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Computer-Aided Design AND APPLICATIONS

Computer Aided Product Packaging Design Based on Genetic Algorithm in Graphic Design Teaching

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Abstract. More and more rich means of product packaging design and connotative product packaging design emerge in endlessly in the market. How to make graphic design meet the aesthetic needs and be more practical, and how to let students master creative thinking and cultivate their design skills in a short time are the problems that teachers need to solve in teaching. In this article, a design method of product packaging computer aided design (CAD) based on genetic algorithm (GA) is proposed, which is used to improve the packaging CAD system in graphic design teaching and innovate the education mode. In this method, GA is used to create the corresponding association between the low-level features of the image and the high-level emotional semantics, and the emotional semantic recognition mechanism is established to realize the emotional recognition of the packaging image. This article compares the accuracy of different algorithms on training set and experimental set, and proves that the accuracy of this algorithm can reach about 90% on training set and 96% on experimental set. Therefore, this method can effectively improve the efficiency and accuracy of product packaging design and enhance the communication effect between designers and consumers. In graphic design teaching, this method can improve students' design thinking and practical ability, and improve the teaching effect and quality of product packaging design.

Keywords: Graphic Design; Genetic Algorithm; Computer Aided Design; Packaging Design
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1 INTRODUCTION

As an important branch of visual communication design, graphic design has developed into a mature art design field. In graphic design teaching, product packaging design is a very important link, which plays a vital role in cultivating students' design thinking and practical ability. Alqudah and Jarrah [1] reported the research results of parallel implementation of genetic algorithms on

FPGA using Vivado advanced synthesis. Genetic algorithm is an optimization method driven by natural selection, often used to solve complex combinatorial optimization problems. However, its parallelization in hardware implementation poses certain challenges. This study utilizes the Vivado advanced synthesis tool to map the various steps of genetic algorithm to the hardware resources of FPGA, in order to achieve parallel operation of the algorithm. The researchers designed a parallel genetic algorithm implementation using Vivado advanced synthesis. They first decompose the main steps of genetic algorithm (selection, crossover, and mutation) into hardware operations, then use Vivado advanced synthesis to convert these operations into Hardware Description Language (HDL), and finally load the HDL code to run on FPGA. However, in the current product packaging design, designers usually rely on subjective experience and intuition, lacking scientific and systematic. Traditional packaging design is constantly looking for new value-added points and breakthroughs in the drive of market economy and the renewal of people's concepts, and modern packaging came into being. With the continuous development of satellite technology, the manufacturing requirements for satellite components are also increasing. Additive manufacturing, as an advanced manufacturing technology, can meet the high-precision and high-complexity manufacturing needs of satellite components. In the additive manufacturing process of satellite components, product design has a significant impact on manufacturing efficiency and cost. Traditional design methods often lack consideration for product integrity, leading to some problems in the manufacturing process, such as high manufacturing difficulty and high costs. Therefore, we need a new design method that can consider product design as a whole, improve manufacturing efficiency, and reduce costs. Borgue et al. [2] proposed a strategy for modular product design based on genetic algorithms. This strategy divides the product design process into two stages: module design and variable selection. In the module design phase, we use genetic algorithms to combine and optimize different modules to maximize the overall value of the product. In the variable selection stage, we screen and optimize variables to further enhance the value of the product. Different from the traditional packaging design, this new modern packaging pays more attention to the psychological and practical needs of consumers on the basis of conveying design concepts. In order to make consumers understand the product characteristics more intuitively and leave a deep impression on the product, and increase consumers' desire to buy, more and more rich means of product packaging design and connotative product packaging design emerge one after another in the market. The application of emotional stimulation in design makes people feel happy and need, and emotion is also the emotional attitude of people towards certain things or certain phenomena. Injection molding is an important process method in the production of polymer products, but it involves multiple interrelated factors, such as mold design and process parameter settings, which have a significant impact on the quality and production efficiency of injection molded parts. Therefore, how to optimize these factors to improve the quality and production efficiency of injection molded parts is an important issue in the field of polymer engineering. Cao et al. [3] proposed an optimization method based on entropy weight, random forest, and genetic algorithm for multi-objective optimization of injection molded parts. Firstly, the entropy weight method is used to objectively assign weights to multiple optimization objectives. Then, the random forest algorithm is used to train a large amount of sample data to predict the quality indicators of injection molded parts. Finally, combining genetic algorithm to optimize the prediction results and find the optimal solution. Through practical case verification, this method can effectively improve the quality and production efficiency of injection molded parts. Emotion focuses on feelings and experiences in the emotional process, while emotion focuses on the physiological state in the process. Product design teaching requires students to have rich creativity. The classroom teaching mode should learn from and use the new platform, clarify the advanced industrial ideas, innovate the education mode, improve students' artistic and cultural design literacy, and constantly try to reform and innovate in teaching design.

