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Retraction

Retracted: Application of Digital Image Processing and GIS Technology in the Evaluation of Rationality of Urban and Rural Planning Spatial Layout

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] H. Jingfeng and S. Xiaoyu, "Application of Digital Image Processing and GIS Technology in the Evaluation of Rationality of Urban and Rural Planning Spatial Layout," *Security and Communication Networks*, vol. 2022, Article ID 1693706, 12 pages, 2022.

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Research Article

Application of Digital Image Processing and GIS Technology in the Evaluation of Rationality of Urban and Rural Planning Spatial Layout

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This work investigates digital image processing technology and presents a super-resolution image reconstruction approach to increase the logic of urban and rural planning spatial layout. Furthermore, this work integrates GIS technology with super-resolution image reconstruction techniques to create a digital image processing and GIS-based urban and rural spatial layout design model. In addition, this paper mathematically expresses the objects and scenes that need to be simulated as a collection of three-dimensional graphic objects stored in the computer. The platform is constructed with a three-tier system of B/S architecture, and the logical structure of the entire system is composed of the client, application server, database server, and other functional servers. Furthermore, this paper constructs the functional structure of urban and rural spatial layout planning model based on digital image processing and GIS technology and verifies the model in this paper through experimental research. The experimental statistical results verify the reasonableness of the model in this paper.

1. Introduction

Geographic information technology is one of the most critical technologies in the informatization and intelligent construction of urban and rural planning management. The geographic information system is a system that can organize, manage, analyze, and display geospatial data. In the real world, most things have geographic location characteristics. The information that expresses this characteristic of things is called spatial information, and the information of other characteristics of things can be called attribute information. Spatial information and attribute information are organically combined, and real objects are inquired, counted, and analyzed in terms of space and attributes, and the results are expressed in the form of spatial visualization map graphical representation. Therefore, from the perspective of the richness and effectiveness of the real-world expression and analysis methods, it is a more advanced system than the traditional information system [1].

The geographic information system is also a technical system. It is a computer technology system based on a geospatial database to use geographic model analysis methods to provide a variety of spatial and dynamic geographic information in a timely manner to serve geographic research and geographic decision-making. Moreover, it is a computer system whose main task is to collect, store, manage, retrieve, analyze, and describe the location and distribution of space objects and related attribute data, and answer user questions in the support of computer hardware systems and software systems [2]. At the same time, the technology also has multiple functions such as space simulation and scientific prediction, which can solve complex planning and management problems. At present, the geographic information system has become an important tool and method for urban and rural planning and construction and modern management decision-making [3].

The traditional two-dimensional planning management method focuses on the qualitative, quantitative, and positioning control aspects of urban and rural planning and construction and primarily solves the review of whether various economic and technical indicator data and building location in planning management meet the relevant technical regulations and planning standards. However, it lacks three-dimensional architectural form control, is unable to perform sunlight analysis, landscape visibility, skyline, special effects analysis, and underground space information management, and ignores how to effectively control architectural form, living environment, urban quality, and other issues in urban and rural planning and management, among other things. At the same time, in planning and management, staff often relies on their own experience and feelings, which can easily lead to out-of-control in the space environment and form management. The resulting problems cannot be solved by two-dimensional planning management alone. Therefore, it is necessary and feasible to establish an auxiliary approval system for three-dimensional planning management.

2. Related Work

The literature [4] pointed out the necessity of applying technology in urban and rural overall planning and the main content of future technology application in urban and rural overall planning. The literature [5] used GIS technology to realize the eight integrated planning of urban and rural spatial layout, ecological environment industry, land, population, public service facilities, infrastructure, and social security, which improved the systematic, innovative, forward-looking, and operability of urban and rural overall planning. The literature [6] proposed that traditional planning techniques can no longer meet the needs of current overall planning, and technological innovation is needed. Moreover, it used GIS technology to explore the advantages and necessity of technical support for urban and rural overall planning in the preliminary analysis, planning scheme design optimization, and conclusion drawing process. The literature [7] used the spatial analysis function of GIS technology to scientifically analyze and quantitatively evaluate the ecological service function and environmental ecological sensitivity of the county's ecological environment and clarify the regional ecological safety protection area, which provides a scientific basis for regional ecological environmental protection, regional ecological security, village layout, industrial layout, and rational use of resources. The literature [8] used the spatial analysis and statistical functions of GIS to analyze the development law of urban and rural construction land, the current situation and characteristics of land, etc., and design the overall plan, which better solved the contradiction between urban and rural construction land, optimizes the land structure, promotes the coordinated development of urbanization and social economy, and narrows the urban-rural gap. The literature [9] used GIS three-dimensional visualization technology to study the layout of villages and simulates three-dimensional virtual landscapes with software modules, which more intuitively expressed the results of three-dimensional planning, made it easier for people to accept, and was conducive to analysis and evaluation of villages and towns from multiple angles to obtain more scientific and feasible planning schemes. The literature [10] took technical support to determine the applicability of urban and rural land through the evaluation of the ecological and distribution suitability of the land to guide the layout of urban and rural land and optimize the urban and rural space. The literature [11] analyzed regional village and town layout design using modelling tools and GIS spatial analysis modules and offered a scientific foundation for village placement choices. The literature [12] used the GIS spatial analysis function to analyze the suitability of ecological environment elements, restrict development zones and prohibited development zones, and improve the scientificity and operability in planning implementation. Moreover, it uses buffering and grid overlay analysis to optimize the global commercial, medical, education, and transportation networks. The literature [13] used the spatial analysis function of GIS to analyze and evaluate the factors affecting the layout of rural residential areas in the context of new rural construction and to optimize the site selection and layout of residential areas, so as to save the land and promote the sustainable development of land resources and optimize the spatial layout of rural residential areas. The literature [14] used fractal theory to discuss the spatial structure and morphological characteristics of the urban system and focused on the construction of new rural areas and the optimization of the layout of village settlements.

