

## *Retraction*

# **Retracted: Processing Methods for Digital Image Data Based on the Geographic Information System**

### **Complexity**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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) Manipulated or compromised peer review

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] X. Wang, T. Chen, D. Li, and S. Yu, "Processing Methods for Digital Image Data Based on the Geographic Information System," *Complexity*, vol. 2021, Article ID 2319314, 12 pages, 2021.

## Research Article

# Processing Methods for Digital Image Data Based on the Geographic Information System

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Digital image data processing is mainly to input digital image data into a computer to complete the conversion of a continuous spatially distributed image model into a discrete digital model so that the computer can identify, process, and store the processing process of digital image information. Geographic information system (GIS) is a computer system that integrates multiple forms of information expression, and it integrates functions such as collection, processing, transmission, storage, management, analysis, expression, and query retrieval, which can quickly discover the spatial distribution of things and their attributes and can express the results accurately and vividly in various intuitive forms. Therefore, on the basis of summarizing and analyzing previous research works, this paper expounded the research status and significance of processing methods for digital image data, elaborated the development background, current status, and future challenges of the GIS technology, introduced the methods and principles of permutation matrix algorithm and subimage averaging method, constructed the processing model for digital image data based on GIS, analyzed the data structure and its database establishment for digital image, proposed the processing methods for digital image data based on GIS, performed the enhancement processing and calculation classification of digital image data, and finally conducted a case analysis and its result discussion. The study results show that the proposed processing methods for digital image data based on GIS can perform analogue-to-digital conversion of continuous images, complete the steps of sampling, layering, and quantization, and then encode the obtained discrete digital signal into the computer to form an in-plane collection of pixels; this processing method can also organically combine spatial information and image data and identify, process, and store digital image data from both spatial and attribute aspects. The study results of this paper provide a reference for further research on the processing methods for digital image data based on GIS.

## 1. Introduction

Digital image data processing is mainly to transform an image signal into a digital signal in certain forms and then use a computer to implement the processing. The information source obtained by this technology is often a kind of two-dimensional data, and this kind of data generally requires very high computer storage space and speed [1]. In terms of information transmission, the frequency band requirements are not very high, and the image compression technology is not too demanding. At the same time, there are often large associations between pixels and pixels in

digital images, and they are not independent. Therefore, digital image data processing technology can achieve data compression. Image digitization is to input graphic coordinate data representing geographic information into a computer to complete the conversion of a continuous spatially distributed image model into a discrete digital model so that the computer can recognize, process, and store image information [2]. In the process of digital image data processing, data processing personnel need to integrate the actual situation, strengthen the detection of information, use modern information system to extensively collect corresponding information data, and continue to

ease the tension between humans and information, and improve the utilization rate quality of digital images [3]. Therefore, data processing personnel can use the information system to continuously improve the accuracy of information collection and then do a good job in the collection of information and data, to provide a good reference and reference for the current digital development, and to meet the wide range of needs for digital images [4].

Geographic information system (GIS) is a computer system, with multidimensional data structure, which collects, stores, manages, analyzes, describes, and applies all or part of the earth's surface and spatial and geographic distribution data, whose main function is to realize the collection, editing, analysis, statistics, and management of geospatial data [5]. If necessary, it can store various attributes of global or regional natural and social factors in a computer database according to geographic location. Whether it is vector, polygon, or grid, it can be converted to each other, so that it can be converted according to geographic location and units are retrieved, accessed, or superimposed [6]. From a disciplinary point of view, GIS is a comprehensive discipline, including geography, information technology, surveying and statistics, etc. It integrates current advanced computer technology, has strong independence, and will follow the technological development progress and development, renewal. From the perspective of actual technical application, GIS is mainly used to effectively solve spatial and geographic problems [7]. It needs to combine actual conditions and adopt advanced technical means and methods to improve the efficiency of information collection. From the actual function point of view, the GIS has changed the traditional data analysis method and realized integrated processing, which greatly facilitated the data analysis by the staff [8].

On the basis of summarizing and analyzing previous research works, this paper expounded the research status and significance of processing methods for digital image data, elaborated the development background, current status, and future challenges of the GIS technology, introduced the methods and principles of permutation matrix algorithm and subimage averaging method, constructed the processing model for digital image data based on GIS, analyzed the data structure and its database establishment for digital image, proposed the processing methods for digital image data based on GIS, performed the enhancement processing and calculation classification of digital image data, and finally conducted a case analysis and its result discussion. The study results of this paper will provide a reference for further researches on the processing methods for digital image data based on GIS. The detailed chapters are arranged as follows: Section 2 introduces the methods and principles of permutation matrix algorithm and subimage averaging method; Section 3 constructs a processing model for digital image data based on GIS; Section 4 proposes the processing methods for digital image data based on GIS; Section 5 conducts a case analysis and its result discussion; and Section 6 is the conclusion.

## 2. Methods and Principles

**2.1. Permutation Matrix Algorithm.** For the multidimensional analysis of image data, the image data cube center can be designed and constructed. The data cube can contain dimensions and metrics for image information, such as color, texture, and shape. The establishment of image data cubes facilitates the multidimensional analysis of image data based on visual content, including summary, comparison, classification, association, and clustering.

From a mathematical point of view, image data processing and analysis refers to obtaining the range of these areas after a given set of geographic areas, and determining the size of the area by the radius of the range. For example, given an object  $x$ , its image. The geographic range set  $Q(x)$  of data processing is defined as follows:

$$Q(x) = |x - a| \cdot |x - b|, \quad (1)$$

where  $a$  is the distance of the geographic area and  $b$  is the radius of the field, that is, the processing distance, which can be a constant or a variable, depending on the specific situation.

The image data cube is a very useful model for multidimensional analysis of image data, but it is extremely difficult to realize a data cube with a large dimension. In the image data cube, attributes such as color, orientation, texture, and keywords must be considered, and many of these attributes are set values rather than single values. How to design an image data cube that not only meets the efficiency requirements but also has sufficient expressive power is a problem that needs to be studied urgently.

