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Research Article

Application of Convolutional Networks in Clothing Design from the Perspective of Deep Learning

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A convolutional neural network (CNN) is a machine learning method under supervised learning. It not only has the advantages of high fault tolerance and self-learning ability of other traditional neural networks but also has the advantages of weight sharing, automatic feature extraction, and the combination of the input image and network. It avoids the process of data reconstruction and feature extraction in traditional recognition algorithms. For example, as an unsupervised generation model, the convolutional confidence network (CCN) generated by the combination of convolutional neural network and confidence network has been successfully applied to face feature extraction.

1. Origin and Development of Convolutional Neural Network

With the development of society, people cannot process data with general statistical knowledge due to the increasing amount of data and the increasing number of dimensions; therefore, processing big data has become a significant problem we face. Machine learning can be divided into supervised learning and unsupervised learning. The core is to classify the characteristics of the data. It can be labeled as data characteristics and by the supervision of learning, these labels can be classified, thus achieving the purpose of feature classification, such as data feature if there is no label, and you can only rely on unsupervised learning to identify these features for clustering [1]. On the other hand, deep learning, commonly referred to by people, relates to machine learning through deep networks, namely multiple networks, such as convolutional neural networks (CNN). The concept of deep learning comes from the research of artificial neural networks, which is a method of data representation learning in machine learning. Deep learning has made breakthrough achievements in image classification, speech recognition, target detection, and other aspects in recent years, showing its excellent learning ability [2]. With the research's

deepening, the convolutional neural network structure is constantly optimized, and its application field is gradually extended. For example, Alibaba, Baidu, Google, and other companies are conducting deep learning research on speech recognition. And the use of face recognition, image search, and human behavior recognition is a reasonable prospect of technology. It can be used in medicine, biology, and other fields. Deep learning can also be divided into supervised and unsupervised learning.

CNN first originated in 1962. Biologists Hubel and Wiesel found that Ding is a cell that covers the whole visual well and is very sensitive to the local, visible input space area, called the receptive field. In 1980, Fukushima proposed a neocognitron with a similar structure based on the receptive field. Neocognitron is a self-organizing multilayer neural network model that can stimulate the upper layer's local receptive field to respond to each layer. At the same time, it is also the primary learning method for convolutional neural networks in early learning. Subsequently, Saad et al. proposed and designed the convolutional neural network LeNet-5 model for character recognition based on neocognitron [3]. The basic structure of LeNet-5 comprises an input layer, a revolutionary layer, a pooling layer, a complete connection layer, and an output layer. The system succeeded

in small-scale hand and number recognition but still has significant limitations. In 2012, CNN made a historic breakthrough. The emergence of alexnetu2 made CNN the core algorithm model in image classification. Compared with the traditional CNN model, Alexie improves the algorithm and realizes multi-GPU parallel computing. With the support of a large amount of data, the error rate of the top-5 is getting lower and lower, which has now reduced to about 3.5% [4]. Recently, GoogLeNet, with a deeper VGg structure and network in network structure, has emerged, and the emergence makes it possible to train hundreds or even thousands of neural networks.

2. Characteristics of Convolutional Neural Network

2.1. Local Perception Method. The local sensing method uses a convolutional neural network method to reduce the number of data parameters. From local cognition to global cognition is a method of people's understanding of the outside world, which is also applicable in image processing. The spatial connection of images is also closely related to the relationship of local pixels, but if the interval is far away, the relationship with spatial pixels is weak.

As in conventional neural networks, neurons in the input layer need to be connected to neurons in the hidden layer. But here, instead of connecting every input neuron to every hidden neuron, connections are created only in a local region of an image.

Therefore, each neuron on the convolutional neural network must only perceive it locally. Then the complete connection layer will comprehensively analyze and summarize the locally perceived parameter information to obtain the global information parameters.

