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RESEARCH ARTICLE

Research on the Artistic Design Method of Cultural and Creative Products Based on Artificial Intelligence and Interactive Virtual Simulation

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ARTICLE INFO	ABSTRACT
	With the rapid development of modern economy, artificial intelligence technology is developing rapidly. Artificial intelligence technology plays an important role in various modern products and practical applications. It also promotes the creation and production of cultural and creative products. In the design of cultural and creative products, artificial intelligence not only improves the quality of cultural and creative products and reduces production costs, but also shortens the time of cultural and creative product design. In this paper, we propose a convolution neural network based on the dilated convolution which is used to identify and classify cultural and creative products in the artistic design method processing. Firstly, we proposed a identify network based on the dilated convolution for cultural and creative products. This network preprocesses, denoises and edge detects the original cultural and creative product images. Secondly, we apply classification network based on the dilated convolution to the field of cultural and creative product classification by introducing the dilated convolution. Simulation results show that the proposed convolution neural network based on the dilated convolution shows good identify and classification performance.

INTRODUCTION

The advancement of humanity into the era of intelligence is increasingly being fueled by artificial intelligence (Hu, Wang & Zhong, 2020; Chen et al., 2022; Lai et al., 2022; Ge et al., 2022). The worldwide industry has evolved and developed to use artificial intelligence innovation ecology in full recognition of the significance of artificial intelligence technology as the catalyst for a new wave of industrial revolution. A new branch of technical science called artificial intelligence studies and creates theories, procedures, tools, and software that can mimic, supplement, and even surpass human intelligence (Zhang et al., 2022; Hu et al., 2020; Hu et al., 2020). Technical research is being done to encourage hearing, seeing, thinking, learning, and acting in intelligent robots. Numerous technologies, including internet of things, self-driving cars, smart healthcare, machine translation, smart education and text recognition, speech recognition, human-computer interac- tion, multiple-input multiple-output and edge computing that involve both humans and machines, use artificial intelligence (Xu et al., 2023; Tang et al., 2022; Lu et al., 2022; Zhao et al., 2019; Zhao et al., 2020).

In the era of artificial intelligence and information, artificial intelligence has gradually become an important means and method to promote economic and industrial development, among which cultural and creative products are also one of the products deeply affected by it (Liu, 2013). Recognized as a sunrise product in the 21st century, cultural and creative products design have attracted global attention with their unique charm and rapid growth rate. Both developed and developing countries regard cultural and creative products as a strategic product, and have now regarded the vigorous development of cultural and creative products as a new economic growth point.

In the production mode of the 5G era, artificial intelligence is widely used in the scenario of cultural and creative products artistic design. In the process of designing based on artificial intelligence technology, i.e., the artistic design of cultural and creative products has com- pletely entered the digitization and informatization process. Artificial intelligence based methods to promote cultural products have become a core part of the development process of cultural and creative product design, and artificial intelligence technology with deep learning and neural networks as the core has become an emerging technical means of design and greatly promoted the development of cultural and creative products. In comparison with the previous design, the intervention of artificial intelligence assisted design, whether in manufacturing techniques or in display, is very different from the previous design.

Artificial intelligence has a very wide range of applications in the field of design (Li & Lin, 2021; Fang et al., 2021). In artificial intelligence-assisted design, the technology can be combined with art design to create more perfect cultural and creative products (Zhang et al., 2020). For designers, designers can use the emerging artificial intelligence technology to further improve and perfect the various work and content on design and apply it to the design of products, which will make the design of cultural and creative products more creative, which also brings changes to it and creates more interest based on artificial intelligence design.

Design based on artificial intelligence technology can enable cultural and creative product designers to change from traditional manual drawing to design with computerized intelligent drawing in product production and manufacturing (Wang & Gu, 2020). Artificial intelligence-based design can also help designers of cultural and creative products to complete program comparison, design content retrieval and drawing design review, which greatly shortens the product design cycle and improves the efficiency of product design, and also facilitates the feedback of information related to product structure analysis and manufacturing after the product design is completed (Dai, 2021; Qiu, 2020). Based on artificial intelligence technology design in the process of cultural and creative product design using computers to intelligently complete control, its intelligent system can complete the management and planning of many factors including the product design: production environment, equipment status, monitoring, logistics transfer, testing and testing, and can deal with the problems arising in the process of product design.