The factor set of digital image data is set as  $C = \{c_1, c_2, \dots, c_n\}$ , evaluation set of permutation matrix is  $D = \{d_1, d_2, \dots, d_n\}$ , and the single factor evaluation of the  $i$ th factor  $c_i$  is  $dc_i = \{dc_{i1}, dc_{i2}, \dots, dc_{in}\}$ , which is a fuzzy subset on  $D$  and  $dc_i$  is the degree of membership of the  $c_i$ th factor evaluation to the  $d_i$ th level. Thus, the first-level evaluation matrix  $E_i$  is formed, which is the fuzzy relationship matrix from  $C_i$  to  $D_i$ , so the evaluation matrix  $E_{ij}$  is

$$E_{ij} = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1n} \\ e_{21} & e_{22} & \cdots & e_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ e_{n1} & e_{n2} & \cdots & e_{nm} \end{bmatrix}. \quad (2)$$

The maximum likelihood method uses the statistical characteristics of digital images, assumes that various distribution functions are normal and uses the maximum likelihood rule to make a judgment according to the normal distribution law to obtain the classification result. From the statistical analysis of probability, in order to discriminate which category the vector  $x$  of a certain position belongs to, the function  $F(x)$  should be determined from the conditional probability:

$$F(x) = \frac{f_i(x)[g(x) - h(x)]}{f_j(x)[k(x) - l(x)]}, \quad (3)$$

where  $f_i(x)$  is the category of the  $i$ th rule corresponding to object  $x$ ;  $f_j(x)$  is the category of the  $j$ th rule corresponding to object  $x$ ;  $g(x)$  is the type of object  $x$  in the normal distribution mode probability;  $h(x)$  is the maximum value of the gray scale of the object  $x$ ;  $k(x)$  is the quantization level of the gray scale of the object  $x$ ; and  $l(x)$  is the minimum value of the gray scale of the object  $x$ .

The association rules related to image objects can be mined in image data, including at least three types of rules: the association of image content and nonimage content, the association of image content that has nothing to do with spatial relationships, and the association of image content with spatial relationships. The classification and clustering of image data are closely related to image analysis and scientific data mining. Therefore, image analysis techniques and scientific data analysis methods can be used in the image data mining process.

**2.2. Subimage Averaging Algorithm.** Due to the large image array, processing directly in the spatial domain involves a large amount of calculation. Therefore, various image transformation methods are often used to convert spatial domain processing into transformation domain processing, which can not only reduce the amount of calculation but also obtain more effective processing. Wavelet transform has good localization characteristics in both time domain and frequency domain, and it has a wide range of effective applications in image processing.

When using the distance discriminator function, the model requires that the center position  $x_o$  of each category cluster is a known point. For any point  $x_i$  in the spectral feature space, calculate the distance  $p(x_i)$  ( $i = 1, 2, \dots, m$ ) from the center point of the cluster; if  $d(x_i) < d(x_o)$ , then  $x_i$  pixel belongs to  $f(x_i)$  type, otherwise  $x_i$  does not belong to  $f(x_i)$  type. Here,  $d(x_i)$  becomes the distance discriminator function:

$$d(x_i) = \int_{i=1}^m \frac{v \cdot r(x_i) - w \cdot s(x_i)}{t(x_i) \cdot u(x_i)}, \quad (4)$$

where  $r(x_i)$  is the distance of pixel  $x_i$ ;  $s(x_i)$  is the band number of pixel  $x_i$ ;  $t(x_i)$  is the total number of bands of pixel  $x_i$ ;  $u(x_i)$  is the brightness value of pixel  $x_i$ ;  $v$  is the category number; and  $w$  is the mean value.

Image coding compression technology can reduce the amount of data describing the image in order to save image transmission, processing time, and reduce the memory capacity occupied. Compression can be achieved without distortion, or under allowable distortion conditions. Encoding is the most important method in compression technology, and it is the earliest and relatively mature technology in image processing technology. The purpose of image enhancement and restoration is to improve image quality, such as removing noise and improving image clarity.

This mode puts all the reconstructed subimages back to their positions in the original image, and for each pixel. Finally, the different pixels are averaged to obtain the final value of the pixel, and the formula for reconstructing the image can be formally proposed:

$$G(x_i) = \sum_{i=1}^n \left[ \frac{H(x_i) - I(x_i)}{J(x_i)} - \frac{M(x_i)}{K(x_i) - L(x_i)} \right], \quad (5)$$

where  $G(x_i)$  puts the  $i$ th subimage back to the original position in the image;  $I(x_i)$  is the distance measure of the  $i$ th subimage;  $J(x_i)$  is the horizontal resolution of the  $i$ th subimage;  $K(x_i)$  is the vertical resolution of the  $i$ th subimage;  $L(x_i)$  is the pixel value of the  $i$ th subimage; and  $M(x_i)$  is the pixel value of the  $i$ th subimage.

It is generally believed that the resolution of a digital image data processing system is one pixel. In fact, due to the continuity of the image, mathematical methods can be used to achieve accuracy below one pixel. Since the smaller the threshold, the more likely it is the location of the marker point, and the weighted average method is used to improve the resolution  $O(x_i)$ , and the formula is as follows:

$$O(x_i) = \frac{1}{n+1} \sqrt{R(x_i) \left( \frac{\alpha}{P(x_i)} - \frac{\beta}{Q(x_i)} \right)}, \quad (6)$$

where  $P(x_i)$  is the coordinates of all points less than the threshold,  $Q(x_i)$  is the result of subpixel accuracy;  $R(x_i)$  is the abscissa of mark point;  $\alpha$  is the landing mark; and  $\beta$  is the vacant mark.

Image segmentation is to extract the meaningful feature parts of the image, which is the basis for further image recognition, analysis, and understanding. At present, many methods of edge extraction and region segmentation have been researched, but there is no effective method that is generally applicable to various images. Therefore, the research on image segmentation is still deepening, and it is one of the hotspots in image processing.

### 3. Processing Model for Digital Image Data Based on GIS

**3.1. Digital Image Database Establishment.** Image segmentation is the process of segmenting a digital image into nonoverlapping regions, where regions are connected sets of pixels. Image segmentation can be achieved using three different principles; when using the area method, it divides each pixel into each object or area. In the boundary method, only the boundary existing between the regions needs to be determined; in the edge method, first determine the edge pixels and connect them together to form the required boundary. The coordinate system refers to the expression form that describes the spatial position, and the datum refers to a series of points, lines, and planes defined to describe the spatial position [9]. In order to improve efficiency, a large amount of image data must be collected on the limited computer memory, and there must be an effective method to store these image data. To provide users with the function of selecting a polygonal image area in the GIS, the image must be segmented to determine which image range the area in the mouse point is in. Image compression technology is divided into lossless compression and compression, and image digitization is to input graphic coordinate data representing geographic information into a computer to complete the conversion of a

continuous spatially distributed image model into a discrete digital model so that the computer can recognize, process, and store image information. Analytical framework of processing methods for digital image data based on GIS is shown in Figure 1.

