

Application of the LBS and GIS Integration in Scenic Area

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Abstract
Development of smart scenic spot has received great attention from individuals and enterprises. This paper focuses on the LBS application in resort management and wants to get an innovation technology applying example in China tourism industry. The LBS can embed in the original GIS platform in OCT east, and then it can provide the added-value service such as promptly catch the visitor location, navigate tour itinerary, schedule scenic transportation shuttle. The new findings in this program is a new system model that integrated GIS and LBS has been put to use, therefore, a LBS service network covering the whole OCT East area can be developed. Through the design, field experiment and simulation tests of this model, the program is proved viable for the promotion in the services of OCT East, and could increase the scenic quality of service, enhance visitor satisfaction
Keywords: LBS, Scenic Areas, GIS, Mobile Communication

1. Introduction

Location Based Service (LBS) refers to the use of Information and Communications Technology (ICT) in a tourism attraction to promptly catch the tourists' location, satisfy their request and to supply them with the added-value services. The design and development of LBS in tourism attractions will develop larger commercial space for the tourism attractions [1]. With the development of tourism, the integration of network, tourism information and the system of e-commerce will be critical in promoting the informatization of tourism and the level of tourism sector. LBS is considered as one of the most promising businesses after the development of messages. It has a tremendous market and good profitable prospect [2].

The study focused on the LBS application in scenic areas in China. Because LBS belongs to the new technology in other industries in China, basically there is no related applications in tourism. The authors explore a new technology to achieve the LBS and GIS integration, for the discovery of new knowledge that can be used for the management of scenic areas, such as visitor's scenic diversion and navigation, emergency and evacuation, visitors dynamic capacity in scenic spots, the transport path optimization and so on.

2. Literature review

LBS originated in 1996 when the American FCC required the mobile cellular operators to provide emergency E911 service for the mobile phone users, which resulted in the appearance of LBS [3]. Later, Germany, France, Sweden, Finland, etc. launched the commercial location service with different features respectively. And then the development of Global Positioning System (GPS) and Geographic Information System (GIS) stimulated the imagination of all walks of life about LBS. Many countries' telecom companies began to make use of this service to provide specially tailored service for the clients following the mobile phone users' geographic location. In Asia, the Japanese NTTDoCoMo company began to provide location service for the whole of Japan in the second half year of 2001. KDDI company also began to provide GPS map service in October, 2004. The Korean KTF company began its location service in January, 2002, using the CDMA technology and GPS positioning system; SKT Company then launched its location service in July, using the GPS package terminals to provide map, guiding, and regional information services [4]. Up till now, the LBS has already become one important information service sector. Be it a traditional company for GIS, such as ESRI, Autodesk and Intergraph, or a telecom company, such as Motorola, Eriesson, and Nokia, or other big operational system providers, such as Microsoft, IBM, they are all study LBS as a problem-solver to seize the profitable business market in this new added-value business [5]. All of the above has laid a firm foundation for the application of the result of the critical technology of LBS in all fields.

Besides, some scholars, such as Charis M. and Dimitrois E, have also offered some foresight views about the application of LBS in some specific sectors. They creatively proposed the Location Aware Auction based on LBS to be applied in tourism, which is very significant in the study of the project [6].

Now more Chinese scholars' study has been focused gradually from the development of LBS technology to the realization and perfection of its application. Yang Peiling [4] proposed the category of it application, and Taiwan researcher Shuchih Ernest Chang et al. [7] have done an in-depth research on the tourists' attitude toward and need for the LBS, and come to the conclusion that the tourists' contentment has a positive correlation with the the application of LBS and the provision of the added-value services. They have offered strong theoretical backup for the study. In addition to that, Hu et al. provided the reference model of the system for the study based on the similarities in use between the design idea of the indoor and outdoor positioning of campus LBS platform and its application in tourist scenic spots [8].

Now more new idea and trend of tourism management is the center of management, which has changed "the management-oriented" in the past into "the tourists-oriented" with the appearance of the concept of tourist contentment. The tourist contentment is now taken seriously and receives a lot of attention [9]. Modern service for scenic spots has now included the application of information technology, and most of the application of new technology aims at promoting tourist contentment. The more services the scenic spots can provide for the tourists, the higher degrees of the contentment may be [10]. At present, the focus of research on the application of information technology in the scenic spots mainly includes the application of radio frequency identification to the security management, the application of three-dimensional panorama technology to the introduction of the scenic spot, and the application of biometric technology to the ticket management.

