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Computer-Aided Design AND APPLICATIONS

Cultural Expression of 3D Modeling in Virtual Reality Landscape Design and Mutual Aesthetics

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Abstract. This article studies and analyzes the application design of virtual reality landscape design in human-computer interaction. By combining cultural expression with high-resolution aesthetic design, we have uniformly extracted innovative features from high-resolution image data for cultural construction. Not only does it strengthen the application of human-computer interaction in landscape design of datasets, but it also simplifies the process of feature point extraction. Compared with the accuracy and efficiency of traditional convolutional networks, the feature point extraction method proposed in this paper provides more powerful technical support for landscape design. In the VR environment, the aesthetic landscape of this article incorporates more user design experiences in the process of feature point extraction. The aesthetic value of landscape cultural expression was studied and discussed through landscape construction in 3D environments. By incorporating precisely created cultural elements, it constructs an aesthetic landscape design model for user feature points. In the process of aesthetic design thinking, the construction of aesthetic models that focus on cultural expression can achieve stronger visual expression in the virtual process of cultural connotation.

Keywords: 3D Modeling; CAD; Virtual Reality; Landscape Design; Cultural Expression; Human-Computer Interaction
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1 INTRODUCTION

The interactive experience mode of urban landscape space has entered a new stage of pursuing development quality and connotation through micro renewal and quality improvement rather than scale and incremental development. It is not difficult to see that the urban renewal stage in China has gradually transitioned from an expansionary urban management model of major repairs to a precise urban repair model [1]. On the other hand, it will start with the national urban renewal policy and the new requirements of the people for urban spatial quality. Relying solely on macro-level urban planning can easily overlook the specific design needs of urban public spaces, making it difficult to meet people's aspirations for a better city [2]. Therefore, both theoretical research on urban development and the actual situation of urban construction and renewal in China indicate that in the current new stage of urban renewal, designers need to stand from the perspective of the public [3].

Based on the above research background, some scholars choose interactive landscape installations as the research object, with art experience theory as the research entry point, based on the current situation and needs of urban renewal in China, to explore the breakthrough points for innovative design of interactive landscape installations. In this era, facing a series of urban design problems such as homogenization of urban design, formalization of the urban landscape, and commercialization of public spaces. Empower urban spaces with more humanized and experiential design content from the perspective of urban experiential users. Then, based on case studies, the main design patterns of interactive landscape installations in China were summarized, providing a realistic model for the formation of design strategies. Finally, based on the correlation characteristics, design patterns, and application frameworks between interactive landscape installations and artistic experience theory, a design strategy for interactive landscape installations was proposed [4]. The theory of artistic experience is an alternative interpretation scheme to subjective aesthetics, which can help us gain a deeper understanding of the essence of artistic works in the increasingly diverse development of art. Applying it to the design theory of interactive landscape installations not only allows for innovation but also extracts objective and realistic design elements from a wide range of artistic works and endows the installation with innovative vitality. Subsequently, the cognitive methods of art experience theory were analyzed and combined with the design process of interactive landscape installations, summarizing the application framework of art experience theory in the design of interactive landscape installations. Starting from the four dimensions of social empowerment, technological innovation, cultural creativity and inheritance, and physical perception, this study provides new design methods for interactive landscape installations in the current context of urban renewal in China, inspiring innovative vitality [5]. It is also possible to deeply integrate art and interactive landscape installations at the social, technological, cultural, and perceptual levels, so as to better serve the development path of urban renewal in China. In the design process, we need to fully consider factors such as harmony and balance between landscape elements, rationality and aesthetics of spatial layout [6]. The application of these technological means can not only improve design efficiency and quality but also provide new ideas and tools for the research and practice of landscape aesthetics. These methods and technological means not only include traditional composition, colour, material and other means but also modern technological means such as digital technology and ecological technology [7]. Virtual design not only focuses on the design practice itself, but also emphasizes the in-depth exploration of the ideological, cultural, and social background behind the design. In the field of landscape architecture, although there is a large amount of literature on design practices and technological applications, there is relatively little literature on design behaviour itself as a research process for in-depth exploration of landscape aesthetics [8].

