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Research Article

Three-Dimensional Reconstruction of Huizhou Landscape Combined with Multimedia Technology and Geographic Information System

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Huizhou architecture is the most important Chinese ancient architecture. Being a traditional architecture, Huizhou architecture has always maintained a unique artistic style of elegance, simplicity, richness, and integration. Huizhou landscape is an essential embodiment of Huizhou culture. The landscape and pattern of Huizhou villages are the external manifestations of Huizhou culture symbols. This architecture needs to be preserved using multimedia technology and geographic information system. This paper uses these systems to extract the landscape image and develop three-dimensional Huizhou village's modeling methods with automation, high efficiency, and low cost. It has realized the functions of landscape information query, high-dimensional measurement, terrain analysis, visibility analysis, and virtual roaming of Huipai village. This modeling has specific promotion effects on landscape spatial analysis, landscape planning, ecological protection, natural and cultural inheritance, and tourism development.

1. Introduction

The Huizhou village landscape is a multifunctional socialized landscape carrier composed of the human landscape and natural landscape formed in a specific time and space environment. It constructs a regional complex ecological landscape with long-term coexistence of people and the environment, reflecting the characteristics. The connotation of "Huihua culture" is the realistic view of "Heaven and Man" and the simple ecological consciousness concept. Its structure is affected by the natural environment such as mountains, vegetation, waters, climate, and human factors such as architecture, customs, Feng Shui, and economic behavior [1]. The traditional Chinese villages represented by Huipai villages are deeply influenced by the conventional Feng Shui doctrine in the process of site selection, construction, and development, fully embodying the model of "harmony between man and nature," natural coordination, and harmonious symbiosis. The spatial pattern, habitat model, architectural form, and social relationship formed in the long-term running-in have deep ecological connotations and are valuable ecological wealth in China. From the ecology perspective, the concept of human settlements in Huizhou villages with multicultural purposes is ideal for human settlements [2]. In today's conflict between human and ecological environment, the spatial characteristics of Huizhou villages are analyzed. Excavating the environmental connotation of the Huizhou village can provide conceptual support for modern human settlement design.

At present, the research on the spatial characteristics of traditional villages mainly focuses on three aspects. First is the qualitative analysis of settlement layout, spatial structure, and impact mechanism from the elements of human factors, Liu Peilin and other "Feng Shui culture", "spiritual space", and "landscape" "Image" and so on as the starting point to study the image of the settlement space, to study the multidimensional spatial stereoscopic image of the ancient Chinese village landscape. To propose the concept of the

village ecosystem from the ecological point of view and the characteristics of the village from the aspects of structure, function, distribution, evolution, and humanities, qualitative analysis was carried out with the model. Hu et al. and Liu Peilin proposed the concept of the traditional settlement landscape genome map and analyzed its relationship with landscape genes and landscape genomes and further studied the types, functions, and significance of conventional settlement landscape genome maps [3]. The second is to use the landscape pattern, GIS spatial analysis, ecological model, and other measurement methods to study the layout, type, scale, system, spatial structure, and settlement evolution of the settlement and use the landscape pattern analysis to reveal the Feng Shui contained in the settlement layout. The third is trying Feng Shui theory and ecological landscape design combined with comprehensive qualitative and quantitative analysis methods to resolve settlement spatial characteristics and application ideas and concepts of village layout to landscape design. The above research increasingly emphasizes comprehensive multidisciplinary research combining qualitative and quantitative methods. The qualitative approach draws on multiculturalism, such as Feng Shui theory, psychological field theory, and landscape genres. The quantitative method uses landscape index to analyze landscape patterns and reveals nature and biology's complex interactions with social forces in time and space. The traditional two-dimensional landscape index ignores the topographic and geomorphological features essential to the ecological landscape pattern, resulting in the distortion of the land unit's accurate geometric shape information, resulting in underestimation overestimation of the landscape index analysis results. The precise measurement of the 3D landscape index can make up for the defects of the 2D landscape index. It can highly enrich the landscape pattern information, reflecting its structural composition and spatial configuration characteristics [4]. This paper takes multimedia technology and geographic information systems as the starting point of studies. The Huizhou village level takes Chengkan as the research object, integrates Chinese traditional Feng Shui theory, psychological field theory, and ideal living environment, and puts forward the idea of human settlement environment. The ecosystem model analyzes the village layout and landscape elements of Chengkan Village, analyzes its spatial structure characteristics, and improves the traditional landscape pattern analysis method. It introduces the 3D landscape index method and replaces the 2D landscape by calculating the landscape patches' surface length and area features: characteristics and quantitative analysis of Huizhou village's landscape pattern [5]. Combining the ideal ecosystem model with the three-dimensional landscape index method can more effectively analyze Huizhou villages' spatial structure characteristics.

At present, there are many three-dimensional reconstruction methods of the two-dimensional image used in medicine, such as CT [6] and MRI [7]. They are also widely used in face reconstruction [8, 9]. In addition, Pan and others have studied the application of two-dimensional images in clothing reconstruction, Zhang has investigated the three-dimensional reconstruction method of two-dimensional images under binocular vision, and Ye has studied the three-dimensional reconstruction of rigid bodies based on two-dimensional image sequences. Several computational reconstruction techniques visualize the 3D image without optically displaying the elemental images [13]. These methods are classified using plane-by-plane reconstruction (PPRT) and viewing point reconstruction techniques (VPRT). The PPRT uses a virtual pinhole array instead of the lenslet array to reconstruct the 3D image. At the reconstructed image plane in Figure 1, each pixel of the primary image is integrated, and the observers can see the 3D image, which is focused on this plane.

On the other hand, in VPRT, the 3D image is reconstructed by extracting one pixel from each corresponding elemental image of the lenslet array [10]. This paper uses multimedia technology and geographic information system to extract the landscape image and develop three-dimensional modeling methods of Huizhou villages with automation, high efficiency, and low cost. It has realized the functions of landscape information query, high-dimensional measurement, terrain analysis, visibility analysis, and virtual roaming of Huipai village. It has specific promotion effects on landscape spatial analysis, landscape planning, ecological protection, natural and cultural inheritance, and tourism development [14]. Compared to the other methods, this strategy can reconstruct the landscape more effectively, and it is with higher precision [11].

The contributions of this paper are summarized as follows:

(1) We consider a new three-dimensional reconstruction scheme that combines multimedia technology and geographic information system. This new method can help to extract the features of data effectively and reconstruct the original data quickly.

(2) We reconstruct the Huizhou landscape with the help of the proposed strategy. The reconstructed landscape can help realize the functions of landscape information query, high-dimensional measurement, terrain analysis, visibility analysis, and virtual roaming of Huipai village.