The geometric figures in the GIS can record text and digital data. These data describe the length, grade, name, and other characteristics of the object represented by the figure and attribute data. As the attribute database of GIS, its structure is relatively simple, and its operability is relatively poor. If the methods directly manipulate the data, it is difficult to use the image operation software system of the data frequently. It makes full use of the advantages of the database system, organizes the database hierarchically, stores the basic, important, and drawing performance data in the attribute database, separates the commonly used image operation data in the external database, and writes back the important data after the calculation. For the attribute database, this reduces the redundancy of data calls, improves the speed, saves a lot of time and thus ensures the accuracy of the results. It connects the attribute information involved in digital image data processing with geographic spatial locations to form a complete digital image data processing dedicated information database, and then uses the spatial information operation function of the GIS to facilitate retrieval, query, analysis, and analysis. At the same time, GIS itself provides many functions for processing graphics, such as layer overlay, optimal path, automatic matching, etc. Therefore, GIS is not only a database in digital image data processing but also a powerful tool for graphics processing, which can be applied in all aspects of the field of digital image data processing and graphical presentation [10].

Nonspatial data are attribute data, and attribute data are used to describe the quality and quantity characteristics of geographic entities. In the topographic map data, the spatial location description of the map elements is graphic data, while the attribute data are to define the map elements and describe their attribute descriptions, describing what the element is. Attribute data are usually expressed by feature codes, which are digital codes defined according to classification features such as the category and level of map elements and other quality features. When building a GIS database, the attribute database must be established at the same time, and the correspondence between spatial data and attribute data is also a very tedious task [11]. The spatial object features of geographic elements include spatial features and attribute features, and spatial features are divided into spatial location and topological relationship. In the GIS, each point is represented by the spatial coordinates and attributes of the surface, and the line is represented by the spatial coordinates of the character string, and each object is stored as a record in the spatial database. The grid data structure uses regular grids to divide the geographic space to form a geographic coverage layer. Each spatial object is mapped to a corresponding geographic grid to represent the geographic location, and each grid records the identification or type of the corresponding spatial object. It depends on the internal data structure of the GIS and the purpose of the GIS which data structure is used.

*3.2. Digital Image Data Structure.* The GIS has a very broad development prospect in the related work of digital image data processing, and it is currently developing in the direction of intelligence, automation, and refinement. On one hand, the GIS is being integrated with the establishment of the digital image database to update relevant data and information in time to ensure the effective development of image processing; on the other hand, the GIS is continuously merging with the image processing model. The related changes can be dynamically simulated to better serve related work; at the same time, it is moving towards secondary development. With the continuous development of technology, more software based on GIS will be continuously developed and provide better services for digital image data processing [12]. For each image processing data, it has a time stamp, which records the time of data collection. At the same time, each data has a geographic stamp, which records the specific location of the data collection. Secondly, the original image processing data are accurate to the minute in the sampling time, and accurate to the measuring point in the sampling position, so the amount of data is extremely huge. Generally speaking, in the image information system, the data involved can be divided into two categories: spatial data and attribute data. Analysis of gray-scale quantization level of digital image data is shown in Figure 2.

The main content of digital image data processing is image restoration, that is, correction of data errors, noise, and distortion caused during imaging, recording, transmission, or playback, including radiation correction, geometric correction, etc.; data compression is to improve transmission, storage, and processing data efficiency; image enhancement is to highlight certain characteristics of data to improve the visual quality of the image, including color enhancement, contrast enhancement, edge enhancement, density segmentation, ratio calculation, etc.; information extraction is from the enhanced image extracting useful remote sensing information from, including the use of various statistical analysis, cluster analysis, spectrum analysis, and other automatic identification and classification [13]. A database is a collection of data organized and stored in accordance with a certain data model. The characteristics of the database are the large amount of data, the need for long-term storage and repeated use, and the sharing of multiple users. Various operations on the data in the database are performed, that is, database management system. Graphics are usually composed of geometric elements such as points, lines, surfaces, bodies, and nongeometric attributes such as gray scale, color, line type, and line width. From the perspective of processing technology, graphics are mainly divided into two categories. One is based on online information, such as engineering drawings, contour maps, surface wireframes, etc.; the other is shading, which is commonly referred to as realistic graphics. The results of digital image data with different data structures based on GIS is shown in Figure 3.

There are two main types of spatial data management: one is to manage it in the form of files, and the spatial data are divided into several areas; the other is to manage the spatial data in the form of a database, which can manage massive

