

Retraction

Retracted: Application of Virtual Reality Technology in Analysis of the Three-Dimensional Evaluation System of Rural Landscape Planning

Mathematical Problems in Engineering

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] J. Li and T. Hou, "Application of Virtual Reality Technology in Analysis of the Three-Dimensional Evaluation System of Rural Landscape Planning," *Mathematical Problems in Engineering*, vol. 2021, Article ID 6693143, 16 pages, 2021.

Research Article

Application of Virtual Reality Technology in Analysis of the Three-Dimensional Evaluation System of Rural Landscape Planning

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From the construction of “new socialist countryside” to the proposal of “full coverage of village planning,” rural construction has gradually been pushed to a climax. However, the current situation of rural landscape construction in China is not optimistic. On the one hand, the rural landscape deviates from its rural and regional characteristics due to deliberately seeking novelty and differences. Based on these two extreme development trends, this article uses virtual reality technology to construct a rural landscape virtual-roaming system, and randomly select 25 people, each group of 5 people, a total of 3 groups, enter the system in batches with a real reduction degree of 30%, 45%, 60%, 75%, and 80% for experimentation and score the system after the experience. The true reduction degree of the first group is 30%; the true reduction degree of the second group is 45%; the true reduction degree of the third group is 60%; the true reduction degree of the fourth group is 75%; and the true reduction degree of the fifth group is 80%. After analyzing the experimental data, it is concluded that when the true reduction degree of the system goes from low to high, people’s satisfaction is higher; when the true reduction degree is as high as 80%, the satisfaction is as high as 9 points; when the true reduction degree of the system goes from low to high, people’s sense of immersion is getting deeper and deeper. When the true reduction degree is 30%, the lowest score for immersion is 1 point; when the true reduction degree is 80%, the lowest score for immersion is 7.5 points; the true reduction of the system decreases from high to low; when it is high, people’s interaction degree becomes stronger and stronger. When the true reduction degree is 30%, the lowest interaction degree score is 2 points; when the true reduction degree is 80%, the lowest interaction degree score is 9 points; it can be seen from this that, with the increase in the degree of realism of the rural landscape virtual-roaming system, it is extremely difficult for people to find whether they are in the virtual or the reality, and their immersion in virtual reality is getting deeper and deeper. This test also confirmed the superiority of the virtual roaming system in rural landscapes, and the experience is extremely effective.

1. Introduction

1.1. Background Meaning. People’s lives have been completely changed with the rapid development of the society. Every family built a new house. In order to improve the living environment, the villagers not only built many modern reinforced concrete buildings across the country but also demolished old buildings and built new ones. The taller the building, the more various shapes are spread across the country [1]. With the development of the economy, modern people pay little attention to rural planning, and rural

landscape planning has long been ignored by people and cannot be evaluated. Therefore, the use of virtual reality technology has a very practical impact on the orderly planning of rural landscapes.

1.2. Related Work. Although our country’s research on rural landscapes started relatively late, relevant scientists have conducted a lot of research studies on our situation, continued to carry out theoretical summaries and practices, and have achieved fruitful results. Ding started with the concept

of the pastoral complex, analyzed the characteristics of the current rural landscape and its existing advantages, and proposed an industrial modernization strategy to encourage the transition to the traditional second and third agribusiness. Through the organic integration of cross-industry and multifunctional spatial units, people can regain the rural landscape, while enabling urban residents and knowledge flow to obtain land and promote the development of the rural economy [2]. Tian discussed the protection of the natural ecological environment and the pursuit of sustainable development, while considering the cultural characteristics of the area and analyzing various types of rural landscapes, such as “rural settlement landscape, rural ecological landscape, and rural production landscape.” In the end, he suggested respecting the traditional rural structure, establishing a warm housing model, creating comfortable rural living spaces, and enhancing the characteristics of rural areas. The landscape must respond to the suggestions of other rural landscape plans, which provide a theoretical basis for economic and civil isolation and the actual rural landscape [3]. Huang et al. after visiting and exploring 30 beautiful villages in Changzhi City, Shanxi, Shaanxi, determined that the rural landscape planning and design needs to be changed urgently, with the disappearance of local characteristics, lack of environmental protection, lack of public participation and scientific control, and other issues. To this end, four planning and design principles regarding integrity, regional characteristics, environmental protection, and sustainability are proposed, as well as three planning strategies for rural, productive, and natural ecological landscapes. For example, in Gucheng Village, Xin’anquan Town, Lucheng City, he conducted planning and design analysis and put forward rural landscape planning and design suggestions related to creating beautiful landscapes [4]. Zhao et al. conducted a field survey on the current planning status of Miyun District in Beijing, explained resource conservation and its application in rural landscape planning, and provided references for future rural landscape planning [5]. Wang et al. Taking Yongji Village, Mingshui County, Heilongjiang Province as an example, in order to solve the important problems existing in the current landscape use, relevant investigations were carried out from four aspects: residential building landscape, public facilities landscape, streetscape, and water resources [6]. Finding and proposing reasonable solutions, problem strategies, and insights are of reference significance for building beautiful towns in the region. In summary, judging from the current status of rural landscape research in the past, most of them have proposed various methods and strategies to plan rural landscapes and rarely mentioned the application of virtual technology to rural landscape planning [7].

1.3. Innovations in This Article. The innovations of this paper are mainly reflected in the following aspects. (1) Using virtual technology to construct a rural landscape roaming landscape system for rural landscape planning. (2) This paper selects the SURF algorithm which is superior to the SIFT algorithm in extracting feature points.

(3) This article is based on the Lumion platform and integrates the results of digital technology applications and research in various stages of rural landscapes. In a gradual process, a low-cost, high-efficiency comprehensive digital virtual reality construction of rural landscapes can be realized.

2. Related Theories of Virtual Reality Technology

Virtual reality (VR for short) refers to the artificial media space created by computers. It is virtual but also realistic. It allows people to enter a virtual environment through multimedia sensor interaction devices and produces an immersive feeling. With the rapid development of computer software and hardware technology, the application of computer graphics in various industries has also developed rapidly. Virtual reality, scientific visualization, and computer animation have become the three major research directions of computer graphics in recent years [8]. This kind of virtual environment is an environment that can be generated by a computer. It can be either a simulation of the real world or a conceived world. Virtual reality has three most prominent features. The first feature is interactivity, through the use of virtual interactive equipment to achieve natural interaction and operation between participants and virtual environment objects; the second feature is immersion, which allows participants to be physically present the real feeling of the environment; the third feature is conception. Participants can get perceptual and rational knowledge through the virtual environment, thereby deepening the concept and germinating new ideas. Virtual reality is a new practical technology involving many disciplines. It integrates advanced computer, sensing and measurement, simulation, and microelectronics technology. It began with the needs of the military field and played a very important role in simulation and training in the military and aerospace fields. In computer technology, it is particularly dependent on computer graphics, artificial intelligence, network technology, man-machine interface technology, and computer simulation technology [9, 10].

2.1. Application of Virtual Technology in Various Fields. The advancement of virtual reality technology has been widely used in education, medicine, entertainment, technology, industry, manufacturing, construction, and commerce. See Figure 1 for details.

