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Enhancing Digital Chinese Painting in Interior Design with Deep Learning and Virtual Reality

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Abstract. Through the study of the aesthetic spirit of the artistic conception of traditional Chinese paintings, this paper clarifies the inner connection between the interior space art and the aesthetic spirit of the artistic conception of Chinese paintings, and establishes an appropriate theoretical basis for the construction of modern indoor space atmosphere. This paper combines deep learning to analyze the application of Chinese painting in interior design. According to the system's construction goal, this paper uses hardware platform, software platform and development tools to comprehensively consider the system's equipment selection and software selection. Finally, on the basis of making full use of certain resources and work guidelines, this paper constructs an interior design system based on deep learning to study the application effects of Chinese painting in interior design. Through research, it can be known that Chinese painting can play an important role in interior design, effectively improving the effect of interior design, and deep learning is also an effective evaluation method.

Keywords: deep learning; Chinese painting; interior design; structural model; Digital
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1 INTRODUCTION

Interior design refers to the interior decoration of people in the residence to meet their personal needs for decoration, material, and aesthetics [17]. The beauty of artistic conception has played a big role in it. Moreover, the development of Chinese painting has a long history. The lightness and coldness of the literati landscape does not explain the seasonal or temporal characteristics of the objective image itself. The important thing is that it has become a spiritual act that expresses people's feelings, embodies feelings in the scene, and creates ideas for the scene, so as to complete the expression of the painter's thoughts and feelings such as being aloof, arrogant and clean, or

pure and elegant, or simple and beautiful. This technique of breaking time and space constraints and connecting different time plots with sceneries is increasingly being used for reference in modern room environment design. The quality of a good Chinese painting is delicate and beautiful, full of personality and aura, dignified, elegant, simple and natural in its style. Moreover, its cultural connotation is deep and long, just like Chinese Moutai, it makes people feel natural and smooth, mellow and fragrant, with endless aftertaste. At the same time, it makes people feel a kind of spiritual vitality, so it becomes an element and symbol of modern Chinese interior design. In the interior design, Chinese painting can heighten the indoor atmosphere, create environmental artistic conception, create secondary space, enrich the spatial hierarchy, soften the space, adjust the environmental color, strengthen the indoor environment style, and reflect the national characteristics. The art of furnishings essentially conveys an inherent, deep-seated and sustainable tradition through representation, finishing, and refinement techniques [1]. The furnishings with elegant style, beautiful shape, and cultural connotation make people feel pleasing to the eye and cultivate sentiment. At this time, the furnishings have surpassed their own aesthetic limits and endowed the interior space with spiritual value. With the collision and integration of Chinese and Western cultures, it is necessary to focus on the spiritual connotations contained in traditional Chinese paintings and to deeply grasp the beautification of the modern living environment. At the same time, the traditional Chinese interior furnishing design also strives to express a specific emotional mood, in order to reach the highest state of conveying emotions. These can be used for reference in modern interior design [15]. Chinese painting and cultural heritage into contemporary interior design, creating immersive and educational experiences for users.

After thousands of years of development, Chinese painting is an indispensable part of Chinese traditional art. The study of Chinese painting must start from the basic composition. Composition is the core link in the process of Chinese painting art creation, and it is also an important way for artists to express their own theme ideas and form individual artistic styles. Moreover, composition is not only a matter of form, but more importantly, how to reveal content through form. Today when the current traditional culture is returning, how to learn from the composition rules of Chinese painting and how to inherit and expand the essence of traditional Chinese art is a subject that every Chinese interior designer must face.