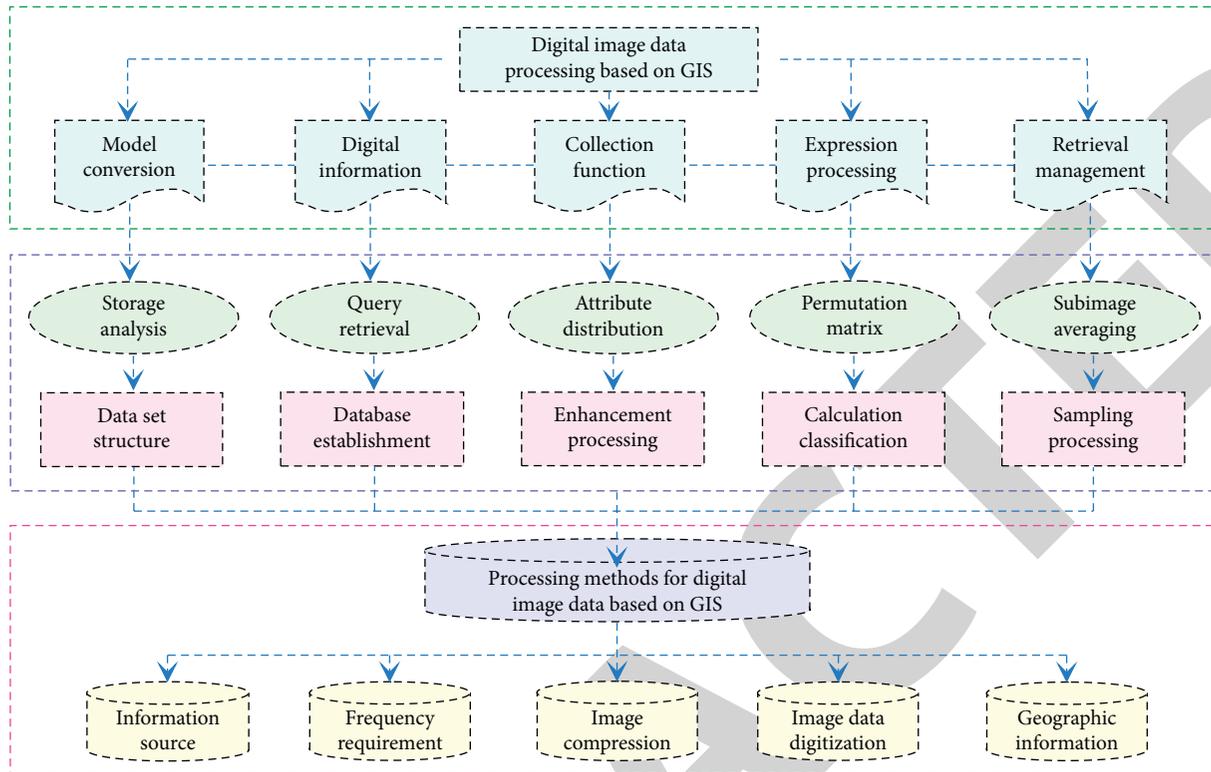


FIGURE 1: Analytical framework of processing methods for digital image data based on GIS.

amounts of data and achieve logical continuity of data. General digital image data processing is to associate spatial data with attribute data and store them in a relational database uniformly, so that all geospatial data can be easily managed by the relational database, and the integrated storage of spatial data and attribute data can be completed. However, relational database systems have low work efficiency, poor ability to describe the semantics of data objects, weak control and manipulation of complex objects, and poor scalability of data set records. Data processing is the most commonly used operation function in computer science and contemporary information science. At present, there is no unified and definite definition of data processing and most of the functions of a computer system can be regarded as data processing operations in an information system. In the field of information science of GIS, from the collection and input of geospatial data to the output of data, the whole process can be regarded as the processing of geographic information, and the functions of data processing can be classified into data editing and conversion, storage, analysis, organization, display, etc.

#### 4. Processing Methods for Digital Image Data Based on GIS

**4.1. Enhancement Processing.** In the process of digital image data processing, data processing personnel need to integrate the actual situation, strengthen the detection of information, use modern GIS to extensively collect corresponding information data, and continue to ease the tension between humans and information and improve the quality of digital

images. Therefore, data processing personnel can use the GIS to continuously build a complete GIS to improve the accuracy of information collection and then do a good job in information data collection to provide a good reference and reference for the current digital development and meet the needs of digital images. As a data processor, the methods need to pay attention to the investigation of current information and analyze the current status of information utilization, so as to provide reference and help for information protection. In order to prevent complex correction behaviors, it is necessary to carefully summarize and analyze abnormal data in the data output process, do daily inspection work, prevent errors, improve the actual rendering quality, and meet the current basic requirements of three-dimensional information output. In the use of GIS, digital image data processing personnel should not stick to the status quo but must combine the actual situation, constantly break the routine, improve the rendering accuracy, and meet the basic requirements of three-dimensional applications [14]. Maximum and minimum values of the gray scale are shown in Figure 4.

The computer classification of digital images is a branch of the pattern recognition technology, and the main function of the pattern recognition system is to distinguish the category of the object to be recognized. To this end, it is necessary to establish a certain discriminating rule, and the discriminating rule is composed of a certain discriminating function with a certain comparison operation relationship. In the case that the feature space already exists, the classification problem of each pixel is to determine which cluster

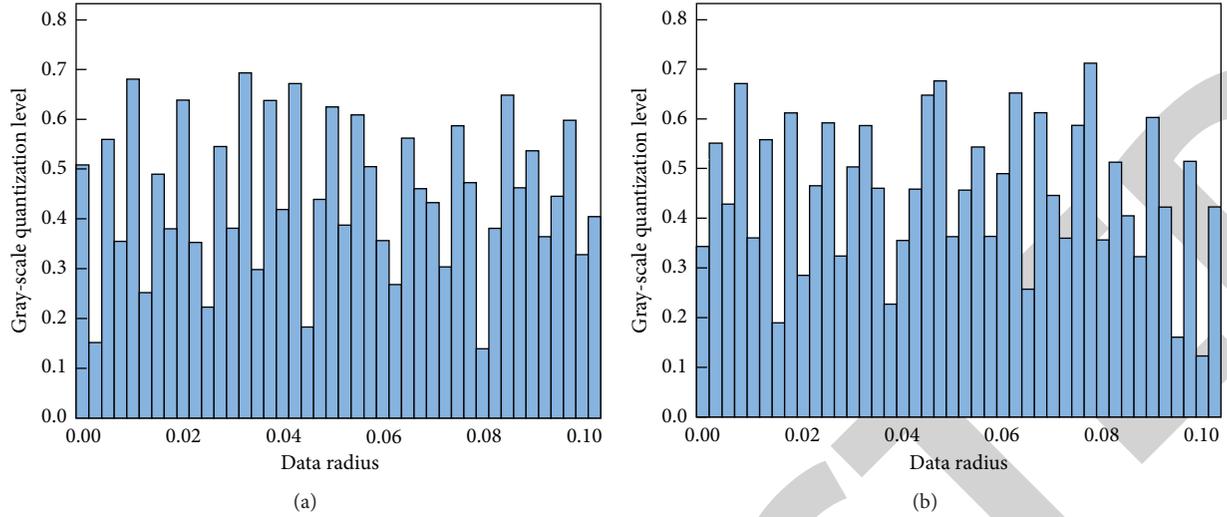


FIGURE 2: Gray-scale quantization level of digital image data with permutation matrix algorithm (a) and subimage averaging algorithm (b).

center it is closer to, or which cluster range is likely to fall within. Therefore, it is necessary to establish a discriminating boundary that divides the feature space. Mathematically, it is a problem of establishing a discriminating function [15]. The establishment of the distance discriminating function is based on the premise that the spectral features of the ground objects are distributed in a cluster manner in the feature space, that is, it is assumed that the probability distribution of the feature vector is not known. The more days there are in these clusters, that is, the greater the density or the closer the distance between the points and the center, the more certain it is that they belong to a category, so the distance between points becomes an important judgment parameter. The distance between points in the same category is generally smaller than the distance between points in different categories. Therefore, when the cluster center is known, the classification work can be completed by using the distance between each point and the cluster center as the criterion for category determination. The results of digital image data with different enhancements based on GIS are shown in Figure 5.