2.2. Overview of Virtual 3D Modeling Technology. Virtual reality technology is a brand-new human-computer interaction technology that can truly simulate vision, hearing, motion, and other human behaviors in the natural environment. The ultimate goal is to place the user in a computer-generated virtual environment. Virtual environment modeling is one of the core technologies of virtual reality technology and the basis for creating virtual reality systems [5].

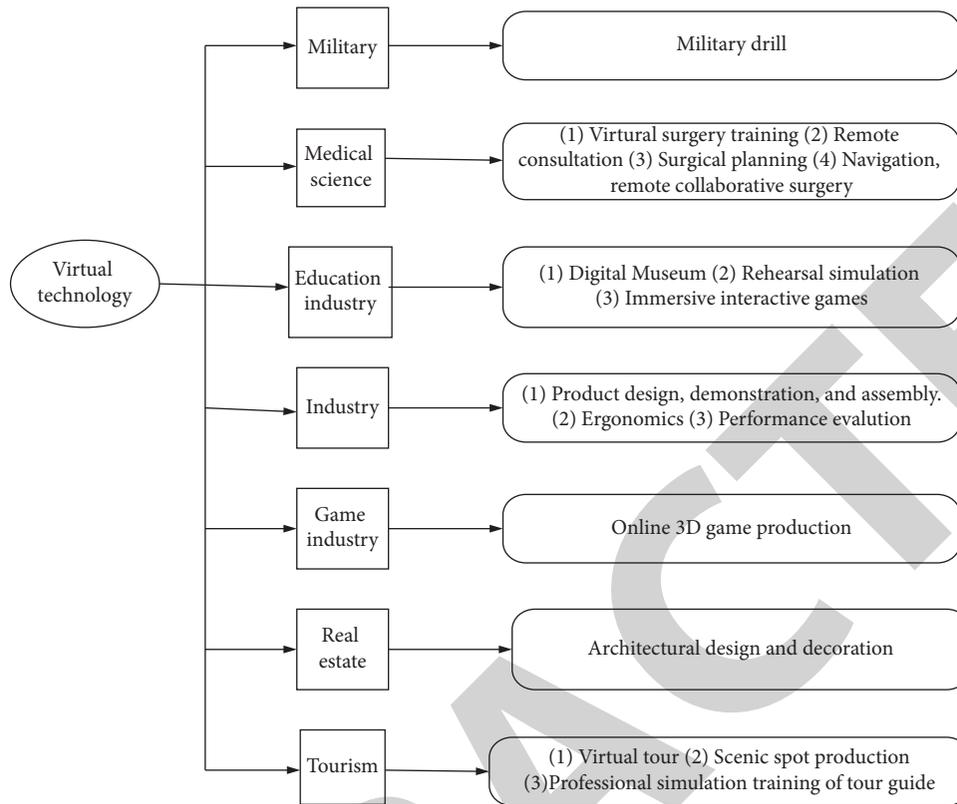


FIGURE 1: Application of virtual technology in various fields.

2.2.1. Main Technical Indicators of Virtual Reality Modeling.

The quality of model construction directly affects the quality of the entire virtual reality system. Therefore, it is necessary to build a good virtual environment to understand the key technical parameters of modeling in more detail [11, 12].

The main technical indicators for evaluating virtual environment modeling are as follows:

- ① *Display Speed.* Many applications have large display time limits. Interactive applications want the response time as short as possible. Too long response time can have a significant impact on system availability.
- ② *Accuracy* It is a measure of the accuracy of the model representation of actual objects and is one of the key elements to express the reliability of the scene.
- ③ *Ease of Use.* Building an effective model is a very complex task. Modelers need to represent the shape and behavior of objects as accurately as possible. Through modeling technology, the design and development of excellent models are as simple as possible.
- ④ *Real-Time Display.* In the virtual environment, the display of the model must be above a certain frame rate limit, which often requires fast display algorithms and model simplification algorithms.
- ⑤ *Manipulation Efficiency.* In practical applications, in a virtual environment with multiple moving objects, model display, motion model movement, and collision detection are very common tasks that must be effectively implemented.

- ⑥ *Extensive* The breadth of modeling technology refers to the range of objects that can be represented. Good modeling technology can provide various geometric, physical, and behavioral object models [13, 14].

2.2.2. Features of Virtual Reality Modeling Technology.

The virtual reality system emphasizes immersion and realism. In other words, it requires a high degree of authenticity, emphasizes natural interaction, and meets the requirements of real-time interaction. Generally, it can produce an immersive feeling in a realistic environment and can meet the needs of real-time and interactivity. Real-time and reality are the basic criteria for evaluating many computer graphics' algorithms. In the process of VR modeling, authenticity, real time, and interactivity are the basic principles of the distinctive features of virtual reality modeling.

2.2.3. Basic Content of Virtual Reality Modeling.

Virtual reality 3D modeling can be divided into data modeling and process modeling. Data modeling includes continuous modeling and discrete modeling. Process modeling includes fractal modeling, image modeling, graphic modeling, geometric modeling, and hybrid modeling. Virtual reality modeling has mainly experienced the development process from geometric modeling to physical modeling and behavior modeling. The modeling of the virtual environment is the basis of the entire virtual reality system, including visual 3D modeling and audible 3D modeling [15].

2.3. Instantiation Technology. When a three-dimensional composite model has multiple objects with the same geometric shapes and attributes but different positions, instantiation technology can be used. Instantiation is an algorithm used in graphics, which can save computer operating costs [16]. If you create multiple objects with the same shape and attributes, the normal copy method will double the number of polygons for each other object. However, the instantiation technology can increase the number of similar objects without increasing the number of polygons. Instancing can greatly reduce the number of polygons in the scene and save a lot of memory. Using this technology in distributed simulation can greatly reduce the workload of data transmission [17, 18].

The main processing method of instantiation technology is matrix transformation. It sacrificed time for memory space. The geometric transformation matrix of the object in the three-dimensional space can be expressed by T_{3D} , and the translation, rotation, and scaling can be expressed as a unified matrix multiplication form. The expression is as follows:

$$T_{3D} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix}. \quad (1)$$

The unified matrix can be derived for each transformation matrix:

2.3.1. Translation Transformation. If the object position is a point $P(x, y, z)$ and the target translates $T_x, T_y,$ and T_z positions in the three axis directions, the translation transformation matrix is as follows:

$$\begin{aligned} [x' \ y' \ z' \ 1] &= [x \ y \ z \ 1] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ T_x & T_y & T_z & 1 \end{bmatrix} \\ &= [x + T_x \ y + T_y \ z + T_z \ 1]. \end{aligned} \quad (2)$$

2.3.2. Scale Conversion. If the scaling ratio is (S_x, S_y, S_z) , then the reference point of the scale transformation is (Xf, Yf, Zf) , and the matrix is as follows:

$$[x' \ y' \ z' \ 1] = [x \ y \ z \ 1] = \begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \quad (3)$$

The process of making ratio $F(Xf, Yf, Zf)$ and rotating transformation relative to the reference point is divided into three steps:

- (1) Move the coordinate origin to the reference point F
- (2) Proportion and rotation transformation are made relative to the origin in the new coordinate system
- (3) Move the coordinate system back to the origin

2.3.3. Rotation Transformation around the Coordinate Axis. In the right-hand coordinate system, the transformation formula for rotating angle A relative to the origin of the coordinate system around the coordinate axis is as follows.

