The Research on the Application of Artificial Intelligence in Visual Art-based on Souvenir Design

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Abstract: - This paper will introduce the application of artificial intelligence (AI), machine learning, and deep learning in art design and visual arts, and how these technologies can be used to create unique souvenirs. In the field of art design, AI and machine learning can be used to automatically generate artwork and patterns, providing more inspiration and creativity, and can also help artists better understand their audience and market. The application of deep learning in the field of visual arts includes image recognition, image classification, image generation, and so on. In the field of souvenir design, the use of AI and machine learning can help designers better understand market needs and consumer trends to create unique souvenirs. Taken together, the application of AI, machine learning, and deep learning technologies has great potential and creativity in the fields of art design and souvenirs.

Key-Words: - AI, Machine learning, Deep learning, Art Design, Visual Art, Souvenir Design, Image recognition.

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1 Introduction

The birth of the field of artificial intelligence (AI) can be traced back to the Dartmouth Conference in 1956, when John McCarthy coined the term "artificial intelligence" for the first time, [1]. AI systems or platforms are intelligent complexes based on machine learning, [2], and deep learning algorithms, [3]. The earliest machine-learning algorithm model is the M-P model , [4]. The model is a mathematical model established from information processing based on known as nerve cell biology. The world's first truly excellent artificial neural network is a neural network structure with three-layer network characteristics, named perceptron, [5]. The perceptron can change the connection weights by learning and can correctly classify similar or different models. However, the single-layer perceptron network model cannot handle linear inseparability problems. In 1986, the concept of the Back Propagation (BP) Network was introduced by Rumelhart, which involved a multi-layer feed-forward network trained using the error backpropagation algorithm, [6]. It addresses the challenge of linear inseparability that cannot be resolved by the original single-layer perceptron. Moreover, several shallow machine learning models have been suggested, including support vector machines (SVM), [7]. Nonetheless, as the number of layers in a neural network increases, such as in the case of the conventional BP network, challenges like local optima, overfitting, and gradient diffusion hinder the advancement of deep models.

Artificial neural networks have undergone rapid development since 2005, and many important advances have been made. The multi-hidden-layer artificial neural network demonstrates remarkable capability in learning features and effectively overcomes the training challenges of deep neural networks by employing layer-by-layer pre-training, [8]. Since then, research on artificial neural

networks has become more and more popular. The layer-by-layer pre-training algorithm in deep learning begins by employing unsupervised learning for the pre-training of each layer in the network. One layer is trained at a time without supervision, and the resulting training output from that layer is subsequently utilized as the input for the next layer. Finally, supervised learning is used to fine-tune the pre-trained network, Convolutional neural network (CNN), [9], is a feed-forward neural network containing convolution operations that can identify and classify images. A recurrent neural network (RNN), [10], is a neural network with a cyclic structure, the most representative of which is long short-term memory (LSTM), [11]. Recurrent neural networks is better at dealing with sequence problems. Autoencoder, [12], is an unsupervised learning algorithm that aims to reduce the data dimension while maintaining the characteristics of the original data as much as possible.

In recent times, with the advancement of hardware computing capabilities and the progress of deep learning technology, the performance of many computer vision and image processing tasks has been greatly improved. Convolutional neural networks have achieved success in vision tasks such as image classification, [13], object detection, [14], and semantic segmentation, [15]. The ImageNet project is a large visualization database for research in visual object recognition software. Since the ImageNet Large-Scale Visual Recognition Challenge (ILSVRC) was held in 2010, many excellent visual recognition artificial neural networks have emerged. Such as AlexNet [16], GoogLeNet [17], VGG [18], ResNet [19]. With the emergence of these high-performance neural networks, AI technology is constantly being pushed forward.

With the maturity of deep learning technology in the field of art, it can stably and quickly help designers complete time-consuming work in the design process, saving a lot of time and greatly improving work efficiency. Designers act more as guides and perfecters in the creative process, requiring designers to devote more energy to the links of imagination, creation, and performance. Use the designer's professional technology to express the work perfectly based on artistic design.

When deep learning technology is applied to visual art creation, it may not only provide new methods for traditional visual art creation forms but also provide designers with more creativity. The intervention of artificial intelligence in art creation is not a replacement, but a joint development of man and machine, and promotes art creation to move towards the intelligent era. With the rapid development of computer science, exploring the help of deep learning technology for visual art design methods can provide new ideas for traditional visual art creation. And promote the interaction between technology and art, promote each other's development and innovation.