The rapid transformation and development of society will inevitably drive a shift in people's needs for life. The study first reviews the theoretical and practical status quo at home and abroad and concludes that there is currently limited and shallow theoretical research on interactive experiential landscapes in communities in China [9]. Under the promotion of a market economy, there have been some exploratory achievements in practical aspects, but a system has not yet been formed. Secondly, based on existing relevant theories, this paper elaborates and defines the connotation of the topic "Research on Interactive Experiential Landscape of Community Shared Space", and analyzes the design trends, laying a theoretical foundation for future research [10]. Based on the three major backgrounds of increasing demand for interactive and experiential landscapes driven by social transformation, the important impact of the concept of shared space on community construction, and the problems existing in community landscape development. The simple visual stimulation and assimilation of landscape styles can no longer meet people's needs for community-shared space landscapes. People who are busy in cities are gradually beginning to pay attention to the homecoming attributes that communities should have. Using SPSS software for dimensionality reduction analysis, it was found that residents have a high level of attention to four aspects of the community landscape: behavioural needs, regional emotions, perceptual satisfaction, and diversity [11]. In response to the current pain points of interactive experiential landscape in community shared spaces, three strategies are proposed to achieve multifunctional diversification of community shared space landscape, create the perceptual perception of community shared space landscape, and explore regional emotions of community shared space landscape. The landscape, which used to be a subsidiary of the community, has gradually become an important factor in measuring the quality and style of the community. Therefore, the interactive and experiential landscape in community shared spaces should serve as a social bridge between residents, in line with the trend of technological development, and optimize the role of the landscape.

Hence, the objective of this article is to offer fresh perspectives for the advancement of landscape design through an in-depth exploration and discussion of the cultural expression and HCI aesthetics inherent in the use of 3D modelling and CAD within VR landscape designs. Highlights of the paper are below.

1. By offering an intuitive visual design platform, 3D modelling technology significantly elevates the quality of landscape design, thus enriching the design experience for both designers and the public.

2. The incorporation of VR technology brings an immersive design experience to landscape design, allowing users to fully engage with the intricacies and effects of the design in a profound way.

3. By integrating cultural elements into VR landscape designs, we not only bolster the design's cultural significance but also foster a stronger sense of identity, rendering the works more culturally and regionally distinct.

4. Emotional expression holds a pivotal role in VR landscape design. This study effectively communicates specific emotional cues through design elements and interactive modalities, thereby deepening users' comprehension and appreciation of the landscape design.

Initially, this article presents the contextual application of 3D modelling and CAD technology in landscape design, along with the pivotal role of VR technology. Following this, it deliberates on the groundbreaking utilization of 3D modelling and CAD within VR landscape designs. Ultimately, the article concludes by summarizing its key points and offering a forward-looking perspective, underscoring the significance of cultural expression and HCI aesthetics in landscape design, as well as outlining potential future research directions.

2 RELATED WORK

In order to further explore the emotional effects of colours in virtual landscape design, Shan and Sun [12] used the SD method (semantic difference method) for colour space perception evaluation. In the era of digital landscape design, colour, as one of the core elements of design, is becoming increasingly important. In the context of rapid economic development in modern society, in the intersection of big data information, the internet and virtual communities have not made human relationships closer but rather highlighted the lonely personal experience and personalized way of life. The proposal of "human landscape intelligent interaction" design is based on the experience of people in the environment. The human experience provides new ideas for landscape design, enabling designers to discover new problems and find solutions. In the era of the knowledge economy, aesthetic design and modern landscape design not only need to conform to modern aesthetics in the appearance of the landscape but also fully consider the personalized psychology and habits of users, thereby reflecting humanistic care. From the perspective of disciplines such as art, ecology, and behavioural logic, as well as the interactive design of ancient Chinese garden landscapes, Shan and Sun [13] conducted in-depth research on the interaction of artistic conception, sound conception, painting conception, and interactive activities. They believe that the study of interactive landscapes in classical garden landscapes has great reference significance. Further, improve the analysis results by studying the deep interaction of spatiotemporal interaction with landscape language in environmental perception. By advocating for harmonious coexistence between people and nature in the landscape, we aim to promote the concept of people-oriented and sustainable development in landscape design. And compare domestic and foreign cases, draw inspiration from their design points, and combine them with actual cases to explore the impact of new perspectives and new technologies on intelligent interactive landscape design, thereby explaining the prospects of interactive landscape design after the application of intelligent and digital technologies. Finally, the phenomenon of colour emotions in virtual landscape design is of great significance in shaping the emotional structure of gardens. Through reasonable colour matching and application, designers can guide the audience's emotional direction and create a spatial colour context that conforms to the design theme. The shaping of this emotional structure can not only enhance the artistic and aesthetic aspects of landscape design but also enable the audience to gain a more authentic and profound emotional experience in virtual space.

