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Emotional Analysis and Expression in Advertising Art Design Based on Deep Learning Algorithms

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Abstract. Emotion, as a core element of advertising art design, has a crucial impact on the dissemination effect of advertising. Computer-aided design (CAD) technology can help designers achieve precise graphic drawing, editing, and rendering operations in advertising art design. This article proposes a method that combines deep learning algorithms and CAD modeling optimization to address the issue of insufficient emotional expression in traditional advertising design. By using sentiment analysis techniques based on recurrent neural networks (RNN) and convolutional neural networks (CNN), the emotional tendencies and themes in advertisements are accurately extracted, and CAD modeling optimization is carried out using support vector machine (SVM) ideas to generate more attractive and distinctive design works. The results show that compared with traditional methods, the design works generated in this article have clearer lines, more prominent product features, and higher subjective user ratings. The research results provide a new data-driven approach for advertising art design, improving advertising effectiveness and user satisfaction and providing valuable references for advertising designers.

Keywords: Deep Learning; Advertising Art Design; Emotional Analysis; CAD Modeling
DOI: https://doi.org/10.14733/cadaps.2024.S15.147-162

1 INTRODUCTION

As an indispensable means of communication in modern society, advertising art design always explores how to attract the audience's attention better, transmit information, and stimulate emotional resonance. As the core element of advertising art design, emotion has a vital influence on the communication effect of advertising. Many scholars have begun to pay attention to applying human emotional factors in product advertising design. Some studies have focused on fields such as human-computer interaction and human factors engineering, exploring the interrelationships between human physiological and psychological characteristics and product design. Other studies

utilize technologies such as machine learning and artificial intelligence to attempt to predict and classify human behavior and preferences. However, most of these studies only focus on a single human factor and fail to fully consider the coordinated effects of multiple factors. Agius et al. [1] proposed an innovative product advertising design concept. By combining machine learning and coordinated knowledge models, accurate prediction and a comprehensive grasp of human subjective emotional factors have been achieved. The practice has proven that this method has significant advantages in improving product design quality and efficiency. Utilize sentiment analysis technology to accurately understand and grasp the user's emotional state. By analyzing users' emotional changes and feedback during the process of watching advertisements, we can understand their acceptance and response to advertisements. In order to improve and optimize advertising art design, and increase the click-through rate and conversion rate of advertisements.

Emotion analysis aims to find out the emotional tendency, emotional intensity, and emotional theme contained in text, image, audio, and other information. Houssein et al. [2] studied the impact of advertising behavior on human emotional recognition through machine learning. Firstly, deep learning algorithms can automatically extract features from advertising images and predict corresponding emotional labels or scores through sentiment analysis techniques. This emotional analysis technology can help designers better understand the emotional needs and experiences of the audience, thereby better meeting these needs in design. If deep learning algorithm analysis shows that a certain advertising image can trigger a positive emotional response from users, then designers can apply this design element to other advertisements to improve their attractiveness and dissemination effect. This positive emotional response may stimulate consumers' willingness to purchase, thereby promoting the occurrence of consumer behavior. Secondly, deep learning algorithms can also optimize and adjust advertisements in real-time based on users' emotional reactions and behavioral data. For example, if the user's response to a certain advertising image is poor, deep learning algorithms can automatically adjust the design elements of the advertisement to better attract the user's attention. This dynamic adjustment can improve the targeting and effectiveness of advertising, thereby promoting the transformation of consumer behavior. It may help consumers better understand advertising information, leading to stronger purchasing intentions. In advertising art design, emotional analysis can help designers better understand the emotional needs of the audience, so as to design more attractive and infectious advertising works. Jin and Yang [3] collected a large amount of image data, including advertising images and related environmental sentiment description data. These data can be obtained through methods such as web crawlers, image search engines, or professional research. At the same time, deep learning algorithms are used to establish an art model for analyzing environmental emotions. After the model training is completed, it combines deep learning algorithms with the advertising art environment using CAD software to carry out product styling design. By using trained models, designers can adjust product attributes such as color, shape, and texture based on these labels to better meet users' emotional needs. At the same time, the model can predict users' emotional reactions to products, providing designers with intelligent recommendation opinions to better meet users' needs and improve sales conversion rates. By inputting the user's photo and clothing image, the model can predict the effect of the user wearing the clothing, providing designers with the function of a virtual fitting mirror to better display the effect of the clothing and improve the sales conversion rate.

Therefore, how to apply emotion analysis technology to advertising art design has become a subject with important research value. Traditional advertising art design methods often rely on designers' intuition and experience and lack scientific and effective emotional analysis methods. Based on deep learning CAD expression technology, the design and visualization of online advertising art can be achieved. And using sentiment analysis technology to accurately understand and grasp the user's emotional state. User data analysis based on deep learning algorithms can obtain user features and preferences. These data can include information such as the user's age, gender, occupation, interests, and hobbies, as well as data on the user's behavior and emotions during the use of the product. By analyzing these data, user characteristics and preferences can be identified, providing personalized data support for online advertising art design. Kołakowska et al. [4] utilized CAD expression technology to achieve the design and visualization of online advertising art. By

