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Quality Optimization of Virtual Reality-Based Efficient Net Model in ArtWorks

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Abstract. The EfficientNet model has shown significant and efficient rendering performance in the field of image classification and recognition in previous models. The current user feedback shows that the realism and vividness of images have greatly improved after using the EfficientNet model. Therefore, this model can well reflect the intrinsic value of user graphics. Its EfficientNet model can innovatively reflect the artistic environment testing resolution of testing quality, thereby achieving optimal model performance. Therefore, this article innovatively rendered visual effects after verifying the resources in the virtual environment. The quality of the processed model has significantly improved. The experimental results show that the artwork optimized using the EfficientNet model has significantly improved image clarity and detail performance when displayed in a VR environment. This further confirms the potential application of EfficientNet models in the field of CAD and VR integration.

Keywords: Art Works; Efficientnet Model; Virtual Reality; CAD; Image Fusion
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1 INTRODUCTION

The application of virtual reality technology is currently one of the main means for domestic and foreign art museums to expand their functions. This technological innovation coincidentally caters to the current era, promotes the development of art museums, and also makes up for the shortcomings of art museums in their development. Virtual reality technology is a branch of digital technology that extends the various functions of traditional art museums and brings tremendous impetus to the development of the art museum industry [1]. By wearing virtual reality devices, visitors can experience the virtual reality technology that creates a realistic three-dimensional exhibition scene. Viewers do not need to be present in person and can watch national exhibitions from anywhere, allowing people to experience the charm of exhibitions without leaving their homes. The perfect combination of virtual reality technology and art museums allows audiences to experience the changes it brings to art deeply. Then, I began conducting in-depth research on virtual reality technology's application in art museums. Its emergence has met the new demand for artistic works that people crave today. Moreover, virtual reality technology has also been applied to mobile apps, allowing people to watch exhibitions anytime and anywhere, greatly providing convenience for people. It is precisely in this way that the application of virtual reality technology has expanded an infinite virtual space for art museums, showcasing their collections to the world through images and the internet. Moreover, the catalog system of the collections can also be used to search and share the resources of the collections of various countries in various libraries through the Internet [2].

In art teaching, a series of practical problems brought about by traditional teaching methods seriously hinder the smooth implementation of still-life placement teaching, and there is an urgent need for new teaching methods to break the reality dilemma. Carpentier et al. [3] conducted in-depth discussions on these issues and explored practical and feasible design solutions for static life placement virtual systems, promoting the smooth implementation of static life placement teaching. At present, research on still-life placement teaching mainly focuses on placement forms, teaching methods, and the cultivation of aesthetic abilities. There is still insufficient research on the analysis and solutions of its practical difficulties and causes. It discusses the promoting effect of combining the characteristics of static life placement virtual systems on cultivating aesthetic ability. It is believed that the diverse real-time interaction, integration of still life resources, construction of virtual scenes, and semi-open and autonomous learning of the system have further enhanced the cultivation of aesthetic abilities. Virtual museums provide a new path for the development and utilization of school art curriculum resources. Demir et al. [4] demonstrated a feasible solution for school art courses to use virtual museum resources for art appreciation teaching through teaching cases. This teaching practice also tests and provides feedback on the effectiveness of virtual museums in assisting school education, providing reference and optimization directions for the integration of digital educational resources in art appreciation courses. Virtual museums provide a real context for teaching, enriching the interactive experience between students and teachers. This allows learners to naturally grasp the logic of appreciation, cultivate expressive thinking, develop exploratory abilities, and enhance media literacy throughout the entire process. By analyzing the design elements and principles in design work, the model can provide aesthetic ratings or suggestions regarding visual composition, helping designers better understand their work and find directions for improvement. This versatility positions the EfficientNet model as a potent tool for image quality optimization tasks.