(3) The new three-dimensional reconstruction scheme has specific promotion effects on landscape spatial analysis, landscape planning, ecological protection, natural and cultural inheritance, and tourism development.

This paper is organized as follows. Section 2 presents some preliminary studies and related works about multimedia technology and geographic information systems. Section 3 proposes the review of three-dimensional reconstruction research. The reconstruction of the Huizhou landscape will be given in Section 4. Finally, Section 5 sums

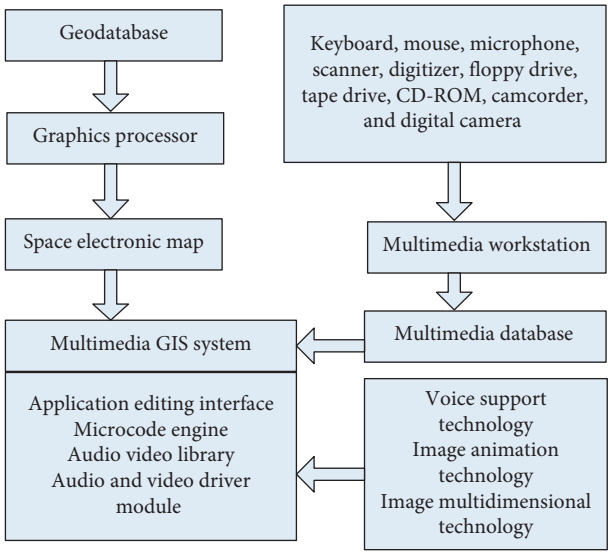

Figure 1: The multimedia GIS integration framework.

up some conclusions and offers some suggestions as to future research topics [12].

2. Overview and Development of Multimedia Technology and Geographic Information Systems

Media refers to the media that delivers the information, including stored entities and carriers that convey information. Disks, tapes, etc., are the entities that represent information, and the values (Number), literature (Text), sound (Audio), graphics (Image), images (Video), etc., are the carriers for transmitting information [15]. The media in what we call "multimedia" refers to the latter. The so-called "multimedia" is often not the multimedia information itself but mainly a set of techniques for processing and applying it. Therefore, "multimedia" is often used as a synonym for "multimedia technology."

2.1. Multimedia Technology Concept. Multimedia technology uses computers to comprehensively process text, graphics, images, sounds, animations, videos, and other types of information to establish logical relationships and human-computer interaction. Accurate multimedia technology involves the object of computer technology, while other simple things, such as movies, television, and audio, are not in the category of multimedia technology [16].

2.2. Geographic Information System Concept. Geographic information system (GIS) is an emerging edge discipline that integrates computer science, informatics, geography, surveying and mapping, environmental science, urban science, management science, and many other sciences. With the support of computer software and hardware, the theory of systems engineering and information systems science is used to scientifically manage and comprehensively analyze geographic data with spatial connotations to provide spatial information systems for planning, management, decision-making, and research [17]. The development of GIS reflects the characteristics of a multidisciplinary intersection. The multimedia GIS integration framework is shown in Figure 1. With the increasing promotion of various national economy sectors, GIS has received more attention from different departments and local governments and the community. Decision-making groups and consumer groups urgently need multimedia products to analyze, inquire, research, and utilize geographical environment information [18]. In the past, many GIS tools can only represent and transmit spatial information employing text, graphics, and tables, which significantly reduces the effect of GIS processing and transmitting spatial information. Therefore, multimedia technology is needed to enhance the visualization of this GIS software [19]. The combination of multimedia technology and geographic information system can express spatial information in an intuitive and vivid way in the form of sight, hearing, and touch, improve the efficiency of GIS data collection, data processing, and expression and output, and give full play to the advantages of multimedia technology, significantly enhancing the effect of GIS spatial information visualization [20]. Therefore, it is necessary to enter multimedia technology into GIS. The combination of multimedia technology and geographic information system has become one of the important development directions of GIS technology. The application of multimedia technology to geographic information systems significantly impacts the system structure, system functions, and application modes of GIS, making GIS more abundant, flexible, and friendly.

The data involved in multimedia GIS's integrated development process mainly includes two sources: one is a spatial, graphic data file, and the other is multimedia attribute data. To enhance the flexibility of data processing of the entire system, a particular storage method is adopted [21, 22]. The integration framework for multimedia and GIS is shown in Figure 1. Multimedia attribute information is the core content of the system and is information for users to use and query. The requirements are very accurate [23]. Multimedia attribute information can be collected in various ways, including text, photos, graphics, audio, video, and animation, and then, this information is checked, organized, and processed. The rich data types of multimedia geographic information systems, integrating sound, image, picture, and text, are necessary to integrate database technology and multimedia technology. Conventional database access is generally more detailed information such as text, numbers, and dates. For multimedia information such as images, sounds, movies, and the like, the database cannot be directly accessed due to the field type's limitation [24]. With the continuous development of database technology, BLOB types (large binary object types) appear in the field type. You can write the program to convert the multimedia type file to BLOB type and then access it in the database. Spatial multimedia attribute data is stored in a relational database. Different fields are set up in the database to provide different types of information. The stored multimedia information can be expanded as needed, and different media information can be interpreted through a particular module [25, 26].

The standardized electronic geographic graphic data is stored in a specific directory in a standard file format, and each object in the graphic has its corresponding unique identifier (ID number). The system uses this as an index to create a graphic data file [27]. When designing the data storage structure and output input interface structure of GIS, the database's built-in connection supports multiple databases to connect different attribute data. Each attribute record's keyword is the object's ID number in the graphic file, thereby realizing the one-to-one correspondence between the spatial, graphical information and the multimedia attribute information.

3. A Review of Three-Dimensional Reconstruction Research

3.1. D Reconstruction Concept. 3D reconstruction refers to establishing a three-dimensional model with a certain level of detail corresponding to a real object in a digital virtual environment. As human exploration of geospatial information becomes more in-depth and more widely used, the three-dimensional model of building monolithic or group can no longer meet people's demand for global spatial information. The three-dimensional model of building group has gradually become urban planning and management, architectural design, necessary infrastructure in many areas such as emergency relief, public safety, environmental protection, real estate and commercial site selection, and traffic navigation.

3.2. Technical Method Classification. Three-dimensional reconstruction of buildings is a research hotspot at home and abroad, and various methods have been developed. Depending on the technology used, they can be roughly divided into the following seven types:

(1) A method based on mapping terrain data
(2) A method on the basis of DEM data
(3) A method on the basis of image recognition technology
(4) A method on the basis of three-dimensional laser scanning technology
(5) A method on the basis of paper-based intelligent identification technology for building vectors
(6) A method on the basis of CSG modeling techniques
(7) Process modeling method

The advantages and disadvantages of the above seven methods can be obtained as shown in Table 1.

