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Computer-Aided Design AND APPLICATIONS

Optimization of Advertising Design CAD Model Driven by Deep Learning and Interactive VR Display

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Abstract. The aim of this study is to enhance the intelligence of the computer-aided design (CAD) model for advertising through the application of deep learning (DL) technology while refining its interactive visualization in virtual reality (VR). By precisely adjusting the model parameters, the performance of each model on advertising design data is evaluated. The results show that the CNN_LSTM model is significantly superior to traditional CNN and LSTM models in accuracy, false alarm rate, F1 evaluation index, and execution speed, especially in dealing with unbalanced data sets and a few categories. This innovative method not only improves the intelligent classification and recognition ability of advertising design but also provides more efficient technical support for real-time interactive display in a VR environment. Through the optimization of the DL-driven advertising design CAD model, this study has achieved a technical breakthrough in the field of advertising design, laying the foundation for intelligent development in this field in the future.

Keywords: Deep Learning; Advertising Design; CAD; Virtual Reality; Intelligent
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1 INTRODUCTION

As science and technology continue to advance, the advertising design industry is undergoing unprecedented transformations. Although the traditional advertising design method has formed a set of relatively mature design processes and tools after years of practice and improvement, it still seems inadequate in the face of increasingly complex and changeable market demand and consumer preferences. Amirovna [1] explored the significant role of fractal composition in advertising design in the fields of art and applied art. The unique rhythmic repetition demonstrated by this design technique is evident in natural products and appearances. Whether it is architectural design, product design, or interior design, fractal design can add unique artistic charm to works through its unique form and texture. In the application of colour, shape, and texture, fractal design can create a harmonious, unified, and rhythmic visual effect, making advertising information more vividly conveyed to the audience. And enhance brand image and market competitiveness. Deep neural networks (DNNs) have shown great potential and significant effectiveness in advertising design tasks

in the fields of image and text processing. The study by Angrish et al. [2] provides us with a flexible approach to handling this diversity. Through training, MVCNN can learn key design features of different product categories and flexibly apply these features in advertising design. It not only performs well in traditional computer vision tasks but also plays an important role in the specific field of advertising design. In order to capture feature details, we introduced the original angle camera technique, which can capture model details from multiple angles, providing richer information for neural network learning and recognition.

Deng et al. [3] proposed a virtual homogenization product in the context of cultural peripherals. It has been optimized to address the common problems in current tourist attractions. This system can construct highly realistic 3D models based on the actual situation of the scenic area, providing tourists with an immersive travel experience. By capturing 452 high-quality panoramic images and utilizing advanced image processing technology, we have successfully created a 360 ° VR panoramic display system for the scenery of Xiangbi Mountain Park. This design not only aims to showcase the unique cultural charm of different scenic spots but also aims to allow tourists to deeply experience the local cultural customs during their travels. At the same time, users who enjoy history and culture can push VR interactive tourism product advertisements related to historical and cultural attractions. In VR interactive tourism products, DL technology can also be used to analyze user interaction behaviour in real time. And then generate a more accurate and individualized design scheme. Fan and Li [4] delved into and improved existing computer advertising graphic design and image processing technologies to stimulate the creative potential of designers and further enhance their innovation capabilities. As an economical and effective way of information transmission, advertising graphic design has become increasingly important in the field of mobile media.

The use of digital technology in new media has provided a vast space for the expansion and extension of public service advertising design. Based on excellent application cases of interactive design in public service advertisements both domestically and internationally, this study focuses on the thinking and methods of interactive design, providing guidance era not only meets people's psychological needs for information exchange, brings people closer to advertising, but also provides innovative basis for the interactive design. The interactive design of new media public service advertising conforms to the development of the times, and its communication concepts and methods are gradually shifting towards diversified development. The creative dimension is also shifting from single to multi-dimensional. Gdawiec and Adewinbi [5] start from the background of defining new media, the characteristics of new media interaction, as well as the development of public service advertising art and public service advertising design. The use of unique immersive experiences such as virtual and real alternation can achieve the presentation and interaction of visual, auditory, tactile, and other sensory information. It utilizes the interactive character characteristics of new media to guide audience communication, interaction, and participation. Research has pointed out that interactive design, based on the character of new media interaction, has created infinite possibilities for the future of public service advertising. It can effectively resonate with the audience and meet their needs for information reception and feedback. The wider and more vivid dissemination and effective interaction indicate that interactive design will become the mainstream direction of public service advertising design in the future. The modified advertisement is visually more impactful and recognizable, effectively attracting the audience's attention and conveying brand information. This change not only enriches the visual language of advertising design but also makes the generated patterns more diverse and personalized in form and structure.