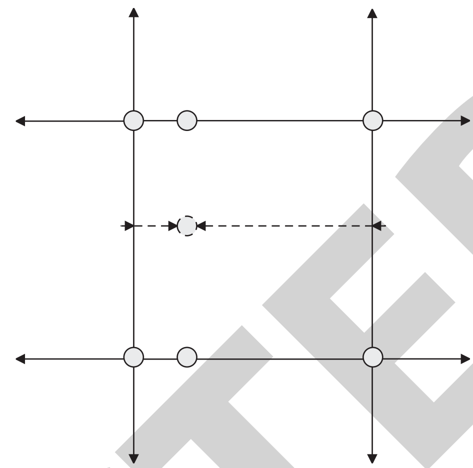

Figure 1: Schematic diagram of bilinear interpolation.

3. The Basic Method of Super-Resolution Image Reconstruction

There are many super-resolution image reconstruction methods. The interpolation-based reconstruction method is the simplest and least complex of many algorithms. The traditional interpolation methods are as follows [15] Figure 1.

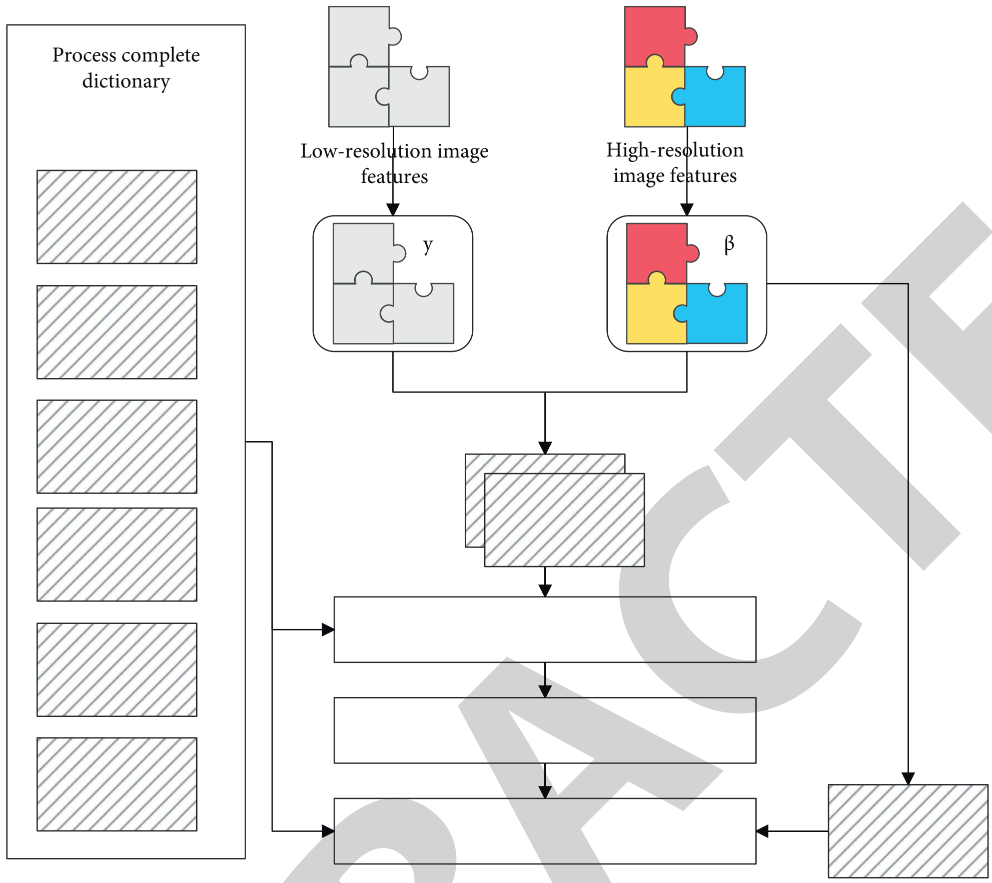

Figure 2: Schematic diagram of image reconstruction algorithm based on learning.

(1) *Nearest Neighbor Interpolation (NNI).* The point that needs to be interpolated in the nearest neighbor interpolation method is determined by the gray value of the nearest point, so the calculation of this method is relatively simple and the interpolation speed is faster. The disadvantage is that the negative effects brought about by the simple rules will cause block effects in the reconstructed high-resolution images, and the edges of the images will also produce different degrees of jagged effects.

(2) *Bilinear Interpolation.* The main idea of bilinear interpolation is to perform linear interpolation in the horizontal and vertical directions, respectively. The bilinear interpolation mentioned in this paper will be used in the matrix formed by image processing. It is a method that uses the pixels around the point to be determined to perform the bilinear operation on the point whose pixel value is to be determined. The schematic diagram of the algorithm is shown in the following figure.

The point (x, y) marked in the figure is the point to be interpolated, and the calculation formula for the gray value $f(x, y)$ at this point is

$$f(x, y) = b[af(i+1, j) + (1-a)f(i+1, j+1)] + (1-b)[af(i, j) + (1-a)f(i, j+1)]. \tag{1}$$

A complete bilinear interpolation algorithm includes the following five steps:

The first step is to create a new image, that is, obtain the size of the corresponding new image through the original image with higher resolution and the scale factor [16].