Rotation around the θ axis is follows:

$$[x' \ y' \ z' \ 1] = [x \ y \ z \ 1] \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \theta & \sin \theta & 0 \\ 0 & -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \quad (4)$$

Rotation around the y axis:

$$[x' \ y' \ z' \ 1] = [x \ y \ z \ 1] \begin{bmatrix} \cos \theta & 0 & -\sin \theta & 0 \\ 0 & 1 & 0 & 0 \\ \sin \theta & 0 & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \quad (5)$$

Rotation around the Z axis:

$$[x' \ y' \ z' \ 1] = [x \ y \ z \ 1] \begin{bmatrix} \cos \theta & \sin \theta & 0 & 0 \\ -\sin \theta & \cos \theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \quad (6)$$

The instantiation technology is mainly used to save storage space. In this sense, it takes up less memory and is faster to view. At the same time, the geometric position of the object must be determined by geometric transformation so that the system increases with the number of instance objects. The calculation is clear. Other calculations will slow down the system and affect the real-time performance of the system. Therefore, when using the instantiation technology, the number of instance objects and geometric transformation must be carefully considered, so as not to affect the real-time performance of the system [19, 20].

2.4. Three-Dimensional Panoramic Technology. Based on the various characteristics of 3D panoramic images, 3D panoramic images have a very wide range of applications. It has been applied to many fields such as virtual campus construction, tourism landscape display, commercial product display, real-estate display, hotel display, and automobile display [21, 22].

2.4.1. Camera Imaging and Transformation Model between Images. Before studying the panoramic image generation technology, it is necessary to theoretically understand the transformation relationship model between camera imaging

and images. The camera is placed in the objective three-dimensional world in a certain posture. Usually, the universal coordinate system and the camera coordinate system do not completely overlap, but have a rotation and parallel relationship. In the secondary coordinates, the meaning of these relationships is represented by a 4×4 matrix:

$$\begin{pmatrix} x_c \\ Y_c \\ Z_c \\ 1 \end{pmatrix} = \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix} = M \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix}. \quad (7)$$

In the formula, C is the camera coordinate system coordinates, W is the world coordinate system coordinates, T is a 3×1 translation vector, R is a 3×3 rotation vector, and 0 is a 1×3 vector with all 0 elements.

The camera perspective photography formula is expressed as follows:

$$Z_c = \begin{pmatrix} x_c \\ y_c \\ 1 \end{pmatrix} = \begin{pmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{pmatrix}. \quad (8)$$

The computer uses a two-dimensional matrix to represent an image pixel by pixel, where one point corresponds to one pixel. Usually, the lower-left corner of the plane is the origin, and the coordinates (u, v) of each pixel are the number of columns and rows of pixels in the image. Therefore, in order to facilitate computer processing, the image plane needs to be set to represent pixels in physical size units. The two-formula conversion formulas are as follows:

$$\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{1}{d_x} & 0 & u_0 \\ 0 & \frac{1}{d_y} & v_0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_c \\ y_c \\ 1 \end{pmatrix}. \quad (9)$$

In the formula, (u_0, v_0) is the coordinates of point O in the coordinate system $o-uv$ and d_x and d_y represent the width and height of each pixel (in physical dimensions).

Combining the above three equations, the relationship between the image plane coordinate system and the world coordinate system can be obtained:

$$\begin{aligned} Z_c &= \begin{pmatrix} \frac{1}{d_x} & 0 & u_0 \\ 0 & \frac{1}{d_y} & v_0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix}, \\ &= \begin{pmatrix} \frac{f}{d_x} & 0 & u_0 & 0 \\ 0 & \frac{f}{d_y} & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix} = K \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix} = P \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix}. \end{aligned} \quad (10)$$

In the formula, the matrix P is called the projective row and column; the matrix P only corresponds to the camera's internal parameters (f, d_x, d_y, u_0 , and v_0), which in turn correspond to the focal length of the camera, the aspect ratio of the lens, and the average coordinates of the image. The T vector and R vector are determined by the position and direction of the camera relative to the coordinate system, which are called external camera parameters. If the internal and external parameters of the camera are known, the coordinates of the image plane of a point in the three-dimensional space are determined according to the formula, and vice versa.

2.4.2. Image Transformation Model. Commonly used graph transformation models include parallel motion transformation, rotation transformation, rigid body transformation, similarity transformation, affine transformation, and perspective transformation. The rigid transformation keeps the size of the object unchanged, the similar transformation keeps the angle between the lines unchanged, and the affine transformation keeps the parallel relationship of parallel lines [23].

The image transformation model describes the coordinate transformation relationship between two three-dimensional images. The image conversion model is the key

technology for 3D panoramic image generation. Before the panoramic image is generated, an appropriate image transformation model must be selected. In homogeneous coordinates, it is usually expressed by a 3×3 matrix. Assuming that a point $P(x, y)$ on the original image is transformed to a point $P'(x', y')$ using a certain image transformation model M , their relationship is as follows:

$$\begin{aligned} \begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} &= M \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}, \\ &= \begin{pmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} R & T \\ C & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}. \end{aligned} \quad (11)$$

In the formula, the matrix R formed by h_{11}, h_{12}, h_{21} , and h_{22} describes the rotation and scale changes between images; the vector T formed by h_{13} and h_{23} describes the translation between images, h_{13} is the displacement in the horizontal direction, and h_{23} is the displacement in the vertical direction; The vector C composed of h_{31} and h_{32} describes the keystone distortion of the perspective transformation between images, that is, the amount of deformation in the horizontal and vertical directions.

2.5. Commonly Used Feature Point Extraction Techniques.

Image features are points that have recognizable features in the image. Properties such as brightness, color, curvature, and texture are usually different from adjacent points, for example, corner points, straight-line intersections, discontinuous points, points with maximum curvature on the contour, etc. Feature point extraction technology includes identifying and describing points in an image that have different attributes from neighboring points. The selected feature points should be clear, easy to extract, and well distributed in the image. In order to uniquely identify each feature point and the requirements of the next feature point adaptation module, usually a smaller neighborhood around the feature point is selected, and a feature-point descriptor vector is generated according to a specific measurement method [17, 24].

The ideal feature point extraction technology should meet the criteria of repeatability, precise positioning, locality, moderate quantity, high efficiency, and robustness. Commonly used feature point extraction techniques include SUSAN, Harris, and SIFT, which are all feature point extraction algorithms based on brightness [25].

2.5.1. SIFT Algorithm. The SIFT algorithm recognizes and describes the local feature points of the image. These local feature points are invariant to the transformation, rotation, scaling, and affine transformation in the scaling space. The basic idea of the SIFT algorithm is as follows: first, detect the end point in the scale space, determine the scale and position of the end point, then use the main tilt direction of the small neighborhood where the end point is located as the direction

feature of the target, and finally use the extreme point neighborhood gradient information. Generate feature-point descriptors with 128 dimensions. The SIFT algorithm generally has the following four main steps:

Step 1. Detect extreme points in the scale space.

In order to make feature points have scale invariance, the scale space is introduced. The scale space is an analysis method that convolves the original image with the function $G(x, y, \sigma)$ of different scales to map the original image to the scale space. The small scale can show the detailed features of the original image, and the large scale describes the general features of the original image [26, 27].