With its powerful image feature detection ability, CNN performs well in image classification, recognition and other tasks. LSTM, on the other hand, with its unique memory cell design, has obvious advantages in processing sequence data such as natural language text and time series prediction. Guo [6] successfully developed a computer-aided design system for artistic Chinese character advertising design based on a numerical differential analysis algorithm. This system not only improves the efficiency of advertising design but also greatly enriches the artistic expression forms of advertising design. Artistic Chinese characters are one of the important elements in advertising design, and their unique and aesthetic design directly affects the overall effect of advertising. Through numerical differential analysis algorithms, the system can automatically

calculate parameters such as curvature and slope of Chinese character strokes at different positions, thereby generating artistic Chinese characters with unique shapes. Designers only need to input Chinese characters and corresponding parameter settings, and the system can automatically generate artistic Chinese character shapes that meet the requirements. In the design of interactive VR display advertisements, performance parameters are key considerations, especially when deploying these applications on mobile devices, the smoothness of graphics, low latency, and effective utilization of CPU are crucial. A common solution is to offload computationally intensive tasks, such as deep learning model inference, to cloud servers for processing. The existing AR framework often cannot fully meet these requirements. However, although this approach improves computing power, it also introduces new issues such as network latency, data transmission costs, and the availability and reliability of cloud services. Even running lightweight MTNN models on mobile devices may face performance bottlenecks, especially when processing high-definition VR images. This framework not only focuses on the graphics performance and latency of mobile AR applications, but also involves multiple aspects such as multimedia retrieval, multimedia processing, and graphics enhancement [7].

However, advertising design encompasses diverse elements such as colour, layout, and copywriting, posing significant challenges in seamlessly integrating these aspects into a DL model. Furthermore, the implementation of VR technology confronts technical hurdles, including scene rendering and interactive design. Consequently, this study strives to not only delve into the specifics of DL application in advertising design but also overcome a myriad of technical obstacles, ultimately aiming to achieve efficient, precise, and personalized advertising designs.

Highlights:

(1) This research innovatively applies DL technology, especially the combination of CNN and LSTM, to advertising design. Through the training and learning of a large number of advertising data by DL, the model can automatically extract key design features, which significantly improves the intelligent level of advertising design.

(2) This study combines VR technology with DL-generated advertising design, providing users with a brand-new and immersive advertising experience. Through this interactive display, users can feel the details of advertising design more intuitively, thus enhancing users' participation and brand impression.

(3) Through the integrated application of DL and VR technology, this research not only improves the visual effect of advertising design but also greatly improves the interactive experience of users. Users can freely interact with advertisements in the virtual environment, and this novel experience is expected to attract more users' attention.

In the next chapter, the application method of DL in advertising design, the implementation details of VR technology, experimental verification and result analysis will be introduced in detail. It is hoped that through these studies and practices, it will provide beneficial enlightenment.

2 LITERATURE REVIEW

Liu and Yang [8] proposed an innovative computer-aided design (CAD) teaching model for art advertising design. This architecture pattern clearly divides data processing, user interaction, and data display, making the entire system clearer, easier to maintain, and expand. According to the principle of modular design in advertising design, the creative teaching mode of advertising art design CAD adopts a three-layer architecture mode of MVC (Model View Controller) based on B/S (Browser/Server). This teaching model not only focuses on cultivating skills in advertising design but also emphasizes the cultivation of innovative thinking and artistic expression abilities. This model aims to provide students with a more flexible and efficient learning experience through the openness and interactivity of the Internet. Wireless connected virtual reality (VR) undoubtedly brings unprecedented convenience to advertising designers and users, enabling them to immerse themselves in high-quality advertising design environments anytime, anywhere. Liu and Deng [9]

proposed an innovative solution, that is, a wireless VR network based on mobile edge computing (MEC). Through this approach, VR devices only need to be responsible for receiving and displaying rendered content, greatly reducing their computational burden. Based on these predictions, they can render the VR content that users may need in advance, greatly reducing the latency of VR interaction. The core idea of this solution is to transfer the rendering task of VR content from the VR device itself to MEC servers with stronger computing power. In the DRL strategy, we continuously optimize these functions through interaction with the environment. Long et al. [10] delved into the impact of interactive advertising design information to maximize the overall profit of the platform. In order to attract sellers, the platform needs to design a mechanism that can both protect their rights and encourage their participation. Secondly, the design of advertising auctions is crucial. The platform needs to ensure the fairness of advertising auctions so that every seller has the opportunity to obtain advertising space by paying reasonable fees. The characteristic of this market environment is that sellers have unique private information about their products, while platforms have access to private data about consumers. By establishing a connection between sponsored advertising and organic search results, the platform can create a strategic listing environment that enables sellers to actively participate in competition in advertising auctions.

