Architecture and Scene Restoration Using Multi-feature Fusion of Building Information

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Abstract. Architecture and scene restoration not only need to provide static display effect, but also need to have interactivity, allowing the audience to interact with the virtual environment, such as roaming, perspective change, query and so on. In the construction industry, computer-aided design (CAD) is widely used in the design and planning stage, while virtual reality (VR) technology provides designers with an intuitive and realistic visual experience, which enables designers to observe and analyze the building in depth before it is completed. In this article, an architectural image algorithm based on multi-feature fusion is studied. The features of architectural images are extracted and analyzed by using Convolutional Neural Network (CNN) to optimize the 3D modeling process, and then the restoration of buildings and scenes based on CAD and VR is realized. In this algorithm, CNN is used to extract and analyze the features of architectural images, so as to optimize the 3D modeling process. The results show that the building image recognition algorithm based on multi-feature fusion has higher accuracy and running efficiency than the contrast algorithm. Moreover, the algorithm in this article has good stability and generalization ability, and can adapt to the needs of different architectural scenes.

Keywords: CAD; Virtual Reality; Architectural Scene; Convolutional Neural Network
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1 INTRODUCTION

Restoration of buildings and scenes refers to the simulation, restoration or reproduction of existing buildings or scenes through technical means, so as to provide a true, intuitive and immersive feeling. The maintenance and operation of substations are crucial for the stable operation of the power system. At the same time, substations are also crucial for maintaining the safety of the power system. It can prevent faults such as short circuits, overcurrent, overvoltage, etc., thereby ensuring the safe operation of the power system. Therefore, effective supervision and management of substations has important practical significance. However, traditional substation supervision methods have some problems, such as high on-site safety risks and low detection efficiency. To address these issues, Barreto et al. [1] proposed a method for designing a virtual reality environment based on CAD floor plan creation systems, aiming and secure new supervision method for substation supervision. More and more researchers are applying virtual reality technology to substation supervision. Through virtual simulation of substations, real-time monitoring and predictive maintenance of substations can be achieved. At the same time, virtual reality technology can also construct three-dimensional models of substation equipment, improving the accuracy and efficiency of equipment detection. This technology can be applied to the restoration of ancient buildings and historical scenes, as well as urban planning and cultural heritage protection. The goal of building and scene restoration is to reproduce the appearance, structure and surrounding environment of the building as truly as possible, as well as the atmosphere and activities of historical scenes. Among them, the application of empowerment algorithms in architectural design is receiving increasing attention. For beginners in computational design, understanding how to use empowerment algorithms to assist in building design will help improve design efficiency and innovation capabilities. Chen et al. [2] analyzed empowering algorithms for novice computational design to assist in architectural design exploration. Establishing a digital model is a crucial step in the architectural design process. Digital models can not only visualize the process and results of architectural design, but also be used to analyze the performance and optimization schemes of architectural design. It is also necessary to understand different modeling methods and ideas in order to flexibly apply them in practical projects. After establishing a digital model, how to optimize it is an important skill that novices in computational design need to master. When selecting optimization algorithms, it is necessary to consider the specific needs and constraints of the project for selection. The restored buildings and scenes need to be as accurate as possible, including the shape, size, color and texture of the building, as well as the layout and atmosphere of the surrounding environment. In order to achieve high-precision restoration, advanced 3D scanning and image processing technology are needed. The restored buildings and scenes need to pay attention to details, showing the detailed features and decorations of buildings as much as possible, as well as the details of characters, props and costumes in historical scenes. Guo and Wang [3] through this method, artists can accurately preview and evaluate their works in the early stages of production, checking whether their shape, proportion, and texture have achieved the expected results. In addition, using rendering techniques, artists can also simulate different lighting and material effects to obtain a visual preview that is closer to the actual production effect. CAD software can handle complex geometric calculations and structural problems well, allowing sculpture artists to create works with more complex structures and unique designs. aiming to highlight its importance and provide new ideas for the development of future sculpture art. Computer assisted styling design is a means of utilizing computer technology for styling design. Through professional design software, creators can more accurately depict and shape artistic images. Computer assisted modeling design can first be applied to modeling and sketch design in the process of sculpture art creation. Using 3D modeling software, artists can accurately construct the appearance and structure of sculpture works. At the same time, through various brushes and tools in the software, creators can try different sketch designs in a virtual environment, providing more possibilities for subsequent creations. On the basis of modeling, computer-aided design can also be used to create materials and textures for sculpture works. By utilizing functions such as mapping, lighting, and rendering, artists can add more realistic materials and texture effects to their works, making sculpture works visually more vivid and realistic.