With the continuous development of computer technology and artificial intelligence, computer-aided design (CAD) has been widely applied in various fields. Among them, fractal art, as a nonlinear art design method, has the characteristics of infinite nesting and fine structure, and is widely used in fields such as image processing and art design. However, traditional fractal art design methods mostly rely on manual operations by designers, making it difficult to achieve mass production and automation. Therefore, how to improve the efficiency and creativity of fractal art design has become an urgent problem to be solved. Chao [4] proposed a fractal art design method based on interactive genetic algorithm, aiming to improve the efficiency and creativity of art design. This method combines the advantages of genetic algorithm and fractal art to generate patterns with complex structures and fine details by simulating the growth process and morphology of nature. At the same time, human-computer interaction has been introduced, allowing designers to modify and adjust the generated artwork in real-time, improving the practicality and plasticity of the artwork. CAD is gradually applied to the teaching of graphic design, which can not only stimulate students' interest in learning, but also stimulate students' creative thinking, thus designing very good design works. How to make graphic design meet the aesthetic needs and be more practical, how to let students master creative thinking and cultivate their design skills in a short time, and how to skillfully express creativity by using design software are problems that teachers need to solve in teaching. In graphic design teaching, CAD can effectively help teachers to arrange words and graphics, save a lot of time for preparing lessons, increase the diversity of courseware, expand the imagination of teachers and students, and cultivate innovative thinking of both sides. Emotion recognition refers to identifying and predicting the emotional state of human beings by analyzing the signals related to human emotions, such as text, voice and facial expressions. In product packaging CAD design, emotion recognition technology can help designers better understand consumers' emotional needs and psychological expectations, so as to make better design decisions. This article presents a packaging CAD design method based on GA. This method uses GA to simulate the stage of natural selection and gene mutation from the bottom features, and creates the corresponding association between the bottom features of the image and the high emotional semantics, so as to establish the emotional semantic recognition mechanism and realize the emotional recognition of the packaging image.

CAD technology has brought immeasurable application value to product packaging design industry, and has become a necessary tool in product packaging design and mass production. This article presents a packaging CAD design method based on image emotion recognition in graphic design teaching.

Innovation:

1. In this article, GA is introduced into product packaging design. By simulating the stage of natural selection and gene mutation, the corresponding relationship between the low-level features of the image and the high-level emotional semantics is created, so as to establish the emotional semantic recognition mechanism and realize the emotional recognition of packaging images.

2. The research provides a new teaching idea and method of graphic design. By introducing CAD and emotion recognition technology, the teaching effect and quality of product packaging design can be improved, and students' design thinking and practical ability can be cultivated.

This article introduces the application of emotion recognition method of packaging image based on GA in graphic design teaching, implements the algorithm in detail, and tests the practical application effect of the algorithm in packaging design.

2 RELATED WORKS

Chen et al. [5] proposed a structural optimization method for the A356 casting quality prediction system based on genetic algorithm. This method improves the accuracy and efficiency of prediction by optimizing the neural network structure of the system. The article first introduces the characteristics of A356 alloy and the possible defects that may occur during the casting process, and then elaborates in detail on the application of genetic algorithm in optimizing neural network structure. The experiment used a large amount of A356 casting data, including casting process parameters and corresponding quality results. Firstly, the main factors affecting the quality of castings were identified through data preprocessing and analysis. Street food packaging design is crucial for the safety and quality of food. However, incorrect packaging design may lead to food spoilage or contamination, thereby affecting consumer health. Quality function deployment is an effective tool that can help designers ensure that packaging design meets consumer needs while improving product safety and quality. Faishal et al. [6] explored how to use Quality Function Deployment (QFD) to improve the safety and quality of street food packaging design. QFD is a systematic method used to transform customer needs into specific requirements for products or services. In the field of street food packaging design, QFD can help designers ensure the safety and quality of packaging to meet consumer expectations and needs. Quality function deployment is a systematic approach based on customer requirements. It ensures that the product or service meets customer expectations by transforming customer needs into specific requirements for the product or service. In the field of street food packaging design, QFD can help designers ensure the safety and quality of packaging. Injection molding is an important process method in the production of polymer products, but it involves multiple interrelated factors, such as mold design and process parameter settings, which have a significant impact on the quality and production efficiency of injection molded parts. Therefore, how to optimize these factors to improve the quality and production efficiency of injection molded parts is an important issue in the field of polymer engineering. Liu et al. [7] proposed an optimization method based on entropy weight, random forest, and genetic algorithm for multi-objective optimization of injection molded parts. Firstly, the entropy weight method is used to objectively assign weights to multiple optimization objectives. Then, the random forest algorithm is used to train a large amount of sample data to predict the quality indicators of injection molded parts. Finally, combining genetic algorithm to optimize the prediction results and find the optimal solution. Through practical case verification, this method can effectively improve the quality and production efficiency of injection molded parts.

