

## *Retraction*

# **Retracted: Intelligent Development of Tourism Resources Based on Internet of Things and 5G Technology**

### **Advances in Multimedia**

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] S. Liu and Y. Hu, "Intelligent Development of Tourism Resources Based on Internet of Things and 5G Technology," *Advances in Multimedia*, vol. 2022, Article ID 2202414, 10 pages, 2022.

## Research Article

# Intelligent Development of Tourism Resources Based on Internet of Things and 5G Technology

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In order to improve the effect of intelligent development of tourism resources, this paper combines the Internet of Things technology and 5G technology to carry out intelligent development of tourism resources to improve the recommendation effect of modern tourism resources. Meanwhile, this paper analyzes the basic knowledge of array signal DOA estimation to get the definition of narrowband signal. Simultaneously, this paper proposes a subspace-based DOA estimation algorithm based on the actual needs of tourism resource management, and uses the observed array data to construct a covariance matrix. Then, this paper decomposes the covariance matrix, and then performs DOA estimation. In addition, this paper constructs an intelligent development system of tourism resources based on the Internet of Things and 5G technology. It can be seen from the experimental research that the intelligent development system of tourism resources based on the Internet of Things and 5G technology proposed in this paper has good tourism resource management and development effects.

## 1. Introduction

Today, the pursuit of individuality and self-expression has become fashionable, and tourism is no exception. At present, quite a lot of tourists, especially the young and middle-aged as the most important part of the tourism market, are no longer satisfied with the way of group travel but are inclined to “self-service travel”. They hope to choose the travel destination they are most interested in according to their personal hobbies and interests, use their favorite means of transportation, and travel freely. Therefore, the personalization of tourism behavior has become the general trend of its development. However, the new propensity to consume creates an obvious contradiction. On the one hand, travel is already a behavior with a wide range of people, and many of them want to make their own travel plans without being constrained by group travel [1]. On the other hand, the formulation of a scientific tourism plan should at least reasonably organize the six elements of “travel, food, accommodation, tourism, shopping and entertainment” according to a certain theme. At the same time, it is neces-

sary to formulate a good schedule to ensure that tourists can obtain the maximum travel experience in the shortest time and at the lowest economic cost. This includes tourism geography, tourism psychology, tourism aesthetics, tourism economics, tourism sociology, and other multidisciplinary knowledge. However, it is impossible for tourists to have professional knowledge in various disciplines involved in tourism, so they need professional help [2].

The knowledge base of a tourism expert system is divided into dictionary base and rule base. The dictionary base includes a noun base and a fact base. The noun base is used to store the keywords and codes describing the recommendation or analysis results of the tourism expert system, including the tourism resources of the tourism system, tourism service resources, and other proper nouns and their explanations [3]. The fact base stores the parameters that tourists may choose to describe the various resource demands in the tourism system [4]. The rule base is used to store all the rules, including the rule precondition library and the rule conclusion library. The rule preware-house stores the preconditions corresponding to each

conditional rule. According to the parameter values and possible results of tourists' actual demand for various tourism resources, the rule conclusion library is divided into rules from demand parameters to demand parameters and rules from demand parameters to conclusion [5]. In the intelligent tourism information system, the tourism expert system includes the tourism expert planning subsystem and the tourism expert recommendation subsystem. For each subsystem, an independent rule base is defined and an independent rule table is established [6].

In the expert system, reasoning is based on the existing knowledge in the knowledge base, which is a kind of knowledge-based reasoning. A computer that implements knowledge-based reasoning constitutes an inference engine. As one of the cores of the expert system, the inference engine's main task is to timely determine the selection and application of knowledge in the process of problem solving. The control strategy of the inference engine determines the choice of knowledge, and the inference mode of the inference engine determines the application of specific knowledge [7]. The inference direction of the inference engine is used to determine the driving mode of inference, which is divided into forward inference, reverse inference and hybrid inference. No matter which direction of reasoning, the system generally requires a knowledge base for storing knowledge, a database for storing initial known facts and problem states, and an inference engine for reasoning [8].

Forward reasoning is the reasoning from the fact to the goal, also known as fact-driven reverse reasoning. It does not start reasoning according to the input facts, and checks the reasoning rules in the knowledge base in turn. If the premise of the rule is true, the rule is employed, thereby generating new facts., it is also possible that new rules are adopted, so that until all relevant rules in the knowledge base are detected, all possible results are obtained, and the inference result is a set of facts [9]. Forward reasoning is suitable for obtaining all possible outcomes from a limited set of facts. Reverse reasoning is the reasoning from goals to facts, also known as goal-driven. Reverse the reasoning process, formulate hypotheses, and use the knowledge in the knowledge base to judge whether the hypotheses are true or false. If it is true, record the knowledge used for explanation; if false, put forward a new hypothesis again, and then make a judgment; judge when the reasoning can be ended; and if necessary, ask the user about the situation [10]. Reverse reasoning does not need to consider rules unrelated to the overall goal, but the choice of goal is blind, and it is suitable for applying to the range of known problem solutions, and the number of solutions is small. The basic idea of the hybrid reasoning strategy is to first select the initial target through data-driven help, and then use the target to drive to solve the target; or first assume a target for reverse reasoning, and then use the information obtained in the reverse reasoning to carry out forward reasoning to deduce more many conclusions. It avoids the blindness of target selection and overcomes the blindness of reasoning in data-driven [11]. The tourism expert system, including the tourism expert recommendation subsystem and the tourism expert planning subsystem, adopts different reasoning rules, respectively. The

tourism expert recommendation subsystem adopts a mixed reasoning strategy. First, forward reasoning is carried out, starting from the initial conditions, and reasoning towards the final goal of the problem to be solved. If the premise of the rule is true, the rule is adopted until each initial condition finds the corresponding goal [12]. Since there may be logical relationships such as "and", "or," and "not" between the initial conditions, the inference results may not be ideal. Then, these goals are used to drive the reverse inference, and the reasoning is repeated, and finally the tourists are satisfied with the conclusion. The tourism expert planning subsystem is driven by facts and adopts forward reasoning [13].