This kind of detail presentation needs a lot of image processing and computer graphics technology. Architecture and scene restoration not only need to provide static display effect, but also need to be interactive, allowing the audience to interact with the virtual environment, such as roaming, perspective change, query and so on. For some large buildings and scenes, the restoration process needs to be real-time so that the audience can observe and experience it in real time. This requires high-performance computing and graphics processing technology to achieve efficient rendering and calculation. The restored buildings and scenes should be reusable, so that they can be repeatedly displayed and used in different occasions and times. This requires the use of common data formats and data structures to facilitate the editing, storage and transmission of data. With the continuous development of technology, computer-aided design software is increasingly widely used in various fields. Among them, AutoCAD is a powerful 3D modeling software, and its application in industrial modeling design has become an important trend. Hu [4] introduced the basic concepts, application scenarios, and applications, and evaluated its advantages and disadvantages through case analysis. AutoCAD 3D modeling features provide rich modeling tools and commands, such as basic geometry such as boxes, spheres, and cylinders, as well as operation commands such as stretching, rotating, and sweeping. These tools and commands can help designers quickly build complex 3D models. For the established 3D model, designers need to check and optimize it to ensure the accuracy and aesthetics of the model. Common inspection and optimization methods include measuring the dimensions of each element in the model and checking whether it meets design requirements. Check if the geometric structure in the model is reasonable and if there are any holes, overlaps, or other issues. Add appropriate material maps to the model according to actual needs to improve visual effects. By adjusting rendering parameters and lighting, the visual effect and fidelity of the model can be improved. With the continuous progress of modern technology, CAD and VR have become important tools for building and scene restoration. In the construction industry, CAD is widely used in the design and planning stage, while VR provides us with an intuitive and realistic visual experience, which enables designers to observe and analyze the building in depth before it is completed. However, extracting accurate 3D information from 2D architectural images is one of the difficulties of this technology. In this algorithm, CNN is used to extract and analyze the features of architectural images, so as to optimize the 3D modeling process. This algorithm can not only improve the accuracy of 3D reconstruction, but also reduce the requirements for the quantity and quality of input images. In addition, the algorithm has a wide range of applicability and can be applied to various types of buildings and scenes. This article expounds the principle of CNN algorithm, and introduces the principle and implementation method of building image proposed in this article. In the stage of implementation, CNN and traditional computer vision algorithm are combined to make full use of their advantages.

Point cloud CAD model recognition and fitting is one of the important applications in manufacturing, construction, the development of deep learning technology has provided new solutions for point cloud CAD model recognition and fitting. Hu et al. [5] explored deep learning-based point cloud CAD model recognition and fitting methods recognition and fitting. In recent years, significant progress has been made in the application of deep learning in the field of point cloud CAD model recognition and fitting. Traditional point cloud CAD model recognition methods are mainly based on feature extraction and classifier design, but these methods are often affected by factors such as noise, occlusion, and complex geometric shapes, resulting in poor accuracy and robustness. The point cloud CAD model recognition method based on deep learning utilizes neural networks for end-to-end feature learning of point cloud data, avoiding manually designed feature extraction steps, and has higher accuracy and robustness. Ma et al. [6] uses the graphics and animation features of Auto CAD to clearly display network design concepts, such as network topology, the location of routers and switches, and how to connect various devices. The Network Architecture Teaching System is an online education platform based on the Internet and computer technology. Through this system, students can learn architectural knowledge at any time and place, and can also engage in real-time interactive communication with teachers and classmates. In the process of designing a network architecture teaching system, we first need to plan the overall architecture. We will use cloud computing technology for deployment, achieving load balancing and data storage. In terms of system testing and maintenance, we will use various, and performance testing to ensure the stability of various functions. At the same time, we will also establish a comprehensive maintenance mechanism to regularly inspect, upgrade, and repair the system to ensure its sustainability and reliability. CAD and VR can restore buildings and scenes with high precision, including the appearance, structure and surrounding environment of buildings, as well as the atmosphere and activities of historical scenes. Through these technologies, we can show the features of ancient buildings and historical scenes more truly and intuitively, and enhance cultural self-confidence and inheritance. VR can provide an immersive visual experience, so that the audience seems to be in a historical scene. Moreover, VR also has interactivity, allowing the audience to interact with the virtual environment, such as roaming and changing perspectives, which further improves the user experience and allows the audience to understand and feel the cultural connotation of ancient buildings and historical scenes more deeply. CAD and VR can reduce the need for physical restoration and reconstruction of ancient buildings and historical scenes, thus saving time and cost. Moreover, these technologies can also digitally preserve ancient buildings and historical scenes before they are destroyed or disappeared, so that future generations can better understand and recognize these cultural heritages. The innovation of the research mainly includes the following aspects:

(1) This article proposes a method for building and scene restoration based on CAD and VR, which combines building image recognition algorithms with CAD and VR technologies to achieve realistic, accurate, and detailed reproduction of buildings and scenes.

(2) This algorithm uses CNN to extract and analyze building image features to optimize the 3D modeling process. By combining CNN with traditional computer vision algorithms, more accurate 3D models have been achieved.

(3) The architecture and scene restoration method proposed in this article not only provides static display effects, but also enhances interactivity and real-time, allowing the audience to interact with the virtual environment, such as roaming, perspective transformation, etc., further improving the user experience.

The structure of this article is arranged as follows:

Part 1: Introduce the research background of this article, and explain the principle and implementation method of the proposed building image recognition algorithm based on multi feature fusion.

Part 2: Summarize the relevant research achievements of scholars in this field and propose local methods for building and scene restoration.

Part 3: Introduce the theoretical and technical foundations of CAD and VR in architecture and scene restoration.

Part 4: Introduce the specific implementation stage of the algorithm proposed in this article, including data preprocessing, feature detection, feature fusion, 3D modeling, and other steps.

Part 5: Experimental verification and analysis of the algorithm proposed in this article, including experimental settings, experimental results, analysis, and discussion.

Part 6: Summarize the research achievements and contributions of this article, and discuss future research directions and application prospects.

