Research Article

Optimization Method of Spatial Layout of Marine Industry Based on Cloud Computing

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Received 21 June 2022; Revised 6 September 2022; Accepted 19 September 2022; Published 4 October 2022

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With the continuous expansion of the marine economy, a large number of problems have been encountered in the spatial layout of the marine industry, such as space intensification, low space utilization, unreasonable industrial structure, poor management system, inadequate scientific research and innovation capabilities, poor ecological environment, poor load balance, and large resource consumption, etc. In response to these problems, this study proposes to reoptimize the spatial layout of the marine industry on the basis of cloud computing. On the basis of collecting the Hilbert values of all data, all nodes are arranged in the order of construction time to improve the Hilbert R-tree structure. Then the idea of clustering is introduced to avoid data overlap. Using the spatial correlation coefficient, the access control model of the marine industry spatial layout platform is established to optimize the marine industry spatial layout under the background of cloud computing. When using the method proposed in this study, the time consumption was about 4 seconds when the number of blocks increased to 5000. Compared with 11 seconds and 7 seconds when using the other two methods, the proposed method greatly reduces the time consumed by the number of pieces of ocean remote sensing images in different query ranges under the ocean information cloud platform. The proposed method also shows good performance in the encryption and decryption test process of the pairing method. In summary, the feasibility and effectiveness of the proposed method in the optimization of the marine industry spatial layout is confirmed, which provides a suitable theoretical basis for the optimization of the marine industry spatial layout.

1. Introduction

The ocean is an important environment for human existence, and the sustainable development of human society is inseparable from a healthy marine environment. In recent years, with the economic development, land resources have been gradually developed. Currently, the ocean has become an important research direction for the resource industry of various countries. The development of marine economy has risen to a national strategic level, including developing marine resources and marine economy, protecting the marine ecological environment, firmly safeguarding national marine rights and interests, and building a marine power [1, 2]. After entering the 21st century, countries have vigorously promoted the construction of seaport infrastructure, scientifically planned the logistics system of sea-land combined transportation, and continuously improved the application level of information technology in the marine industry [3–6]. The marine economic industry has begun to take shape, and various marine emerging industries with high technology content and huge development potential have come into being. This has laid a solid foundation for the comprehensive development of the marine economy. However, it should be noted that there are still many deficiencies in the marine economy, such as the low proportion of marine economy in regional GDP, the low level of marine industry development, and the application and efficiency of marine science and technology and information technology [7, 8]. The coordinated development of sea and land needs to be further strengthened and improved. Therefore, it is particularly important to study and optimize the spatial layout of the marine industry.
After decades of development, China’s marine industrial structure has achieved a first-class improvement, and the structural system has been initially perfected in some areas. However, there are still some problems in the internal structure of the industry and the front-end development of the industry in some regions, such as unreasonable development methods, low level of science and technology, insufficient quality of employees, poor load balance, and high resource consumption. In this study, the marine industry structure is considered to be the result of a systematic mechanism. The optimization of the substructure not only is a static process but also must be continuously adjusted during the optimization process. Therefore, it is necessary to propose a more reasonable and efficient optimization method of spatial layout of marine industry [9]. In recent years, with the development of science and technology, cloud computing technology has gradually been used in people’s lives. Unlike existing Internet environment and distributed computing environment, the core concept of cloud computing technology is service. It is a new computing service model, a new business service model, and a new service support platform for optimizing the spatial layout of the marine industry. As a new computing service model, cloud computing allows users to obtain computing resources and information services required for optimizing the spatial layout of the marine industry through a simple interface. Cloud computing technology has been rapidly developed, popularized, and applied and achieved significant economic and social benefits [10–12]. It has attracted increasing attention from government, research institutions, information companies, and various commercial institutions. To this end, a cloud computing-based optimization method for marine industry spatial layout is proposed. And while optimizing the spatial distribution system of the marine industry, it constantly adjusts and innovates the marine comprehensive management system and increases government support and management. In response to the national policy call to further promote the strategic goal of “rejuvenating the sea with science and technology,” it provides a new perspective for strengthening the construction of the marine industry [13, 14].