comprehensively considering multiple objective factors such as product functionality, appearance, user experience, and emotional expression, online advertising artworks that better meet user needs and enhance user experience can be designed. At the same time, augmented reality technology can integrate virtual elements with real scenes to achieve a more vivid and vivid display of online advertising artworks. In order to solve this problem, this article puts forward an emotional analysis method of advertising art design combining deep learning algorithms and CAD technology, so as to realize intelligent graphic advertising art design works. As a new branch of machine learning, deep learning has strong feature learning and classification capabilities. In the field of sentiment analysis, deep learning algorithms have been widely used in sentiment analysis of text, images, and audio. Emotional analysis can understand users' emotional states and needs by analyzing their behavior and emotional data. By using deep learning algorithms to learn and analyze user data, an accurate understanding and grasp of user emotional states can be achieved, thereby providing more personalized and intelligent data support for commercial advertising art design. Lei [5] utilizes CAD expression technology to achieve the design and visualization of commercial advertising art, as well as emotional analysis to accurately understand and grasp user emotional states. The use of CAD expression technology can achieve the design and visualization of commercial advertising art. By comprehensively considering multiple objective factors such as product functionality, appearance, user experience, and emotional expression, business advertising artworks that better meet user needs and enhance user experience can be designed. At the same time, augmented reality technology can integrate virtual elements with real scenes to achieve a more vivid and vivid display of commercial advertising artworks.

Traditional advertising design often places too much emphasis on the characteristics and advantages of the product itself while neglecting the emotional needs and experiences of the audience. This approach makes it difficult to resonate emotionally with the audience, thereby affecting the dissemination effect of advertising. Advertising design often lacks creativity and imagination in emotional expression, making it difficult to leave a deep impression on the audience. This is mainly because designers lack a deep understanding of emotional expression and effective design methods and tools. Designers often rely on intuition and experience to design and cannot accurately evaluate the emotional expression effect of advertisements. Liu and Yang [6] proposed a method that combines deep learning algorithms with CAD modeling optimization. It has established a model to analyze and predict the emotional expression of advertising images. This model can automatically extract features from images. The model utilizes CAD software to optimize product design. Specifically, the emotional expression effect of a product can be enhanced by adjusting its shape, color, texture, and other attributes. Evaluate and optimize the trained deep learning model to improve its accuracy and generalization ability in emotional analysis. Effectively solving the problem of insufficient emotional understanding in traditional methods. Text sentiment analysis can help designers understand the emotional expression in advertising copy and provide emotional, creative inspiration for the design. In the aspect of image emotion analysis, deep learning also shows great potential. The application of deep learning in film art and design can help us better understand and analyze emotions, and through CAD expression, emotions can be visualized to better convey the theme and emotions of movies. Firstly, deep learning can help us extract features from movie images and predict their emotional labels or scores. Through emotional analysis of movie images, we can better understand the audience's feelings and reactions to the movie, thereby better adjusting the plot and presentation of the movie. For example, if deep learning algorithm analysis shows that a movie poster can elicit a positive emotional response from the audience, designers can apply this design element to other posters to improve their attractiveness and communication effectiveness. Secondly, deep learning can also optimize and adjust movie advertisements in real-time based on users' emotional reactions and behavioral data. For example, if the audience's response to a movie trailer is poor, deep learning algorithms can automatically adjust the design elements of the trailer to better attract the audience's attention. This dynamic adjustment can improve targeted and effective advertising, thereby promoting audience attention and interest in the movie [7]. There is a significant gender difference in the impact of online video advertising design on online shopping goals. This may be due to differences in cognitive style, needs, and interests between men and women. Therefore,

when creating online video advertisements, these differences should be taken into account to develop more effective advertising strategies. Deep learning algorithms can automatically extract features from advertising images and predict corresponding emotional labels or scores. This emotional analysis technology can help designers better understand the emotional needs and experiences of the audience, thereby better meeting these needs in design. For example, if deep learning algorithm analysis shows that a certain advertising image can trigger a positive emotional response from users, designers can apply this design element to other advertisements to improve their attractiveness and dissemination effect. Moharrami and Tahmasebi [8] analyzed the application of deep learning algorithms in the emotional analysis of online advertising art design. The results showed that it can have a significant impact on online shopping by automatically extracting features, predicting emotional labels, optimizing and adjusting advertising design, and providing evaluation feedback.

CAD technology, as an important tool in the field of advertising design, plays an important role in improving design quality. In advertising art design, CAD technology can help designers achieve precise graphic drawing, editing, and rendering operations, thereby improving the precision and visualization of the design. In order to achieve emotional analysis and CAD expression in advertising art design combined with deep learning algorithms, this article proposes an intelligent method for graphic advertising art design. Firstly, deep learning algorithms are used to perform emotional analysis on advertising copy and images, mining out their emotional tendencies and themes. Then, based on the results of emotional analysis, CAD technology is used to achieve visual expression of advertising design, including color matching, graphic element design, layout, etc; Finally, through human-computer interaction, the design work is finely adjusted and optimized to meet the emotional needs and visual aesthetics of the audience. This study has made the following innovations:

(1) This article introduces deep learning algorithms into emotional analysis in advertising art design, and through deep mining of advertising copy and images, we can more accurately understand the emotional tendencies and themes in advertising.

(2) This article not only conducts an emotional analysis of text and images but also integrates the analysis results of the two, comprehensively analyzing the emotional connotations of advertising works from multiple dimensions, providing more comprehensive emotional creative inspiration for the design.

