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Computer-Aided Design AND APPLICATIONS

Design and Development of Interior Design CAD System Based on Class Definition

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Abstract. The birth of CAD design software effectively combines computer technology with interior design. In the process of interior design, using CAD system can not only design elegant and concise indoor environment effect map, but also be convenient to modify and suitable for multiple use. Based on this, this text analyzes the application of CAD software in interior design in detail. The class definition and DL (Deep learning) algorithm are comprehensively introduced, and the construction and training of DL network model are systematically studied. On this basis, a new interior design CAD system is designed based on class definition and DL algorithm. Finally, the simulation experiment is carried out using ShapeNet data set. The results show that the system in this text can still achieve 89.095% stability under the condition of relatively large usage. In addition, the user rating of interior design CAD system reached 93.598. Both theoretical and simulation results show that the indoor design CAD system based on class definition and DL algorithm has achieved good results and its overall performance is good. The research in this text provides a new idea for intelligent interior design.

Keywords: Class Definition; Deep Learning; Neural Network; Interior Design; CAD System
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1 INTRODUCTION

Interior design is a building activity that people carry out in order to achieve a certain goal. It centers on people's use function and visual feeling, and processes the internal space of the living environment, so as to realize the full and reasonable utilization of material materials and has the characteristics of feasibility and economy. At present, modern interior design has developed into a discipline. People no longer use hand-drawing to design the interior, but begin to use computers to design it. However, in the current interior design, the process of scheme design and construction design are out of touch with each other, and most of them are using general software to design at

various stages. How to integrate all aspects of interior design in a system is a difficult problem in practical professional design software, and it is also a blank in related fields. In order to effectively combine computer technology with interior design, it is necessary to use some Computer-aided design software, such as CAD, 3DMax, SketchUp, etc. At the same time, it is necessary to continuously learn and update your design knowledge and skills to adapt to the development of the times and changes in user needs. This includes learning new design concepts, materials, colors, and lighting techniques, as well as understanding user preferences and needs. Finally, it is necessary to establish good communication and cooperative relationships with users to understand their needs and feedback, and make adjustments and improvements based on their opinions and suggestions. Only through continuous practice and exploration can you perfectly combine computer technology with interior design and create satisfactory design works.

Interior design CAD system is a CAD system based on class definition and deep learning algorithm, which is used to support Interior designer to carry out design work. The design and development process of this system is as follows: Firstly, we need to define the classes of the system. These classes will represent objects in the system, such as rooms, furniture, doors and windows, etc. Each class should contain the properties and methods of the object. In interior design CAD systems, the attributes of objects can include position, size, color, material, etc., while methods can include operations such as movement, rotation, scaling, etc. To achieve automatic design and optimization functions, we can use deep learning algorithms. For example, we can use Convolutional neural network (CNN) to identify and segment furniture in images, thus helping the system to automatically layout and optimize interior design. Next, we need to design the functionality and interface of the system. The functions of the system should include creating, editing, saving 2D and 3D images, as well as importing and exporting CAD files. The interface should be concise, easy to use, and provide a wealth of tools and options to support designers in their design work. Finally, we need to use programming languages and corresponding development tools for system development and implementation. In interior design CAD systems, we can use Python and related deep learning frameworks such as TensorFlow or PyTorch for development. At the same time, we also need to use CAD software and technologies such as OpenGL or DirectX to create and render 3D images. In summary, the design and development of interior design CAD systems require the integration of class definitions, deep learning algorithms, and programming techniques. Such a system can improve the work efficiency and design quality of designers, and provide support for the development of the interior design industry. CAD software is a kind of design work software with powerful functions. It can effectively help interior designers to carry out interior design and give full play to the auxiliary functions of computer technology. At the same time, CAD has powerful drawing function, which can capture objects and exchange information. Interior design can be divided into four parts in the design process: design preparation, scheme design, construction drawing design and specific implementation process. CAD software can be applied to all aspects of indoor scheme design. By using CAD design, not only can the view be concise and beautiful, but also it is easy to modify and reuse. Therefore, CAD plays an increasingly important role in interior design. So far, in the design and development of CAD, structural analysis design method is mostly adopted. However, due to the process-oriented nature of the structural analysis design method, the change of user requirements will often have a great impact on the structure, design, procedures and documents of the whole system. In addition, the stability, modifiability and reusability of the system are not high.

Traditionally, 3D reconstruction technology is realized by laser scanning equipment or multiple color cameras, but the disadvantages of high price, complex operation, large data volume and poor real-time performance have always restricted the development of 3D reconstruction technology. In recent years, the development of artificial intelligence has attracted more and more attention of researchers. The new technology represented by DL is gradually changing the development of various fields. Traditional segmentation methods need to manually screen features, and have some shortcomings, such as low efficiency and dependence on artificial prior knowledge, low segmentation accuracy, and inability to deal with large-scale scenes. The development of DL network provides technical support for solving these problems. In addition, the

data-driven deep modeling learning technology, with enough data sets, uses the designed network model for training, which makes the task of 3D reconstruction simple and vivid from the original complexity, and becomes a new research direction at present. Different from the traditional methods, DL algorithm can make the machine learn features and classification automatically, and it has excellent performance in the field of images in recent years. As the intuitive information of the model, the view conforms to the human visual system and can be used as the input information of DL. The modeling framework uses octree grid to reorganize the data, and stores two representative features of point cloud, normal and curvature information, into the grid. Through the convolution and down-sampling operation of DL network, 3D objects are mapped to high-dimensional vector space. Finally, the modeling framework uses the Euclidean distance between objects as the retrieval basis to retrieve the most similar model from the database, and completes the modeling through scene registration. Its innovations and main contributions are as follows:

① In this text, the construction and training of DL network model are systematically studied, thus an interior design CAD system is constructed. It provides new ideas and methods for intelligent interior design.