Guo and Li [5] proposed an innovative method of directly extracting I frames (keyframes) in the compressed domain. The new model proposed not only promotes the information transformation of art and design activities but also provides solid theoretical support for the extension of digital networks to art and design. This method of scene summarization not only provides powerful tools for video analysis and understanding but also offers new ideas for innovation in art and design. This platform can not only help them improve their professional level but also promote the healthy and orderly development of artistic creation. Models can effectively improve the efficiency and quality of art and design, enabling art creators and producers to complete design tasks more quickly and achieve higher-quality design results. Kim et al. [6] used deep neural networks and weakly supervised learning techniques to carefully select soundscape music that matches visual artworks, in order to significantly enhance the user experience during the viewing process. In order to accurately measure the subjective feelings of users during the appreciation process, they proposed a multidimensional evaluation method. Although these vague concepts are difficult to quantify, their existence is crucial for understanding the true feelings of users. Let them not only enjoy visual pleasure when appreciating artworks but also feel the unique charm and emotional resonance brought by sound. In addition, it was found that when artworks were combined with classical music, the consistency of implicit feelings reached as high as 0.75%. The test results are comparable to the immersive media artwork "Bunker de Lumi è res: Van Gogh" directed by renowned artist Gianfranco Lannuzzi. Art is undergoing a digital revolution. More and more artworks are carefully scanned, digitized, and constructed into massive databases, providing researchers with an unprecedented treasure trove of resources. Researchers who focus on studying the colour of artworks in existing databases may face some challenges. Li et al. [7] utilized these databases to explore the mysteries of materials, structures, colours, and other aspects of artworks. Traditional metadata query methods often fail to accurately capture subtle colour changes in artworks. Although some image retrieval engines provide text description-based retrieval capabilities, these systems mainly focus on the main colours or overall features of the image. For researchers in specific fields such as colour matching, colour or pigment, what they may need is a more refined and intuitive colour retrieval method. The objective of this investigation is to construct an image quality enhancement model for artworks, leveraging the EfficientNet model to elevate the CAD and VR integrated display's impact. Our research inquiries encompass: how can we effectively harness the EfficientNet model to optimize the image quality of artworks? How can we ensure the model's recognition accuracy and swift fusion quality optimization, especially when working with limited sample datasets? To address these inquiries, we first delve into the structure and traits of the EfficientNet model, revealing its prowess in maintaining accuracy while reducing computational costs through a balanced approach to network depth, width, and resolution adjustments.

Traditional loss functions often focus on measuring pixel-level differences, but in art image processing, these differences often cannot fully reflect the improvement of image quality. The colour, texture, lines and other characteristics of artworks often contain rich cultural connotations and artistic value. Therefore, the improvement of image quality is not only related to technical optimization but also involves respect and protection of the artworks themselves. In the experimental stage, we comprehensively validated the model using multiple datasets. This insight not only provides a solid theoretical basis for establishing a model for optimizing the quality of artwork images, but also opens up a new path for the digital preservation, display, and inheritance of artworks. The model has achieved significant improvements in both recognition accuracy and fusion quality optimization speed. We also provide an in-depth examination of the experimental outcomes. Our aim is to offer readers a comprehensive and insightful understanding of the research process and achievements in optimizing the integration quality of CAD and VR in artworks, leveraging the EfficientNet model as a foundation.

2 RELATED WORKS

3D digital virtual reality technology, as a cutting-edge digital medium, is fundamentally changing the way we perceive and interact with the world. This technology is not only based on the fusion of diverse artistic information but also a three-dimensional visual and physical behaviour system simulation that can interact and dynamically change in real-time. With the help of 3D digital virtual reality technology, Li [8] has broken through traditional creative boundaries and built a virtual world that resonates deeply with the audience. As creators of visual art, we are in a rapidly changing digital age and must constantly expand our horizons, attempting to observe and understand the world at a deeper level. In every aspect of visual art design, they are committed to conveying our profound understanding and unique insights into the world through 3D digital virtual reality technology. Digital technology has made significant progress in art dissemination and display, providing audiences with a near-real art appreciation experience. In virtual exhibitions, the projection size of text and painting needs to be adjusted according to the audience's visual habits and comfort level to ensure that the audience can clearly see and understand the content and details of the work. Lin et al. [9] explored the experience of art appreciation through desktop virtual reality and head-mounted display technology and conducted a detailed comparative analysis with traditional physical painting appreciation methods. The research results show that there is no significant difference in the evaluation of painting works and the emotions expressed during the appreciation process among participants in desktop VR, HMD VR, and physical painting appreciation. With the rapid progress of science and technology and the continuous integration of new technologies, the upgrading speed of artistic works is becoming increasingly rapid, and their lifecycle is significantly shortened. In order to establish a foothold in such a fierce market environment, art development must be more efficient, precise, and innovative. Liu [10] proposed a new solution - a product configuration editor based on 3D visualization interface software. They combined this editor with a PDM (Product Data Management) system to form a complete and efficient art development software system. This system not only supports rapid product design and editing but also enables comprehensive and systematic management of product data, ensuring data consistency and traceability during the design process.