In this study, the main body of the text is divided into three parts. The first part proposes the spatial layout optimization method of marine industry based on Hilbert R-tree under cloud computing background. In this part, the structure of Hilbert R-tree is introduced in detail, and then the optimization method of marine industry spatial data based on Hilbert R-tree is introduced. The second part discusses the specific method of optimizing the spatial layout of the marine industry. In this part, the optimization of the spatial layout of the marine industry is systematically analyzed based on the spatial correlation coefficient. Then, the access control model of the cloud platform for optimizing the spatial layout of the marine industry is established, and finally, the implementation of the optimization method for the spatial layout of the marine industry in the cloud computing environment is introduced in detail. The third part presents the experimental analysis and results part, and the optimization method proposed in this research is verified. The purpose of this research is to optimize the existing spatial layout and structure of the marine industry, thereby promoting the development of the marine economy.

2. Spatial Layout Optimizing Method of Marine Industry Based on Hilbert R-Tree under Cloud Computing

2.1. Hilbert R-Tree Structure. The development of data center technology, Internet technology, and information terminal technology based on cloud computing provides information technology support for the theory and practice of cloud computing [15]. Cloud computing technology integrates massive hardware in the data center [16]. Various computing resources such as software and network are virtualized, so that users can call information service resources on demand without paying attention to the configuration, scheduling, and evolution of computing resources. Internet technology provides the necessary basic platform support for the development of cloud computing. All services of cloud computing need to be provided for cloud users through the Internet [17]. Information terminal technology provides a friendly human-computer interaction environment for cloud users to use multisource information services in the context of cloud computing conveniently and efficiently. Users can obtain the required services on demand through simple operation.

Since the development of Hilbert R-tree is based on R-tree, the spatial layout of marine industry contains some features of R-tree. R-tree belongs to a high-dimensional multilevel balance tree. The “area criterion” is used to define the minimum circumscribed rectangle in the marine industrial space [18], and its structure is shown in Figure 1.

In Figure 1, the numbers 1 to 12 represent the root node. The Hilbert curve belongs to a continuous curve full of marine industrial space, which can traverse all points in the space, and the mapping distance of points close to the curve is short. Hilbert R-tree is a static R-tree built on this mapping relationship. Any data point can be mapped to a value on the Hilbert curve, and then these points are arranged in ascending order. The distribution of root nodes is shown in Figure 2.

Since the Hilbert curve can reflect the distance information of high-dimensional data of marine industrial spatial layout, the information with small difference in Hilbert value is also very close in the high-dimensional space of marine industrial spatial layout [19]. To this end, the leaf nodes of the R-tree are constructed. The process of establishing the Hilbert R-tree is as follows:

Step 1: Obtain the Hilbert value of the real data on the spatial layout of all marine industries.

Step 2: Arrange the spatial layout data of marine industry in ascending order combined with its own Hilbert value.

Step 3: Assuming level \( L = 1 \), if there is unprocessed spatial layout data of marine industry, build a new R-tree node and save the previous \( C_i \) data to this node.
Step 4: If there are nodes higher than 1 on the layer, sort all nodes according to the construction time, $L = L + 1$. Thus, the two-dimensional Hilbert structure of the spatial layout of marine industry is obtained, as shown in Figure 3.

### 2.2. Spatial Data Optimization of Marine Industry Based on Hilbert R-Tree

Through analysis of R-tree efficiency, it can be seen that reducing leaf node area and enhancing leaf node data aggregation can reduce the coincidence between R-tree coverage and nonleaf node MBR, so as to improve the search performance of Hilbert R-tree. Therefore, this study introduces the idea of clustering to make the Hilbert r-leaf node area smaller, so as to avoid the overlap between nonnodes.

The clustering and grouping process of marine industry spatial data in GIS is as follows:

**Step 1:** Obtain the maximum number of groups $k_{\text{max}}$ and ensure $n/k_{\text{max}} \geq m$, where $n$ refers to the number of spatial targets of marine industry, and $m$ refers to the minimum number of subtargets to be included in the node.

**Step 2:** Take $k = 2$ as the starting condition until the number of $k_{\text{max}}$ packets, conduct grouping according to the following methods: select $k$ targets and assign them to $k$ subsets, respectively, as the seed targets of these subsets, take the maximum sum of the distances between $k$ targets as the selection criterion, and take the center of $k$ targets as the collection center at the same time.

