



## Innovative Application and Effect Evaluation of CAD and Deep Learning in Brand Packaging Design

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**Abstract.** With the growth of the social economy, the quality of life is gradually increasing, and consumers' standards for brand design and packaging are more distinctive. Against this background, this paper studies the innovative application of brand packaging design based on CAD technology and deep learning algorithms and evaluates and analyzes its application effect. Firstly, the development process of CAD technology and deep learning algorithms is described. CAD technology is used to analyze the brand design style from the data layer and establish a 3D visual model. On this basis, the texture information in packaging design is extracted, and the relevant values are dynamically changed in CAD software. Finally, the deep learning algorithm is used to optimize the packaging design further. Image fusion is used to improve the resolution and matching effect of packaging design patterns. The features related to packaging design in big data are extracted by algorithms to achieve innovative design goals. The research results show that CAD computer-aided and deep learning technology can make innovative design styles play a good application effect in brand packaging design so that modern design style is more popular.

**Keywords:** CAD Technology; Deep Learning Algorithm; Brand Packaging Design; Innovative Application; Three-Dimensional Modeling

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### 1 INTRODUCTION

The concept of interactive experience, as a product of modern economic, social, and industrial development, has gradually penetrated various fields, especially playing a crucial role in brand building and consumer communication [1]. Brand packaging design, as an important component of a brand visual recognition system, is not only aimed at protecting products but also a key tool for conveying brand information, shaping brand image, and triggering emotional resonance among consumers. In brand packaging design, the application of interactive experience not only enriches the communication between the brand and consumers but also greatly enhances the attractiveness of the brand and the emotional connection of consumers [2]. Therefore, incorporating the concept of

interactive experience into brand packaging design has become a new trend. Secondly, utilizing modern technological means such as QR codes RFID, etc., to achieve digital interaction between consumers and packaging. For example, designing interesting opening methods, and reusable or deformable packaging, allows consumers to have a pleasant experience and memory while opening or using the product. With the diversification and personalization of consumer demands, traditional and static packaging designs are no longer able to meet the needs of modern consumers [3]. Consumers can scan the QR code on the packaging to obtain product details, usage methods, and promotional information, and even interact with the brand online, share usage experiences, participate in brand activities, and more. In addition, brand packaging design can also be combined with social media activities to enhance brand awareness and reputation through interactive marketing both online and offline. This digital interaction not only enhances brand interactivity but also increases consumer engagement and sense of belonging [4]. The application of interactive experience in brand packaging design can be explored from multiple aspects. Firstly, through innovative packaging structures and materials, physical interaction between consumers and packaging can be achieved. The digital age, as the cultural background of the current spiritual needs, puts forward new requirements for brand and design. Therefore, the development of brand packaging needs to provide more diversified and diverse design works with visual aesthetics and comprehensive functions from the perspective of customers [5]. The brand market consumer environment and marketing ideas are changing with each passing day, and many brand companies have begun to redefine the concept of packaging. Its packaging function is not only the simple placement of goods but also involves the innovation and change of visual aesthetic level. The packaging style, like the brand, needs to have a distinct personality. As traditional culture and the concept of inheriting Chinese style becomes more popular, the brand design concept of Chinese cultural products is also more abundant, and the country's soft power can directly enhance its international influence. Through the innovative application of brand packaging design, national culture can be carried forward, and the combination of intelligent technology in the context of confident strategy presents a vigorous development trend [6]. Consumers understand the cultural connotation through the visual symbols and marketing means provided by the brand, and packaging is the most intuitive expression of the concentration of brand culture. Packaging design exists for brand products and has a direct interaction with consumers. At the same time, the packaging style and style are also the links that cannot be ignored when the masses buy products. Different packaging styles also bring different brand influence, which plays a key role in consumers' cognition of brand culture.

In tea packaging design, the application of social semiotics can help designers deeply understand the meaning behind specific cultural symbols and elements, as well as how they resonate with consumers. Interactive packaging design is based on this idea, which establishes a new way of communication between people and packaging, allowing consumers to participate and experience products more deeply [7]. Taking tea packaging as an example, symbols such as dragon, phoenix, and cloud, as well as colours such as red and gold, are not only decorative elements but also carry profound cultural connotations. In tea packaging design, the use of visual analysis methods can help designers analyze the impact of different design styles on consumer visual perception and purchasing behaviour. By combining social semiotics and visual analysis methods, brand packaging design can better convey cultural and emotional significance, thereby influencing consumers' perception of product brand image and quality [8]. At the same time, visual analysis methods also provide strong support for brand packaging design. The study emphasizes the influence of visual elements such as form, colour, and texture on the audience's psychological and emotional responses. For example, simple and vivid packaging designs may be more likely to attract the attention of young consumers, while complex and exquisite designs may be more appealing to elderly consumers who pursue quality and tradition. In the modern consumer terminal market, the emotional experience gained by users in product packaging has become a key factor. This requires brand packaging design to not only focus on the beauty and uniqueness of the appearance but also pay attention to the emotional connection with consumers. These elements and colours represent noble, elegant, and ancient traditions in traditional Chinese culture. When cleverly integrated into tea packaging design, they can effectively convey the high quality and profound historical heritage of tea brands [9]. This is crucial for designers

as they need to have a deep understanding of consumer needs and preferences, creating packaging designs that are both attractive and impactful. Sociosemiotic methods play a crucial role in brand packaging design, delving into how culture influences visual expression and meaning, particularly in shaping and conveying the image, quality, and historical significance of tea brands [10].

