, the art field has gradually become

digitized. CAD technology can not only be used for precise modeling and rendering but also assist artists in creating and modifying virtual environments. The combination of DL and CAD not only helps to transform the style of artistic works but also provides a more in-depth DM and analysis of artistic works. Through the DL algorithm, artists can transform the style of one painting into another while preserving the content and details of the original painting. CAD technology can provide a stable and efficient platform, making this style conversion more accurate and controllable.

The deep learning of CAD technology and art is becoming increasingly common. Among them, artistic style transformation and image segmentation are two important research directions. Through deep learning models such as Convolutional Neural Networks (CNN), different regions or objects in images can be automatically recognized and accurately segmented. This technology can help artists edit and process images more effectively, achieving more refined artistic creations. For example, in digital painting, artists can use deep learning techniques to automatically recognize and segment various elements in artwork for more accurate digital simulation or modification [5]. CAD technology is a digital design tool that can assist artists in modeling, rendering, animation production, and other operations. In art style conversion, CAD technology can help artists create and produce works. Through CAD software, artists can design and produce more efficiently, achieving finer and more realistic design effects. Meanwhile, CAD technology can also provide artists with a digital way to preserve and showcase their creations, promoting the dissemination and promotion of their works. CAD technology mainly focuses on two aspects: image processing and style conversion. Image processing can convert images into different styles by adjusting parameters such as color, brightness, and contrast. Style conversion is the process of mapping an image from one style to another to create a new artistic style. Through CAD technology, artists can more flexibly transform their artistic styles and innovate their designs.

CAD technology also provides researchers with a new perspective to examine and understand artworks, making it possible to preserve, disseminate, and analyze artworks digitally. Effectively classifying and recognizing massive 3D sensor data is a challenging problem. Deep learning technology, as a powerful machine learning technique, provides new solutions for the classification of three-dimensional sensor data. Griffiths and Boehm [6] outlined the application of deep learning techniques in 3D sensor data classification. Deep learning technology constructs multilayer neural network models by simulating the connections of human brain neurons. Deep learning models are typically trained on large amounts of data, which endows the model with better generalization ability. When dealing with complex and nonlinear data, deep learning models perform better than traditional methods. In addition, due to its hierarchical structure, deep learning models also have better robustness when dealing with lost or noisy data. Convolutional neural networks are a commonly used deep learning model suitable for processing two-dimensional data such as images and videos. In 3D sensor data classification, 3D images or videos can be converted into 2D images or videos, and then CNN can be used for classification. CNN can automatically extract features from images or videos and achieve data classification and recognition through multilayer convolution and pooling operations. Despite having powerful data processing and analysis tools, DM still faces many challenges in the field of art. The data of artistic works is highly complex and unstructured, and effectively representing and processing this data is a challenge. The creative stage of an artwork often involves many factors and complex background knowledge. How to accurately understand and interpret these data is also a challenge. In the field of visual arts, the rise of DL technology provides artists and researchers with a new perspective to explore the creative process of artworks, the transformation of artistic styles, and DM. As an art form with a profound cultural heritage, the color rendering and design of New Year paintings have always been a challenging issue. The client accesses the server through a browser, and the server is responsible for processing user requests and returning the results to the client. This architecture has advantages such as cross-platform, easy maintenance, and scalability. Guo [7] provides various color selection methods, including fixed colors, custom colors, etc. Users can choose the appropriate color for drawing according to their own needs. It provides color adjustment functions, including adjusting parameters such as brightness, contrast, saturation, etc. Users can adjust colors as needed to achieve better visual effects. The front end is developed using technologies such as HTML, CSS, and JavaScript. HTML and CSS are used to build page layouts and styles, and

JavaScript is used to achieve interactive functionality and data processing. At the same time, use the Canvas API to implement the drawing function of New Year's paintings. The system uses the MySQL database for data storage and management.

Art style conversion technology can convert images from one style to another, providing more possibilities for artistic creation. Meanwhile, CAD technology, as a digital design tool, can assist artists in modeling, rendering, animation production, and other operations. In art teaching, combining deep learning algorithms with CAD technology can help students transform and create artistic styles to improve their aesthetic ability and creativity. He and Sun [8] discussed algorithms and CAD techniques in art style transformation-assisted art teaching. Perform deep learning from a large amount of image data and apply it to the transformation of artistic styles. In art style transformation, deep learning algorithms can be used to identify and extract features of different art styles, helping students engage in style transformation and innovative design. In the process of artistic style transformation, CAD technology can help students model, render, create animations, and perform other operations on their works. Through CAD software, students can design and produce more efficiently, achieving more refined and realistic design effects. Meanwhile, CAD technology can also provide students with digital storage and display methods, facilitating the dissemination and promotion of works. The style transformation and DM of artworks based on DL and CAD is a research topic full of challenges and opportunities. It not only helps researchers to have a deeper understanding of the essence and laws of artistic creation but also provides strong technical support and innovative inspiration for artists and designers. With the deepening of research and the maturity of technology, the integration of art and technology will produce more significant results, bringing richer and more colorful experiences to human cultural life and artistic creation. This article constructs a style transformation and DM model for an artwork based on the DL algorithm and CAD technology. Firstly, the model learns and simulates the features of different styles of artwork through the DL algorithm. Then, DM technology was used to quantitatively and qualitatively analyze the converted artwork, revealing the underlying meaning behind the artwork.