**Step 3:** Take the clustering idea as the grouping criterion for selecting the remaining targets; add the targets to the set according to the “nearest” principle followed by updating the set center.

**Step 4:** Repeat the previous step until the remaining targets are fully allocated to $k$ sets. The evaluation function is calculated, and the coverage area and coincidence area of marine industry spatial layout are taken as evaluation indexes.

**Step 5:** Complete data clustering for the number of partition clusters with the lowest evaluation function value. Based on the above clustering, the process of optimizing the spatial layout data of marine industry by using Hilbert R-tree is as follows:

**Step 1:** Take MBR as the center and use the above clustering method to obtain $K$ clusters. Suppose $M$ represents the maximum number of entities that any node in the Hilbert R-tree can carry, and $N_i (i = 1, 2, ..., k)$ represents the number of cluster nodes.

**Step 2:** Perform the following operations on the generated $K$ clusters: obtain the Hilbert values of the entity target MBR in the class and rank them from small to large. Combined with the above sequence, the clustering of the number $\leq M$ of marine industry spatial layout data is not processed, so that it can automatically form a leaf node. For clusters higher than $M$, grouping is carried out. When the total number of marine industry spatial layout data in the cluster is higher than $M$, a new leaf node is formed. Finally, each cluster set obtains $\geq \lfloor N_i / M \rfloor$ leaf nodes, and the leaf nodes’ overall number is $\geq \lfloor (N_1 + N_2 + ... + N_k) / M \rfloor$.

**Step 3:** Take the newly generated node as the new clustering target [20]. The Hilbert values are clustered by the above clustering methods. Repeat steps 1 and 2 to form the upper layer nodes until the number of clusters generated is lower than $M$, and complete the spatial layout data optimization of marine industry.
3. Optimization Methods of the Spatial Layout of Marine Industry

3.1. Optimization Analysis of Marine Industry Spatial Layout Using Spatial Correlation Coefficient. Firstly, the features are analyzed according to the acquisition means of optimization of spatial layout of marine industry, the features of marine science as well as its processing process; secondly, the environment of cloud computing and mixed cloud storage mode applicable to optimization of spatial layout of marine industry storage are put forward, and the mixed cloud storage mode and optimization of spatial layout of marine industry are formally defined [21, 22]; finally, the spatial correlation coefficient is used to optimize the spatial layout of marine industry under cloud computing background, and the data with high correlation are stored in the same or neighbor data center. The specific process is shown below:

In this study, the diversified acquisition methods and means for optimization of spatial layout of marine industry are summarized from space-based aspects, foundation aspects, shore-based aspects, and underwater aspects. Various monitoring equipment and instruments’ observation elements and corresponding data formats are summarized. The features of optimization of spatial layout of marine industry are analyzed. The set of public cloud in mixed cloud storage mode existing in optimization of spatial layout of marine industry center is recorded as \( P_{abc} = \bigcup_{i=1}^{n} \{ P_{abc_i} \} \), and the storage space of optimization of spatial layout of marine industry center set \( P_{abc} \) in public cloud storage is recorded as \( +\infty \). The collection of optimization of spatial layout of marine industry centers in private cloud storage is recorded as

\[
P_{rNC} = \bigcup_{i=1}^{n} \{ P_{rNC_i} \},
\]

where \( P_{abc_i} \) represents the optimization of spatial layout of marine industry center numbered \( i \); \( C_i \) refers to the storage space of the optimization of spatial layout of marine industry center \( P_{rNC} \), under cloud computing background.

Marine data model: The optimization of spatial layout of marine industry model is recorded as \( R(A_0, A_1, \cdots, A_k) \), indicating the attribute set of optimization of spatial layout of marine industry, where \( A_0 \) and \( A_1 \) indicate the longitude attribute and latitude attribute of optimization of spatial layout of marine industry, respectively [23].

Marine shoreline data model: the model of marine shoreline data is as below:

\[
L = (B_0, B_1),
\]

where \( B_0 \) and \( B_1 \) indicate the longitude and latitude information of ocean data, respectively.