Ma and Hong's [11] research delves into the advertising investment decisions of manufacturers and retailers in a supply chain environment with manufacturer encroachment, as well as the economic logic behind them. In most cases, manufacturers may choose to increase direct sales costs, which may be to test market reactions or seek higher profits. In a fiercely competitive market, if manufacturers increase sales through direct sales channels, retailers may face greater market pressure. They analyzed in detail how these factors affect the strategy choices of participants and the final profit distribution. In order to maintain or increase their market share, retailers may increase advertising investment to attract more consumers. However, this strategy is not always advantageous for manufacturers, as when direct sales costs are too high, retailers may adopt more effective advertising strategies to offset the manufacturer's competitive advantage. It provides more accurate data analysis and user behaviour prediction capabilities for interactive advertising. Through new media platforms such as social media and mobile applications, interactive advertising can reach a wider audience and achieve more efficient advertising dissemination. Interactive VR technology brings a brand new visual and sensory experience to interactive advertising, allowing users to participate more deeply in advertising content, improving the interactivity and attractiveness of advertising. Through deep learning algorithms, advertising platforms can more accurately capture user interests and consumption habits, providing advertisers with more accurate advertising placement strategies. In addition, interactive advertising also has the characteristic of strong creativity, which can attract users' attention through various innovative advertising forms, and improve the memory and dissemination effect of advertising [12]. The visualized Kleinian group not only attracts the attention of mathematicians with its beautiful fractal structure but also provides rich sources of inspiration for advertising designers. Rendering images of Kleinian communities on a computer often requires a significant amount of computational time and resources. The technology proposed by Nakamura [13] has demonstrated extremely high practicality and flexibility in the field of advertising design. By utilizing this technology, designers can integrate various creative elements into their advertising works, making them more vivid, interesting, and infectious. The introduction of this technology undoubtedly injects new vitality into the innovation and development of advertising design. By fully utilizing one's imagination and creativity. Thereby improving the dissemination effect of advertising. The research results can not only be used for fractal image rendering in advertising design but also widely applied in other fields, such as scientific visualization, game development, etc.

Shi and Sun's [14] research has brought innovation to the advertising industry in online advertising and process management systems based on cloud computing platforms. This hybrid strategy not only ensures the security and reliability of advertising push but also gives administrators a high degree of flexibility to adjust advertising content in real time according to market demand and advertising strategies. These features enable advertisers to easily manage their advertising resources, ensuring the accuracy and timeliness of advertising content. Through the cloud computing platform, the system can synchronize key information such as advertising placement data, user

feedback, and market changes in real-time. Through cloud computing platforms, the system can analyze user behaviour and preferences in real time, providing personalized advertising push services for advertisers. Siti et al. [15] explored in depth the current use of advertising image tools and their acceptance among modern student groups through carefully designed qualitative research methods. These students have been immersed in the digital environment since childhood and are accustomed to using various technological tools for daily learning and communication. Modern student groups generally possess a high level of technical proficiency and adaptability, which is closely related to their background of growing up in the digital age and being known as "digital natives". Wang's [16] research indicates that the interactive application of visual communication technology in advertising design is of great significance in the new media environment. Digital technology provides more innovative possibilities for advertising design, making the visual expression of advertising design more diverse and artistic. At the same time, the fusion of visual and auditory elements also makes advertising information more intuitive, understandable, and easily accepted. In advertising design, both visual and auditory elements are important carriers for conveying information. In the new media environment, digital technology makes the fusion of these two elements easy. Through multimedia forms such as video and audio, advertisements can simultaneously present visual and auditory information, forming a richer sensory experience. This fusion not only enhances the artistic value of advertising but also makes the advertising information more intuitive and understandable. Consumers can understand and accept advertising information more quickly through the dual stimulation of visual and auditory stimuli when watching advertisements. making it easier for the audience to accept and remember. With advanced image processing software, 3D modelling tools, and virtual reality technology, designers are now able to create realistic and vivid visual scenes. This allows advertising works to not only convey information but also bring viewers a more diverse and colourful audio-visual experience. Through image processing software, designers can easily adjust colours, lighting, and composition, thereby creating unique advertising images.

Xu and Zheng [17] found that by properly utilizing data visualization technology. This model clarifies the design activities, available design methods, and design points for each stage, providing a systematic guidance framework for designers. Through detailed data visualization and expression analysis, we not only conducted in-depth research on visual presentation and interaction factors but also deeply correlated these factors with the sub-patterns of the image. Yang and Lee [18] provide a detailed introduction to the mainstream VR advertising design concept sketch tools currently available in the market and analyze their characteristics and advantages in depth. In this environment, designers can freely sketch like on traditional paper. Secondly, VR sketching tools provide designers with a more intuitive and interactive design approach. The core advantage of this type of VR advertising design concept sketch tool lies in its immersive experience. Especially in the field of clothing advertising design, VR-based clothing design concept sketch tools not only overturn traditional design patterns but also open up a new creative space for designers. Interacting with the virtual environment through natural gestures and voice commands not only makes the design process smoother but also stimulates the designer's creativity and imagination. The selection and combination of colours are crucial for conveying advertising information, shaping brand image, and attracting target audiences. The Munsell colour model is considered an ideal colour design tool due to its intuitive description of colour attributes and logical relationships between colours [19].