② Aiming at the shortcomings of the traditional NN (Neural network), this text introduces an algorithm to adjust the momentum value adaptively, thus speeding up the learning rate and improving the learning accuracy.

③ In this text, using the Point Net network as the basic module, the traditional Point Net is improved, which solves the problems that the Point Net network will lead to the loss of local information of the point cloud and limit the network's ability to extract the detailed feature information of the point cloud.

According to the needs of research content and structure, the article is divided into five parts. The specific arrangements are as follows:

Section 1: Introduction. This section summarizes the background of the topic and the innovation of the article. Section 2: This section discusses the related issues of class definition and DL algorithm construction. Section 3: The design of interior design CAD system based on DL model, and the implementation process is given. Section 4: The model and system constructed in this text are simulated and tested, and its performance is analyzed. Section 5: Summarizes the research work of this text and discusses the research prospects in related fields.

2 RELATED WORK

Based on CAD virtual reality and indoor mobile augmented reality technology, it can be reflected in interior design, providing users with a more immersive and interactive experience. Through CAD virtual reality technology, designers can create a virtual indoor environment on the computer and simulate indoor lighting, materials, colors and other effects. In this way, designers can more accurately predict the final effect during the design phase and make timely adjustments and modifications. At the same time, customers can also experience the interior effects through virtual reality technology, thereby better understanding the designer's intentions and providing timely feedback. The indoor mobile augmented reality technology can make users more intuitively understand the interior design effect by adding virtual furniture, decoration and other elements to the real indoor environment. For example, by running augmented reality applications on mobile devices, users can see virtual furniture, decoration and other elements in the real indoor environment through the camera, and can interact and adjust, so as to better understand the interior design effect. Interior design based on CAD virtual reality and indoor mobile augmented reality technology can provide a more immersive and interactive experience, making communication and exchange between designers and customers more convenient and efficient. An interior design system based on CAD virtual reality and indoor mobile augmented reality can render virtual reality scenes in real-time on mobile devices. Enable users to immerse themselves in the interior design effect. The system can aim the mobile device camera at the actual indoor

environment, and superimpose virtual furniture, decoration and other elements into the real scene to achieve augmented reality effect. At the same time, users can freely move and interact in virtual reality scenes, such as rotating and scaling virtual furniture, or changing colors and materials. In addition, the system can generate multiple design schemes for users to compare and choose from, and personalized design schemes can also be generated based on user preferences and needs. Users can synchronize design data between mobile and desktop devices, enabling cross platform design and real-time collaboration. In summary, an interior design system based on CAD virtual reality and indoor mobile augmented reality can provide designers and users with a more intuitive, real-time, interactive, and personalized design experience.

Arbab et al. [1] conducted a project development and construction on the energy performance of computer buildings, aiming to establish an artificial neural network regression model for energy prediction dataset analysis. The internal energy performance of the building was optimized through the use of artificial intelligence AI models for machine learning neural networks and retrograde design of indoor louvers. Bao et al. [2] conducted a structured paradigm shift in interior design processing. It has developed a set of process innovation Engineering design process using production lines and standardized intelligent programs. The construction design and construction of building delivery were carried out through the use of manufacturing and assembly design. Böke et al.'s [3] analysis of energy consumption comfort in buildings has led to changes in energy demand for building exterior walls. Through grid analysis of CAD based intelligent building systems, the differences between intelligent buildings and static buildings were analyzed. Chang et al. [4] studied and analyzed an indoor mobile augmented reality application based on CAD virtual reality. By utilizing virtual object representations of interior design symbols, the 3D model of the design drawing is used for user interaction. The results indicate that using CAD intelligent technology for interior design learning assistance can significantly enhance the value of learning indicators. There is an increasing interest in the application of CAD 3D models to architectural semantic analysis. However, the inspection results based on 3D models often disappoint. Chen et al. [5] constructed a deep learning model for semantic algorithms and conducted multi feature relationship recommendation analysis through semantic matching of 3D models. Cho and Suh [6] constructed specific spatial models for interior design based on 3D and 2D information. It has developed a spatial Achievement test system for indoor buildings, which provides a high quality guarantee for the visual transformation of two-dimensional to three-dimensional forms of indoor products Hoang et al. [7] At the same time, it provides indoor visualization reference under the CAD system. Juan et al. [8] developed and designed a user oriented interior design and decoration decision-making system based on CAD virtual reality. Through integer planning of indoor space scenes in buildings, the optimal solution for the overall indoor color scheme was constructed. The survey results show that the coordination of color matching in CAD virtual overall space has certain advantages in realizing the decoration scene. The use of CAD virtual environment for interior design has become one of the current research directions in technology. Kalantari and Neo [9] conducted sensory feedback evaluations on the factors of realism and immersion in interior design. It considers interior design applications that enhance authenticity and immersion. Kciuk et al. [10] conducted an integrated analysis of indoor building information data processing based on the Internet of Things. Calculated the spatial sunlight autonomy of the interior in a 3D model. By implementing digital sensing control of micro control modules on the thermal comfort of indoor 3D models, the matrix efficiency of indoor thermal comfort has been improved. Lin et al. [11] conducted a regularized color design analysis for 3D indoor scenes. By fixed allocation of natural scenes in indoor images, it performs functional convergence checks on interior design constrained images in multiple aspects. Liu [12] conducted a structural range design for indoor color conversion and proposed a deep machine learning based indoor color transfer method. By introducing image mean target processing based on K-means algorithm and combining machine learning, it optimizes the clustering results of target images in interior design. Ma et al. [13] proposed an environment model of Building information modeling comfort based on CAD neural network model. It considers the energy-saving efficiency of human comfort in the thermal environment of building spaces. By analyzing the dynamic transformation of the returned