2 RELATED WORK

Artistic conception is an immortal concept of the aesthetic spirit of traditional Chinese art. The aesthetic spirit of artistic conception includes the thoughts and perceptions of the ancestors, as well as the inheritance, criticism, and reflection of the literature and thoughts and emotions of the predecessors, as well as the aesthetic theory formed by thinking about the national culture and philosophical connotation [14]. Artistic conception reveals the Chinese nation's unique way of experience, language expression, thinking and perception, aesthetics and so on. Moreover, it develops dynamically in history, and our understanding and interpretation of artistic conception are also constantly developing, changing, and growing. The aesthetic spirit of the artistic conception of Chinese painting is in the same line as the concept of artistic conception of Chinese classical aesthetics [9]. The artistic conception of Chinese painting embodies the in-depth experience and insights of Chinese literati and doctors on nature, life, art, and aesthetics, and cultivates a rich source of thought. The creation of Chinese painting has always pursued the creation of a rich artistic conception at all stages of history, thus forming a unique art form. Therefore, the basic content of the concept of artistic conception in Chinese classical aesthetics is also the core of the aesthetic spirit of the artistic conception of Chinese painting. The process of interpretation of artistic conception to indoor space generally radiates from philosophy, literature, and painting to gardens, and then from garden art to architecture and indoor space. In the feudal society, court painters often acted as engineers (such as Yan Liben in the early Tang Dynasty), in charge of the civil engineering of the

country's royal gardens. Moreover, this type of painter is influenced by Chinese classical aesthetics in terms of aesthetic thoughts and aesthetic orientation. Therefore, Chinese painting intensively reflects and embodies ancient Chinese philosophy and Chinese classical aesthetics. All works of art, including interior design, should be based on whether there is artistic conception or the depth of artistic conception to determine the level of its style.

Literature [6] proposed that "artists use their minds to mirror all phenomena and speak on behalf of mountains and rivers. What they express is the blending and interpenetration of subjective life sentiment and objective natural phenomena, creating a flying kite, lively and exquisite, deep but deep spiritual realm", This is the "artistic conception" that constitutes the art of art. The artistic conception of Chinese art reflects different realms according to different people, different things, different places, and different emotions. The literature [4] divides this situation into five realms: one is the utilitarian realm that meets material needs; It is the ethical realm of mutual love and mutual existence; one is the political realm of mutual restraint among groups; the other is the academic realm of the pursuit of wisdom; the other is the religious realm of faith. Artistic conception has rich cultural and philosophical connotations [5]. The artistic conception of Chinese painting is that the subject of creation uses exquisite artistic techniques to forge the unity of emotion and scenery, form and spirit, and virtuality and reality, so that the objective scenery evolves in the aesthetic process to be subjective, feeling and thinking, matter and self as one, and virtual and reality coexist. Thoughts and emotions can make aesthetics feel happy through artistic images, realize the philosophy of life, trigger resonance and thoughts, and get a broader artistic aesthetic pleasure. The special connotation and temperament embodied in the specific artistic form of the aesthetic spirit of the artistic conception of Chinese painting presents pluralism, diversity and hierarchy. It not only shows the Chinese philosophical concept with Confucianism, Taoism, and Buddhism (Zhan) as the main body, but also plant It is rooted in the social and political consciousness of the historical period [2]. The aesthetic spirit of the artistic conception of Chinese painting is a kind of "thought", a thought that conforms to the principle of aesthetics and dominance. It is not the spiritual function of man, but the spirit of man who transcends himself and exists between heaven and earth. From an aesthetic point of view, the artistic conception of traditional Chinese painting is an artistic realm of living environment and fusion of thoughts and feelings embodied in paintings [19]. The artistic conception of Chinese painting is the emotion expressed through objective images and aesthetic associations beyond emotions. It is an abstract modeling concept reflected in people's thinking objectively, and is used to guide people's image associations of beauty; "("Outside the image", "Outside the image"), on the other hand, "meaning" sublimates from the perception of objective to the feeling of emotion. This kind of philosophical sense of life, history, and universe is the connotation of "artistic conception". Therefore, "yijing" is a type of metaphysical meaning in "images"[18].

3 DEEP LEARNING DATA PROCESSING

The principle of neural network is to use the mechanism of error back propagation to adjust various parameters (weights, thresholds, bias, etc.) of neurons. It is a feed-forward neural network. As a learning algorithm, BP neural network uses the continuous back propagation error method to correct the connection weights between the neurons of each layer of the multi-layer network, so as to obtain the desired target result.