Interactive genetic algorithm for traditional pattern novel design is a technology that combines genetic algorithm and human-computer interaction. Lv et al. [8] provide a novel, efficient, and innovative solution for traditional pattern design. This scheme achieves automation and intelligent design of traditional patterns by simulating the genetic mechanisms in biological evolution and combining the creativity and professional knowledge of designers. Firstly, select traditional patterns as the initial population. These patterns can be classic patterns extracted from historical literature or original works provided by designers. Evaluate the diversity of each pattern in the population to ensure that the algorithm can consider various design schemes when exploring the solution space. Diversity assessment can be achieved by calculating the similarity between patterns or using other relevant indicators. Based on the fitness and diversity of each pattern, select a portion of the pattern as the parent. Patterns with higher fitness have a higher probability of being selected to guide algorithm evolution towards better solutions. According to ACI 318-19, genetic algorithm is used for the optimization design of reinforced concrete footings. The foundation of a building bears all the weight of the building and needs to ensure its stability and safety. Therefore, optimizing the design of footings is crucial for improving the performance and lifespan of buildings. In genetic algorithms, Solorzano and Plevris [9] use the design of the footings as chromosomes and the range of design variables as genes. By simulating the selection, crossover, and mutation operations in biological evolution, we can generate new footing design schemes. In each generation, we will evaluate the fitness of all footing schemes and select excellent schemes for breeding based on their fitness. At the same time, we will also conduct gene crossover and mutation operations to generate new gene combinations, thereby generating new footings. By continuously iterating through this process, we can gradually approach the optimal footing design solution. The resulting foundation design scheme will have the best strength, stiffness, and durability, and can significantly improve the performance and lifespan of the building. Sun et al. [10] proposed a method for automatically designing convolutional neural network (CNN) architectures using genetic algorithms for image classification tasks. Firstly, this method generates an initial set of CNN architectures by simulating biological evolution processes. Then, based on certain evaluation criteria, select high fitness architectures from these architectures for crossover and mutation, and generate new CNN architectures. By repeating this process repeatedly, one or more optimal CNN architectures will ultimately be obtained. The author tested the proposed method for automatically designing CNN architecture on a large image classification dataset. Firstly, they randomly generated 100 initial CNN architectures as populations. Then, they used classification accuracy as the evaluation criterion, and after every 10 iterations, they selected the CNN architecture with the highest fitness as the current optimal architecture.

In each iteration, they randomly select two CNN architectures for crossover and mutation, generating two new CNN architectures. This process continues until the preset number of iterations is reached, or a CNN architecture that meets the requirements is found. In today's fiercely competitive market environment, product packaging design has become one of the important factors in improving product added value and customer satisfaction. A unique and attractive packaging design can attract consumers' attention, increase the attractiveness of the product, and increase consumers' willingness to purchase the product. Packaging design plays a crucial role in increasing product added value. Through unique packaging design, products can be distinguished from competitors and gain an advantage in the market. Vasileiadis et al. [11] explored how to combine product and packaging design to increase added value and customer satisfaction. Through research and analysis, we have found that good packaging design can enhance the competitiveness of products in the market, enhance customer awareness and sense of value of products. At the same time, packaging design that combines product characteristics can also increase the added value of the product and meet the personalized needs of customers. With the increasing global environmental awareness, green packaging has become a topic of common concern for consumers and businesses. Green packaging not only improves the environmental friendliness of products, but also helps to increase consumer acceptance of products. Wandosell et al. [12] explored the sustainability of green packaging from both consumer and commercial perspectives. From a consumer perspective, the primary demand for green packaging is to ensure the health and safety of the product. Green packaging made of environmentally friendly materials can reduce the risk of product pollution to the environment and human body. Adopting renewable resources and reducing packaging waste in green packaging, showcasing the company's concern for the environment, can help improve consumers' liking for the company. From a business perspective, the sustainability of green packaging has a significant impact on the operation and development of enterprises. At the same time, green packaging can also reduce the return rate of products in the market, further saving enterprise costs. Xue [13] proposed an intelligent system for personalized product design based on genetic algorithms. This system simulates the genetic mechanism in the process of biological evolution and utilizes fuzzy logic and artificial intelligence technology to achieve optimization and intelligence of personalized product design. The article first introduces the importance of personalized product design, and then elaborates on the specific application of genetic algorithm in the optimization design process.