(3) Through deep learning for emotional analysis and the use of CAD technology for visual expression, this article has developed an intelligent method for graphic advertising art design, thereby improving the efficiency of advertising design.

This article aims to conduct an emotional analysis of advertising art design through deep learning technology and optimize CAD modeling based on the analysis results. The article first introduces the research background and purpose, and then elaborates on emotion analysis methods based on RNN and CNN, and applies them to CAD modeling optimization of advertising art design. The entire article aims to provide a data-driven advertising design method to enhance advertising effectiveness and user satisfaction.

2 RELATED WORK

Augmented reality adaptive advertising based on deep learning is an innovative advertising placement method that can accurately grasp and analyze user behavior and needs, providing a more personalized and dynamic decision-making basis for advertising placement. At the same time, this advertising method can also achieve the integration of virtual and reality through augmented reality technology, providing more possibilities for improving the creative effect of advertising. By inserting virtual models or scenes into real scenes, users can enhance their sense of immersion and engagement. At the same time, this fusion method can also be adjusted and optimized in real-time based on user feedback and behavioral data to achieve the best advertising effect and user experience. CAD tools based on deep learning algorithms can also simulate and predict user data. Moreno et al. [9] used CAD tools to simulate and predict user sentiment data to evaluate the effectiveness of different marketing strategies and advertising placement plans. By comparing and

analyzing simulation and prediction results, develop more accurate marketing strategies and advertising plans to promote user purchasing decisions and improve sales effectiveness. Personalized advertising design based on automatic analysis of personal appearance is an innovative advertising design method that can make personalized recommendations and designs based on personal appearance characteristics and emotional states to enhance the targeted and precise nature of advertising. At the same time, this design method can also achieve the integration of virtual and reality through augmented reality technology, providing more possibilities for improving the creative effect of advertising. Personalized CAD advertising design based on automatic emotional analysis of personal appearance can be efficiently and accurately designed and expressed using CAD tools. Moreno et al. [10] utilized techniques such as image processing, modeling, and rendering in CAD tools to combine personal appearance features with advertising creativity to achieve personalized advertising design and expression. Insert virtual models or scenes into real scenes, dynamically adjust and display them based on personal appearance characteristics and emotional states, to enhance users' immersion and participation. At the same time, this fusion method can also be adjusted and optimized in real-time based on user feedback and behavioral data to achieve the best advertising effect and user experience.

With the rapid development of digital media, online advertising has become an indispensable part of commercial activities. In order to attract and retain users' attention, advertising design requires continuous innovation and optimization. In recent years, a new advertising design concept - emotional analysis of advertising art design based on deep learning algorithms - has gradually attracted the attention of researchers and the industry. The theory suggests that advertising design should stimulate users' autonomous sensory and emotional responses; that is, by stimulating users' perception and behavioral responses, users can generate positive cognition and behavior toward advertising. Sin and Yun [11] explored how to use deep learning algorithms to aggregate the effectiveness of online advertising design, providing theoretical support and practical guidance for improving the dissemination effect of online advertising. Stimulate users' perception channels and attract their attention through diverse visual, auditory, and other means. Understand and utilize the emotional needs and values of the target audience to establish an emotional connection between the brand and users. Deeply understand the needs and preferences of the target audience and develop targeted advertising strategies. Simultaneously utilizing diverse visual elements and narrative techniques to create attractive advertising content. The emotional analysis of facial expressions in advertising art design based on deep learning algorithms can help designers better understand the emotional needs and experiences of the audience and thus better meet these needs in design. This emotional analysis technology can be applied to various media such as movies, television, and advertisements to achieve more accurate audience analysis and advertising effectiveness evaluation. Tadalagi et al. [12] used a gradient-direction histogram-based method to divide facial images into several units and compile a gradient-direction histogram for the pixels within each unit. These histograms can describe the appearance and shape of local objects, thereby capturing facial features. This method is based on machine learning algorithms for recognition, avoiding the impact of human factors on the recognition results and improving objectivity and fairness. While analyzing facial expressions and emotions, CAD can be used to visualize emotions and better convey the theme and emotions of advertisements. Facial expression emotion analysis and CAD expression based on deep learning algorithms can be applied in emotional marketing. By analyzing and visualizing the emotions of the audience, it is possible to better understand the needs and psychology of consumers and develop more accurate marketing strategies.

Compared to traditional hand-drawn designs or handmade prototypes, CAD 3D animation advertising design has higher production efficiency and better visual effects. At the same time, CAD technology can also make precise adjustments and corrections to design data, making advertising design more refined and accurate. Tang [13] utilizes deep learning algorithms to automatically analyze and understand user emotional data, combined with 3D animation scene design technology to achieve more accurate and personalized advertising graphic design. Automatic analysis and understanding of user emotional data through deep learning algorithms, combined with 3D animation scene design technology for advertising graphic design. Utilize user sentiment analysis technology to