The correlation between local pixels is strong and the correlation between distant pixels is weak. Inspired by the human visual reception system, visual neurons receive only local information, i.e., each neuron does not respond to the global. Our observation of the outside world is from local to global, not pixel by pixel but area by area, through which we get local information and then the aggregation of this local information before we get the global information. Assuming that each implicit layer neuron is constructed by perceiving only two input neurons. It can also be 3 or 4, which is mainly related to the size of the image and the size of the feature that we want to obtain.

2.2. Weight Sharing. Compared with the local sensing method, weight sharing has more significant advantages. The Lenet-5 model proposes the weight-sharing network. The Lenet-5 model proposes the weight-sharing network because of too many parameters. The weight-sharing network first simplifies the structure, then reduces the number of training parameters with more application space. This means that all neurons in the first hidden layer detect the same feature at different locations in the image. This mapping from the input layer to the hidden layer is also called feature mapping (or filters, kernels), because the weights are shared so that the

features are detected in the same way. The weights of this feature mapping are called shared weights, and its deviation is called shared bias.

For example, a neuron in a nerve needs 100 information parameters, so these 100 information parameters are equivalent to an extraction method and are independent of location [5]. A convolutional neural network can extract the corresponding features from these 100 parameters and then apply them to other parts of the image. Generally speaking, it is to randomly pull a small amount from a large-scale image to an image to extract a small amount from a large-scale painting randomly. Then the extracted small part can be learned to become a feature detector, which can be applied to any image. Then through convolution learning processing with the original image, different characteristic values at different positions in the original image can be obtained.

2.3. Multiconvolution Kernel. In the weight-sharing network, the local features extracted by observing the case cannot meet the requirements of image processing, so the help of a convolution kernel is needed. Each shared weight parameter is a convolution kernel, and multiple convolution kernels can solve this problem [6]. Each convolution kernel will generate an image after local feature extraction and weight sharing, and multiple convolution kernels will form various photos, which can be regarded as multiple channels. As shown in Figure 1, the process of convolution operation with four convolution kernels, that is, four channels, is offered. In this process, the convolution results on the four channels are added first, and then the value of the function is taken. The value obtained is the value of $W1$ and $W2$.

2.4. Model of the Convolutional Neural Network. Because of their high fault tolerance and nonlinear description ability, neural networks have been widely studied and applied, especially in pattern classification. Their primary classification mode of pattern classification is based on feature classification, so some features must be extracted before sorting. The classification model is shown in Figure 2. Samples are extracted from the input and required features F_1, F_2 ... F_n, then classifies to get the output.

A convolutional neural network is a feedforward neural network that can extract the topology structure from a two-dimensional image and use the backpropagation algorithm to optimize the network structure and solve the unknown parameters in the network. A convolutional neural network is often used to study two-dimensional image recognition problems. It only needs a small preprocessing; the recognition range is vast and can allow the image to change. The traditional classification model is shown in Figure 2. Firstly, the image should be input, and complex preprocessing is carried out to extract features. Then, the classification is done according to the extracted features, and the results are given at the output end. The difference between the classification model of a convolutional neural network and the traditional model is that it can directly input a two-dimensional image into the model and then give the classification result at the output end, as shown in Figure 3. Its advantage is that it does
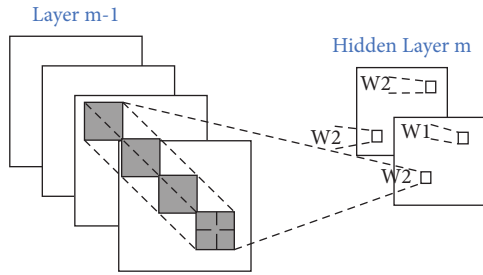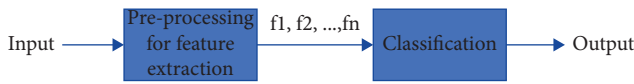
FIGURE 1: A multiconvolution kernel.

FIGURE 2: Classification model.