3.3. 3D Reconstruction Model Design. This chapter focuses on the landscape pattern analysis method based on the ideal ecosystem model and 3D landscape index and the landscape visualization method based on rule modeling.

3.3.1. Ideal Ecosystem Model. An ecosystem is a geographic unit or an ecological zone and a system unit with input and output functions and a natural or artificial boundary [19]. The ideal habitat ecosystem is to optimize the survival, development, and continuation of human beings and optimize the energy exchange, material metabolism, information exchange, and biological migration between the ecosystem's internal elements. The ecological functions of each element are shown in Table 2. The site selection also requires compliance with building environmental science.

3.3.2. Three-Dimensional Landscape Index. The 3D landscape index improves the traditional 2D landscape index method, which mainly replaces the projected area and side length of the conventional landscape index with the landscape patch's surface area and the length of the surface side [20]. Calculating the surface area and side length of landscape patches is the key to the three-dimensional landscape index.

The number of landscape indices is large, and the correlation is strong, and any index selection is likely to cause a surplus in the index. According to the topographical characteristics of the Huipai village, according to the research results of a large number of landscape patterns, the selection of the mountain landscape index focuses on reflecting the scale, shape, and concentration of the landscape. The study used three-dimensional indicators, as shown in Table 3.

In a complex mountainous landscape environment, the two target points' surface distance is greater than the projection distance. The surface area of the landscape patch is larger than the projected area. Using the DEM superimposed landscape type data to calculate the surface area and side length of the landscape patch, the H-angle method is used to calculate the surface area and side length of the window sill, and the analysis window size is set to 30 m∗30 m according to the DEM precision. The moving window traverses the study area to calculate the surface area and perimeter of each landscape patch. The ground surface area of a grid is calculated by the triangle formed by the two adjacent grids' points. The surface distance is calculated by the triangle Pythagorean Theorem. The adjacent eight triangles calculate each triangle's area to calculate the central grid's ground surface area. It can be denoted by

$$a_s = \sum_{i=1}^{n} \frac{c^2}{\cos\left(s_i\left(\pi/180\right)\right)}, \tag{1}$$

$$d_s = \sum_{i=1}^{n} \sqrt{a_i^2 + 2c^2}. \tag{2}$$

In this formula, a_s is to study the regional surface area, d_s is the length of the surface of the study area, c is the size of the raster pixel, s_i is the slope of the pixel, a_i is the relative altitude difference between the center point of the pixel i and the center point of the adjacent pixel, and $2c^2$ is the square of the distance between the center points of any two adjacent cells.

If the unknown parameters are unchanged, there is a parametric equation.

Table 1: Summary of advantages and disadvantages of standard methods for 3D reconstruction.

Numbering	Method	Advantage	Disadvantage
1	A method based on mapping terrain data	Eliminate the cost of primary data, high model accuracy	Fundamental data is challenging to obtain, data cost is high, the cycle is long, timeliness is poor, and human interaction is prominent
2	A method based on DEM data is greatly affected by terrain and features	A wealth of information to simulate complex buildings	DEM data is costly and difficult to obtain due to terrain and ground objects
3	A method based on image recognition technology	Convenient and cheap	Lack of a unified framework to guide the accuracy and efficiency needs to be improved, lack of research on the building complex
4	A method based on three-dimensional laser scanning technology	Point cloud data with high precision and architectural details in place	Need professional equipment, point cloud processing complex, a large amount of manual interaction, high cost, long cycle
5	A method based on paper intelligent identification technology of building vector	Take advantage of existing resources	Strict format and precision, only for small scale
6	A method based on CSG modeling technology	Fast modeling speed, simple structure, a small amount of data	It is difficult to break down complex shapes
7	Process building modeling method	Fast modeling speed, easy to control and adjust parameters, challenging to promote	High technical threshold, complicated operation, and difficult promotion

Table 2: Ecological functions of various elements in the village ecosystem.

	Element	Ecological function
Natural element	Mountain	Closure effect, safe haven
	Forest, woodland	Provide living food
	Arable land	
	Waters	
Human element	Building	Provide habitat
	Architectural environment thought	Affect the location and structure of the village
	Mental field	Affect the location and structure of the village
	Clan tradition	Affecting village structure and architectural pattern

Table 3: Landscape index selection and description.

Index	Index	Formula	Formula description
Quantity	Plaque number	$\mathrm{NP} = n_i$	n is the type of landscape, i is the number of landscapes
Area and perimeter	The total length of the boundary	$\mathrm{TE} = \sum_{i-}^{m} E$	The sum of all plaque lengths of a landscape type m
	Area of a landscape type	$\mathrm{CA} = \sum_{i-1}^{n} a_m (1/10000)$	The sum of all plaque areas of a landscape type hm^2
	Average plaque area	$\mathrm{BREB} * \mathrm{MN} = B/N10^{-4}$	Divide the total area of the landscape by the total number of patches and multiply by 10^{-4}
	Landscape shape index	$\mathrm{LSI} = 0.25(E/\sqrt{B})$	E is the total length m of all plaques, B is the landscape's total area, and 0.25 is the square correction constant
Shape	Area-weighted average patch fractal dimension	$\mathrm{FRUC} * \mathrm{UM} = \sum_{i-1}^{m} \sum_{i-1}^{n} [((2 \ln(0.25q_y))/\ln a_y)(a_y/U)]$	q_y is the plaque circumference, a_y is the plaque area, and 0.25 is the square correction constant
Diversity	Landscape diversity Index	$\mathrm{NHDI} = \sum_{i-1}^{n} [p_i \ln(p_j)]$	The proportion of the total area of the landscape for each plaque type
Aggregation	Walking and juxtaposition index	$\mathrm{TJI} = ((-\sum_{i-1}^{m} \sum_{j-i-1}^{m} (r_{ij}/E)\ln(r_{ij}/E))/(\ln(0.5[m(m-1)])))(100)$	E is the perimeter of plaque i
	Aggregation	$\mathrm{COMT} = [\mathrm{i} + \sum_{i+1}^{m} \sum_{j+1}^{n} (p_i \ln(p_{ij})/2 \ln(m))](100)$	m is the number of landscape types