(1) This study combines the DL algorithm with CAD technology and applies it to the style conversion and DM of artworks, thus realizing the organic combination of technology and art.

(2) Through the DL model, this method successfully simulates and learns the characteristics of various styles of artwork, which provides an algorithmic basis for style conversion.

(3) This method uses the high-precision modeling and rendering ability of CAD technology to ensure the accuracy and high quality of style conversion so that the converted works not only retain the essence of the original but also show a new style of artwork.

This article will first review the latest progress of DL in image processing and style conversion of artworks and then discuss the use of CAD in artistic creation and DM. Then, we will introduce the style conversion method of artworks based on the DL algorithm and CAD technology in detail and verify its effectiveness and feasibility through experiments. In addition, this article will use DM technology to analyze the converted artworks so as to reveal the internal relationship between different styles and the deep law of artistic creation.

2 RELATED WORK

How to apply these two technologies to the transformation of artistic style in primary school art teaching to improve students' artistic creation ability and aesthetic level is an important issue that needs to be explored at present. Hui et al. [9] explored the application of deep learning algorithms and CAD technology in the reform of primary school art teaching. It can extract style features from a large amount of image data and apply them to the transformation of artistic style. In primary school art teaching, teachers can use deep learning algorithms to grasp the characteristics of different art styles and improve their aesthetic and creative abilities. Meanwhile, deep learning algorithms can also provide inspiration and guidance for students to create more unique and creative works of art. CAD technology is a digital design tool that can assist artists in modeling, rendering, animation production, and other operations. In primary school art teaching, teachers can use CAD technology to

help students create artwork. Through CAD software, students can design and produce more efficiently, achieving more refined and realistic design effects. Meanwhile, CAD technology can also provide students with a digital way to save and showcase their works, promoting their dissemination and promotion. In the field of art, intelligent image detection systems can help artists, collectors, and researchers more accurately identify and compare artworks. Jang et al. [10] introduced an intelligent art image detection system. Deep learning techniques can be applied to object detection. In the intelligent art image detection system, object detection technology based on deep learning can help the system recognize various objects in the image, such as people, scenery, textures, etc. This system can learn the features and patterns of different objects, thereby achieving accurate detection of objects in images. Weber contrast is a method of measuring image contrast, which can be used to compare the similarity of different images. In the intelligent art image detection system, image comparison technology based on Weber contrast can help the system compare the similarities of different artworks. By calculating the Weber contrast values of different images, the system can determine the degree of similarity between them, thereby achieving classification and recognition of artistic works. Especially in terms of artistic style transformation, this software provides designers with new creative methods and broader creative space. Computer-aided design software can quickly and accurately process a large amount of design data, greatly improving design efficiency. This software is equipped with a large number of design resources, including various materials, textures, colors, etc., making it convenient for designers to choose and combine. Art style transformation mainly includes analyzing the characteristics of different art styles and using computer technology to transform one style into another. In environmental art design, artistic style transformation can help designers combine traditional art elements with modern design concepts, creating more personalized and charming works. Through image processing software, designers can adjust the color, brightness, contrast, and filter effects of images to achieve style conversion. 3D design software can help designers create highly realistic environmental models and achieve style transitions by adjusting parameters such as materials and textures. Interactive design software allows designers to interact with the audience, adjust design elements in real time based on audience feedback, and achieve style conversion [11].

In animation production, deep learning algorithms can be used to identify and extract art forms with different styles and features, helping designers innovate their designs. Meanwhile, deep learning algorithms can also provide inspiration and guidance for designers, helping them create more unique and creative art forms. Computer CAD-assisted design is a digital design tool that can assist designers in modeling, rendering, animation production, and other operations. In the design and production of shapes. Through CAD software, Jing and Song [12] have achieved higher design and production efficiency, achieving more refined and realistic design effects. This also provides a digital way for designers to preserve and showcase their designs, promoting the dissemination and promotion of their works. 3D immersive virtual reality technology has brought new perspectives and experiences to art consumption, allowing people to experience and understand artworks more deeply. Kim and Lee [13] discussed the impact and significance of 3D immersive virtual reality technology for the future. Virtual reality technology can combine various art forms, such as painting, sculpture, music, dance, etc., to create more diverse works of art and forms of expression. 3D immersive virtual reality technology provides artists with the ability to create richer and more diverse artworks and forms of expression through virtual reality technology, meeting the diverse needs of consumers. Experience more authentic sensory stimulation and emotional resonance, improving consumer engagement and satisfaction. The application of 3D immersive virtual reality technology will promote the diversified development of the art consumption market, provide consumers with more diverse artworks and experience methods, and promote the prosperity and development of the art market.