Smart tourism service is one of the cores of smart tourism, emphasizing the use of smart technology to provide tourists with higher-quality services and improve their service levels. Generally speaking, before traveling, tourists will first search for the attractions they want to visit on the Internet, and then arrange the itinerary according to their own time after making a decision. At the same time, relevant staff of tourist attractions will collect and sort out travel records and travel information, and formulate targeted travel plans to attract the attention of tourists [14]. Tourism enterprises can design specific travel plans that meet the needs of tourists in advance through the online tourism system platform, provide tourists with multiple optional tourist attractions, and create humanized tourism services. Secondly, in the context of big data, the smart management model will update tourism information at any time, provide tourists with the latest tourism trends, provide more service space for the tourism industry, and promote the development of the tourism industry [15]. In the smart management model, tourism industry staff can comprehensively collect and organize tourists' booking status, identity information, and travel information to ensure the security of tourists' personal information, and establish travel information and travel platform websites across the country to realize travel information sharing. Finally, the smart tourism service platform based on big data is a powerful tool for the conversion of new and old kinetic energy, which helps tourism companies to achieve precise marketing, improve the quality of tourism services, and meet the personalized and differentiated needs of tourists [16]. At the same time, the development of tourism will often lead to the development of catering, accommodation, transportation and other service industries, thereby driving regional economic development. The smart tourism service based on big data improves the management level of the tourism management department, solves various new problems encountered in the development of the tourism industry more scientifically and quickly, and can effectively protect the legitimate rights and interests of tourists. In addition, the smart tourism service platform has a public welfare nature, providing free tourism reference data for tourists and tourism enterprises, improving the quality of tourism public services and achieving high social benefits [17].

Building a smart tourism management model is inseparable from perfect information equipment, but from the current point of view, smart tourism is still in the early stage of development. Although the tourist attractions have solved

the problem of weak signal of network tourism resources, they have not fully realized the full coverage of the radio tourism resources signal, which brings a lot of inconvenience to tourists. In terms of mobile platform construction, the level of tourism management informatization is low, and there are defects in data collection and information processing. Especially during holidays, the number of tourists is large, and the intelligent platforms of many scenic spots cannot intelligently process information, making it difficult to effectively evaluate the number of tourists, which will reduce the tourist experience of tourists [18].

This paper combines the Internet of Things technology and 5G technology to carry out the intelligent development of tourism resources, so as to improve the recommendation effect of modern tourism resources and improve the effect of tourism development.

## 2. Array Tourism Resource Signal Model

*2.1. Basic Building.* We consider a total of  $M$  omnidirectional array elements in the antenna array in space, and there are  $D$  tourist resource signal sources in the far field at the same time. First, there must be a calibration location. For the sake of convenience, this paper regards the position of the first sensor array element as the origin of the coordinates processed by the algorithm. After obtaining this coordinate origin, the expression for the arrival of the  $i$ -th tourist resource signal at the coordinate point is:

$$S_i(t) = z_i(t)e^{j\omega_0 t}, i = 0, 1, \dots, D-1. \quad (1)$$

In Formula (1),  $z_i(t)$  is the  $i$ -th tourism resource signal, and  $e^{j\omega_0 t}$  is the high-frequency carrier frequency that the tourism resource signal propagates in space. In the previous paper, it has been assumed that the tourism resource signal has the characteristics of narrowband, so there are:

$$z_i(t - \tau) \approx z_i(t). \quad (2)$$

Then, the tourism resource signal can be expressed as Formula (3) after the spatial propagation delay of time  $t$ .

$$S_i(t - \tau) = z_i(t - \tau)e^{j\omega_0 t} \approx z_i(t)e^{j\omega_0 t}, i = 0, 1, \dots, D-1. \quad (3)$$

Therefore, without considering any other errors, the spatial tourism resource signal source detected by the  $m$ -th array element is in the form of:

$$x_m(t) = \sum_{i=0}^{D-1} s_i(t - \tau_{mi}). \quad (4)$$

In Formula (4),  $t_{mi}$  is the relative time from the  $i$ -th sensor to the  $m$ -th sensor relative to the calibrated origin array position. According to Formula (3) and Formula (4), the tourism resource signal received by the entire antenna sen-

sor array can be written in the form shown in

$$x(t) = \sum_{i=0}^{D-1} s_i a_i = AS(t) = \begin{bmatrix} e^{-j\omega_0 \tau_{1i}} & e^{-j\omega_0 \tau_{2i}} & \dots & e^{-j\omega_0 \tau_{Di}} \\ e^{-j\omega_0 \tau_{1i}} & e^{-j\omega_0 \tau_{2i}} & \vdots & e^{-j\omega_0 \tau_{Di}} \\ \vdots & \vdots & \vdots & \vdots \\ e^{-j\omega_0 \tau_{Mi}} & e^{-j\omega_0 \tau_{Mi}} & \vdots & e^{-j\omega_0 \tau_{Mi}} \end{bmatrix}. \quad (5)$$