Ocean dataset: Ocean dataset \( D \) is a triple, which can be expressed as follows:

\[
D = (R, S, \sigma),
\]

where \( R \) represents the ocean data model under the background of cloud computing; \( S \) represents the file size of marine dataset \( D \); \( \sigma \) represents the sensitivity of optimization of spatial layout of marine industry, of which the calculation expression is

\[
\sigma = \frac{H - \sqrt{y_j^2 - y_i^2}}{H},
\]

where \( H \) indicates the threshold of the sensitive range for the optimization of the spatial layout of the marine industry. When the distance from the point to the marine shoreline is smaller than \( H \), the point sensitivity is calculated. \( y_j \) represents the attribute of marine data; \( y_i \) represents the marine shoreline data’s longitude attribute.

Space saturation: the private cloud data center’s space saturation is calculated as follows:

\[
\theta = \frac{S_i}{\sigma},
\]

where \( S_i \) represents the storage space applied by the private cloud data center at present. The system is triggered when the storage space saturation \( \theta > \mu \) of the marine data center under the background of cloud computing; then execute the optimization of spatial layout of marine industry. \( \mu \) represents the threshold of the saturation of the marine data center.

Use the relevant index to analyze the optimization of spatial layout of marine industry under the background of cloud computing, and layout the storage based on the optimization of spatial layout of marine industry in the mixed cloud storage mode.

Spatial correlation coefficient of optimization of spatial layout of marine industry: the spatial correlation coefficient of optimization of spatial layout of marine industry refers to the attribute \( A_m \) correlation in spatial position, i.e., longitude and latitude \( (A_{0i}, A_{1j}) \), where \( 2 \leq m \leq k \).

In the research on the spatial correlation of optimization of spatial layout of marine industry, the correlation index is the most commonly used, which is divided into global and local correlation indexes. The working principles of the two are detailed below:

(1) The global correlation index is adopted for measuring the spatial correlation degree of monitoring data in the neighbor spatial range of the optimization of the spatial layout of marine industry. Assuming that \( x_i \) refers to the element value of the \( i \)-th monitoring point in a certain sea area, \( (x_i - \bar{x})(x_j - \bar{x}) \) reflects the similarity of element values and determines the proximity relationship \( W_{i,j} \) and element value similarity \( C_{i,j} \) between monitoring points at neighbor locations. The calculation expression of global correlation index is as follows:

\[
I(D) = \frac{\sum_{i=0}^{n} \sum_{j=1}^{n} W_{i,j} (x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=0}^{n} \sum_{j=1}^{n} W_{i,j}},
\]

where \( S \) is the standard deviation of \( D \).
Among them:

$$S^2 = \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2,$$

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i.$$

(7)

The value of global correlation index \( I(D) \) is within \([-1, 1]\). If the global correlation index \( I(D) \) is within \((0, 1]\), there is a spatial correlation between the element value of optimization of spatial layout of marine industry and the spatial location of optimization of spatial layout of marine industry and vice versa; if \( I(D) = 0 \), it is proved that the element value of optimization of spatial layout of marine industry does not have spatial dependence on the spatial distribution of optimization of spatial layout of marine industry.

(2) The calculation expression of local correlation index is

$$I_i = \frac{(x_i - u)}{m_0} \sum_j w_{ij} (x_j - u),$$

where \( w_{ij} \) represents the adjacency matrix for optimization of spatial layout of marine industry [24]. \( u \) indicates the average of the same element of monitored values within a sea area; summing \( j' \) indicates that all monitoring stations next to a monitoring station in the sea area should be included in calculation; \( m_0 \) indicates the monitoring value of a monitoring station in the sea area, of which the calculation expression is

$$m_0 = \frac{\sum (x_i - u)^2}{n}.$$

(9)

According to results obtained by calculating the local correlation index of optimization of spatial layout of marine industry through formula (10), a positive \( I_i \) value represents that there is an element value in the sea area presenting spatial agglomeration. Otherwise, this indicates that there is no similar spatial agglomeration of element values in the sea area. The standardization formula of adjacency matrix \( w_{ij} \) for optimization of spatial layout of marine industry is shown below:

$$Z(I_i) = \frac{I_i - E(I_i)}{\sqrt{V_{X_{AR}}(I_i)}}$$

(10)