2 RELATED WORK

Ma et al. [7] performs point by point operations by independently applying convolution at each point. In this way, the features of each point can be updated separately without considering the information of other points. This operation method can preserve more local details. Input the extracted features into fully connected layers or other classifiers for final 3D object segmentation. According to actual needs, up-sampling or down-sampling operations can be selectively applied to adjust the output resolution. Using label data to train MS-PointConv can use common loss functions such as cross entropy loss or Dice loss. The optimization algorithm can choose random gradient descent (SGD), Adam, etc. Multi scale point by point convolutional neural network is a deep learning network specifically designed for point cloud data. By using point by point convolutional layers and multi-scale feature fusion strategies, point by point feature extraction and global information integration can be performed on input point clouds. In the network structure, each convolutional layer adopts a point convolution kernel that adapts to the point cloud structure, capturing the features of each point, point by point. Furthermore, local information is propagated to the global level, allowing the network to fully consider the spatial distribution characteristics of point cloud data. Specifically, the network first performs preliminary feature extraction on the input point cloud through convolutional layers, and then uses point by point convolutional layers to extract features and propagate neighborhood information for each point. On this basis, a multi-scale feature fusion strategy is used to integrate feature information from different scales, forming a richer feature expression. Finally, the fully connected layer is used to classify features and obtain the segmentation results of 3D objects. Among them, desktop virtual reality technology has become an important tool for studying the learning process due to its low cost, high popularity, and ease of use. Makransky and Petersen [8] introduced a structural equation modeling method based on desktop virtual reality technology for studying the learning process. During the learning process, students acquire knowledge and skills through interaction with virtual environments. In order to better understand the learning process, we can design an experiment or survey questionnaire to collect data on students' learning process, including personal attributes, learning behavior, and learning outcomes. Learning outcomes can be reflected through students' academic performance, skill mastery, and other factors. After collecting these data, we can use structural equation modeling methods to analyze the learning process. Structural equation modeling is a statistical method that can be used to test and estimate causal relationships. Through structural equation modeling, we can reveal the relationship between learning outcomes and individual attributes, learning behavior, and how these factors interact to influence the learning process.

Mourtzis and Angelopoulos [9] uses AR devices to capture real-world input data (such as video recording through smartphones or headsets), and then preprocesses this data. The preprocessing steps may include cleaning, standardizing, and normalizing the data. In the AR environment, users can use an intuitive interface to create ANN models. This may include establishing connections by dragging and dropping neurons, as well as adjusting the weights and activation functions of each neuron. To provide useful ideas and directions for research and practice in related fields. After data collection and preprocessing, an artificial neural network model can be constructed for in-depth analysis of the data. The specific choice of model depends on the requirements of the specific task. For example, CNN is suitable for image and video processing, while RNN is more suitable for processing temporal data such as voice and text. By adjusting the architecture and parameters of the neural network, the accuracy and efficiency of the model can be further improved. Asynchronous event driven refers to the ability of a system to perform asynchronous processing based on priority and event triggering conditions in a multitasking environment. This can be achieved by introducing mechanisms such as event queues and thread pools to ensure the system has efficiency and responsiveness when processing various tasks. The system can automatically learn and optimize behavior strategies to better meet user needs. Users' demand for VR experience is also increasing. In VR environments, 3D modeling and design reviews are key factors that affect user preferences and experiences. Therefore, evaluating user preferences in these areas is quality and user satisfaction of VR technology. Nysetvold and Salmon [10] evaluating user preferences and design elements, the correlation between user preferences and design elements can be further analyzed. For example, certain design elements may be more well received by users, while certain elements may need improvement. By analyzing these correlations, designers can better grasp user needs. Through methods such as questionnaire surveys, user interviews, and user experience analysis, we can obtain user preferences and feedback on different aspects of the VR environment. On this basis, we can further analyze the correlation between user preferences and design elements, providing guidance for optimizing 3D modeling and design reviews in VR environments. Water surface waves are a common physical phenomenon that cause fluctuations in the water surface, forming waves. In some cases, we may need to improve the spatiotemporal resolution of water surface waves in order to better understand their dynamic changes. Peng et al. [11] will introduce a spatiotemporal super-resolution water surface wave learning method based on learning frequency aware convolutional neural network (FAP-CNN). In order to train FAP-CNN, we need to prepare a set of spatiotemporal super-resolution water surface wave data as the training set. These data need to include the spatiotemporal variation characteristics of various water surface waveforms, so that the model can learn various possible waveform shapes and dynamic behaviors. When training FAP-CNN, we use the Random Gradient Descent (SGD). The study conducted experimental validation using both synthetic and measured datasets. The synthesized dataset is generated by a mathematical model and contains water surface waves of various complexities. The measured dataset is collected by high-precision instruments and includes various dynamic changes of real water surface waves.