In this paper, a convolution neural network based on dilated convolution is used to identify and classify cultural and creative products in the artistic design method processing. Firstly, this paper proposes a two-channel dilated convolutional neural network-based recognition algorithm for cultural and creative products. This algorithm first preprocesses, denoises and edge detects the original cultural and creative product images. Then, the edge image and action image are used as two input channels of dilated convolution net respectively. And the recognition results are classified with a SoftMax classifier. Secondly, this paper applies the one-dimensional dilated convolutional neural network to the field of cultural and creative product classification by introducing the dilated convolution, and studies the end-to-end detection of cultural and creative product categories, analyzes the effect of convolution type and iteration number on the classification results of cultural

and creative products, and compares the results with those of back propagation and support vector machine methods

Artistic Design Method of Cultural and Creative Products Based on Artificial Intelligence

The design of cultural and creative products is the process of reconstructing the mapping relationship between rational imagery and appearance features, and also the process of transforming user needs into cultural and creative product design plans. The design mainly applies the theory of product semantics to stop translating the cultural elements, and then uses the way to generate the design of product appearance and exterior ornamentation, and then stops optimizing and adjusting the integration of imagery and appearance according to the demand, and finally completes the cultural and creative product design.

Color is the most intuitive visual element of cultural and creative products, and as an important part of cultural image, it has a distinct expression. It can clearly reflect the spirit of local culture and historical and cultural connotations. Color is a relatively stable existence in the development of human civilization, and is a subjective reflection of the overall impression of culture formed gradually by human beings in the geographic environment, economic activities and production development, which not only contains the influence of natural and human environment factors, but also includes the history and culture behind it. In the design of cultural and creative products, the study of color will further reveal that the formation of different colors is a reflection of the social consciousness of the time, which is ultimately reflected in the corresponding colors through cultural and creative products. Color is not only a fusion of design, plastic art, industry and other disciplines, but also an extension of humanities, geography and psychology.

By identifying and classifying the color of cultural and creative products, understanding the cultural roots and symbols behind it, sorting out the local culture and collecting colors, refining, summarizing and drawing the cultural symbols with cultural characteristics, integrating them with color language, adding their own understanding and feelings, and applying them to the design of cultural creation products, making them cultural creative products with color expression, artistry and practicality.

Identify Network Based On Dilated Convolution

The main purpose of dilated convolution is to address several issues with image segmentation. Typically, the perceptual field is expanded through pooling to lower the image size, and the image size is then restored through upsampling. However, this technique sacrifices accuracy. So in order to reduce this loss, it is natural to think of removing the pooling layer, however, this leads to the feature map perceptual field is too small, so the dilated convolution is born. The spacing of the values when the convolution kernel processes the data is defined by a hyper- parameter termed the dilation rate, which is introduced into the conventional convolution but not in the dilated convolution. The dilation rate is also called dilated size. It can be said that the normal convolution is a special case of the hole convolution. In addition, the dilated convolution increases the perceptual field, but it can not change the size of the image output feature map and resolution.
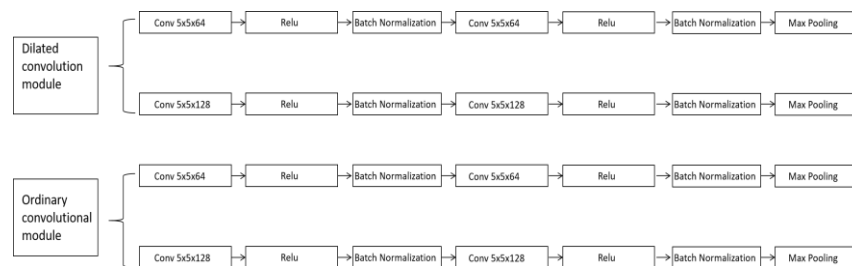

Fig. 1. The structure of identify network based on dilated convolution.
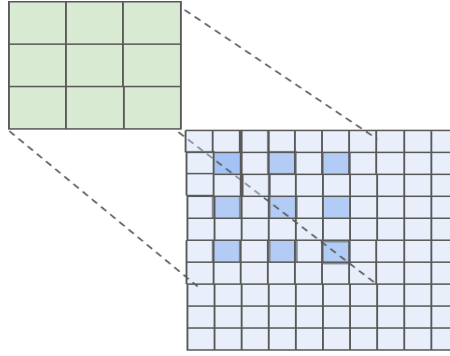
Fig. 2. The convolution schematic.