The second step is pixel mapping, that is, find a pixel (x, y) of the created new image and map it to the pixel of the original image.

The third step is pixel rounding, that is, rounding the obtained mapped image pixel $(x\prime, y\prime)$ to get the corresponding value, which can be recorded as (xx, yy), and then, the value of the pixel point related to it is obtained by calculation, which is, respectively, recorded as (xx, yy).

The fourth step is to obtain the pixel value of the new image, that is, apply the bilinear interpolation algorithm to the above several pixels to obtain the pixel (x, y) of the new image.

The fifth step is iteration, that is, repeat the above steps until all the pixels of the new image are recorded.

(3) *Bicubic Interpolation (BI).* This interpolation method is more complicated than the above two different methods (nearest-neighbor interpolation and

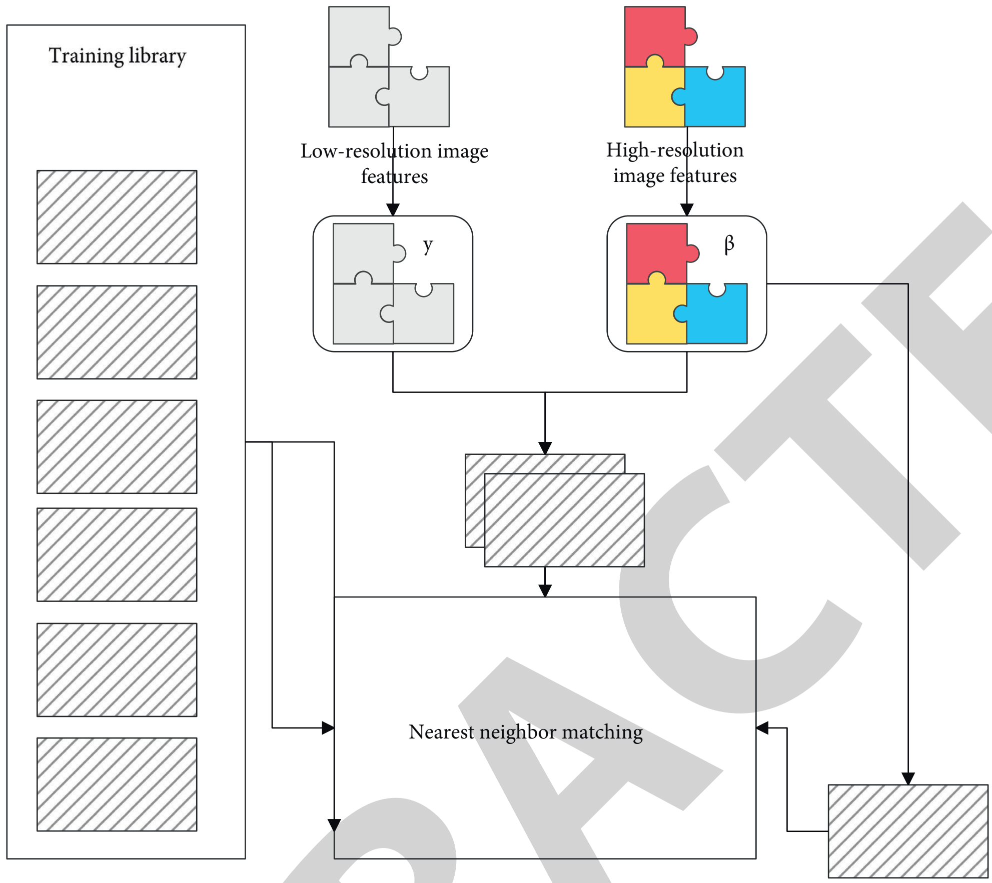

Figure 3: Schematic diagram of image super-resolution reconstruction algorithm based on example.

bilinear interpolation). The main idea is to use a total of 16 pixels in the four neighborhoods around the point to be interpolated to perform cubic interpolation, and its name is also derived from this. In terms of calculation, bicubic interpolation has a relatively large amount of calculation and a longer operation time, which leads to poor real-time performance. However, this algorithm also has many obvious advantages. It can eliminate the jagged effect and blocking effect of the image edge very well, and the visual effect of the image after its interpolation will be significantly better than the previous two algorithms [17].

The primary concept behind reconstruction-based image super-resolution reconstruction is to linearly restrict the recovered picture with high resolution. The observed low-resolution pictures achieve this limitation, which is a method of simulating the image degradation process in general. Among them, motion estimation and extracting the prior information of the image are the two key steps of the algorithm. The reconstruction-based super-resolution mainly solves the problem of how to obtain the image forward observation model, and the solution is to use the image degradation model formula; namely [18],

$$g_k = DBM_k z + n_k. \tag{2}$$

In the above formula, the meaning of g_k refers to a certain image with lower resolution, and z is a vector that represents the high-resolution image to be reconstructed. M_k, B, and D all represent matrices, which are geometric motion matrix, blur matrix, and subsampling matrix, respectively, and n_k represents additional noise in the image. Super-resolution methods mainly include the following categories.