Tai and Sung [12] propose a method of using photographic images to obtain the geometric and physical features of the measured object for object recognition, measurement, and digital modeling. This technology is mainly used for photogrammetry and digital modeling of architectural space in digital archiving. 3D laser scanning is a method of using the principle of laser ranging to obtain 3D coordinate data of the object surface by scanning the surface of the measured object, thereby establishing a 3D model of the object surface. This technology has a wide range of applications in digital archiving of building spaces, which can quickly and accurately obtain data such as the shape, position, and size of building spaces. Building Information Model (BIM) technology is a process of architectural design and document management that improves design quality by generating, managing, and exchanging architectural information, while reducing project costs and timelines. BIM models can contain information such as the geometric shape, spatial relationships, geographic information, component attributes, and rules of buildings. This model can be updated and modified at various stages of design, thereby reducing errors and conflicts. However, the perception and experience of architectural space is not only an understanding of physical space, but also an understanding of the way space is used. One method is to use virtual reality (VR) and augmented reality (AR) technologies. Virtual reality (VR) technology can create a three-dimensional environment where users can enter and interact through wearable devices. By using VR technology, designers can create three-dimensional models of buildings and explore and explore them. This can help designers better understand the way architectural space is used, thereby improving the design scheme. Virtual reality technology has become an important tool in many fields. Which can help designers create and modify building models more intuitively, improving design efficiency and accuracy. Tastan et al. [13] explored how to use handheld user interfaces and direct operations for building and analyzed their advantages, disadvantages, and future development directions. The application of handheld user interfaces in virtual reality has become increasingly widespread. In architectural modeling, handheld user interfaces can provide a more intuitive and convenient way of operation, helping designers quickly create and modify models. At the same time, the handheld user interface can also support multiple input methods, such as gesture recognition, touch screen, etc., providing a more flexible operating experience. The advantage of direct operation is that it is very intuitive and allows designers to create building models more naturally. In addition, direct manipulation can also enhance the designer's immersion and deepen their involvement in the modeling process. Wang [14] has analyzed a virtual reality technology that can create virtual environments that are close to reality. This enables designers and planners to more intuitively experience and evaluate the effectiveness of landscape design. Intelligent algorithms are powerful tools for processing large amounts of data, which can help designers optimize and select various design solutions in a short period of time. The use of virtual reality technology and intelligent algorithms can greatly improve the efficiency and effectiveness of coastal landscape design. Which helps to improve design quality and efficiency. Intelligent algorithms are algorithms that can automatically, quickly, and effectively analyze and process data. It can automatically find and discover useful information and patterns based on given data and objectives, thereby providing designers with scientific and quantitative decision support. By utilizing virtual reality technology, designers can quickly construct and adjust various design schemes in computers, while combining intelligent algorithms for data analysis to provide scientific basis for design schemes. Through virtual reality technology, designers can simulate the entire design process in a computer, comprehensively evaluate and compare various schemes, and select the optimal design scheme.

The decorative art of ancient architecture, as an important component of human civilization, has extremely high historical and cultural value. However, over time, these precious cultural heritages may suffer losses due to various factors. Digital technology provides new solutions for the protection and inheritance of ancient architectural decorative art. By digitizing the decorative art of ancient buildings, permanent preservation of these cultural heritage can be achieved, and its application in cultural tourism, cultural relic protection, and art design can be facilitated. Xin and Daping [15] will explore the importance and significance of a digital system for the inheritance and development of ancient architectural culture. The digital system for ancient architectural decoration art mainly includes modules such as data collection, data preprocessing, neural network training, and inference. The data acquisition module is responsible for obtaining image data of ancient architectural decoration art, which can be achieved using high-resolution cameras or laser scanners. The data preprocessing module performs denoising, enhancement, and other processing on the collected images to improve image quality. Zhang et al. [16] explored how to use augmented reality technology to construct three-dimensional architectural scenes, as well as its related technologies and applications. By using augmented reality technology, virtual objects, scenes, and other objects can be overlaid with the real environment, allowing users to experience a richer and more three-dimensional visual experience in the real environment. There are also some challenges in the construction technology. Firstly, the difficulty of model establishment is significant, requiring high-precision 3D scanning equipment and professional modeling technicians. Secondly, the cost of data collection is high, requiring a significant amount of time and capital investment. In addition, real-time rendering and interactive display of augmented reality technology also require high-performance hardware devices and efficient software algorithm support. Therefore, how to reduce costs and improve efficiency is an important issue faced by this technology. In the field of architectural space design in coastal cities, virtual reality technology has brought new design concepts and methods. Zhou [17] aims to explore the architectural spaces in coastal cities, and analyze its advantages, disadvantages, and future development directions. Through practical application and testing, it has been found that virtual reality technology has the following advantages in the design of architectural spaces in coastal cities. Virtual reality technology can visually display the design effect of architectural spaces, facilitating communication and exchange between designers and clients. Virtual reality technology can greatly shorten the design cycle, improve design efficiency, and also enable the design and comparison of multiple schemes. Virtual reality technology can simulate various environments and scenarios, helping designers engage in diverse design and creativity.

These methods usually require a large number of input images and lack adaptability to dynamic changes in the scene. Most existing methods focus on specific buildings or scenes, and cannot be widely applied to different types of buildings and scenes. This article expounds the principle of CNN algorithm, and introduces the principle and implementation method of building image proposed in this article. Combining the building image recognition algorithm with CAD and VR, a method of building and scene restoration based on CAD and VR is proposed.

3 ARCHITECTURE AND SCENE RESTORATION BASED ON CAD AND VR

With the continuous growth of CAD and VR, these technologies in architecture and scene restoration. This section will introduce the theoretical and technical basis of CAD and VR in architecture and scene restoration.

(1) The application of 1) CAD in architecture and scene restoration.