Although deep learning algorithms and CAD techniques are powerful, they are typically based on preset rules and algorithms. In some cases, this may limit the artist's creativity. Maintaining the freedom of artistic creation while using these tools is a balancing issue. Applying deep learning algorithms and CAD technology to computer graphic design requires integrating knowledge from multiple fields, including computer science, mathematics, art design, and graphic design. This

requires students to have an interdisciplinary knowledge background and comprehensive abilities. Kimani et al. [14] conducted an artistic style transformation of graphic design techniques among college students majoring in art and design and analyzed the reasons for it. Among them, one can master CAD basic technology and deep learning algorithms well, but the ability to transform artistic styles into computer graphic design skills still needs to be improved. Most students still cannot flexibly carry out projects, and there is still a significant gap in cultivating high-difficulty conversion skills and innovative thinking. Students majoring in art and design face many challenges in improving their computer graphic design skills to achieve artistic style transformation. In today's digital age, deep learning algorithms and CAD technology are widely used in the fields of art and design. College students majoring in art and design need to continuously improve their skills in artistic style transformation and computer graphic design to adapt to market demand and industry development trends. Traditional art creation is limited by the artist's own skills and imagination. Style conversion technology breaks this limitation and provides artists with a way to transform ordinary images or photos into unique works of art. This greatly expands the artist's creative expression space. In traditional art creation, artists need to spend a lot of time manually adjusting and modifying their works to achieve the expected style effect. Style conversion technology greatly improves creative efficiency through automation, allowing artists to complete their works faster. Style conversion technology can not only apply one artistic style to another image but also produce unique effects by mixing multiple styles or creating new ones. This provides a new way for artists to explore and express their creativity. Especially the application of deep learning algorithms in image processing and style transformation has brought infinite possibilities for artistic creation. By combining deep learning algorithms with CAD technology, Liu and Yang [15] explored a new computer-aided design mode for artistic style transformation, injecting new vitality into contemporary art creation. In art design, CAD also achieves more refined and realistic design effects. By using CAD software, designers can easily modify and optimize their design works, achieving more flexible and efficient design creation.

In the field of art, through deep learning algorithms and CAD technology, one style of image can be transformed into another style, providing more possibilities for artistic creation. Meanwhile, image retrieval technology can help users quickly find other images that are similar to the input image, providing users with a more intuitive experience. Lu et al. [16] utilized deep learning algorithms and CAD techniques to explore discrete deep hashing and sorting optimization techniques in art-style transformation image retrieval. Deep learning algorithms can extract style features from a large amount of image data and apply them to the transformation of artistic styles. In art style transformation, deep learning algorithms can be used to identify and extract images with different styles and features, helping artists perform style transformation and innovative design. Meanwhile, deep learning algorithms can also provide inspiration and guidance for artists to create more unique and creative works of art. Through CAD software, artists can design and produce more efficiently, achieving finer and more realistic design effects. Meanwhile, CAD technology can also provide artists with a digital way to preserve and showcase their creations, promoting the dissemination and promotion of their works. Perspective distortion related to artistic style refers to the distortion of image style and features caused by the perspective transformation of the image. In the field of art, this distortion has a significant impact on the visual effects and artistic style of images. To address this issue, Wan et al. [17] optimized the perspective transformation of images to maintain their style and features. The phase CAD technology based on particle swarm optimization can be applied to optimize perspective transformation. By adjusting the phase function, perspective transformation of the image can be achieved, thereby maintaining the style and features of the image. In order to verify the application effect of particle swarm optimization-based phase CAD technology in the extension of perspective distortion in images related to artistic style, we conducted practical research. Firstly, we selected some representative artworks as samples and optimized the perspective transformation using particle swarm optimization-based phase CAD technology. In practice, we have found that the phase CAD technology based on particle swarm optimization improves the accuracy of image perspective transformation. Through this approach, designers can gain a deeper understanding and mastery of different artistic styles, enhancing their aesthetic and creative abilities. This combination

approach can also provide inspiration and guidance for designers to create more unique and creative works of art.