In Formula (5), the direction vector of the  $i$ -th tourism resource signal is  $a_i = [e^{-j\omega_0 \tau_{1i}}, e^{-j\omega_0 \tau_{2i}}, \dots, e^{-j\omega_0 \tau_{Mi}}]^T$ , the array manifold is  $A = [a_0, a_1, \dots, a_{D-1}]$ , the tourism resource signal matrix is  $S(t) = [s_0(t), s_1(t) \dots s_{D-1}(t)]^T$ , and  $[\bullet]^T$  represents the operator for transposing the matrix.

If noise is taken into account, then Formula (4) can be rewritten as follows:

$$x_m(t) = \sum_{i=0}^{D-1} s_i(t - \tau_{mi}) + n_m(t). \quad (6)$$

In Formula (6),  $n_m(t)$  is the noise on the  $m$ -th sensor element of the array, and Formula (5) can be rewritten as follows:

$$X(t) = \sum_{i=0}^{D-1} s_i(t) a_i + N(t) = AS(t) + N(t). \quad (7)$$

In the formula,  $N(t)$  represents the  $M \times 1$ -dimensional additive noise matrix, which can be specifically expressed as the following formula:

$$N(t) = [n_1(t), n_2(t), \dots, n_M(t)]^T. \quad (8)$$

*2.2. Array Geometry.* The research in this paper is based on Uniform Linear Array (ULA) and Sparse Linear Array (SLA). Therefore, the following will give a detailed introduction to the two layout methods of uniform line array and sparse line array.

*2.2.1. Uniform Linear Array.* A schematic diagram of the layout of the uniform linear array is shown in Figure 1.

As shown in Figure 1,  $M$  array elements with a distance of  $d$  are arranged on a straight line, and the position labels of the array elements start from 0 and end at  $M-1$ . An array of this type of arrangement is called a Uniform Linear Array (ULA). It positions the first array element at the origin of the coordinates. When the angle between the incident angle of the target and the formation is 0, the time difference of the tourism resource signal on the  $n$ th sensor relative to the specified origin sensor is:

$$\tau_n(t) = \frac{2\pi(n-1)d}{\lambda} \cos \theta. \quad (9)$$

In the above formula,  $\lambda$  represents the wavelength of the tourist resource signal. Substituting the Formula (9) into the direction vector  $a(\theta)$ , the specific expression of the steering

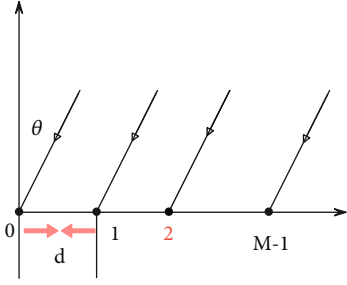


FIGURE 1: Schematic diagram of ULA array.

vector of the linear uniform array can be obtained as shown in

$$\begin{aligned} a(\theta) &= \left[ e^{-j\omega_0 2\pi d/\lambda \cos \theta}, \dots, e^{-j\omega_0 (M-1) 2\pi d/\lambda \cos \theta} \right]^T \\ &= \left[ 1, e^{-j\varphi}, \dots, e^{-j(M-1)\varphi} \right]^T. \end{aligned} \quad (10)$$

In the formula,  $\varphi = \omega_0 (2\pi d/\lambda) \cos \theta$ . From Formula (7), we get:

$$A = \begin{bmatrix} 1 & e^{-j\omega_1 \tau_{1i}} & \dots & 1 \\ e^{-j\varphi_1} & e^{-j\varphi_2} & \vdots & e^{-j\varphi_D} \\ \vdots & \vdots & \vdots & \vdots \\ e^{-j(M-1)\varphi_1} & e^{-j(M-1)\varphi_1} & \vdots & e^{-j(M-1)\varphi_D} \end{bmatrix}. \quad (11)$$

Formula (11) gives the specific representation of the array manifold of the equidistant linear array.

It can be seen that the array flow pattern of ULA has a Vandermonde matrix structure, which allows many array processing algorithms to process signals received by a uniform linear array. The layout form of the uniform line array is simple, and it is also very beneficial to the realization of the project. In the following chapters, a post-processing flow based on Vandermonde matrix decomposition is used in the proposed grid-free DOA algorithm. The specific content will be discussed in detail in Chapter 3.

**2.3. Sparse Linear Arrays.** There are many specific sparse forms of sparse linear arrays. The sparse linear array introduced here is one of them, which can be regarded as a special uniform array. For a uniform linear array with  $M$  array elements, the wavelength of the signal source is denoted by  $\lambda$ , and the distance between the two is  $d = \lambda/2$ . Then, the direction vector  $a(\theta)$  of the  $k$ -th signal source has the following form:

$$a(\theta_k) = \left[ 1, e^{-j2\pi\theta_k}, \dots, e^{-j2\pi(M-1)\theta_k} \right]^T. \quad (12)$$

In Formula (12),  $\theta = -\varphi/2\pi$ . It can be seen that  $\theta_k$  is the frequency of the uniformly sampled complex sinusoid  $a(\theta_k)$ . This is why  $\theta$  is called the frequency parameter.