Song and Jing [14] conducted in-depth research on the management of urban infrastructure in China by combining virtual landscape design aesthetics with intelligent urban landscape design technologies. The importance of urban environmental design in current urban planning and development is self-evident, but in China, a widely accepted and applicable universal virtual landscape design model has not yet been formed. It proposes an innovative and adaptive approach aimed at integrating China's best policies and sustainable building planning into virtual landscape design practices. It emphasizes the importance of environmental friendliness, resource efficiency, and cultural heritage. Through in-depth research and application of virtual landscape design aesthetics, we can better simulate and predict the urban environmental effects under different design schemes, thereby providing decision-makers with a more scientific and comprehensive decision-making basis. Wu and Yan [15] focused on the aesthetics of virtual landscape design, exploring its deep integration with the concept of sustainable development, and proposed a vision for socio-economic and social ecology. In addition, the aesthetics of virtual landscape design can help us better understand the needs and preferences of residents for urban space, thereby achieving more humane and personalized urban design. It will also compare and analyze developed visions and other research methods, especially in the practice and application of virtual landscape design aesthetics. By comparing domestic and foreign cases, we will explore whether Chinese cities are ready to implement intelligent services, architecture, and territorial planning based on natural laws and integrate these advanced concepts into virtual landscape design.

With the rapid development of the social economy and the continuous innovation of computer software and hardware technology, computer technology is playing an increasingly important role in various industries. Through virtual reality technology, Xu and Wang [16] simulated the landscape effects under different time and weather conditions in order to better grasp the dynamic changes and emotional expression of the landscape. Under the guidance of virtual landscape design aesthetics, landscape designers can more intuitively feel and understand the impact of spatial layout, colour matching, material selection, and other factors on landscape effects. This technology not only improves the accuracy and efficiency of design but also endows landscape design with richer emotional and cultural connotations. However, although computer-aided design software has achieved certain results in landscape planning and development, its in-depth exploration and application potential still needs to be further explored. In the practical application of landscape design, computer landscape design software plays a crucial role. Different software has different functions and characteristics, and it is suitable for different design needs. In addition, the aesthetics of virtual landscape design also emphasize the interaction between the landscape and people. By designing interactive elements and experiential scenes, people can not only appreciate the scenery but also gain deeper emotional experiences.

With the rapid development of 3D point cloud technology, its application in remote sensing and measurement is becoming increasingly widespread, especially in the measurement of urban vegetation. Measurement mainly relies on vegetation point cloud data, which can be obtained through various means, but there is often a problem of missing information, which poses challenges to traditional measurement methods. This method not only integrates the accuracy of voxel measurement methods but also efficiently organizes point cloud data through an octree structure, providing a new perspective for the measurement of typical urban vegetation and landforms. Zhang and Deng [17] proposed a new estimation method combining virtual landscape design aesthetics - a voxel octane vegetation volume estimation model. The verification results indicate that the estimation method has significantly improved computational efficiency and accuracy. Compared with traditional methods, this method not only has higher efficiency but also more reliable computational accuracy. Through preprocessing, we obtained point cloud data of individual and multiple plants, which were finely organized and rendered in a virtual environment, allowing designers to intuitively experience the volume and shape of different vegetation in an immersive virtual space. Under the guidance of virtual landscape design aesthetics, this method not only focuses on measurement accuracy but also pursues realistic restoration of vegetation morphology and ecological features in virtual environments.

3 THE APPLICATION OF 3D MODELING AND CAD IN VR LANDSCAPE DESIGN

3.1 Application of 3D Modeling Technology in Landscape Design

In today's world, the application of intelligent interactivity in landscape design is a relatively new research field. In the field of intelligent interactive application in landscape design, there are not many theoretical achievements and a lack of systematicity. Most of them are simple discussions based on foreign research, and there are not many independent studies in China. The interaction of landscape design is not only an attitude but also a necessary spatial structure or appearance that starts with the awareness and thinking of practitioners. The interaction in landscape design is not only an attitude but also a thinking and behaviour. Deeply understand the ideological connotation of interaction design concepts and find design methods that match them. Based on landscape design, applying scientific design methods to change urban landscapes should not only focus on art, ecology, and behavioural logic itself but also adopt technological means for digital quantification research. We need to consider both traditional landscaping techniques and integrate them with historical and cultural characteristics, truly achieving a scientific design of behavioural experience in modern landscape interaction design. Figure 1 is a conceptual diagram of the VR landscape tour experience.

Figure 1: VR landscape tour.