In the context of new media, deep learning algorithms can help designers quickly generate images or videos with specific styles, providing more possibilities for new media content creation. Meanwhile, deep learning algorithms can also provide inspiration and guidance for designers, helping them create more unique and creative artworks. CAD technology, as a digital design tool, can assist designers in modeling, rendering, animation production, and other operations. In the context of new media, CAD technology can help designers create and produce works. Through CAD software, designers can design and produce more efficiently, achieving more refined and realistic design effects. Meanwhile, CAD technology can also provide designers with a digital way to preserve and showcase their works, promoting their dissemination and promotion. Integrating deep learning algorithms with CAD visual communication and interactive art style transformation in new media scenarios. Firstly, use deep learning algorithms to learn and extract artworks of different styles. Then, using CAD technology for modeling and design, different styles can be transformed and adjusted [18]. Through modeling software, students can learn how to create various shapes, textures, and lighting effects and apply them to art and design works. Animation techniques in computer graphics can help students understand the motion patterns and dynamic effects of objects. Through animation software, students can learn how to create animations and apply them to art and design works, increasing their vitality and enjoyment. Zhang and Rui [19] enable students to learn how to edit and process images, such as adjusting colors, cropping, and decorating. These skills are very important in art and design. Through image synthesis technology, students can combine multiple images together to create new visual effects. This technology can create more personalized and charming works. Zhang [20] explored algorithms and CAD techniques for artistic style transformation in ocean graphic design. Significant achievements have been made in style transformation. By training deep neural networks, we can learn the features of different art styles and apply them to ocean graphic design. For example, we can use deep learning algorithms to transform images with ocean elements into another artistic style, thereby creating unique visual effects. CAD technology is a digital design tool that can assist designers in modeling, rendering, animation production, and other operations. In ocean graphic design, CAD technology can be used to construct complex ocean scenes, simulate lighting and reflection effects, etc. By using CAD software, designers can easily modify and optimize their design works, achieving more refined and realistic design effects. Many existing algorithms lack precise control over users during the style transition phase, such as specifying the degree of style transition or preserving the details of the original content. By combining a small amount of sample learning and transfer learning strategies, our method can achieve better style transformation effects on limited data. By introducing multimodal data and external knowledge bases, this approach can better understand the cultural and semantic background of artistic works.

3 STYLE CONVERSION OF ARTWORKS BASED ON THE DL ALGORITHM

3.1 Principle and Model Selection of DL Algorithm

DL is a pivotal subfield of machine learning. It mimics the working of the human brain by creating multilayer neural networks, enabling the abstract representation and efficient handling of intricate data. One of its key strengths is the ability to autonomously learn relevant features from vast datasets, bypassing the need for manual feature engineering as in traditional methods. CNN is a type of DL model particularly popular in image processing and artistic style transfers. They mirror the processing methods of the human visual cortex, utilizing convolutional kernels to extract features from input images. In this study, we employ a pre-trained CNN model to extract style and content features from images for the purpose of artistic style transfer. These features are then combined and refined using a specific loss function, ultimately achieving the desired stylistic transformation in artworks. The DL principle for identifying the style features of artworks is shown in Figure 1.

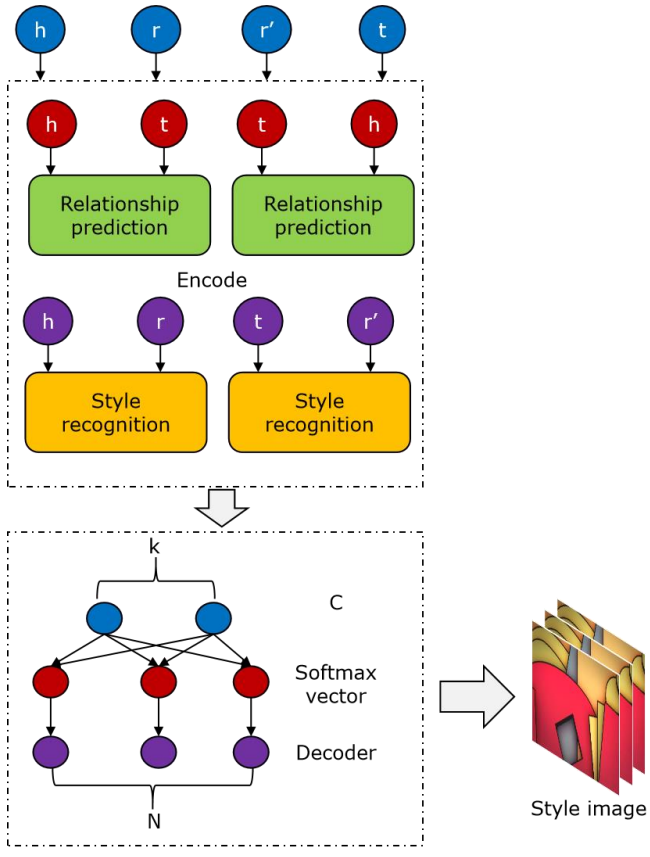


Figure 1: DL principle.