The specific process of digital conversion of analogue images is to perform photoelectric conversion or analogue-to-digital conversion of continuous images, complete the steps of sampling, layering, and quantization, and the main work is to physically measure the gray intensity and spatial density of continuous image fields. The discrete digital signal is encoded into the computer to form a collection of pixels in the plane, which is stored in the computer as a two-dimensional matrix. Although image understanding has made considerable progress in the research of theoretical methods, it is a relatively difficult research field and there are many difficulties. As humans themselves still have little understanding of their own visual processes, computer vision is awaiting. People are further exploring new areas. Owing to this, image processing theory and technology have received extensive attention from all walks of life [16]. The main task of current image processing is to study new processing

methods, construct new processing systems, and open up wider application areas. The generation of digital images is usually through the spatial sampling of physical images to obtain a digital array. The generated digital array is used to reconstruct an image that can be displayed and processed on a computer, and this process is called discrete digitization of the image. From the point of view of the convenience of image input and output, the square lattice is the most advantageous and widely used.

**4.2. Calculation Classification.** The demand for high-precision data has led to the development of high-precision digital image data processing. GIS can help image data processing personnel avoid errors and inconveniences caused by traditional image data processing subjective factors and emergencies. Based on the geospatial model, starting from the basic fixed-point and frequency modulation work, the work speed is improved with the support of various automated equipment, and the analysis accuracy of the measurement data and the scientific degree of application are improved with the support of cloud computing and cloud storage. Through the completeness of the GIS functions, it is possible to achieve full coverage of the content of digital image data processing, so that the overall image data processing can be realized in a reasonable, orderly, standardized, and controllable manner. Each area displayed in a digital image has the characteristics of field attributes and multiple attributes. When displaying the field attributes, technicians can use technical means such as grading density values, symbols, and colors to make the image appear to be scattered. All in all, it is the most basic requirement of modern digital image data processing to use different representation methods for different geographic display types to improve the collection and processing speed and efficiency of dynamic geographic information conditions. Average  $p(x_i)$  and  $r(x_i)$  of different distance measures in digital image data is shown in Figure 6.

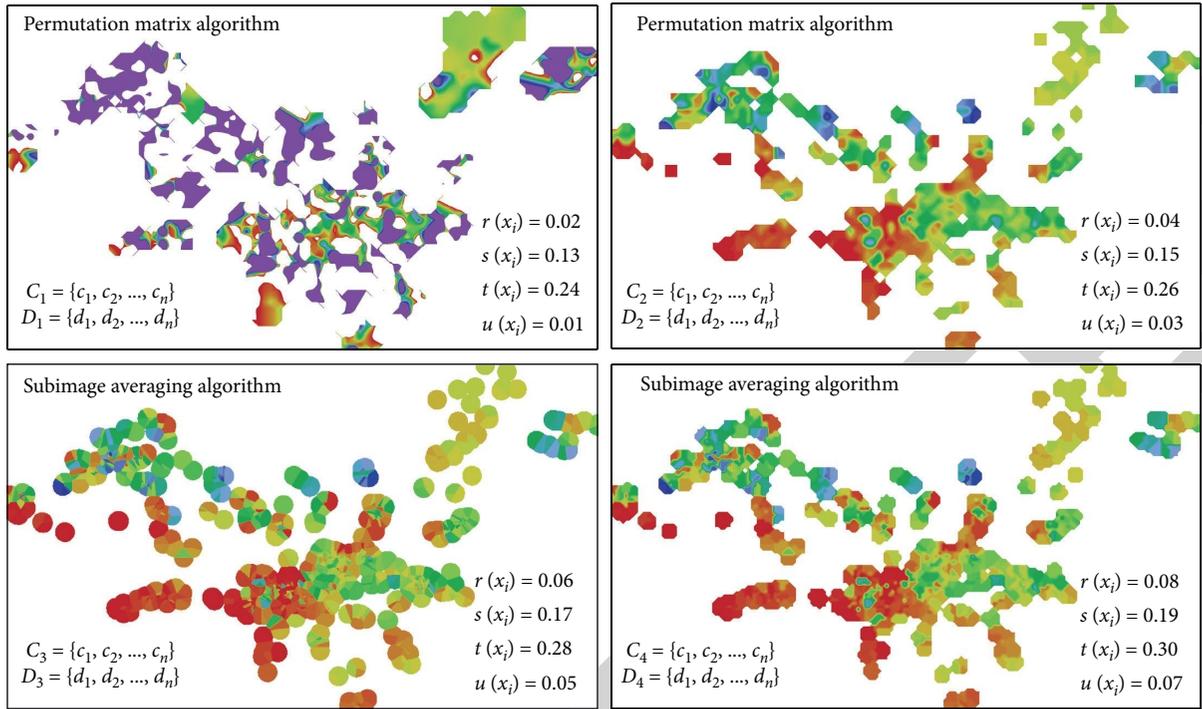


FIGURE 3: Processing methods for digital image data with different data structures based on GIS.