3.2 Application of CAD in Landscape Design

In landscape design, designers should strive to achieve harmonious coexistence between humans and nature and harmonious coexistence between humans. The focus was on analyzing the interactive characteristics of Chinese classical garden landscapes in terms of painting, sound, and artistic conception. Studying Chinese classical gardens can help analyze interactive landscapes and draw inspiration from the interactive design of Chinese classical garden landscapes. Enhance the humanistic characteristics of landscape design, with a focus on showcasing the cultural, artistic, intelligent, and ecological characteristics of landscape design. Based on traditional landscape design techniques, combined with relevant theories such as human-computer interaction design elements and behavioural logic, we aim to improve and supplement existing research theories in the field of intelligent interactive landscape design. Dedicated to interdisciplinary analysis, making the theoretical foundation of interaction design more solid and rich, as a fusion and innovation of interdisciplinary fields. And summarize relatively reasonable design strategies, thereby providing certain theoretical reference significance for design practice work, and ultimately guiding the practical work of intelligent interactive landscape design.

In the past, design methods only focused on the inherent attributes and characteristics of individual problems, while in modern interaction design, the relevance of problems should be emphasized more. After the advent of the digital age, many disciplines have experienced cross-disciplinary phenomena, so interaction design has become more theoretically based due to this cross-disciplinary research, serving as a fusion and innovation of interdisciplinary fields. The process of design is dynamic, and the design subject changes into a "relationship" between subject and object interaction, rather than a form of existence. Interaction design is actually about input and output, but it can exhibit many different characteristics, just like the interaction between humans and nature can bring about the behavioural process of input and output landscapes, and the interaction forms present diverse characteristics. This article aims to organize and summarize the design characteristics and methods of intelligent interactive landscape design based on relevant theories from different disciplines.

4 VR LANDSCAPE DESIGN BASED ON 3D MODELING AND CAD

This article believes that from the beginning of landscape installation design behaviour, designers consciously use the artistic experience of personality subjects to construct the structural characteristics and spiritual connotations of design works and run through the entire design process. In the process of integrating the theory of artistic experience into the design of interactive landscape installations, in order to fully expand the designer's horizontal and vertical design perspective and depth. By analyzing and refining Gadamer's theory of artistic experience, we aim to explore its feasibility in the design of interactive landscape installations and transform it into a concrete and accessible system design theory. The purpose of endowing interactive landscape installations with richer spiritual and cultural connotations and practical usage functions. So as to better serve the long-term goal of improving the quality of the urban environment and effectively improving the happiness index of the people. The comprehensive decomposition of unpredictable variable analysis in VR landscape design is shown in Figure 2.

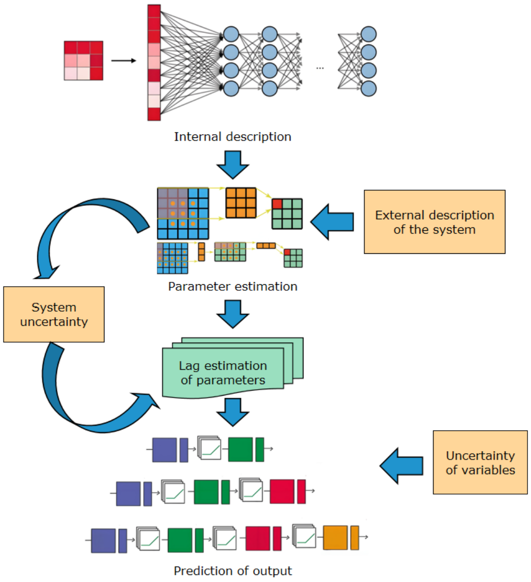

Figure 2: Uncertainty factor analysis process.

$$A = soft\max\ w_2\varphi\ w_1x^T \quad (1)$$

In the aforementioned formula, the computation $soft\max\ \cdot$ proceeds along the second dimension of the input matrix, ensuring the summation of each weight vector group equals 1. Notably, in our experiment, the superparameter r, signifying the quantity of weight vectors, was set to 1.