CAD is a kind of CAD, which uses devices to help designers with architectural design, planning and construction. In architecture and scene restoration, CAD is mainly used in the following aspects:

⊖ Design modeling: Using CAD software, designers can construct 3D models according to the actual situation of buildings and scenes. This modeling method can not only improve the design efficiency, but also provide important data support for the subsequent restoration of buildings and scenes.

㊁ Detail design: In architecture and scene restoration, CAD can be used for detail design and decoration. For example, CAD software can accurately draw the shapes and sizes of doors and windows, furniture, electrical appliances and other components, and can accurately calculate and simulate them to improve the authenticity and restoration accuracy of buildings and scenes.

㊂ Material and cost control: Through CAD software, designers can accurately calculate and control building materials, quantities and costs. This calculation method not only improves the accuracy of the budget, but also provides important technical support for the cost control of the whole stage of building and scene restoration.

(1) The application of VR in architecture and scene restoration.

VR is a computer technology that can create and experience virtual worlds. By simulating human sensory experiences such as audio-visual, tactile and so on, it makes users feel as if they are immersed in a virtual environment. In architecture and scene restoration, VR is mainly used in the following aspects:

㊀ Realistic experience: Through VR, users can get a realistic experience in the virtual environment where buildings and scenes are restored. This experience can not only enhance users' knowledge and understanding of buildings and scenes, but also provide important reference and support for subsequent architectural design and urban planning.

㊁ Interactive experience: VR can not only provide users with static display effect, but also realize interactive experience. For example, users can roam in buildings and scenes through VR, or change their perspectives to observe different angles of buildings and scenes. This interactive experience not only improves the user experience, but also further enhances the user's knowledge and understanding of buildings and scenes.

㊂ Real-time experience: Through high-performance computing and graphics processing technology, VR can realize real-time virtual environment rendering and computing. This real-time experience allows users to observe and experience the restoration effect of buildings and scenes more smoothly, which improves the fluency and satisfaction of user experience.

CAD and VR are important theoretical and technical foundations in architecture and scene restoration. The application of these technologies can not only improve the restoration accuracy of buildings and scenes, but also enhance the user experience, save time and cost, and expand the application scope. Moreover, these technologies can also provide important historical basis for urban planning and cultural heritage protection, and promote the inheritance and growth of culture.

CNN adopts a mechanism similar to biological visual neural network. Input layer: input the original data, prepare the data and send it to the neural network. When processing image data, the input layer converts the original image data into a numerical matrix. Convolution layer: it extracts local features of input data through convolution kernels. Each convolution kernel can learn and extract a specific feature, such as edge and texture. Pool layer: Pool layer is usually located behind convolution layer, and its main function is to down-sample, reduce the dimension of data, while retaining important features.

In the feature detection and analysis of building images, building images are taken as input data, and features are extracted by CNN model. Firstly, the input layer converts the image data into a numerical matrix; Then, the convolution layer extracts different features of the image, such as texture, edge, shape and so on, through multiple convolution kernels. Then, the pooling layer down-samples the data to reduce the dimension of the data; Finally, the features extracted before are integrated through the full connection layer to get the final feature vector. This feature vector contains rich feature information of architectural images. The stage of building image recognition based on CNN is shown in Figure 1.

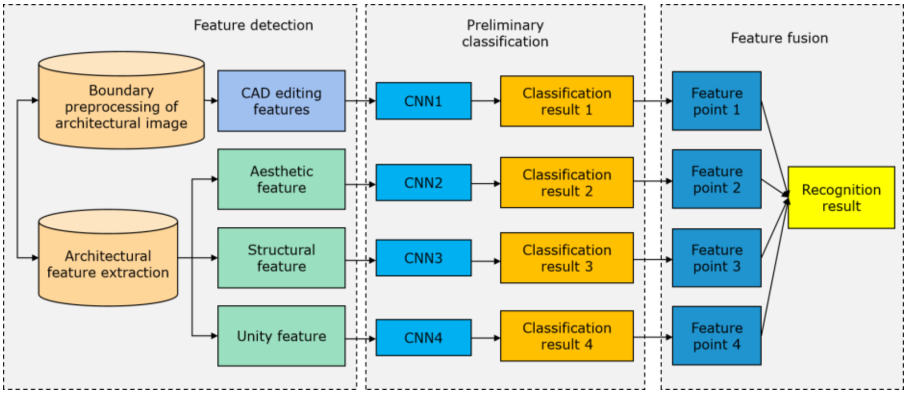

Figure 1: Building image recognition process.

In the feature detection of architectural scenes, it is necessary to collect related data including pictures, 3D models, historical documents and so on. These data can be obtained through online search, on-the-spot shooting and historical literature sorting. Using computer vision and image processing technology, features are extracted from the preprocessed building scene data. These features can include color, texture, shape, spatial structure and so on, so as to be used for subsequent restoration of architectural scenes. Different features are fused to get richer feature representation. Weighted fusion or series fusion can be used for feature fusion to obtain better reduction effect. See Figure 2 for the feature detection stage of building scene.