The learning of backpropagation neural network is divided into two propagation processes. The forward propagation of the signal, input samples, analyze and calculate the input data through the hidden layer, and output the calculation results. Back propagation of error, when the moral result of forward propagation does not meet expectations, that is, when the error exceeds a certain threshold, the error will be continuously propagated back and passed to each layer of neurons, making the entire network Perform weight correction. The two propagation processes are continuously looped until the error obtained is lower than the threshold, that is, the desired result is obtained[8].

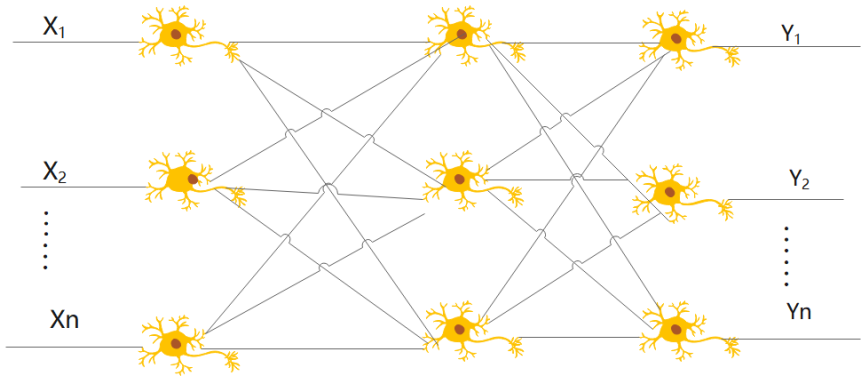


Figure 1: BP Neural Network Structure Diagram.

The common BP neural network model is shown in Figure 1. When we input the sample x into the neural network for analysis and calculation, the output result y can be obtained. If it is assumed that the desired target result is y^*, then the error calculation formula is[11]:

$$E(w,b)=\frac{1}{2}\sum\left(y_i-y_i^*\right)^2 \tag{1}$$

It adjusts the network parameters according to the gradient descent method, and the weight correction value of the connection between the i-th neuron and the j-th output neuron is:

$$\Delta w(i,j)=-\eta\frac{\partial E(w,b)}{\partial w(i,j)} \tag{2}$$

According to $net_j=\sum_i w_{ij}y_i$, we can get the following formula:

$$\frac{\partial net_j}{\partial w_{ij}}=\frac{\partial}{\partial w_{ij}}\sum\nolimits_j w_{ij}y_j \tag{3}$$

We set $\delta_{ij}=\frac{E_p}{net_j}$. Through further transformation, we can get:

$$\delta_i=y_i(1-y_i)\sum\nolimits_j \delta_i w_{ij} \tag{4}$$

Thus, the weight correction value can be calculated:

$$\Delta w_{ij} = \eta \delta_i y_i \tag{5}$$

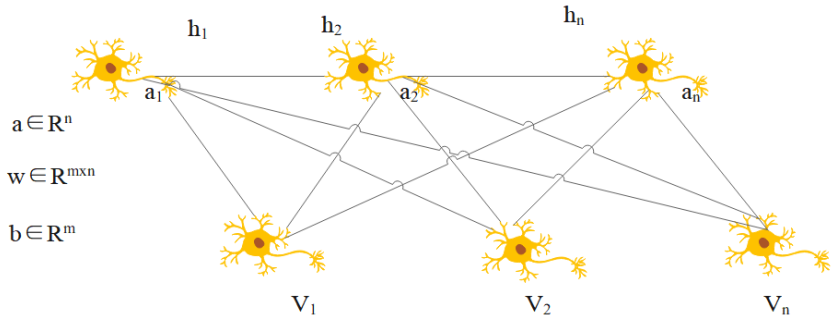


Figure 2: Single-Layer Boltzmann Machine.

The development of BP neural network has been relatively mature, with obvious advantages and disadvantages. The advantage is that the network structure is flexible. The number of layers and the number of nodes in each layer can be adjusted. The disadvantage is that the convergence speed is too slow. If the training speed is set to increase, it is easy to fall into the local minimum. In this case, network structure setting requires a lot of experience, otherwise the results obtained will be very different, and even too many network layers will cause error dispersion[12].