A sparse linear array can be thought of as a uniform linear array with “missing.”

The red array elements shown in Figure 2 indicate that there are no array elements originally placed at the position. It can be considered that the sparse linear array defined here is a linear array that only uses a subset of the array elements of the uniform linear array. This paper calls it  $\Omega$ , therefore, the set of element position indices  $\Omega \in [M]$  of the SLA array. Without loss of generality, we assume that according to the increasing order of  $\Omega_1 = 1$  and  $\Omega_D = M$ , then the direction vector of the  $k$ -th source represented by  $a_\Omega(\theta_k)$  under the SLA array is:

$$a_\Omega(\theta_k) = \left[ e^{j2\pi(\Omega_1-1)\theta_k}, e^{j2\pi(\Omega_2-1)\theta_k}, \dots, e^{j2\pi(\Omega_D-1)\theta_k} \right]^T. \quad (13)$$

We denote  $\Gamma_\Omega(\theta_k) \in \{0, 1\}^{D \times M}$  as a selection matrix such that the  $j$ -th row of  $\Gamma_\Omega$  contains all 0s, but a single 1 at the  $\Omega_j$ th position. Obviously, there are:

$$a_\Omega(\theta_k) = \Gamma_\Omega a(\theta_k). \quad (14)$$

**2.4. Introduction to Subspace Class Algorithms.** There are many methods for DOA estimation using multi-element arrays, among which the method based on eigendecomposition is a large category. This type of method uses the observed array data to construct a covariance matrix, then decomposes the covariance matrix, and then performs DOA estimation.

The covariance matrix  $R$  obtained from the array data can be mathematically divided into signal subspace and noise subspace, namely:

$$R = U_s \sum_s U_s^H + U_N \sum_N U_N^H \quad (15)$$

In Formula (15),  $[\bullet]^H$  strictly represents the transpose operation of the matrix. You can get:

$$R U_N = A(\theta) R_s A^H(\theta) U_N + \sigma^2 U_N = \sigma^2 U_N \quad (16)$$

According to Formula (16), we can get:

$$A(\theta) R_s A^H(\theta) U_N = 0 \quad (17)$$

The rank of the matrix  $R_s$  is full, and the matrix is a non-singular matrix, so its inverse must exist. Thus, Formula (17) can be transformed into the form of Formula (18):

$$A^H(\theta) U_N = 0 \quad (18)$$

Formula (18) shows that each column in the direction vector matrix  $A(\theta)$  is orthogonal to the noise subspace. Orthogonality is decomposed by the mathematical dimension, so there are:

$$U_N^H a(\theta_i) = 0, \quad i = 1, 2, \dots, D \quad (19)$$

Due to the orthogonal relationship between the

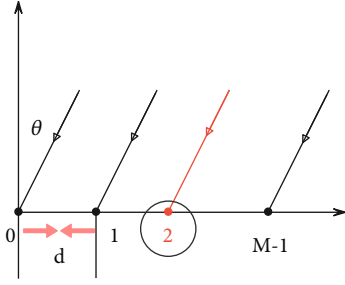


FIGURE 2: SLA array: ULA with missing 3rd element.

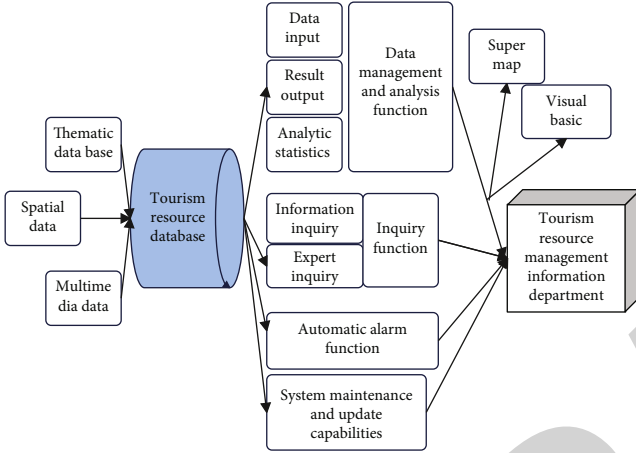


FIGURE 3: Tourism resource management information system.

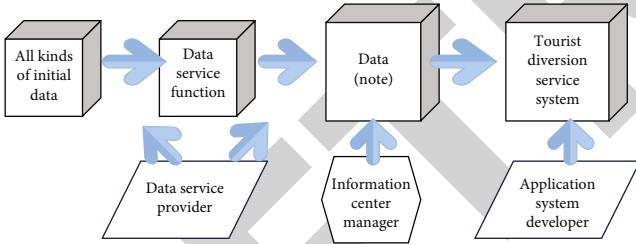


FIGURE 4: Design mode of tourist diversion system for popular scenic spots in scenic spots based on the Internet of Things.

decomposed noise subspace and the tourist resource signal subspace, the spatial spectral function of the entire receiving antenna array can be derived in the form of Formula (20).