accurately understand and grasp user feedback. This method can provide more personalized and accurate data support for advertising graphic design, improving the effectiveness and accuracy of advertising recommendations. By using techniques such as 3D modeling, material mapping, and lighting rendering, we construct attractive and visually impactful animation scenes and integrate advertising information into them to achieve a more vivid and vivid display of advertising content. Effective multimodal emotion analysis based on deep learning from unstructured advertising art big data is a challenging task. Due to the fact that advertising art data typically includes multiple modalities such as text, images, and audio, each modality has its own unique way of expressing information. Therefore, it is necessary to adopt a multimodal emotional analysis method to comprehensively utilize this information. Deep learning-based multimodal emotion analysis can utilize deep neural networks and multimodal fusion techniques to automatically analyze and understand unstructured advertising art data. Thandaga et al. [14] used a large amount of advertising art data for model training and testing to verify the feasibility and effectiveness of the proposed multimodal sentiment analysis method. The results indicate that the highlighted methods can adapt to the continuous updates and changes in advertising art data. Therefore, it is ensured that the proposed model has good generalization ability and can adapt to different datasets and scenarios. Emotional product design has become an important direction in the field of industrial design. The purpose of emotional product design is to meet user needs and enhance user experience through emotional communication between products and users. In emotional product design, it is crucial to accurately understand and grasp the user's emotional state. Wang et al. [15] analyzed the multi-objective emotional product design of data-driven 3D modeling and color fusion. Color fusion technology is the combination and fusion of different colors and tones to produce color effects with specific emotions and atmospheres. In emotional product design, color fusion technology can analyze user emotional data, understand user emotional states and needs, and select corresponding colors and tones for product color design. By utilizing deep learning technology to automatically analyze and understand user data, user features and preferences can be obtained, leading to personalized 3D multi-color advertising design. At the same time, CAD tools can be used to visualize the expression of three-dimensional multi-color advertising art design and comprehensively consider multiple target factors for emotional product design.

Art advertising art design based on deep learning algorithms can enhance advertising and marketing effectiveness by accurately grasping consumer emotions, triggering resonance and emotional resonance among consumers. Firstly, deep learning algorithms can automatically recognize and analyze facial expressions, thereby helping designers better understand consumers' emotional needs and experiences. By identifying and analyzing facial expressions, consumers' emotional states, such as pleasure, sadness, and anger, can be determined, thereby helping designers better grasp the emotional direction and expression of advertisements. In art design, designers usually use techniques such as painting, sculpture, photography, etc., to express their creativity and emotions. CAD design is a technique that utilizes computers and their graphic devices to assist designers in their design work. Yang and Ren [16] use CAD software to more accurately implement their design concepts, improving design efficiency and quality. Deep learning algorithms can also predict and analyze consumer behavior and purchasing decisions. By analyzing consumers' historical purchasing behavior, we can better develop marketing strategies and advertising plans to better attract consumers' attention and purchasing behavior. VR advertising art design driven by deep learning CAD can be interrelated with multimedia emotional personalized recommendation analysis. The use of CAD technology can achieve the design and visualization of VR advertising art. By comprehensively considering multiple objective factors such as product functionality, appearance, user experience, and emotional expression, VR advertising artworks that better meet user needs and enhance user experience can be designed. At the same time, VR technology can integrate virtual elements with real scenes to achieve a more vivid and vivid display of VR advertising artworks. User data analysis based on deep learning algorithms can obtain user features and preferences. These data can include information such as the user's age, gender, occupation, interests, and hobbies, as well as data on the user's behavior and emotions during the use of the product. By analyzing these data, user characteristics and preferences can be identified, providing personalized data support for

VR advertising art design. Zhao [17] utilized CAD technology to design and visualize VR advertising art and utilized sentiment analysis technology to accurately understand and grasp the user's emotional state.

3 EMOTION ANALYSIS MODEL BASED ON DEEP LEARNING

3.1 Text Sentiment Analysis

Deep learning has powerful feature learning and classification capabilities, which can automatically extract deep features of data and learn complex nonlinear relationships. In advertising art design, deep learning can extract advanced features from advertising copy and images, providing an effective means for emotional analysis. Emotional analysis is a computational technique that uses multimedia data such as text and images to determine emotional tendencies and themes. It involves multiple fields, such as natural language processing and computer vision, aiming to uncover emotional information contained in data. In advertising art design, emotional analysis can help designers understand the emotional needs and preferences of the audience, providing an important basis for advertising creativity.

Deep learning has significant advantages in emotional analysis. By training deep neural network models, deep learning can automatically extract features from text and images and learn the nonlinear mapping relationship between emotions and features. In text sentiment analysis, deep learning models such as RNN and CNN can handle variable-length text sequences and capture contextual information in the text, achieving accurate sentiment classification. In image sentiment analysis, deep learning can extract low-level and high-level features of an image and achieve accurate judgment of image sentiment by establishing associations between emotions and image features. Through the application of a deep learning algorithm, the text and image information in advertisements can be efficiently extracted and analyzed, providing designers with objective and accurate emotional analysis results. The combination of deep learning and emotional analysis can realize the intelligence of advertising art design, improve design efficiency, and promote innovation in the advertising industry. Text sentiment analysis refers to the task of analyzing, processing, and mining text to identify the emotional tendencies, intensity, and themes expressed in the text. In advertising art design, text sentiment analysis can help designers accurately grasp the emotional colors in advertising copy and the audience's emotional response to the advertisement. Traditional text sentiment analysis methods are mainly based on dictionaries and rules, which often have poor performance when dealing with complex contexts and implicit emotional expressions. RNN is a deep learning model suitable for sequential data, which can capture temporal dependencies in text. In text sentiment analysis, RNN can effectively extract contextual information from text by modeling text sequences. Specifically, the text sentiment analysis model based on RNN represents the text as a sequence of word vectors and inputs the word vectors into the RNN network. The RNN network captures long-term dependencies in text by continuously iteratively updating hidden states. Finally, the output of the RNN network is passed through the fully connected layer and softmax layer to obtain the sentiment classification results of the text.