Utilizing the attention weight matrix as a foundation, this article subsequently computes a two-dimensional embedding matrix M for the aggregation of the feature sequence about the virtual reality landscape:

$$M = AX \quad (2)$$

The m_i vector within the i-th row of matrix M represents the weighted summation of feature vectors corresponding to various timestamps in the sequence. In the embedded representation matrix M for virtual reality landscapes, each vector uniquely attends to distinct portions of the entire feature sequence, enabling the retention of diverse landscape features from the sequential data. The modified loss function, incorporating an additional penalty factor, is formulated as follows:

$$L\left(y_n, \hat{y}_n\right) = -\left[\alpha y_n \log \hat{y}_n + \left(1 - \hat{y}_n\right)\log\ 1 - \hat{y}_n\ \right] \quad (3)$$

Herein, α serves as the penalty factor, n denotes the sample count, and $L\ y_n, \hat{y}_n$ represents the loss function associated with a n sample about a specific landscape label. Specifically, it is a hybrid of the standard binary cross entropy at $\alpha = 1$ and the binary cross entropy at $\alpha > 1$, where the latter assigns a loss weight of 0 for judging 1. This hybrid loss function is ultimately adopted in our proposed methodology.

CAD software boasts a robust data analysis capability, enabling comprehensive processing and examination of various landscape design data. Designers can harness CAD tools for tasks like terrain analysis, vegetation coverage evaluation, and traffic flow assessment. This aids in refining the landscape design approach and bolstering its practical application.

In this study, we employ an enhanced 3D point cloud model to seamlessly convert conventional image boundaries into precise spatial ones. The essence of this method hinges on the in-depth manipulation and exact analysis of point cloud data. This ensures an accurate capture of the spatial position and form of the boundary line. Refer to Figure 3 for a detailed technical breakdown. Initially, cutting-edge image processing techniques extract boundary details from the image. These boundary data are then incorporated into the enhanced 3D point cloud model. By leveraging the model's high-precision spatial data, the image boundaries are seamlessly transformed into spatial ones. This conversion not only maintains the inherent characteristics of the boundary line but also elevates its precision and trustworthiness within the 3D environment.

After obtaining the spatial boundary line, it is further closed. This step aims to ensure the continuity and integrity of the boundary line and eliminate possible breakpoints or gaps. Through advanced algorithms and calculation technology, these potential problems can be accurately identified and repaired, so as to get more accurate characteristic boundary lines.

Supposing a dataset comprising M samples of landscape image feature data, we designate $q_j\ t\ , j = 1, 2, \cdots, N$ as the weight of a newly introduced sample, and $p_i\ t-1\ , i = 1, 2, \cdots, C$ as the clustering weight. We then partition the N_t data samples into C distinct clustering centres, with each centre represented as follows:

$$p_i\ 1\ = \sum_{j=1}^{N_i} u_{ij} q_j\ 1\ + \sum_{i=1}^{C} u_{ij} q_j\ 0 \quad (4)$$

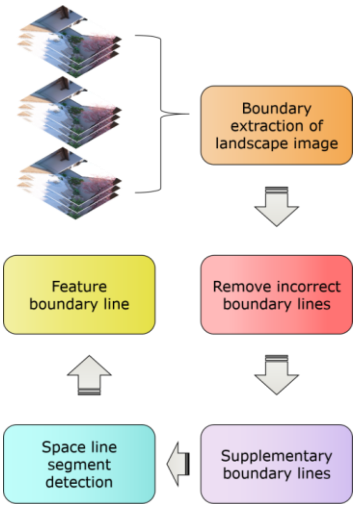

Figure 3: Process of feature boundary line extraction algorithm.

The fuzzy membership level of a sample about the cluster's centroid is denoted as u_{ij}, with $1 \le i \le C, 1 \le j \le N_i$. Additionally, T signifies the weighted grey density threshold, serving as a standard to differentiate between pixels with and without noise. Consequently, we arrive at the following:

$$T(u(g),u(h)) = \log_2\left(\frac{u(g)^2 + u(h)^2}{2}\right) \quad (5)$$

Following the grayscale etching process, if the etching value is positive, it indicates that the grayscale value of the neighbouring pixel (x_g, y_g), representing a noise-free pixel g, exceeds the grayscale value of the neighbouring pixel (x_h, y_h) situated within a noisy area h. Utilizing the grayscale value, structural elements, and pixel-weighted grayscale density of the target high-frequency sub-band feature image, a distinction is made between noisy and non-noisy pixels, enabling noise reduction.

The normal vector, perpendicular to the plane where the point cloud data resides, signifies the plane's directionality. Using the estimated normal vector and label information of point cloud data, the connection mode and closure of each plane entity are further determined. Label information may include the type (such as floor, wall, roof, etc.), material, colour, and other attributes of the plane, which together with the normal vector constitute a complete description of the plane. The likelihood of the specified point x residing within the plane p is calculated as follows:

$$P(x|p) = \frac{N(dist(x,p);0,\sigma_d^2)}{N(0;0,\sigma_d^2)} * \frac{N(|N_x * N_p|;1,\sigma_n^2)}{N(1;1,\sigma_n^2)} \quad (6)$$

The distance between x and plane p is denoted as $dist(x,p)$, while $|N_x, N_p|$ signifies the normal vector associated with point x and plane p. Furthermore, $N(z;\mu,\sigma^2)$ represents the evaluation of the normal distribution's density function at a point z, given an average value of μ and a variance of σ^2.