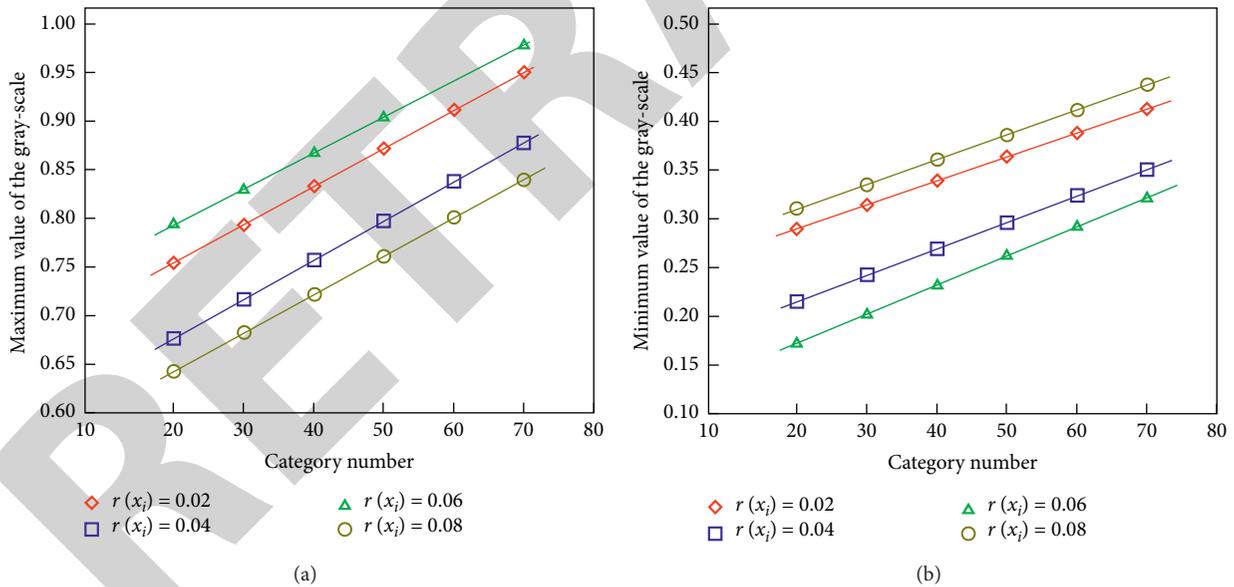


FIGURE 4: Maximum (a) and minimum (b) values of the gray scale in digital image data with different  $r(x_i)$  values.

With the increasing development and improvement of image processing technology, many image algorithms have been applied to image denoising and image restoration. In order to be able to evaluate the image quality after algorithm processing, image quality evaluation has become a research hotspot in the neighborhood of image information engineering. Image quality evaluation is an important part of image processing, which mainly includes subjective evaluation methods and objective evaluation methods. The

processing of the permutation matrix algorithm requires mathematical operations on the pixels. In the process of operations, the pixel values must be added, subtracted, multiplied, divided, and compared. These operations will generate corresponding floating-point numbers, and these floating-point numbers will enter the next step. In a one-step operation, this will make it impossible to achieve [17]. The original data of the image is of integer type, it should be converted to single-precision floating-point first and then

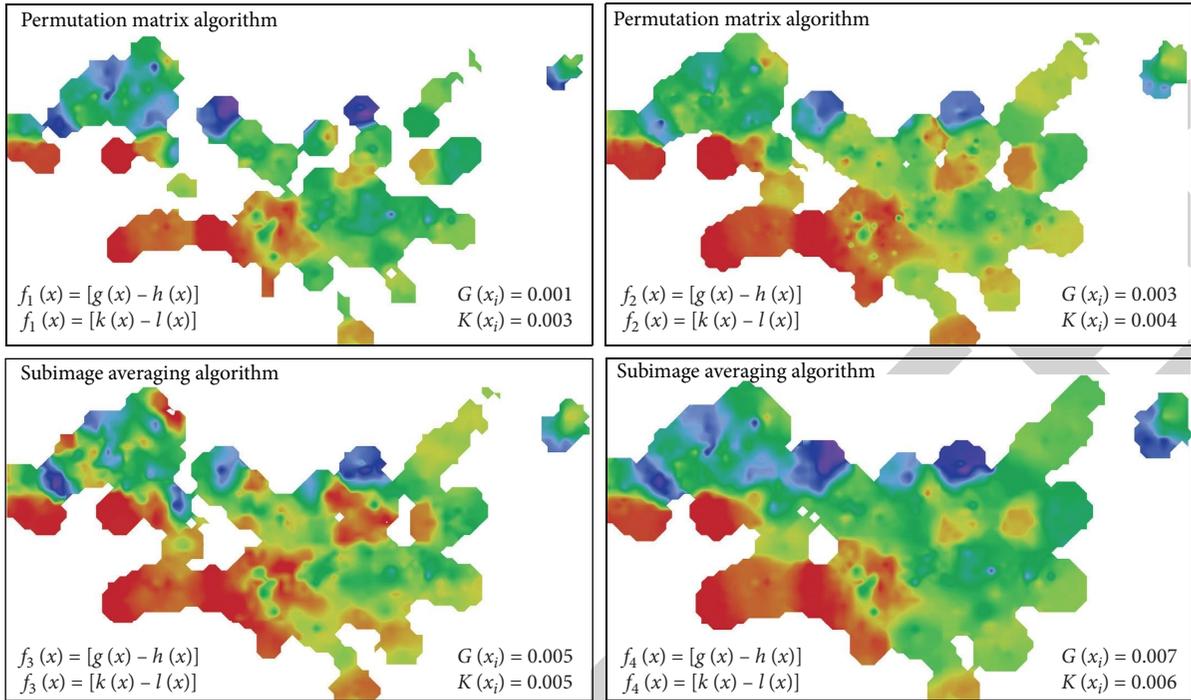


FIGURE 5: Processing methods for digital image data with different enhancements based on GIS.

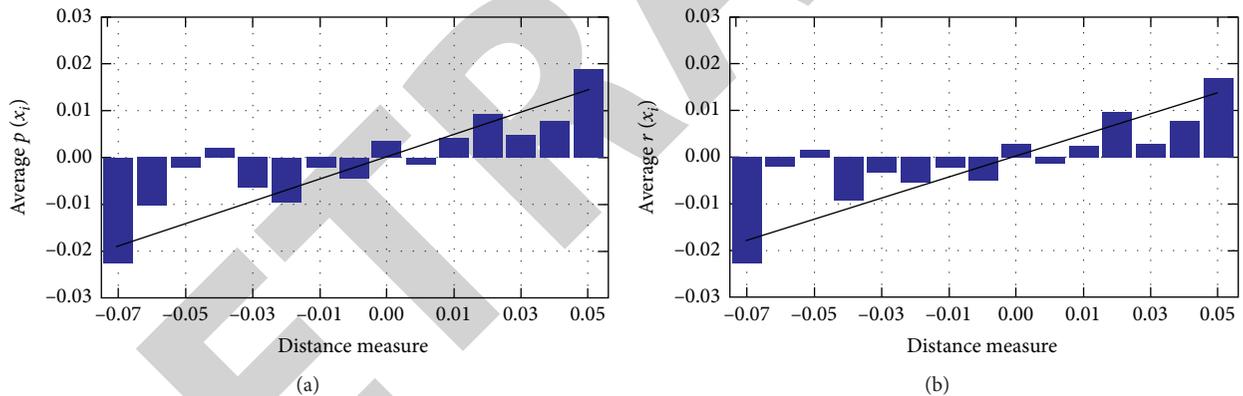


FIGURE 6: Average  $p(x_i)$  (a) and  $r(x_i)$  (b) of different distance measures in digital image data.

the subsequent operations should be performed. Subjective evaluation is to evaluate the image based on the subjective feelings of the observer. The subjective quality scoring method is the most representative subjective evaluation method for image quality. It judges the image quality by normalizing the observer's score. The subjective evaluation method can be divided into two types: absolute evaluation and relative evaluation. The methods are the ultimate recipients of images, and the results of subjective evaluation can most directly reflect the observer's subjective feelings on images and are the most accurate and reliable method in image quality evaluation. The results of digital image data with different calculation classifications based on GIS as shown in Figure 7.