Self-shaping machine woven textiles are a unique type of textile that not only attract people's attention for their beauty and functionality but are also known for their unique ability to change shape. At present, weaving software on the market mainly relies on 2D graphic descriptions to simulate the appearance and performance of fabrics. Due to the difficulty in accurately predicting the shape and size changes of these fabrics through 2D graphics, existing weaving software often cannot provide effective design support and solutions. Meiklejohn et al. [11] created a weaving behaviour library categorized by attributes, which includes the behavioural characteristics of various yarn materials and fabric structures under different conditions. In terms of exhibition design, firstly, traditional art museums need to do a lot of preparation work before the exhibition opens. In terms of space, firstly, the artworks of traditional art museums are diverse in form, including sculptures, traditional Chinese paintings, calligraphy, oil paintings, installation works, etc. Some works require different items such as display stands and display cabinets to assist in the exhibition process. Therefore, traditional art museums need to rely on a larger space to present their works. In the application of virtual reality technology, various forms of work are scanned with the support of digital technology. Secondly, it is precisely due to the limitations of space that the display space lacks flexibility. Once the position of the work is selected during the exhibition process, it is not easy to change; as the saying goes, pulling one hair can move the whole body. Choose or adjust the position of exhibits according to the display needs, making the display space more flexible and diverse and the display effect more colorful. In addition, in display design, it is necessary to consider the viewing route of the audience and develop a clear visiting route for them from their perspective. In order to fully demonstrate its public education function, traditional art museums divide exhibition forms into various forms, such as long-term exhibitions, temporary exhibitions, and touring exhibitions, in order to promote art dissemination better. Converting words into images for display in virtual scenes allows for the display of a large number of art pieces without worrying about insufficient space. With the help of virtual reality technology, many links are eliminated during the exhibition layout process, greatly saving manpower, material resources, and financial resources. Through the application of technology, real scenes are transformed into virtual display spaces. Visitors can use mice, keyboards, or virtual reality devices to formulate their own exhibition routes, which, to some extent, gives them the freedom to watch the exhibition [12]. Directly designing and analyzing through 3D models not only greatly reduces development time but also significantly improves product quality and performance. The introduction of MBE technology has brought revolutionary changes to the field of engineering. It bypasses the tedious process of drawing artistic two-dimensional drawings. It subverts the traditional design process that relies on artistic two-dimensional drawings and instead utilizes advanced digital technology to construct three-dimensional models, greatly improving the efficiency and accuracy of engineering design [13]. Artificial neural networks can learn and recognize complex patterns in images by simulating the workings of human brain neurons. Cloud manufacturing systems use cloud computing technology to centrally manage and schedule manufacturing resources and capabilities, achieving flexibility and efficiency in the manufacturing process. In order to adapt to product changes during the production process of parts, Soori and Asmael [14] developed a flexible process planning system using dynamic CAPP technology. Through cloud computing platforms, artists and designers can share design concepts and manufacturing data in real time, promoting the application and development of art products in different industries. In terms of image enhancement and restoration, ANN can recognize and restore lost details in images, improving image clarity and contrast. In the process of art manufacturing, cloud manufacturing systems can quickly adjust manufacturing resources and process planning according to different production needs, achieving personalized customization and rapid response.

Traditional calligraphy is limited by the knowledge and experience accumulated by appraisers, making it difficult to cope with increasingly complex forgery techniques. EfficientNet is an efficient and lightweight convolutional neural network with excellent performance and low computational complexity. Wang et al. [15] propose a calligraphy work authentication method based on an improved EfficientNet network. In the data preprocessing stage, in order to increase the model's generalization ability, we expanded the extracted calligraphy characters. This data augmentation method not only improves the robustness of the model but also enables the model to better cope with calligraphy authentication in various complex situations. The CBAM module can enhance the model's attention to the channels and spatial positions of feature maps, making the model more focused on key information in calligraphy works. Through studying these data, the model gradually learned to distinguish the styles of different calligraphers and identify abnormal features in forged works. In the field of product design, visual aesthetics has always been one of the core criteria for evaluating the success of design solutions. These image features not only cover the physical properties of the product such as form, colour, and material, but also contain the designer's insight into user needs, grasp of market trends, and interpretation of brand concepts. Through a series of analyses of online virtual museum learning resources, Wu et al. [16] found that museum education is no longer just a general education aimed at the public. There are three modes of using virtual museum-related learning resources, one of which is to organize teaching content through the virtual museum platform. By utilizing the multi-node linking module of the platform, this open mode can replace the closed teaching approach of simply presenting content in PowerPoint. For the platform, both the accuracy of data and the rigour of teaching plans. The novelty of arrangement and design is the reflection and effort of the entire museum staff. They face countless real audiences, on how to better convey the educational content of museums. It is not just an electronic data archive for cultural relics, collections, or exhibition halls to visit or read, but a carefully considered and organized educational medium.