(1) Iterative back projection (IBP):

The back-projection process of the iterative back-projection method (IBP) is as follows. First, the algorithm needs to get a low-resolution image, and then, it needs to get an estimated error value and finally use the obtained estimation error to iteratively correct and continuously update to obtain a high-resolution image. The specific iterative process can be expressed as follows [19]:

$$Y^{(j+1)} = Y^j + \sum_k BE_k, \tag{3}$$

where E_k represents the estimated error value between the two low-resolution images, and the expression for E_k is

$$E_k = X_k^{(j)} - X_k, k = 1, 2, \ldots, K, \tag{4}$$

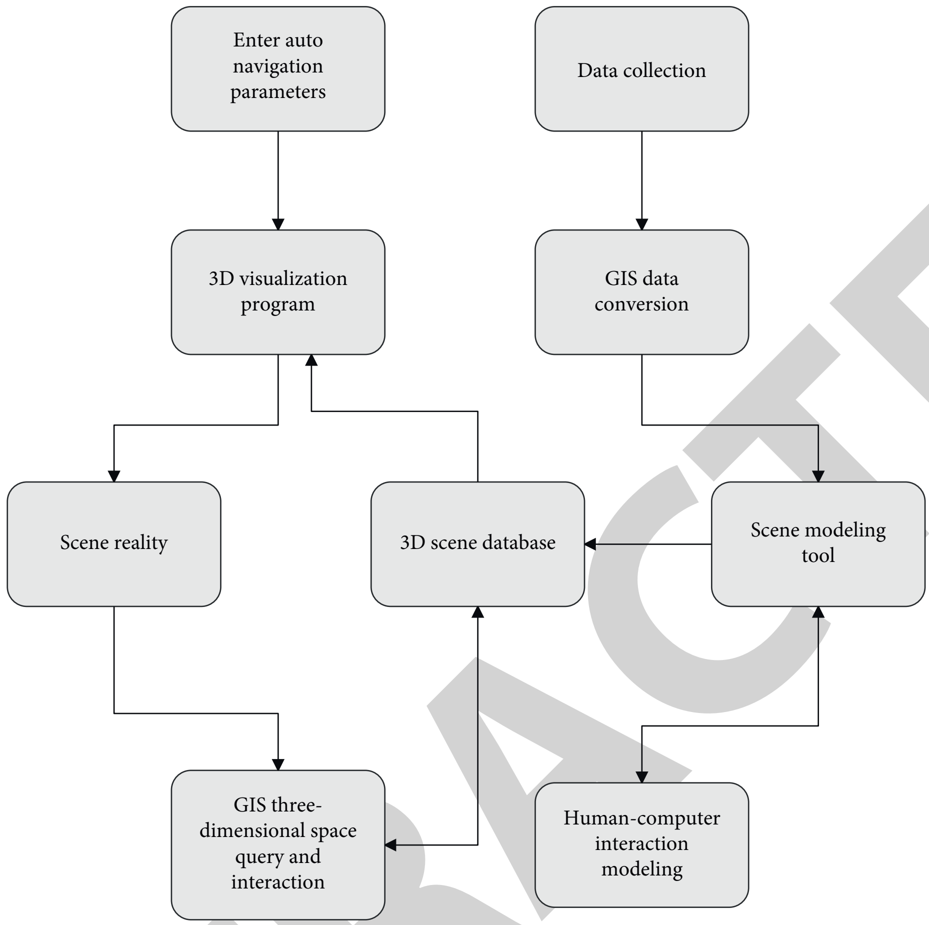

FIGURE 4: Basic architecture diagram of 3D visualization.

where $X_k^{(j)}$ represents the low-resolution image produced by the forward observation model, that is, the prior model.

$$X_k^{(j)} = W_k Y^{(j)} + N_k, k = 1, 2, \ldots, K, \tag{5}$$

where the letter k represents k frames of images, and X_k represents the original k frames of low-resolution images, the letter B represents the back projection kernel, and J represents the maximum number of iterations using the estimation error.

The iterative back-projection method has many obvious advantages. For example, related theoretical ideas are more intuitive and easier to understand, and the algorithms used are easier to implement. However, the algorithm has not reached perfection. It has the nonuniqueness and instability of the obtained solution, and it also has the disadvantage of nonconvergence caused by iteration.

(2) Maximum posterior probability (MAP) algorithm:

The algorithm has three steps, which are described in detail as follows.

In the first step, the process of inputting a low-resolution image (indicated by X) and the process of obtaining a high-resolution image (indicated by Y) are regarded as two random processes, respectively. Then, the posterior probability of the original high-resolution image is required to reach the maximum value, which can be achieved by using the following formula [20]:

$$Y_{\text{map}} = \operatorname{argmax}_Y [P(Y|X)]. \tag{6}$$

In the second step, using the Bayes formula, the above formula can be further transformed into

$$Y_{\text{map}} = \operatorname{argmax}_Y \left[\frac{P(X|Y)P(Y)}{P(X)} \right]. \tag{7}$$

In the third step, due to the irrelevance of the denominator in the logarithm, the negative logarithm of the above formula can be taken, and then, the following formula can be obtained through a series of transformations and simplifications:

$$Y_{\text{map}} = \operatorname{argmax}_Y [-\log P(X|Y) - \log P(Y)], \tag{8}$$

where $P(Y|X)$ represents the conditional probability and specifically refers to the conditional probability of the input low-resolution image to the known high-resolution image. Taking into account the randomness, its value is usually different according to