The scale space of a two-dimensional gray image is as follows:

$$\begin{aligned} L(x, y, \sigma) &= G(x, y, \sigma) * I(x, y), \\ G(x, y, \sigma) &= \frac{1}{2\pi\sigma^2} e^{-((x^2+y^2)/2\sigma^2)}. \end{aligned} \quad (12)$$

$G(x, y, \sigma)$ is the scale-variable Gaussian function, $I(x, y)$ is the grayscale image of the original image, the symbol $*$ represents the convolution operation, (x, y) represents the position of the pixel in the image, and σ represents the scale space factor. The smaller the σ value, the smaller the corresponding scale, the more image details are retained. As σ gradually increases, the image is smoothed more and more, leaving only the overview of the image.

In order to efficiently detect stable feature points in the scale space, it is necessary to use the Gaussian difference function to project the source image into the difference scale space. The difference function is the difference between two kernels of different scales, defined as follows:

$$\begin{aligned} D(x, y, \sigma) &= (G(x, y, k\sigma) - G(x, y, \sigma)) * I(x, y), \\ &= L(x, y, k\sigma) - L(x, y, \sigma). \end{aligned} \quad (13)$$

In the formula, k is a constant. In actual implementation, the subtraction of two adjacent scale images in the scale space $L(x, y, \sigma)$ is used to obtain the differential scale space $D(x, y, \sigma)$ because the subtraction operation greatly reduces the calculation amount.

Step 2. Screen and accurately locate feature points.

The detection in the previous step obtained a set of candidate feature points with scale invariance. However, these candidate feature points include some unstable feature points, such as points on the edges of low-contrast points, which are extremely susceptible to noise. Therefore, in this step, candidate feature points need to be screened to eliminate unstable feature points.

First, apply a quadratic function that accurately estimates the location and proportion of feature points based on the data around the candidate feature points and then is affected by noise such as “apply some simple points.” For example, points with low contrast and curved edges are excluded from the threshold. Improve regulation stability and noise suppression.

To delete low-contrast candidate feature points, first fit a quadratic function according to the data around the candidate feature points to accurately estimate the position and proportion of the feature points:

$$D(X) = D + \frac{\partial D^T}{\partial X} X + \frac{1}{2} X^T \frac{\partial^2 D}{\partial X^2} X, \quad (14)$$

$$\hat{X} = \frac{\partial^2 D^{-1}}{\partial X^2} \frac{\partial D}{\partial X}$$

In the formula, $X = (x, y, \sigma)^T$ represents the offset of the original sample point.

Delete candidate feature points on the edge. Edge points usually have these characteristics. The curvature in one direction along the edge is small, and the curvature in the direction perpendicular to the edge increases. Therefore, if the principal curvature ratio is too large, edge points can be removed because the eigenvalues of the Hessian matrix are proportional to the principal curvature. Therefore, the principal curvature is calculated by the Hessian matrix. The complex matrix eigenvalues cannot be analyzed to improve the calculation efficiency, but the ratio matrix is calculated:

$$H = \begin{bmatrix} D_{xx} & D_{xy} \\ D_{xy} & D_{yy} \end{bmatrix},$$

$$\text{Tr}(H) = D_{xx} + D_{yy} = \alpha + \beta,$$

$$\text{Det}(H) = D_{xx}D_{yy} - (D_{xy})^2 = \alpha\beta,$$

$$\text{ratio} = \frac{\text{Tr}(H)^2}{\text{Det}(H)} = \frac{(\alpha + \beta)^2}{\alpha\beta} = \frac{(\gamma\beta + \beta)^2}{\gamma\beta^2} = \frac{(\gamma + 1)^2}{\gamma}. \quad (15)$$

The value of the ratio only depends on r and has nothing to do with the size of α and β . When $r = 1$ ($\alpha = \beta$), the ratio takes the minimum value; as r increases, the ratio also increases. Therefore, the edge points can be eliminated by ratio calculation.

Step 3. Specify the direction of feature points.

Due to the rotation invariance of the feature point descriptor, the main tilt direction of the pixel in the small local neighbor where the feature point is located is called the directional feature of the feature point. The small communities in this area are concentrated on the characteristic points, and the 1.5σ perimeter is a circle with a radius. Use the formula to find the gradient coefficient $m(x, y)$ and direction $\theta(x, y)$ of each pixel in the smaller local neighborhood:

$$m(x, y) = \sqrt{(L(x+1, y) - L(x-1, y))^2 + (L(x, y+1) - L(x, y-1))^2},$$

$$\theta(x, y) = \arctan\left(\frac{L(x, y+1) - L(x, y-1)}{L(x+1, y) - L(x-1, y)}\right). \quad (16)$$

In the formula, L is the scale space image of the feature point (scale is σ), and (x, y) is its coordinates.

Step 4. Generate local feature point descriptors.

A 16×16 rectangular area centered on the feature point and the feature point direction: use a function (which is a measure of variance feature points) to weight the gradient coefficient values of all pixels in the rectangular area, and divide a 16×16 area into $16 \times 4 \times 4$ subareas. For each partition, you can use the same as in step 3..

2.5.2. SURF Algorithm. The SURF is a fast and powerful method for identifying and describing local invariant feature points. The overall thinking process of the SURF algorithm is similar to that of the SIFT algorithm, but the feature-point detection module uses a box filter to approximate the function and uses the integral image to speed up the convolution and calculation speed; in the

feature point direction module, the radius is represented by 6σ (σ is the scale of the image where the feature point is located). The extreme value of the wavelet response of the Haar in the circle represents the direction of the feature point; in the feature-point description module, the sum of the horizontal and vertical Haar wavelet responses is relative to the feature point direction and the response. The sum of absolute values constitutes the descriptor vector [28].

The integral image is defined as follows:

$$I_{\Sigma}(x, y) = \sum_{i=0}^{i \leq x} \sum_{j=0}^{j \leq y} I(x, y). \quad (17)$$

In the formula, $I(x, y)$ is the original grayscale image and $I_{\Sigma}(x, y)$ represents the sum of all pixels in the matrix area with the image origin and point (x, y) as the diagonal vertices.

2.6. Three-Dimensional Modeling Technology. Virtual technology is realized by modeling in a virtual environment. Modeling is actually the real environment of simulation. Before modeling, use conventional radiation or laser scanning, take photos and other methods to obtain 3D data required for modeling, align them, and bring the aligned data into appropriate 3D modeling software to create virtual scene models [29].

2.7. Real Rendering Technology. In a virtual reality system, a certain sense of reality must be given to the virtual scene so that users can experience immersion. Therefore, the main task of photorealism reception is to simulate the visual characteristics of real objects, such as the optical properties, texture, smoothness, and other characteristics of the object surface, in order to maximize the final image effect of the real scene.

2.8. Human-Computer Interaction Technology. Virtual simulation technology can use input or output devices (such as helmet display technology, data globe, and data clothing) to obtain a free world for interacting with virtual objects, just like they are in the real world, but this is not very good. It can also interact with the body and limbs, including hands, ears, and knees, which is a natural interaction technology in a virtual environment. In recent years, some scientists are continuing to improve their existing interactive hardware and software to improve people's natural interaction in the virtual environment and, at the same time, strengthen research with new interactive methods. Gesture recognition, speech recognition, gaze tracking, and other interactive technologies have been widely used in virtual reality, and they are more common and convenient-focused interactive technologies.