Assuming that an L -level RNN works on a dependency graph $g = v,\varepsilon$, then that output of the k lay node i is h_i^k :

$$h_i^k = \rho\left(\sum_{j=1}^{q} A_{ij} W^k h_j^{k-1} + b^k\right) \tag{1}$$

Where W^k is the weight matrix, b^k is the partial differential vector, $\rho\cdot$ is the activation function RELU, and A is the adjacency matrix of the dependency in the dependency tree.

The probability occupation of text sentiment analysis is described as:

$$P\ i_j \left| k,\theta \right. = \frac{\exp\ x_j\ k,\theta}{\sum_{1\le i\le |X|} \exp\ x_j\ k,\theta} \tag{2}$$

Where $x_j\ k,\theta$ is the average pool result, the parameter set θ corresponds to the class j, and the class space is expressed as X. Select the cross entropy function as the loss function:

$$loss = -\sum_i \sum_j y_i^j \log \hat{y}_i^j + \lambda \left\| \theta \right\|^2 \tag{3}$$

Where y is the expected value, $\hat{y}$ is the predicted value, λ is L2 regularization, and θ is the parameter set of the model.

During the training process, the RNN-based text sentiment analysis model adopts supervised learning and uses training datasets with sentiment labels for training. In typical scenarios, the approach to assessing the overall sentiment of a document's text involves aggregating the emotional leanings of individual sentences. These emotional leanings of a sentence are derived from the summation of the sentiment orientations of distinctive words. Through this progressive aggregation, the aim of evaluating the document's holistic sentiment is accomplished. The formula utilized to calculate the sentiment orientation of these distinctive words is:

$$tendency = \frac{1}{n}\sum_{i=1}^{n} sim\ \ word, seed_{1i}\ \ - \frac{1}{m}\sum_{i=1}^{n} sim\ \ word, seed_{2j} \tag{4}$$

When $a_i \neq 0$ the corresponding vector X_i is the support vector. Therefore, the decision function is rewritten as:

$$f\ \ x\ \ = \mathrm{sgn}\left(\sum_{i=1}^{M} a_i y_i K\ \ x, x_i\ \ + b \right) \tag{5}$$

Where M represents the number of support vectors.

The formula for calculating the similarity between two sememes is:

$$Sim\ \ p_1, p_2\ \ = \frac{a}{d+a} \tag{6}$$

Where p_1 is the original meaning 1; p_2 is original meaning 2; d is the path length of p_1, p_2 in the semantic tree system; a is an adjustable parameter.

The text sentiment analysis model based on RNN can automatically extract advanced features from text, avoiding the tedious feature engineering work in traditional methods; The RNN model can capture long-term dependencies in text and better handle emotional analysis tasks in complex contexts; The RNN-based model has strong generalization ability and can be applied to text sentiment analysis tasks in different fields. In advertising art design, a text sentiment analysis model based on RNN can help designers better understand the emotional tendencies and themes in advertising texts. Designers can input advertising copy into an emotion analysis model to obtain the emotional classification results of the copy. Based on the emotional classification results, designers can selectively select appropriate visual elements, color combinations, and layouts to create advertising design works that align with the emotions of the copy.

3.2 Image Sentiment Analysis

Image emotion analysis is an interdisciplinary research field between computer vision and emotion computing, with the aim of enabling computers to recognize and understand the emotional content contained in images. In advertising art design, images serve as key elements to convey emotions and attract audiences, and their emotional color is crucial for advertising effectiveness. Image sentiment analysis technology can provide designers with emotional labels and intensity of images, helping

them more accurately touch the emotions of the audience when selecting and designing images. CNN is a network structure particularly suitable for processing image data in deep learning. In image sentiment analysis, CNN can automatically extract useful features from the original image and learn the relationship between these features and emotions. The CNN-based framework for image sentiment classification and recognition is shown in Figure 1.

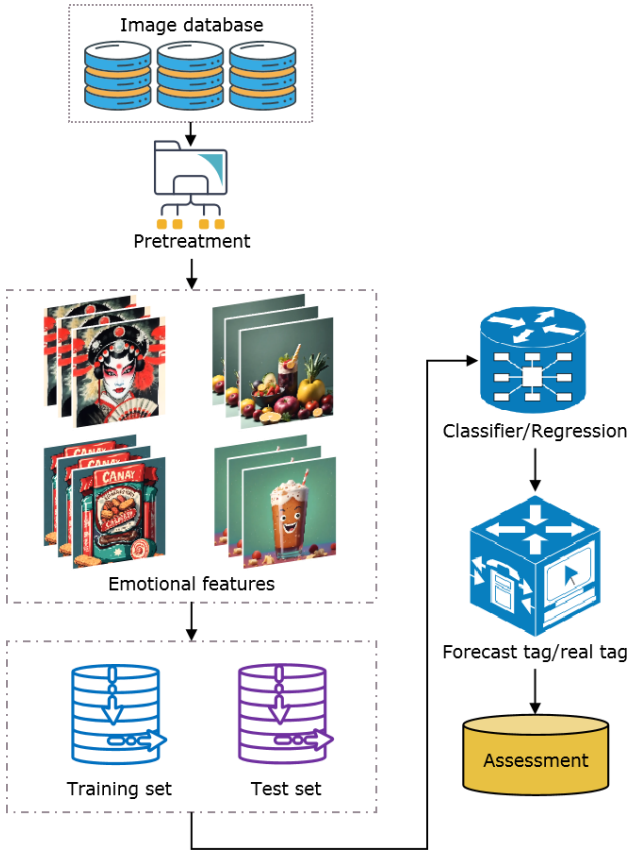

Figure 1: Framework for sentiment classification and recognition.