The current situation of the integration of artificial intelligence and art design is different in stages and forms, [20]; the combination of artificial intelligence and art design can improve efficiency and enrich the way of thinking; the integration and development of computer technology, artificial intelligence and art design will bring benefits to all People create a better world. AI has also impacted the field of design, [21]; AI can assist designers in replacing repetitive and inefficient work, and even assist artistic expression; social and scientific progress has improved human design capabilities, but also given opportunities for AI to learn and assist human designers. The increasing interest in exploring the intersection of AI and artistic creation and focus on researching the innovation process of AI art creation in China, [22]. The study examines the influence of AI art creation technology on the efficiency of the manufacturing innovation process. The findings reveal that the first stage, which focuses on research and development of innovative technology in art creation enterprises, demonstrates higher efficiency compared to the second stage, which involves the transformation of innovative achievements. Artificial neural network (ANN) can be applied to perfume bottle shape design, The HN1-C model has the highest prediction accuracy (90.39%) and is used to help product designers determine the best form combination for new product designs, [23].

The structure of this paper is as follows: Section 2 provides an overview of the research methodology employed in this study. Section 3 presents a comprehensive list of relevant cases for analysis. Section 4 explores the concept of art creation by transfer learning. Finally, section 5 provides a conclusion to this paper.

2 Research Method

2.1 The Literature Review Method

The literature research method refers to the formation of new understandings after the literature research based on collecting and sorting out relevant literature in the research field, which requires comprehensiveness and objectivity, [24].

This paper is a research on visual design based on artificial intelligence, so it mainly collects and organizes papers on artificial intelligence and art. By searching and reading a large number of papers, to determine the research purpose and significance of this paper. And discover the existing problems, and grasp the focus of this paper. Focus on the research and analysis of artificial intelligence in visual design. Explore the help and significance of artificial intelligence to visual art creation in the digital age.

2.2 The Case Analysis Method

Qualitative case studies can use data from different sources to study a phenomenon from different directions, which effectively avoids the subjective tendency of researchers in different research backgrounds, [25]. The method of case analysis is a systematic approach that entails conducting thorough and detailed research on representative entities to achieve a comprehensive understanding, [26]. This paper collects and screens representative cases of the integration of artificial intelligence and art design for further in-depth analysis. Based on the summary of actual cases, it explains the new form of artificial intelligence and visual art.

2.3 The Experimental Analysis Method

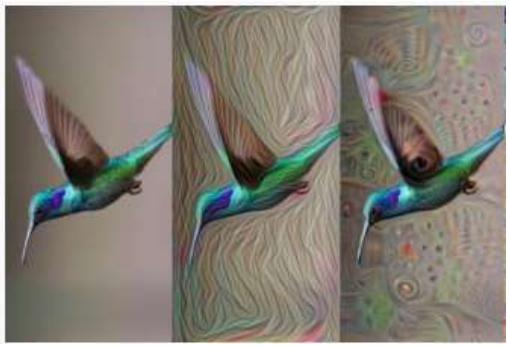
The experimental analysis method refers to the design of simulation experiments to reproduce the various factors and development processes of things, to find various useful data about such things in the real world, [27]. The realization of intelligent visual art creation relies on the experimental research of computer science. to show the research results of intelligent visual art more intuitively, this paper will carry out analysis experiments. Compare the experimental data and analyze it from the aspect of artistic creation.

3 The Case Analysis

3.1 The Art Design based on Transfer Learning

In 2015, Google opened up Inceptionism, a neural network used to classify images, named Deep Dream, [28]. Initially, Deep Dream was designed to understand what a deep neural network sees when it looks at a given image. As shown in Figure 1, the current version of Deep Dream has gradually become a new form of expressing psychedelic and abstract art. In addition, Deep Style is an upgraded version of Deep Dream, which can show a new style of painting through the learned image element information. Thin Style is a simplified version of Deep Style that does not create advanced transitions, but processes faster and outputs more detailed images.

Artificial intelligence technology was mainly used in image recognition, natural language processing, and other fields before. The emergence of Deep Dream enables computers to consciously create some meaningful images, some original visual languages that did not exist before. Deep Dream has an algorithm that is different from traditional image recognition, and it no longer relies on manual guidance and correction in the later stage. It can create psychedelic, magical, and weird images entirely with its consciousness.