FIGURE 3: Convolutional neural network classification model.

not need complex preprocessing and ultimately puts feature extraction and pattern classification into a black box. It obtains the required parameters of the network through continuous optimization and gives the required type in the output layer. The core of the network is the structural design of the network and the solution of the network. This solution structure has higher performance than many previous algorithms, such as complex texture processing, good feature extraction effect but boundary extraction algorithm, feature processing based on wavelet network, and SVM with special classification effect. These algorithms require much computation when extracting features.

3. Remote Sensing Image Research Based on Convolutional Neural Networks and Its Application in the Design Field

Convolutional neural networks have made significant breakthroughs in machine learning in recent years, mainly thanks to big data and computer performance. Studies have shown that constantly deepening network layers can effectively improve network expression of identities of vast amounts of dataset [7]. The network structure of wider deepen let convolutional neural network become very complex, and depth of retraining a convolution of the new model via the network requires a lot of training samples to adjust the network weights. This is not the reality for small datasets. The proposed migration theory enables small data sets to share the development results of convolutional neural networks and deploy large networks into practical applications.

Remote sensing is a comprehensive Earth observation technology developed in the 1960s that has become one of the leading technologies for studying Earth resources and the environment. After years of development, remote sensing technology has achieved the ability to perform hyperspectral, high spatial resolution, and real-time Earth observation. Currently, the ground resolution of remote sensing images can reach a centimeter level. Remote sensing image classification is one of the essential applications of remote sensing technology, which has critical applications in
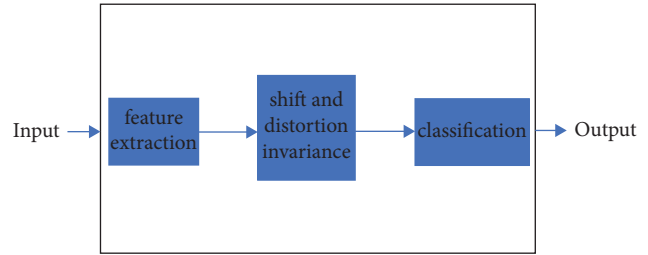
land use, urban planning, environmental monitoring, etc. It has vital significance for battlefield environment analysis in the military [8]. This paper applies the migration theory to the classification of remote sensing images with the pretrained VGG-16, GoogLeNet, and RESNET-152. Training tests were carried out on the remote sensing image datasets UC Merced and Siri-WHU, and the experimental results were analyzed in detail [9].

3.1. Migration Theory. For a multilayer convolutional neural network, the initial layer extracts more general features of the image. As the network structure becomes deeper, shallow features are combined into advanced features and further transformed into semantic features to achieve classification. For the convolutional neural network trained on ImageNet's extensive image data set, the bottom layer of the convolutional neural network has been prepared with much detailed information, and what needs to be trained prepared is in the combination information of these features at the top layer and the classification information of the final fully connected layer, which also proves that the convolutional neural network has the ability to transfer learning to a certain extent. There are usually two ways to apply transfer theory to convolutional neural networks.

(1) The trained network model is used as a feature extractor. The last complete connection layer of the trained network is removed, and the rest of the network is used as a feature extractor. For the Alex grid work, removing the last convolutional layer will generate a 4096-dimensional feature vector, which will be used to train a linear classifier for practical tasks [10].

(2) They are fine-tuning the trained network with new data sets. For networks pretrained on large databases, the weight parameters of the network are fine-tuned on the new database by a backpropagation algorithm. The features extracted from the first few layers of the pretrained network are usually general. In contrast, those removed from the last layer are related to the task of data set classification. During fine-tuning, you can adjust the parameters of different network layers. You can adapt and change the parameters of all network layers. You can also change the parameters of the first several network layers and fine-tune the parameters of the last network layers.

3.2. Deep Convolutional Neural Network

3.2.1. GoogLeNet Network Model. Lenet-5, AlexNet, and VGGNet are the accumulation of multiple convolutional layers, only deepening in depth. GoogLeNet expands the width of the network while increasing the network depth. The network depth of GoogLeNet is 22 layers [11]. Its primary grouping unit, inception, is shown in Figure 4.