Digital image data processing is in the process of converting an image signal into a digital signal. General images

are analogue images, that is, the information on the image is a continuously changing analogue quantity. For such analogue images, only analogue processing methods can be used for processing, and computers cannot accept and process analogue signals [18]. They can only be stored and processed by transforming continuous analogue signals into discrete digital signals. For this reason, computer image processing is often referred to as digital image data processing. The digital image database system belongs to a relatively independent data service center in the system, which supports the data requirements during the operation of the entire system and is very important in the entire system. Good digital image data backup arrangements play a very important role in the safety of the entire system. Differential processing means that all data that has changed since the last full backup can be stored. When the differential processing is restored, the

media that needs to be completely processed and the latest differentially processed media. The GIS is the key to this system, and the database as the core of the information system plays an important role. In order to prevent accidental power failure, the database management system should have system protection capabilities, which is necessary to back up the corresponding database data and restore the database when necessary.

## 5. Simulation Experiment and Result Analysis

*5.1. Simulation Design.* The GIS can collect the distribution of space objects in detail, which is of great significance for digital image data processing. After the complete data collection, the GIS can also perform corresponding graphical data analysis and calculations and analyze the digital image environment, the distribution of spatial objects within the digital image, and the distribution of spatial objects around the digital image. For example, the GIS can collect a certain community and the road conditions around the community and can analyze in detail the reasonable distance between the community and the road during the construction of the community, so that the buildings of the community can be constructed in a sustainable and reasonable manner. And for the terrain surveying and mapping at the time of digital image construction, the data collection and analysis of spatial objects by the GIS can reasonably carry out the construction planning of the terrain. Compared with the traditional digital image planning, it is more reasonable and has certain accurate data and they support to ensure that digital image data processors make reasonable data processing, which can better promote the processing of digital images. Advances in science and technology have made GIS more refined, with powerful positioning functions and precise navigation. The influx of a large number of people in the process of digital imaging construction, traffic problems are also particularly important in the construction of digital imaging.

The GIS mainly adopts the form of digital images to visually express the information of features and perform operations such as graphic modification, interactive query of graphics and attributes, spatial analysis, and attribute query. The acquisition of digital images is the first problem to be solved in the development of a GIS. Therefore, the methods need to convert the acquired paper images into digital images and use a hand-held tracking digitizer to generate coordinate data by manually selecting points or tracking line segments. Generally used for relatively regular images or images with unsatisfactory original quality, graphics editing software can be used to edit and modify [19]. The methods use a scanner to scan the obtained drawing and save it as a raster image, and then use other image processing software to further process to improve the image quality, such as graphic stitching, noise reduction, thinning, etc., and then register the raster image. They also use this raster image as the base map, and finally remove the raster image to get the required vector diagram. This method requires good drawing quality, a high degree of software automation, and convenient and reliable interactive tools. The resolution

setting during the scanning process is an important factor affecting the image quality. The scanning mode can also be set according to their needs and binary images, gray-scale images, and color images can be obtained, respectively.

*5.2. Result Analysis.* Digital image data processing technology is mainly to transform the image signal into a digital signal in a certain form, and then use a computer to implement processing. The initial stage of this technology is mainly to improve the visual effects of graphics. Owing to the relatively high accuracy of image processing and the large amount of information, this technology is gradually being used in artificial intelligence, aviation, military, and other fields through continuous development. This technology has significant characteristics and the information source it acquires is often a two-dimensional data. This type of data generally requires very high computer storage space and speed. The processing technology of digital images is the same as that of ordinary voice information technology. In contrast, in terms of information transmission, the frequency band requirements are not very high, and the image compression technology is not too high. In image enhancement, it is mainly to change the gray level of the image, improve its contrast, and eliminate edge noise [20]. According to the processing requirements of different spaces, image enhancement methods are generally divided into spatial domain and frequency domain methods. The spatial domain method mainly changes the gray values of pixels to achieve an image enhancement effect. The frequency domain is mainly to transform the image in real time, change the image spectrum in the frequency domain, and achieve an enhancement effect on the image. Training result and distance measures for gray-scale quantization levels of digital image data based on GIS as shown in Figure 8.

The GIS is a computer system that integrates multiple forms of information expression, which integrates functions such as collection, processing, transmission, storage, management, query retrieval, analysis, and expression, and organically combines spatial information and attributes data. The query, retrieve and analyze real objects from two aspects of space and attributes, quickly discover the relationship between the spatial distribution of things and their attributes, and express the results accurately and vividly in various intuitive forms and provide them to user judgment, prediction, and decision-making can significantly improve work efficiency and effectiveness [21–31]. At present, the data models of spatio-temporal GIS mainly include object-oriented spatio-temporal data model, event-based spatio-temporal data model, feature-based spatio-temporal data model, etc. Each data model is a projection of the relationship between the real things it expresses. Therefore, any modeling must be based on a full understanding of the characteristics of the research object, and an appropriate data model should be established according to the characteristics of the research object and the needs of reality. A change in digital image data will trigger a series of complex changes in many other spatial elements, and the original