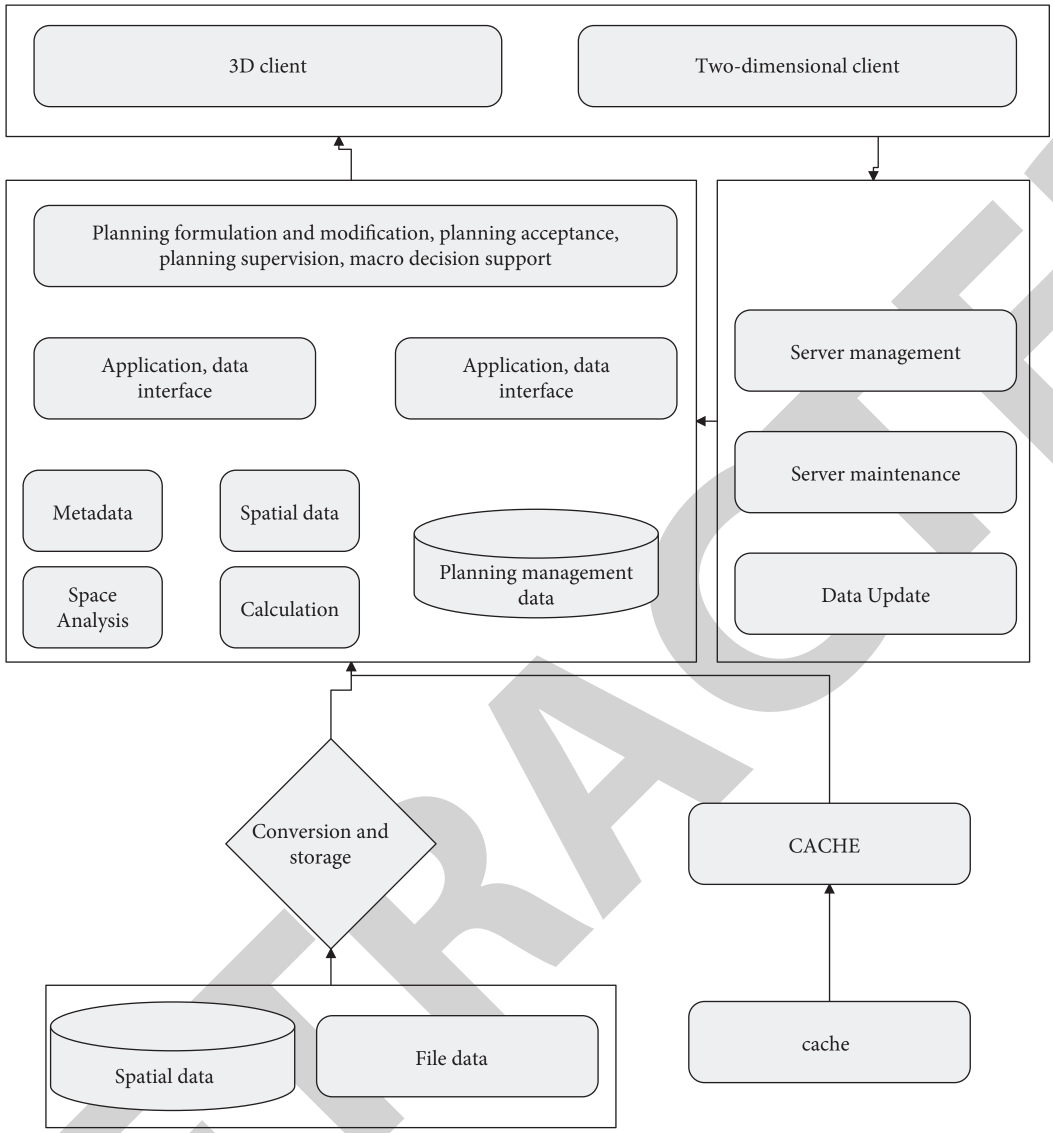

Figure 5: Digital platform of urban and rural planning and management.

the noise distribution of the system. $P(X)$ represents the prior probability contained in the ideal high-resolution image, and $P(Y)$ represents the posterior probability of the input low-resolution image, and its value can be determined by the added prior information [21].

(3) Projection onto convex sets (POCS):

The earliest projection onto convex sets (POCS) is to solve the intersection of a series of constrained convex sets that have been obtained in an iterative way, and obtaining high-resolution images is the core idea of this method. Compared with other methods, the most breakthrough point of projection onto convex sets is that the starting point is located at a certain pixel in the high-resolution image, and then, the relevant formula is used to find the next pixel, which satisfies all the constraint convex sets. This calculation process can be expressed as

$$Y^{(1)} = P_N \ldots P_2 P_1 Y^{(0)}, \tag{9}$$

where $Y^{(0)}$ represents the initial value of a certain pixel in the set high-resolution image, and P_N is the convex set projection operator corresponding to each constrained convex set.

(4) Hybrid method of maximum likelihood estimation and projection onto convex sets (MLE, POCS).

Specifically, the image super-resolution algorithm based on learning is to first find the relationship between a low-resolution image and its corresponding high-resolution image. Then, it corresponds to the low-frequency and high-frequency parts of the high-resolution image, performs intensive learning and training after partitioning, and finally applies this relationship to the super-resolution reconstruction of other images, as shown in Figure 2[22].