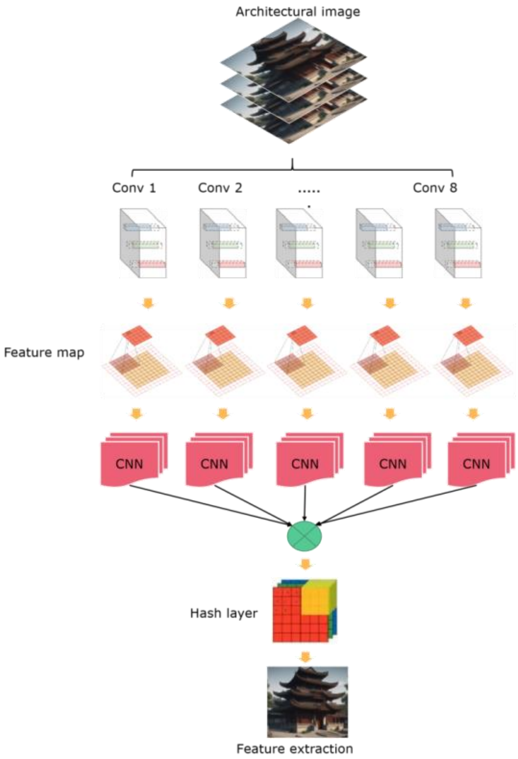

Figure 2: Feature detection stage of building scene.

In the stage of collection and transmission, architectural images are often affected by noise, illumination, occlusion and other factors, so it is necessary to preprocess them to enhance the usability and accuracy of the images. Through 3D reconstruction technology, the plane image of the building can be transformed into a 3D model, which can be used in virtual roaming, collision detection, engineering budget, effect display and so on. It is necessary to analyze and process the image data, and choose different modeling methods and technologies according to different application requirements. Through visualization technology, the data and results in the stage of building image processing can be displayed in the form of graphics or animation for better understanding and analysis.

$$p_i = \frac{n_i}{MN} \tag{1}$$

If the image pixels are divided into two types of C_0, C_1 by the threshold T, the probabilities are:

$$w_0 = \sum_{i=0}^{T} p_i,\ w_1 = 1 - w_0 \tag{2}$$

The average gray values of the two classes are:

$$\mu_0 = \frac{1}{w_0} \sum_{i=0}^{T} i p_i \tag{3}$$

$$\mu_1 = \frac{1}{w_1} \sum_{i=T+1}^{L-1} i p_i \tag{4}$$

$$A \cdot B = (A \oplus B) \Theta B \tag{5}$$

$$\begin{bmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{bmatrix} = \begin{bmatrix} R & T \\ 0^T & 1 \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} \tag{6}$$

Average pooling is a common pooling method, which aims to reduce the dimension of data and retain important features by calculating the average value in each window. In CNN, the average pooling layer is usually located behind the convolution layer, which is used to spatially down-sample the output of the convolution layer. Specifically, average pooling divides the input data into multiple windows, calculates the average values in each window, and combines these average values as the convolution features after pooling. Average pooling is to calculate the average values in each window and combine them as the convolution features after pooling. The expression for maximum pooling is as follows:

$$P_{\max}(X) = \max(X_i) \tag{7}$$

The expression of average pooling is as follows:

$$P_{ave}(X) = \frac{1}{N} \sum_{i=1}^{N} (X_i) \tag{8}$$

The adaptive weighted pool function is expressed as:

$$P_{AWP}(X) = S(f_{AW}) P_{\max}(X) + (1 - S(f_{AW})) P_{ave}(X) \tag{9}$$

Where P_{AWP} represents the output of the adaptive weighted pool layer; $S(\cdot)$ stands for sigmoid function, and its output is used as the mixing ratio between the maximum value and the average value.

By combining convolution layer and pooling layer, CNN can effectively extract the features of input data and reduce the dimension of the data. The application of CNN in the field of architectural image recognition and architectural scene restoration can provide more accurate and efficient methods and technical support for related research. Finally, the reconstructed and optimized 3D model is displayed visually. 3D models can be embedded in the virtual environment, and effects such as lighting and materials can be added to improve the realism and immersion of architectural scenes. Moreover, visual display can also provide important reference and support for subsequent urban planning and cultural heritage protection.

4 RESULT ANALYSIS AND DISCUSSION

In the experimental process, data outlier removal is an important step. By removing outliers from data, a more accurate and reliable junction can be obtained, as shown in Figure 3.

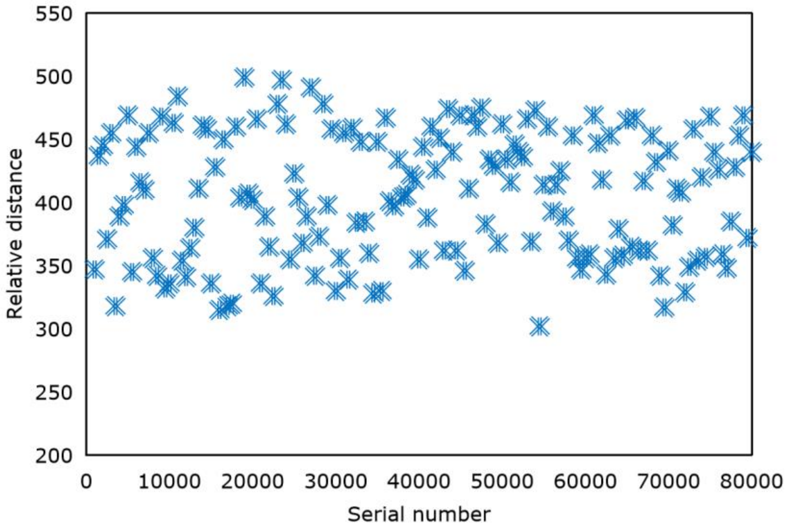

Figure 3: Handling outliers.

