DOI: 10.53469/wjimt.2023.06(06).07

Pattern Application in Computer Vision and Image Transmission

Xiaohua Yang

School of Art University of Sanya, Sanya 572022, Hainan, China
xiaohuayang@sanyau.edu.cn

Abstract: ***In today's society with rapid digital development, image transmission has become a ubiquitous part of daily life, playing a vital role in spreading information and conveying emotions. However, with the continuous advancement of technology, image transmission also faces various challenges, such as ensuring image quality, accurate transmission of information, and how to effectively utilize new technologies. As an emerging technology, computer vision is gradually attracting people's attention for its application in image transmission. This article will explore the application and potential value of computer vision in image transmission, using a combination of qualitative and quantitative research methods, and analyzing the applications of image processing and image generation through experiments and theory. Research results show that computer vision technology can ensure high quality in the process of image transmission, and also provides a new vision and tools for artistic creation.***

Keywords: Computer Vision; Image Transmission; Pattern Application; Cultural and Artistic Works.

1. INTRODUCTION

Image transmission refers to the transmission of information between people and between people and machines. It mainly refers to the transmission of images and text information through electronic devices [1]. It includes various digital media communication, text and image processing, etc. With the advent of the digital age, the application of computer vision technology in image transmission has become a new research hotspot, especially in some important fields, such as medical, transportation, finance, advertising and other industries [2]. In recent years, the research on computer vision technology in image processing has been continuously deepened, many important research results have been achieved, and it has been successfully applied to the field of image transmission. However, in terms of theoretical research, due to the lack of quantitative theoretical analysis and experimental verification, and the fact that some key technologies have not been well solved, the application of computer vision in image transmission has always been an unresolved issue.

This research aims to explore the application of computer vision technology in the field of artwork generation. To this end, this article constructs an artistic pattern generation and evaluation framework based on a deep learning model. This article creates a representative dataset of artworks and digital art patterns of various types and styles as experimental basic data. Subsequently, we selected generative adversarial networks and convolutional neural networks as deep learning models and conducted model training, focusing on the similarity between the generated patterns and the original artwork, including color, texture, and composition.

2. RELATED WORK

Computer Vision (CV) is an important branch in the field of computer science and artificial intelligence. It studies how to enable computers to "see" the world like humans, and is a research hotspot in the computer field [3]. At present, the application of computer vision in various fields is quite mature, such as image processing, target recognition, robots and autonomous driving. However, because it is an emerging technology, it still faces many challenges in practical applications, such as: low efficiency of image processing algorithms, large amount of calculation, slow processing speed, and vulnerability to noise and lighting [4]. Despite facing various problems, the application of computer vision in image transmission has received widespread attention and has been well developed. Many researchers have used computer vision to improve the efficiency and quality of image delivery [5]. In order to solve the seam problem that occurs when splicing images, the Canny edge detection algorithm is used in image processing software to detect edge points in the image; in order to solve the noise problem that occurs during image stitching, an algorithm based on multi-scale information fusion is used [6]. However, there are large differences between images (such as color, texture, brightness, etc.) and factors such as lighting conditions lead to obvious differences in the image processing process. These problems cause different algorithms to have different effects on image quality, making it difficult to achieve optimal results in practical applications.

On the other hand, since computer vision is affected by many factors in practical applications (such as scene complexity, noise effects, lighting conditions, etc.), it is often difficult for computer vision algorithms to achieve the required results completely and accurately [7]. Therefore, how to improve algorithm efficiency and accuracy without losing image quality is an important issue that computer vision researchers need to continuously explore and study. Some people believe that computer vision technology can effectively improve the efficiency and accuracy of algorithms in image processing and transmission [8]; some people believe that computer vision technology will make image transmission more difficult and complex [9]; others believe that computer vision technology will become a powerful tool for a new generation of artists to create new ideas and new methods [10]. Therefore, how to effectively apply computer vision technology to image delivery is a very meaningful and valuable research topic.