3 METHODOLOGY

With the continuous advancement of technology, advertising has evolved from traditional media such as newspapers, television, and radio to being disseminated through different media platforms. For example, social platforms such as WeChat, Weibo, TikTok, etc., carry out advertising in the form of individuals. Most H5 advertisements rely on WeChat platforms for dissemination, which is in line with the overall trend of advertising development. In the era of the experience economy, the prevalence of digital media has led to the diversified development of communication methods and media. Digital media is a method of information dissemination with animation, sound, video, and interactivity.

Digital media can enhance information, and when information is more accurately targeted, advertisers will have better results.

Figure 1 outlines the task analysis flow for mobile agents.

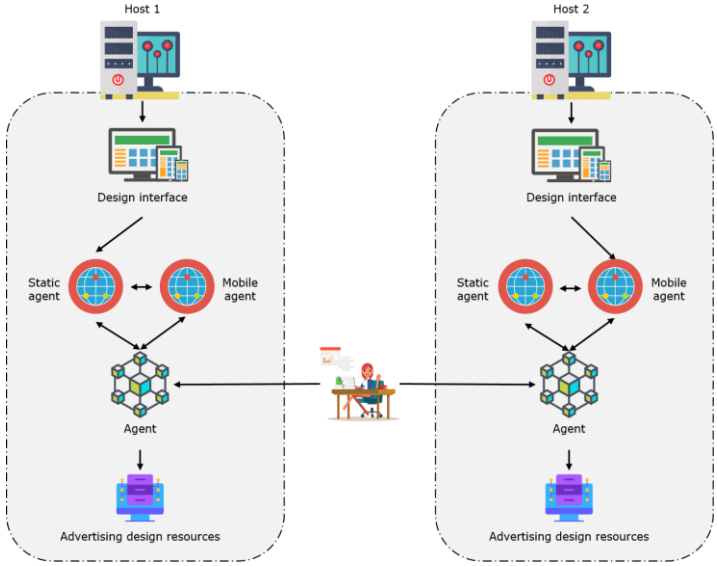

Figure 1: Task analysis of mobile agent.

Integrated media has gradually become the mainstream of design, and visual communication design is no longer limited to graphic design but is evolving towards multi-dimensional design. Experience design adheres to the principle of involving users in design. In order to meet the social and respectful needs of consumers, the traditional way of visual communication design has been changed, and interactivity has been optimized and strengthened in multiple aspects. Graphics have evolved from static to dynamic, and traditional static page design can easily bring aesthetic fatigue to users, making it difficult for them to maintain their attention for a long time. Dynamic design can bring designers new designs, ideas, and creativity, making them more imaginative and expressive. Meanwhile, dynamic design allows users to generate a sense of freshness and maintain attention. Dynamic design, combined with different time lengths, rhythms, and colours, can effectively convey information, allowing users to receive the content that the designer wants to convey more comprehensively. Enhancing interface interactivity, traditional visual design often outputs information unilaterally. Users in a passive state often refuse to receive product information, feeling like they are wasting time and energy. Integrating aesthetic trends with appropriate interactions not only avoids making users feel uninteresting but also enables them to convey more authentic emotions while interacting. At the same time, it can receive the most authentic feedback from users and improve design quality. It is able to remember historical data and incorporate it into current calculations, which gives it a significant advantage in dealing with time-dependent tasks. In the field of advertising design, images are the main carrier for conveying advertising information. LSTM can capture these dynamic relationships, helping designers better understand the combination and evolution of design elements, thereby creating more cohesive and attractive advertising designs. Figure 2 illustrates the amalgamated DL model, which seamlessly blends CNN and LSTM.

These features may include colour distribution, shape features, texture information, etc. Then, the feature sequence extracted by CNN is input into the LSTM model. The LSTM model can learn and remember the temporal relationship between these features, thus generating a coherent and attractive advertising design. Through the processing of LSTM, a series of time-related design elements can be obtained.