Because the BP neural network will have error dispersion when there are too many neural network layers, it will eventually lead to poor adjustment of the underlying parameters, and it is impossible to accurately extract the data features. In response to this problem, Hinton et al. proposed the concept of a deep belief network in 2006. The Deep Belief Network (DBN) is a stack of multi-layer restrictive Boltzmann machines. It is a probabilistic generative model (that is, it requires two kinds of data: observation data and label data. Both types of data are evaluated, while the other discriminant model only evaluates the label data). Compared with the back propagation network, the deep belief network has more network hierarchical structure and the training effect is better.

Restricted Boltzmann Machines (RBMs) are a kind of stochastic neural network, while Restricted Boltzmann Machines remove the connections between neural units in the same layer on the basis of Boltzmann machines. In simple terms, RBMs is a bipartite graph, that is, each RBMs can be divided into two layers: the visible layer (v) and the hidden layer (h). Assuming that the value of all network parameters is not O or 1, the layers are connected but the nodes in the layer are not connected, and P (v, h) satisfies the Boltz probability distribution, then this bipartite graph is RBMs.

Figure 2 shows a schematic diagram of a single-layer Boltzmann machine.

Since RBMs are an energy model, the energy calculation method for its joint configuration is as follows[10]:

$$E(v,h,\theta) = \sum_{ij} w_{ij} v_i h_j - \sum_i b_i v_i - \sum_i a_i h_j \tag{6}$$

The neural units in the layer are independent of each other, and it is:

$$P(h \mid v) = \prod_j P(h_i \mid v) \tag{7}$$

By decomposing the factors, we calculate that the probability that the j-th node is 0 or 1 is:

$$P\left(h_j=1|v\right)=\frac{1}{1+\exp\left(-\sum w_{ij}v_i-a_j\right)} \tag{8}$$

We define the sample set that satisfies the independent and identical distribution: $D=\left\{v^{(n)}\right\}$, where n=1,2...N. At this time, in order to learn the desired parameters, we calculate its maximum likelihood estimate:

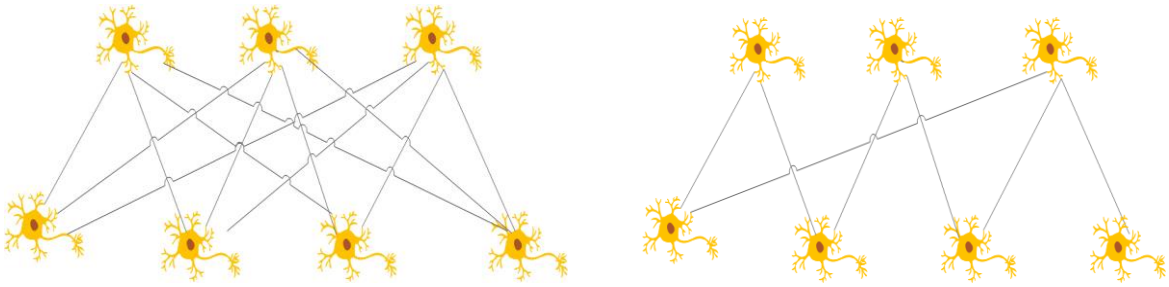
$$L(\theta)=\frac{1}{N}\sum_{n=1}^{N}\log P_\theta\left(V^{(n)}\right)-\frac{\lambda}{N}\|w\|_F^2 \tag{9}$$

Then, we take the derivative of the maximum likelihood estimate to obtain the corresponding w value when L is maximum:

$$\frac{\partial L(\theta)}{\partial w_{ij}}=E_{p_{data}}\left[v_ih_j\right]-E_{p_\theta}\left[v_ih_j\right]-\frac{2\lambda}{N}w_{ij} \tag{10}$$

Multiple such restricted Boltzmann machines are connected layer by layer. Among them, the hidden layer of each restricted Boltzmann machine is used as the visual layer input of the next Boltzmann machine, which forms a deep confidence network.