The features of different scales can be obtained by using multiple convolutional kernels of different scales at the same layer, and better features can be obtained by fusion of the accepted elements than by using a single convolutional kernel. The initial Inception architecture does not use a $1 * 1$ convolutional kernel, which has the advantage of reducing a large number of network parameters. For an input with a 256-dimensional feature, the parameter can be reduced by 1/9 by using $1 * 1$. The parameters of GoogLeNet are 1/12 of those of 8-layer AlexNet [12].

3.2.2. ResNet-152 Network Model. ResNet is a residual network model that solves the gradient dispersion problem of the original deep learning network as the number of network layers increases. As a result, shallow network parameters cannot be updated in the backpropagation process, and the network depth cannot be further deepened. ResNet uses a shortcut to connect the inputs and outputs of a module during model design. In the process of backpropagation updating weights, ResNet gradient signals can be directly transmitted to the upper network through shortcuts, which solves the problem of gradient disappearance and makes the network layers of the deep learning network reach 152 layers. The essential components of ResNet are shown in Figure 5.

4. Application of Convolutional Neural Network in Clothing Design

With the rapid development of computer technology, computer-aided design has emerged endlessly and is widely used in business, industrial medicine, art design, entertainment, and other fields. At present, the applications of juice computers in the clothing industry include clothing computer-aided design (clothing CAD), clothing enterprise management information system (MIS), and clothing cutting machine technology system, as well as clothing sales system, clothing fitting system, and contactless clothing measurement system.

Clothing CAD (computer aided design) technology; that is, computer-aided clothing design technology, is a unique technology that uses computer software and hardware technology to input, design, and output new clothing products and clothing processes according to the basic requirements of clothing design [13]. It is a comprehensive high-tech that integrates computer graphics, databases, network communication, and other computer and other fields of knowledge to realize product technology development and engineering design. It is called the interdisciplinary subject of art and computer science. It is a new art

school based on cutting-edge science, which is different from any prior art. Clothing CAD technology integrates designer Ding's ideas and technical experience and, through the powerful computing function of the computer, makes clothing design more scientific and efficient and provides a modern tool for clothing designers. It is an essential means of future fashion design [14].

The clothing CAD system mainly includes fashion design system, pattern design system, grading system, marking system, fitting design system, and management system.

4.1. Introduction to Garment Design CAD. The clothing CAD was developed in the United States in the early 1960s. Currently, the popularity of clothing CAD in the United States, Japan, and other developed countries has reached more than 90%. China's clothing CAD technology started late; although the development speed is breakneck, there is still a big gap with foreign technology.

The popularization, application, and popularization of clothing CAD is a vital tent and long-term task of clothing technology transformation in China. Garment CAD software is a common standard in the modern garment industry, and it also improves the production efficiency and product quality of garment enterprises [15]. After entering the WTO, China's clothing industry will further develop rapidly. Therefore, using and promoting clothing CAD software is an inevitable trend for further developing China's clothing industry.