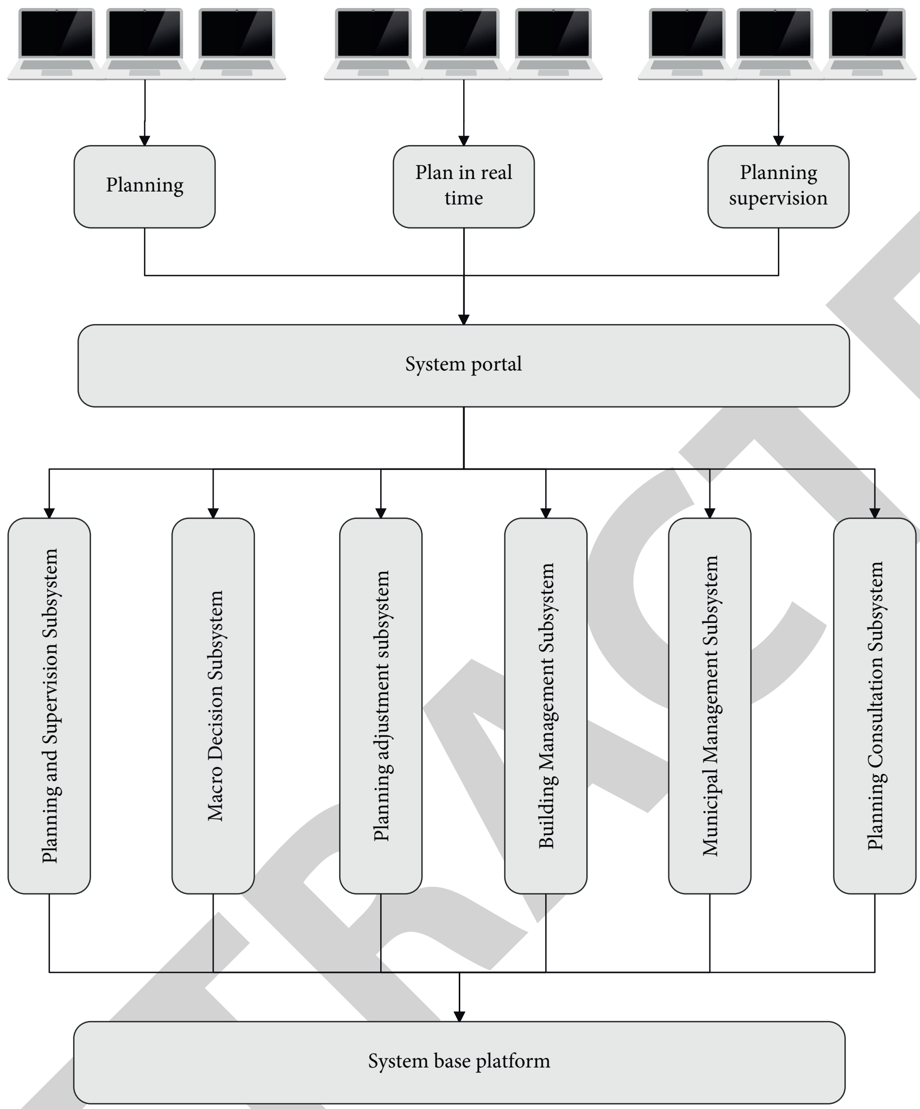

Figure 6: Schematic diagram of the system hierarchy.

The specific steps of this method have the following three steps:

(1) Degrade the high-resolution image according to the degradation model to generate a training set.

(2) Divide the high-resolution image into low-frequency and high-frequency parts, divide the image into blocks according to the corresponding relationship between them, and then conduct intensive learning and training on these corresponding block models through a certain algorithm to obtain the first experience of knowledge and establish a learning model.

(3) Divide the input low-resolution image into blocks, use these image blocks as a basis, search in the training set established in the first step, and finally find the high-frequency image block that best matches it.

The key to the learning-based super-resolution method is to use the image blocks corresponding to the low-frequency and high-frequency parts to establish a learning model and to use the trained model to obtain sufficient prior knowledge. At present, the commonly used learning models mainly include Markov random field model (MRF), principal component analysis model (PCA), image pyramid model, and neural network model.

Sample-based super-resolution image reconstruction is a kind of learning reconstruction method. It was first proposed by WTFreeman et al. It is based on the Markov random model. First, it is necessary to combine the low-resolution image of the provided sample with the high-resolution image. The resolution image is divided into blocks. Then, according to the relationship between the divided low-resolution image blocks and high-resolution image blocks, corresponding learning and training are carried out. After training, a Markov network needs to be formed, which should be used. It realizes the

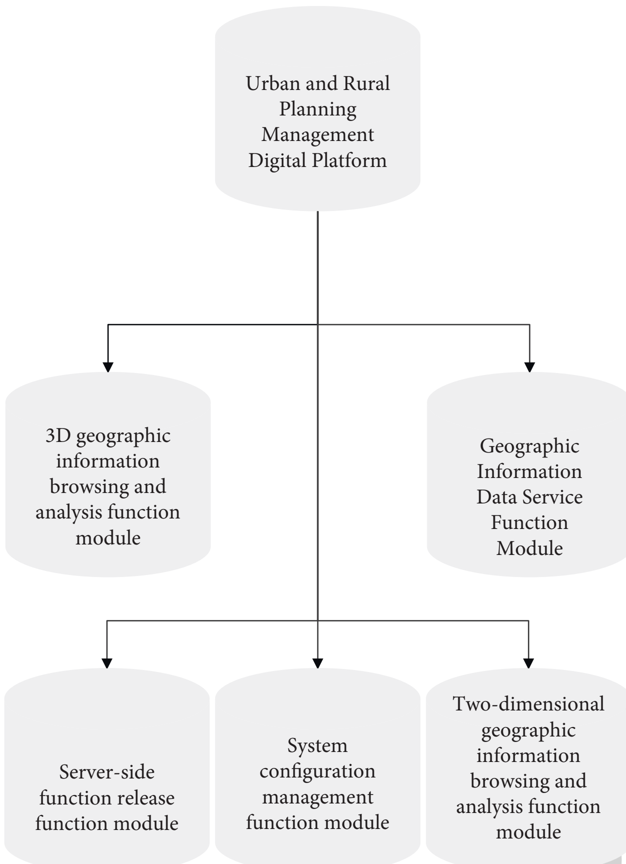

Figure 7: Platform module composition.

concept of probability transition model and the relationship between the models. Finally, the previously prepared application part is represented as a new low resolution image. It can be divided into the following parts. First, it is divided into blocks, and then the established marl finds its corresponding best position in the cove network, adds all matching high-resolution image blocks, and finally obtains the reconstructed high-resolution image.