Because the feature extraction based on the improved deep belief network removes the pooling layer of the convolutional deep belief network, only a feature of local perception is added to the deep belief network. The traditional neural network model uses a fully connected method as shown in Figure 3(a), and this paper introduces the use of partial connections as shown in Figure 3(b)[7]:



(a) Traditional way (b) Ways to improve

Figure 3: Network Structure Diagram.

The neural network algorithm is as follows:

The algorithm inputs a v-dimensional vector. The neural network has two forward layers, the first layer includes m neurons, and the second layer includes n neurons. The inverse and forward directions are in an approximate projection relationship and are also two layers, but they belong to the same inversion neural network. Therefore, as the reverse direction, the 2 layers are the third and fourth layers, the third layer has n neurons, and the fourth layer has m neurons. We assume

that the bias of the i-th neuron in a certain layer of the neural network is b_i, the output of the j-th neuron in the previous layer is O_j, and the distance between the j-th neuron in the previous layer and the i-th neuron in this layer The weight of is w_{ij}, and the output of the i-th neuron in this layer is O_i. Then, the weighted sum is net_i:

$$net_i = \sum w_{ij} O_j + b_i \tag{11}$$

The final output value is[17]:

$$O_i = f\left(net_i\right) = \frac{1}{1+e^{-net_i}} \tag{12}$$

Evolutionary algorithm is an algorithm that imitates the biological evolution mechanism, and the evolutionary strategy, as a branch of the evolutionary algorithm, was proposed by I. Rechenberg et al. in the early 1960s. The evolution strategy uses the idea of biological mutation to randomly modify the parameter values, and through iterative evolution, a satisfactory result is finally obtained. The evolution strategy was initially used in fluid mechanics. In-depth research, especially in wind tunnel experiments, has achieved significant results. Interactive evolution strategy is based on the evolution algorithm, plus an interactive process. This article uses the more common $1+\lambda$ evolution strategy. The principle of $1+\lambda$ evolution strategy is: the algorithm initializes the parameters to find the best individual, and if it meets the conditions, it stops the iteration. Otherwise, the algorithm mutates the best individual and generates a new generation of individuals, and then finds the best individual details as follows:

Begin

Type A;

While (A does not meet the condition or is less than the number of iterations){

Mutation A, produce a new individuals, combined into 1+a individuals;

A=findBest( );

)

Output A;

End

In this paper, the $1+\lambda$ evolution strategy uses a variety of evolution or mutation algorithms in the experiment process, including differential mutation, uniform mutation, and Gaussian mutation. These mutation algorithms achieve different effects in different scenarios. Therefore, in this paper, at different stages, three mutation algorithms will be tested, and the appropriate algorithm will be selected based on the experimental results. The specific principles of the three mutation algorithms are as follows[13]:

1.Differential variation

We assume that F is the scaling factor, and y_i^k is the value of the i-th individual in the k-th generation, and y_i^{k-1} is the value of the i-th individual in the k -1 generation, and y_z^{k-1} is the value of the jth individual in the k-1st generation, and y is the value of the z-th individual in the k-1th generation. The calculation formula of A is:

$$y_i^k = y_i^{k-1} + F*\left(y_j^{k-1} - y_z^{k-1}\right) \tag{13}$$

2.Gaussian mutation

In evolutionary algorithms, $P\left(\frac{|x-\mu|}{\sigma} < 3\right) = 0.9974$. $y_{\max} = x+3$ .and $y_{\min} = x-3$ .If it is assumed that the detection condition value is c and the constraint condition value is d, the median value y of the Gaussian variation is:

$$y = y_{\min} + 1.0*\left(y_{\max} - y_{\min}\right)*rand\left(0,1\right) \tag{14}$$

The constraints are:

$$c = \frac{1}{\sqrt[2]{2\pi}} * e^{-\frac{(y-y_{\min})^2}{2}} \tag{15}$$

$$c = \frac{1}{\sqrt[2]{2\pi}} * rand\left(0,1\right) \tag{16}$$

If d>c, the algorithm re-values y and performs a test. Otherwise, the output value of Gaussian mutation is g=y[16].