To enhance computational efficiency, the transfer gradient (surface local normal vector) $x_s^{ij} - x_s^{ji}$ is discretized to align with the Woolf shape's normal vector S. Consequently, the correlation between the probability distribution $P_s\ n$ per unit voxel length S, aligned with the normal vector direction $n \in S$, and the Woolf shape's distance d_s^n can be formulated as:

$$P_s\ n\ = e^{-\varphi^{ij}\ n} = e^{-\max_{p\in W_{H_s}}\ p^T n} = e^{-d_s^n} \tag{7}$$

Hence, the following conditions must be met:

$$d_s^n = \text{-}\log\ P_s\ n \tag{8}$$

To approximate $P_s\ n$, a histogram can be constructed based on the input method vector, where the respective surface areas serve as weights. The horizontal axis of this histogram depicts the normal vector's direction $n \in S$, while the vertical axis signifies the weighted frequency associated with each direction.

$$d_s^n = \text{-}\log\ P_s\ n \tag{9}$$

Let's assume $P_i \middle| P_i \in R^3, i = 1, \cdots, N$ stands for the initial point set, while $Q_i \middle| Q_i \in R^3, i = 1, \cdots, M$ signifies the subsequent point set. The alignment and synchronization of these two point sets are achieved by minimizing the functional value derived from the subsequent equation:

$$f\ R,T\ = \sum_{i=1}^{n} \left\| Q_i^k -\ RP_i + T\ \right\|^2 \tag{10}$$

Utilizing R,T the rotation and translation matrix, the algorithm is capable of achieving a more precise determination of the transformation matrix between two frames of point clouds.

In the VR landscape design based on 3D modelling and CAD, the integration of cultural expression and HCI aesthetics is very important. Designers need to fully consider local history, culture, customs and other elements in the design process and integrate them into the modelling and rendering of the virtual landscape. For example, designers can reflect the regional culture by adding elements such as architecture, sculpture, and plants with local characteristics to the landscape. Furthermore, designers also need to pay attention to the user's interactive experience in the virtual environment and design an easy-to-operate and easy-to-understand interactive interface and way to improve the user's satisfaction.

5 EXPERIMENTAL RESULT

5.1 Experimental Setup and Data Set

Eight representative new Chinese-style landscape images were selected as research materials in the experiment (as shown in Figure 4). These images not only reflect the unique charm of the new Chinese style but also contain rich texture, colour and composition elements, which provide rich data support for learning the characteristic basis function of the new Chinese style.

In order to deeply explore the characteristics of the new Chinese style, this study uses the standard sparse coding algorithm to process the image. Sparse coding is an unsupervised learning method, that can learn a set of basis functions (also called dictionary elements or codebooks) from input data, and these basis functions can effectively represent the main features of input data. In the training process, each image is first divided into several small blocks, and these small blocks are used as the input data of the sparse coding algorithm. Then, the algorithm iteratively updates the basis function and the corresponding sparse coding coefficients to minimize the reconstruction error and sparsity constraints. In this way, we finally get a set of basis functions that can accurately express the characteristics of the new Chinese style.

Figure 4: Style sample diagram.

These feature basis functions not only contain the typical texture and colour information of the new Chinese style but also reflect the composition characteristics and spatial layout of the style. By applying these basic functions to the new image data, we can realize the tasks of identifying, classifying and generating the new Chinese style.

In this experiment, two different data sets are specially selected to evaluate the performance of our algorithm. One group is an evenly distributed data set, which is mainly composed of a series of carefully designed and balanced new Chinese-style landscape images. This set of data is mainly used to test the performance of the algorithm under ideal and non-interference conditions and to ensure that the algorithm can accurately learn and extract the core feature basis functions of the new Chinese style.

The other data set is a real data set, which contains a variety of natural and man-made landscape images covering a variety of complex scenes, lighting conditions, and visual elements. This data set is closer to the actual application scenario, aiming at comprehensively evaluating the performance of the algorithm in practical applications, especially the robustness and accuracy when dealing with real and complex images.