3. Application and design of LBS based on GIS

3.1 General introduction of the area of study

The area of study of this article is the ecological scenic spot of Shenzhen OCT East, which is the first national super comprehensive eco-tourism model park with group leisure resorting, sightseeing, outdoor sporting, popular science education, and eco-exploring. This scenic spot occupies near 9 square kilometers. It mainly includes six parts: the Knight Valley Eco Park, the Tea Brook Valley Leisure Park, the Sea-Cloud Valley Sports Park, Huaxing Temple, Theme Hotel Community, Tianlu Manor. In the OCT East, the infrastructure and supporting facilities are well built. In 2011, a geographic information spatial database covering the whole OCT East has been built up based on field survey. This means there is a basic platform on which OCT East is conducive to develop and apply of new technologies.

There exists uneven distribution of flow of tourists in the tourist peak in the scenic spot, though they occupy a large area. For example, the problem of transit time is too long caused by the long distances between the three valleys (the Knight Valley, the Tea Brook Valley and the Sea-Cloud Valley), especially in the Knight Valley, the problem of long queues is very serious. It's very difficult for the tourists to tour the whole scenic spot within very short time, so the tourists' complaints often occur, and the tourists' contentment is down greatly. As a result, the side effect has damaged greatly the brand image of OCT East and its economic profits. Besides, because of the large size, the tourists have to take shuttle bus to see the sights in the different parks. However, limited by the natural land for of the scenic spot, the traffic has become the bottleneck for the efficiency of tourists' sightseeing. Therefore, under the limited condition, strengthening the surveillance of shuttles and promoting the efficiency of dispatching shuttles have now become the main problems hindering the promotion of services and the tourists' contentment of the scenic spot.

3.2 The integration of LBS in the services

The following problems should be solved in order to construct services for the scenic spot to fit its own development. (1) The existing software and hardware resources should be made good use of to cut the cost of construction and operation; (2) The application of the software and hardware integrated technology should be studied to promote the efficiency of location service; (3) The LBS platform for commercial operation should be constructed.

3.2.1. Service design: The Aims of the Construction of Location Service in Scenic Spots: (1) To construct a comprehensive telecom network in the complex landforms of the scenic spots, whose functions are to undertake sound communication, transit location information, and to do computer communication; (2) To center round the rear computer service network and compute the middleware/ components with the multi-platform of heterogeneous network with distributed computing, connecting the management, the handhold/in-shuttle terminals and the management center of the scenic spot; (3)The combination of GPS and the wireless radio station is adopted, and the brief digital communication order of the radio station is used instead of the message communication of LBS in the public sector and the long spatial information communication of the data package, providing the scenic spot with high efficient telecom network mechanism and supporting the service of the scenic spot with constant, stable location service.

3.2.2. The general design: The LBS of the scenic spot consists mainly of mobile terminal, positioning center, LBS interface module, GIS module (see Fig. 1 for the general structure).

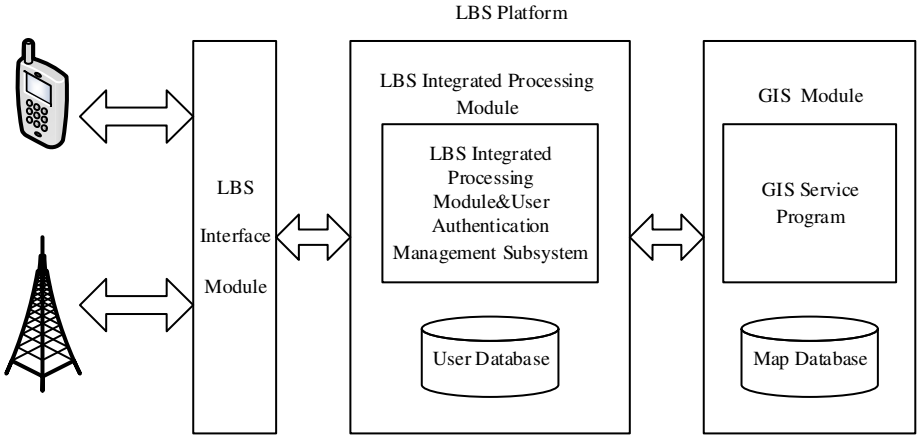

Figure 1. The Overall Structure of LBS in Scenic

The work flow for LBS platform is: the mobile terminal sends request information to LBS platform, and the operational server of the LBS platform receives the request information and communicates with the positioning center to locate the cell phone user's position, and then uses the GIS server to obtain the relevant map information and send it to the user according to the returned key geographic information from the mobile positioning center.