From the perspective of the new era, product packaging should not only show its own functionality but also highlight the product's own attributes and brand image. This design concept runs through the whole life cycle of brand development. With the purpose of attracting target consumers, text, pattern and other style means are used to spread brand culture and effectively convey the dominant information of the brand. Through the packaging style and design scheme, the brand's own unique concept is transmitted to the public, so the packaging has the role of marketing. Therefore, in the design innovation, we should pay attention to the visual image, so as to clearly distinguish the standard from the peer competitors. Expand the contrast between brand products and highlight the unique quality of products. With the concept of green and ecological environmental protection becoming a new regulation in the market packaging design, packaging materials and design styles need to be green and environmental protection at the core. This also marks the need for an overall reform of corporate brand design in terms of material selection, structure and form. The specific analysis of different configurations of brand resources, in the packaging design scheme, and choosing the design method suitable for brand products, can further show the distinctive characteristics of the brand. Therefore, the requirements for designers are getting higher and higher. Designers should not only consider the needs of brand packaging design but also update and optimize it in combination with modern technology. So that it can meet the environmental protection innovation concept and the diversified development of the brand, to improve the application effect. As modern life is deeply rooted in the hearts of the people, each group has its own consumption pattern and aesthetic characteristics. Different values also show the epochal nature of cultural orientation. In the innovation of packaging design, it is necessary to pay attention to the experience of the masses and shift from a single functional configuration to diversified aesthetic needs. The unique packaging design style allows consumers to closely connect with the products in the purchase process, giving more value to the brand. Therefore, this paper explores the innovative application of brand packaging design under CAD technology and deep learning algorithm and finally evaluates the effect of the innovative brand design style in practical application.

## 2 DEVELOPMENT STATUS OF CAD TECHNOLOGY AND DEEP LEARNING ALGORITHM

Brand packaging semi-structured interviews are an efficient and targeted interview method aimed at revealing consumers' true views, motivations, expectations, needs, and preferences toward brand packaging. In semi-structured interviews, Pelliccia et al. [11] will guide respondents to share their perspectives based on a predetermined question framework. Based on the above information, brands can provide more targeted suggestions for packaging design. For example, optimizing the appearance and materials of packaging based on consumer expectations and needs to enhance its practicality and functionality. Based on the innovative perspective of consumers, introduce new design elements and concepts to create more creative and attractive brand packaging. This interview method not only provides a window for brands to understand consumer psychology deeply but also provides a strong basis for the improvement and innovation of brand packaging design. But at the same time, Saleh et al. [12] flexibly adjusted questions based on real-time feedback from interviewees to ensure the depth and comprehensiveness of interview content. By using renewable and environmentally friendly materials, reducing waste and pollution, reflecting ecological aesthetics, emphasizing sustainability, and promoting recycling, brands can create packaging designs that are both aesthetically pleasing and environmentally friendly, thereby conveying their respect and protection for nature and the environment. Based on the emotional connection between brands and consumers, emotional communication and interaction between brands and consumers are strengthened. Meanwhile, as consumers continue to pay attention to environmental protection and sustainable development, brand packaging also needs to pay more attention to environmental protection and sustainable development. In summary, semi-structured interviews on brand

packaging are an effective research method that can help brands gain a deeper understanding of consumer opinions and needs, providing strong support for the improvement and innovation of brand packaging design. Meanwhile, with the popularization of environmental protection and sustainable development concepts, brands also need to pay more attention to the application of environmental protection and sustainability in packaging design, in order to shape a more attractive and influential brand image.

According to the relevant data survey, some brand companies with special consumers for children have made reasonable changes to the relevant beverage packaging. This independent packaging is based on the design of children, grasping the characteristics of children like new things, and the use of packaging products to establish a connection with children. Designers found that children in the process of playing, learning, and exploring new things, unique structural packaging design can attract their attention. At the same time, the shape of this packaging product is very pressure-resistant, and the product quality is more in line with the use habits of children. This entertaining packaging design creates a huge opportunity for brands in terms of unique shape and experience. In addition, there are some food brands that pay attention to the combination of structural materials and vision in packaging design. The appearance of the packaging highlights the characteristics of the product, so that the food becomes more attractive, this packaging is easy to store and place, and is a popular product in major convenience stores. In the above packaging design, CAD computer-aided rendering and deep learning algorithms are applied to realize the process of image processing and reorganization.