3. Uniform variation

We assume that in the evolutionary algorithm of uniform mutation, due to the particularity of mutation requirements, only a certain range of positive integers needs to be obtained. Therefore, the algorithm is very simple, the output y of this paper is[20]:

$$y = rand()\%\mathrm{n} \tag{17}$$

In strategy $1+\lambda$, the main control parameters used are population size and mutation probability. These parameters need to be manually set by the user, but generally speaking, the population size of the evolution strategy is smaller than other evolution algorithms.

4 APPLICATION ANALYSIS OF CHINESE PAINTING IN INTERIOR DESIGN BASED ON DEEP LEARNING

According to the system's construction goal, this paper uses hardware platform, software platform and development tools to comprehensively consider the system's equipment selection and software selection. Finally, on the basis of making full use of certain resources and work guidelines, this paper makes the overall operating performance of the auxiliary system reach a certain level. The system structure of the implementation process is shown in Figure 4:

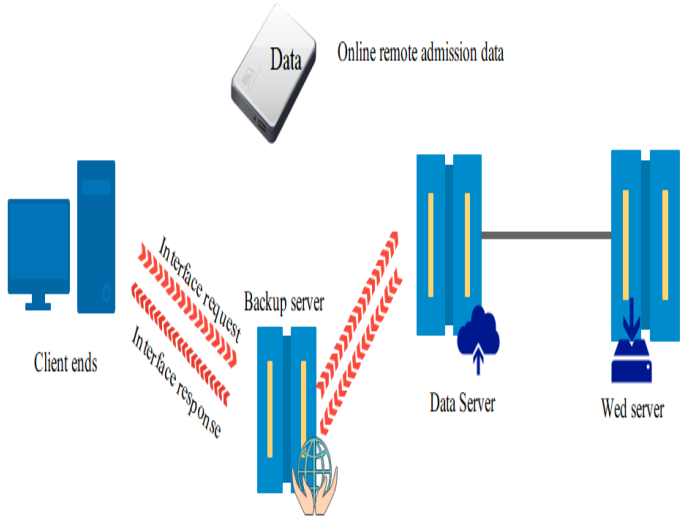


Figure 4: Structural Model.

Figure 5 mainly illustrates the framework of the overall system. The system is divided into several main modules and some system management elements for data input. This article subdivides the classification of modules.

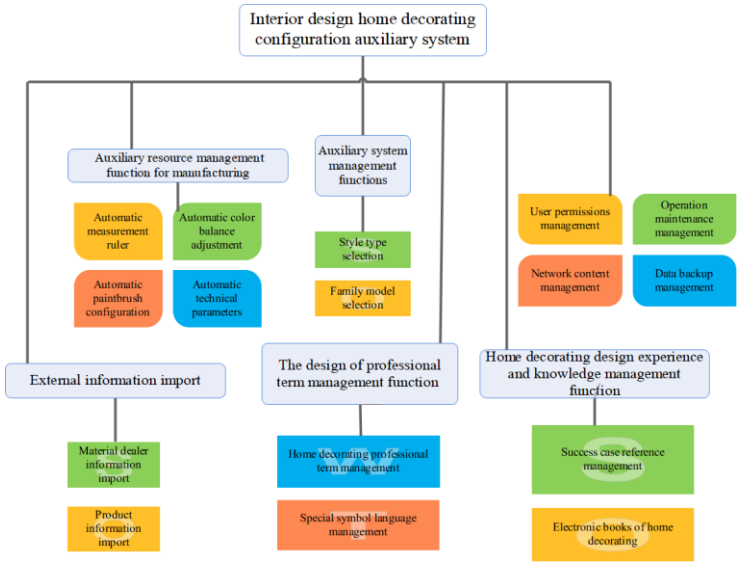


Figure 5: Overall Framework Diagram.

File and data sharing can be achieved through external links between files. This method is called file linking. The working diagram of file link collaborative design is shown in Figure 6.