Perform necessary preprocessing on the original image, such as normalization and denoising, to facilitate subsequent feature extraction. Extracting low-level to high-level features of images, such as edges, textures, shapes, etc., using the convolutional layer of CNN. Input the extracted features into the fully connected layer and obtain the sentiment classification results of the image through the softmax function. In order to train an effective CNN-based image sentiment analysis model, a large amount of image data with sentiment labels is required. These data can be obtained through network crawling, dataset expansion, or manual annotation. To ensure that the CNN model gradually converges towards the global optimum, intelligent initialization of weights is essential. These weights, represented as convolution kernels in the convolutional layer of the CNN, are randomly initialized following a specific uniform distribution. This initialization process aids in achieving the desired overall image sentiment orientation calculation:

$$W \sim U\left[-\frac{\sqrt{6}}{\sqrt{n_{in}+n_{out}}}, \frac{\sqrt{6}}{\sqrt{n_{in}+n_{out}}}\right] \tag{7}$$

Where n_{in}, n_{out} is the number of input and output neurons at the convolution kernel weight.

This layer is an innovation of CNN, which is different from the traditional fully connected neural network, and mainly aims at emotional feature extraction. The specific operation definition formula is as follows:

$$X^L = f\ Z^L\ = f\ X * K^L + b^L \tag{8}$$

$*$ is convolution operation, Z^L is the input value of the L st layer convolution, and X^L is the feature mapping value obtained after the nonlinear activation function. f is the activation function.

Use the linear regression function $f\ x\ = w \cdot x + b$ to fit the sample data according to the collected samples:

$$\begin{aligned} y_i - \ w \cdot x_i + b\ &\leq \varepsilon \\ w \cdot x_i + b\ - y_i &\leq \varepsilon, \quad i = 1,2,\cdots,n \end{aligned} \tag{9}$$

The problem of finding a hyperplane solution is transformed into:

$$\begin{cases} \min \|w\|^2 / 2 \\ s.t. \quad y_i\ w \cdot x + b\ \geq 1 \end{cases} \tag{10}$$

The corresponding prediction function is:

$$f\ x\ = \operatorname{sgn}\left(\sum_{i=1}^{n} a_i y_i \langle x_i \cdot x \rangle + b \right) \tag{11}$$

Designers can choose images that match the desired emotions based on the theme and target audience of the advertisement. For existing images, designers can receive advice on how to modify the image to enhance a certain emotion. This method not only improves the efficiency of design but also ensures that the designed advertisements more accurately touch the emotions of the audience.

3.3 Result Analysis

The experimental results revealed the changes in the loss-fitting curve of the model during initial and final training. By comparing Figure 2 and Figure 3, the optimization and convergence of the model during the training process can be observed.

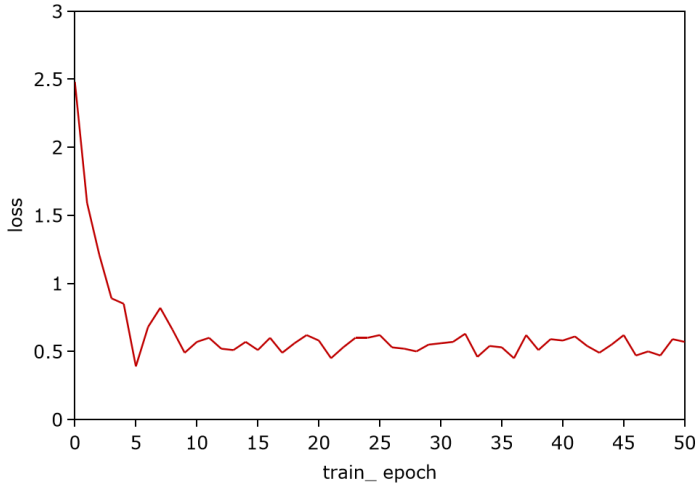

Figure 2: First training loss curve.

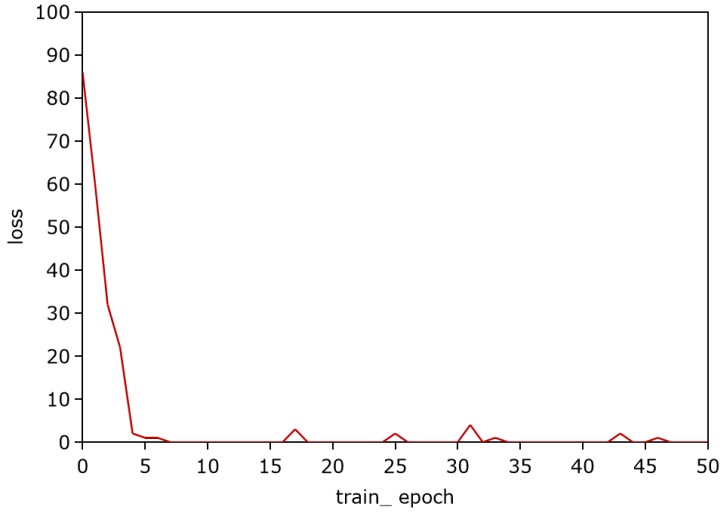

Figure 3: Loss curve of 20th training.