In brand packaging design practice, Shepherd and Fitzsimons [13] use professional annotation tools to accurately annotate 3D mapping planes, allowing designers to express design intentions and packaging details in more detail. Professional data conversion and transmission tools can greatly reduce errors in manual operations and improve design efficiency. To ensure the integrity and accuracy of data, universal data formats should be used for conversion and transmission. This type of annotation not only facilitates effective communication between internal teams, but Shukla et al. [14] ensures accurate information transmission with suppliers or manufacturers. In the process of brand packaging design, data transmission between different design software is an important link. The packaging design should not only be aesthetically pleasing but also meet the functional requirements of the product, as well as the aesthetic and practical requirements of consumers. When designing packaging, brands should comprehensively consider various factors such as product characteristics, market demand, environmental requirements, and brand tone. When purchasing in physical stores, consumers can personally experience the packaging texture and user experience of the product. Exquisite packaging design and high-quality packaging materials can enhance consumer confidence and willingness to purchase products. Digital marketing can also provide timely after-sales service support. Through social media and other platforms, brands can quickly respond to consumer issues and concerns, and address after-sales issues. This timely interaction can enhance consumer trust and loyalty to the brand, and promote the spread of brand reputation. Yang et al. [15] provide personalized solutions for packaging design by collecting and analyzing consumer data. Brands can discover new market opportunities and design inspiration, and this transparent information display helps consumers make wiser decisions before making a purchase and improves the shopping experience. Using professional packaging design software for design can ensure the accuracy and completeness of data during the design process, thereby improving the overall quality of brand packaging. In addition, physical stores can also provide personalized packaging services to meet the special needs of consumers and further enhance the shopping experience.

### **3 RESEARCH ON INNOVATIVE APPLICATIONS AND EFFECT EVALUATION**

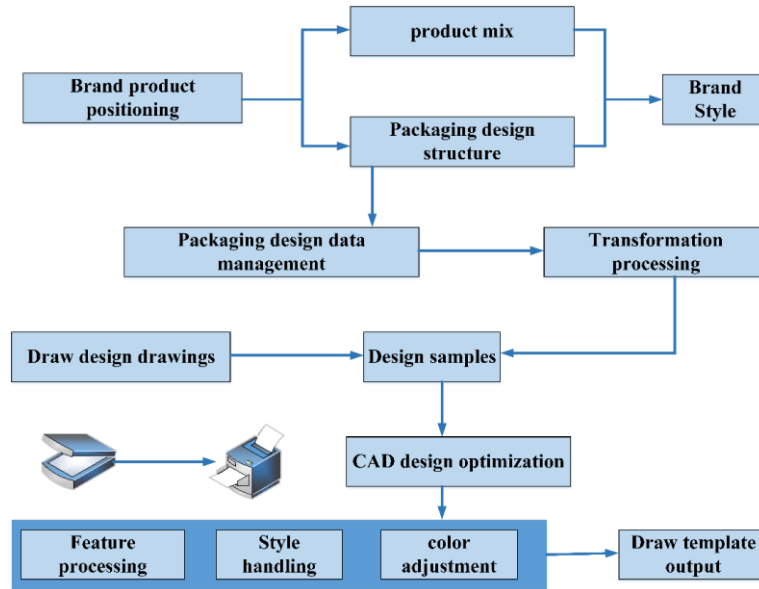
#### **3.1 Brand Packaging Design Based on CAD**

CAD technology originated in the 1950s, from the very beginning of the processing of surface modelling and three-dimensional images, experiencing the updating process of parameterization and variable quantization. Nowadays, various 3D modelling synchronization technologies meet more

design requirements. It can use the powerful computing power of computers to serve designers in any field and improve the work efficiency and ability of designers. The use of CAD technology can not only improve the product design effect and speed but also reduce the cost of the entire design process. More and more enterprises are beginning to pay attention to the use of CAD technology to optimize the design process. American researchers have also applied CAD technology in the military field, establishing CAD operation models from the system, and users can complete the drawing of the target on the screen with strokes. Subsequently, with the birth of two-dimensional and three-dimensional drawing systems, CAD parameter modelling also made graphic processing more convenient. Deep learning uses its own good training data effect and has excellent results in image recognition, speech recognition, image processing, and other aspects. In the current development process, the combination of deep learning and network structure can improve the efficiency of complex problem processing. The purpose of multi-feature and co-processing is achieved by increasing the number of network layers. The more network layers, the more complex the processing structure and task. In the field of deep learning today, research results have surpassed the vast majority of machine learning networks, and its development in artificial intelligence is also more prominent. The deep learning algorithm itself optimizes the feature samples in the model calculation through continuous iterative training so as to get closer to the generation requirements of the real data set. Japanese scholars have applied the core technology of deep learning algorithms to home robots. The home robot they designed can not only meet daily cleaning and functional tasks but also complete autonomous learning and simulation training to improve the authenticity of interaction with users. To sum up, the development of CAD technology and deep learning algorithms has promoted progress in the design field towards innovation. The cost of traditional packaging design is too high to be popularized in small design enterprises. The application of this high and new technology has created new opportunities for the packaging design industry. In the era of brand marketing, only by focusing on the shaping of brand image can we gain development advantages in the market competition. Through innovation, brand packaging design can really contribute to the improvement of packaging quality and gain the welcome of consumers in the market. First of all, the brand packaging design needs to be clear about the main objectives. Control the fit degree of packaging design style and brand culture, and rationally develop the direction of packaging design. Choose the logo that conforms to the brand concept as the packaging design idea, so that consumers really understand the brand information. Secondly, in the design process, the packaging appearance needs to fully present the brand content. Consumers can understand the specific content of the product for the first time, which is conducive to the brand product in the market consumer group identification. Finally, the packaging design style should fully show the personalized characteristics of the brand, combine the brand positioning and the pursuit of their own, and strictly formulate the packaging design standards. Integration of environmental protection concept, the use of simple design, complex presentation mode, improve packaging quality.