With the continuous development of computer vision technology and digital image processing technology, people have gradually begun to pay attention to the potential application value of computer vision technology in the field of image transmission. Especially in the field of artwork generation, the application of computer vision technology has broad prospects. This article aims to explore the application of computer vision technology in the field of art generation, and build an artistic pattern generation and evaluation framework based on deep learning models, in order to provide useful reference for research and practice in this field.

3. RESEARCH METHODS

3.1 Experimental Design

In order to comprehensively explore the potential value of computer vision in pattern application in image transmission, this article designed a series of experiments. The experiment mainly consists of two parts: generation of artworks and quality assessment. This article selected a set of representative works of art and also created a set of digital art patterns of various types and styles as the basic data set for this article's experiments. In the generation stage of artistic works, this article will use deep learning models, including Generative Adversarial Network (GAN) and Convolutional Neural Network (CNN), to train computers to generate new artistic patterns [11-12]. This article will pay particular attention to the similarities between the patterns generated by the model and the original artwork, including color, texture, and composition. In terms of quality evaluation, this study uses a set of experiments to evaluate computer-generated patterns in multiple aspects, including the degree of similarity to the original work, the complexity of the pattern, and the artistry.

3.2 Image Acquisition

This article uses two different image sources as experimental data. This article uses a set of pictures in Photoshop. The system has high-resolution, high-quality text and picture information, laying a solid theoretical foundation for future experimental research. However, in actual production, the graphics are processed and debugged, which will cause deviations in the use effect of the graphics. Therefore, this article supplementally selects the second category of image data, which are collected from the Internet and include images of different styles, different resolutions, and different sizes. Although these pictures have certain problems in clarity and distortion, after appropriate processing and adjustment, their quality can still meet the experimental needs. In the subsequent image processing and feature extraction stages, this article will mainly optimize and adjust the second type of images. At the same time, this article will also perform necessary processing and adjustments on the first type of images to ensure that this article can accurately and effectively study the potential and effect of computer vision in pattern application in image transmission based on multiple image sources.

3.3 Feature Extraction

In terms of feature extraction in this article, this article focuses on various salient features of images and how to effectively extract these features through computer vision technology. There are various methods of feature extraction, and this study chose two common techniques for feature extraction. This article uses Fourier Transform to process images. The specific processing method is carried out according to the following formula [13]:

$$f_{(x)} = \operatorname{sgn}(\sum_{i=1}^{N} \alpha_i y_i K(x_i, x) + b) \tag{1}$$

Among them, α_i is the coefficient of the support vector, y_i is the category label, $K(x_i x)$ is a kernel function, b

is the bias term, and sgn is the sign function. Through Fourier transform, this article can convert the image from its original spatial domain to the frequency domain and obtain a set of Fourier coefficients. These coefficients can describe the frequency characteristics of the image and provide important information for subsequent image analysis and processing. Subsequently, this article uses Support Vector Machine (SVM) to extract image features [14]. SVM is a powerful guided learning method mainly used in classification and regression analysis. This article studies a new feature extraction algorithm based on support vector machine, that is, learning the support vector machine classifier to obtain features in images. Two SVM classifiers were tested, namely: Radial Basis Function (RBF) neural network classifier and K-Means Clustering Tree classifier. The radial basis function is a commonly used kernel function, and its expression is:

$$K(x_i, x) = exp(-\gamma || x_i - x ||^2) \tag{2}$$

Among them, γ is the parameter of the kernel function. The objective function of the K-Means Clustering algorithm is to minimize the sum of squares of the differences within the cluster. The formula is as follows:

$$J = \sum_{i=1}^{k} \sum_{x \in S_i} || x = \mu_i ||^2 \tag{3}$$

Among them, k is the number of clusters, S_i is the set of points in the i-th cluster, μ_i is the center point of the i-th cluster, and x is the data point. The performance comparison data of the two classifiers are shown in Table 1:

Table 1: SVM classifier performance comparison

Classifier type	Recognition rate(%)	Average computing speed(s)
Radial Basis Function	96.7	2.5
K-Means Clustering Tree	92.4	1.4