The global and local autocorrelation analysis of optimization of spatial layout of marine industry can be obtained by calculating the global and local correlation indexes, respectively. The quantitative expression of the correlation coefficient of optimization of spatial layout of marine industry is given by using the above working principles:

3.2. Access Control Model of Cloud Platform for Spatial Layout Optimization of Marine Industry. As can be seen from the previous description, once the data to be processed or the users in the access system of the platform for spatial layout of marine industry become very large with the growth of the access system, the management and maintenance of access rights will become very difficult. To figure out the availability and compatibility of the existing platform for spatial layout optimization of marine industry, and fully combine the efficiency of attribute-based ciphertext access control scheme in the management of platform for spatial layout of marine industry and the technical advantages of the rapid deployment of docker container virtualization, a platform for spatial layout optimization of marine industry supporting container virtualization is constructed, so as to improve the efficiency of management and deployment of access control model.

The processes of establishment and initialization, the key generation process, the encryption process, and the decryption process of the access control model of the cloud platform for the spatial layout optimization of marine industry are as follows:

(1) Establishment and initialization process of access control model of platform for spatial layout optimization of marine industry: firstly, \( p \) order bilinear group \( G_0 \) with generator \( g \) is selected by the access system of the cloud platform for spatial layout optimization of marine industry. Then, the random parameter \( a, b \in Z_p \) is selected. After that, the public key \( P_K \) and master key \( M_K \) of the platform for spatial layout optimization of marine industry access system are calculated as follows:

$$P_K = G_0, g^h = g^\beta, e(g, g)^a.$$  

(12)

(2) Key generation process of access control model of cloud platform for spatial layout optimization of
marine industry: the subject obtains user attribute set \( S \) from the attribute authority, and the attribute authority generates the key \( S_K \) for it. The system selects \( r \in Z_p \), \( r_j \in Z_p \) in a random manner, and \( j \in S \) is any attribute in the user attribute set. \( S_K \), indicating private key, is calculated as follows:

\[
SK = (D = g^{(r+j)\beta}, \forall j \in S: g^j \cdot H(j)^r \cdot D_j = g^j), \tag{13}
\]

where \( H(j) \) refers to a hash function, mapping any attribute \( j \) in the user attribute set \( S \) to a point on the bilinear group, which can be realized in combination with the mapping function in the bilinear group operation library or by itself.

(3) Encryption process of access control model of cloud platform for spatial layout optimization of marine industry: the set of access policies in standard CP-ABE algorithm is represented by tree structure. Each leaf node in the tree indicates an attribute, and each nonleaf node refers to a threshold value, indicating the logical combination of child nodes. Therefore, the access control strategy of the cloud platform for the spatial layout optimization of the whole marine industry can be expressed at the root of the tree. Firstly, the system chooses the order \( d_x \) of a polynomial \( q_x \) for each node \( x \) from the root down in the policy tree and sets it to be the threshold \( k_x \) value of node \( x \) minus 1. Then, \( s \in Z_p \) is selected for root node \( R \) randomly to meet \( q_{R}(0) = s \). After that, \( d_x \) other points are selected in a random manner to complete the setting of polynomial \( q_B \) by polynomial interpolation algorithm. For other nodes \( x \) except the root node, there is

\[
q_x(0) = q_{p(x)}(I_{\text{index}}(x)), \tag{14}
\]

where \( p(x) \) indicates that the parent node \( I_{\text{index}}(x) \) of node \( x \) returns \( x \) as its parent node.

(4) Decryption process: The decryption process is carried out recursively. Firstly, let \( z \) be any child node of \( x \); \( D_z \) \((C_T, S_p, x)\) is called for all child nodes of \( x \) and \( F_z \) when returned. Let \( S_p \) be the size, and \( k_z \) is used to store the combination of all child nodes \( z \) of \( F_z \neq \Pi \). If there is no such set, \( F_z = \Pi \). Combined with the above processes, an attribute-based access control model is constructed.