At present, with the continuous development of computer and drawing software, more and more image processing and drawing are widely used in the field of design. This software features image editing, colour synthesis, special effects production and more, with the help of powerful layer templates to design a variety of visual effects. CAD software is a common tool in computer-aided drawing. It has powerful functions and good performance, not only can realize 3D visual modelling but also can dynamically adjust the design parameters in the design process. This paper briefly analyzes the application process of CAD drawing software in packaging design innovation, as shown in Figure 1.

As can be seen from Figure 1, the first step is to analyze the brand product positioning and manage the design data by determining the product structure and brand style selection. Through image transformation and style processing in CAD software, we try to generate new packaging samples. After feature analysis, colour adjustment, 3D modelling, and other links, the final drawing of the design draft and layout data. Therefore, the application of computer-aided drawing technology in packaging design can improve the efficiency and quality of designed products and can also effectively supplement the shortcomings of traditional manual packaging design.



**Figure 1:** The application process of CAD drawing software in packaging design innovation.

In the innovation of brand packaging design, the geometric information of packaging is formed by combining the results of digitization and feature collection. The edge and corner coordinates of the packaging pattern are extracted, and the two-dimensional output results of the design image are displayed in the three-dimensional space. Connect the relevant feature points of packaging design style and build the geometric model after brand design innovation. On this basis, the formulas involved in 3D modelling are as follows:

$$A=A_0 - K[\lambda_1(a - a) + \theta_0(b - b) + \varpi_1(c - c)] \quad (1)$$

$$B=B_0 - K[\lambda_2(a - a_r) + \theta_1(b - b_r) + \varpi_2(c - c_r)] \quad (2)$$

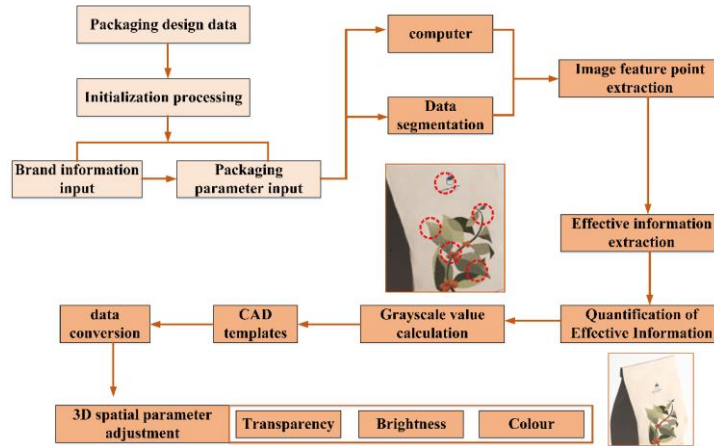
Among them,  $A$  Represents the plane coordinates for extracting packaging design style and related information.  $B$  Represents the spatial coordinates after 3D modelling. Considering that the brand packaging design is usually in a static state, we use the mapped image to obtain the relevant texture features and the digital surface model. The digital model is combined with the two-dimensional image to build a complete three-dimensional visual packaging design. The application process of CAD technology in the visual 3D modelling of the entire packaging design is shown in Figure 2.

As can be seen from Figure 2, in the CAD packaging design template, data is pre-processed and information related to brand packaging design is input to complete the initial graphic establishment. The useful feature points are obtained by calculating and dividing the data. Then in the feature processing, the effective information is quantized, and the gray value is calculated. Finally, the data input is completed in the design drawing presentation template, the two-dimensional plane information is reorganized in the three-dimensional space, the grey value, transparency, colour, and other related information is adjusted, and the innovative design image is output.