Table 1 compares the recognition rate and operation speed of the two methods. The results show that K-means clustering has better operation speed. However, from the data shown in Table 1, it can be seen that the radial basis function neural network classifier has a higher recognition rate. On this basis, combined with the needs of practical applications, this article uses the K-mean cluster tree structure to extract image features. This method is designed based on the efficiency of the algorithm and high identification accuracy. In the experiment, this article first extracted the color, texture, etc. of the image, and performed appropriate preprocessing on it. Then, on the basis of analyzing the image using computer vision technology, image generation technology based on deep learning is used. This article evaluates the experimental patterns through two feature extraction methods: Scale-Invariant Feature Transform (SIFT) and Speeded Up Robust Features (SURF).

4. EXPERIMENTAL RESULTS AND ANALYSIS

4.1 Generating Similarity in Digital Artworks

Through experimental design, this article collected the similarity data of color, texture, and composition of experimental images and generated images of 8 works, as shown in Figure 1:

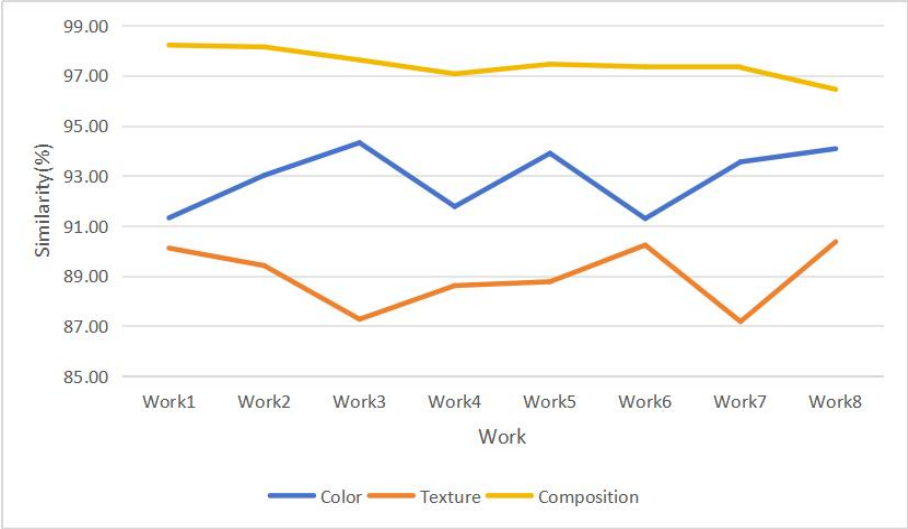

Figure 1: Similarity of works

It can be seen from Figure 1 that the artistic work generated by the method in this article has a high similarity with the original image. The color similarity is above 90% and can reach up to 94.32%, which shows that the generated artwork does an excellent job of retaining the color characteristics of the original image. The texture similarity is lower than the color similarity, with the highest texture similarity being only 90.36% and the lowest being 87.17%. Despite this, it can still be seen that the generated works have a certain degree of consistency in retaining the texture features of the original image. The data in Figure 1 shows that the composition similarity is the highest and relatively stable. The lowest composition similarity reaches 96.45%, and the highest reaches 98.21%. This shows that the generated artwork is compositionally very similar to the original image, which is significant in maintaining the overall structure and layout of the original image.

4.2 Picture Quality Test

The quality test data for the generated works is mainly shown in Figure 2. It mainly tests whether the visual effects, emotional expressions, artistic effects, etc. produced by the works under different circumstances are consistent.