(a) Deep Dream

(b) Deep Style

(c) Thin style

Fig. 1: Three image stylization methods provided by Deep Dream Generator

In August 2016, Google held an art exhibition for DeepDream in San Francisco called “Deep

Dream: The Art of Neural Network". In this art exhibition, the creator presented novel works of art with the help of Deep Dream, [29]. As shown in Figure 2, the creator chose the Google map plan of the British intelligence and security agency, input it into the Deep Dream Generator, generated multiple morphed versions, and finally fused the multiple versions into the final work.

The enlarged version of the work has even more shocking visual effects. It eventually sold for $8,000, a positive affirmation of the collaborative creative model of humans and artificial intelligence.

Fig. 2: Auction of "Deep Dreams: The Art of Neural Networks"

In August 2016, Google held an art exhibition for DeepDream in San Francisco called "Deep Dream: The Art of Neural Network". In this art exhibition, the creator presented novel works of art with the help of Deep Dream, [29]. As shown in Figure 2, the creator chose the Google map plan of the British intelligence and security agency, input it into the Deep Dream Generator, generated multiple morphed versions, and finally fused the multiple versions into the final work.

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3.2 The Art Design based on Image Generation

Transfer learning is a machine learning technique that leverages a model created for one specific task during the development process of a model for another task, allowing for reuse and adaptation of existing knowledge, [30]. In 2014, the Generative Adversarial Network (GAN) was proposed by former Google artificial intelligence scientists. This model can create images close to the real one by learning from a large number of training data sets, [31]. In 2014, the Generative Adversarial Network (GAN) was proposed by former Google artificial intelligence scientists. This model can create images close to the real one by learning from a large number of training data sets. Based on the power of GAN, GAN has also been applied in the field of art. As shown in Figure 3, artist Jake Elwes places images randomly generated by a GAN in a tidal landscape. Active selection from neural network-generated images of birds lets images migrate from one bird to another accompanied by artificially generated bird calls. The machine intensively learns latent characteristics of different swamp birds from photographic training data. Morphologies that vary between species are found in the process. And without reference to an anthropological taxonomic system, unexpected type transfers have occurred on their own. While these non-existent artificial birds stand on the tidal flats, real-world birds land and fly away around them.

The art design of the future will show more of a new model of collaborative innovation of artificial intelligence and the human brain. This also requires designers to maintain a business mindset to accumulate materials, discover things with creative potential, and develop a keen ability to explore. Improve the analysis ability of modeling structure, aesthetic judgment ability, and cohesion and coherence ability between constituent elements.

Fig. 3: Displaying randomly generated images based on GAN in a tidal landscape

3.3 The Art Design based on Image Identification

In 2016, Google opened the smart drawing tool AutoDraw to the public, [32]. As shown in Figure 4, AutoDraw uses deep learning to recognize drawn sketches and then matches the background database to generate new graphics composed of smooth curves. Deep learning collects a large amount of hand-painted data with the help of web search engines, which not only realize the training of machine drawing but also simulate the process of human drawing. The main difficulty of this application is to judge the direction and order of the user's hand drawing. It is not difficult to guarantee a 100% success rate in actual use.

Image recognition technology makes it possible to find different pictures of the same work, or to find similar works.