The above algorithm is shown in Figure 3.

The super-resolution image reconstruction algorithm based on examples has many advantages over other algorithms. For example, it can recover more details of the image to make the image clearer, and it can also make the edges of the obtained image smoother, and the image has no obvious block effect. However, from the steps of the algorithm, it is not difficult to see that the training image library data of this method are relatively large, and the corresponding calculation amount will be relatively large. Moreover, the result of the operation is more obviously affected by the image library, which has the disadvantage of poor antinoise ability. One of the extensions is the super-resolution image reconstruction algorithm based on neighborhood embedding.

The neighborhood embedding reconstruction approach relies heavily on local linear embedding

Table 1: Statistical table of layout planning effect of urban and rural spatial layout planning model based on digital image processing and GIS technology.

Number	Space layout
1	89.5
2	91.7
3	89.5
4	93.2
5	92.7
6	90.9
7	92.1
8	92.4
9	90.7
10	94.3
11	93.6
12	90.9
13	92.3
14	94.2
15	89.2
16	94.0
17	91.6
18	93.0
19	89.2
20	93.9
21	92.4
22	92.5
23	90.0
24	89.8
25	89.1
26	92.1
27	90.9
28	94.8
29	93.7
30	94.8
31	91.2
32	90.3
33	91.8
34	90.1
35	94.8
36	90.3
37	91.5
38	89.8
39	91.7
40	94.1
41	89.4
42	90.5
43	89.7
44	90.1
45	89.8
46	92.7
47	93.2
48	89.6
49	92.5
50	90.8
51	90.4
52	91.5
53	93.5
54	89.0
55	93.4
56	94.4
57	90.7
58	93.5

Table 1: Continued.

Number	Space layout
59	93.4
60	93.9
61	92.1
62	89.9
63	92.4
64	94.6
65	94.6
66	89.2
67	93.0
68	92.6
69	89.5

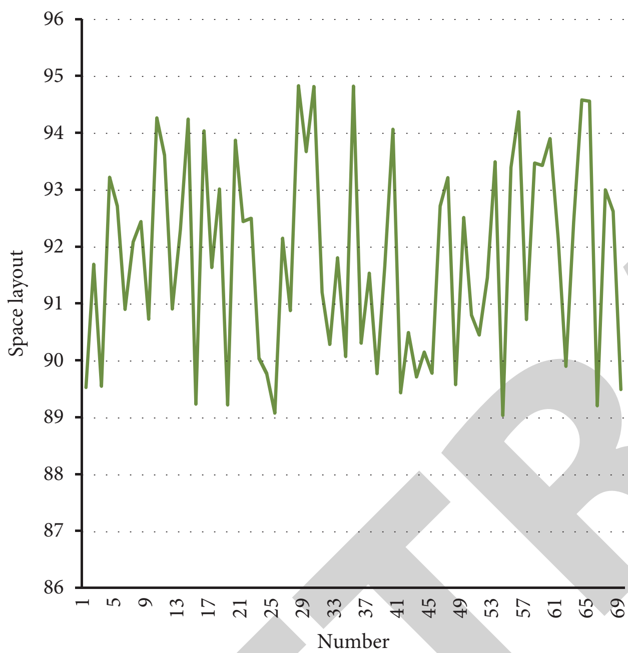

Figure 8: Statistical diagram of layout planning effect of urban and rural spatial layout planning model based on digital image processing and GIS technology.

information and leverages the sample's thinking process as its guiding philosophy. It is to identify some lower resolution in two separate feature spaces, namely, image blocks, and make them meet the condition that they have similar geometric structures locally, and then, these image blocks with similar geometric structures can form some manifolds in the same two spaces with different characteristics and combine these manifolds with their corresponding ones. The manifolds formed by higher resolution image blocks are combined, and these manifolds are locally linearly embedded.

The specific steps of this algorithm are mainly divided into the following five steps.

The first step is to train the sample, that is, select some images with higher resolution, divide them into blocks, and then use them as a training sample

Table 2: Statistical table of evaluation of urban and rural planning spatial layout.

Number	Evaluation effect
1	91.4
2	91.5
3	90.9
4	84.0
5	81.7
6	87.7
7	91.1
8	88.5
9	87.6
10	85.4
11	81.9
12	88.2
13	91.3
14	85.5
15	89.0
16	89.5
17	86.9
18	87.6
19	87.8
20	90.0
21	89.0
22	91.2
23	82.1
24	91.4
25	84.7
26	87.0
27	91.5
28	87.1
29	86.4
30	89.2
31	91.1
32	89.8
33	88.8
34	88.0
35	88.2
36	86.7
37	88.1
38	81.5
39	87.9
40	86.1
41	84.3
42	82.3
43	87.1
44	87.5
45	88.5
46	91.8
47	85.4
48	89.9
49	88.6
50	82.5
51	81.6
52	88.4
53	82.8
54	88.6
55	82.7
56	85.2
57	83.1
58	87.0
59	91.6

Table 2: Continued.