parameters, its construction simulated different spatial design optimization indicators for different schemes. This study provides guidance for creating green buildings based on thermal information and building models. Pepe et al. [14] used geometric resolution generalization and sharpening techniques for color images to construct a feature 3D model of the building. By analyzing the orthomorphic effects of visual analysis and quality index on learning application performance indicators, it provides precise guidance on the performance indicators of commercial building construction. The current digital interactive CAD virtual technology has been widely applied in interior design. Tang et al. [15] conducted an analysis of the virtual design function of indoor architecture on digital platforms, and constructed quality factors from a consumer perspective by analyzing the factors of platform digitization. Wu et al. [16] carried out a new data plane graphics driving technology for effective boundary building plane graphics analysis. The core of this method is to construct an encoder-based network effective training rule dataset for the learning network. Through feasibility and effectiveness analysis, it refined the rules for artificial floor plans. Young et al. [17] investigated the perceived differences among educators in traditional design of architectural spaces. By introducing deep learning, the respondents were effectively analyzed for their professional practice in architectural space. Identified the differences in architectural learning perspectives under neural networks.

3 CLASS DEFINITION AND DL ALGORITHM CONSTRUCTION

In recent years, DL technology has developed in an unprecedented way and has become a powerful tool in the fields of image classification, video processing, computer vision, and healthcare. In addition to the achievements made in the two-dimensional field, researchers have also applied the DL method to the three-dimensional field, conducting extensive research and achieving many results. DL based multi view feature extraction is common in 3D visual tasks. In the field of 3D object detection, the original feature extraction method based on perspective dimension is improved, a group similarity measurement method is proposed to obtain the similarity relationship of multiple perspective images, and multiple target Loss function are designed to optimize the learned features for 3D object retrieval tasks. A multi resolution Reeb map was constructed using the geodesic distance function to achieve model representation and similarity evaluation. Although the horizontal ground distance can well describe the topological structure of the 3D model, that is, the extracted features are independent of the deformation of the model. However, the selection of thresholds has strict requirements, and a small change can result in a completely different topology. Convolutional neural network is one of the most famous DL algorithms. With the tremendous success of CNN based DL methods in images, it indicates that DL has strong application prospects. At the same time, there are relatively complete DL based algorithms for various tasks of semantic understanding of two-dimensional images. Due to the excellent performance of DL in the field of image recognition, some scholars have introduced DL into the retrieval of 3D models. Render a 3D model to obtain a view and use it as input to DL to extract features for retrieval or classification. This processing method can also be classified as a view-based 3D model retrieval algorithm. The features of multi view images are extracted through Transfer learning on VGG16 network and used for 3D target recognition and classification tasks. This method adopts a feature fusion idea based on perspective dimension, which makes the fused multi view image features have more robust semantic information and achieves good results in 3D object recognition tasks. The end-to-end DL network converts depth maps into complete 3D voxel scenes and outputs category labels for each voxel. The cylinder surrounds a three-dimensional object, and the connecting line between the points on the cylinder and the height points corresponding to the object axis is determined by the number of triangular patches in the model as the pixel value. The cylinder is unfolded to obtain a two-dimensional rendering of the model. On this basis, use DL to extract features for 3D model classification. The gradient descent algorithm is a learning mode for the input layer of DL networks, so standardizing the input data can help improve the learning efficiency of the network. Then, the features of the input data are extracted through hidden layers to obtain advanced semantic information. After forward propagation, the

prediction result is compared with the objective function, and then the rule loss and Loss function are used to feedback the error. Finally, the parameters of each layer are corrected. In this way, the training does not end until the error is limited within a reasonable range, and this process is equivalent to the process of continuously approaching the objective function with weights. Assuming that the input layer, hidden layer, and output layer have, respectively, and neurons:

$$\mathrm{j}=1,2,\ldots,\mathrm{r};\mathrm{i}=1,2,\ldots,\mathrm{s1};\mathrm{k}=1,2,\ldots,\mathrm{s2} \tag{1}$$

The input is P, and the activation functions of the hidden layer and the output layer are $F1$ and $F2$ respectively. The thresholds are $b1$ and $\mathrm{b2}$, the outputs are $a1$ and $\mathrm{a2}$, and the target vector is T. The output of the i neuron in the hidden layer is as follows:

$$\mathrm{a1}_{\mathrm{i}}=F1(\sum_{\mathrm{j}=1}^{\mathrm{r}}\omega 1_{\mathrm{ij}}\mathrm{p}_{\mathrm{j}}+\mathrm{b1}_{\mathrm{i}}),\mathrm{i}=1,2,\ldots,\mathrm{s1} \tag{2}$$

The output of the k neuron in the output layer is as follows:

$$\mathrm{a2}_{\mathrm{k}}=F2(\sum_{i=1}^{s1}\omega 2_{\mathrm{ki}}a1_{i}+\mathrm{b2}_{\mathrm{k}}),\mathrm{k}=1,2,\ldots,\mathrm{s2} \tag{3}$$

The error function is defined as:

$$E(W,B)=\frac{1}{2}\sum_{k=1}^{s2}\left(t_{k}-\mathrm{a2}_{\mathrm{k}}\right)^{2} \tag{4}$$

DL network automatically obtains the weight parameters through multiple trainings, and it is easy to get the optimal segmentation result, so the algorithm has better generalization. However, training a high-precision model for point cloud semantic segmentation requires a lot of annotated point cloud data, so effective data sets can accelerate the research progress of semantic segmentation. At the same time, for DL technology, the standard, quantity and labeling information of data sets play a decisive role in the smooth progress of algorithm research. At present, the common 3D reconstruction data sets are as follows: Shape Net data set, Pix3D data set and NYU data set. The image description generation model proposed in this text adopts encoder-decoder framework. The network structure of DL model is shown in Figure 1.