Attribute authority is in charge of all attributes under the environment of cloud computing. Users can obtain the corresponding user attribute set from one attribute authority or obtain each subset of the user attribute set from multiple attribute authorities and then integrate it into a complete user attribute set. The attribute authority performs the key generation process in the attribute-based encryption method for key generation of the user. After receiving the user’s access request, the access control execution point extracts the user key contained in the request, and then the access control decision point judges the access request. The access structure used in the process of access policy matching is transformed from the attribute set based on the access policy. If the user’s key meets the access control set of spatial layout data of the visited marine industry, the access request is allowed; otherwise, the access request is rejected. The access control execution point and access control decision point can be placed on the cloud server or the user, which depends on the specific needs of the actual scheme and the security level to be achieved.

3.3 Implementation of Optimization Method of Spatial Layout of Marine Industry under the Background of Cloud Computing. \( \tau \) feasible solutions are constructed in the solution space of optimization of spatial layout of marine industry, and \( x_1, x_2, \ldots, x_{\tau} \) represent \( \tau \) central nodes to be selected for optimization of spatial layout of marine industry.

(1) Initializing the initial population of the spatial layout, which can be expressed as

\[
X^0 = \{X^0_1, X^0_2, \ldots, X^0_{\tau}\}, \tag{15}
\]

where \( X^0_i \) refers to the position of the \( i \) firefly in the \( g \) generation, \( i \in \{1, \tau\} \).

(2) Establishing the relationship between the absolute brightness \( L_i \) of firefly \( i \) and the objective function value of the optimization of spatial layout of marine industry: Generally, the absolute brightness of firefly is described by the objective function of optimization of spatial layout of marine industry. The better the objective function, the greater the absolute brightness value of firefly. Its expression is as follows:

\[
\begin{align*}
L_i &= f(X_i^g), \\
&= C_e - S^e, \\
f(X_i^g) &= C_e - S^e, \tag{16}
\end{align*}
\]

where \( C_e \) represents the available resources of the e server of the optimization of spatial layout of marine industry center under the environment of cloud computing; \( S^e \) refers to the migration cost for optimizing the spatial layout of marine industry from server e to server o, and its calculation expression is shown below:

\[
c^e_o = \eta \times r^e_o, \tag{17}
\]

where \( \eta \) represents the migration cost per minute for the optimization of spatial layout of marine industry; \( r^e_o \) represents the time required for optimizing the spatial layout and migration of marine industry.

(3) \( \beta_{ij} \) is relevant to the distance between two fireflies and their absolute brightness. When \( L_i > L_j \), the definition of attraction between two fireflies is the same as that shown in formula (16).

(4) Updating the fireflies’ location according to the attraction between them: Firefly \( j \) which is attracted by firefly \( i \) moves to firefly \( j \); then the position update of firefly \( j \) is can be expressed as follows:
\[ X_j(T + 1) = \omega X_j(T) + \beta_j \left( X_j(T) - X_j(T) \right), \]  

(18)

where \( X_j(T) \) refers to firefly \( i \)'s spatial position during \( T \) iterations. The increasing iterations lead to the gradual decrease of distance between fireflies and the gradual increase of mutual attraction. To prevent fireflies from oscillating back and forth or near local extreme points, the adaptive inertia weight \( \omega \) for the optimization of spatial layout of marine industry is added, and its calculation expression is

\[ \omega(T) = f(X_j^0) \times \exp(T). \]  

(19)

After multiple iterations, firefly’s personal experience is gathered at the position with the largest absolute brightness value, that is, the optimal objective function of optimization of spatial layout of marine industry. Nevertheless, the optimal solution obtained according to the algorithm may not be the best solution for saving bandwidth. Some available suboptimal solutions should be obtained and the solution that can save bandwidth should be further calculated. To solve this problem, the last \( N \) global optimal position of the last iteration of the firefly algorithm should be recorded. Through the objective function of bandwidth in the optimization of spatial layout of marine industry under the environment of cloud computing, the minimum value of bandwidth is calculated as the optimal solution, and the optimization of spatial layout of marine industry is finally realized.