The experiment used various product design parameters and corresponding design results, including mechanical parts, furniture, and electronic equipment. Firstly, by preprocessing and analyzing the data, the main factors affecting the product design results were identified. Then, using these factors as inputs to the genetic algorithm and the design results as outputs, a preliminary model was constructed. During this process, the structure and parameters of the model are encoded as chromosomes, and its performance is evaluated through fitness functions. After multiple rounds of iteration, the optimal model structure and parameters are selected and used to construct the final personalized design intelligent system. Yuan et al. [14] introduced an artificial intelligence assisted simulation framework based on genetic algorithm optimization of initial parameters of artificial intelligence models, which is used for risk estimation of solder joint reliability. This framework includes steps such as building an artificial intelligence model, optimizing the initial parameters of the model using genetic algorithms, applying the optimized model for simulation and risk assessment. The effectiveness and accuracy of the framework were verified through case analysis. This framework can improve the efficiency and accuracy of solder joint reliability assessment, providing strong support for the electronic product manufacturing industry. With the intensification of market competition, product packaging design is receiving increasing attention. Excellent packaging design can attract consumers' attention and increase product sales. However, traditional packaging design methods have certain limitations, such as poor communication between designers and consumers, and low design efficiency. In recent years, with the development of VR technology and CAD software, new solutions have been provided for packaging design. Yun and Leng [15] introduced how to apply VR technology combined with CAD software development to optimize packaging design. Through VR technology, three-dimensional display of packaging design can be achieved, making the design more intuitive and realistic, and improving communication efficiency between designers and consumers. At the same time, CAD software can also optimize packaging design details, such as making precise adjustments to the folding structure, fit, size, and other aspects of the packaging box. The application of VR technology and CAD software can not only improve the efficiency and quality of packaging design, but also reduce costs and shorten product launch time.

In product packaging design, GA can simulate the stage of natural selection and gene mutation, and start from the bottom features to create the corresponding relationship between the bottom features of the image and the high-level emotional semantics, thus establishing the emotional semantic recognition mechanism and realizing the emotional recognition of packaging images. In this article, GA is introduced into product packaging design. By simulating the stage of natural selection and gene mutation, the bottom features are regarded as the chromosomes of GA, and through the operations of selection, crossover and mutation, the association model corresponding to the high-level emotional semantics is generated, and the corresponding association between the bottom features of the image and the high-level emotional semantics is created.

3 METHODOLOGY

Graphic design is a practical art, and it can also be said to be artistic creation to some extent. Graphic design can bring people a pleasant emotional experience, convey content and meaning to people, and is also an emotional expression, because this emotional experience is the need of the purpose and utility of subordination and design. With the growth of computer, the efficiency of product packaging design has been improved. In order to express the appearance of packaging design more accurately, the field of packaging design has already taken on a new look. In the traditional packaging design and manufacturing process, the lack of advanced technology and modern equipment, such as the pattern design in the packaging appearance and the appearance embodiment of traditional culture, all need to be based on manual design and manufacturing, relying heavily on the support of a large number of manpower. Based on the emotional analysis of graphic design, the following design rules can be followed in image design. Sensory stimulation respectively; Personalization; And feelings of self-realization. The emotional experience stimulated by the sensory level is realized through contrast, saturation and freshness. The requirement of packaging design for CAD technology. After the designer collects and imports the detailed information of the product into the computer equipment, the computer technology can be referred to the designer as the basic reference information for preliminary formulation.

In order to realize emotional recognition of product packaging images, it is necessary to extract elements that can represent emotional characteristics from the images. These elements can include colors, textures, shapes, and words in images. Through the extraction and analysis of these features, we can understand the emotional information conveyed by packaging images. This article puts forward a design method of packaging CAD based on GA, aiming at improving the packaging CAD system in graphic design teaching and innovating the education mode. In this method, GA is used to simulate the stage of natural selection and gene mutation, to create the corresponding relationship between the low-level features of the image and the high-level emotional semantics, and to establish an emotional semantic recognition mechanism to realize the emotional recognition of packaging images. It consists of multi-feature selection, deep belief network (DBN) and extreme learning machine (ELM) within the framework of ensemble learning. The system framework is shown in Figure 1.

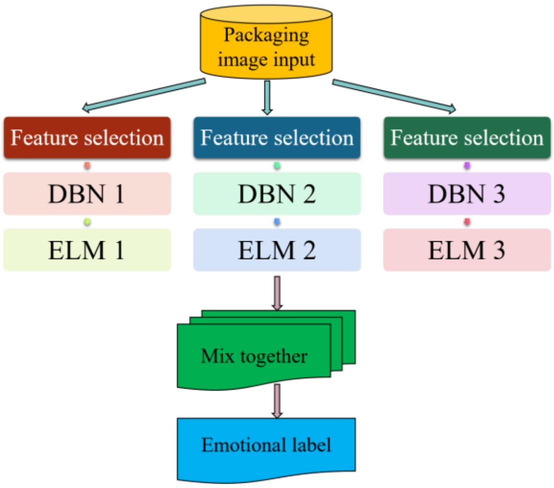

Figure 1: Emotional identification stage of product packaging based on multi-feature learning.

Different colors can trigger different emotional reactions. For example, red is usually regarded as a color with enthusiasm and vitality, while blue is often regarded as a calm and calm color. By analyzing the main color and color distribution in the image, we can get a preliminary understanding of the emotions expressed in the packaging image. Rough texture can convey ancient or retro feelings, while smooth texture can convey modern or fashionable feelings. By analyzing the texture of the image, we can further understand the emotional information conveyed by the packaging image. Different shapes can convey different emotions. For example, a circle is often regarded as a gentle and friendly shape, while a triangle is often regarded as a dynamic and exciting shape. Through the extraction and analysis of these features, we can build a model that can identify the emotional features of product packaging images. This model can accept a product packaging image as input and then output the emotional information expressed by the image.