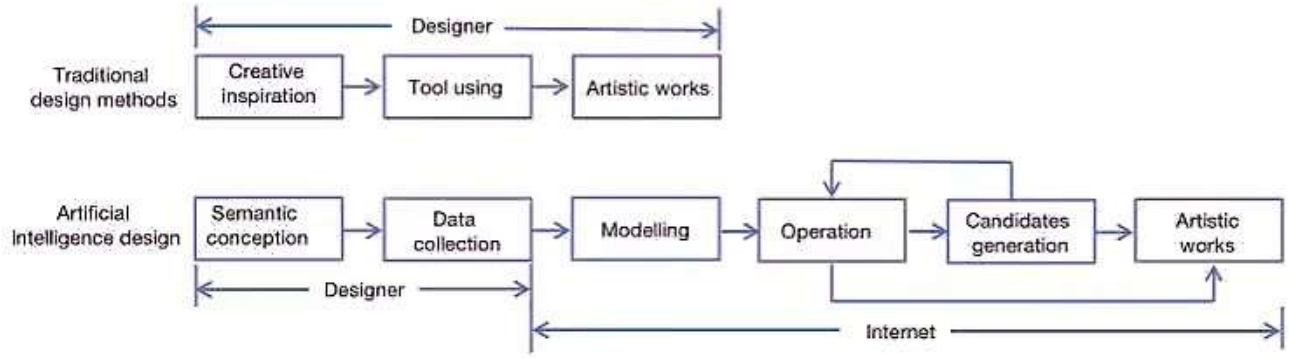

Fig. 5: The difference between traditional design and AI design

The combination of image recognition technology and big data technology is more conducive to the analysis and research of artworks. For example, this technology can be used to find the signature of the artist in the picture and to analyze the category and creation style of the artwork. If the data mining is deep enough, AI can even directly rely on the artist's creative style to distinguish the authenticity of the artwork. In the future, AI and machine vision will play a major role in the field of art, which can help people recognize real art and find high-level art creators.

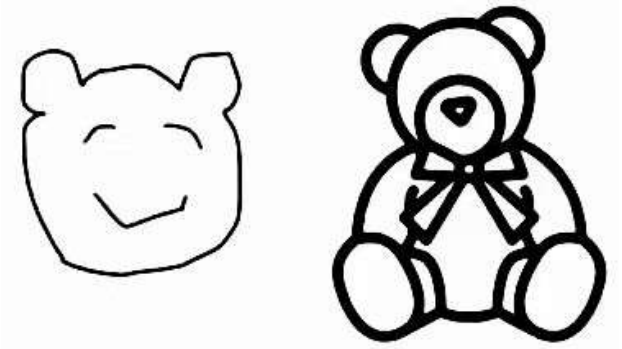

Fig. 4: Bear stick figure recognition based on the AutoDraw tool

4 AI Art Practice Exploration

4.1 Art Creation Process based on AI Technology

Traditional art design does not rely on computers or artificial intelligence, and highlights human creativity. With the rise of AI technology, there are more and more ways to use AI for artistic creation. Using AI technology for artistic creation will be more efficient, and it will also give new styles to artistic works.

In Figure 5, the traditional art design process is depicted, which includes determining design goals, collecting and analyzing data, conceptualizing, developing design proposals, implementing designs, and evaluating and adjusting designs. On the other hand, the AI art design process involves preparing a dataset, selecting and training a model, performing style transfer or generating a design, evaluating the generated design, and making necessary adjustments and optimizations. The entire process involves data preprocessing, model training, model application, and result evaluation, with data processing and model training being time and resource-intensive steps. Compared to the traditional art design process, the AI art design process focuses more on data and algorithm support, leading to more efficient achievement of design goals and creative possibilities that may be hard to attain through traditional art design.

4.2 CNN

LeNet-5, [33], is a pioneering convolutional neural network that was successfully utilized for digit recognition problems. It has shown impressive classification accuracy of 99.2% on the MNIST dataset, [34]. The network is composed of a 7-layer structure, which includes three convolutional layers, two pooling layers, and two fully connected layers.

The convolutional layer of CNN extracts the features of the image through the convolution kernel. These features include the texture and color of the image. The learning process of the convolution kernel is a process of constantly adjusting the weights. The pooling layer of CNN is to reduce the size of the feature map, thereby

reducing the calculation amount of the network. The pooling layer mainly has two operations: taking the maximum value or the average value. This operation is to downsample the feature map to reduce the size of the feature map. Each neuron in the fully connected layer of CNN is connected to all neurons in the previous layer, enabling the network to learn features and output each category. Each neuron in the fully connected layer corresponds to a specific class label, thereby achieving accurate classification.

4.3 VGG19

The Visual Geometry Group (VGG) at the University of Oxford developed VGG19, a convolutional neural network architecture. As shown in Figure 6 and Figure 7, the VGG19 structure consists of a series of convolutional layers, pooling layers, and fully connected layers. VGG19 has the characteristics of a small convolution kernel and a small pooling kernel. The size of the convolution kernel is 3×3 and the size of the pooling layer is 2×2.