$$V = B\widehat{X} - 1. \tag{3}$$

The corresponding law equation is

$$B^T Q^{-1} B\widehat{X} = B^T Q^{-1} l. \tag{4}$$

There will be an addition and deletion error equation in the adjustment calculation process when such a situation occurs [21]. The observations are divided into two groups. Then, the coefficient matrix B, the weight matrix Q, and the constant matrix L are expressed as

$$\begin{cases} B = \begin{bmatrix} b_{k-1} \\ b_k \end{bmatrix}, \\ Q = \begin{bmatrix} q_{k-1} \\ q_k \end{bmatrix}, \\ L = \begin{bmatrix} l_{k-1} \\ l_k \end{bmatrix}, \\ v = \begin{bmatrix} v_{k-1} \\ v_k \end{bmatrix}, \end{cases} \tag{5}$$

after that

$$v_{k-1} = B_{k-1}\widehat{X} - L_{k-1}, \tag{6}$$

$$v_k = B_k\widehat{X} - L_k. \tag{7}$$

For formula (7) to adjust separately, there is a result

$$\begin{aligned} N_{k-1} &= B_{k-1}^T Q_{k-1}^{-1} B_{k-1}, \\ \widehat{X}_{k-1} &= N_{k-1}^{-1} B_{k-1}^T Q_{k-1}^{-1} L_{k-1}, \\ V_{k-1} &= B_{k-1}^T \widehat{X} - L_{k-1}. \end{aligned} \tag{8}$$

Based on the above adjustment results, the adjustment result after adding or deleting the second group of measurements can be calculated according to the following recursive formula:

$$\begin{aligned} K_x &= N_{k-1}^{-1} B_k^T \left(Q_k \pm B_k N_{k-1}^{-1} B_k^T\right)^{-1}, \\ \widehat{X} &= \widehat{X}_{k-1} \pm K_x \left(l_k - B_k \widehat{X}_{k-1}\right). \end{aligned} \tag{9}$$

Among them, K_x is called the Kalman gain matrix. When adding an observation, use the symbol that exists in the formula [22, 23]. When deleting the observations, use the symbols below in the formula. According to the sequential recursive formula, it can be found that each time an observation data is increased or decreased, only the known observation data can be used to find the unknown parameters $\widehat{X}_{k-1}$ right inverse $Q_{\widehat{x}_{i-1}} = N_{k-1}^{-1}$. Then, according to the recursion formula, the adjustment result can be obtained $\widehat{X}$ and $Q_{\widehat{x}} = N^{-1}$.

3.3.3. Landscape Pattern. The landscape index method was used to analyze the landscape pattern of Chengkan Village, and the scale, shape, and distribution of each landscape type in Kancun Village were described. The method of 3D landscape index is introduced, and the calculation results are compared with the 2D landscape index to explore the landscape pattern of the village Table 4.

According to the quantity, area, and perimeter indicators, there are five landscapes, and the total number of plaques is 45. Each landscape type area ranges from large to small for forest land > cultivated land > construction land > water area > grassland. The area ratio of forest land and cultivated land exceeds 65% and 30%, respectively, in the village landscape matrix [24]. Forest land is distributed on the hills around the village, controlling the flow of matter and energy within the village ecosystem. The cultivated land is distributed on the low-lying hills between the construction land and the forest land, providing survival data. The waters have the most significant number of patches, but the area is small; some are rivers running through the village, and the other is small lakes and ponds widely distributed in the village. The construction land has the smallest area and the minor proportion of the area, reflecting the less impact of the residents' activities on the environment [25]. In landscape type II, the three-dimensional landscape index's relative change rate is the forest land, reaching 7.8%. The smallest is the construction land, reaching 4.3%; the most significant change rate of the area-specific gravity is the forest land, reaching 1.0%; the relative change rate of the area-specific gravity of other landscape types is negative; the relative change rate of the village landscape's level average patch area reaches 6.7%. From the relative change rate perspective, the traditional two-dimensional landscape index underestimates the area and perimeter index of landscape types, underestimates the dominance of natural patches to some extent, and overestimates the dominance of artificial patches. The two-dimensional and three-dimensional landscape pattern index of the Chengkan village-type index is shown in Table 4.

3.3.4. Rule-Based 3D Model Construction. The steps of H-dimensional modeling of the Huizhou village based on rules are determining the attributes of landscape plots, extracting landscape image features, compiling landscape modeling rules, importing parcel rules and generating models, and model optimization [26]. The rule's CGA language is a tree structure expression. Its nodes represent the shape, shape segmentation, repeated operations of the entity, and the segmentation operation of the component, which can capture the landscape feature structure. CGA can make full use of existing CAD, OSM, or GIS data and build a single landscape model to perform batch modeling. It can quickly make batch modeling of the landscape in three dimensions. Rule modeling improves the efficiency of 3D modeling. The field of landscape 3D modeling provides a new approach to *Pq*. Rule-based modeling only needs to input the corresponding parameters of the landscape elements and integrate the 3D feature data and the texture data according to the CGA rules of the forest land, grassland, square, building, road, etc., in the scene, and the commonality of similar structures and textures. The higher landscapes (mainly buildings) are written in general rules,

Table 4: Two-dimensional and three-dimensional landscape pattern index of Chengkan village-type index.

Class	NP	Plaque type circumference		Plaque type area		Plaque area		Landscape shape index		Scattered in the parallel index
		2D	3D	2D	3D	2D	3D	2D	3D	
Woodland	8	115846	117245	1446.53	1559.72	65.32	66.03	7.36	7.45	5.73
Arable land	11	109827	111653	698.34	720.15	33.26	31.29	10.65	10.35	28.05
Construction land	3	8739	8937	42.69	47.23	3.08	2.06	3.23	3.69	73.21
Waters	24	15309	15487	18.32	19.68	0.69	0.72	8.73	1.35	56.43
Grassland	3	2387	2369	2.36	2.49	0.15	0.15	3.69	3.79	43.56

and the CGA rules are written separately for less common landscapes (particularly natural landscapes).

According to the shape of the landscape elements, the landscape elements can be divided into three categories: point, line, and surface. Based on the rules, rapid batch modeling of three types of landscape elements can be realized.