The still-life placement virtual system is a virtual reality work, which naturally requires high-quality images. However, in the development process, the operational efficiency of the system should also be considered. In fact, still life itself is beautiful, and the process of placing still life is the process of perceiving beauty, imagining beauty, and creating beauty [17]. Try to use PNG lossy format for unimportant images, and create corresponding normal maps for high-resolution models to achieve high-resolution display effects for low-resolution models. Beautiful things have rich expressive and infectious power, so they can better stimulate students' enthusiasm. The more students experience beauty in the process of placing still objects. Using the modular approach in object-oriented theory, the virtual system for still-life placement can be divided into theoretical guidance modules, appreciation and copying modules for still-life paintings, and practical modules according to their functions. Because interactivity is an important indicator for measuring the virtual system of still life placement, low operational efficiency affects interactivity, making it difficult for users to have a good experience. To ensure the operational efficiency of the system, we need to optimize the art resources to a certain extent. The stronger the feeling of beauty, the more interested one becomes in learning. This interest and enthusiasm will encourage students to actively grasp and understand the knowledge they have learned [18]. Therefore, the design of a virtual system for still life placement should not only reflect the natural beauty of still life itself but also conform to the aesthetic principles of users in the production of art resources. Models, animations, UI, sound effects, etc. should be harmonious and unified. Each module is further decomposed into smaller modules. The purpose of doing so is to make the overall structure clearer and more convenient for users to use. At the same time, it greatly reduces the complexity of modifying code during the implementation process and makes the system easier to maintain and expand.

3 METHODOLOGY

This section will introduce the optimization method of art image quality based on the EfficientNet model in detail, including the basic structure of the EfficientNet model, the design of the art image quality optimization model, and the specific steps of algorithm implementation.

3.1 Design of an Optimization Model for Art Image Quality

Before designing the optimization model of art image quality, we must realize the uniqueness and complexity of artworks. These works often contain the artist's deep feelings and exquisite skills, and every detail may be the crystallization of the artist's painstaking efforts. Therefore, optimizing the image quality of artworks is different from the general image processing task, which requires that the artistic style and details of the original work be fully preserved while improving the image quality. Based on the above considerations, this study constructs an image quality optimization model specifically for artworks based on the EfficientNet model. The model takes EfficientNet as the main network and makes it more suitable for the processing task of art images by fine-tuning the network structure and parameters. The feature extraction process of art images based on the EfficientNet model is shown in Figure 1.

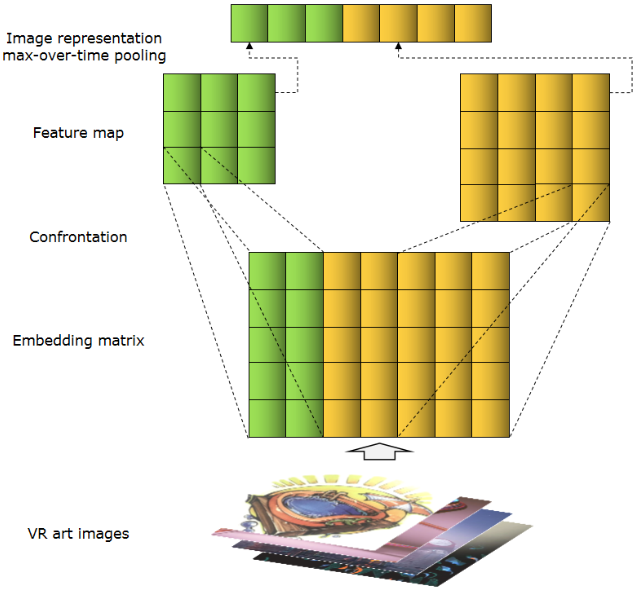

Figure 1: Feature extraction of art images.