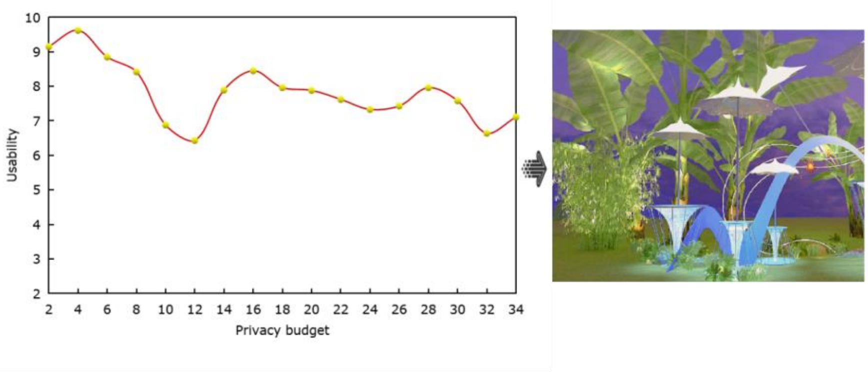

Figure 5: Effect of landscape image in uniform data set.

Figure 5 illustrates the outcome of 3D reconstruction utilizing high-resolution VR landscape image data from a consistent dataset. Thanks to the even distribution of data, the resulting 3D model exhibits a distinct structure and intricate details.

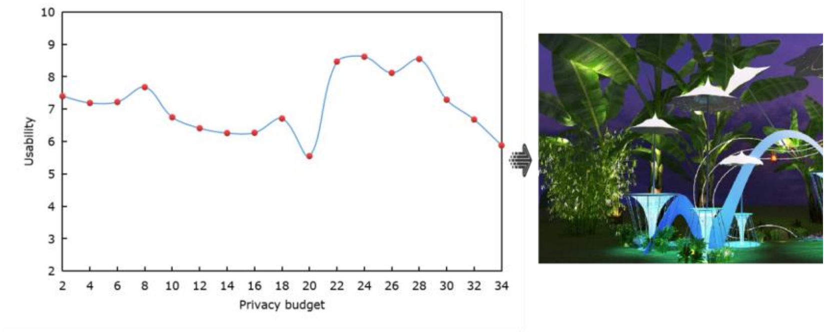

Figure 6: Effect of landscape image in real data set.

Meanwhile, Figure 6 presents the results obtained from the same set of high-resolution landscape images after undergoing 3D reconstruction within an authentic dataset. Real datasets introduce diverse and intricate scenes along with varying lighting conditions, elevating the challenge of 3D reconstruction significantly. Despite these complexities, our sophisticated algorithm remains adept at precisely identifying crucial feature points within the imagery, thus crafting a more precise 3D model.

5.2 Feature Point Extraction and 3D Reconstruction

In the process of 3D reconstruction, it is a key step to accurately extract the feature points of 2D images, which directly determines the accuracy of the final 3D model. Therefore, a new feature point extraction method is proposed and compared with the traditional CNN method. Firstly, the features in the image are preliminarily identified by using the boundary representation method. However, because the boundary representation is easily influenced by noise and illumination conditions, the recognition result is not accurate enough. Therefore, the feature point extraction method introduced in this article is further proposed.

In the aspect of feature point extraction, the method of this article first uses the deep convolution network to learn the features of the image at multiple levels to capture rich information in the image. Then, by introducing a new attention mechanism, the network can automatically pay attention to the key areas in the image, thus extracting the feature points more accurately. Figure 7 shows the results of the feature detection fitting test using the CNN model, while Figure 8 shows the results of the feature detection fitting test using this method.

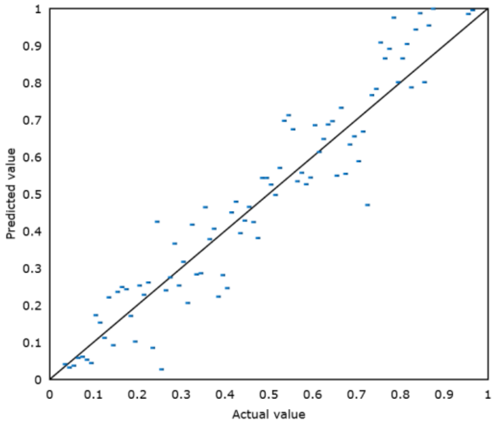

Figure 7: Test results of CNN model.