3. Practical Application of Virtual Reality Technology in Rural Landscape Planning

This chapter is based on the Lumion platform and integrates the results of digital technology applications and research in various stages of rural landscapes. In a gradual process, a low-cost, high-efficiency, comprehensive digital virtual reality construction of rural landscapes can be realized. This method is not only the integration of the previous results but also the overall improvement of the protection of the rural landscape. Realization through the virtual reality platform cannot only better serve rural tourism and publicity but also improve the accuracy of rural protective planning and design, thereby effectively improving the implementation effect of protection projects.

3.1. Collection of 3D Information of Rural Landscape Architecture in a Certain Place

3.1.1. Surveying and Mapping Three-Dimensional Data. The measurement of data on the doors, windows, beams, etc., of rural buildings has two functions. One is to make postmodels, but to prepare for the digitalization of subsequent buildings. At

this stage, the focus is on various data such as the plan, elevation, and section of the rural building, and even the high-definition digital camera is used to photograph the building, the surrounding environment, and some details, so as to have a reference when making the building model and scenery. According to the basis, in addition, some building structural components should be sketched by hand in order to better understand and refer to it later. In the measurement, we should not only pay attention to the rural building itself but also carry out some measurement work on the surrounding environment of the building. For example, do some understanding and related data work on the entire topography, landform of the village, and the greening situation around the village houses to pursue the artistic beauty of the rural landscape. In order to measure accuracy, expensive high-end measuring instruments, and advanced technical means must be used. For example, 3D laser scanning technology can be used to complete the acquisition of spatial information of historical buildings.

3.1.2. Photo Shooting of the Rural Landscape. The work at this stage is of great significance to the restoration of the later ancient buildings because the on-site photos can clearly and intuitively reflect any changes in the building and can also be used as basic materials for later restoration at any time, such as the compilation inside and the compilation of doors and windows. In addition, these photos can also be used as a reference for future building restoration. Through comparison, we found that the building can be restored to its original appearance through many details; therefore, in the shooting process, not only high-definition angle shooting, but also classified shooting; not only to distinguish the long-term view and the close-up view of the building, but also to pay attention to the exterior wall, structural form, etc. After shooting, number the photos in the texture map accordingly and even the detailed texture and plane CAD of brick structure, stone structure, ceramic tile, wood structure, etc. The graphs match, so the model will not cause confusion. At the same time, try to avoid obstacles blocking details, such as a surface that needs to be used as a texture. After completing this model, this is the only way to ensure the quality of texture photos and the difficulty and workload of processing textures.

3.1.3. Classifying and Summarizing the Information. This stage is mainly to sort and organize the data and pictures collected in the previous stages. First, classify the photos. The compilation objects include the following: historical pictures, architectural panoramas and landscapes, all building facades, individual building components, and inspection nodes are numbered according to certain rules. The next step is the surveying and mapping data. The principle of data sorting is to ensure that it is simple and clear, so as to prevent the production staff from seeing flowers. AutoCAD software can be used for drawing to accurately record the various data of the entity. Data classification also helps to improve the efficiency of team development and collaboration which is very useful for engineers after model making.

3.2. Establishment of a Three-Dimensional Model of the Rural Landscape. In the preliminary investigation stage of the thesis, we carried out detailed on-site surveying and mapping work, completed the field survey of the rural landscape, and obtained accurate plane and elevation data. Based on the CAD plan drawing, three-dimensional modeling can be developed. The author mainly uses Sketch Up and 3DSMAX 3D software for modeling and also uses Rhino software sparingly. Based on Sketch Up and 3DSMAX-based modeling methods and focusing on the characteristics of the two software, there are focused choices. Let us take the SketchUp modeling method as an example. The generated model is mainly surface. The advantage is that the file size is small and must meet a large number of models. The disadvantage is that the model is not very accurate, and the model is easy to cut and overlap lines. The model created using the 3DSMAX example is mainly based on points and lines, and the surface is optimized using points and lines. The model perfectly represents a high level of accuracy and detail. The disadvantage is that the model is large in size and occupies a lot of memory, which increases the computational pressure of computer hardware equipment. At the same time, the accuracy of CAD drawings is high during the modeling process. If there are heavy lines and nonclosed line segments in the drawings, it will cause the model to appear broken. At the same time, the commonly used modeling software is Rhino, which has high accuracy in the arc of the model and is often used in the modeling of industrial products. Rural buildings rarely have curved shapes, so they are not often used in architectural modeling.

3.2.1. Establishment of a Three-Dimensional Model of Traditional Houses Based on SketchUP. In the process of functional design and development, SketchUp modeling software considered the rapid modeling requirements of 3D software and introduced the concept of virtual reality development. According to the development of modeling functions, SketchUp software simplifies the details and accuracy of model processing in the modeling phase and emphasizes the speed and ease of use of modeling. Simple user interface and powerful function settings can significantly improve modeling efficiency and reduce the amount of computer calculations. The requirements for CAD drawings are also greatly reduced, so there is no need to provide a full set of drawings. In the actual operation, a rapid modeling and preliminary restoration plan is created according to the local conditions of the rural landscape and residential buildings; at the same time, in the process of coordinating the restoration, the communication opinions between the designer and the expert can also be directly used in the model creation and space modification, which greatly improves the work efficiency and realizes the rapid effect preview. In the development of virtual reality-based functions, SketchUp software provides powerful 3D visualization functions, which greatly enriches the visual presentation of the space and realizes timely preview of effects. At the same time, the functional architecture of virtual reality is also combined with the Internet platform, which can smoothly import files into the platform to establish a virtual display of models and real scenes, which greatly

improves the visual experience and establishes an intuitive effect display. It is very suitable for reuse when the country is fully digitalized to establish a virtual reality scene.

On the basis of the completion of the modeling work, the scale and structure of the model were adjusted many times, and the structural relationship of the model was explained as clearly as possible, and the connection method of the building construction was restored. Comparing the real-life photos in the original appearance of the countryside, attach the material to the white film to restore the authenticity of the houses.

3.2.2. Establishment of a Three-Dimensional Model of Traditional Houses Based on 3DSMAX. For the more complete protection of traditional dwellings and ancient building systems with the high historical value, the follow-up protection work should be done to maintain or optimize the current status quo as much as possible. After the implementation of physical protection measures, digital protection should also be carried out. To protect the residences of great significance, a thorough site survey and detailed data surveying and mapping are carried out to provide accurate data and reference systems for the later digital 3D modeling. Through the modeling of three-dimensional software, the later material rendering, effect debugging, the virtual imaging, and the restoration of the physical space are realized. Taking 3DSMAX modeling as an example, the model is more sleek, more segmented (the surface enclosed by points and lines can be automatically optimized), the model is highly accurate, the rendered image quality is excellent, and the picture is realistic. It meets the needs of high-quality modeling and is often used to make high-value digital 3D models of traditional houses.

In the process of creating the 3DSMAX model, relying on its fine segmentation and accurate data, the various modules of the object are restored one by one, and it is often used in the field of high-precision modeling. Through the comparison chart, it can be concluded that the 3DSMAX model, through the adjustment of the material and the simulation of the lighting environment, has clear picture quality and excellent effects, which vividly restore the original appearance of the countryside. Through the post-beautification processing of the image processing software Photoshop, a realistic real-life simulation is achieved. The rendered renderings are of practical significance for the guidance in the transformation process.