X_i^k denotes the aggregate of inputs received by the neurons i in the k layer, while Y_i^k signifies the output.

$$Y_i^k = f \; X_i^k \tag{1}$$

$$X_i^k = \sum_{j=1}^{n+1} W_{ij} Y_j^{k-1} \tag{2}$$

Typically, f is employed as the asymmetric Sigmoid function.

$$f \; x_i^k \; = \frac{1}{1 + \exp \; -X_i^k} \tag{3}$$

$$e = \frac{1}{2} \sum_i \; Y_i^m - Y_i \; ^2 \tag{4}$$

In the reference image and the image to be matched, feature extraction is a necessary step before image matching based on features, without the need to directly collect and process grayscale information of the image. If these features are unique to the key target object in the image, the position information of the target object in the image can be quickly calculated. Feature-based matching methods have good robustness to changes in image rotation scale, lighting changes, and noise effects and have low time loss, gradually becoming the most concerned image matching method. By extracting the features of the image and describing them, feature descriptors are used to match the reference image and the image to be matched. This algorithm has strong resistance to interference such as noise, differences in imaging conditions, or sensor differences and has strong stability. Line features refer to using the entire edge or a segment within the edge of an image as a feature, such as boundary lines or contours. However, the extraction of edge features from line features requires the use of edge detection algorithms, and the quality of edge or line information extracted by edge detection algorithms has a significant impact on the matching results. These line features contain the structure and edge information of the target object in the image. Therefore, the matching performance of this type of algorithm depends on the quality of the edge detection algorithm.

This chapter first provides a detailed introduction to image processing methods based on machine vision. Secondly, the key elements of image matching were explained in detail, with a focus on two basic methods of image matching - image matching methods based on grayscale or features. The analysis explains two preprocessing methods, grayscale preprocessing and denoising preprocessing algorithms, providing methodological support for subsequent workpiece image processing. Still able to maintain good characteristics, providing ideas for improving image matching algorithms in the following text. At the end of the chapter, a brief introduction was given to the evaluation criteria for image-matching performance. An analysis and explanation of the applicable conditions and advantages and disadvantages of the two types of methods were conducted, and a summary was made of the feature-based image-matching methods for dealing with changes in rotation scale, blur, lighting, and other factors.

3.2 Algorithm Implementation Steps

This loss function is designed to narrow the distributional disparities between the two domains, positioning Deep CORAL as a formidable tool in unsupervised adaptation scenarios and bolstering the model's generalization performance and precision. Figure 2 shows the architecture of the Deep CORAL model.

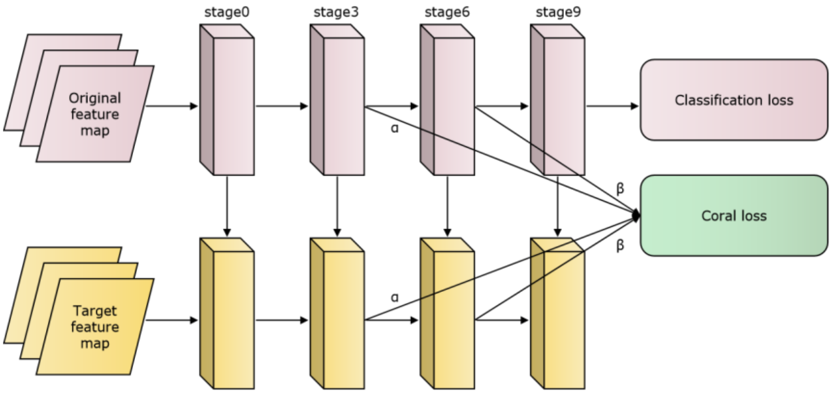

Figure 2: Deep CORAL model architecture.

Art image fusion can be envisioned as a task of binary classification, where the objective is to differentiate between clear and unclear images. In building the classifier for the network, we make use of Softmax, and for the loss function, we adopt the Softmax loss:

$$L = -\sum_{k} y_k \log a_k \tag{5}$$

In this context, a_k represents the output generated by the Softmax classifier, signifying the predicted probability value for the k class, whereas y_k corresponds to the actual probability value. The formula for determining the output a_k from the Softmax function is defined as follows:

$$a_k = \frac{e^{z_j^L}}{\sum_k e^{z_k^L}} \tag{6}$$

Here, z_j^L denotes the input received by the j neuron located in the final layer of the network, while $\sum_k e^{z_k^L}$ signifies the weighted input from all neurons in that layer.