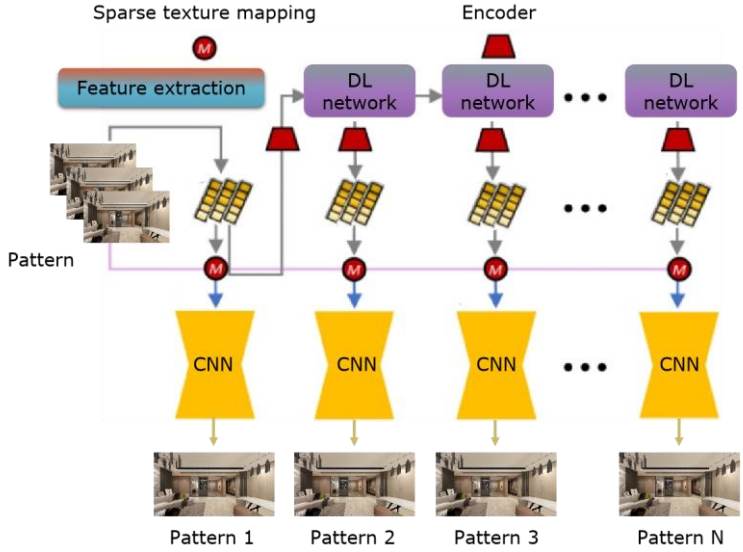

Figure 1: DL algorithm model structure diagram.

Point Net is a pioneering work to directly process the extracted features of point clouds by using DL method. It adopts the input mode of original point cloud, which preserves the spatial characteristics of point cloud to the maximum extent in data format, and also provides a unified framework for different tasks including model classification, object segmentation and scene semantic understanding. Based on DL technology, this text studies the 3D model reconstruction task based on DL technology. The constructed deep network classifier consists of multiple layers: input layer, several hidden layers and output layer. Taking the extracted view as input, more abstract conceptual features are extracted and synthesized by several hidden layers, and the output layer is used to output the category to which the model belongs. NN is used to design 3D model generation networks based on multi-view and single-view to reconstruct 3D geometry and structure of objects from multiple RGB images. By studying the method proposed by 3D model features, the framework of multi-network collaborative training is constructed, and finally the accuracy of 3D model generation is improved.

4 DESIGN OF INTERIOR DESIGN CAD SYSTEM BASED ON DL MODEL

This section designs interior design CAD system based on DL model. The interior design CAD system based on DL model is designed and developed with the idea of object-oriented, and the operation and use style of popular software such as AutoCAD and 3dMax are fully considered, so that designers who are familiar with this software can easily intervene. The objects in real interior design, such as doors, windows, walls, etc., are regarded as the first-class objects in the graphic database of Auto CAD, so that they can be directly operated with the editing command of Auto CAD. These professional objects also have flexible characteristics and intelligent genes. In this text, Point Net is used as the basis NN for extracting point cloud features, and semantic segmentation and instance segmentation are used as two task branches of the network to train the network. Point Net network adds input transformation matrix and feature transformation matrix, and performs matrix transformation on input point cloud data and extracted features respectively; All the added matrices are transformed into orthogonal matrices through the transformation parameters automatically generated by T-Net module. This makes point cloud have rotation invariance in network learning, and has the ability to adapt to the changes of different perspectives and realize automatic alignment of data and features. In order to speed up the training process of the network and improve the final test accuracy of the network, Batch Normalization layer operation is added behind the convolution layer when designing the self-coding network in this text. Batch Normalization standardizes each layer of NN, and the mean and variance of data learned from training samples are taken as the mean and variance of this layer during testing. Semantic segmentation and instance segmentation tasks share the global feature vector of point cloud and the feature vector of each point obtained by encoder and decoder, and send the feature vectors to the semantic segmentation task and instance segmentation task respectively. Semantic segmentation method is similar to Point Net, and instance segmentation adopts cosine similarity coupling method. The ViewPool layer uses the maximum pool operation. The purpose of this operation is that each unit of the output feature graph is the strongest feature, which ensures that the view feature is a concise and effective descriptor after learning by NN. Figure 2 shows the NN network structure diagram of this paper.

In this text, the iterative nearest point algorithm is used to register the retrieved database objects with the initial scene to complete the final modeling process. In essence, the algorithm continuously calculates the corresponding rotation and translation matrix by repeatedly selecting the point pairs corresponding to the adjacent relationship. Finally, through this process, the gap between the two-point clouds is continuously narrowed, and finally the registration process is completed. The 3D model generation network consists of two separate loss functions: the self-encoder module and the image feature extraction module, which are used to optimize the network structure in stages. These two loss functions are cross entropy loss and Euclidean distance loss respectively.