4. Experimental Analysis

The efficacy of the cloud computing-based optimization method of spatial layout of marine industry is compared with the methods of Bergamasco et al. [26] and Zheng [27]. The main frequency of the processor is 3.40 GHz and the memory is 4 GB, which runs on JRE. During the experiment, the correlation coefficient of optimization of spatial layout of marine industry is set to 256 bits. The access deadline is defined as 150 ms. Due to the limited experimental conditions, it is impossible to obtain real marine information spatial data. Based on the core metadata elements of the data set of the marine information cloud platform, this paper simulates and constructs a metadata table containing different temporal-spatial scales and different types of marine information data within a certain range, with a total of 2 million records, which is used as the basic data for constructing the primary authorization optimization of the marine information cloud platform. At the same time, the pixel size of remote sensing image with LM resolution of an area is 256 × 256. A total of 202257 marine remote sensing images are used as the basic data for building a cloud platform accessing the spatial layout data authorization optimization of marine industry.

Firstly, a set of blocks of remote sensing image of marine information containing 3000 spatial authorization information is randomly generated. Based on 8 groups of query ranges and three different cloud platforms access optimization methods of spatial layout of marine industry, the performance of marine information data is tested, respectively. Figure 4 shows the number of blocks of ocean remote sensing image in various query ranges under the ocean information cloud platform and the time consumed by the corresponding three methods.

Figure 4 shows the time consumed by the three methods with the number of marine remote sensing image blocks corresponding to different query ranges. With the continuous increase of the number of ocean remote sensing image blocks, the time consumed by the three methods generally increases, among which the method proposed by Bergamasco consumes the most time, and when the number of blocks increases to 5000, the time consumed is about 11 seconds. For the method proposed by Zheng, when the number of blocks increases to 5000, the time consumption is about 7 seconds. For the method proposed in this study, when the number of blocks increases to 5000, the time consumption is about 4 seconds. Compared with the other two methods, the method adopted in this study greatly reduces the time consumption. In order to further compare the influence of the three methods on the spatial layout, the three methods were, respectively, used for the access experiment of the marine industry spatial layout information cloud platform. The experimental results are shown in Table 1.

As shown in Table 1, it can be seen that, among many rating indicators, the three methods have relatively high comprehensibility, information control flow, and applicability, but there are gaps in the three indicators of time limit, location constraint, and platform integrity constraint. The methods proposed by Bergamasco et al. and Zheng do not support the indicators, and only the method proposed in this study supports them. The method proposed by Bergamasco et al. actually integrates the spatial layout of the marine

![Figure 4: Test results of data access control performance of marine industry spatial layout information grid.](image-url)
information platform into specific roles, assigns specific locations to corresponding roles, and then associates roles with spatial information. This method also confirms that hierarchical spatial roles can construct a method to implement multilevel security policies. However, this method only considers the relationship between roles and space, rather than the relationship between objects and space; it cannot be applied to ocean information clouds. Zheng’s method shares many similarities with that of Bergamasco et al. For example, topics have certain permissions that are consistent with the task lifecycle. They only have permissions when the task is executed. When the task is executed, the corresponding permission is revoked. However, according to Zheng’s method, when using task-centric access control, the subject’s access to the object is closely related to the task, and the permission life cycle is the same as the task. Once the task is over, the subject’s special access to the object is revoked. When the task is not executed, the access control subject of the object is determined according to its own security flag. This permission has a long-term relationship with the permission in the task. Access rights do not change until the security token remains the same. However, there is still no convincing evidence for the safety of the optimization method. In contrast, the access control method of the information cloud platform for the spatial layout of the marine industry has better control performance and better comprehensive efficiency.

After comparatively analyzing the three methods based on the above seven indicators, four indicators are proposed to further compare the three methods based on the cloud computing-based optimization method for the establishment of marine industry spatial layout. The analysis results are shown in Table 2.

As shown in Table 2, for the index of object priority protection, only the cloud computing method proposed in this study is supported, and the other two methods are not supported. The method proposed by Bergamasco et al. has low context information. In terms of initiative, the methods proposed by Bergamasco et al. and Zheng show a certain degree of passivity. In terms of inspection mechanism, Zheng’s method shows high dependence, and the cloud computing in this study shows high independence. Although the method of Zheng [27] does not specifically point out the collaborative environment, it takes the task as the main goal, and the solution is mainly realized through management means. For example, for the role that completes the task through cooperation, if the role cannot meet the access requirements of the task, the requirements for a security attribute can be relaxed by using “inspection room” and “confidential room.” Many additional requirements are put forward for security administrators. They not only need to formulate execution policies under special circumstances, but also need to determine preconditions and execution conditions for the implementation of policies and supervise these execution conditions. The method of Bergamasco et al. [26] involves the requirement of two-way information flow through checking components, which raises additional requirements. In this method, the uncertainty of illegal operation in access is measured mainly through information entropy theory. Besides, the docker container virtualization technology and the ciphertext access control scheme are used for joint control over cross domain and cross level access of users. Compared with the above methods, the advantage of the proposed method is that it considers the new requirements in the cloud platform environment; the access rights are task and context related. The proposed method supports two-way controlled marine information flow.