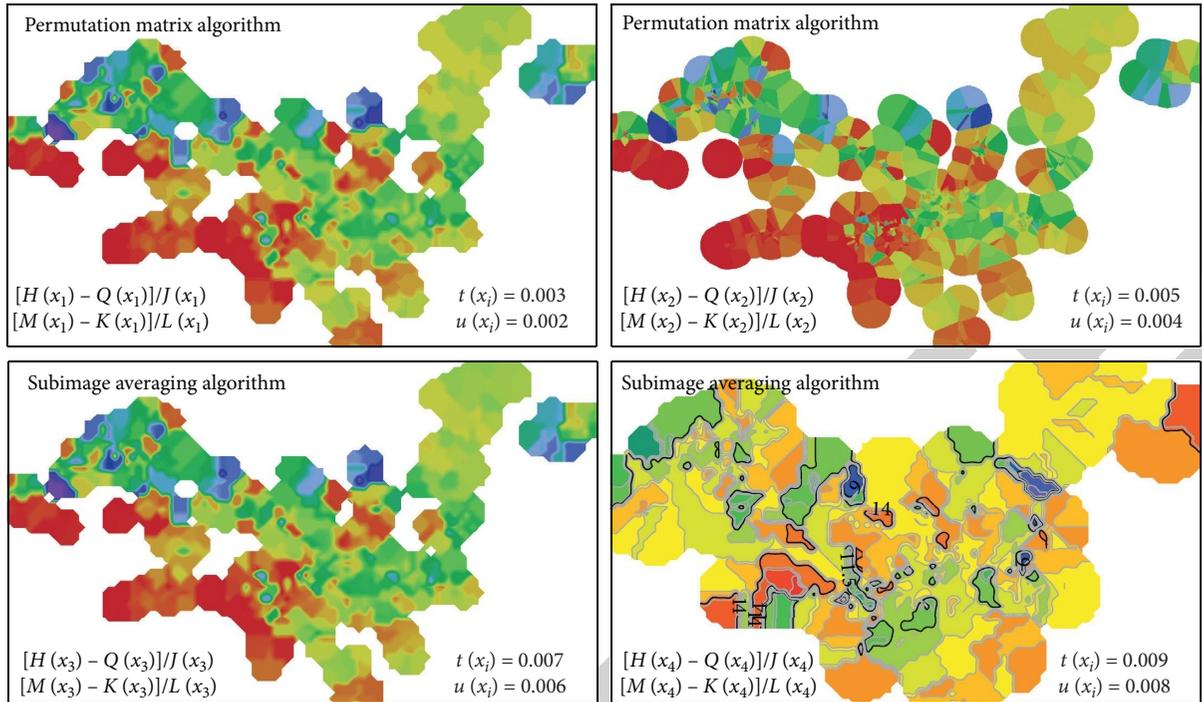


FIGURE 7: Processing methods for digital image data with different calculation classifications based on GIS.

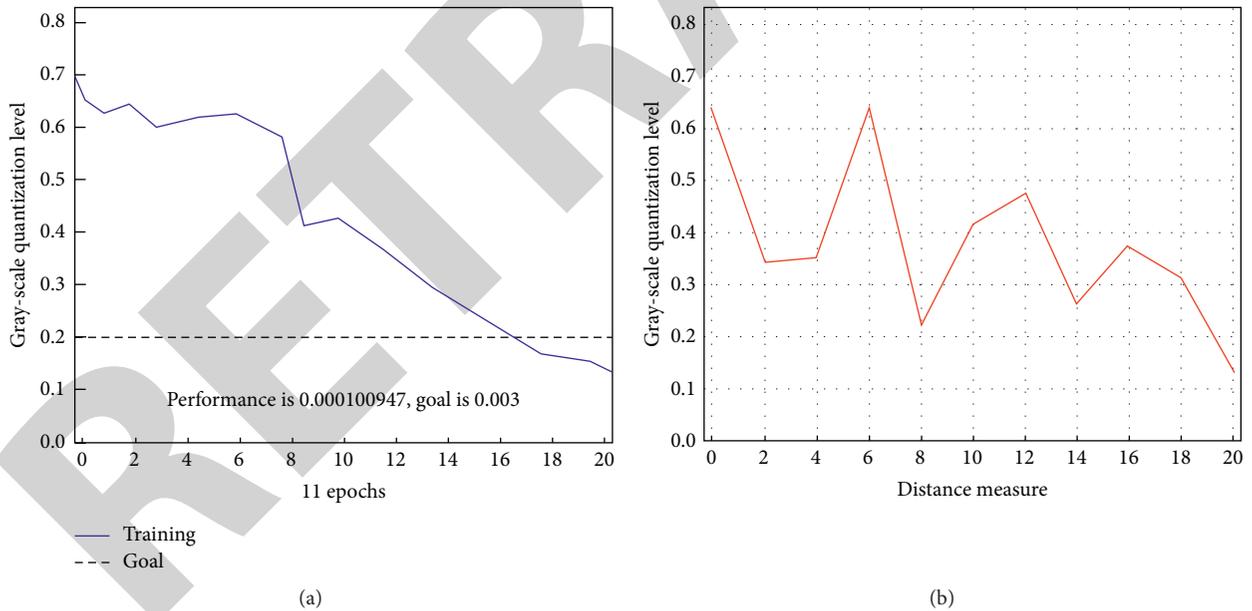


FIGURE 8: Training result (a) and distance measures (b) for gray-scale quantization levels of digital image data based on GIS.

spatial topological relationship will also be broken. The topological relationship of the spatial elements needs to be re-established. If multiple digital image data transformation events occur at the same time, the change of this topological relationship will be more complicated.

## 6. Conclusions

This paper constructed the processing model for digital image data based on GIS, analyzed the data structure and its database establishment for digital image, proposed the

processing methods for digital image data based on GIS, performed the enhancement processing and calculation classification of digital image data, and finally conducted a case analysis and its result discussion. The demand for high-precision data has led to the development of high-precision digital image data processing. The GIS can help image data processing personnel avoid errors and inconveniences caused by traditional image data processing subjective factors and emergencies. Image coding compression technology can reduce the amount of data describing the image in order to save image transmission, processing time, and reduce the memory capacity occupied. General images are analogue images, that is, the information on the image is a continuously changing analogue quantity. For content with regular gray distribution in the image, such as background, edge, and texture, these features are identified through local pixel statistics of the image, and some idealized assumptions of computer graphics are introduced, such as image background high-level smoothness and edge jumps. The processing of the permutation matrix algorithm requires mathematical operations on the pixels. In the process of operations, the pixel values must be added, subtracted, multiplied, divided, and compared. The study results show that the proposed processing methods for digital image data based on GIS can perform analogue-to-digital conversion of continuous images, complete the steps of sampling, layering, and quantization and then encode the obtained discrete digital signal into the computer to form an in-plane collection of pixels. The study results of this paper provide a reference for further researches on the processing methods for digital image data based on GIS. Further researches should determine the search area of the current image can greatly reduce the amount of calculation, improve computing speed, and alleviate the morbidity of the single-frame image super-resolution problem by introducing some ideal conditions to obtain a unique solution.

### Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

### Conflicts of Interest

The authors declare that there are no conflicts of interest.

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