3.3 The function and structure of the service

3.3.1. Service center: The center's servers consist of several servers such as WebGIS, authentication, I/O, GIS database, navigation, positioning and communication etc. In the function module of the LBS service center, the WebGIS system supports the basic map operation of enlarging, reducing, distance measuring, etc. and various ways of inquiry of ground objects and information of ground objects, which meets the user's various needs for practical operations. When the sub-system terminal of the navigation service sends request for navigating to the center, the center forms the navigating information according to the terminal's location and the path plan that passes the navigating map, and returns to the terminal. The track-following monitor system includes the real-time monitor, the replay of historical traces, the statistical analysis of data, reports etc.

3.3.2. Mobile terminal: At present, the precision of the positioning provided only by network is not ideal and can no be used as such location service as navigating, so ordinary users use the blue-casting as the way of their short distance telecom, encapsulating the blue-cast module and the GPS module together into one independent positioning module, which makes use of the blue-casting telecom technology to obtain the positioning data for the positioning module and then combines the mobile GIS to reach the purpose of positioning navigation. Wi-Fi wireless telecom positioning form can be adopted to compensate the demerit of GPS with no signal indoors [11]. So the Wi-Fi positioning module can be added to obtain the Wi-Fi positioning data through the mobile terminal's USB interface.

3.4 Function design

In the function module of the LBS system including the followings:

3.4.1. Information stand: It consists of a computer, power control module, working network, display and touch-screen, which show the information about the scenic spot. It can be put at the gate to the scenic spot, or in such place as the queuing area. With high data vision, it can serve the mobile users with no handhold terminals. As shown, the control module include the power control module and remote control, which can control the different states(door sill, vibrating, temperature, etc.) of the remote terminal and change the password and restart the terminal remotely through the remote control.

3.4.2. Positioning model: The author constructs a positioning setting through positioning sensor, positioning return system, the setting and design of the positioning points of response; it obtains parameter and forms the database of positioning empirical value through obtaining the parameter and collecting the coming positioning parameter; then he designs the positioning calculation, which calculates the data appearing in the positioning system. A series of adjustments should be done to the parameter quantity of these calculations to suit the changeable surrounding setting; at last the terminal positioning is realized with the user's terminal communicating with the designed setting of the system, the service end of the system in the mobile process. The location information and its relevant information are sent to the system through the application procedure in the

terminal.
3.4.3. The telecom model based on GPRS: The GPRS data link layer is the bridge of the mobile terminal and the telecom server. The GPRS network increases two new important nodes on the basis of GSM network: GGSN (Gateway GPRS Support Node) and SGSN (Serving GPRS Support Node), which provide supports for the functions of GPRS. The main function of SGSN is to transfer the mobile terminal to the transit channel of GGSN and receive the group data transmitted from the mobile terminal of BBS. GGSN mainly plays the role of network management.

The telecom service layer is of arborescence structure. Ideally, if the network cost is excluded, the data transit rate is 100kbit/s, the coordinate location (latitude and longitude) is 16 bytes, the number for the target itself is 4 bytes, then the mobile target set number=(100×1000)÷(20×8) =625 (sets/S). Therefore, a telecom server can send and receive information from about 600 sets of mobile targets. The number of telecom server depends on the scale of the mobile target. The adoption of GPRS telecom module as information transit network of shuttle control system can do real-time control of mobile target on a large scale.
3.4.4. The telecom protocol: The adoption of non connection-oriented protocol has a relatively low load demand on the network and is comparatively fit the real-time data transit, though it does not ensure the data reach the target completely. Data compression technology and the compression of the protocol header is the key to promote the compatibility of the monitoring platform, and to reduce the load of the system before the data is transmitted. The authors complies a set of telecom monitoring protocol according to the TCP/IP network transit protocol [12]. The protocol does not define the length, and all is shown by ASCII code.