$$P_{\text{MUSIC}}(\theta) = \frac{1}{a^H(\theta)U_N U_N^H(\theta)} \quad (20)$$

It can be known from Formula (20) that  $\theta$  is constantly changing in space, and the angle of arrival is estimated by searching for wave peaks. Then Formula (20) can be expressed as formula.

$$\theta_i = \arg_{\theta} \min (a^H(\theta)U_N U_N^H(\theta)) = \arg_{\theta} \min \text{tr}(P_a U_N U_N^H) \quad (21)$$

In the formula, the operation expression  $\arg, \min[\cdot]$  rep-

resents the value corresponding to  $O$  when  $[\cdot]$  obtains the minimum value,  $P$  is the projection matrix of  $a(e)$ , and its specific expression is:

$$P_a = a(\theta)(a^H(\theta)a(\theta))^{-1}a(\theta) \quad (22)$$

According to the above reasoning, the steps of the MUSIC algorithm can be summarized as:

- (1) First, the estimation result of the covariance matrix is obtained from the direction vectors of the  $N$  snapshot tourism resource signals received by the sensor array:

$$R = \frac{1}{N} \sum_{n=1}^N x(n)x^H(n) \quad (23)$$

We eigendecompose the covariance matrix obtained by Formula (23):

$$R = U \sum U^H \quad (24)$$

- (2) In this paper, all the eigenvalues are arranged in descending order, and the space formed by  $D$  large eigenvalues with the same number as the tourism resource signals is selected from the largest to the smallest, which is called the tourism resource signal subspace. Note that this operation is a division above the digit dimension. Next, the space formed by all the remaining  $(M-D)$  eigenvalues is called the noise subspace, and the covariance matrix can be rewritten as shown in Formula (25).

$$R = U_S \sum_S U_S^H + U_N \sum_N U_N^H \quad (25)$$

- (3) In this paper,  $\theta$  is divided into grids in space, and the spectral peak function value of the spatial angle corresponding to each grid is calculated according to the spectral peak expression of Formula (20). The desired DOA estimate is the maximum value of the spectral peak function in the entire grid calculation result. If there are multiple signal sources, know the number of signal sources in advance, and sort the spectrum peaks from large to small. The value corresponding to the number of signal sources represents the required estimation result

2.5. *The Principle of ESPRIT Algorithm.* The computational cost of the ESPRIT algorithm is very low. The rotation-invariant subspace method has many excellent properties in the estimation of direction of arrival, and the ESPRIT algorithm has been widely used in recent years. Moreover,

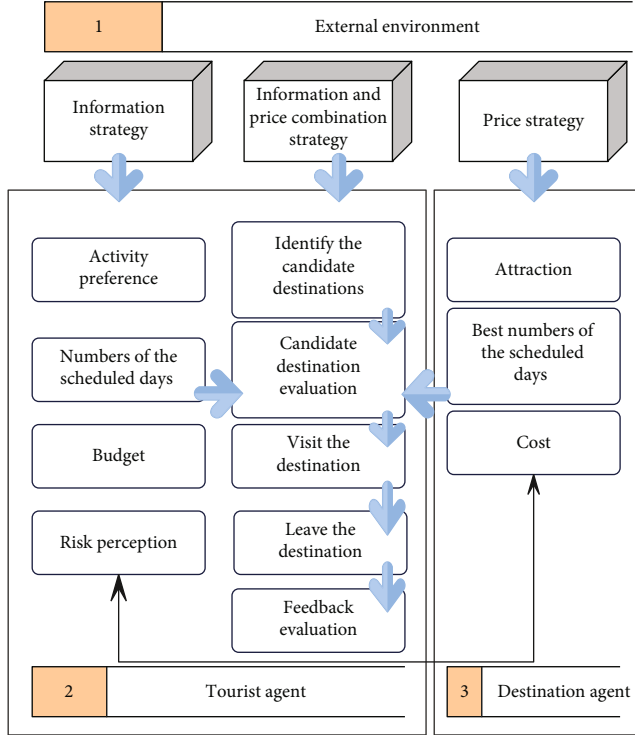


FIGURE 5: Framework diagram of tourist destination selection model based on multiagent.

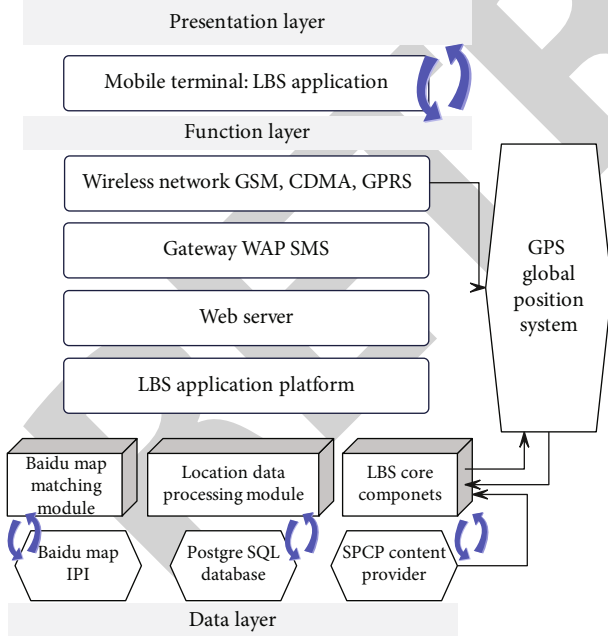


FIGURE 6: Tourism resource collection module.

there have been many variants of algorithms, such as least squares ESPRIT algorithm, overall least squares criterion ESPRIT algorithm, singular value decomposition ESPRIT algorithm, and other variants of RSPRIT algorithm.