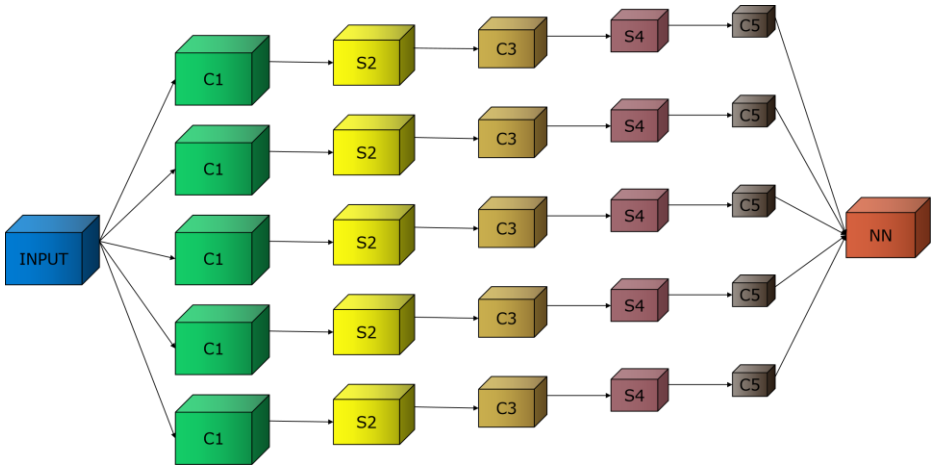

Figure 2: NN network structure.

Taking the weight variable W_{ij} as an example, the momentum term is introduced to make:

$$\Delta W_{ij}^{'} = -\eta \frac{\partial e(k)}{\partial \omega} \tag{5}$$

Then:

$$\Delta W_{ij}(t+1) = \Delta W_{ij}^{'}(t+1) + \alpha \Delta W_{ij}(t) \tag{6}$$

If:

$$\Delta W_{ij}^{'}(t+1) * \Delta W_{ij}(t) > 0 \tag{7}$$

It means that on the error surface. If:

$$\Delta W_{ij}^{'}(t+1) * \Delta W_{ij}(t) < 0 \tag{8}$$

It shows that a local minimum point has been crossed from $\Delta W_{ij}(t)$ to $\Delta W_{ij}^{'}(t+1)$ on the W_{ij} axis. In order to avoid oscillation, this text hopes that the modification range of $\Delta W_{ij}(t+1)$ is smaller, and the sum of $\Delta W_{ij}^{'}(t+1)$ and $\alpha \Delta W_{ij}(t)$ just meets this requirement. From the feature point of view, the quality of network feature extraction affects the performance of DL-based model, and avoiding the loss of information in the process of feature extraction often enhances the richness and robustness of extracted features. The feature extraction network can be regarded as mapping a point cloud object to a point in a high-dimensional space. The network performs four convolution and down-sampling operations on the octree mesh storing curvature information and normal vector information respectively, and obtains two 64-dimensional feature vectors. Then, the two features are fused, and the fused features are convolved and down-sampled twice to obtain a 256-dimensional vector. Finally, through full connection and Softmax operation, the 55-dimensional vector is obtained, which is the output of the feature extraction network. In order to solve the problems that the Point Net network will lead to the loss of local information of the point cloud and limit the ability of the network to extract the detailed feature information of the point cloud, an improved hierarchical recursive network model Point Net++based on the idea of multi-layer receptive field. Based on this, this text uses Point Net network as the basic module, and extracts features from local areas by repeatedly using Point Net to generate new point sets, and

then uses Point Net to realize multi-level feature learning in some areas of point sets, and finally obtains the final global features through multi-layer network structure.

On the contrary, the lower the similarity of vectors. According to the characteristics of cosine function, its value range is [-1,1]. In order to facilitate the training of NN, this text shifts and scales the cosine similarity value [0,1], as shown in the following formula:

$$S_{ij} = \frac{1}{2}\left(\frac{1+X_i^T X_j}{\|X_i\|_2\|X_j\|_2}\right) \tag{9}$$

In the interior design CAD system based on class definition and DL algorithm, a variety of modeling methods are provided, and designers can build 3D building models conveniently and quickly according to their own needs. At the same time, the type, style and shape determined by the system according to the class definition of professional objects such as doors and windows can be randomly changed according to the parameters required by users through interactive dialogs. Therefore, the flexibility of the system is greatly improved. The indoor design CAD data acquisition system is shown in Figure 3.

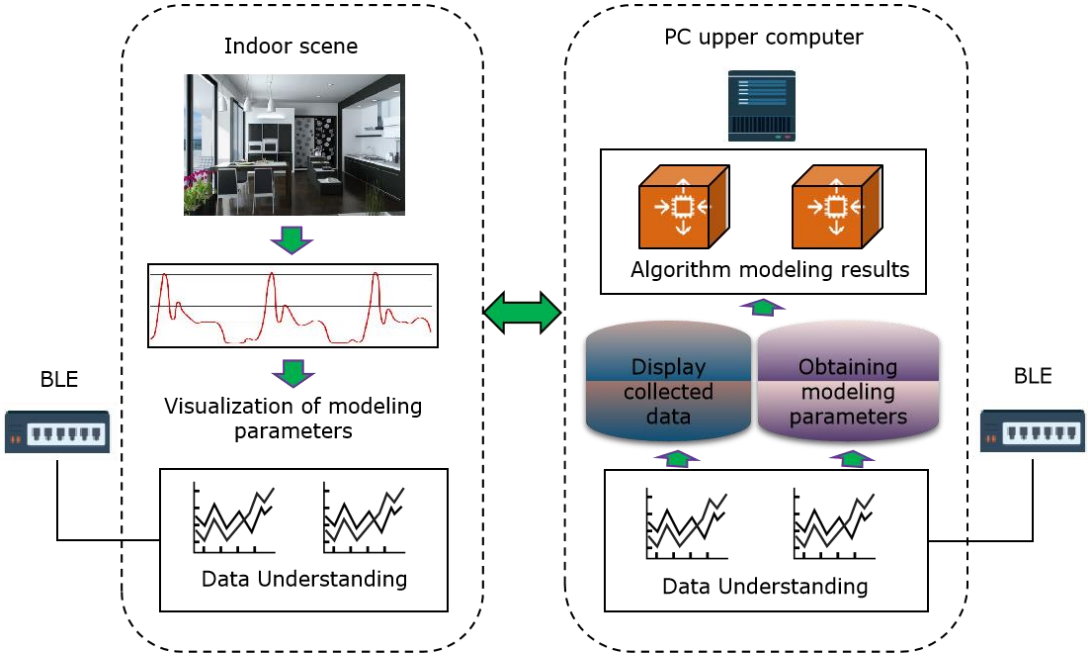

Figure 3: Block diagram of indoor design CAD data acquisition system.