To ensure that the extracted feature points have scale invariance, the SIFT algorithm first uses a Gaussian kernel to construct a scale space, then constructs an image Gaussian difference pyramid, namely the Gaussian difference scale space (DOG), and finally searches for extremum points in the obtained DOG scale space. In the process of searching for extreme points, DOG pixels need to be compared not only with adjacent points in the same layer but also with points on adjacent layers. A total of 26 points need to be compared (8 in the same layer and 18 in adjacent layers). If the points are all smaller than (or larger than) the surrounding points, they are considered extreme points.

$$y = f\ x;\theta \tag{7}$$

Where x represents the input art image, y represents the output image quality optimization result and θ represents the model parameters.

In order to optimize the quality of art images, a loss function is defined:

$$L\ \theta\ = \frac{1}{N}\sum_{i=1}^{N}\xi\ y_i,\hat{y}_i \tag{8}$$

$$L\ \theta\ = \frac{1}{N}\sum_{i=1}^{N}\xi\ y_i,\hat{y}_i\ + \lambda\sum_{w\in\theta}\frac{1}{2}w^2 \tag{9}$$

The algorithm utilizes integral images to reduce computational complexity, thereby accelerating detection speed and reducing time consumption. Before introducing the integral image, the sum of pixels within the region is the sum of all pixel values. When changing regions, the addition calculation needs to be repeated, making it increasingly complex and time-consuming to calculate the sum of pixel values in different regions. The establishment of integral images simplifies the process of summing pixel values in different regions. After introducing the integration image, the sum of all pixel values in a rectangular area composed of any point on the integration image and the origin of the image can be calculated first. Then, the sum of pixel values for any rectangular region within that region can be calculated by performing addition and subtraction operations. Let any point (ty) in the image form a rectangular region with the image origin, where I - (x, y) is the sum of all pixel values within this rectangular region. In order to preserve the scale invariance of the algorithm, the algorithm must be able to find feature points at different scales when detecting them accurately. The SURF algorithm also uses the image pyramid method to construct the scale space. Unlike SIFT, SURF uses filter templates of different sizes to respond and obtain images of different scales, thereby completing the scale space construction.

$$Q = \frac{1}{M}\sum_{j=1}^{M}\frac{\left|\hat{y}_j - y_j\right|}{y_j} \tag{10}$$

Where M represents the number of fused images, y_j represents the true quality score of the j fused image, and $\hat{y}_j$ represents the quality score predicted by the model.

In order to optimize the quality of fast fusion, the gradient descent method is adopted:

$$\theta_{t+1} = \theta_t - \alpha\nabla_\theta L\ \theta \tag{11}$$

Where θ_t represents the model parameters of the current iteration step, α represents the learning rate, and $\nabla_\theta L \ \theta$ represents the gradient of the loss function to the model parameters.

Based on the test outcomes, further optimization and fine-tuning of the model take place. For instance, we have the option to modify the network architecture, incorporate regularization terms, or adopt more sophisticated optimization algorithms, all aiming to enhance the model's performance and generalization capabilities. Upon completing the training process, the model is ready for deployment in a real-world application setting. In practical use, this model serves to refine the quality of new artwork images, thereby improving the overall visual integration in CAD and VR displays.

4 RESULT ANALYSIS AND DISCUSSION

In the practical application of deep learning, the choice of model is not only related to accuracy but also closely related to training efficiency and resource consumption. In order to find the most suitable backbone network for this research task, we compared several popular convolutional neural network models, including Vgg16, ResNet50, Mobilene ETV 2, and EfficientNetV2. These models perform excellently in image recognition and processing tasks, but their structures, parameters, and computational efficiency are different. Firstly, the trainable parameters of these models in the case of frozen feature layer (F) and unfrozen feature layer (NF) and the time required to train an epoch on GPU and CPU are measured through experiments (see Table 1 for details). Freezing feature layer is a commonly used transfer learning strategy, which can retain the feature extraction ability of the pre-training model and greatly reduce the number of parameters to be trained, thus speeding up the training process.

Model	*Params*	*GPU/s*	*CPU/s*
Vgg16-NF	135.4M	71	3311
Vgg16	135.4M	55	3205
Vgg16-F	16 9M	46	1307
ResNet50-NF	23.7M	67	1588
ResNet50	23.7M	66	1518
ResNet50-F	15.1K	47	731
MobileNetV2	2.3M	66	688
MobileNetV2-NF	2.3M	64	688
MobileNetV2-F	9.2K	43	311
EfficientNetV2	20.5M	105	3599
EfficientNetV2-NF	20.5M	101	3551
EfficientNetV2-F	339.7K	61	1541

Table 1: Efficiency comparison of migration model.