4.2. 3D Digital Design Technology. In the current international manufacturing field, manufacturing technology is developing from traditional manufacturing methods to advanced manufacturing technology. The informatization of the manufacturing industry has become an important trend in the development of the manufacturing industry. The core of the digital construction of manufacturing enterprises is the digital design and manufacturing of products and the integration of related digital technologies. Three-dimensional digital design technology is gradually becoming a hot spot in the application of enterprise design, and it is also a necessary tool for enterprises to deepen their application. As an essential part of information technology, CAD combines the high-speed and massive data storage, processing, and mining capabilities of computers with people's comprehensive analysis and creative thinking capabilities and plays a vital role in accelerating the development of engineering and products; it shortens the design and manufacturing cycle; improves quality; reduces costs; and enhances the market competitiveness and innovation ability of enterprises. Whether it is military or civil industry, construction or manufacturing, processing industry, machinery, electronics, light textile products, literature and sports, film and television advertising production, three-dimensional digital design technology is indispensable [16]. Three-dimensional digital design technology is an essential technical basis for enterprise informatization, and it is also an admission ticket for enterprises to enter the international market.
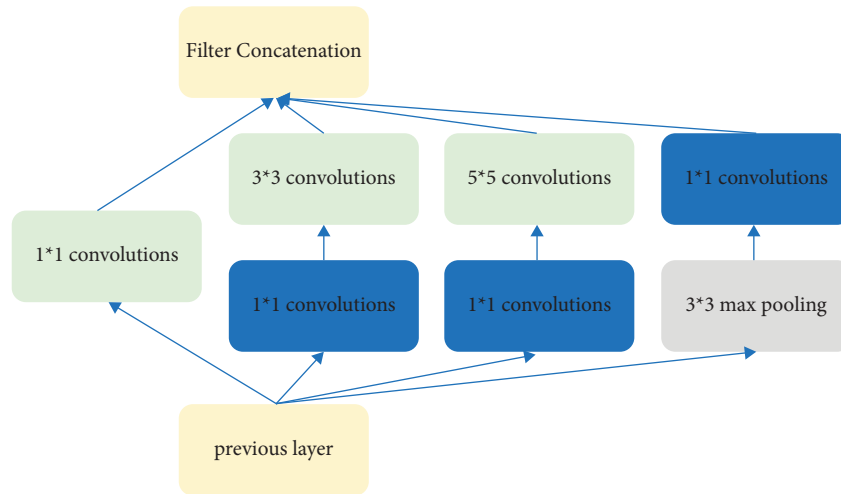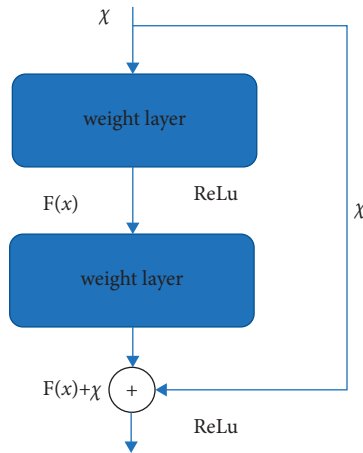
FIGURE 4: GoogLeNet network.

FIGURE 5: ResNet workflow model.

4.2.1. Working Principle of 3D CAD Technology. The clothing size based on the mass production of clothing cannot accurately reflect the body characteristics of people. The establishment of human body databases of all kinds of people is being carried out at home and abroad. Through three-dimensional anthropometry on many people with different skin colors, regions, ages, and heights, we collect various body size data of the human body and establish a database to provide essential data for formulating clothing specifications and sizes [17].

Three-dimensional anthropometry generates a virtual three-dimensional human body by acquiring the human body's vital geometric parameters, establishing a static and dynamic human model, and forming a complete set of systems with the functions of virtual human body display and dynamic simulation. On this basis, 3D clothing CAD generates the three-dimensional effect of clothing fabric, realistically displays the three-dimensional color image of the dressing impact on the screen, and expands the three-dimensional design into plane clothing pieces [18]. Using

advanced computer image capture and recognition technology, laser measurement and positioning technology, numerical control technology, three-dimensional computer software, and data processing technology, the working principle of the system is standing on a unique working platform. Four laser heads are used that can move up and down scan the human body from the top of the head to the heel in four directions and read the position and color information of the human body into the computer and then use special software to process the measured human body information to obtain detailed and accurate size and color information of each characteristic part of the human body and generate standard data formats that can be read by 3D CAD software and animation software.

The basis of 3D garment CAD is 3D anthropometry [19]. The three-dimensional human body measurement system has been commercialized abroad, and its technology has been relatively mature. France, the United States, Japan, and other countries can complete the three-dimensional human body using the natural light grating principle in 40 milliseconds, 10 seconds, and 1.8 seconds, respectively, measurement data. The commonly used three-dimensional anthropometry technology in the world is generally non-contact. The image formed by the light projected onto the human body surface is captured by photosensitive equipment. Then the three-dimensional characteristics of the human body are described by computer image processing. The three-dimensional human body measurement system has many advantages over traditional measurement technology, such as short measurement time and extensive data.