In this paper, the feature extraction and classifier of convolution neural network is improved by passing the input through four blocks and then accessing the fully connected layer for the output, as we can seen in Fig. 1 for the dilated convolution network structure and Fig. 2 for the convolution schematic. The first two Blocks firstly use the dilated convolution instead of the normal convolution to expand the perceptual field and extract the overall features. Then the details are extracted by two ordinary convolutional kernel modules. Finally, the training is completed by two layers of fully connected layer output.

Multichannel convolutional neural network is a new structure of convolution neural network. Different features can be obtained to as input and perform convolution for network. The traditional convolution method slides the filter over adjacent elements and extracts the higher-level features between these elements. In contrast, in the dilated convolution, there are spaces between the points involved in the convolution filter. Therefore, the perceptual field can be expanded without increasing the filter size and computation time.

We consider that the input image size is (N, N), the convolution kernel size is (M, M), the step size is α, the padding is P, and the output size after convolution of the convolution kernel is $(N + 2P - M)/\alpha + 1$. Therefore, the large size convolution layers can be replaced by the stack of small size convolution layers, and the sensory field size remains unchanged. Two consecutive 3×3 ordinary convolutions with the same step size of 1 and padding of 0. The two 3×3 dilated convolutions are equivalent to the perceptual field of a 9 × 9 ordinary convolution, and the extracted features are larger and can obtain richer information, thus improving the segmentation accuracy. And the ReLU function can be express as

$$F(X) = \sum_{i=1}^{inf} \sigma(X - i + 0.5), \quad (1)$$

$$\approx \log(1 + E^X), (2)$$

$$\approx \max(0, X + N(0,1)). \qquad (3)$$

And

$$\sigma(Z) = \frac{1}{1 + E^{-Z}} \quad (4)$$

Classification Network Based on the Dilated Convolution

When convolutional neural network models are applied to the field of image semantic segmentation, repeated convolution and pooling operations will reduce the feature map resolution, resulting in the loss of image detail structure and edge information. This problem is also faced in image classification, for which the problem is solved by introducing dilated convolution, which expands the filter

perceptual field while maintaining the resolution and preserving the image detail features as much as possible. For the case of one-dimensional images, a one-dimensional dilated convolution operation is required. the dilated convolution is equivalent to the standard convolution when the dilated equal 1 and the filter processes the input signal in a continuous manner, and when rate 2, a zero is inserted between each element of the original filter to process the signal in a jumping manner.
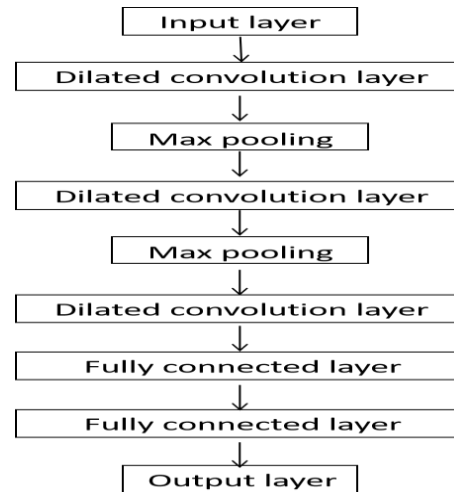

Fig. 3. The structure of classification network based on the dilated convolution.

Therefore, this model is designed for the characteristics of cultural and creative product data, and Fig. 3 shows its structure. The model contains one input layer, three dilated convolution layers, with convolution kernel sizes of 7 × 1, 5 × 1 and 5 × 1, respectively, and the number of convolution kernels are 128, with step size 1 and hole rate 2. The 2 pooling layers are immediately after the 1st and 2nd hole convolution layers, with the pooling kernel size of 5 × 1, step size of 2, and the pooling type of maximum pooling. The 3rd dilated convolutional layer is followed by 2 fully connected layers, and finally the classification probability prediction is obtained by the softmax output layer.