Virtual reality module is the simulation design module of this system. It draws a real 3D scene by means of material texture mapping, light source camera setting, scene arrangement, etc., and makes a 3D simulation effect map, and records it into a virtual roaming cartoon that can be played repeatedly by means of setting animation paths. Firstly, the 3D point cloud needed for indoor data set sampling is used as the input data of the network, and a group of offsets from the center of mass are generated for the object through the first coding and decoding structure. Then, the coordinate information of the origin cloud is superimposed in the second stage by using the offset attention mechanism, and each point in the point cloud is given a corresponding semantic label. The network puts forward the features of each view image by the method of transfer learning, and uses a view dimension pooling operation to fuse the features of multiple view images. The fused

features will be input to the decoder network as the aggregated information representing the target object to recover the 3D model information. The database of this system adopts Auto CAD database. This enables the system to directly access the structure in the Auto CAD database by using the classes provided by AcDb, while defining professional objects and primitives such as lines, circles and arcs, and at the same time increasing the ability of Auto CAD to support existing objects and primitives through protocol extension. When drawing with interior design CAD system, we should follow the following flow sequence: first, set up the unit and proportion of the renderings, usually in millimeters; Secondly, it is need to set the boundary of the drawing; Then, build the necessary layers such as axis; Finally, edit text and linear formatting styles.

5 EXPERIMENTAL RESEARCH

The indoor design CAD system based on class definition and DL algorithm is based on ARX and designed by object-oriented technology. The main professional objects often used in interior decoration and renovation engineering design are defined by classes, and the class libraries, functions and methods provided by Object ARX are fully utilized. Therefore, the system has certain functionality and flexibility. The data set used in this experiment is Shape Net, which is a large online 3D model library. Several categories of data are selected for training and testing: airplanes, sofas, monitors, telephones and so on. At present, the more advanced literature methods all choose the same category to test the algorithm, which is convenient for evaluating the performance of the algorithm. Training for the network for 60 cycles, the batch size is 6, and the basic learning rate is set to 0.001. Adam optimizer is used to optimize the network on a single GPU, and the momentum is set to 0.8. A cycle takes about 30 minutes. In this text, the network can capture the local geometric structure while maintaining the invariance of arrangement by generating the relationship between a point and its adjacent points, and directly generate the characteristics of points from their embedding. As shown in Figure 4.

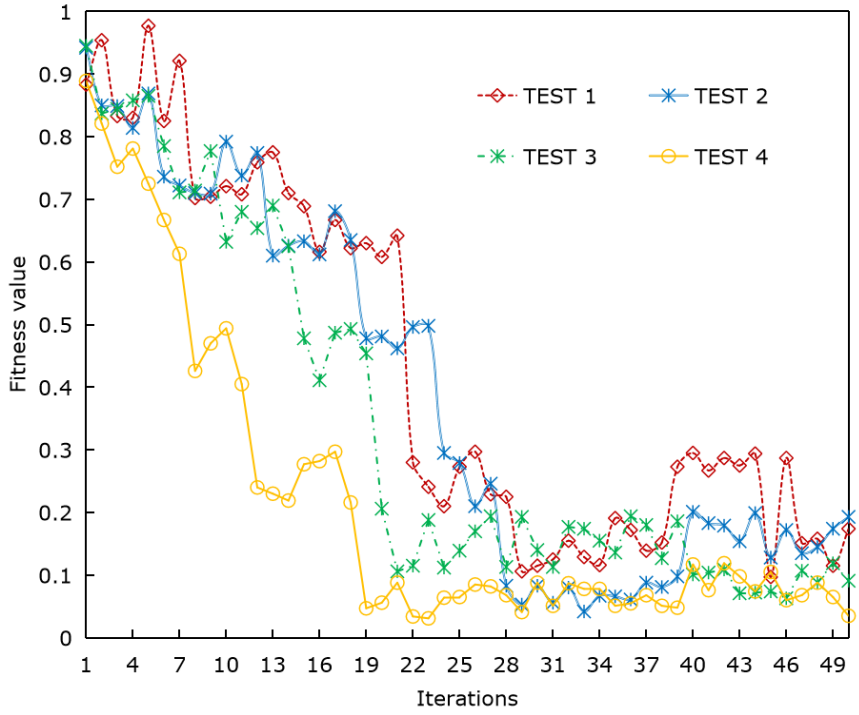

Figure 4: Network convergence trend diagram.

As can be seen from Figure 3, after 20 iterations, the network output error has converged to a certain extent. In this text, 20 iterations can meet the requirements. If higher accuracy is required, the quantity of iterations can be increased according to the situation.

In order to improve the accuracy of 3D model generation, a strategy based on multi-network collaborative learning and two-stage training is designed to train the multi-view 3D model generation network. During the training, the self-encoder network is used as the auxiliary network of the network that directly generates 3D models by using multi-view image features, and the parameters of the two network modules are trained respectively until the models converge. The traditional NN algorithm, PSO algorithm and this algorithm are used to retrieve the image matching degree. The relationship between the values is analyzed by line chart, and the test results are shown in Figure 5.