4.2.2. Application Status of 3D Garment CAD. At present, there are two main types of applications of 3D garment CAD in foreign markets:

First, it is used for customization: to measure the human body parameters of specific customers and their specific requirements for clothing styles (such as relaxation, length, width, and other preference information), carry out clothing design, and regenerate into corresponding plane clothing

samples [20]. Such products can be remotely controlled through the Internet, among which the systems of the United States, Britain, France, Germany, Japan, and Switzerland are more advanced.

Second, it is used to simulate the fitting system. Interactive clothing design is carried out through the three-dimensional measurement of a customer's body shape, and the corresponding plane clothing samples are regenerated. Such applications can also be realized by using the Internet for remote control of e-commerce. For example, Lands' End company in the United States can establish a virtual human model of customers on the Internet. Through simple operations, customers can try on the company's clothes and carry out the three-dimensional interactive design until they are satisfied.

Presently, some foreign products can realize three-dimensional clothing wearing, matching design and modification, reflect the animation effect of clothing wearing comfort, simulate the three-dimensional suspension effect of different fabrics, and realize 360-degree rotation and other functions [21]. Among them, the three-dimensional garment CAD software developed by the United States, Japan, Switzerland, and other countries is relatively advanced, such as the concept 3D garment design system launched by CDI company of the United States, the 3D plan of lick company of France, the am-ee-sw3d system of Gerber company of the United States, the 3D system of Pad Company of Canada, the 3D design of Toyo textile company of Japan, etc.

4.2.3. Huge Benefits of 3D CAD Technology. 3D CAD technology can significantly improve the design efficiency and quality of products and projects, working conditions, and competitiveness of products and projects in the market [22]. Statistics from foreign countries show that the application of 3D CAD design technology can reduce engineering design cost by 13%–30%. It can reduce the time from product design to production by 30%–60%, improve product quality by 5–15 times, and increase the breadth and depth of problem analysis by 35 times. Also, it improves product productivity by 40–70% and increases the productivity of input equipment by 2–3 times while reducing the processing process by 30%–60% and labor costs by 5–20%. The research, development, and wide application of 3D digital design technology can promote the development of China's software industry, especially the development of the application software industry [23]. This will accelerate the technological transformation of traditional industries and products and promote the rapid development of conventional disciplines. The resulting direct and indirect economic benefits are enormous, and their social benefits are immeasurable.

5. Development Trend of Garment CAD Technology

5.1. Development Status of Three-Dimensional CAD for Clothing. With the development of computer technology and the social economy in China, people have higher and higher requirements regarding clothing quality, fit, and individuality. The existing two-dimensional clothing CAD technology can no longer meet the CAD application requirements of the textile and clothing industries. It is urgent to develop clothing CAD from the current plane to a three-dimensional design. Therefore, in recent years, three-dimensional clothing CAD, virtual reality clothing design, and other aspects of theoretical research and practical applications both at home and abroad.

According to Autodesk's widespread application of CAD statistics. Currently, about 30% of the users in the world use 3D CAD for product design, and the remaining 70% still use 2D CAD design [24]. Three-dimensional CAD has been widely used in the world. Still, in the clothing field, the development and application of three-dimensional CAD are lagging because clothing is not like solid products in the machinery and electronics industry; its texture is flexible and will change with different external conditions, so it is not easy to simulate. In particular, the transformation of garment CAD from two-dimensional to three-dimensional needs to solve the technical problems of fabric texture and dynamic performance, three-dimensional reconstruction, realistic and flexible surface modeling, and the transformation from a three-dimensional garment design model to a two-dimensional plane garment. These problems lead to a long development cycle and great technical difficulty in 3D garment CAD.