Neural style transfer is a DL-powered image generation technique. It involves learning the style and content characteristics of the input image, followed by their fusion and optimization to create a novel image exhibiting the desired style. The pre-trained CNN model is used to extract features from input images and reference images. Some middle layers of CNN are usually selected as feature extractors, which can capture the features of different abstract levels of images. Low-level features can capture low-level information, such as the texture and color of the image, while high-level features can capture high-level information, such as the shape and structure of the image. On the basis of feature extraction, the content loss of the input image and the style loss of the reference image are calculated, respectively. In the whole image, starting from the pixel with a gray level i, the probability that the gray level of another pixel with distance (D_X, D_Y) is j is called frequency, and the mathematical expression is as follows:

$$P(i,y,d,\theta) = (x,y) \left| f(x,y) = i, f(x+D_x, y+D_y) = j; x,y = 0,1,\ldots,N-1 \right. \quad (1)$$

In the formula, x,y the coordinate of image pixels i,y represents the gray level of the image θ refers to the direction of two pixels.

3.2 Technical Realization of Style Conversion of ArtWorks

After calculation, the generated image is adjusted by the optimization algorithm to minimize the total loss. In the stage of optimization, it is necessary to iteratively update the pixel values of the generated image until a satisfactory visual effect or a preset quantity of iterations is achieved. After

the optimization is completed, the generated image is post-processed, such as denoising and color adjustment, to improve the visual quality of the image. In order to capture the style information of different scales, we can scale the input image to different sizes by multi-scale input, extract features, and transform styles, respectively, and then fuse the results to get the final output image. In order to avoid the over-fitting phenomenon of the generated image in the optimization process, a regularization term is added to the style loss function to encourage the generated image to maintain a certain diversity.

In the research of data mining of artworks based on CAD technology, the gray level co-occurrence matrix (GLCM) plays an important role, especially in extracting and analyzing the texture features of works. GLCM can capture the spatial relationship between gray levels of pixels in an image, thus effectively describing the texture features of the image. By calculating various statistics of GLCM, the extracted texture features can be quantized and coded. These quantized features can be used as the input of data mining algorithms for tasks such as classification, clustering, or association rule mining. The solution stage of GLCM is shown in Figure 2.

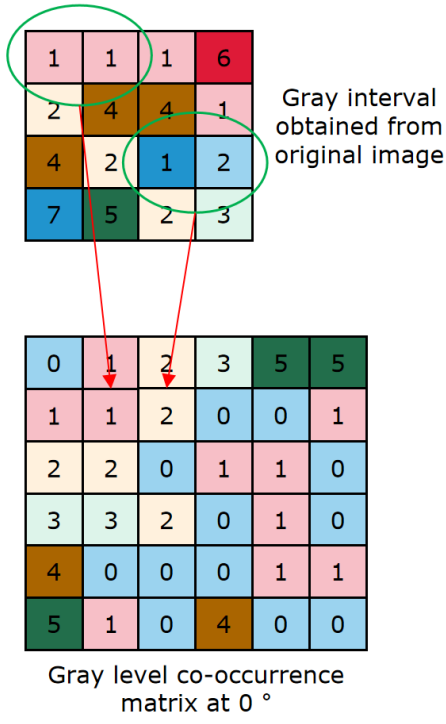


Figure 2: Solution of GLCM.

These are all symmetrical about the diagonal line, which comprehensively reflects the information of gray level images in many aspects, such as direction, change degree, adjacent gray level difference, etc. This information also contains the texture characteristics of image texture, such as situation change and arrangement shape, and the elements in the GLCM have a certain degree of quantitative description of the texture of the original image.

In accordance with the fundamental concept of the variational autoencoder, the algorithm's objective is delineated as acquiring a pair of encoders and decoders, thereby achieving a bidirectional mapping relationship from graph G to latent variable $Z \in R^c$. The loss function for the graph variational autoencoder is defined as follows:

$$L(\varphi,\theta;G)=E_{q\varphi(z|G)}[-\log p_\theta(G|z)]+KL[q\varphi(z|G)|p(z)] \tag{2}$$

Among these components, the initial $E_{q\varphi(z|G)}[-\log p_\theta(G|z)]$ represents the reconstruction loss, responsible for guaranteeing the resemblance between the produced graph and the original input. The subsequent term, KL divergence, ensures that the vector Z is sampled directly from the distribution $p(Z)$. The maximum likelihood estimation for each observation within the graph can be broken down into:

$$-\log p(G|z)=-\lambda_A \log p(A|z)-\lambda_F \log p(F|z) \tag{3}$$

Due to the inherent flexibility of graph structures, the generated data cannot always adhere to a strictly consistent node order. This leads to challenges in accurately calculating the loss function. To address this issue, the present paper incorporates evasion techniques during the training process.