### 3.2 Effect of Brand Packaging Pattern Processing Innovative Design

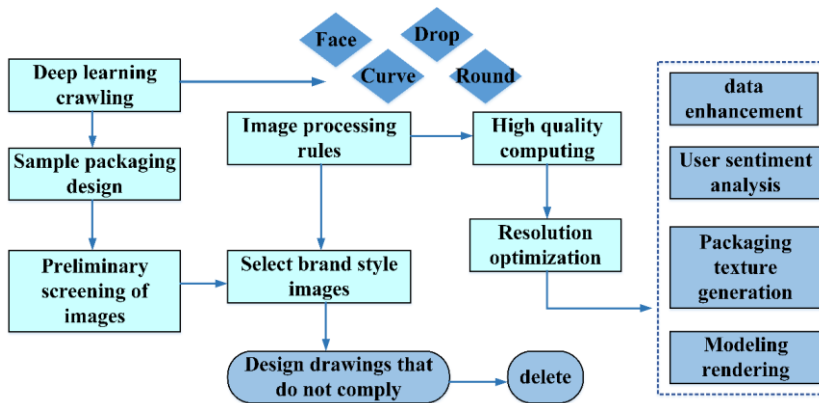
Innovation in brand packaging design: to use scientific means to position brand packaging accurately, designers need to start with innovative thinking and understand the needs of brand goods in order to complete targeted design in all aspects. In addition, the brand packaging design should be combined with the purchasing tendency of consumers, and a wider audience design scheme should be adopted for different groups.





**Figure 2:** CAD technology for packaging design visualization and 3D modelling.

In the process of brand packaging design, it is necessary to give the consumer group a clear understanding of the product content and the brand's connotation and culture. In the design direction, it is necessary to have a beautiful effect, use rich colours, and simple lines, and present a good brand image for consumers. Brand packaging design fully attaches importance to the innovative application of various elements and patterns, the use of conventional graphics, and text coordination, which affect these comprehensive elements to achieve the role of commodity promotion. It can be seen that the innovative development of brand packaging is an inevitable trend in the design field, and branding drives packaging design to improve its own standards further and shape the influence of the brand itself from an innovative perspective. In this study, the deep learning algorithm is used to study pattern innovation and generation in brand packaging design. The processing process of image screening and rendering design is shown in Figure 3.



**Figure 3:** Image filtering and rendering design processing process.

As can be seen from Figure 3, deep learning is used to crawl most of the packaging design samples on the network and extract relevant features. After preliminary screening, the design style suitable for the brand is selected. Data enhancement, perceptual analysis, image rendering, and other steps are used to generate the final packaging design. Due to the randomness of different packaging design angles, there are different degrees of visual differences between images. We use the method of image Mosaic to deal with the interaction between different patterns. The quality of traditional

artificial feature extraction algorithms is poor, and it is difficult to obtain good-quality feature information. Deep learning algorithms can learn abstract and process complex features from the perspective of original data by training its model and using a multi-level structure. Excellent performance in image recombination, text analysis, pattern recognition and so on. According to the mapping principle of graphics and patterns, the two-dimensional plane is projected and transformed, and the three-dimensional matrix formula formed at this time is as follows:

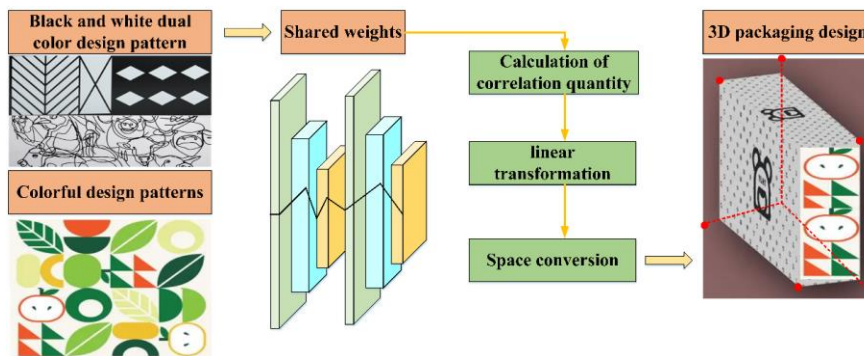
$$H = \begin{bmatrix} h_{00}, h_{01}, h_{02} \\ h_{10}, h_{11}, h_{12} \\ h_{20}, h_{21}, h_{22} \end{bmatrix} \quad (3)$$

In general, in matrix solving, there is a homologous change process for variables of different degrees of freedom, which can be defined as:

$$h_1 = \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} \quad (4)$$

$$H_r = \begin{bmatrix} h_{00}, h_{01}, h_{02} \\ h_{10}, h_{11}, h_{12} \\ h_{20}, h_{21}, h_{22} \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}_r \quad (5)$$

Integrate relevant elements in brand packaging design and align them with innovative images using a homologous matrix. Then the fine coordinates in the matrix are obtained by deep learning neural network. Through supervised learning, the image is reconstructed in three-dimensional space, and the multi-modal features of the design works are extracted to obtain better design results. The reconstituted images under different viewing angles may be deformed in a small range, resulting in an unsatisfactory stitching effect of the packaging design. In order to solve this problem, we added neural network optimization training on the basis of deep learning, and fused the patterns in line with the brand packaging design for color images, as an input to make the packaging design image structure more obvious. The transformation process of packaging design style generated by the unsupervised transformation of network structure by deep learning algorithm is shown in Figure 4.