3.3. Establishment of Rural Virtual Reality Based on Lumion Technology. Lumion is a real-time 3D visualization tool for making movies or photos. Related disciplines include architecture, planning, and design. We can also provide live demonstrations. The advantage of Lumion lies in its ability to provide excellent images. It combines a fast and efficient workflow to save time, energy, and money, and people can create virtual reality on the computer. Lumion reduces production time by rendering high-resolution movies faster than ever, and the video shows how to create visualizations of amazing structures in seconds. In addition, you can

directly import, edit, and use files compatible with SketchUp and 3DSMAX files. In short, it provides ease of use, speed, low cost, and various functions that are very suitable for virtual roaming in the countryside.

3.3.1. Virtual Reality Scene Production. SketchUp files are compatible with Lumion software. Act-3D adds more than 330 new objects, such as furniture, flags, and new cars. The existing character set has also been expanded to include multiple high-quality 3D animated characters, and the number of postprocessing effects, such as weather and artistic painting effects, has greatly increased. Through rapid rendering technology, even if you add more buildings, vegetation, mountains, and other landscape elements will not affect its fluency. As the principle of gradual progress, it strives to realize the comprehensive digitization of ancient villages at a lower cost, and it has huge technical advantages in terms of establishing the final operation platform of virtual reality scenes.

3.3.2. Importing the Overall Model into the Virtual Reality Platform. Put the overall model established in Sketch Up software into proper order, save the dac format, and import it into Lumion software. There are many scenes on the Lumion platform that can be selected as the background, mainly the following typical scenes: valleys, rivers, hills and plains, nature, seascapes, etc. We can choose according to the needs of the object, such as the building scene in the countryside above us to choose a natural and idyllic plain and mountains as the background, and the “sky box” in virtual reality is very similar to this kind of scene.

3.3.3. Scene Optimization. The postoptimization function of the Lumion software is relatively powerful. It can re-optimize the terrain scene imported in the early stage. For example, the terrain surface can be adjusted through the stretching function to make it rougher or smoother, or it can be made according to the nature of the terrain. The texture generates a scene close to the real geographical environment, which can be optimized to generate terraces that simulate rock walls or the terrain of villages surrounded by lakes.

3.4. Virtual Reality Scene Application. Lumion is more flexible in operability and practical functions. Through the operation and editing of various functions in the virtual scene, we can feel more real in the digital virtual experience of the rural landscape. During the interaction, we can walk freely or take a certain means of transportation. The digital dynamic simulation of the rural landscape can be realized through repeated editing, and static or dynamic images can be generated.

3.4.1. Editing and Touring Based on Virtual Reality. Lumion can completely inherit the materials contained in the SketchUp platform, their display effects are the same, and they can be optimized and edited repeatedly; in order to

distinguish objects, we can also import different solid color blocks in the SketchUp software, such as red, yellow, and blue so that it is clear at a glance. After completing the above steps, use the Lumion software to paste the material on the object. Since the calculation logic of the Lumion software platform is based on the same material as the basic selection unit for editing, it is necessary to distinguish objects of different materials in SketchUp. If the final effect after the material is pasted is quite different from the previous design, it can be optimized and modified on the Lumion platform.

After inserting the materials, there are two ways to obtain these plants, one of which comes from Lumion’s own plant library. This plant library contains various buildings, cars, people, animals, streets, street decorations, soil, stones, etc., dynamic and static, with various shapes and colors, which can meet the needs of various scenes. Another way is to make it directly from SpeedTree. The advantage of this method is that it is more flexible and can satisfy some rare or unique plants, making the botanical library more abundant. These colorful botanical libraries bring great convenience to the later scene configuration and also assist the designer in the green design of the site. The scene is configured, and then, you can modify and adjust the model. There are two ways to choose. The first is to directly import the model components into the virtual reality scene, and the second is to modify the SketchUp scene model. The former method is restricted by the Lumion software and can only be placed in a scene that does not require high size, while the latter is relatively complicated, it must be operated under the logic of the SketchUp software and can be placed in some more precise sizes. Above, the two methods have their own advantages and disadvantages. These two methods cooperate with each other to achieve a perfect dynamic simulation of rural landscape renovation. For example, adding some landscape sketches to a certain scene can choose the first type, which is convenient and easy to implement; for example, the second method can be used to demolish privately constructed buildings, which can be accurately presented and can facilitate analysis and research. Through the use of virtual reality technology, the real scene of the rural landscape can be greatly restored, and through this interactive control process, a tour of the detailed scene of the rural landscape and the overall environment can be realized.

3.4.2. Static Image Rendering and Animation Production Based on Virtual Reality. Compared with other 3D software, Lumion has a faster rendering speed, and the rendering time under the same conditions is ten times faster than other software, which greatly improves work efficiency. It also has a night-vision rendering system that can turn into a beautiful night sky scene with dim moonlight and sky. Another function of the rendering engine is to improve the sound mapping and light occlusion in the screen area. The Act 3D demo scene looks good.

3.4.3. Experimental Experience Detection Stage. When the virtual roaming system is installed by default, users should be able to test the entire system based on experimental

experience, such as swelling detection. The user's actions and the movement of objects in the virtual environment will cause frequent expansion between objects, and the corresponding collision response will be calculated, and the screen result can be updated. Otherwise, an intrusion will occur between objects. When problems occur, timely feedback and corrections are required to ensure the authenticity of the final roaming environment.

4. Application Analysis of Virtual Reality Technology in the Analysis of the Three-Dimensional Assessment System of Rural Landscape Planning

4.1. Performance Comparison of Feature Point Extraction Algorithms. In order to find a universal feature point extraction algorithm, this experiment will compare the SIFT algorithm and the SURF algorithm from three aspects: the number of feature points extracted by the algorithm, the time required for the algorithm, and the number of correct matching point pairs. The images used in the experiment are all extracted from the video taken by the camera. The video is captured by the camera in indoor and outdoor environments. In order to make the data comparable, the same feature point matching algorithm is used to match the feature points extracted by the SIFT and SURF in the experiment. For details, see Tables 1 and 2 and Figures 1 and 2.

It can be seen from Table 1 and Figure 2 that, in the SHIFT algorithm, the number of correct matching points in the first group is 114, the second group has 55 matching points, and the third group has 13 correct matching points. The longest time for the second group B was 1.187 seconds, and the shortest time was 0.5 second for the third group A. In summary, the number of feature points extracted by the SIFT algorithm and the number of correct matching points are large, but it takes longer.

It can be seen from Table 2 and Figure 3 that, in the SURF algorithm, there are 62 correct matching points in the first group, 28 matching points in the second group, and 4 correct matching points in the third group. The longest time for the second group and the first group was 0.203 seconds, and the shortest time was 0.109 seconds for the third group A. All in all, the number of feature points and correct matching points extracted by the SURF algorithm is not large, but they do not take time.

In order to compare and analyze more intuitively, which of the SURF algorithm and the SIFT algorithm runs faster, compare the correct matching points and the required time of the two algorithms, respectively, as shown in Figure 4.

The comparative analysis shows that the SURF runs faster than the SIFT algorithm, and in the panorama image generation process, when the image quality is good, the number of effective feature points it can detect can meet the requirements of estimating model parameters. Therefore, the SURF can be used as a feature point detection method.