(1) Point feature modeling: the street trees, street lamps, and street signs in the landscape elements can be abstracted into point elements in the computer environment. They can be stretched, moved, deformed, etc. The model construction of the point elements can be realized [27]. Rules can generate the point elements such as the utility poles. The element models in the network resources are modified and applied to the point elements such as trees and stone statues with complicated shapes

(2) Linear feature modeling: roads, fences, fences, etc., in landscape elements, can be abstracted into linear elements in a computer environment. Their shapes are composed of simple line segments, which can be stretched, twisted, rotated, filled with materials, and the like. The lanes and fences of the Huipai village can be generated by stretching and mapping the computer linear elements

(3) Modeling of planar features: the expression of landscape elements is mainly three-sided, and the three-dimensional modeling of a planar landscape is the focus of landscape visualization. Landscape elements such as mountains, woodlands, cultivated land, grasslands, waters, and plazas can be modeled by terrain stretching and mapping; for complex Huizhou buildings, the characteristics should be summarized and exemplary models constructed, including the overall Huizhou architecture [28]. The framework can be modeled by rule writing. The model components with emblem characteristics such as the bucket arch and the horse headwall are manually modeled employing human-computer interaction. This part is replaced in the building to realize the model construction of the Huizhou architecture

4. Construction of "Three-Dimensional Cross Framework" for 3D Reconstruction of Huizhou Landscape

4.1. Huipai Landscape System. The landscape includes natural landscapes of forests, grasslands, mountains, farmland, wetlands, and a combination of geographical features and cultural landscapes that reflect regional cultural, economic, and social characteristics. The landscape pattern results from the complex interaction between nature, biology, and chemical forces in time and space. It is imperative to analyze the landscape pattern to understand the spatial structure and ecological changes.

The traditional Huizhou-style architecture and the unique Qingshan green water and the profound history and culture constitute a unique Huizhou landscape environment system. The overall landscape pattern, the settlement distribution, the village texture, the courtyard combination, the street stream, and the omnipresent three-carving art in the building have been integrated into the landscape and become a landscape element [17, 18]. With its extensiveness and cultural connotation, the Huizhou landscape environment system transmits profound construction philosophy and aesthetics, exquisite construction technology, and art. When we are in the middle, we are more amazed and moved. How do we feel more? The mission and mission of preservation and how to inherit and rejuvenate.

4.2. Deconstruction of Huizhou Landscape Target Recognition Technology System. Target recognition is a typical type of image analysis task. Image analysis means the processing of image semantics. In most cases, the critical semantic information used to understand an image is expressed by meaningful image objects and their interrelationships rather than a single cell. In essence, the object of image analysis is the target or meaningful object. Based on this, related scholars put forward the spatial cognition theory of remote sensing "graph-spectrum" information coupling based on geospatial information Atlas theory and constructed a remote sensing information map of "pixel-primary-primary-one-one pattern." The theoretical method system of calculation is as follows. At present, many target recognition technology systems based on buildings and based on remote sensing images (from now on referred to as "Huipai landscape target recognition technology system") are developed regarding the above or similar theories. The content is as shown.

4.2.1. Pixel-Level Processing. The traditional digital image processing process takes the pixel value of each deleted grid as input. It obtains a new pixel value of the grid point through a special function mapping relationship. This mode of processing the entire image point by point is "pixel-level"

image processing. Pixel-level processing includes data preprocessing, image segmentation, raster data vectorization, and more.

(1) Data preprocessing, including geometric correction, registration, image mosaic and cropping, cloud removal processing, spectral normalization, image fusion, etc. Its purpose is to make the remote sensing image data to be processed meet the requirements for postprocessing and analysis to ensure the validity and accuracy of the results

(2) Image segmentation refers to the decomposition of an image into a set of nonoverlapping regions (also called map spots). According to the general segmentation definition, the segmented regions need to satisfy the conditions of uniformity and connectivity at the same time. Uniformity means that all pixels in the region satisfy specific similarity criteria based on features such as grayscale, texture, color, etc. Connectivity refers to a path connecting any two points in the region. The purpose is to separate the pixel areas representing different objects such as buildings, shadows, green spaces, and roads and provide conditions for the next level of processing

(3) Raster data vectorization (from now on referred to as "vectorization") refers to forming a vector arc segment along the boundary of an adjacent region and connecting the adjacent arc segments to form a closed vector polygon that encloses the grid region. Although the resulting vector polygon has primitive features, the entire vectorization process is based on the pixel, so it belongs to pixel-level processing. Compared with raster data, vector data has absolute advantages in various types of analysis and application (primarily based on the analysis and application of massive remote sensing data). Therefore, vectorization is a critical step in the whole system, which will be based on primitive analyses and process the foundation

4.2.2. Primitive Processing. The primitive is a connected region composed of pixels with homogeneous features such as spectrum and texture extracted by a specific calculation method at a particular scale and constitutes the basic unit of a visual image. Each primitive has properties such as spectrum, texture, shape, geometric relationship, spatial topological relationship, and hierarchy (i.e., features), which is the basic unit for realizing "object-level" information extraction. The operation based on primitives is called primitive processing, which mainly includes feature calculation and selection, primitive classification and merging, vector graphics optimization, and primitive extraction of buildings and shadows.

4.2.3. Target-Level Processing. The target-level processing is a level that is raised based on the processing at the primitive level and is the processing of the primitives required for a specific application. Taking building target recognition as an example, two types of primitives, building, and shadow, are usually needed. The former is used to describe the coordinates and contours of genuine buildings, and the latter is used to assist in extracting information such as building height and number of floors. The target-level processing in the building target recognition technology system mainly includes building contour optimization, building height extraction, building layer number estimation, and building texture extraction.

4.3. Deconstruction of the 3D Reconstruction Technology System of Huizhou Landscape

4.3.1. Terrain Analysis. The terrain expresses the fluctuation of the terrain only by the change of chromatic aberration on the plan. In the H-dimensional analysis, the profile of the terrain of a particular area can be extracted to visually find the fluctuation of the terrain in this area [28]. As shown in Figure 2, in the three-dimensional scene, two points can be randomly selected for profile analysis, and the starting point of the section can be obtained by the intensity, the elevation information and the projection distance, the spatial distance, the surface distance W, and the highest and lowest elevation information of the profile. The starting point of the section is N29.93°, E118.26°, and the elevation is 391.66 m. The ending point is N29.93, E118.30°, and the elevation is 292.99 m. The highest pitch of the profile is 258.04 m. The lowest elevation is 189.49 m, the profile's projection distance is 4041.23 m, and the surface distance is 4109.35 m.

4.3.2. Deconstruction of 3D Reconstruction Technology System. The Huizhou landscape elements' three-dimensional reconstruction technology system mainly includes the style, texture, contour, height layer, and 3D model. Building 3D reconstruction technology system is shown in Figure 2.