It is assumed that two array elements with exactly the same properties are called an even array element, and the

distance between the two array elements between an even array element is  $\Delta$ . We assume an arbitrarily arranged planar array with  $M$  array element pairs. That is, the array actually has  $2M$  array elements, but two array elements form an array element called an even array element. We assume that there are spatial tourism resource signal sources less than the number of even array elements that propagate in space at the same time and are captured by the array, then different tourism resource signal sources can be distinguished by DOA estimation. We assume that the noise is independent white Gaussian noise with variance  $\sigma^2$ . With the above assumptions, an array can be called as two arrays  $Z_x$  and  $Z_y$  whose translations are both  $\Delta$ . The output tourism resource signal on the  $i$ -th array element pair can be expressed as:

$$\begin{aligned} x_i(t) &= \sum_{k=1}^K s_k(t) a_i(t) + n_{xi}(t), i = 1, 2, \dots, M, \\ y_i(t) &= \sum_{k=1}^K s_k(t) e^{j\omega_0 \tau \sin \theta_k / c} a_i(t) + n_{yi}(t), i = 1, 2, \dots, M. \end{aligned} \quad (26)$$

Among them,  $s_k(t)$  is the  $k$ -th signal source received by the subarray  $Z$ , and  $\theta_k$  is the arrival direction of the  $k$ -th tourism resource signal.  $a_i(\theta_k)$  is the array element response of the  $i$ -th array element to the  $k$ -th array element.  $c$  is the speed of light,  $n_{xi}(t)$  and  $n_{yi}(t)$  are Gaussian white noise on the subarrays  $Z_x$  and  $Z_y$ , respectively. The specific expression of the tourism resource signal output by each antenna radiating element of any subarray at time 1 is as follows:

$$x(t) = As(t) + n_x(t), \quad (27)$$

$$y(t) = A\Phi s(t) + n_y(t). \quad (28)$$

In Formula (27) and Formula (28),  $a$  and  $A$  are called direction vector and direction matrix, and the specific values are  $a(\theta_k) = [a_1(\theta_1), a_2(\theta_2), \dots, a_M(\theta_M)]^T$  and  $A = [a(\theta_1), a(\theta_2), \dots, a(\theta_M)]$ , respectively.  $\Phi$  is a  $K \times K$ -dimensional diagonal matrix, and its diagonal elements represent the phase delay of each tourism resource signal source on each radiation unit, which is expressed as:

Among them,  $\mu_k = (\omega_0 \Delta \sin \theta_k) / c, k = 1, 2, \dots, K$ , the matrix  $\Phi$  is the operator that connects the two arrays corresponding to an even array element. That is, (30) means that any one of the two subarrays corresponding to the even array element receives the tourism resource signal multiplied by the operator  $\Phi$  to get the other array to receive the tourism resource signal. The travel resource signal of the entire array consists of two arrays together. Therefore, the output tourism resource signal matrix of the entire array is:

$$z(t) = \begin{bmatrix} x(t) \\ y(t) \end{bmatrix} = \bar{A}s(t) + n_z(t). \quad (29)$$

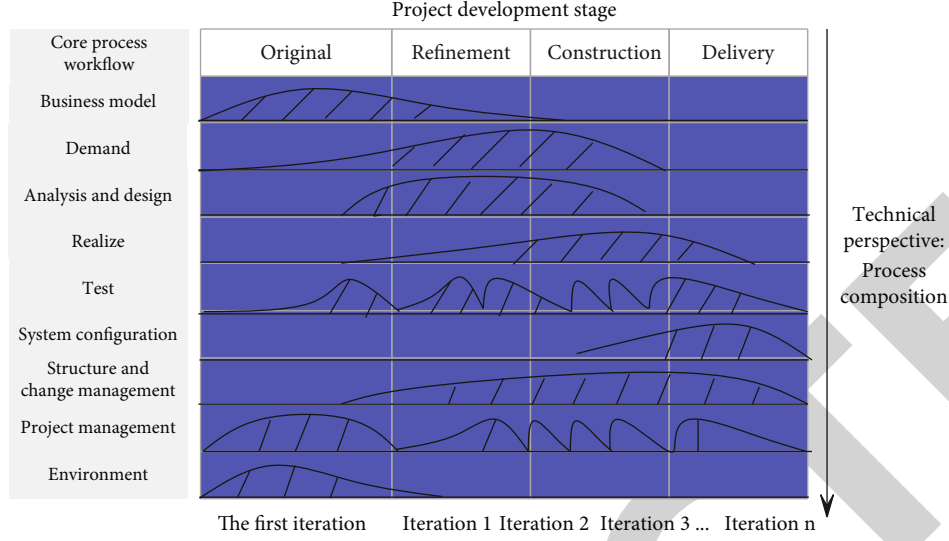


FIGURE 7: Unified development process.

TABLE 1: Setting table of simulation parameters of MUSIC method.