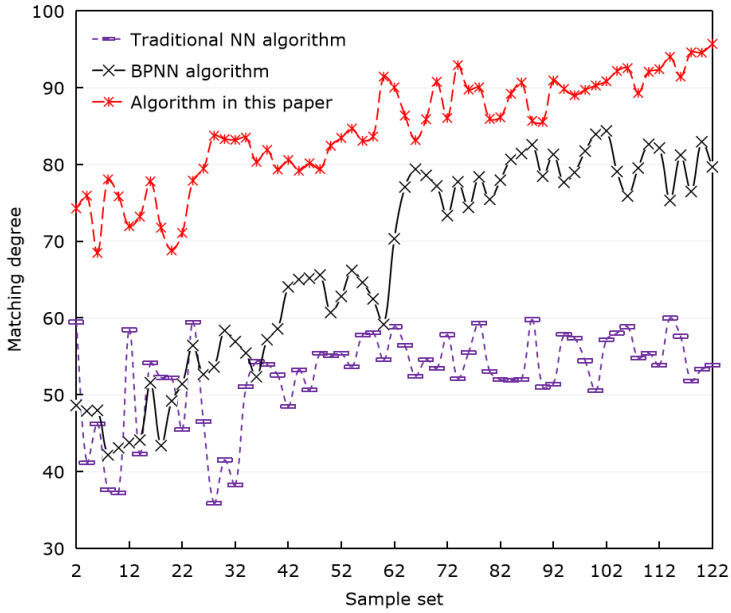

Figure 5: Algorithm to retrieve matching results.

From the results shown in Figure 4, it can be seen that this algorithm is superior to the traditional NN algorithm and BPNN algorithm. It is proved that the interior design CAD system based on DL algorithm in this text meets the design requirements. Under the same experimental conditions, the Traditional NN algorithm, BPNN algorithm and Algorithm in this paper are tested respectively, and the experimental results are counted. Figure 6 shows the comparison of algorithm time. As can be seen from the figure, under the same experimental conditions, the Algorithm in this paper takes less time, only about 0.2s, and it can get ideal results in a shorter time.

In this text, the farthest sampling point method is used to get the sampling points, and then the local domain points of the sampling points are obtained according to the grouping layer, and the coordinate system is converted into the local coordinate system. Finally, using Point Net to extract the features in this local area to get new points. Through the iteration of the abstraction layer in the local area, the points of the original point cloud are gradually abstracted and the number is decreasing, but the newly generated points carry more and more information features, which is equivalent to the enlargement of the receptive field, and the purpose of extracting local features is achieved.

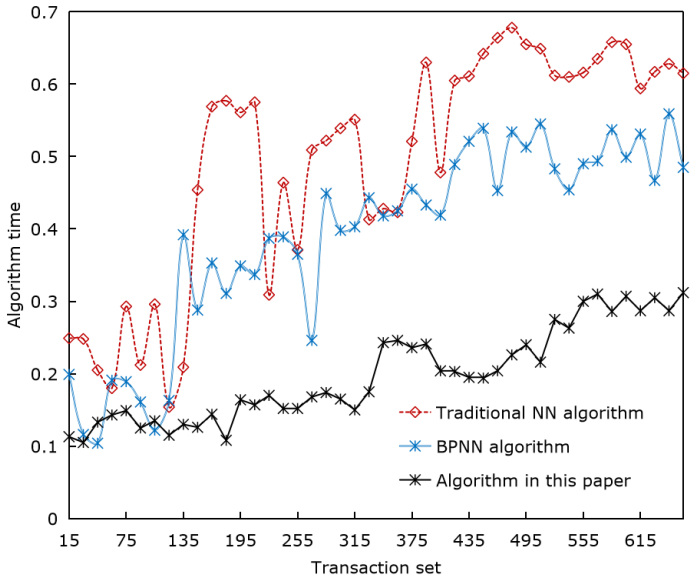

Figure 6: Algorithm time comparison.

When testing, it has certain error to randomly select three perspective images of each 3D model in the test set for testing. In order to reduce the test error and improve the accuracy of the experimental test results, this text randomly selects three perspective images for each test sample in the test set for 120 times during each test, and obtains the average value of each test result as the experimental test accuracy data of each test sample. After 50 iterations of network training, the traditional NN, BPNN and the improved network MAE in this text are shown in Table 1, Table 2 and Table 3 respectively.

Iterations	*Test 1*	*Test 2*	*Test 3*	*Test 4*
5	2.26	2.13	2.39	2.21
10	2.04	2.03	2.23	2.19
15	1.91	2.08	2.14	2.27
20	2.17	1.93	1.97	2.29
25	2.22	2.27	2.13	2.03
30	2.25	2.06	2.06	2.09
35	1.98	1.91	2.27	2.05
40	2.16	2.24	2.06	1.92
45	2.17	2.14	1.98	1.93
50	1.94	2.09	1.98	2.14

Table 1: MAE of traditional NN.

Iterations	*Test 1*	*Test 2*	*Test 3*	*Test 4*
5	2.11	2.56	2.01	2.03
10	2.17	2.63	1.92	2.17
15	2.22	2.26	2.02	2.18
20	2.24	2.15	1.94	2.2
25	1.92	1.91	1.94	2.22
30	2.01	1.94	2.14	2.09
35	2.26	2.27	2.14	2.08

40	2.17	2.26	1.92	2.08
45	1.93	2.04	2.01	1.99
50	1.89	1.90	1.83	1.76

Table 2: MAE of BPNN.

Iterations	*Test 1*	*Test 2*	*Test 3*	*Test 4*
5	1.33	1.39	1.43	1.35
10	1.27	1.21	1.41	1.37
15	1.32	1.26	1.64	1.43
20	1.29	1.43	1.61	1.44
25	1.26	1.44	1.74	1.42
30	1.34	1.24	1.51	1.41
35	1.28	1.47	1.74	1.26
40	1.26	1.42	1.41	1.23
45	1.42	1.46	1.79	1.43
50	1.20	1.27	1.22	1.21

Table 3: MAE of this network.