4. Design and implementation of LBS module of the scenic spot

4.1 The integration of platform systems

The SuperMap GIS solution consists of three parts: data service center, internet platform, and mobile terminal software. The data service center is developed based on SuperMap ogjects.net/Java and is responsible for the data maintenance of the whole platform and the clients' information statistic data. It provides the group's clients with background

management platform: the internet platform is developed based on the SuperMap Server platform, having the features of cluster and cache and providing high usable network service. It is responsible for online releasing map, providing desktop and browser visits. It can implement such functions as travel information, daily life information, tourism information, advertisement information; the mobile terminal software is developed based on SuperMap SNE platform, covering Windows, mobile, Symbian, Linux, etc.

4.2 The implementation of shuttle control module

This module can be divided into: the system of shuttle control center, the sub-system of the control terminal, and the sub-system of onboard terminal (see Fig. 2).

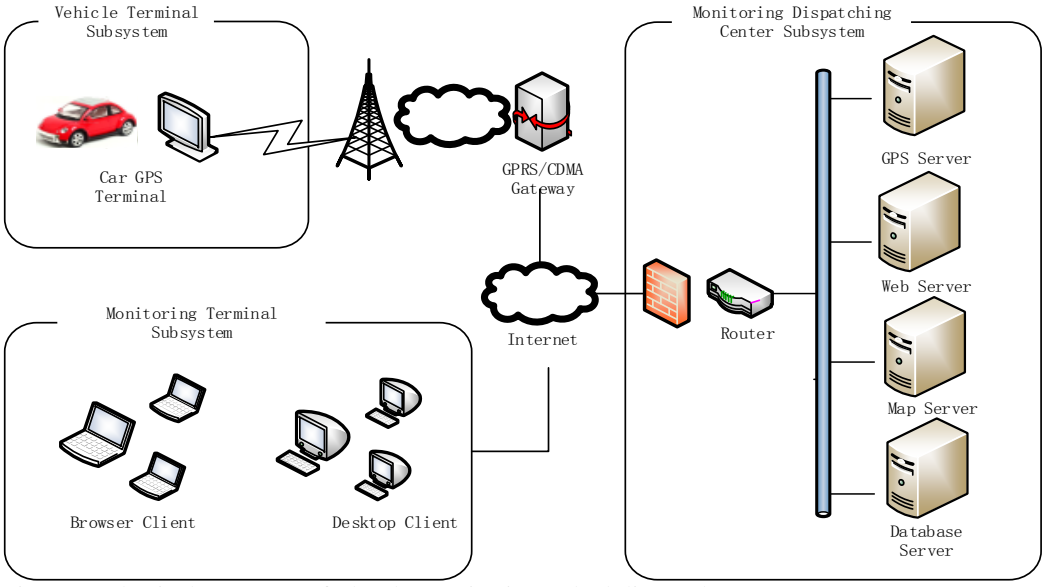

Figure 2. Physical Structure of Shuttle Monitoring Scheduling Subsystem

The sub-system of the control center consists of GPS, Web, map and database server, which is distributed computer system and implements such operational functions as shuttle positioning track-following, control

alarm, control order.

The sub-system of the monitoring terminal and the sub-system of the onboard terminal are clients of the system of the shuttle monitoring control center. For the sub-system of the monitoring terminal, it handles the user's request and returns the results of response; for the sub-system of the onboard terminal, it is responsible for receiving, handling, storing such information as the location of the shuttle uploaded by the onboard terminal and sending control, dispatching order to the onboard terminal.

The sub-system of the monitoring terminal does such tasks as dispatching the operating staff to do the shuttle location tracking, data report generation, data inquiry analysis. The sub-system of the terminal monitoring provides both clients' terminal setting based on the browser user's terminal and the desktop client's terminal. The browser client's terminal is fit for the temporary users of the system or those users who do not need complicated data analysis based on map; the desktop client's terminal is fit for the operator who need to handle many shuttles or need to do complicated map data analysis.

The sub-system of the onboard terminal obtains the current location data of the shuttle through GPS satellite positioning system and uploads the data to the GPS server of the shuttle monitoring control center through such mobile telecom network data channel as GRPS/CDMA; the shuttle monitoring control center can also send control, dispatching order to the onboard terminal through mobile telecom network.