(1) *Style*. Style is an architectural style, mainly expressed in architectural texture, and the other is the spatial form of architecture. Since the texture has been used as an independent element in this paper, the architectural style here refers to the latter, mainly in the form of roof (flat house, sloping roof, curved roof or multiwave folding roof, etc.), the plane of the building, and the shape of the facade changes. The architectural style information is usually obtained employing ground-based or laterally shot aerospace images, obtained by manual visual interpretation, and expressed in the 3D modeling process. If the architectural style's accuracy is not high, the building can be randomly assigned by calling the present architectural style library

(2) *Texture*. Architectural textures include roof textures and facade textures. The roof texture can be directly obtained from the aerial image, and the side texture is relatively difficult to obtain

(3) *Contour Outline*. It refers to the building's outer contour's projection on the ground plane under a particular geographic coordinate system. At present,

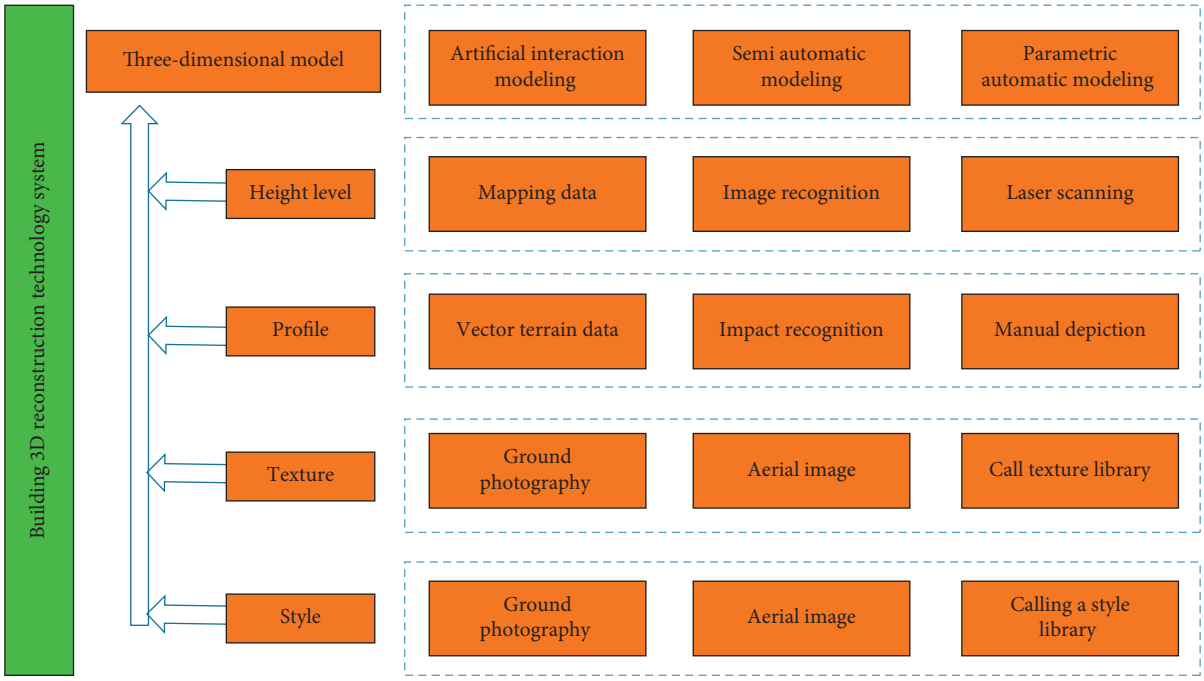

Figure 2: Building 3D reconstruction technology system.

most of the 3D modeling work of buildings uses urban vector terrain data (including architectural outlines) provided by the surveying and mapping department. However, for the sake of national defense and security, such high-precision topographic data is not open to the general public in China. Therefore, there is a lack of universality. Simultaneously, such terrain data has high production costs, long cycles, and poor timeliness, challenging to meet the urgent needs of all sectors of society for real-time and accurate spatial data. In addition to the surveying and mapping department's direct supply, building contour data can also be obtained by image-based target recognition, manual vectorization, and other methods

(4) *Height Level*. Building height and number of floors are essential factors in expressing the volume and shape of the three-dimensional space of the building. A small number of building elements or groups can be manually extracted from existing design drawings or survey data. However, it is a time-consuming and almost impossible task to accurately obtain the height and number of each building's layers for large-scale urban buildings. Therefore, it usually uses technical means such as image recognition and laser scanning

(5) 3D *Model*. The construction of the 3D model is the core of the whole technical system, and it is the critical step to realize the transformation from 2D to 3D. The advantages and disadvantages of the used techniques will directly affect the whole modeling's efficiency and accuracy. The prior art can be divided into three types: manual, semiautomatic, and parametric automatic modeling. The overall framework of the three-dimensional reconstruction of the Huizhou landscape is shown in Figure 3

Under the PC with 4 Core i7 CPU, 32G RAM, and VIDA GeForce GTX 950 Graphics Board (Graphics memory is 2G), the whole procedure takes about 48 minutes to acquire and complete the scene 3D model reconstruction. Table 5 shows the comparison of the running time of each scheme of the scene 3D model reconstruction. For the proposed method, the whole program takes about 48 minutes, with the best performance.

4.4. Cross-Path Analysis. From the composition of the two consortiums, both contain a three-dimensional reconstruction technology system. From the consortium's mainline, the former is "remote sensing image building basic data." The latter is "building basic data one-dimensional model." There is continuity of process between the two. Therefore, in theory, there is crossover feasibility between the two technical complexes.

Secondly, from the perspective of the cause of the "binary parallel framework," the differences between the research focus and the application field are not enough to become the main factors hindering the cross, because with the continuous deepening of the interdisciplinary and the continuous expansion of the application field, this kind of differences will continue to diminish, and the overlapping of research and application areas between different disciplines will become more and more common. Therefore, the technical system's closure and deficiency have become the most