4 ARTWORKS DM BASED ON CAD TECHNOLOGY

4.1 The Role and Application of CAD Technology in DM

In the field of art, CAD technology can provide an accurate and efficient creative platform for artists. Through CAD software, artists can easily create 3D models, carry out complex geometric transformations, and accurately control materials and lighting effects. These functions enable artists to create and experiment in a virtual environment. Through CAD technology, artworks can be transformed into digital data format, and then these data can be analyzed and mined by DM technology. The application of CAD technology in artworks DM mainly includes:

(1) Digitization of works: Using CAD technology to transform artworks into digital 3D models or two-dimensional images to provide basic data for data analysis and mining.

(2) Feature extraction: By analyzing the digitized data, the geometric, texture, color, and other features in the artworks are extracted, which can reflect the style and theme of the works.

(3) Data visualization: Using the visualization function of CAD technology, the extracted features are presented in an intuitive way.

(4)DM: Based on the extracted features, use DM technology to discover the potential laws and deep meanings in artworks.

4.2 The Method and Stage of Dm of ArtWorks

DM of artworks is a complicated process involving many steps and methods. First of all, we need to collect a large quantity of data on artworks. This data can come from different sources, such as museums, art galleries, and private collections. Use CAD technology to digitize the collected artworks. For 3D works, a 3d scanner or CAD software can be used for modeling. For two-dimensional works, digital images can be obtained by high-definition scanning or photography. On the basis of digitalization, the features of the works are extracted. These features can include geometry, texture, color, spatial structure, and so on. By analyzing and comparing these characteristics, we can reveal the internal structure and laws of the works. Using the visualization function of CAD technology, the results of DM are presented in an intuitive and easy-to-understand way. This can help researchers better understand and analyze the mining results. In addition, users can explore and analyze data according to their own interests and needs through interactive design.

In the art works DM based on CAD technology, cluster analysis can reveal the potential relationship and hidden mode between works. The position of each particle is comprised of the cluster centers of k classes. Since the data sample is a d -dimensional vector, the dimension responsible for determining the particle's location and velocity is $k\times d$. The procedure for computing the fitness value of an individual is outlined below:

$$Z_r = \frac{1}{n_r}\sum\nolimits_{\forall x_i \in C_r} x_i \tag{4}$$

Where n_r is the quantity of samples in cluster r ?

The training sample set undergoes processing, and SVM undergoes training to obtain the support vector set. Subsequently, the average classification error of the test set serves as the fitness value for the particles. The fitness function is defined as follows:

$$Fitness = \frac{1}{M}\sum\nolimits_{i=1}^{M}(f_i - y_i)^2 \tag{5}$$

In this context, M it represents the number of samples in the test set, f_i denotes the predicted value, and y_i corresponds to the actual value. Based on the aforementioned formula, it can be inferred that a smaller particle fitness value indicates better performance.

Each cluster can be regarded as a group of works with similar styles, themes, or other characteristics. Using the visualization function of CAD technology, the clustering results are presented in an intuitive way.

$$f(x) \to \sum\nolimits_{i=1}^{n}(a_i * C(E_{x_i}, E_{n_i}, H_{e_i})) \tag{6}$$

$$w_{ij} = \frac{(i-j)^2}{(N-1)^2} \tag{7}$$

$$SSE = \sum\nolimits_{i=1}^{K}\sum\nolimits_{x \in C_i} dist(c_i, x)^2 \tag{8}$$

$$d(p,C) = \frac{d_c + d_N}{m} \tag{9}$$

5 RESULT ANALYSIS AND DISCUSSION

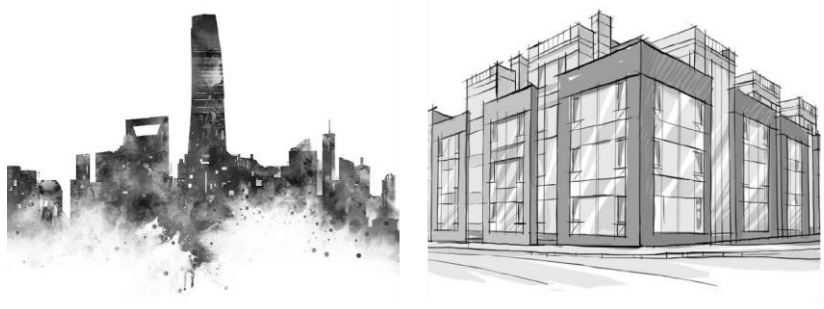
CNN has obvious advantages in the field of image processing, especially its unique processing method for image content and style representation. This network structure can separate the content and style expression of images, which provides artists and researchers with a brand-new way to create and explore visual arts. A series of experiments were carried out to verify the separation of content representation and style representation in CNN. In these experiments, the Oriental Pearl TV Tower and Notre Dame de Paris are selected as the original images. These two buildings represent modern and classical architectural aesthetics, respectively, and have distinct visual characteristics, so they are suitable for testing the effect of style conversion. Next, two different styles of artwork, ink painting, and sketch painting, are introduced. Ink painting is famous for its smooth lines and soft colors, which can give images an elegant and mysterious aesthetic feeling; Sketch is famous for its fine brushwork and strong contrast between light and shade, which can add a vivid and realistic texture to the image. Using CNN's style conversion technology, the style of ink painting and sketch artworks has been successfully applied to the original images of the Oriental Pearl TV Tower and Notre Dame de Paris. Figure 3 shows the original image. Figure 4 shows the style chart. Figure 5 shows the results of these style transformations.