The model evaluation approach uses the discriminant accuracy of the training and test sets as the model evaluation metric. The discriminant accuracy D can be expressed as,

$$D = \frac{C}{A} \times 100\% \quad (5)$$

where C is the number of correctly discriminated samples. A is the total number of samples.

SIMULATION RESULTS

In this paper, we provide simulation results to demonstrate the effectiveness of the propose artistic design method of cultural and creative products based on artificial intelligence. In sim- ulation, we use $10,000$ homemade datasets of uniform size 227 × 227 × 3, divided into 10 categories, and $1,000$ photos for each category of cultural and creative products in the network training and validation stages, and the training and validation ratio is 8 : 2. The propose network model uses cross-entropy as the loss function and is trained using a stochastic gradient descent optimizer with specific parameters set as learning rate is 0.008, weight decay factor decay is 0.0001, momentum is 0.5, and Epoch is 200. To achieve fast convergence of the propose network model, the training set was divided into batches and the number of batch size was set to 40.

As can be seen from Fig. 4 and Tab. I, the best accuracy of the identify network based on the dilated convolution is 71% during the network training process. In terms of convergence speed, the identify network based on the dilated convolution achieves a classification accuracy of 62% after 100 iterations. Thus, the introduction of dilated convolution can simultaneously speed up the

convergence speed and improve the classification efficiency, so that the identify network based on the dilated convolution can obtain accurate results faster. When the number of epochs is small, the model is not sufficiently trained, the network parameters are not optimal, and the classification accuracy is poor. As the number of epochs increases, the accuracy increases. When the number of epochs reaches a sufficient amount, the model identify effect does not change much and the network reaches convergence.

We can see from Fig. 5 and Tab. II that the best classification accuracy of the classification network based on the dilated convolution is 72%. For convergence speed, the classification network based on the dilated convolution achieves a classification accuracy of 63% after 150 iterations. So the introduction of dilated convolution can simultaneously speed up the convergence speed and improve the classification efficiency, so that the classification network based on the dilated convolution can obtain accurate results faster.

The propose identify network combines the dilated convolution and ordinary convolution to effectively recognize products, as shown in Fig. 6 and Tab. I. The loss value is reduced to 0.72 after co-training of ordinary image and products. The identify network combines the dilated convolution and normal convolution for overall feature and detail feature extraction. Compared with the traditional method, the features extracted by the propose identify network is more complete and the loss value is better.
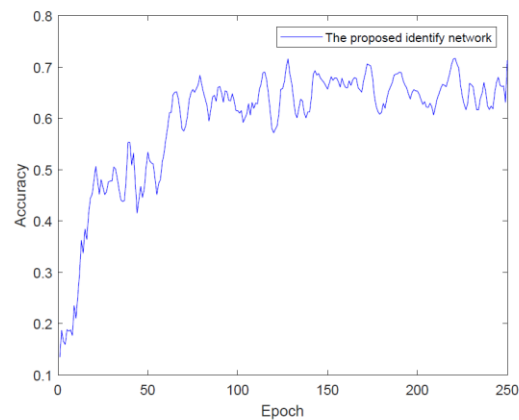

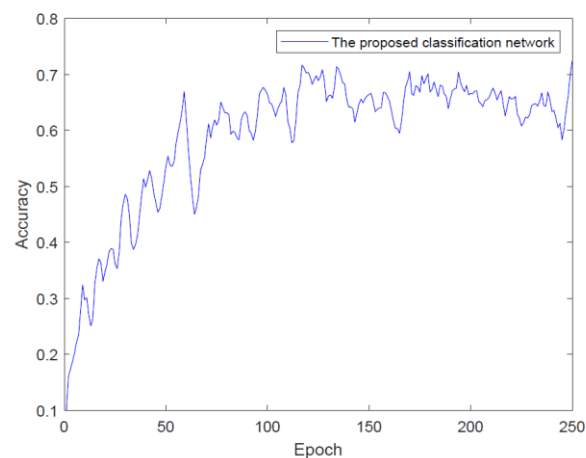**Fig. 4. The accuracy of identify network based on the dilated convolution.**