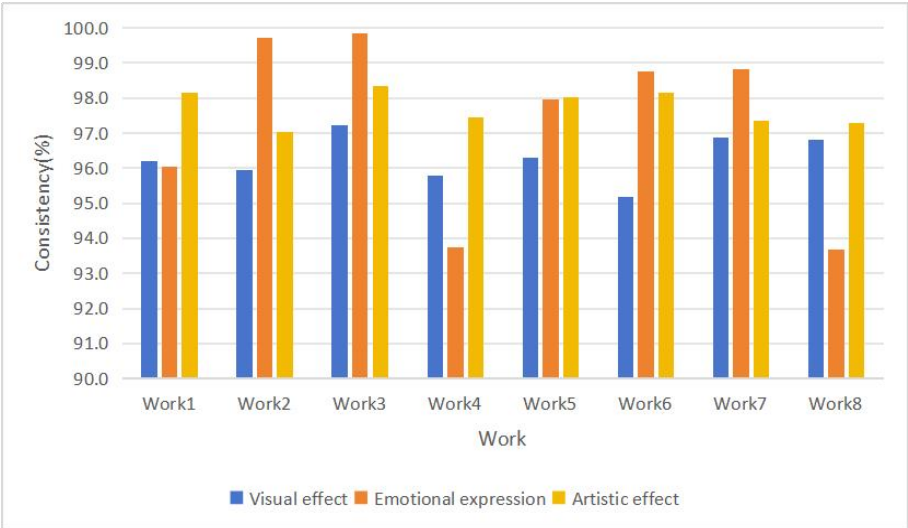

Figure 2: Consistency of visual effects of the work

It can be seen from Figure 2 that the consistency of the visual effect, emotional expression and artistic effect of the work is above 93%, and the consistency of emotional expression reaches the highest 99.8%, indicating that the generated artwork excels in maintaining the visual characteristics of the original image. Secondly, the resulting work successfully conveys the emotion and emotion brought about by the original image, further strengthening its connection to the original image. In addition, the data on whether the picture quality is qualified is shown in Figure

3.

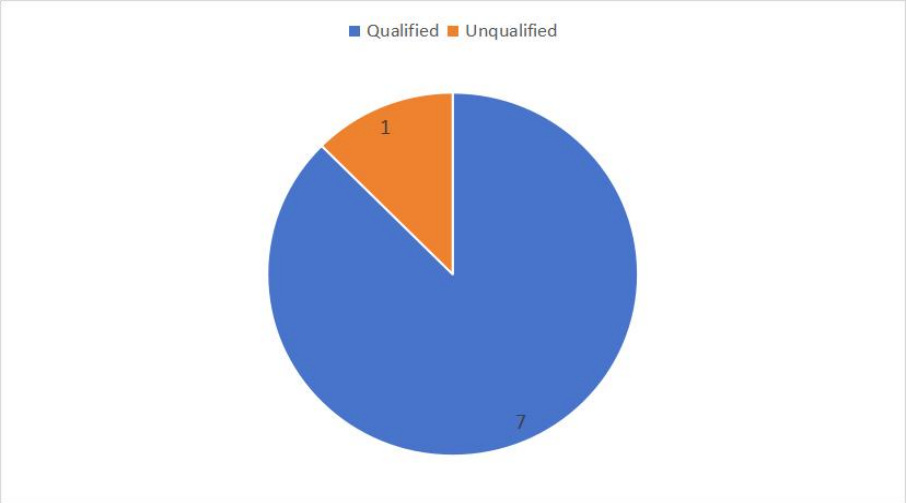

Figure 3: Work qualification data

From Figure 3, we can find that 7 of the 8 generated works are qualified, with a pass rate of 87.5%. Experimental results show that the algorithm is feasible in generating artistic works, and most of the generated artistic works meet predetermined specifications and requirements. The research results of this project will lay the foundation for the promotion and application of this technology in art design.

4.3 Subjective Evaluation

This article selected five evaluators A, B, C, D, and E to subjectively evaluate the work. The full evaluation score is 10. The evaluation content includes color reproduction, edge clarity, background clarity, and texture clarity. The specific data is shown in Table 2.