**Figure 4:** The process of packaging design style transformation.

As can be seen from Figure 4, design images with different colour combinations and pattern splicing are added to the calculation of shared weights. According to the global iteration and related feature calculation, the space transformation on the linear transformation is completed. Finally, the output of packaging design images is realized. After multi-level processing of the data after sharing features extraction, the similarity of design styles can be calculated as follows:



$$CV(x_0) = F(X), F(B)(x_2) \quad (6)$$

$$CV'(x_1) = F(A), F(x_0)(x_1) / M + [D(X)_Y] \quad (7)$$

The formula,  $CV'$  Represents the position of the feature points in the pattern. A part of the design image is obtained through the front network. The feature matches are labelled as the same data, and the relationship between them can be expressed by the formula:

$$\begin{bmatrix} U \\ V \\ 1 \end{bmatrix} = H \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}_{x+y+z} \quad (8)$$

In the deep learning neural structure, the change of each neural unit has an important effect on the parameters. The weight between the connected moulding unit and the data is expressed as:

$$Net = \sum_{i=1}^n w_1 * x_i \quad (9)$$

$$y_j = f(Net - 0)_{i+j} \quad (10)$$

After activation function threshold processing, the output result of the algorithm is normalized and screened, and the output is as follows:

$$y = f(o) = \begin{cases} 1, \delta > 0 \\ 0, \delta < 0 \end{cases} \quad (11)$$

Function definition reorganization:

$$G_0 = \arg \min G + d + [\lambda(x)^2] \quad (12)$$

In order to expand deep learning to create new style changes in brand packaging design, we need to use centralized discriminators to make design performance better. Due to the prominent common characteristics of design styles, we calculated the loss function generated in the generation process in the neural network:

$$L(G, D, X, Y) = IE_{y-pdata} [(D(y) - 1)] \quad (13)$$

$$M = \max[(1 - D)(g(X))^2] \quad (14)$$

The formula, Represents the loss function value. According to the calculation of the loss function, the similarity between the packaging design styles can be judged. After initializing the parameters, Multiple real picture samples are extracted in each design training and iteration to reduce the impact of noise on the authenticity of samples:

$$V = \frac{1}{m} \sum_{i=1}^m \log D(x)^2 \quad (15)$$

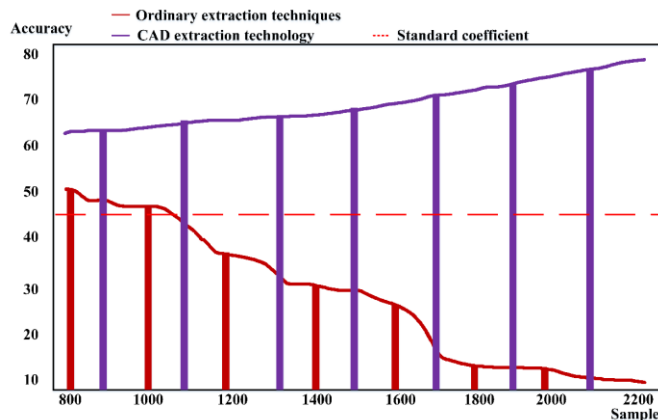
Through the above calculation, when the real sample is imported into the deep learning brand packaging design generation model. After the grey value and brightness, colour rendering. Make the brand packaging design style more distinctive, with personalized characteristics.

## 4 RESEARCH RESULT ANALYSIS

### 4.1 Analysis of Research Results

The innovation process of brand packaging design needs to pay full attention to the consumer's consumption experience, which is also an inevitable factor for the success of packaging design. Take the audience as the centre of packaging design, consider the needs of packaging design from the perspective of buyers, fully recognize the concept of sustainable packaging design, and the

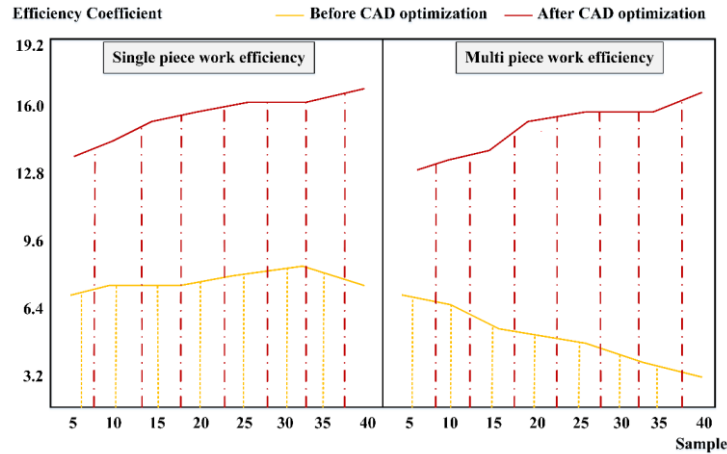
construction and development of brands. Designers need to in-depth analysis of consumer psychology and the use of high-tech and intelligent means so that the brand packaging style is more in line with modern people's aesthetics. In this paper, CAD technology is used as a common tool software, combined with a virtual platform to form a 3D modelling system. Extract different pattern characteristics in brand packaging design as reference elements. Most of these reference elements refer to the points, faces or lines of the brand packaging shape, on which the reference elements are entered as data for the 3D model. The accuracy changes of elements extracted by ordinary extraction and elements extracted by CAD technology are shown in Figure 5.