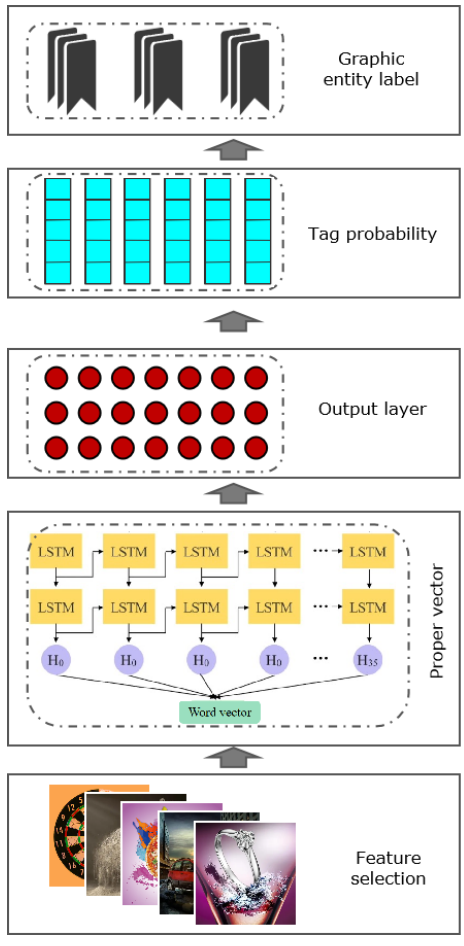

Figure 2: CNN_LSTM model.

Loss serves as a comprehensive metric that quantifies the disparity between the model's final output and the expected results from the training dataset. Among various loss functions, cross-entropy stands out as a popular choice, and it is also adopted in this study. The mathematical expression for cross-entropy is as follows:

$$H\ \ p,q\ \ =-\sum_{x} p\ \ x\ \ \log q\ \ x \tag{1}$$

The input layer, denoted as x_p, is a m-dimensional vector, while the output layer is an n-dimensional vector labelled y_p. The intervening hidden layer, made up of $Z_i, i=1,2,\cdots,j$, produces an output from the k hidden layer neuron, which is expressed as:

$$y_k=\sum_{i=1}^{j} w_{ik}\cdot\exp\left(-\frac{1}{2\sigma^2}\left\|x_p,Z_j\right\|\right) \tag{2}$$

To ease network pruning and expedite the convergence of network weights towards zero, it is advisable to incorporate a penalty function into the error function during the training process. This penalty function is given by:

$$P = \ w,v \ = \frac{\varepsilon}{2}\left(\sum_{m=1}^{h}\sum_{l=1}^{n} w_{ml}^{2} + \sum_{m=1}^{h}\sum_{p=1}^{c} v_{pm}^{2}\right) \tag{3}$$

Connection weights are parameters used in neural networks to adjust the strength of connections between input layer nodes and hidden layer nodes, as well as between hidden layer nodes and output layer nodes. These weights are adjusted during the training process through optimization methods such as backpropagation algorithms to minimize prediction errors. Hidden layer nodes are nodes located between the input and output layers in a neural network. They receive weighted inputs from the input layer and generate outputs through activation functions, which are then passed to the output layer. The total number of hidden layer nodes (usually represented as H) is a key parameter of neural network architecture, which affects the network's expressive power and computational cost.

$$F \ x,y \ = F_R * F_G * F_B \tag{4}$$

The value of x,y point corresponds to the coordinate $R^{'},G^{'},B^{'}$, where x,y serves as the pixel reference.

Following the filtering process, both each pixel $F \ x,y \ = 1$ within the original image and its neighbouring points are retained. Subsequently, the contour is extracted and smoothed utilizing a Gaussian function:

$$G_{\sigma} \ x,y \ = \frac{1}{2\pi\sigma^{2}}\exp\left(-\frac{x^{2}+y^{2}}{2\sigma^{2}}\right) \tag{5}$$

In advertising design, feature colours are an important visual element. In order to encode feature colours into numerical forms that can be processed by neural networks, we can define a numerical range (such as [color_min, color_max]), where color_min and color_max represent the minimum and maximum values in the colour space, respectively. Then, we can use some mapping function (such as normalization or normalization) to map the feature colours to this numerical range.

$$BF_{p}^{I} = \frac{1}{w_{p}}\sum_{q\in\Omega} G_{\sigma_s}\left\|p-q\right\| \ G_{\sigma_r}\left\|k-I_{q}\right\| \tag{6}$$

p designates the pixel point located at position p, q signifies the adjacent point of pixel p, and k identifies a constant pixel point. The normalized factor is incremented to guarantee that the total of pixel weights equals 1.

The denoising procedure aims to minimize the disparity between the image matrices X and X post-denoising, striving to align the denoised image closely with the original noise-free image data. Essentially, the sparse representation of noisy images equates to the sparse representation of X, which is expressed as:

$$X = \alpha d \tag{7}$$

When the noise present in the error signal exhibits significant autocorrelation, the step factor μ undergoes substantial fluctuations. This, in turn, impacts the convergence speed and precision of the algorithm. Leveraging insights from prior research, this study introduces an adaptive filtering algorithm that accounts for variations in step size and $\mu \ n$ fluctuations. The iterative formula for this approach is as follows:

$$\mu \ n \ = \beta\left[1-\exp\ -\alpha * sqrt\ \left|e \ n \ e \ n-1\right|\ \right] \tag{8}$$

$$W \ n-1 \ = W \ n \ -2\mu \ n \ e \ n \ r \ n \tag{9}$$

Knowing that the algorithm will converge when $\beta < 1/\lambda_{\max}$ we can deduce that the maximum value of μ is β. In real-world scenarios, simulation experiments can assist in determining the optimal α,β value.