Firstly, the color, texture and shape features of packaging images are extracted. These features constitute our input data set. After extracting the bottom features, GA is used for optimization. GA is a search algorithm, which simulates the stage of natural selection and gene mutation. Taking the low-level features as the chromosomes of GA, an association model corresponding to the high-level emotional semantics is generated through operations such as selection, crossover and mutation. One of the key problems in genetic algorithm optimization is the selection of fitness function:

$$y = \frac{1}{\sum_{i=1}^{m} k_i (X_i)^{-a_i}} \tag{1}$$

The optimization condition is: $e_s < E$, that is, under the condition that the position volume error e_s is less than the specified precision requirement, the manufacturing cost of tolerance is minimized.

Adjust the structure of two parent individuals according to a certain crossover probability to generate two new individuals:

$$g_1^{'} = \lambda g_1 + (1-\lambda) g_2 \tag{2}$$

$$g_2^{'} = \lambda g_2 + (1-\lambda) g_1 \tag{3}$$

In the equation: g_1, g_2 is two parent individuals participating in the intersection; $g_1^{'}, g_2^{'}$ is the generated two offspring individuals; λ is a random number between (0,1).

As a cultural symbol, packaging image enriches the conventions of human beings, but it is inherently innovative at the same time, and the inherent paradox of packaging image contributes to the internal cause of art breaking through the stereotypes. This shows that the essence of art is actually innovation, and at the same time, it is necessary to inherit the good and essential parts. Moreover, the breakthrough of cultural symbols to this stipulation makes the expression of art become a rational medium of information dissemination, so it seems inevitable that art does not resemble the object of reproduction.

In the improved GA, a fitness function is defined to assess the merits of each chromosome. Fitness function is used to measure the fitness of each chromosome, that is, the matching degree between the underlying features and emotional semantics. According to the fitness function, excellent chromosomes are selected for crossover and mutation to produce new chromosomes. By repeating this process, the optimal correlation model is finally obtained. The improved GA process is shown in Figure 2.

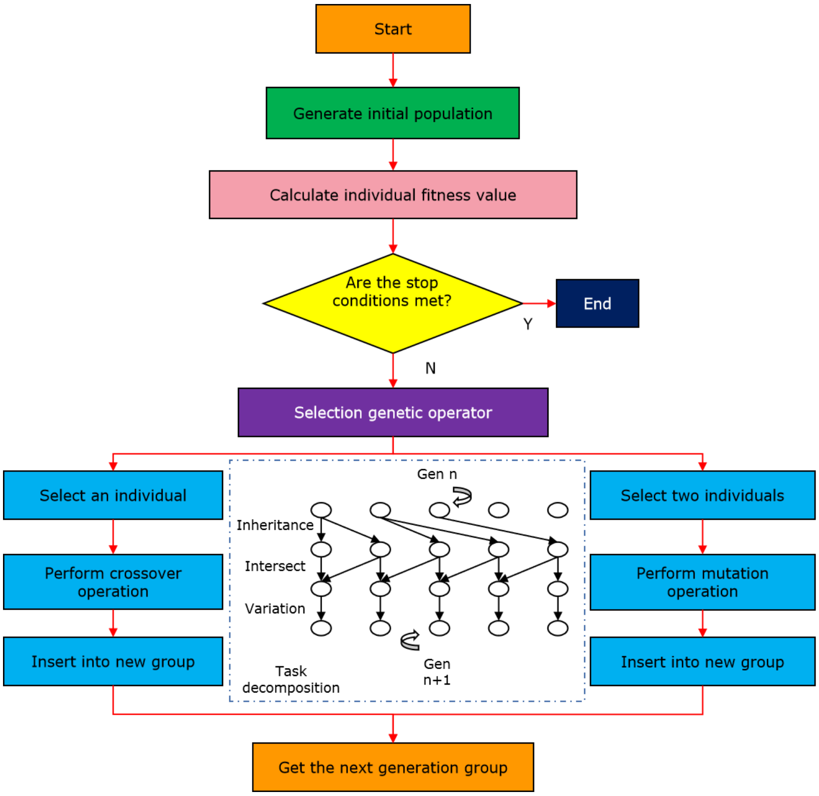

Figure 2: Improved GA process.

The main object in product packaging is the area where designers' inspiration and emotion are concentrated. According to the image saliency and stroke complexity, the region of interest can be extracted to obtain the region with rich emotional expression in product packaging. In this article, taking (x_{center}, y_{center}) as the center point, the region of interest of product packaging image is extracted, and the side length of the region is:

$$l = \delta \min(I_{width}, I_{height}), \delta \in (0,1] \tag{4}$$

In which, I_{width}, I_{height} represents the width and height of image I respectively, and δ is the cropping threshold.