As can be seen from Table 1, after freezing the feature layer, the amount of trainable parameters of all models is greatly reduced. Among them, the amount of trainable parameters of Vgg16 is reduced to 12.7% of the original model, ResNet50 to 0.07%, MobileNetV2 to 0.5%, and EfficientNetV2 to 1.5%. This strategy significantly reduces the complexity of the model and makes it possible to train a larger model with limited computing resources.

Next, the performance of these models is tested on the VOC2012 data set. Although MobileNetV2-F has the least trainable parameters and the shortest training time, its performance is the worst among all models. This may be because the structural design of MobileNetV2 pays more attention to computational efficiency than performance, which leads to limited performance in complex tasks. In contrast, the MobileNetV2-NF model shows a good balance in CPU training, and its training speed is about 5 times faster than that of the optimal EfficientNetV2-NF.

When training on GPU, the training time of each backbone network is not much different. This is because GPU has powerful parallel computing ability, which can efficiently handle large-scale matrix operations, thus making up for the differences in computational complexity of different models. In this case, EfficientNetV2-NF, EfficientNetV2-F and Vgg16-NF performed best. However, considering that the training parameters of Vgg16 are too large, which may lead to over-fitting and waste of computing resources, we choose EfficientNetV2 for the next experiment.

In order to further verify the performance of EfficientNetV2, we made a visual analysis of it. Figures 3 and 4 show the visual examples of the identification of EfficientNetV2-F and EfficientNetV2-NF on the VOC2012 data set. From these examples, it can be seen that EfficientNetV2 can accurately identify the target object in the image, and give a clear bounding box and category label. This further proves the effectiveness of EfficientNetV2 in the quality optimization task of the integration of CAD and VR in artworks.

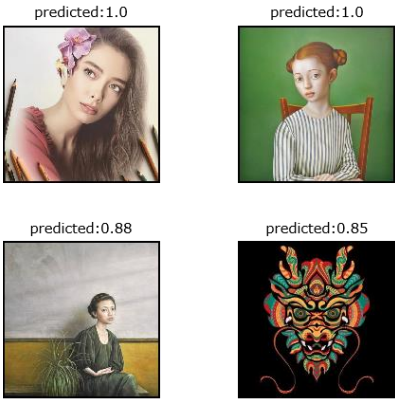

Figure 3: Effi-cientNetV2-F.

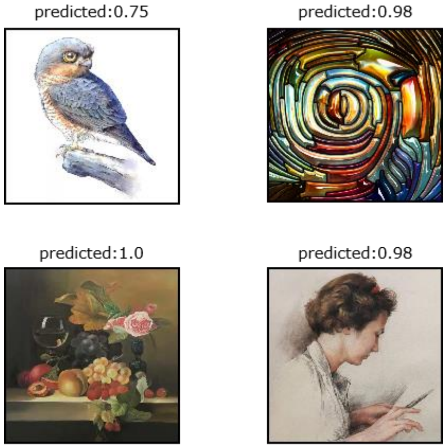

Figure 4: Effi-cientNetV2-NF.

By utilizing CAD technology, we construct precise 3D representations of artworks, encompassing not just their geometric forms but also meticulously replicating their materials and textures. Subsequently, VR technology facilitates the seamless integration of these models into a virtual realm, enabling users to fully immerse themselves in exploring and admiring the artworks. Refer to Figure 5 for a comparative analysis of various optimization algorithms' accuracy in enhancing image quality. Notably, the EfficientNet-based optimization algorithm stands out for its remarkable precision.

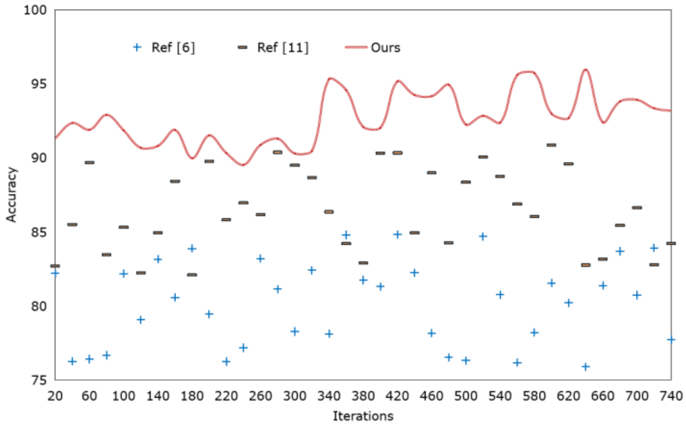

Figure 5: Accuracy comparison of different optimization algorithms.