4.2. Experience Test Analysis of the Virtual Roaming System in Rural Landscape

4.2.1. Basic Situation of the Tester. In order to carry out the experience test analysis of the virtual roaming system in rural landscape, 25 people were randomly selected as experimental subjects in a certain village, and 5 of them were 0–18 years old (including 3 males and 2 females); 3 males 5 the age group is 18–28 years old (including 2 males and 3 females); 5 of them were 18–28 years old (including 2 males and 3 females); 5-person age group is 38–48 years old (including 3 males and 2 females), and 5 people are over 48 years old (including 4 males and 1 female), see Table 3 and Figure 5.

4.2.2. The Tester's Experience of the Rural Landscape Virtual Roaming System. This experiment is based on the rural landscape virtual-roaming system of a village, randomly selecting 25 people (divided into 5 groups of 5 people) in batches to enter the system with a real reduction degree of 30%, 45%, 60%, 75%, and 80% for the testing experiment. The true reduction degree of the first group is 30%; the true reduction degree of the second group is 45%; the true reduction degree of the third group is 60%; the true reduction degree of the fourth group is 75%; the true reduction degree of the fifth group is 80%. Test the average stay time of 20 people in the system, the number of people who found the penetration phenomenon, and the number of people who returned to the origin. The test data is shown in Table 4.

It can be seen from Table 4 that the average stay time of the first group was 2 minutes, and 5 people were found to have penetrated the system, and 1 person returned to the original point; the average stay time of the second group was 3.5 minutes, and 3 people were found to have penetrated the system. 1 person returned to the origin; the average stay time of the third group was 5 minutes, and 2 persons were found to have penetrated the system, and 2 persons returned to the origin; the average stay time of the fourth group was 8 minutes, and 1 person was found to have found the penetration phenomenon, and 3 persons returned to the origin; the average stay time of the fifth group was 8 minutes, and 1 person was found to have penetrated the system, and 4 people returned to the original point.

It can be seen from Table 4 and Figure 6 that when the real reduction degree of the system goes from low to high, the average stay time of people is longer. When the real reduction degree is as high as 80%, the average residence time is 8 minutes; the real reduction degree of the system at that time increased from low to high, the number of people who found penetration in the system gradually decreased. When the true reduction degree was as high as 75%, the number of people who found the penetration phenomenon was 1; when the true reduction degree of the system went from low to high, the number of people returning to the original point gradually increased; when the true reduction degree is as high as 80%, there are 4 people returning to the original point. In summary, with the increase in the degree of realism in the rural landscape virtual-roaming system, it is

TABLE 1: The effect of the SIFT on extracting feature points.

		Number of feature points	Time required (s)	Number of correct matches
No. 1	A	556	1.094	114
	B	472	0.969	
No. 2	A	724	1.187	55
	B	437	0.828	
No. 3	A	206	0.500	13
	B	257	0.578	

TABLE 2: The effect of SURF on extracting feature points.

		Number of feature points	Time required (s)	Number of correct matches
No. 1	A	226	0.203	62
	B	263	0.203	
No. 2	A	158	0.141	28
	B	146	0.140	
No. 3	A	95	0.109	4
	B	120	0.125	

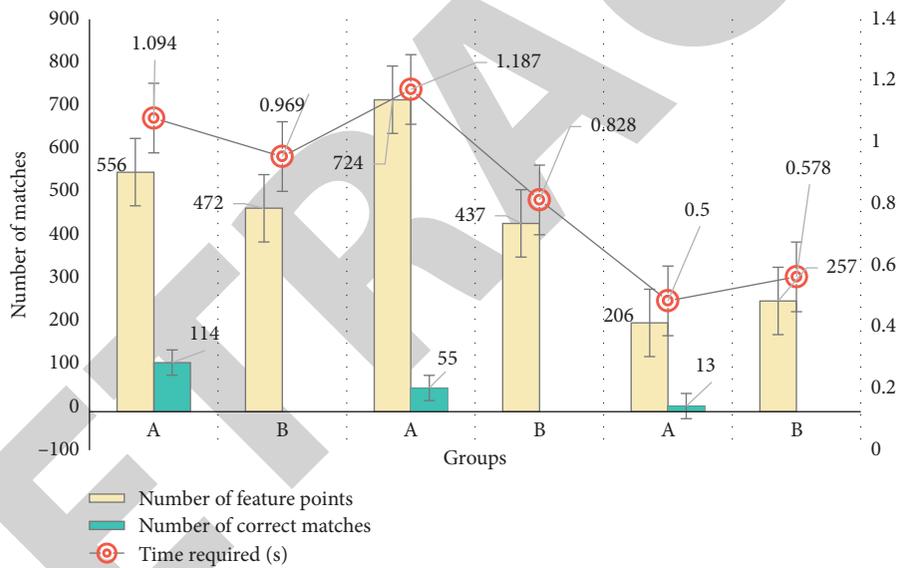


FIGURE 2: The effect of the SIFT on extracting feature points.

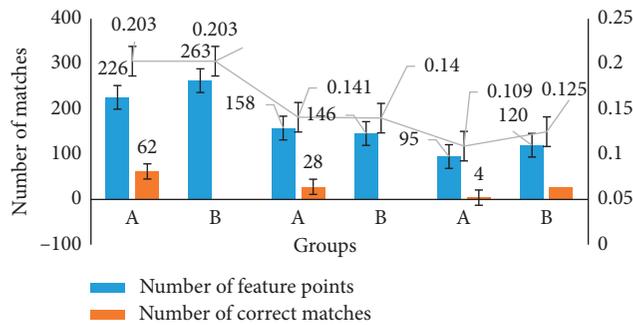


FIGURE 3: The effect of the SURF on extracting feature points.

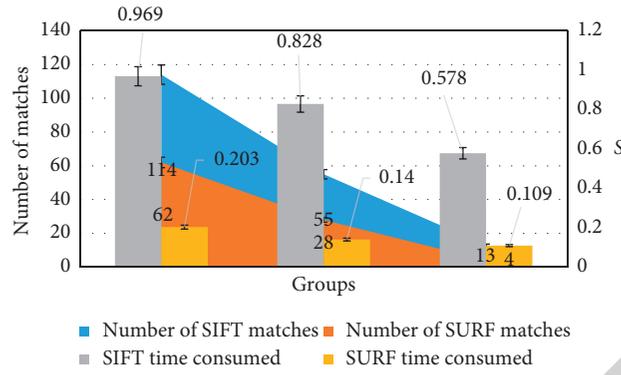


FIGURE 4: Comparison of the SIFT algorithm and SURF algorithm.

TABLE 3: Age group of testers.

	0–18 years old	18–28 years old	28–38 years old	38–48 years old	Over 48 years old
Male	3	2	1	3	4
Female	2	3	4	2	1

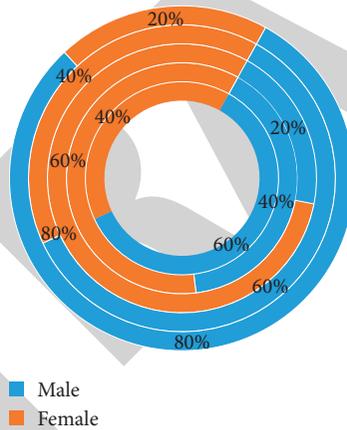


FIGURE 5: Age group of testers.

TABLE 4: Experience analysis of the virtual roaming system in rural landscape.