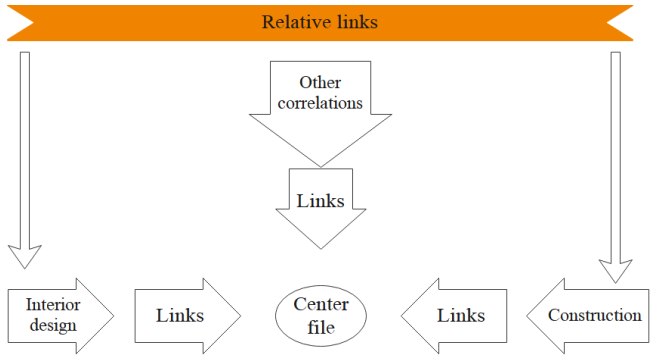


Figure 6: Working Diagram of File Link Collaborative Design Method.

In order to distinguish the information related to the system construction from the irrelevant information, the business process of the organization should be analyzed and researched. We need to clarify the information flow in business activities through research. On the one hand, we need to clarify the scope of information investigation in business activities, the content of the investigation, the order of investigation, and the processing time requirements. On the other hand, we need to figure out the content of the organization's business information, the source of the information, the address where the information is stored, and the information form. Finally, these situations are expressed in a business flowchart. The flow of this module is shown in Figure 7.

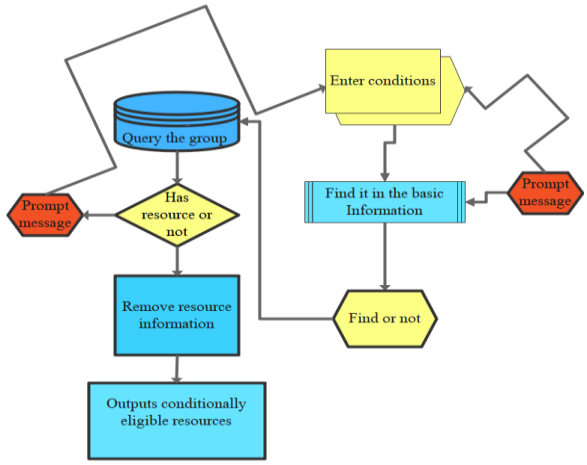


Figure 7: Flow Chart of Resource Query Module.

Resource management is the main part of resource library design. The effective management of resources is itself the essence of the design of the material resource library platform. Therefore, it is particularly important to realize the effective management of the entire resource library resources through the classification method. In order to optimize the classification management of the resource library, this paper draws on the optimized classification method of the material resource library. According to this resource classification method, material resources can be divided into file-type multimedia resources and text-type resources. The specific classification is shown in Figure 8.

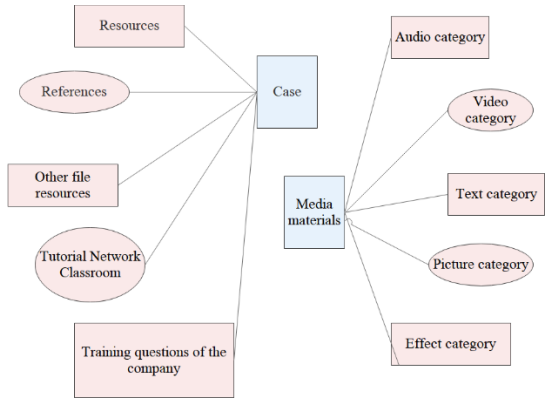


Figure 8: Resource Classification Diagram.

After constructing the above interior design model based on deep learning, the role of Chinese painting in interior design can be judged through this model.

With the development of the times, the application of traditional aesthetics in interior space design is becoming more and more sought after by people. Studying the application of Chinese painting composition rules in interior space design is not only an application of traditional aesthetics, but also a process of exploring how two-dimensional painting art transforms to three-dimensional space art. At the same time, it is also a process of exploring how pure art forms transform to practical art, and it is an expansion of our thinking and an inheritance of tradition. Figure 9 shows a way of applying Chinese painting in interior design.

Figure 9: Application Example of Chinese Painting in Interior Design.