In terms of ciphertext marine information under the cloud platform, the performance of the proposed method is measured for access control of the marine information cloud platform according to encryption and decryption time. A user in the receiver set is randomly selected to generate the corresponding private key. The decryption method is executed to obtain the key, and the time to obtain the proposed method is tested, as shown in Figures 5 and 6.

Figure 5 shows the relationship between the encryption time and the number of blocks of ocean remote sensing images in different query ranges. Figure 6 shows the relationship between decryption time and the number of blocks.
of ocean remote sensing images in different query ranges. In the encryption process, when the number of blocks is small, the time consumption is extremely small; when the number of blocks increases to 1500 blocks, the time consumption increases significantly. When the number of blocks increases to 3000, the encryption time is about 23 seconds; in the decryption process, the decryption time is proportional to the number of blocks, and the decryption time increases with the increase of the number of blocks. When the number of blocks increases to 3000, the decryption time also increases to about 22 seconds. In summary, the increase in the number of ocean remote sensing image blocks leads to the increase in the execution time of ocean information encryption and decryption methods under the cloud platform. Among them, the growth rate of the encryption method increases with the increase of the number of blocks, which is consistent with the theory of the proposed method. In addition, due to the application of cloud computing technology, virtualization is realized at the operating system level, directly multiplexing the operating system of the local host and decrypting the efficiency of the accessed remote sensing image information block. The ocean data has been greatly improved, and there is a linear relationship with the number of pieces of ocean remote sensing images. Also, the time consumption is much lower than that of the encryption method.

5. Conclusion

Since the “18th National Congress of the Communist Party of China,” marine resource development, marine economy, and marine ecological environment have been emphasized at a strategic level. However, the current marine industry still faces a lot of problems; for example, there is still room for improving the spatial layout of the marine industry. In view of these problems, this study optimizes it on the basis of cloud computing. The research results show that, through the comparison of the number of marine remote sensing image blocks in different query ranges under the marine information cloud platform and the time consumed by three methods, with the continuous increase of the number of marine remote sensing image blocks, the time consumptions of the three methods are generally increasing. Particularly, the method proposed by Bergamasco consumes the most time; when the number of blocks increases to 5000, the time consumed is about 11 seconds. For the method proposed by Zheng, when the number of blocks increases to 5000, the time consumption is about 7 seconds. For the method proposed in this study, when the number of blocks increases to 5000, the time consumption is about 4 seconds. Compared with the other two methods, the proposed method greatly reduces the time consumed by the number of pieces of ocean remote sensing images in different query ranges under the ocean information cloud platform. When studying the encryption and decryption performance of the proposed method, it is found that, with the increase of the number of oceanographic remote sensing image blocks, the encryption and decryption time is also increasing. When the number of blocks increases to 3000, the encryption time is about 23 seconds and the decryption time is about 20 seconds. To sum up, it shows that the proposed method can effectively optimize the spatial layout of the marine industry, and it can lay a solid theoretical foundation for the proposal of the optimization planning measures of the marine industry layout.

Data Availability

The data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.
Acknowledgments

The research was supported by Basic Scientific Research Business Fee Research Project of Heilongjiang Provincial Colleges and Universities in 2021, 3D Design and Motion Analysis of Bridge CNC Gantry Milling Machine (no. 145109402), Development of NC Machine Tool Machining Process Simulation Monitoring System Based on Digital Twin (no. 145109404), and Key Research Projects of Qiqihar Science and Technology Bureau in 2022, Development of Single Frequency Green Laser in Medical Equipment (no. ZDGG-202109).

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