In order to train and optimize the DL model, we use a lot of advertising data for training. These data include various types of advertising designs, such as posters, banners, and video advertisements. Through iterative training and adjustment of model parameters, the DL model can automatically extract key design features from advertising data and generate innovative advertising designs. By calculating the error between the model output and the actual label and propagating this error back, the weight and bias of the model are updated so that the model output is closer to the real value. Through a large number of advertising data training and learning, the DL model can automatically extract key design features and generate attractive and innovative advertising designs.

Supposing that n images are involved in the reconstruction process, let C_i represent the internal and external parameters of the i image. Assuming m 3D spatial points have already been reconstructed, and the coordinates of the j 3D spatial point are denoted as X_j. The beam adjustment method aims to optimize the following objective function:

$$g\ C,X\ =\sum_{i=1}^{n}\sum_{j=1}^{m}w_{ij}\left\|q_{ij}-P\ C_i,X_j\ \right\|^2 \tag{10}$$

In the context of image processing or computer vision, when we mention the existence of "points" and their coordinates on the image, we usually refer to the position of image pixels. A binary value (such as 0 or 1) is typically used as an indicator to mark whether a specific feature or object exists at a pixel position in an image. In some cases, these coordinates may differ from the projected coordinates (T (x, y)), especially in applications involving image correction, registration, or geometric transformations. Projection transformation is a commonly used technique in image processing, used to correct geometric distortions in images or map them to different coordinate systems. This transformation may involve rotation, scaling, translation, or more complex transformations. By applying projection transformation, we can transform an image from one coordinate system to another, thereby changing the position of points in the image.

To imprint texture lines on the surface S, determining the correlation between spaces A and B is crucial. Supposing the radius of the surface S equals R, and fixing the chord height as $PF=h$, we calculate $OP=R-h$. Assuming $AB=x$, we can formulate the subsequent correlation:

$$\frac{R}{R+x}=\frac{R-h}{R} \tag{11}$$

Upon simplification, we arrive at:

$$x=\frac{hR}{h-R} \tag{12}$$

Furthermore, we have:

$$s-x^{*\ 2}+\ t-y^{*\ 2}+z^{*}=\left(\frac{hR}{h-R}\right)^2 \tag{13}$$

Subsequently, $B\ x^*,y^*,z^*$ the surface segment meticulously aligns with $A\ s,t$ the texture design, and analogously, all remaining points on the surface conform to this analogous correlation.

Therefore, we can infer:

$$\sin\theta=\frac{\left|AB\right|}{\left|A^*B^*\right|}=\frac{am+bn+cp}{\sqrt{x_1^*-x_2^{*\ 2}\ \ y_1^*-y_2^{*\ 2}\ \ z_1^*-z_2^{*\ 2}}} \tag{14}$$

This impeccable alignment enables a more precise concave-convex model mapping.

4 RESULT ANALYSIS AND DISCUSSION

4.1 Data Set and Experimental Design

This article selected advertisements from different industries for image verification. It covers nearly 500 industry images from both the service and industrial industries. By carefully constructing a database of image rendering styles using open machine vision. A machine language design analysis was conducted on the performance of advertising rendering using integrated dynamic optimization. The CAD rendering function plays an important role in information dissemination during this design process. The advertising effect advantage of the image was perfectly demonstrated through the design of different angles of colour lighting. Figure 3 shows adjustments to some of the proposed databases.

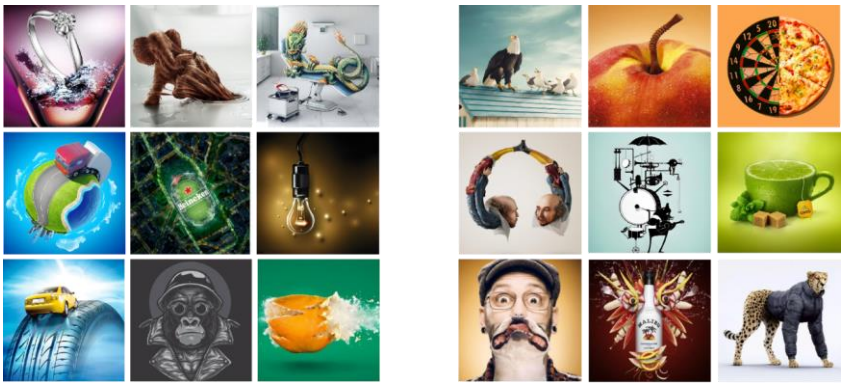

Figure 3: Partial data set samples.