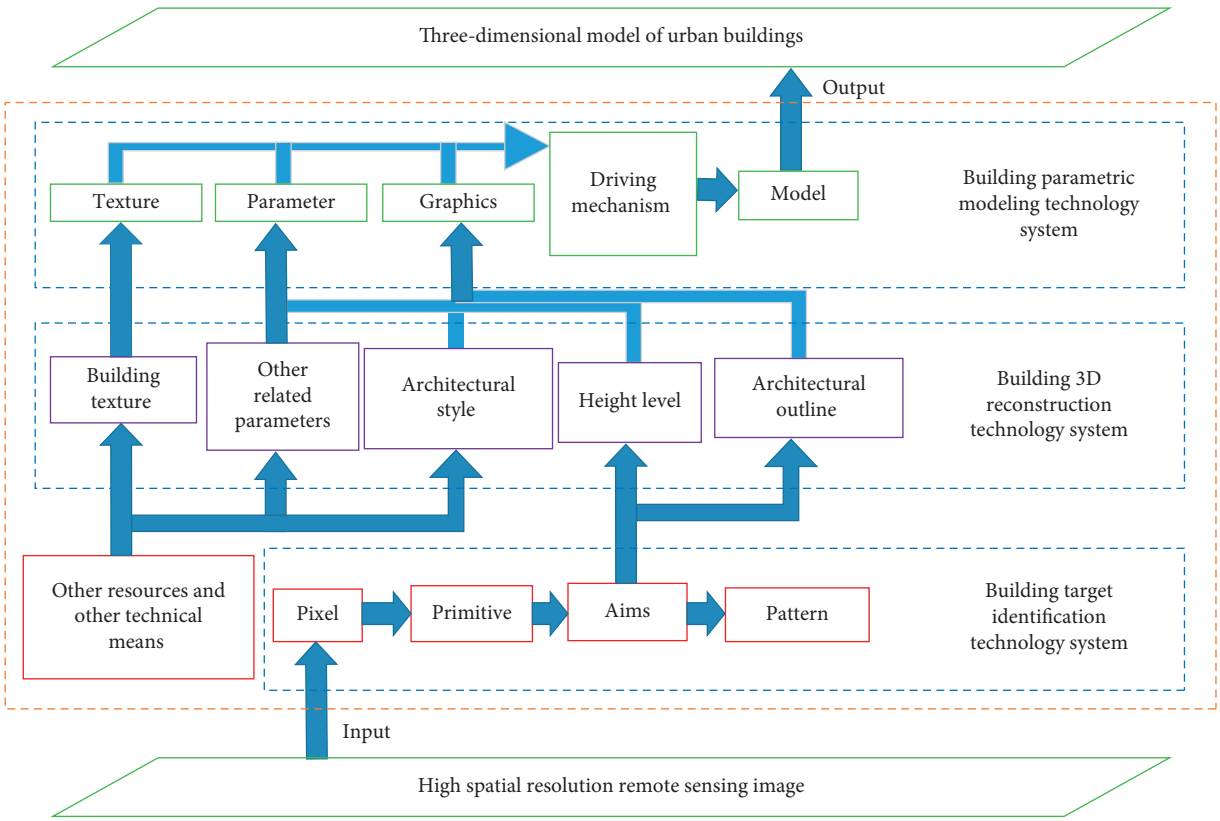

Figure 3: The overall framework of the 3D reconstruction of the Huizhou landscape.

Table 5: Comparison of the running time of each scheme.

Steps	Proposed scheme	Multimedia technology	GIS
Dense point cloud generation	15 min	20 min	18 min
Mesh construction	13 min	19 min	18 min
TIN net optimization	15 min	22 min	25 min
Texture mapping	5 min	9 min	12 min

critical factor restricting the three technical systems' cross-integration.

Based on the above analysis, the author believes that it is necessary to break through the closeness between the systems and make up for the shortcomings of the technology itself in the following three aspects to truly achieve the effective cross-integration of the three major technical systems:

(a) Intersystem: combining the relationship between the elements of the system, finding the connection points, and constructing the independence and closure of the internal structure of the overall framework system, resulting in the cross-fusion of the complete system as a unit, and even if it is crossed. It is just simple technical splicing that does not meet specific needs or optimize the solution. Therefore, we must break down the system barriers, sort out the interrelationships between the various elements of the system, find all possible connection points, and build a three-dimensional reconstruction of the overall framework

(b) Within the system: reorganizing and integrating elements within the system, seeking the best solution, and building the subframe. The above-mentioned overall framework is at the macrolevel. It needs to be effectively organized and integrated by the elements within the system and form a subframe at the mesolevel. For the target recognition technology system, it is necessary to recombine the system elements such as image segmentation, vectorization, and vector graphics optimization and establish a set of object-oriented technology, which can acquire the primary data of large-scale urban buildings immediately, efficiently, and cheaply subframework. For parameterization, in terms of the modular technology system, it is necessary to reorganize and integrate the system's internal elements and form several functional modules whose internal

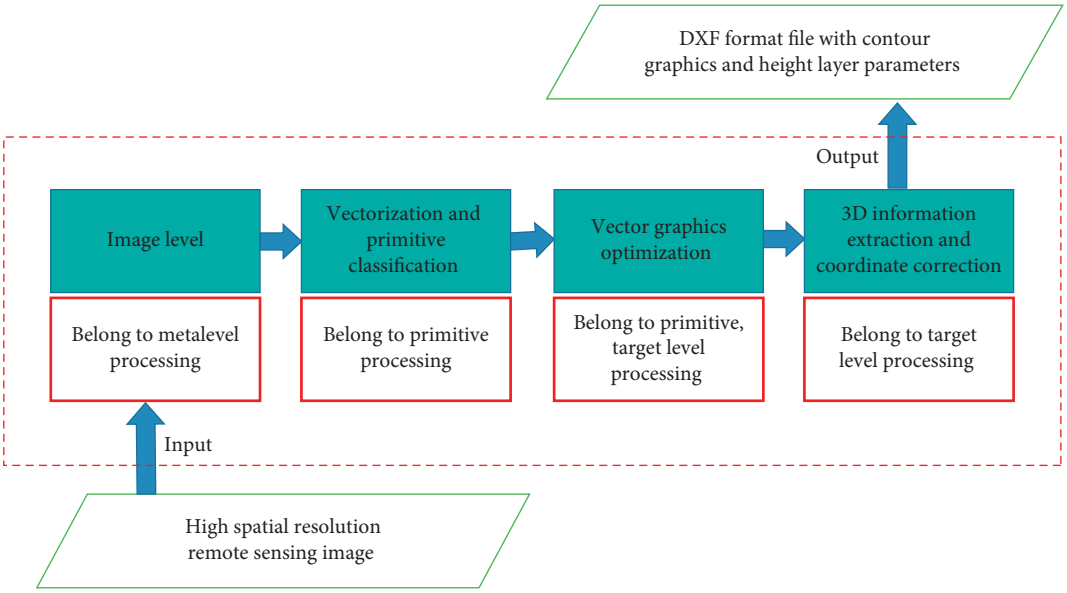

Figure 4: Huizhou landscape target recognition subframe.

functions are relatively independent and closely related to each other, forming a set of system architecture based on "single construction and separation." The subframework of large-scale 3D models can be constructed quickly, easily, and realistically

(c) Internal technology: improvement and innovation, exploring the optimal solution, laying the underlying foundation for the system crossover. The mesolevel mentioned above subframework needs to be implemented according to practical microtechnical methods. Firstly, the target recognition technology is not mature enough. The recognition efficiency and accuracy cannot meet the requirements of subsequent modeling. It is an essential factor hindering the intersection of technology systems. Therefore, image segmentation, vector graphics optimization, three-dimensional information extraction, and coordinate correction must be applied in the target recognition technology system. And there are other critical links for technical improvement and innovation. Second, pass

The parametric modeling platform has high thresholds, complicated operation, and significant initial investment. It is another important factor that hinders the intersection of technical systems. Therefore, it is necessary to propose a series of functions based on the "Shenyi Construction Separation" system architecture. The module's innovative approach improves the parametric modeling platform's modeling efficiency and reduces the technical threshold and marginal cost of the platform. The above technologies' improvement and innovation will lay the foundation for the three technical systems' effective cross-integration. Huizhou landscape target recognition subframe is shown in Figure 4.