Number	Evaluation effect
60	88.0
61	83.9
62	87.9
63	90.6
64	86.0
65	91.9
66	89.3
67	90.1
68	91.9
69	87.9

and train them. The second step is to calculate and obtain the local geometric structure manifold, that is, divide the low-resolution image into blocks, input these image blocks, calculate the feature vectors of these low-resolution image blocks, collect these feature vectors, and obtain the local geometric structure of the low-resolution image block in the vector set. The third step is mapping, which is to map the local geometric structure of the low-resolution image and find the image block that best matches the input image block structure from the training set. The fourth step is to reconstruct the image and select K adjacent distances in four directions of the low resolution image block. Then, the selected distance relation is reflected to the feature value set of the trained high-resolution image block, and the corresponding feature vector of the high-resolution image block is found, that is, the reconstructed high-resolution image can be obtained.

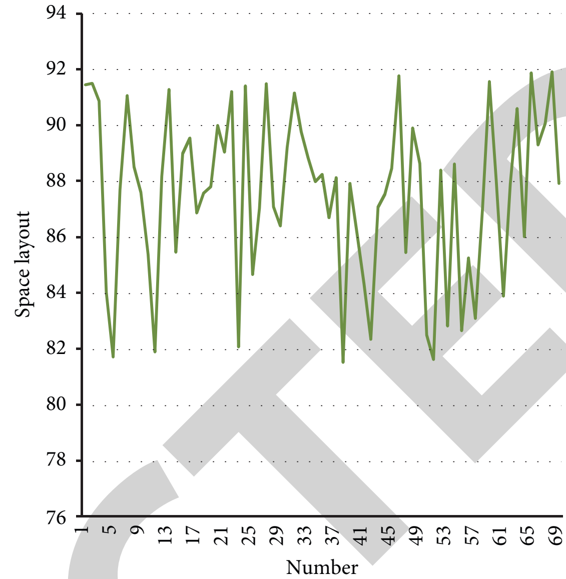

Figure 9: Statistical diagram of evaluation of urban and rural planning spatial layout.

The other is gradient-based sample super-resolution reconstruction, where the following formula can be used to find the image block from the training set that best matches the structure of the input image block.

$$\min f_{i,j} = \left(\sum_{m=1}^{M} \left(y_{im} - y_{jm} \right) + \alpha \sum_{m=1}^{M} \left(y'_{im} - y'_{jm} \right) + \beta \sum_{n=1}^{M} \left(x_{in} - x_{jn} \right) \right)^2, \quad (10)$$

where α and β, respectively, represent the weight of the gradient and high-frequency overlap, and y'_{im} and y'_{jm}, respectively, represent the pixel value of the pixel in the gradient image and the training set image. Compared with other algorithms, this super-resolution algorithm based on examples has the most breakthrough in the search vector construction method. This method can solve the problem of dissimilar matching structures. It can not only ensure the matching between image blocks as a whole but also ensure the matching similarity of image structural features, and it can well reflect the external structural features through a little change in the pixel value of the internal pixel of the image block.

(4) Urban and rural layout planning model based on digital image processing and GIS.

The establishment of a three-dimensional scene model is to mathematically express the objects and scenes that need to be simulated into a collection of three-dimensional graphic objects stored in the computer. It can be seen from Figure 4 that the construction of a three-dimensional model requires the following steps.

The urban and rural planning management digital platform is a multidata type, multiscale, massive basic geographic information sharing platform under the network environment. This platform is constructed with a three-tier system of B/S architecture. The logical structure of the entire system is composed of the client, application server, database server, and other functional servers. The system architecture is shown in Figure 5.

According to the logical structure of the system, the platform can be divided into three levels: application layer, platform layer, and data layer, as shown in Figure 6.

According to the function division of the platform, the entire platform can be divided into the following functional modules, as shown in Figure 7.

4. System Performance Verification

This article uses digital image processing and GIS technologies to create an urban and rural spatial layout design model. The approach described in this research may help with the urban and rural spatial layout design as well as assess such planning. Therefore, this paper combines the system function framework model to conduct simulation research. First, this paper analyzes the effect of urban and rural planning spatial layout, and the results are shown in Table 1 and Figure 8.

The above research shows that the urban and rural spatial layout planning model based on digital image processing and GIS technology has a certain spatial planning effect. After that, the evaluation and statistics of urban and rural planning spatial layout are carried out, and the results are shown in Table 2 and Figure 9.

From the above experimental research, we can see that the urban and rural spatial layout planning model based on digital image processing and GIS technology constructed in this paper can effectively improve the rationality of urban and rural spatial layout.

5. Conclusion

Digital image processing and GIS technologies are essential components of digital city information architecture. With the three-dimensional view, multitemporal and object attributes of the managed objects, it can help the urban and rural planning management department get rid of the two-dimensional static management mode and accurately grasp the planning situation in the three-dimensional, interactive, dynamic, and virtual city environment. Moreover, it will help more effectively carry out landscape planning, urban construction, and management and then realize efficient, standardized, and scientific information management, which will surely bring obvious economic, political, social, and ecological benefits to the urban planning management industry.

This paper constructs an urban and rural spatial layout planning model based on digital image processing and GIS technology. The system in this paper can assist in urban and rural spatial layout planning and can evaluate urban and rural spatial layout planning. After the system model is constructed, the system performance is verified through simulation experiments. From the experimental research, it can be seen that the urban and rural spatial layout planning model constructed in this paper based on digital image processing and GIS technology can effectively improve the rationality of urban and rural spatial layout.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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