The coordinates of the upper left corner of the circumscribed rectangle $E(x,y)_s$ with the highest complexity are $(x_{\min}, y_{\min})$ and the coordinates of the lower right corner are $(x_{\min}, y_{\min})$, then the coordinates of the center point of $E(x,y)_s$:

$$(x_s, y_s) = \left(\left[\frac{x_{\min} + x_{\max}}{2}\right], \left[\frac{y_{\min} + y_{\max}}{2}\right]\right) \tag{5}$$

In this article, it is proposed to extract emotional features of product packaging by using activation maximization technology visual network. $f_{ij}(\theta, H)$ is used to represent the activation of the first i element in the j layer of the network, and when $f_{ij}(\theta, H)$ is maximum, enter the value of H :

$$H^* = \arg \max_{s.t\|H\|=\rho} f_{ij}(\theta, H) \tag{6}$$

H^* approximates the visualization of channel features to the greatest extent. After the network training is completed, the parameter θ is known, and the gradient ascending method is used to find the local maximum, and the nonconvex optimization problem is calculated, that is, the gradient of $f_{ij}(\theta, H)$ is calculated as the moving direction, and the input sample H changes accordingly. After many iterations, it can approximate the features learned by convolution kernel from data set.

The higher the similarity of sample categories between source domain and target domain, the better the transfer learning effect; On the contrary, the greater the difference between the source domain and the target domain, the more negative the transfer learning effect will be. Therefore, when using the transfer learning method to classify and identify image emotions, all or part of the parameters of the pre-trained model can be transferred according to the actual situation, and the model can be fine-tuned by using the experimental data set to improve the accuracy of model classification and prevent the phenomenon of over-fitting.

There are two parents as follows, and the positions of intersection points are selected as 2, 6 and 10 respectively, and after crossing, two children are generated as shown in Figure 3 below:

Parent individual 1	0 1 1 0 0 0 1 1 0 1 0
Parent individual 2	1 0 1 0 1 1 0 0 1 0 1
Subindividual 1	0 1 1 0 1 1 0 1 0 1 1
Subindividual 2	1 0 1 1 0 0 0 0 1 0 0

Figure 3: Two children are generated after crossing.

According to the results of emotion classification, feedback and suggestions for product packaging design are generated. For example, if a certain packaging design is more emotionally welcomed by consumers, the original packaging design can be improved and optimized according to this feedback. Calculate the sum of fitness sizes of all individuals in the population F according to the following equation:

$$F = \sum_{i=1}^{N} f(i) \tag{7}$$

Where N is the population size and f_i is the fitness function value of the i th individual. Then calculate the relative fitness of each individual in the population, and the equation for calculating the relative fitness P_i of the i -th individual is:

$$P_i = \frac{f(i)}{F} \tag{8}$$

Finally, the roulette operation is simulated for multiple rounds of selection. The larger the P_i, the larger the area occupied by the individual in the roulette, so the greater the probability and times of being selected.

Designers can input their own design works into the system, and the system will automatically calculate the emotional score. According to the emotional score, designers can understand the emotional expression effect of their works and make corresponding adjustments. Let the initial time of the sequence be t_0, the time corresponding to the last emotional value of the sequence be t_n, and the effective value of the sequence be m, then the interval of the new sequence is $\frac{t_n - t_0}{2m}$, and the new sequence $\{x_t\}$ is shown in equation (9):

$$G(x_t) = smooth(t_i), t_i \in \left\{\frac{t_n - t_0}{2m}\right\} \tag{9}$$

Among them, the $smooth(x)$ function is the expression of the variable parameter linear trend prediction model obtained in the smoothing step:

$$smooth(x_{t+1}) = \frac{2-\alpha}{1-\alpha} S_t^{(1)} - \frac{1}{1-\alpha} S_t^{(2)} \tag{10}$$

When the emotional expression of students' works is inaccurate, the system can give corresponding suggestions to help students improve their design. Through this adaptive learning method, students can better master the emotional expression skills of product packaging design. Through this model, designers can better understand consumers' emotional needs for products, so as to better design product packaging. Moreover, consumers can also understand the emotional information conveyed by different product packages through this model, so as to better choose the products that suit them.

The packaging CAD design based on image emotion recognition is a complex process, which needs to combine the knowledge of computer technology, artificial intelligence and psychology. By implementing and optimizing the corresponding algorithm, designers can better understand consumers' feelings about product packaging and provide more valuable feedback and suggestions, thus improving the design effect and market benefit of product packaging. In the next section, the performance of the algorithm will be simulated and tested.

4 RESULT ANALYSIS AND DISCUSSION

The purpose of the experiment is to assess the effectiveness and superiority of packaging CAD design method based on GA. The experimental environment includes a graphic design teaching laboratory and a development environment equipped with high-performance computers and related software. During the experiment, a variety of image processing technologies and machine learning algorithms are adopted to realize the emotional semantic recognition and design of product packaging images. Moreover, the experiment also involves the investigation and interview of students and designers to understand their acceptance of the new system and the practical application effect.

In the experiment, a large number of product packaging images are used as training data sets, and the corresponding emotional labels of each image are determined by labeling. The convergence trend of the algorithm is shown in Figure 4.