Fig. 5. The accuracy of classification network based on the dilated convolution.
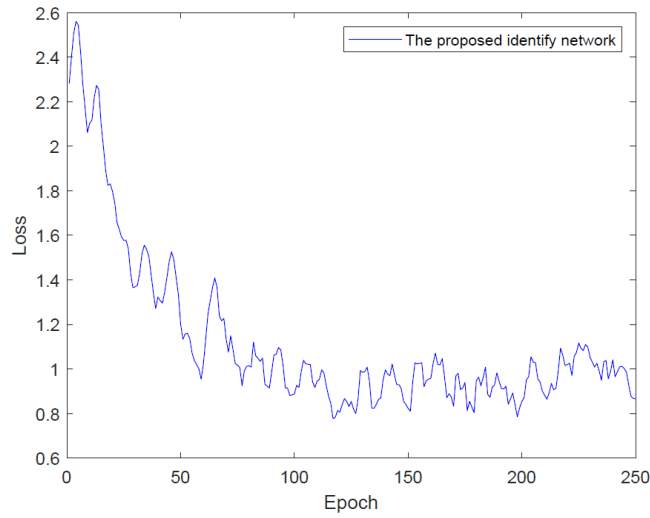
Fig. 6. The loss of identify network based on the dilated convolution.
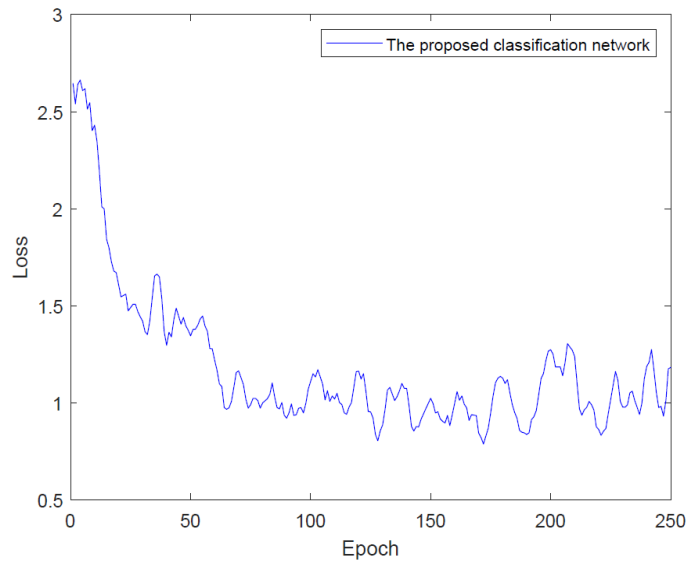

Fig. 7. The loss of classification network based on the dilated convolution.

Table 1. The Accuracy and Loss Value of Identify Network Based on the Dilated Convolution.

		Epoch						
		0	10	50	100	150	200	250
Identify network	Accuracy/%	0.15	0.2	48	62	66	67	71
	Loss	2.3	2.2	1.1	0.89	0.78	0.72	0.86

Table 2. The Accuracy and Loss Value of Classification Network Based on the Dilated Convolution.

		Epoch						
		0	10	50	100	150	200	250
Classification network	Accuracy/%	0	20	55	61	63	71	72
	Loss	2.6	2.5	1.33	1.08	1.02	1.23	1.1

From Fig. 7 and Tab. II, we can find that the propose classification network combines the dilated convolution and ordinary convolution can effectively classify products. The best loss value is 1.02 after training. For feature extraction and classification, the propose classification network combines the dilated convolution and normal convolution. Compared with the traditional method, the features extracted by the propose classification network is more complete and the loss value is better.

CONCLUSION

In this paper, we proposed a convolution neural network based on the dilated convolution which is used to identify and classify cultural and creative products in the artistic design method processing. Firstly, we proposed a identify network based on the dilated convolution for cultural and creative products. This network preprocesses, denoises and edge detects the original cultural and creative product images. Then the feature fusion is performed in the fully connected layer. And the recognition results are identify with a SoftMax classifier. Secondly, we applied classification network based on the dilated convolution to the field of cultural and creative product classification by introducing the dilated convolution, and studied the end-to- end detection of cultural and creative product categories. Simulation results showed that the proposed convolution neural network based on the dilated convolution showed good identify and classification performance.

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