Parameter	Parameter value
Number of array elements	16.0 (units)
Element spacing	0.50 (cm)
The incoming wave direction of source 1	0.0 (°)
The incoming wave direction of source 2	20.0 (°)
The incoming wave direction of source 3	30.0 (°)
Number of snapshots	256

In Formula (29), there are:

$$\bar{A} = \begin{bmatrix} A \\ A\Phi \end{bmatrix}, n_z(t) = \begin{bmatrix} n_x(t) \\ n_y(t) \end{bmatrix}. \quad (30)$$

A matrix with a dimension of  $2M \times N$  can be formed by using snapshot data of consecutive  $N$  moments, and Formula (29) can be matrixed. Therefore, it can be re-expressed in the form of

$$Z = \begin{bmatrix} X \\ Y \end{bmatrix} = \bar{A}S + N_z. \quad (31)$$

In Formula (31),  $Z = [z(t_1), z(t_2), \dots, z(t_N)]$ ,  $S = [s(t_1), s(t_2), \dots, s(t_N)]$ ,  $N_z = [n_z(t_1), n_z(t_2), \dots, n_z(t_N)]$ . In this paper, the covariance matrix is obtained from the observed array data, and then the covariance matrix is decomposed. In the mathematical dimension, the signal subspace and noise subspace of tourism resources can be extracted from the data. First, the autocorrelation matrix of the output matrix  $Z$  of the array data can be obtained as:

$$R_{zz} = E[Z(t), Z^H(t)] = \bar{A}R_{ss}\bar{A}^H + \sigma^2 I. \quad (32)$$

In the formula,  $R_{zz}$  represents the autocorrelation matrix of the tourism resource signal, and the variance of the noise is represented by  $\sigma^2$ . The rank of the autocorrelation is full, and the dimension of its rank is the number of tourist resource signal sources. Of course, this conclusion must be obtained when the source of tourism resources is incoherent. If it is a coherent tourism resource signal, the two subspaces cannot be distinguished in the mathematical dimension, which will reduce the rank. At the same time, because the arrival angle of each tourism resource signal is different, there is no relationship between the columns of  $\bar{A}$ . The autocorrelation matrix  $R_{zz}$  eigendecomposition is:

$$R_{zz} = \sum_{i=1}^{2M} \lambda_i e_{ii}^H = E_s \Lambda_s E_s^H + \sigma^2 E_n E_n^H \quad (33)$$

In Formula (33), the eigenvalues are arranged in descending order. Then, according to the number of tourist resource signal sources, the corresponding eigenvector  $E_s = [e_1, \dots, e_K]$  is drawn into the tourist resource signal space and the eigenvector  $E_n = [e_{K+1}, \dots, e_{2M}]$  into the noise space orthogonal to the tourist resource signal subspace. This shows that there is a matrix  $T$ , and this matrix is unique, so that Formula (34) holds.

$$E_s = \bar{A}T \quad (34)$$

We mathematically divide  $E$  into two parts according to the shift-invariant characteristics of the array, namely  $E_x \in C^{M \times M}$  and  $E_y \in C^{M \times K}$ , and these two parts correspond to two subarrays  $Z_x$  and  $Z_y$  corresponding to an even array element:

$$E_s = \begin{bmatrix} E_x \\ E_y \end{bmatrix} = \begin{bmatrix} AT \\ A\Phi T \end{bmatrix}. \quad (35)$$



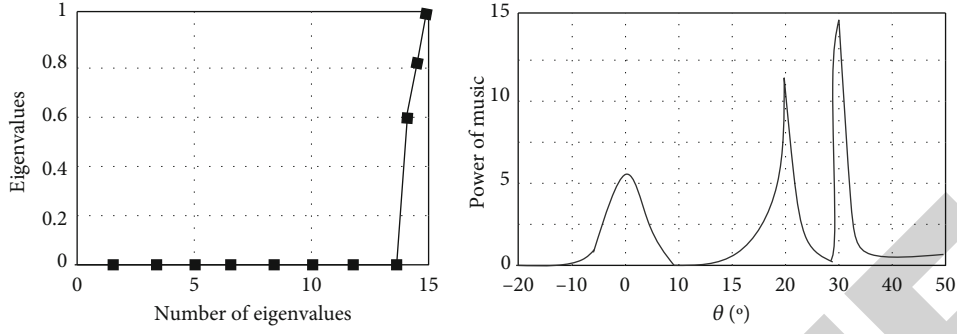


FIGURE 8: Simulation result of MUSIC algorithm.

TABLE 2: The effect verification of the intelligent development system of tourism resources based on the Internet of Things and 5G technology.

Number	Simulation effect	Number	Simulation effect
1	83.52	18	86.14
2	88.21	19	84.65
3	86.70	20	88.20
4	87.51	21	88.14
5	82.48	22	86.45
6	82.96	23	87.84
7	83.68	24	86.24
8	85.76	25	85.74
9	88.63	26	87.11
10	85.51	27	84.35
11	84.35	28	88.24
12	83.35	29	88.19
13	85.63	30	88.56
14	83.69	31	88.15
15	87.44	32	83.91
16	86.25	33	82.86
17	83.17	34	83.76

From Formula (35), we can get:

$$E_Y = E_X T^{-1} \Phi T = E_X \psi. \quad (36)$$

In Formula (36),  $\psi = T^{-1} \Phi T$ . From the analysis, it can be concluded that  $E_X$  and  $E_Y$  form similar subspaces, and the value on the main diagonal of matrix  $\Phi$  is the eigenvalue of matrix  $\psi$ .