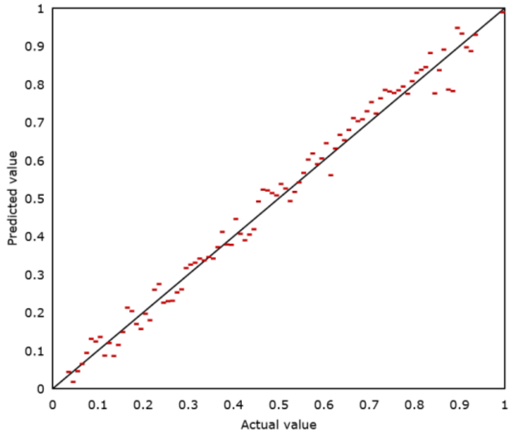

Figure 8: Test results of this method.

The feature points extracted by this method are closer to the feature points in the real image, and the distribution is more uniform. This demonstrates the method's ability to more precisely extract essential image information, thereby enhancing the precision and efficiency of 3D reconstruction.

6 LANDSCAPE CULTURAL EXPRESSION AND HCI AESTHETICS

In a prior experiment, I confirmed the remarkable precision and efficiency of 3D modelling and CAD technology when applied to VR landscape design. Yet, beyond the pursuit of technical mastery, the true essence lies in utilizing these technological advancements to articulate the cultural significance of landscape design and elevate the user's experience. This section will discuss the important role of landscape cultural expression and HCI aesthetics in VR landscape design.

6.1 Landscape Cultural Expression

The expression of landscape culture is the soul of landscape design, which involves in-depth understanding and refining of regional characteristics, history and culture, national customs and so on. In VR landscape design, cultural expression not only requires designers to restore the real landscape elements in the virtual environment but also integrates cultural elements into the landscape design through artistic techniques and technical means, so that users can feel the profound cultural heritage in the virtual space.

The human landscape is the result of mutual adaptation and interaction between humans and nature, which to some extent reflects people's pursuit of beauty and their unique creativity. How to guide and control the movement trajectory of visitors in the landscape, and stimulate their interest and emotions, is what designers need to consider while improving the beauty of the landscape. A good atmosphere and emotional scene design can help visitors integrate into the landscape more quickly. In the 21st century, where technology is developing rapidly but the ecological environment is becoming increasingly harsh, landscape design can no longer solely aim to beautify the human living environment. The emergence of landscapes reflects people's hopes and ideals placed on them, with some landscapes reflecting the designer's thinking about certain things, and others responding to the expectations of visitors. However, it is necessary to further regulate the relationship between humans and nature, allowing people to think about the landscape while enjoying it. In addition to using colours, shapes, volumes, and other aspects to immerse people in the infinite charm of the landscape, the combination of lighting can also allow people to visually immerse themselves in the landscape. In fact, many commercial pedestrian streets in various regions use a large amount of lighting to enhance the landscape effect at night in order to increase popularity. The beautiful lighting is set off by the night and often does not require people to have too much movement to bring an intelligent and beautiful experience. Visual immersion as the main landscape immersion technique can be the most intuitive way to attract tourists, and sometimes the presentation of landscape effects is also the best. For the landscape construction of commercial pedestrian streets, whether using colour to create the landscape or lighting to create the landscape, the most fundamental method is to capture the beautiful scenery through the sensitivity of human visual perception.

7 CONCLUSIONS

When we delve deeper into the cultural expression in VR landscape design and HCI aesthetics, it is not difficult to find that the integration of technology, culture, and aesthetics is the core driving force behind the leap in this field. Here, 3D modelling and CAD technology are no longer just cold tools, they have become magical brushes in the hands of designers, drawing virtual landscapes that are both accurate and full of imagination. Through 3D modelling and CAD, we can cleverly integrate cultural essences such as regional characteristics and historical inheritance into landscape design, making the work not only a picture but also a cultural carrier rich in storytelling and connotation. These technologies not only give designers unprecedented creative freedom, allowing them to construct more diverse and intricate landscape works, but more importantly, they provide the possibility for the integration of cultural elements. The introduction of HCI (Human Computer Interaction) has injected new vitality into this field. It makes landscape design no longer just a static display, but a work of art for users to interact, feel, and experience. Designers guide users to engage in in-depth communication with virtual landscapes through carefully designed interactive interfaces and methods, allowing each user to gain unique perceptions and insights. In summary, the combination of 3D modelling, CAD technology, cultural expression, and HCI aesthetics has opened a new door to the field of landscape design. In the face of the future, we look forward to further deepening the integration of technology and culture in this field, exploring more possibilities, and creating a better and more meaningful living and working environment for people.

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