In the first training (as shown in Figure 2), the loss of the model rapidly decreased in the initial stage, indicating that the model had a poor fitting effect on the training data at the beginning and had a significant loss. However, as Epoch increases, the loss of the model gradually decreases. After Epoch reaches 9, the downward trend of the loss curve significantly flattens out, which means that the parameter adjustment of the model is relatively small at this time, and the fitting effect on the training data gradually stabilizes. After 20 rounds of iterative training (as shown in Figure 3), the loss-fitting curve of the model shows a faster convergence trend. When Epoch reaches 4, the model's losses have already reached a stationary state. This indicates that after multiple iterations of training, the model is more familiar with the characteristics of the data and can adjust parameters faster to adapt to the data distribution, thereby achieving faster convergence and better fitting results. As the number of training rounds increases, the loss of the model gradually decreases and tends to stabilize, indicating that the model gradually optimizes and converges to the optimal solution during the training process. This provides an effective solution for the emotional analysis task in advertising art design, which helps to improve the accuracy and emotional resonance of advertising design.

4 OPTIMIZATION OF CAD EXPRESSION OF ADVERTISING ART DESIGN BASED ON EMOTIONAL ANALYSIS RESULTS

4.1 Optimization of CAD Modeling

In advertising art design, accurate emotional analysis is the foundation of design, and how to translate these emotional analysis results into visual expression is a key issue that designers need to face. This section will explore how to optimize advertising art design using CAD technology based on the emotional analysis results obtained from the previous section. To achieve this goal, this section will introduce the idea of SVM to guide parameter optimization in the CAD modeling process. The core idea of SVM is to use kernel functions to map the data in the training set in order to find the optimal segmentation plane, which is the maximum edge hyperplane, and thus achieve the division of different categories. This process typically transforms the SVM problem into a solution problem for the maximum edge hyperplane, in order to effectively distinguish different categories. Through Figure 4, the concept of maximum edge hyperplane can be intuitively and clearly understood. In the figure, the solid line in the middle represents the optimal hyperplane.

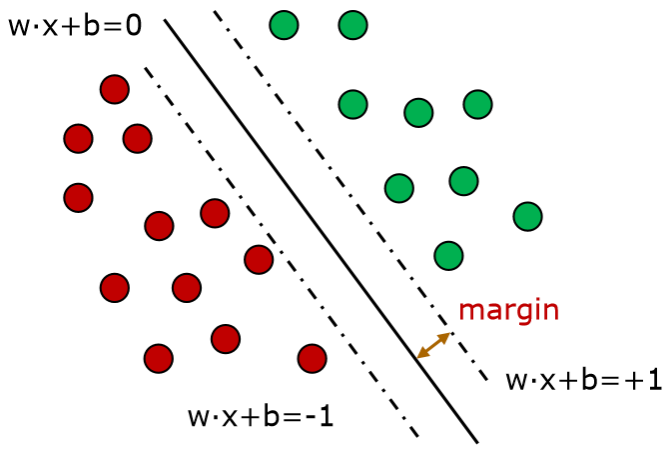

Figure 4: Maximum edge hyperplane of two kinds of linear partition.

Firstly, based on the emotional analysis results, set an initial CAD modeling parameter set for advertising art design. These parameters may include color, shape, layout, etc. Treat all possible CAD parameter combinations as design spaces. Each parameter combination corresponds to a design work. Drawing on the idea of SVM, define an objective function to measure the distance between the design work and the target emotion. Then, by continuously adjusting CAD parameters, the objective function value is minimized. This process can be seen as finding the optimal "hyperplane" in the design space, enabling the design work to best match the target emotion. After each round of optimization, a new parameter set is obtained. Generate a new design work using this new parameter set and evaluate it again. Repeat this process until a satisfactory design result is achieved.

In order to minimize the influence of errors in feature extraction on recognition results, fuzzy distribution requires the following conditions: when the value of feature difference is small, the curve slowly decreases; When the characteristic difference value is large, the curve drops rapidly. The formula of this fuzzy distribution function is:

$$\mu\ x\ = \frac{1}{2} - \frac{1}{2}\sin\frac{\pi}{a_2 - a_1}\left(x - \frac{a_1 + a_2}{2}\right) \tag{12}$$

The membership matrix μ between features of the same dimension is constructed by fuzzy distribution function;

$$\mu = \begin{bmatrix} \mu_{11} & \mu_{12} & \cdots & \mu_{1Q} \\ \mu_{21} & \mu_{22} & \cdots & \mu_{2Q} \\ \vdots & \vdots & \ddots & \vdots \\ \mu_{M1} & \mu_{M2} & \cdots & \mu_{MQ} \end{bmatrix} \tag{13}$$

The pixel value $H\ v$ of the emotional feature distribution of advertising art design is:

$$H\ v\ = L_{xx}\ x,\sigma\ + \frac{1}{\sqrt{L_{yy}}}\exp\left(\frac{j\pi}{4}\right)\exp\left[\frac{-j\pi}{L_{yy}S\ t}\right] \tag{14}$$

Among them, $L_{xx}\ x,\sigma$ are the ambiguity function of multi-scale transformation, L_{xx}, L_{yy} the wavelet high-frequency coefficient, and the low-frequency coefficient of emotional feature decomposition of advertising art.