According to the above analysis, the steps of DOA estimation by the LS-ESPRIT algorithm based on the correlation matrix can be summarized as follows:

- (1) The algorithm obtains the tourism resource signal matrix  $Z$  from the array and obtains the estimation  $R_{zz}$  of the correlation matrix  $R_{zz}$
- (2) The algorithm performs eigendecomposition on  $R_{zz}$   $R_{zz} \bar{E} = \bar{\Lambda} \bar{E}$ , of which  $\bar{\Lambda} = \text{diag} \{ \lambda_1, \dots, \lambda_{2M} \}$ ,  $\lambda_1 \geq \dots \geq \lambda_K \geq \lambda_{K+1} = \dots = \lambda_{2M} = \sigma^2$ ,  $\bar{E} = [e_1, \dots, e_{2M}]$
- (3) The algorithm estimates the number  $K$  of tourism resource signals
- (4) The algorithm takes the tourism resource signal subspace of the two subarrays corresponding to the eigenvalues of the corresponding number of Zhang Chengven array elements
- (5) The algorithm calculates the eigenvalue of  $F = E_X^+ E_Y$
- (6) The algorithm calculates to reach the estimated value of the angle  $\theta_k = \arcsin \{ c \cdot \text{angle}(\lambda_k) / (\omega_0 \Delta) \}$

### 3. Intelligent Development of Tourism Resources Based on Internet of Things and 5G Technology

Tourist resources have the characteristics of various types, large quantities, wide distribution, diverse geographical combinations, and flexible and changeable market supply and demand. Therefore, in the process of investigation, evaluation, development, planning, dynamic monitoring, and protection of tourism resources as the basis of tourism development, it is necessary to improve the effect of intelligent development of tourism resources through intelligent methods. Figure 3 shows the tourism resource management information system.

When some popular scenic spots are saturated and overloaded, the managers of most scenic spots often resort to artificial current limiting and diversion, which is obviously hysteretic and passive. If tourists are informed in advance through mass media and the Internet, the economic and social benefits of the scenic spot will be affected. The design mode of the tourist diversion system for popular scenic spots in the scenic spot based on the Internet of Things is shown in Figure 4.

This paper designs two types of agents: tourist agent and destination agent. Among them, each destination agent has a different attractiveness level, cost level, and optimal play days for each activity type. The tourist agent makes the decision whether to choose and which destination to choose based on its own preferences, budget and time constraints, and risk perception level. After the tourist agent leaves the destination, it performs feedback evaluation with a certain

possibility and changes the original attractiveness score of the destination, as shown in Figure 5.

The module of tourism resource collection is shown in Figure 6.

As shown in Figure 7, for tourism resource management, the unified process is described in two-dimensional space. The horizontal axis represents the time to formulate the development process, which reflects the dynamic structure of the process and is expressed in terms of cycles, phases, iterations, and milestones. The vertical axis represents the static structure of the process, which is described in terms of activity, workflow, artifact, and role. The life cycle of a RUP consists of 4 sequential phases (Initial phase, refinement phase, construction phase, and delivery phase) along the horizontal time axis and 9 core workflows (includes 6 core “engineering” workflows: business modeling workflow, requirements workflow, analysis and design workflow, implementation workflow, test workflow, and system configuration workflow. And 3 core “support” workflows: configuration and management workflow, project management workflow, and environmental engineering workflow) along the vertical axis, as shown in Figure 7.

#### 4. Simulation Test

The parameter settings used in the simulation are shown in Table 1.

The simulation results are shown in Figure 8.

It can be seen from the eigenvalue results in Figure 8 that three large eigenvalues are obtained. These three large eigenvalues correspond to three peaks in the spectral peaks, corresponding to the three different source angles set. Among them, the angle value is correct, and it should be known that these three peaks represent the level of orthogonality, which has nothing to do with the actual signal-to-noise ratio. The reason is that the three tourist resource signal sources are set with the same signal-to-noise ratio during simulation. The simulation results show that the MUSIC algorithm can successfully resolve incoherent sources.

On this basis, the effect of the intelligent development system of tourism resources based on the Internet of Things and 5G technology is verified, and the results shown in Table 2 are obtained through simulation research.

It can be seen from the experimental research that the intelligent development system of tourism resources based on the Internet of Things and 5G technology proposed in this paper has good tourism resource management and development effects.

#### 5. Conclusion

The intelligent tourism information system combines the functions of the traditional tourism information system and focuses on the construction of the tourism expert system. Moreover, it uses artificial intelligence reasoning and other methods, mainly including knowledge base, database, method base, model base, etc., to achieve according to the different needs of tourists. In addition, it integrates the involved tourism resources and tourism service information

and provides users with a complete and fast personalized solution for different users through the knowledge system. At the same time, it provides tourists with various tourism-related information inquiries, prediction of tourism information, and three-dimensional simulation of scenic spots in tourist destinations, and simulation of tourist travel routes, so that tourists have a well-prepared travel plan. This paper combines the Internet of Things technology and 5G technology to intelligently develop tourism resources to improve the recommendation effect of modern tourism resources. It can be seen from the experimental research that the intelligent development system of tourism resources based on the Internet of Things and 5G technology proposed in this paper has good tourism resource management and development effects.

#### Data Availability

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

#### Conflicts of Interest

The authors declare no competing interests.

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