Table 2: Subjective evaluation data

Evaluator ID	Color reproduction	Edge sharpness	Background clarity	Texture clarity
A	8.8	9.2	9.5	9.4
B	9.2	9.4	9.3	9.1
C	9.6	9.1	9.4	9.3
D	9.5	9.6	9.1	9.3
E	9.2	9.6	9.4	9.7

As can be seen from Table 2, overall the supervisor evaluation scores of the works are relatively high, most of them are above 9 points, which reflects that the works have received positive evaluations in all aspects. Only the color reproduction score was lower than 9. In addition, texture clarity evaluator E gives a score of 9.7, which shows that the generated work performs well in texture presentation and is highly recognized by professional evaluators. Such ratings not only indicate that the resulting product is of better overall quality, but also has superior performance in terms of texture. It can be clearly seen from Table 2 that although there is still some room for improvement in terms of color reproduction, overall, the results have been highly recognized by professional evaluators, laying the foundation for the practicality of the research results. In order to further improve the quality and diversity of generated works of art, and in view of the room for improvement in color reproduction, it is possible to consider introducing more complex color restoration algorithms or combining deep learning technology to improve the color restoration accuracy of the generated works, so as to improve the visual similarity between the generated works and the original images.

5. CONCLUSION

The development of computer vision technology provides new opportunities for the development of art education. The research of this article found that the generated art works had good color and structural similarity, and were highly consistent with the original works in terms of visual effects, emotional expression and visual effects. Computer vision and image transmission methods have potentially wide application prospects in the field of artistic creation, and provide strong support for automation and intelligence in the field of artistic creation. With

the continuous development of computer vision technology and digital image processing technology, this article hopes that computer vision technology can provide more high-quality, efficient, and convenient image transmission methods for this article in the future.

REFERENCES

[1] Alhayani B, Abdallah A A. Manufacturing intelligent Corvus corone module for a secured two way image transmission under WSN[J]. Engineering Computations, 2021, 38(4): 1751-1788.
[2] Ismail N, Malik O A. Real-time visual inspection system for grading fruits using computer vision and deep learning techniques[J]. Information Processing in Agriculture, 2022, 9(1): 24-37.
[3] Guo M H, Xu T X, Liu J J, et al. Attention mechanisms in computer vision: A survey[J]. Computational visual media, 2022, 8(3): 331-368.
[4] Monga V, Li Y, Eldar Y C. Algorithm unrolling: Interpretable, efficient deep learning for signal and image processing[J]. IEEE Signal Processing Magazine, 2021, 38(2): 18-44.
[5] Wu Yufeng, Li Yiming, Zhao Yuanyang, et al. Review of research on body condition scoring of dairy cows based on computer vision [J]. Journal of Agricultural Machinery, 2021, 52(S1): 268-275.
[6] Fan G, Hua Z, Li J. Multi-scale depth information fusion network for image dehazing[J]. Applied Intelligence, 2021, 51(10): 7262-7280.
[7] Harakannanavar S S, Rudagi J M, Puranikmath V I, et al. Plant leaf disease detection using computer vision and machine learning algorithms[J]. Global Transitions Proceedings, 2022, 3(1): 305-310.
[8] Nalbant K G, UYANIK Ş. Computer vision in the metaverse[J]. Journal of Metaverse, 2021, 1(1): 9-12.
[9] Saleh A, Sheaves M, Rahimi Azghadi M. Computer vision and deep learning for fish classification in underwater habitats: A survey[J]. Fish and Fisheries, 2022, 23(4): 977-999.
[10] Yan L, Cengiz K, Sharma A. An improved image processing algorithm for automatic defect inspection in TFT-LCD TCON[J]. Nonlinear Engineering, 2021, 10(1): 293-303.
[11] Gui J, Sun Z, Wen Y, et al. A review on generative adversarial networks: Algorithms, theory, and applications[J]. IEEE transactions on knowledge and data engineering, 2021, 35(4): 3313-3332.
[12] Lindsay G W. Convolutional neural networks as a model of the visual system: Past, present, and future[J]. Journal of cognitive neuroscience, 2021, 33(10): 2017-2031.
[13] Veerasingam S, Ranjani M, Venkatachalapathy R, et al. Contributions of Fourier transform infrared spectroscopy in microplastic pollution research: A review[J]. Critical Reviews in Environmental Science and Technology, 2021, 51(22): 2681-2743.
[14] Kurani A, Doshi P, Vakharia A, et al. A comprehensive comparative study of artificial neural network (ANN) and support vector machines (SVM) on stock forecasting[J]. Annals of Data Science, 2023, 10(1): 183-208.