**Figure 5:** Changes in the accuracy of ordinary element extraction and element extraction using CAD technology.

The horizontal axis in Figure 5 represents the number of samples. This refers to the number of packaging design pattern samples used to extract pattern features from brand packaging design. As the number of samples increases, we can observe how the accuracy of extraction techniques changes. The vertical axis represents the extraction accuracy or precision. This is an indicator that measures the degree of matching between reference elements (such as points, surfaces, and lines) in the extraction process and the actual brand packaging design pattern features. The higher the extraction accuracy, the closer the extracted elements are to the original design pattern and the smaller the error.

The ordinary extraction technique curve shows the accuracy changes when extracting brand packaging design pattern features using traditional or ordinary methods. As the number of samples increases, the accuracy of ordinary extraction techniques is relatively low and may be affected by dynamic sample size or other factors, resulting in significant fluctuations in accuracy. The curve of CAD extraction technology shows the accuracy changes when using CAD technology to extract features of brand packaging design patterns. The precision of CAD technology enables it to more accurately capture the details of design patterns. As the number of samples increases, the accuracy of CAD extraction technology remains stable and above the standard range, indicating that CAD technology can maintain high accuracy when processing different numbers of samples. The standard coefficient accuracy line represents the minimum acceptable accuracy standard commonly considered in the industry or research. If the accuracy of the extraction technique is higher than this line, it is considered that the technique has sufficient accuracy. From the figure, it can be seen that the accuracy of CAD extraction technology is much higher than this standard, indicating its high application value in element extraction in brand packaging design. The work efficiency changes of brand packaging design generation before and after CAD optimization are compared, as shown in Figure 6.



**Figure 6:** Changes in work efficiency before and after CAD optimization.

The horizontal axis usually represents the passage of time or a certain stage in the workflow. In Figure 6, the horizontal axis represents the number of samples generated by brand packaging design. It represents different stages of a single design project or a comparison of multiple design projects conducted at different points in time. The vertical axis represents work efficiency. In Figure 6, work efficiency may be measured by the number of designs completed per unit time, the reduction in completion time for individual design projects, and the proportion of error rate reduction. Here it is mentioned that "single piece work efficiency can be improved by more than 50%", so the vertical axis may more specifically represent the percentage reduction in time required to complete a single design task, or the increase in the number of design tasks completed within the same time. The pre-optimization curve represents the efficiency of brand packaging design generation before using CAD optimization tools. It displays a relatively gentle slope, indicating that the efficiency improvement during the design process is not significant or there are bottlenecks. The curve after CAD optimization shows that the efficiency of brand packaging design generation has significantly improved after using CAD optimization tools. From the graph, it can be seen that the slope of the curve is steeper, indicating a significant improvement in work efficiency. Especially when it is mentioned that "the efficiency of a single piece can be improved by more than 50%", this curve will have a significant jump or rise after a specific point (possibly the time point when CAD optimization is introduced).

## 4.2 Evaluation Result Analysis

The concept of packaging design changes people's lives, and the rapid development of modern life and economic levels will inevitably impact people's cognition of packaging design. At the same time, the innovation of packaging design will also lead to the prosperity of the brand, and play a positive role in the fields of clothing, automobiles, and construction. Therefore, packaging designers need to grasp the lifeblood of The Times and complete the innovation of design works under high-tech. In addition to using CAD technology to complete the 3D modelling of brand packaging design, we also use deep learning to further improve the quality of packaging design. Deep learning is used to extract different style features in packaging design and add them to the training model for system optimization. In order to further verify the effectiveness of the algorithm, we randomly sample the innovative brand packaging design. Compare the changes in the design image resolution before and after using the depth algorithm, as shown in Figure 7. The horizontal axis in Figure 7 represents different data points or samples. In this scenario, they may represent different brand packaging design patterns, or design images at different stages of the processing. Due to the random sampling

conducted here, the data points on the horizontal axis may represent a randomly selected sample of innovative brand packaging design.

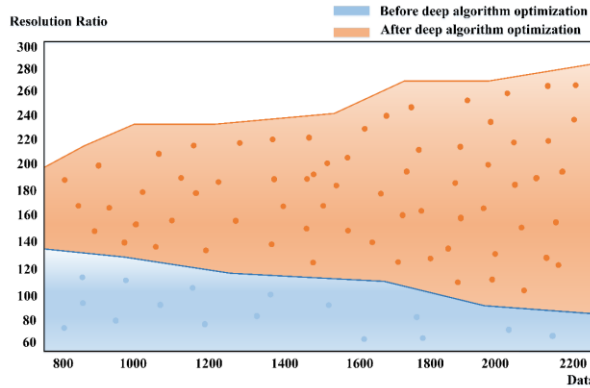


Figure 7: Changes in image resolution before and after algorithm optimization.