4.5. Construction of 3D Modeling of Huizhou Village Landscape. The overall framework of the three-dimensional reconstruction of the Huizhou landscape has broken through the system barriers. A complete and ternary framework system has been formed through the effective organization and connection of the systems' elements (as shown). The framework first inputs the (high spatial resolution) remote sensing image into the building target recognition technology system. After processing the pixel level, the primitive level, and the target level, the building contour and height layer elements in the 3D reconstruction technology system are obtained. Building textures, architectural styles, other relevant parameters, and other elements are obtained through other resources or technical means (as can be seen from the introduction of the parametric modeling subframework of the building group below, these elements can be called by calling the rule base, paste library, style library obtained, very convenient) [29]. Secondly, the building outline is introduced into the building parametric modeling technology system in the form of graphics. The height layer, architectural style, and other related parameters are transmitted in the form of parameters. The architectural texture library is transmitted in the form of texture (from below). As can be seen from the introduction of the parametric modeling subframework of the building group, the texture and style are encapsulated in the automatic modeling module in the form of a rule base and do not need to be passed [30]. These incoming data are ultimately automatically and quickly generated by the driving mechanism in the parametric modeling technology system [31]. Huizhou landscape parametric modeling subframe is shown in Figure 5.

In essence, the overall framework is merely a schematic of a cross-cutting idea, a guiding process that cannot be implemented. The overall framework's core value lies in

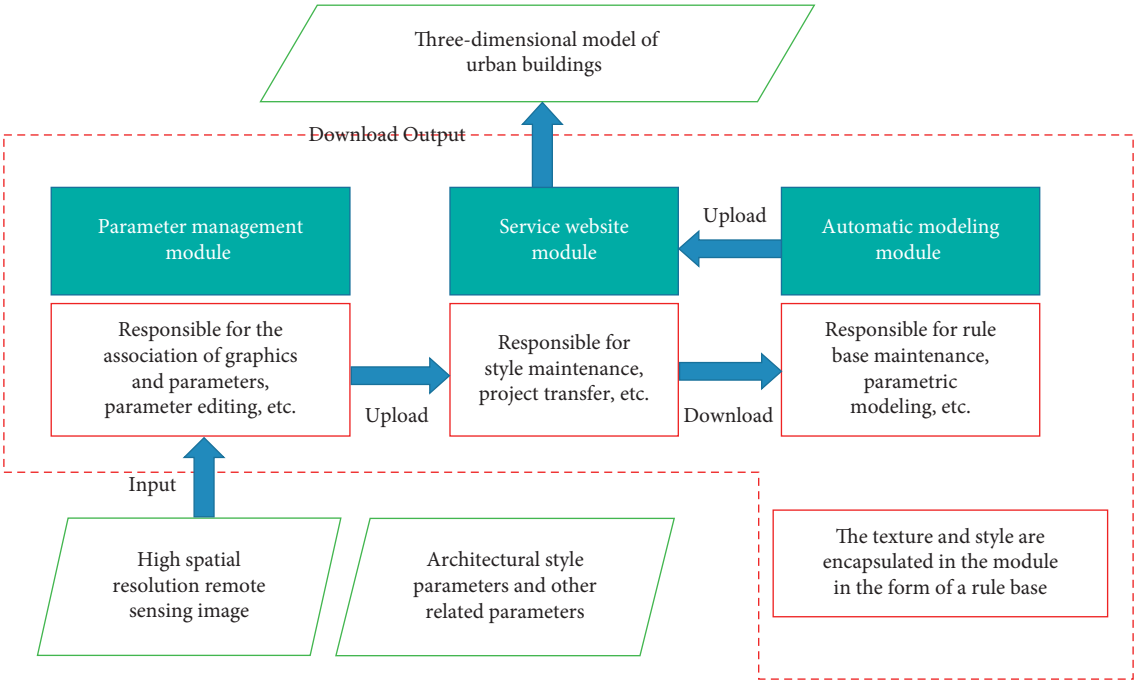

Figure 5: Huizhou landscape parametric modeling subframe.

combining the relationship between the three major technology systems. For the system's internal structure, further improvement and innovation are needed. A new subframework is needed to realize the smooth flow of the entire process and the optimization within the system, the "three yuan cross" in a sense.

For this network, the original picture data may come from other communication systems. Therefore, it is essential to realize the effective communication of multiple terminals, and it is the prerequisite to ensure the performance of this system. We need to ensure that the data can be transmitted to the processing center quickly and safely. This network may face the following security problems: (1) malicious attacks by hackers, such as DoS, (2) network management defects, and (3) software design vulnerabilities or "backdoor" problems.

5. Conclusion

The pavilion plotting is the basis of modeling, which determines the overall structural layout of the Huipai village and the architectural form of the Huizhou village. The Huizhou architecture is integrated with natural landscapes such as woodland, grassland, and waters to form a harmonious and beautiful picture. After combining the multimedia technology and 3D reconstruction technology to introduce each landscape element's rules, the H-dimensional model is adjusted according to the field environment. The reconstruction of the typical Hui-style landscape is completed. The road network structure of large-scale centripetal and small-scale rules is the centripetal type village's landscape structure feature. The centripetal Huizhou village is centered on the ancestral clan hall, and various buildings spread to the periphery, and the same clan people lived together. According to the village-type Huizhou-style village network's large-scale pattern radiation, the small pattern is organically connected. The building expands from the center, and the water system's imaging system that runs through the settlement area automatically generates the square-shaped blocks of the Xianghui-type Huipai village. Large-scale strips and small-scale organically connected road network structures are structural features of strip-type villages. Strip-type Huizhou village construction land, grassland, water area, and forest land are distributed in strips. Although this method's performance is better than other existing algorithms, this algorithm's timeliness needs to be improved in the case of complex terrain. The next step is to improve the performance of the algorithm further and reduce its time complexity.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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