It can be seen that when the quantity of iterations is 50, the MAE of the network in this text is smaller than that of the traditional NN and the standard BPNN. This proves that the DL network proposed in this text has strong 3D model reconstruction ability. To some extent, it also shows that the DL network in this text has stronger 3D feature extraction ability, which can ensure the reconstruction accuracy and the robustness of feature extraction.

In the interior design CAD system based on class definition and DL algorithm, there are interrelated relationships between doors, windows and walls, between wall products such as air conditioners, wall clocks and paintings, and between computers, desk lamps, telephones and desks. Based on this, this text considers writing a corresponding program to form an add command, and only by using the add command can this relationship be realized on the surface. According to statistics, the comparison of user ratings of different systems is shown in Figure 7.

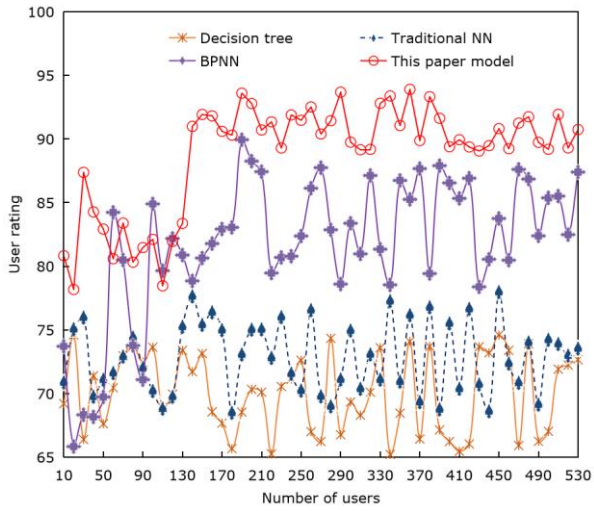

Figure 7: Comparison of user ratings of different systems.

From the data analysis in Figure 5, it can be concluded that the user rating of the system designed in this text is better than the other three comparative system design. Table 4 shows the test results of system stability.

Sample set	*Traditional NN*	*Standard BPNN*	*The method in this text*
800	77.707	77.33	91.349
825	77.275	73.253	90.671
850	73.269	74.034	92.151
875	71.542	72.369	93.258
900	72.282	72.531	89.095
925	73.541	74.222	91.216
950	72.62	73.793	89.395
975	73.982	78.128	89.872
1000	67.641	78.328	91.678
1025	69.919	74.374	89.377

Table 4: System stability test results.

Because of the advantages of object-oriented design and class definition, the system has a certain level of intelligence. The test results in this section show that the system in this text can still achieve 89.095% stability under the condition of relatively large usage. In addition, when the quantity of iterations is 50, the MAE of this network is smaller than that of traditional NN and standard BPNN, which means that its calculation results are better. The user rating of the system designed in this text is better than the other three comparative system designs, and the highest user rating reaches 93.598. This shows the superiority and practicability of this method. It is proved that the interior design CAD system based on DL algorithm in this text meets the design requirements.

Deep learning (DL) algorithms can play an important role in interior design CAD systems to meet design requirements. Using deep learning algorithm to automatically layout, such as Convolutional neural network (CNN), you can automatically layout furniture, decoration and other elements in interior design. This not only improves the work efficiency of designers, but also makes the layout more uniform and aesthetically pleasing. Deep learning algorithms can identify and segment elements such as furniture, walls, and floors in interior design CAD systems, thereby helping designers design and modify more accurately. Image generation using deep learning algorithm: for example, the Generative adversarial network (GAN) can generate high fidelity images, 3D models and other elements in the interior design CAD system, so as to help designers predict the final effect more accurately. By using deep learning algorithms for style transfer, style conversion can be achieved in interior design CAD systems. This can make it more convenient for designers to achieve different styles of design and meet the needs of customers. Intelligent optimization can be realized in interior design CAD system by using deep learning algorithm, such as Reinforcement learning algorithm. This can enable the system to automatically adjust the elements in the design to achieve better results and higher user satisfaction. In summary, deep learning algorithms in interior design CAD systems can meet design requirements, improve designers' work efficiency, and make designs more accurate and aesthetically pleasing.

6 CONCLUSIONS

In order to meet the needs of the people, it is need to apply CAD system to interior design to further improve the level of interior design. This text discusses the application of CAD software in interior design. And the class definition and DL algorithm are introduced comprehensively. On this basis, based on class definition and DL algorithm, a new interior design CAD system is designed,

and the construction and training process of DL network model are given. The network model realizes the fusion of multi-view image features by a pooling operation according to the view angle, and uses the multi-network collaborative learning method to train the network parameters in two stages. Which can further improve the performance of the multi-view 3D model generation task. Finally, the simulation experiment is carried out using Shape Net data set. The results show that the system in this text can still achieve 89.095% stability under the condition of relatively large usage. In addition, the user rating of interior design CAD system reached 93.598. The system is developed and designed according to the characteristics of interior design industry, and comprehensively integrates 3D modeling, floor plan entry, interior decoration, construction drawing, statistical calculation, 3D virtual reality and other modules, which realizes the integrated design of each stage in the decoration process and has important application value. Both theoretical and simulation results show that the indoor design CAD system based on class definition and DL algorithm has achieved good results. The system has obvious advantages over the system based on traditional technology in terms of function and performance. In the future, we will further study and explore, and strive for the real comprehensive application of interior design CAD system.

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