	Average residence time	Found penetration	Back to the start
No. 1	2	5	1
No. 2	3.5	3	1
No. 3	5	2	2
No. 4	8	2	3
No. 5	8.5	1	4

extremely difficult for people to find out whether they are in virtual or reality, and their immersion in virtual reality is getting deeper and deeper. This test also confirmed the superiority of the virtual roaming system in rural landscapes, and the experience is extremely effective.

4.2.3. *Survey of Satisfaction of Testers on Experience of the Virtual Roaming System in Rural Landscape.* In order to further understand the tester’s satisfaction with the

experience of the virtual roaming system in rural landscape, 25 people who were tested were divided into groups to conduct a questionnaire survey and scored at the true reduction degree of 30%, 45%, 60%, 75%, and 80%. The score includes authenticity, interaction, immersion, functionality, usage, expansion, and satisfaction (the lowest score for each item is 0 point, and the highest score is 10 points). See Table 5 and Figure 7 for details.

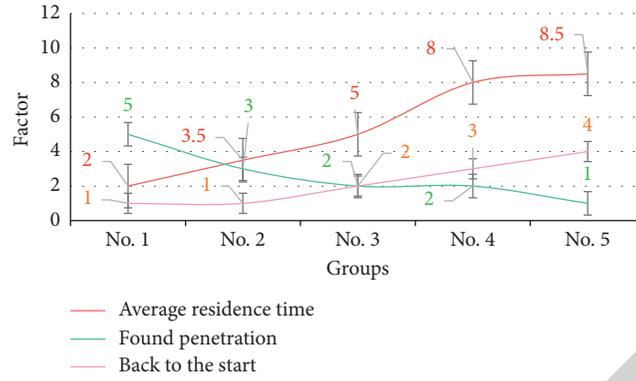


FIGURE 6: Experience analysis of the virtual roaming system in rural landscape.

TABLE 5: Testers' satisfaction with system experience.

	Trueness	Interaction	Immersion	Functionality	Usage	Expansion	Satisfaction
No. 1 (30%)	1	2	1	1	0	0	1
No. 2 (45%)	2	2	1	1	1	1	2
No. 3 (60%)	5	4	3	3	5	3	5
No. 4 (75%)	7	6.5	5.5	5	7	6	6
No. 5 (80%)	8.5	9	7.5	6	7	8	9

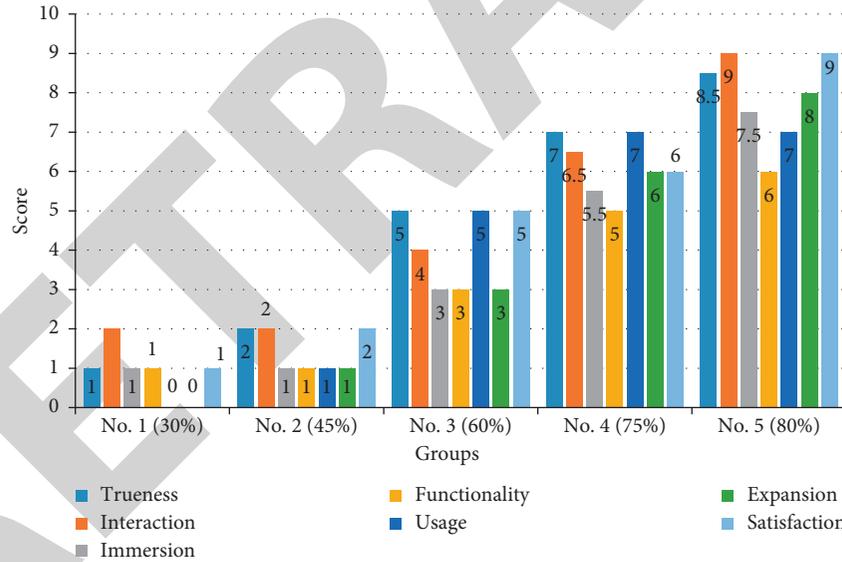


FIGURE 7: Testers' satisfaction with system experience.

From Table 5, it can be concluded that when the true reduction degree is 30%, the tester scores 1 point for authenticity, 1 point for interaction, 1 point for immersion, 1 point for functionality, and 1 point for functionality. The expansion score is 0 points, and the satisfaction score is 1 point; when the true reduction degree is 45%, the tester scores 2 points for authenticity, 2 points for interaction, and 1 point for immersion. The function score is 1 point, the function score is 2 points, the expansion score is 2 points, and the satisfaction score is 2 points; when the true reduction degree is 60%, the tester's authenticity score is 5 points, the degree of interaction score is 4, the immersion

score is 3, the functional score is 3, the functional score is 5, the expansion score is 3, and the satisfaction score is 5; when the true reduction is 75%, the test participants rated authenticity as 7 points, interaction score as 6.5 points, immersion score as 5.5 points, function score as 5 points, function score as 7 points, expansion score as 7 points, and satisfaction score as 7 points; when the true reduction degree is 80%, the tester's authenticity score is 8.5 points, the interaction score is 9 points, the immersion score is 7.5 points, the function score is 6 points, the function score is 7 points, the degree of expansion score is 8 points, and the satisfaction score is 9 points.

It can be seen from Table 5 and Figure 7 that when the true reduction degree of the system goes from low to high, people's satisfaction is higher. When the true reduction degree is as high as 80%, the satisfaction level is as high as 9 points; when the true reduction degree of the system goes from low to high, people's sense of immersion is getting deeper and deeper. When the true reduction degree is 30%, the lowest score for immersion is 1 point; when the true reduction degree is 80%, the lowest score for immersion is 7.5 points; the true reduction degree of the system decreases to low when it reaches high levels, and people's interaction becomes stronger and stronger. When the true reduction degree is 30%, the lowest score for interaction is 2 points; when the true reduction degree is 80%, the lowest score for interaction is 9 points; the survey shows that with the increase in the degree of true restoration of the rural landscape virtual-roaming system, people's ratings of the system also increase. At the same time, it has once again confirmed that the system has a very obvious effect on rural landscape planning.

5. Conclusion

In terms of the landscape design, virtual reality technology has a great future. Although current examples of the application of virtual reality technology are not common, the core ideas of the landscape project design are clarified, the characteristics of virtual reality technology are better utilized, and landscape design is actively constructed. After the platform and in-depth exploration of the simulated landscape design, it can promote the process of combining virtual reality technology with the landscape design, making this technology more comprehensive for the landscape design work.

Based on the Lumion platform, this paper has developed a rural landscape planning three-dimensional evaluation system by integrating virtual and three-dimensional panoramic technologies. In the process of gradual application research, a low-cost, high-efficiency rural landscape comprehensive digital virtual reality construction has been realized.

Landscape planning has a strong demand for visualization technology, and virtual reality technology has a huge application space in both urban planning and rural planning. The unique immersion and interactivity of virtual reality technology can enable planning departments, developers, technicians, designers, and ordinary people observe the results of future plans from all angles, allowing users to better grasp the scale and scope of urban planning and also allow customers to better understand design intent and design ideas and modify the unsatisfactory nodes in the design and planning in the environment. It is useful for planning and managing large projects. Designers and managers are also encouraged to modify the design plan and add it to the design in the future to detect design errors and avoid design risks.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Both authors contributed equally to this work.

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