ConvNet Configuration					
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input (224 × 224 RGB image)					
conv3-64	conv3-64 **LRN**	conv3-64 **conv3-64**	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 **conv3-128**	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 **conv1-256**	conv3-256 conv3-256 **conv3-256**	conv3-256 conv3-256 conv3-256 **conv3-256**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

Fig. 6: The overall frame diagram of VGG19

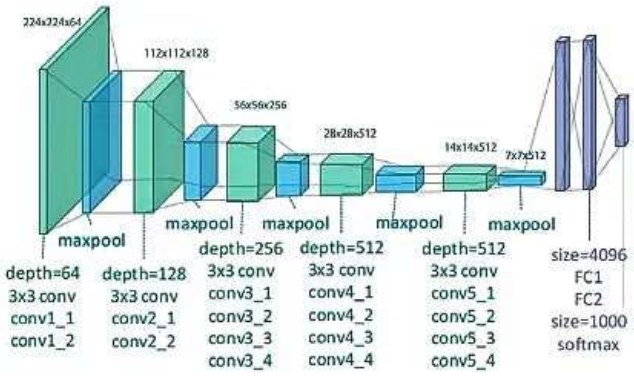

Fig. 7: VGG19 network structure diagram

4.4 Adaptive Moment Estimation (Adam) Optimizer

The Adam optimizer is an optimization algorithm based on gradient descent, [35]. The advantage of Adam over the stochastic gradient descent (SGD) algorithm, [36], is that it can adaptively adjust the learning rate. The Adam algorithm is an optimizer that combines the RMSprop algorithm, [37], and the Momentum algorithm, [38]. It updates the parameters by computing the first and second-moment estimates of the gradient.

The main advantage of the Adam algorithm is that the learning rate can be adjusted adaptively and it can handle sparse gradients. Adam tends to converge faster when training deep neural networks, so it is widely used in practice. However, in some cases, such as training GAN, etc., Adam may not perform as well as other optimization algorithms.

4.5 Method

This paper utilizes VGG19 to extract image features, which are used to represent the content and style of the image, for achieving artistic image style transfer. By matching the features of a content image with a style image, a new artistic image can be generated, which retains the structure and detail of the content image while possessing the texture and color characteristics of the style image. The generated artistic image is then optimized using the Adam algorithm to make it progressively closer to the target image. Artistic image style transfer can be generally divided into two stages: feature extraction and image generation optimization. Here are the specific steps involved:

(1) Import the VGG19 model and load the pre-trained weights, ensuring that the parameters of the model remain unchanged when extracting features.

(2) Select a content image and a style image, and extract their respective content and style features using the VGG19 model.

(3) Initialize a generative image, which is a random noise image with the same size as the

content image, and optimize it through constant tweaking using an optimization algorithm.

(4) Define loss functions, which include content loss and style loss. Content loss is used to preserve the structure and details of the content image, while style loss is used to preserve the texture and color features of the style image. The overall loss function is obtained by a weighted summation of the two losses.

(5) Use the Adam algorithm, to minimize the overall loss function for generating images. During optimization, the pixel values of the generative image are adjusted to more closely resemble the target image.

(6) Repeat steps (3) to (5) until the generated artistic image is close to the target image or the maximum number of iterations is reached.

(7) Output the resulting art image, which possesses the content structure and detail of the content image and the texture and color characteristics of the style image.

4.6 Result

Applying the above method, we transferred the style of Figure 8 and Figure 9, and the result is shown in Figure 10. Figure 10 has the original picture as the background with the artistic style of Van Gogh's Starry Night applied to it. The resulting picture is more psychedelic and dizzying, giving it a more artistic feel. By blending the content of Figure 10 with the style of Starry Night, the resulting image combines the structure and details of the original image with the texture and color characteristics of the famous artwork, resulting in a unique and visually striking composition.

Fig. 8: Stylistic drawing (Van Gogh's work: Starry Night)

Compared to traditional image processing methods, the advantage of using neural networks for artistic image style transfer is that they can adaptively learn and apply different styles, resulting in more diverse and artistic images. The resulting images have great artistic value and are visually striking, making them a popular subject for research and exploration in the field of computer vision.

Fig. 9: The original image

Fig. 10: The graph after style conversion

4.7 Souvenir Design

This paper proposes the use of AI technology to create souvenir patterns with a unique blend of local cultural characteristics and rich artistic effects. Based on Figure 10, the paper designs a series of souvenir renderings as shown in Figure 11. The scenic spots with local cultural characteristics are processed in an artistic style inspired by world-famous paintings and are then applied to the design of various tourist souvenirs such as mugs, postcards, puzzles, badges, etc. The graphics are extracted and converted with attention to matching and the design of colors to ensure that the souvenirs possess a unique artistic charm.