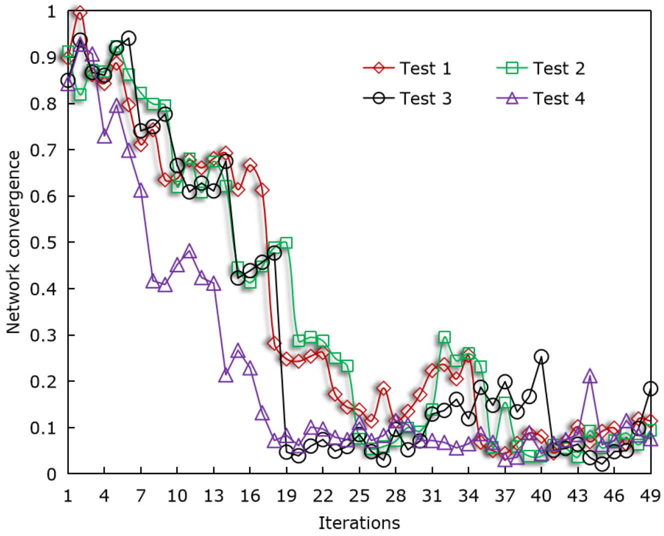

Figure 4: Convergence trend of algorithm.

After about 19 iterations, the output error of the algorithm has converged to a relatively ideal level. This means that the model in this article can learn effective feature representation from the training data and be used to generate packaging design corresponding to emotional semantics.

In the experiment, by simulating the stage of natural selection and gene mutation, the best combination method is selected from the bottom features. This process can not only improve the accuracy of the model, but also reduce the complexity of the model and improve the interpretability of the model. The packaging CAD design method based on GA proposed in this article has shown excellent performance in both training set and experimental set. The accuracy of different algorithms on training set and experimental set are shown in Figure 5 and Figure 6 respectively.

From the comparative experiments of different algorithms on training set and experimental set, it can be concluded that the accuracy of the algorithm in this article is about 90% in training set and 96% in experimental set. This means that the algorithm can effectively extract and understand emotional semantics from the underlying features, thus showing high accuracy in predicting emotions. This result also shows that the model in this article has good generalization performance, and can effectively deal with unseen packaging images and corresponding emotional labels.

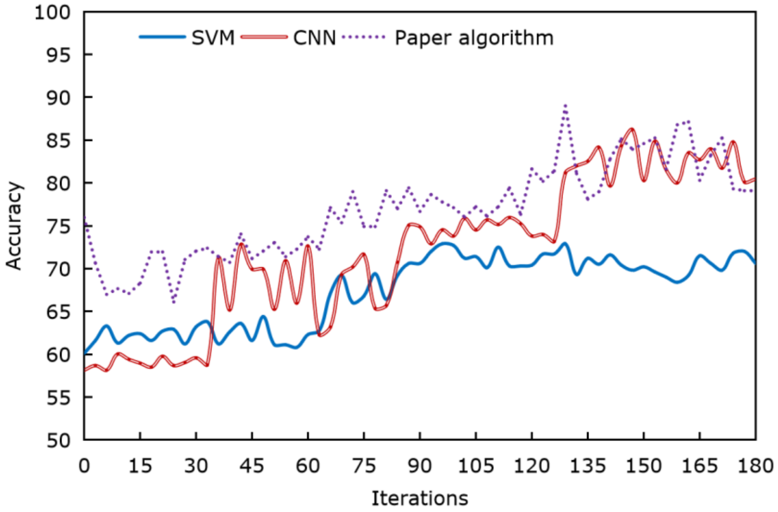

Figure 5: Accuracy of the algorithm on the training set.

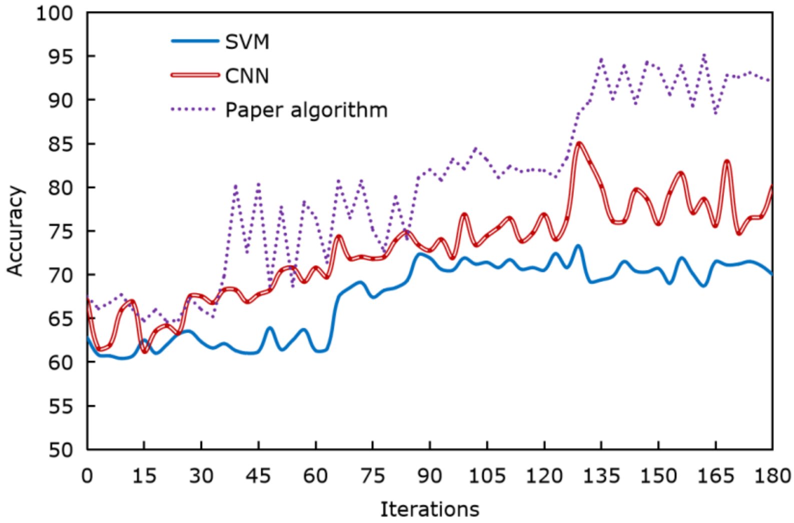

Figure 6: Accuracy of the algorithm on the experimental set.