These newly generated images not only retain the basic structure and details of the original images but also successfully integrate the unique aesthetic characteristics of the selected artworks.

We chose the appropriate standard template as the benchmark. The standard template should be a 3D model with high precision and fidelity of detail, which can represent the true form of the original artworks. Then, the reconstructed models generated by different methods are registered with the standard template to ensure their relative positions in space are consistent.

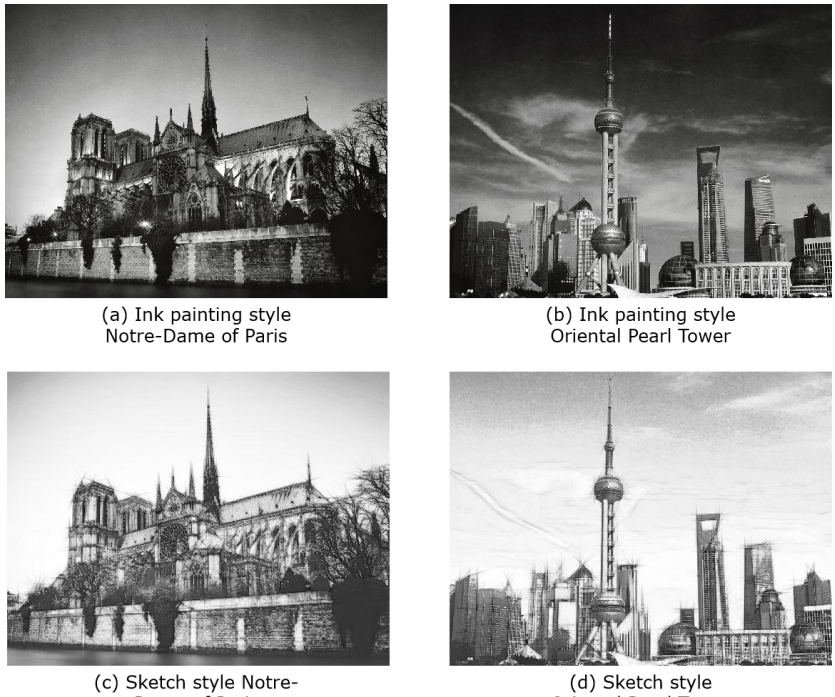
(a) Notre-Dame of Paris (b) Oriental Pearl Tower

Figure 3: Original image.



(a) Ink painting style (b) Sketch style

Figure 4: Style image.



(a) Ink painting style Notre-Dame of Paris

(b) Ink painting style Oriental Pearl Tower

(c) Sketch style Notre-Dame of Paris

(d) Sketch style Oriental Pearl Tower

Figure 5: Image after style conversion.

After registration, the geometric distance between each point of the reconstructed model and the nearest point on the standard template is calculated. These distances can reflect the deviation between the reconstructed model and the standard template. The error comparison between the two methods is shown in Figure 6.

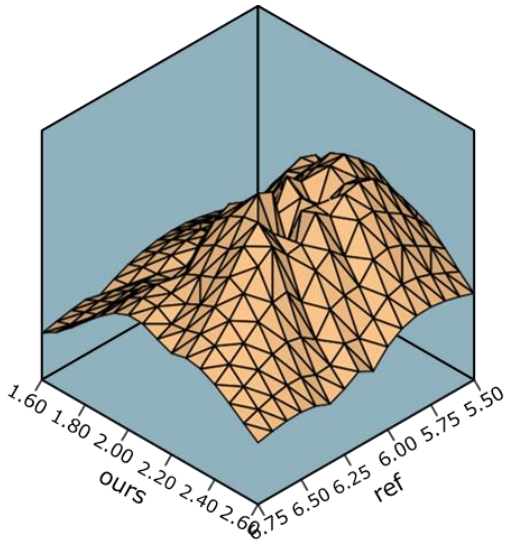


Figure 6: Algorithm error comparison.