The loss function parameter $\alpha = 0.2, \gamma = 3$, which is verified by experiments and has excellent performance, is selected, and many experiments are carried out. In the performance evaluation of the DL model, precision and false alarm rate are two core indicators. Precision reflects the proportion of real positive samples in the case where the model predicts positive samples; However, the false positive rate shows the proportion that the model incorrectly predicts negative samples as positive samples. Figure 4 clearly shows that with the increase of the convolution kernel, precision first shows an upward trend, and then decreases. This shows that the size of the convolution kernel plays a key role in feature detection. A smaller convolution kernel may not fully capture the spatial structure information in the image, while a larger convolution kernel may lead to feature redundancy or over-fitting, thus reducing precision.

Figure 4 illustrates that, with a convolution kernel size of 5 and 30 ganglion points in the hidden layer, precision peaks. This demonstrates that selecting the proper number of hidden layer nodes can boost the model's expressive power, enabling it to learn and fit data more effectively.

Figure 5 reveals how the false alarm rate fluctuates with varying convolution kernel sizes and the number of hidden layer nodes. The false positive rate hits its lowest when the convolution kernel size is set to 5, and the hidden layer comprises 30 nodes. This indicates that this configuration allows the model to more accurately distinguish true positive samples, minimizing incorrect identifications of negative samples as positives. However, as the convolution kernel size increases, so does the false alarm rate. The larger convolution kernel introduces more noise or redundant information when extracting features, which leads to misjudgment in model classification.

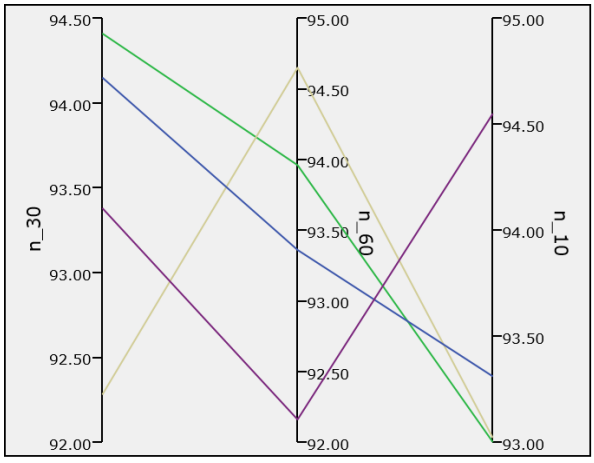

Figure 4: Influence of convolution kernel size and number of hidden layer nodes on precision.

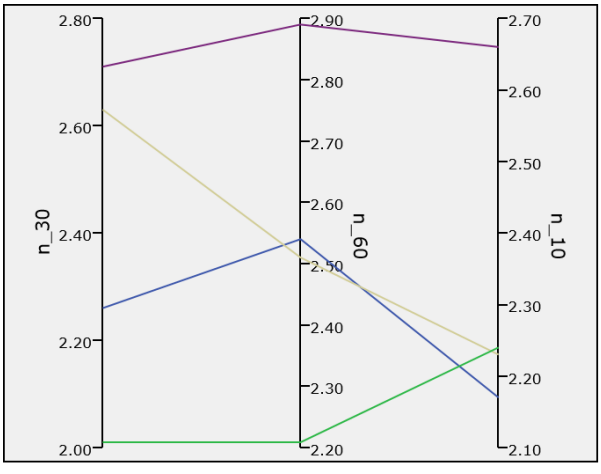

Figure 5: Influence of convolution kernel size and number of hidden layer nodes on false positive rate.

In order to comprehensively evaluate the performance of the CNN_LSTM model proposed in this article in advertising design classification tasks, especially in a few categories, experiments on F1 overall evaluation indicators on different types of data were conducted. Figure 6 shows the F1 scores of CNN, LSTM and CNN_LSTM on these five types of data.

In all data categories, the CNN_LSTM model shows better performance than traditional CNN and LSTM. This shows that the model can understand and classify advertising design data more effectively after combining CNN's feature detection ability and LSTM's time series processing ability. The F1 index of CNN_LSTM is 11.66% higher than CNN and 13.85% higher than LSTM. In advertising design, the order, temporal dynamics, and interactive relationships between design elements are crucial for creating coherent and attractive advertisements. After loading the page node for advertising scenes, the main node is the scene selection page. The scene selection page is actually a part of global navigation. The scene node game ending R stone is stored on a rating page and a node for recommending musicians and promoting music festivals. Design navigation methods based on the structure types of parallel structures mixed with tree structures. Afterward, taking the music scene style as a cross-section, it can be found that the advertisement includes three style scene experience nodes.