Souvenirs serve as a crucial way to strengthen the memory and experience of tourists. Among various types of souvenirs, mugs are essential for daily drinking water at home or in the office. Postcards are great for sharing the joy of traveling with friends through the mail. Puzzles are a fun way to create a lasting impression of scenic spots, and badges have a special significance as commemorative items.

Fig. 11: The Souvenir renderings display

5 Summary

AI technology has been widely used in various fields, and its application in artistic creation has become increasingly popular. This article explores in depth how to use AI technology for artistic creation. First, by introducing relevant cases and conducting in-depth analysis, we aim to gain a more comprehensive understanding of the role of artificial intelligence in the art field. Next, this article shows a specific process of using AI technology for artistic creation. Specifically, we used the VGG19 neural network and Adam optimizer to perform style conversion on the original artistic pictures through transfer learning, using pictures of a specific style as a reference. The style-migrated picture retains the basic elements of the original picture while showing a new artistic style, so it can be used as interesting material for creating souvenirs. Future research will focus on further optimizing AI technology and innovatively expanding methods of using AI technology for artistic creation. Developments in this field are expected to provide more creative inspiration and tools for art creators.

References:

[1] Rajaraman V. JohnMcCarthy—Father of artificial intelligence. *Resonance,* 2014,19:198-207.

[2] Jordan MI, Mitchell TM. Machine learning: Trends, perspectives, and prospects. *Science,* 2015,349:255-260.

[3] LeCun Y, Bengio Y, Hinton G. Deep learning. *Nature,* 2015,521:436-444.

[4] Pouyanfar S, Sadiq S, Yan Y, Tian H, Tao Y, Reyes MP, Shyu ML, Chen SC, Lyengar SS. A survey on deep learning: Algorithms, techniques, and applications. *ACM Computing Surveys (CSUR)*, 2018,51:1-36.

[5] Gardner MW, Dorling S. Artificial neural networks (the multilayer perceptron)—a review of applications in the atmospheric sciences. *Atmospheric Environment*, 1998, 32:2627-2636.

[6] Rumelhart DE, Hinton GE, Williams RJ. Learning representations by back-propagating errors. *Nature*, 1986, 323:533-536.

[7] Joachims T. Making large-scale SVM learning practical. In: *Technical report*, 1998.

[8] Hinton GE, Salakhutdinov RR. Reducing the dimensionality of data with neural networks. Science, 2006, 313:504-507.

[9] Kattenborn T, Leitloff J, Schiefer F, Hinz S. Review on Convolutional Neural Networks (CNN) in vegetation remote sensing. *ISPRS Journal of Photogrammetry and remote sensing*, 2021, 173:24-49.

[10] Yin W, Kann K, Yu M, Schütze H. Comparative study of CNN and RNN for natural language processing. *arXiv preprint* arXiv:1702.01923 2017.

[11] Sherstinsky A. Fundamentals of recurrent neural network (RNN) and long short-term memory (LSTM) network. *Physica D: Nonlinear Phenomena*, 2020, 404:132306.

[12] Bengio Y, Lamblin P, Popovici D, Larochelle H. Greedy layer-wise training of deep networks. *Advances in neural information processing systems*, 2006,19.

[13] He K, Zhang X, Ren S, Sun J. Deep residual learning for image recognition. *In: Proceedings of the IEEE conference on computer vision and pattern recognition*, 2016. pp. 770-778.

[14] Ren S, He K, Girshick R, Sun J. Faster r-cnn: Towards real-time object detection with region proposal networks. *Advances in neural information processing systems*, 2015, 28.

[15] He K, Gkioxari G, Dollár P, Girshick R. Mask r-cnn. *In: Proceedings of the IEEE international conference on computer vision*, 2017. pp. 2961-2969.

[16] Alom MZ, Taha TM, Yakopcic C, Westberg S, Sidike P, Nasrin MS, Esesn BCV, Abdul A S. Awwal, Vijayan K. Asari. The history began from Alexnet: A comprehensive survey on deep learning approaches. *arXiv preprint*, arXiv:1803.01164 2018.