5.2. Development Trend of Garment CAD Technology. In recent years, the CAD technology in achieving rapid development at the same time also exposed the problems in the story; the main problem is the unit's placing too much emphasis on the development of technology, emphasizing the system's generality and ignoring the product's whole life cycle of the design process-oriented design, dismissing the application of network technology, ignoring butyl database, the development of the characteristic library, and so on [25]. Given these problems, combined with the latest evolution of manufacturing information technology, CAD technology developers put forward a three-dimensional digital design system for industry and process (product life cycle). This system has become a hot spot for research and development at home and abroad. It is regarded as the only way to deepen CAD technology's application and leap in evolution.

The original CAD system and its supporting technology have been integrated into CIMS (Computer Integrated Manufacturing System) [26]. Another garment CAD system development trend is establishing the interface and integration with CAM, MIS, PDM, ERP, etc.

With the rapid development of the Internet in recent years, it is expected that online fashion design will gradually become mainstream. Under the increasingly specialized and globalized production and management mode, the CAD system based on the network can realize data sharing and standardization. The parallel product design will also support the efficient and rapid CAD system. To effectively enhance the market size and product profits, the integration of apparel CAD and e-commerce is also an inevitable trend.

An Internet-based remote data transmission and monitoring system for garment enterprises is coming out, which also provides adequate technical support for the networking of garment design and the informatization of garment enterprises.

In recent years, the United States, France, Germany, Japan, and Switzerland have also developed the research and development of Virtual garment CAD and started the application research of ultra-dimensional garment design [27]. Is the so-called super-d clothing design, super-dimensional visual design, for fashion designers in fashion design not only consider a one-dimensional line, two-dimensional plane, three-dimensional body, 4 d, and 5 d design elements such as the meaning of, and feel the person's psychology, the aesthetic view of people's vision, and the interest of the people, and many other factors, paying attention to the use of environmental psychology and ornamental psychology. Through visual, auditory, and tactile means, clothing designers use virtual reality design technology, virtual reality computer display environment for clothing designs, virtual reality design technology and virtual reality computer display environment for clothing design. This virtual clothing CAD technology, the use of network transmission, and the creation of virtual reality technology make the designer able to work in the environment of virtual garment design; the outdoor reading computer hardware equipment still needs data gloves, clothing, and so on for digital human body sensor and helmet stereoscopic display devices such as displays, shutter glasses, and other related equipment [28]. This virtual reality design technology realizes the automation of clothing design.

Currently, all clothing CAD products are more complex, and it takes professional and technical personnel a considerable amount of time to learn and apply them thoroughly, which is also an important reason for the slow popularization of CAD products [29]. Therefore, it is expected that garment CAD products in the future will develop towards high intelligence. More garment model modules and design wizards will be established to provide intelligent support for designers. This academic support includes self-learning, self-organization, self-adaptation, self-correction, parallel search, associative memory, pattern recognition, automatic knowledge acquisition, and other intelligent technologies [30] which step by step become easy to learn like WINODWS operating software. In the future, with the development of hardware technology, embedding software into the human body measurement instrument to become a brilliant clothing design silly machine will become a reality.

Since AlexNet made a breakthrough in the ImageNet competition in 2012, deep learning based on the convolutional neural network has become a common research hotspot for various enterprises and many scholars and has made great breakthroughs in natural images, language processing, and other aspects. With theoretical innovations and improved computational performance, modern convolutional neural networks are evolving in a wider and deeper direction, but eschewing the development in depth. But it is necessary to increase the depth of network computation to improve the learning ability of the model for better region classification and interclass differences. The clothing design work can rely on computer-aided design, fabric organization, pattern, and clothing modeling design out. Based on the CAD system, this paper presents the situation of the fabric directly and improves the efficiency of garment design. To sum up, under the diversified network environment, computer technology develops rapidly and has a wide range of applications, which are applied in all aspects of clothing design, production, and sales. According to the content and requirements of clothing design, the content and form of computer-aided design can be flexibly used to minimize the production costs in the process and improve the quality and efficiency of clothing design and production. Throughthe prediction, the garment fabric, style, color, and other popular elements, trends have an intuitive understanding of comfort, fit, beautiful quality clothing design to meet the needs of consumers and for China's garment industry to open up a broader space for competition and development.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

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