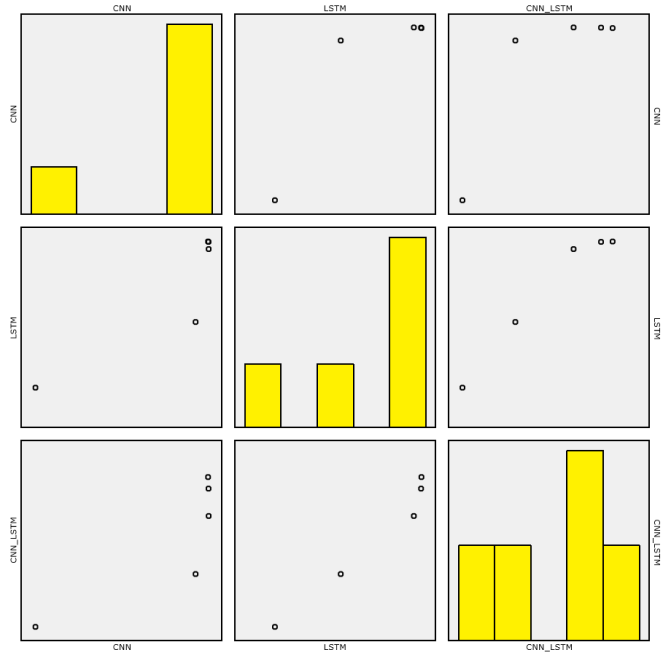

Figure 6: Three algorithms for different categories of F1 values.

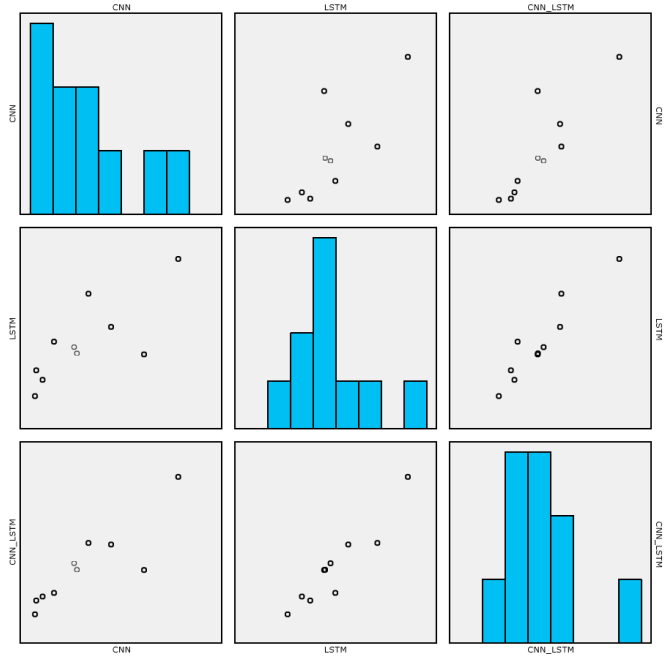

Figure 7: Comparison of execution time of three algorithms.

The previous three nodes have a subordinate relationship with it. The type of advertising structure belongs to a hybrid model of parallel structure and tree structure. After the game is completed, a

replay button will appear, which is an auxiliary navigation that provides a shortcut to re-enter the game node, allowing users to transfer the direction of browsing without starting from scratch and without affecting the structure of the advertisement. These features are of great help in understanding the image of advertising and designing your content. Especially in the long-term dependency relationship on neural network data, it exhibits excellent dependency performance. When dealing with long-term advertising sequence relationships, this comprehensive model can handle more complex relationships. Figure 7 compares the execution time of different algorithms. It is evident that CNN_LSTM outperforms CNN and LSTM algorithms in terms of speed.

5 CONCLUSION

DL possesses the ability to extract valuable features from vast datasets through analysis and learning, subsequently generating precise and tailored design solutions. This study delves into the utilization of DL models, specifically CNN, LSTM, and an innovative hybrid CNN_LSTM model, in the realm of advertising design. The objective is to enhance the intelligence of advertising design CAD models and refine their interactive display within a VR setting.

Comprehensive experimental evaluations reveal that the CNN_LSTM model excels in multiple aspects. In terms of accuracy and false positive rates, the model demonstrates efficient feature recognition and precise classification, thanks to its optimized convolution kernel size and hidden layer node count. This provides advertising design with a higher degree of accuracy and intelligent assistance. When tackling imbalanced datasets, particularly those with limited categories, the CNN_LSTM model notably outperforms traditional CNN and LSTM models in terms of the F1 evaluation metric. Additionally, refinements to the model's structure and algorithm have successfully elevated processing speeds, a crucial factor in a VR display setting that demands swift responses and real-time engagement.

To sum up, through DL technology, especially the innovative CNN_LSTM model, this study has significantly improved the intelligence of advertising design CAD model and the effect of VR interactive display. This not only brought new technological breakthroughs to the advertising design industry but also laid a solid foundation for the future development of intelligent advertising design and VR interactive display.

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