CNN can automatically learn and extract features from original image data through convolution layer and pooling layer. This avoids the tedious stage of designing features by hand, and can automatically adjust the way and quantity of feature detection according to different architectural scenes. The model structure of CNN can be optimized by back propagation algorithm, and the network structure and parameters can be adjusted to improve the accuracy and operation efficiency of the model. When dealing with complex architectural scenes, CNN can automatically optimize the model structure to better adapt to the data characteristics. Figure 4 shows the running time comparison between this algorithm and SIFT algorithm.

From the comparison results of running time, we can see that the running time of SIFT algorithm is lower than that of CNN when dealing with architectural scenes with low complexity. This is because SIFT algorithm is a feature detection method based on manual design, which is simpler than CNN's automatic feature learning process, so it has certain advantages in dealing with simple data. However, with the increasing complexity of architectural scene information, CNN began to show higher operational efficiency. This is because CNN can automatically learn and extract features from the original image data, avoiding the tedious stage of designing features by hand, and can continuously optimize model parameters in the training process to improve the generalization ability of the model. Therefore, when dealing with more complex architectural scenes, CNN can process data more effectively and shorten the running time.

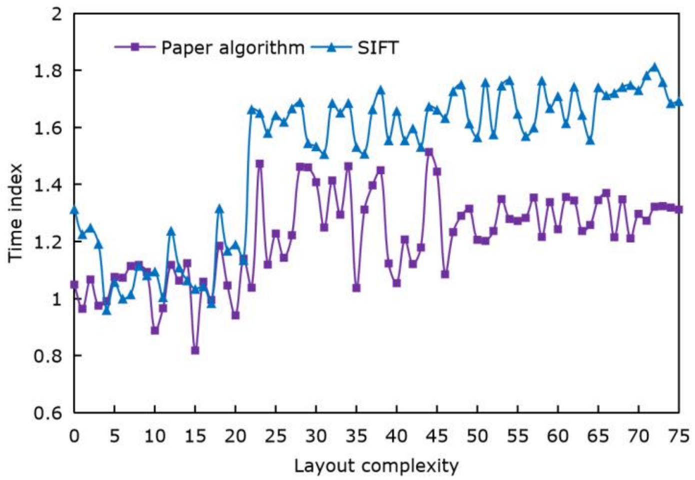

Figure 4: Calculation time comparison of the algorithm.

From the comparison of the architectural feature detection results of CNN algorithm and SIFT algorithm, we can see that the output results of CNN algorithm are more consistent with the actual results (see Figure 5 and Figure 6). Specifically, CNN algorithm can detect the edge, texture and other features of buildings more accurately, and give relatively accurate segmentation results.

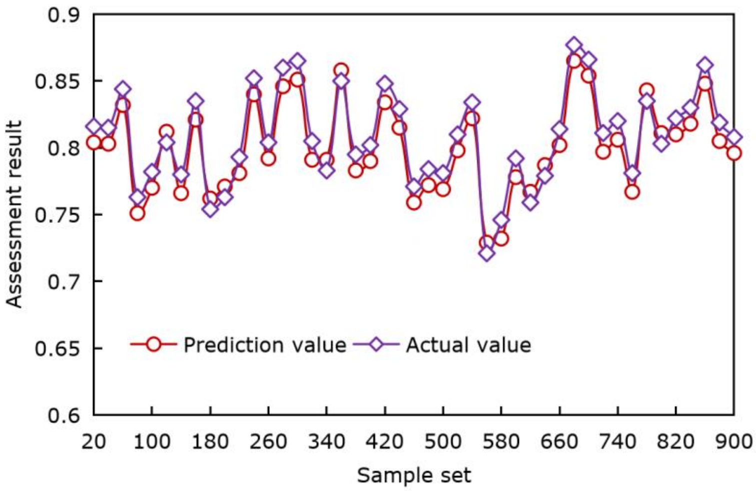

Figure 5: CNN algorithm detection performance.

CNN can automatically learn and extract features from the original image data through the combination of multiple convolution layers and pooling layers. Compared with SIFT algorithm based on manual design features, CNN can better adapt to the characteristics of different architectural scenes and improve the detection accuracy. The building image recognition algorithm based on multi-feature fusion proposed in this article can fuse different features and further improve the accuracy of feature detection. By combining the information of different features, CNN can better understand and use a variety of information in the image and give more accurate detection results.

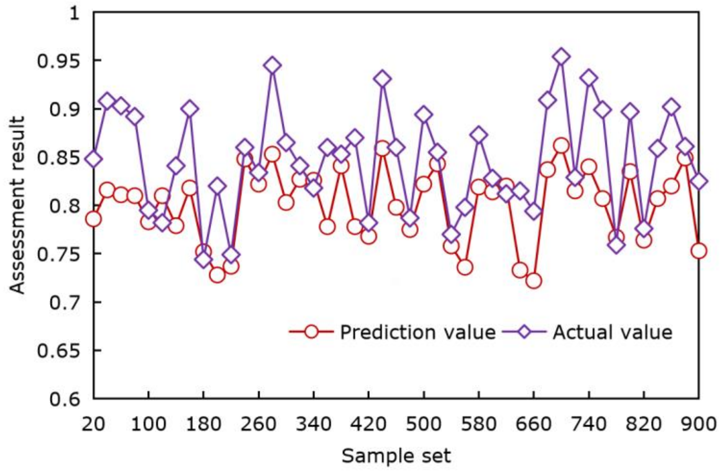

Figure 6: SIFT algorithm detection performance.