The reconstruction error obtained by this method is lower, which shows that it has higher accuracy in the digital reconstruction of artworks. This method adopts a more advanced reconstruction algorithm, which can better deal with complex geometric shape and texture information and improve the accuracy of the reconstruction model.

For each data set, a set of user-independent experiments were conducted. In this experiment, samples of various styles of artwork were selected, and each style was trained and tested. Compared with traditional methods, it is found that this method has high accuracy in the style recognition of artworks. This division can ensure that we have sufficient independence in assessing the performance of the model. For each art style, only the first two captured themes are selected as training samples, which means that there are only six training samples for each art style. Through training, the model can learn the differences and connections between different styles of artwork. In the testing stage, I input the test samples into the trained model and observe the recognition results of the model on the style of artwork. Compared with traditional methods, this method has higher accuracy in identifying the style of artwork (Figure 7 and Figure 8).

Which can more accurately capture the subtle differences between different styles of artwork. These features may include higher-level visual elements and abstract concepts, which help the model better distinguish different styles of artwork. Compared with traditional methods, this method has higher accuracy and stronger generalization ability, which provides strong support for artistic research and creation.

This study deeply explores the style conversion and DM method of artworks based on DL and verifies its effectiveness in practical application. The results show that compared with the traditional methods, this method has higher accuracy in style recognition, showing its great potential in art creation and art research. CNN provides artists and researchers with a new perspective to examine and understand artworks by separating the content and style of images. This separation not only reveals the deep structure behind artworks but also enables us to manipulate these two representations independently, thus creating new images with perceptual significance.

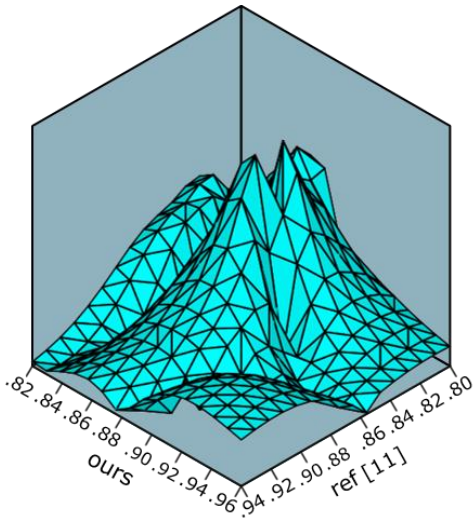


Figure 7: Recognition accuracy (Dataset 1).

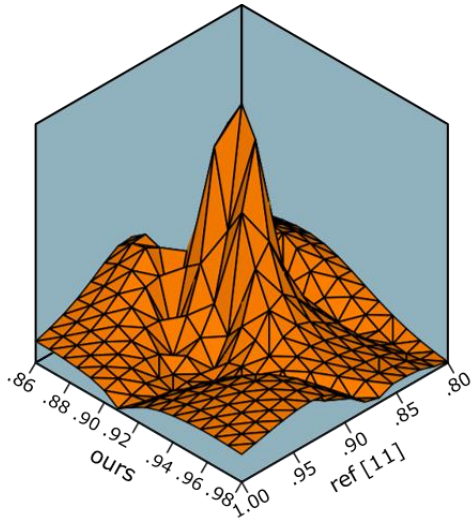


Figure 8: Recognition accuracy (Dataset 2).

By applying ink painting, sketching, and other artistic styles to modern architecture, we can not only endow these buildings with new aesthetic value but also display and spread traditional art in a novel way. The style recognition method of artworks based on DL has high accuracy and generalization ability. Even in the case of limited training samples, this method can still achieve satisfactory recognition results.

6 CONCLUSION

In the digital age, the integration of art and technology has become an irreversible trend. Based on the progress of computer graphics and CAD technology, the art field has been gradually digitized. DM processes and analyzes a large amount of data through a specific algorithm and finds the

correlations, trends, and patterns among the data. This study discusses the application of CNN in the style recognition and transformation of artworks and verifies its effectiveness through a series of experiments. The method based on CNN shows higher accuracy in style recognition and shows its great potential in art creation and art research. The characteristics of CNN make the content and style of images separate, which provides a new perspective and tool for artistic creation. Artists can learn from and apply different styles of artwork to their own works to realize the innovation and integration of styles. By applying the style of traditional artworks to modern works, we can not only endow the works with new aesthetic value but also display and spread traditional art in a novel way and promote the modernization and transformation of traditional culture.

While notable progress has been achieved in this research, certain limitations remain. For example, for some highly abstract or complex artistic styles, the recognition performance of this method may be affected. In the future, we can further improve the recognition accuracy by introducing more advanced neural network structures and optimization algorithms.

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