Through the establishment of emotional semantic recognition mechanism, the bottom features correspond to the high-level emotional semantics. This process can help designers better understand the emotional needs of consumers and design on this basis. In addition, emotional semantic recognition can also provide designers with more specific feedback and suggestions to help them improve their design.

The research is devoted to building a system that can understand users' emotional needs and generate corresponding packaging design. In this article, GA is used to simulate the stage of natural selection and gene mutation, and from the bottom features, the corresponding relationship between the bottom features of the image and the high-level emotional semantics is created, and the emotional semantic recognition mechanism is established. This process fully considers the complexity and diversity of users' emotions, so the system can generate designs that are more in line with users' emotional needs. In the experiment, by letting students practice with the new system, we can know their acceptance and application effect of the system. Students generally believe that the new system can improve their design efficiency and emotional expression ability, and help them better understand the emotional needs of consumers. Figure 7 shows the subjective scoring results of product packaging CAD system in graphic design teaching.

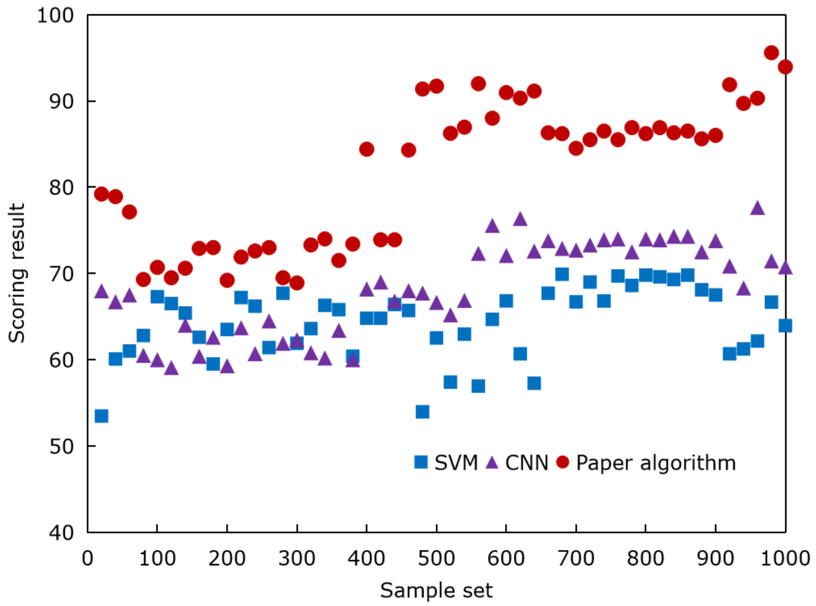

Figure 7: Subjective scoring results.

The comparison results in Figure 7 show that the product packaging CAD system constructed by this method has the highest subjective score, which is significantly higher than CNN method and SVM algorithm. The emotional feature input vector proposed in this article better reflects the emotional feature information of packaging images and improves the performance of packaging design system to some extent.

By introducing GA into product packaging design, it can provide designers with more scientific and accurate emotional identification support, thus improving the effect and quality of product packaging design. Through the emotional analysis of product packaging images, designers can better understand the emotional tendency of consumers for different packaging designs, thus providing designers with more valuable feedback and suggestions. Moreover, packaging CAD design based on image emotion recognition can also help enterprises to improve and optimize packaging, so as to improve the market share and sales efficiency of products. Moreover, this method can also provide a new idea and method for the field of emotion recognition, and promote the development and application of emotion recognition technology. In graphic design teaching, this method can improve students' design thinking and practical ability, and improve the teaching effect and quality of product packaging design.

5 CONCLUSIONS

In graphic design teaching, this method can improve students' design thinking and practical ability, and improve the teaching effect and quality of product packaging design. This article presents a packaging CAD design method based on GA. Based on GA, this method simulates the stage of natural selection and gene mutation from the bottom features to create the corresponding relationship between the bottom features of the image and the high-level emotional semantics.

Simulation results show that the accuracy of this algorithm is about 90% in the training set and 96% in the experimental set. This means that the algorithm can effectively extract and understand emotional semantics from the underlying features, thus showing high accuracy in predicting emotions. The subjective assessment results show that the product packaging CAD system constructed by this method has the highest subjective score, which is significantly higher than CNN method and SVM algorithm. In the future research, more data sets can be considered for testing to further assess the generalization performance and stability of the model. In addition, we can try to optimize the model, such as adjusting parameters, introducing more features or adopting more advanced machine learning algorithms to further improve the accuracy of the model.

In the future research, more data sets can be considered for testing to further assess the generalization performance and stability of the model. In addition, we can try to optimize the model, such as adjusting parameters, introducing more features or adopting more advanced machine learning algorithms to further improve the accuracy of the model. With the continuous optimization and improvement of the system, it will play a greater role in practical teaching and commercial applications, and provide better services and experiences for designers and consumers.

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