In the codebook, each code exists in the form of a character:

$$c_{i,j} = \begin{cases} 1 & if \quad j = \arg\min_{j=1,2,\cdots,M} \left\| p_i - f_j \right\| \\ 0 & else \end{cases} \tag{15}$$

4.2 Result Analysis

To validate the effectiveness of CAD modeling optimization for advertising art design based on sentiment analysis results, this study collected a set of advertising design tasks with different sentiment labels. Then, for each task, analyze it using the sentiment analysis model in the previous section based on its emotional labels to obtain a sentiment analysis result. Next, based on this result, CAD modeling optimization is carried out to generate a preliminary draft of the advertising design. Finally, submit this initial draft to the designer for evaluation to check whether it meets the emotional expression needs. Figure 5 shows the generated results of graphic advertising art design based on the traditional SVM algorithm, and Figure 6 shows the generated results of graphic advertising art design combined with the emotion recognition method in this article.

Figure 5: Art design of print advertisement based on traditional SVM algorithm.

The comparison between the generated results of graphic advertising art design based on the traditional SVM algorithm (Figure 5) and the generated results of graphic advertising art design combined with the emotion recognition method in this article (Figure 6) reveals the advantages of this method in advertising design.

Traditional SVM methods mainly rely on manually designed features and fixed classification boundaries when dealing with classification tasks, which means they may not be able to fully capture the complex emotional expressions and subtle differences in product features in advertising design. When observing the design work combined with the emotion recognition method in this article, it is evident that the lines are clearer and the product features are more prominent. This is because the emotion recognition method in this article can provide a deeper understanding of the emotional content in advertisements. In advertising design, the clarity of lines and the prominence of product features are closely related to the attractiveness and communication power of the advertisement. Clear lines can guide the audience's gaze while highlighting product features can quickly convey the core value of the product. Through deep learning algorithms for emotional analysis of advertising

copy and images, it is possible to more accurately grasp the emotional tendencies and themes of advertisements, thereby providing more targeted guidance for advertising design.

Figure 6: Art design of print advertisement combined with emotion recognition method in this article.

The success of advertising design ultimately depends on the actual experience of users as an important reference. The user subjective rating results shown in Figure 7 provide us with a comparison of the actual user experience of advertising design styles. From the figure, it can be clearly seen that compared to traditional methods, the improved method has achieved higher user ratings for the designed print advertising works. This result further validates the superiority of the proposed method in advertising art design.

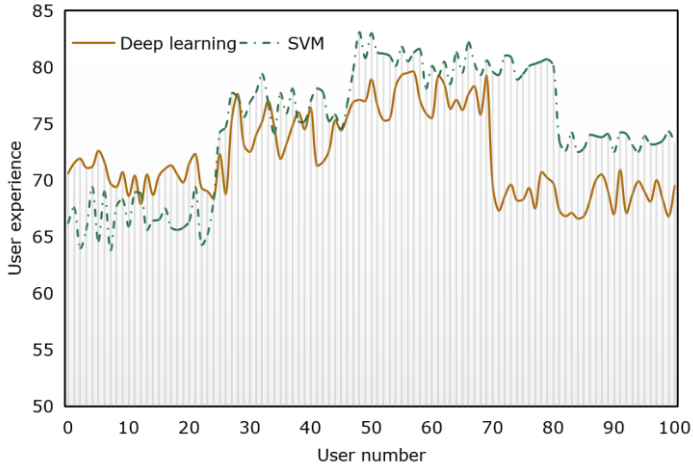

Figure 7: User experience score.

The improved method uses deep learning algorithms for sentiment analysis, which can more accurately grasp the emotional theme of advertisements. In advertising design, it is crucial to quickly

and accurately convey product characteristics. The improvement method utilizes emotion analysis and CAD modeling optimization to better showcase product features in design works, thereby increasing user awareness and interest in the product. The scoring results also reflect the advantages of the improved method in terms of visual appeal. Clear lines, prominent product features, and colors and layouts that align with design emotions all make the improved design work more visually appealing.

5 CONCLUSION

Advertising art design, as an indispensable means of communication in modern society, has always been exploring how to better attract the audience's attention, transmit information, and stimulate emotional resonance. In advertising art design, emotional analysis can help designers better understand the emotional needs of the audience, thereby designing more attractive and infectious advertising works. Deep learning, as an emerging branch of machine learning, has powerful feature learning and classification capabilities. This article successfully applies deep learning algorithms to emotional analysis in advertising art design and proposes a CAD expression optimization method for advertising art design based on emotional analysis results. Through text sentiment analysis based on RNN and image sentiment analysis based on CNN, this method can accurately extract emotional tendencies and themes in advertisements. At the same time, combining the ideas of SVM, optimization is carried out in the CAD modeling process to make the generated design works more prominent in product features and clearer in lines. The research not only enriches the theoretical system of emotional analysis and advertising design but also provides a new, data-driven creative design approach for advertising designers. In future research, it is possible to further explore how to apply more advanced deep learning technologies to advertising art design to provide more accurate and intelligent design support, thereby improving advertising effectiveness and user satisfaction.

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