The findings reveal that the optimization approach rooted in the EfficientNet model notably enhances the image quality in CAD and VR fusion, thereby boosting user immersion and delivering a more precise representation of artistic styles and intricate artwork details.

Moreover, the performance of the virtual exhibition platform utilizing the EfficientNet model has undergone rigorous testing. Refer to Figure 6 for platform stability test results, indicating that the platform maintains a high level of stability even when handling a substantial volume of transactions.

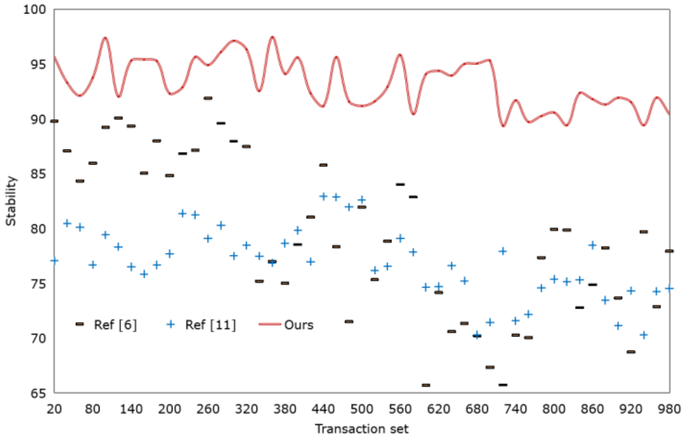

Figure 6: Stability test results of virtual display platform.

In order to evaluate the quality optimization effect of the integration of CAD and VR based on the EfficientNet model more comprehensively, we specially invited a group of art educators and learners to experience this technology and asked them to make subjective scores according to their experience. Figure 7 shows the results of these scores. Most art educators and learners give high marks to the display of CAD and VR with the EfficientNet model. They believe that through this optimized fusion technology, the details of artworks are clearer, the colours are more vivid, and the overall visual effect has been significantly improved.

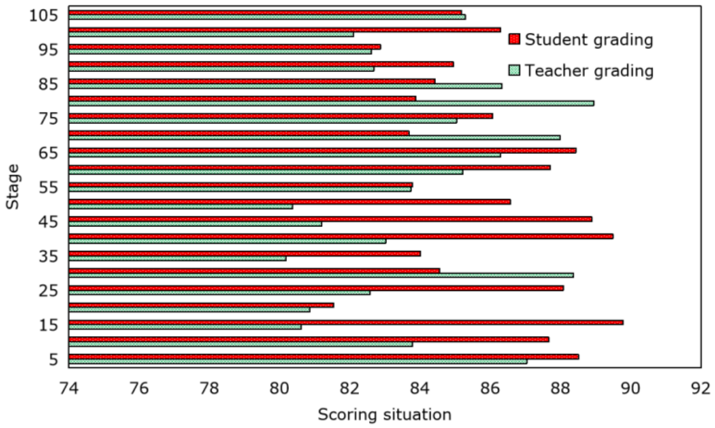

Figure 7: Subjective scoring results of art educators and learners.

5 CONCLUSIONS

In the modern digital age, the integration of CAD (computer-aided design) and VR (virtual reality) has brought revolutionary changes to art creation. In this study, we introduced the EfficientNet model to achieve seamless integration between CAD-generated 3D models and VR environments, providing higher visual appeal and immersion for the presentation of artworks. The results of comparative experiments further confirm the superior performance of the EfficientNet model in improving image quality. In the fusion of CAD and VR, the application of EfficientNet models enables us to more accurately capture the details of 3D models and render them with high quality to the VR environment. The selection of the EfficientNet model is based on its excellent performance in image classification and recognition tasks. The integration of this technology not only provides artists with new creative tools but also offers audiences an unprecedented artistic experience. This model can achieve high-precision image feature extraction while maintaining efficient computation by balancing the depth, width, and resolution of the network. By comparing the image quality before and after using the EfficientNet model, we found that the model can significantly improve the clarity of images and enrich the detailed representation of artwork.

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