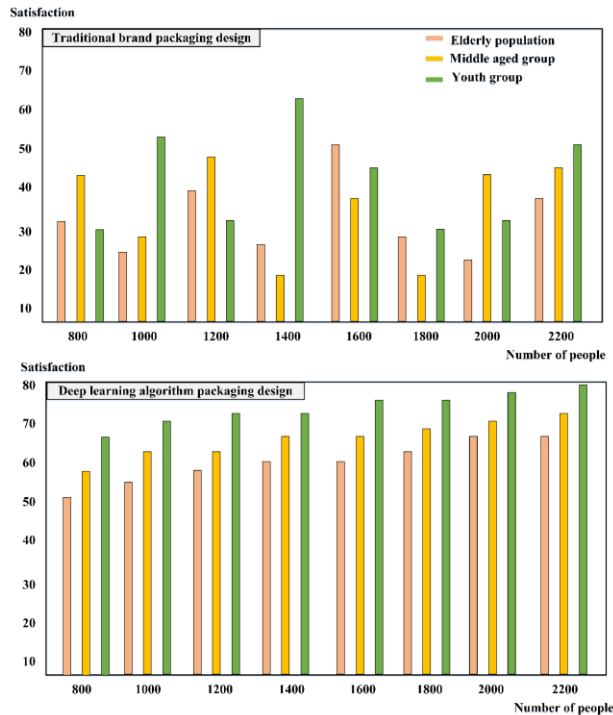


Figure 8: Satisfaction of different groups with brand packaging design innovation before and after.

The vertical axis represents the resolution of the image. Resolution is an important indicator of image quality, representing the number of pixels per unit length in an image. The curve before algorithm optimization shows the resolution of brand packaging design images before using deep learning algorithms for optimization. Due to technical limitations or traditional processing methods, the resolution of these images may be relatively low, resulting in unclear design details. The optimized algorithm curve shows that after using deep learning algorithms for optimization, the resolution of

brand packaging design images has significantly improved. Deep learning algorithms can automatically learn and extract key features from images, and improve image resolution through optimization algorithms. Therefore, the optimized image has shown significant improvements in both detail and clarity. Through a questionnaire survey, different groups' satisfaction with brand packaging design innovation was explored, as shown in Figure 8.

The horizontal axis represents different groups, specifically the elderly, middle-aged, and young. The vertical axis represents the level of satisfaction, which is a quantitative indicator used to measure the satisfaction of different groups with brand packaging design innovation. In the figure, the bar chart on the left or bottom may represent the satisfaction level of traditional brand packaging design. The height of these bar charts reflects the satisfaction level of different groups with traditional design. From the description, it can be inferred that the heights of these bar charts may be relatively close, indicating that the satisfaction changes of different groups with traditional designs are relatively unstable and lack certain regularity. In the graph, the bar chart on the right or top represents the satisfaction level of innovative design styles optimized through deep learning algorithms. The height of these bar charts is generally higher than that of traditional design bars, indicating that the majority of the population is more satisfied with innovative design styles. Through the comparison in Figure 8, it is clear that different groups are much more satisfied with brand packaging design innovation than traditional design. This proves that deep learning algorithms have significant effects in optimizing brand packaging design. Not only does it enhance the innovation and attractiveness of the design, but it also meets the needs and preferences of consumers of different age groups.

## 5 CONCLUSIONS

In the process of social development, brand packaging design has become a more important industry. The innovative development of packaging design is not only a trend in the future but also a practical process of innovative ideas. Through different packaging styles, brand products complete market competition, not only promoting their own development but also improving the feedback effect of brand image in the masses. Therefore, under the above background, this paper uses CAD and deep learning technology to explore the innovative application of brand packaging design. First of all, from the perspective of the development of CAD technology and deep learning technology, it is combined with pattern design, graphic reorganization, and feature recognition, and applied in the process of packaging design innovation. Using CAD technology to complete the image recombination, in the case of improving the resolution of the design image, complete the three-dimensional modelling. At the same time, the visualization effect of the design product is more realistic in the three-dimensional space. Secondly, using a deep learning algorithm to supervise the image training process can effectively avoid the accuracy reduction caused by noise in image feature extraction. Through the analysis of shape characteristics, the frame of different design styles is formed. The data set is imported into the neural network for training, and a large number of packaging design works are obtained. Finally, the brand packaging design style generated by CAD and deep learning algorithm is transferred and rendered. The application effect of high design works. A questionnaire was adopted to investigate and analyze the degree of consumer satisfaction. The research results show that CAD and deep learning algorithms have good innovation effects in brand packaging design, which can meet the needs of different groups for design styles and have high evaluation and satisfaction in practical applications.

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