[17] Al-Qizwini M, Barjasteh I, Al-Qassab H, Radha H. Deep learning algorithm for autonomous driving using Google. *In: 2017 IEEE Intelligent Vehicles Symposium (IV): IEEE*, 2017. pp. 89-96.

[18] Sengupta A, Ye Y, Wang R, Liu C, Roy K. Going deeper in spiking neural networks: VGG and residual architectures. *Frontiers in Neuroscience*, 2019, 13:95.

[19] Targ S, Almeida D, Lyman K. Resnet in Resnet: Generalizing residual architectures. *arXiv preprint*, arXiv:1603.08029 2016.

[20] Han Z. Combined Development of Artificial Intelligence and Art Design. *In: 2021 6th International Conference on Intelligent Computing and Signal Processing (ICSP): IEEE*, 2021. pp. 1023-1026.

[21] Ye C. Evolution and Application of Artificial Intelligence Art Design Based on Machine Learning Algorithm. *In: 2021 IEEE 4th International Conference on Information Systems and Computer Aided Education (ICISCAE): IEEE*, 2021, pp. 293-297.

[22] Gao Z, Man S, Wang A. AI Art and Design Creation Industry: The Transformation from Individual Production to Human-Machine Symbiosis. *In: 2022 World Automation Congress (WAC): IEEE*, 2022, pp. 52-56.

[23] Lin Y-C, Chen Y-T. Artificial intelligent models for new product design: An application study. *In: 2016 International Conference on Computational Science and Computational Intelligence (CSCI): IEEE*, 2016. pp. 1134-1139.

[24] Snyder H. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 2019, 104:333-339.

[25] Baxter P, Jack S. Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report,* 2008, 13:544-559.

[26] Seawright J, Gerring J. Case selection techniques in case study research: A menu of qualitative and quantitative options. *Political Research Quarterly*, 2008, 61:294-308.

[27] Batsell RR, Louviere JJ. Experimental analysis of choice. *Marketing Letters*, 1991, 2:199-214.

[28] Suzuki K, Roseboom W, Schwartzman DJ, Seth AK. A deep-dream virtual reality platform for studying altered perceptual phenomenology. *Scientific Reports*, 2017,7:1-11.

[29] Ferreira DP. Artificial Dreams: Contemporary Intersections Between Art and Technology. *Estetyka i Krytyka*, 2019, 52:41-55.

[30] Tammina S. Transfer learning using vgg-16 with deep convolutional neural network for classifying images. *International Journal of Scientific and Research Publications (IJSRP),* 2019, 9:143-150.

[31] Creswell A, White T, Dumoulin V, Arulkumaran K, Sengupta B, Bharath AA. Generative adversarial networks: *An overview. IEEE Signal Processing Magazine*, 2018,35:53-65.

[32] Bitkina OV, Jeong H, Lee BC, Park J, Park J, Kim HK. Perceived trust in artificial intelligence technologies: A preliminary study. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 2020, 30:282-290.

[33] Application of improved LeNet-5 network in traffic sign recognition. *In Proceedings of the 3rd International Conference on Video and Image Processing*, pp. 13-18.

[34] Cheng K, Tahir R, Eric LK, Li M. An analysis of generative adversarial networks and variants for image synthesis on MNIST dataset. *Multimedia Tools and Applications*, 2020, 79:13725-13752.

[35] Kingma DP, Ba J. Adam: A method for stochastic optimization. *arXiv preprint,* arXiv:1412.6980 2014.

[36] Bottou L. *Stochastic gradient descent tricks. Neural Networks: Tricks of the Trade*. Second Edition 2012:421-436.

[37] Xu D, Zhang S, Zhang H, Mandic DP. Convergence of the RMSProp deep learning method with a penalty for nonconvex optimization. *Neural Networks*, 2021, 139:17-23.

[38] Kuhl D, Ramm E. Constraint energy momentum algorithm and its application to non-linear dynamics of shells. *Computer methods in applied mechanics and engineering*, 1996, 136:293-315.

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Liping Qiu is mainly responsible for writing the paper.
- Ahmad Rizal Abdul Rahman: Mainly responsible for the methodology part of the paper.
- Mohd Shahrizal bin Dolah participated in the design of the research methodology.
- Shengguo Ge is mainly responsible for the operation of neural networks in Section 4.4 of the paper.

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