The artistic conception of Chinese painting also emphasizes the blending of scenes and the harmony between the object and the self. Through the sceneries in the painting, he expresses the creator's thoughts and emotions, and also allows the viewers to enjoy the spirit through the emotional resonance of the painting. The interior space design is centered on " The harmony between people and the interior space is centered. The creation of the "god" of the indoor space is the artistic conception of the indoor space. The "god" makes the "force field" effect of the indoor space emerge spontaneously. People appreciate the "god" of the space in this "force field", and reverie condense

the nature of nature. Beauty, condensing the regional culture, condensing the taste of folk customs, condensing the fashion of the city; thus, there is a silent dialogue between man and "nature", man and "space". Therefore, "Artistic Conception" is an indispensable space "God" of indoor space. Artistic Conception contains the psychology and emotions of the owner of the room, and embodies his aesthetics, values, personality characteristics, and so on. And these aesthetics, values and character characteristics are the manifestation of all aspects of regional culture and national culture. Therefore, interior design must pay attention to regional culture and national culture, so that people can establish a harmonious relationship with the space, such as (Figure 10) The design of the bedroom is based on the theme's aesthetic ability, regional artistic characteristics, and exquisite art craftsmanship to create such a warm, cultural and artistic space, which makes the indoor mood and atmosphere touch people's hearts. The "god" of indoor space can only be built on the basis of national culture and regional culture to build a rich connotation; the same indoor space artistic conception atmosphere creation also promotes and inherits national culture, and national culture re-analyzes and re-analyzes with the concept of modern interior space design. Notes, injecting the vitality of the times into national culture and regional culture

Figure 10: Effect Diagram of Bedroom Interior Design.

The application of Chinese painting in interior design is evaluated, and the results are shown in Table 1 and Figure 11.

Number	*Evaluation*	*Number*	*Evaluation*	*Number*	*Evaluation*
1	*77.43*	*17*	*74.73*	*33*	*83.59*
2	*89.03*	*18*	*89.89*	*34*	*82.52*

3	71.04	19	73.19	35	87.08
4	81.53	20	82.41	36	84.91
5	90.52	21	85.57	37	75.81
6	76.56	22	80.98	38	84.30
7	89.81	23	72.69	39	72.52
8	74.39	24	82.26	40	72.49
9	86.94	25	81.80	41	80.18
10	85.66	26	82.23	42	74.52
11	89.64	27	71.53	43	82.49
12	81.69	28	85.73	44	79.34
13	74.07	29	79.09	45	78.54
14	87.17	30	81.43	46	73.28
15	83.89	31	83.50	47	85.48
16	76.19	32	88.37	48	78.05

Table 1: Evaluation of the Effect of Chinese painting in Interior Design Based on Deep Learning.

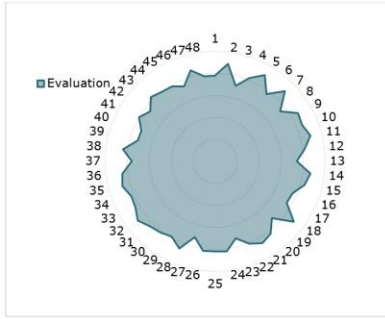


Figure 11: Effect Analysis of Chinese Painting in Interior Design.

Through the above research and analysis, it can be seen that Chinese painting can play an important role in interior design, effectively improving the effect of interior design, and deep learning is also an effective evaluation method.

5 CONCLUSION

Chinese interior space design is a derivative of the development of Chinese art. The "shape" of the indoor space refers to the scenes such as objects, shapes, structures, etc., which fall into the real place, rather than the illusory mirror image of spiritual emptiness and unrecognizable reality. The constituent elements of the indoor space and the morphological separation of the indoor space are the material basis for the creation of the artistic conception of the indoor space. Chinese interior space design is to create a rich artistic conception, that is, "God" by using the "shape" of the interior space. As far as aesthetic pursuit is concerned, Chinese interior space design artistic conception creation generally forms China's unique personality from many aspects such as spatial scale relationship, spatial artistic conception creation, interface design, business location, material use, aesthetic awareness, ethical system and so on. The aesthetic spirit of the artistic conception of Chinese painting and its creative techniques provide us with many ways and enlightenments that can be used for reference in modern interior design.

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