From the comparison results of convergence between the SIFT algorithm and CNN, we can see that the convergence speed and accuracy of CNN are better than SIFT algorithm (see Figure 7). Specifically, CNN has achieved better convergence effect in fewer iterations, and its accuracy has been continuously improved with the increase of iterations.

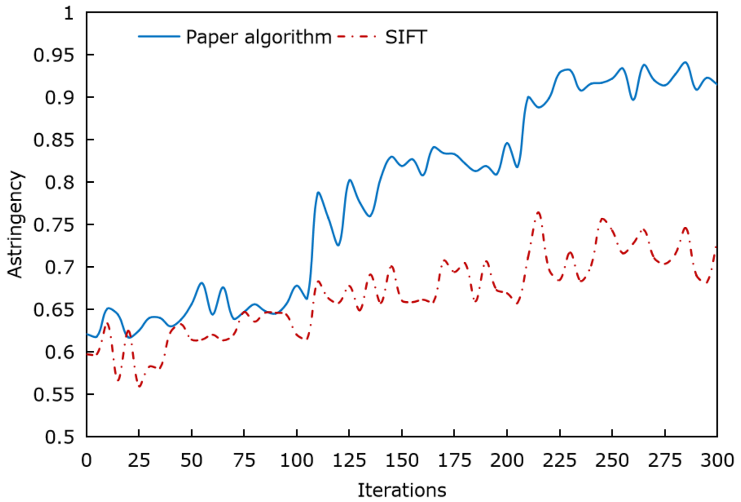

Figure 7: Convergence comparison results.

The hierarchical structure of CNN makes it more expressive and generalization, and it can achieve better convergence effect with fewer training samples and shorter training time. However, SIFT algorithm needs feature detection and matching in each local area, which may have some limitations for complex architectural scenes.

From the results of the accuracy of the given algorithms in building information feature detection, we can see that the accuracy of the proposed algorithm in building information feature detection is higher, which is 26.36% higher than that of SIFT algorithm (see Figure 8).

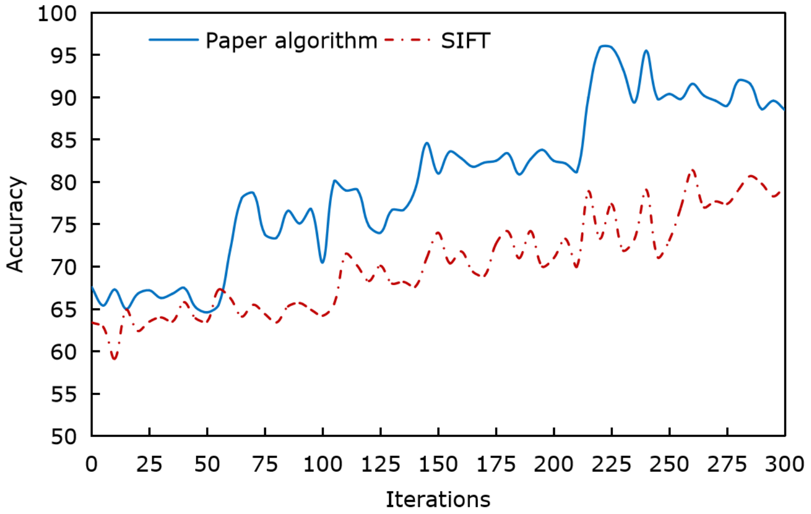

Figure 8: Comparison of accuracy of building information feature detection.

From the experimental results, the building image fusion proposed in this article has higher accuracy in building information feature detection. This is mainly because the algorithm can fully represent various features of building information, and use CNN's powerful learning ability and optimization method to achieve more accurate feature detection and classification. Therefore, the algorithm proposed in this article has high application value and practicability in the field of architecture.

5 CONCLUSION

CAD and VR can restore buildings and scenes with high precision, including the appearance, structure and surrounding environment of buildings, as well as the atmosphere and activities of historical scenes. Through these technologies, we can show the features of ancient buildings and historical scenes more truly and intuitively, and enhance cultural self-confidence and inheritance. In this article, the algorithm of building image recognition based on multi-feature fusion is studied in order to improve building information feature detection. By combining various features and using CNN to extract and classify features, the algorithm in this article realizes efficient recognition of architectural images. In the experimental part, the performance of traditional image processing algorithm, deep learning algorithm and other building image recognition algorithms are compared. The results show that the building image recognition algorithm based on multi-feature fusion has higher accuracy and running efficiency than the contrast algorithm. Moreover, the algorithm in this article has good stability and generalization ability, and can adapt to the needs of different architectural scenes. The algorithm can improve the accuracy and efficiency of building information feature detection, adapt to the needs of different building scenes, and provide a new solution for the building field.

The building image proposed in this article provides a new idea and method for building and scene restoration. This algorithm can not only improve the accuracy and efficiency of 3D reconstruction, but also be widely used in different buildings and scene types. In the future research, the algorithm will continue to be optimized and improved to further improve its performance and application scope.

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