4.3 Implementation of the monitoring module of the positioning of the flow of people

In the scenic spot, there often appear thick flows of people in some parks at the peak of tourism, which poses security threat and reduces the quality of sightseeing. Therefore, monitoring and diverting the flow of people in the scenic spot is one of the key solutions to promoting the quality of service of the scenic spot.

The whole framework of the module is divided into such three module monitoring terminals as telecom sub-module, monitoring terminal, and diverting sub-module, whose functions include: map inquiry, intelligent broadcasting of order report dispatching information, data retrieval, analysis of source of danger, set-route navigating, picture uploading, etc. The functions of diverting sub-module include: location monitoring, sending order reports, dispatching information, terminal users' management, terminal record inquiry, regional alarm, inquiry statistics, data management of the source of danger, data imports and exports, backup, etc.

The module makes use of SuperMap GIS platform and combines the present wireless telecom network technology, implementing the location monitoring of the people in the scenic spot and the source of danger, record tracking back, intelligent broadcasting of order reports, etc. (see Fig. 3).

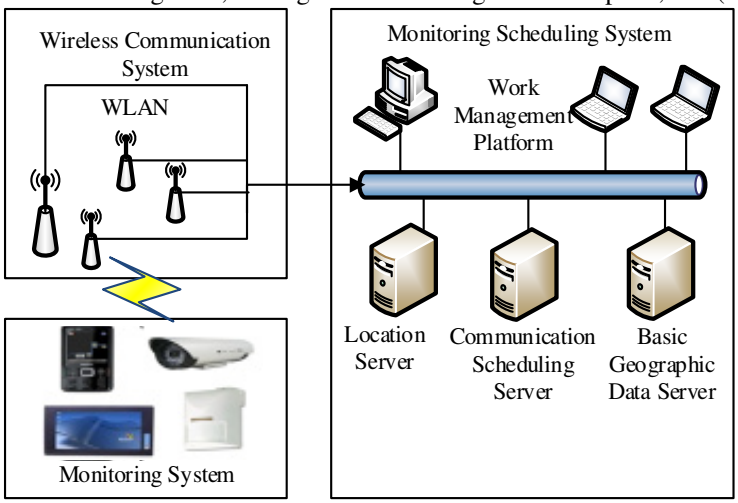

Figure 3. People Positioning Monitoring Subsystem Network Architecture

The mobile information terminal: implementation of such functions as map navigating, order reception, sending locations.

The information service center: implementation of the management of the concrete location of the computing staff and the source of danger, and implementation of the management work of wireless routing.

The location monitoring service system: (1) monitoring the target's detailed information inquiry and map position through inputting the target's attribute information inquiry; (2) monitoring one or several targets simultaneously; (3) record replaying, choosing one monitoring target to inquire the record data within a certain

time interval and to show the positioning model on the map; (4) multi-window monitoring, the implementation of dynamic grouping, dynamic adjusting and monitoring the targets with the same attributes as one group. Different monitoring groups can use different map monitoring screens; (5) regional monitoring, access monitoring, modifying the attribute information of the monitoring regional boundary to control access monitoring so as to do the function of alarm. (6) statistic function, implementation of topic analysis of the various states of the monitored target within a certain time interval, showing it on the map by way of topic pictures; (7) showing the results of the statistic analysis visually; (8) implementation of seamless combination of indoor and outdoor monitoring positioning navigation, implementation of the function of positioning monitoring navigation for the indoor and outdoor targets through GPS and navigating technology, implementation of indoor monitoring through Wi-Fi technology, and implementation of the function of sending set routes through GPRS and Wi-Fi technology; (9) imports and exports of data management, users' information, location information, etc. , implementation of such functions as backup, etc.; users' access control management, providing different access control to different users, which uses the management system of three-level users' access control: they are super administrator, administrator, and different user; (10) journal-log management system, all users' operations are stored in the form of journals.

In many scenic areas and resorts in China, there are lacks of the technology support to improve their management efficiency. In this case study of Shenzhen OCT East, because it covers wide area from up and down of the mountain, so the tourists uphill and downhill transportation links is relatively difficult. After a complete GIS data platform has been established, LBS services can be equipped with it easier. In some urgent point such as the shuttle scheduling and monitoring, tourists stream positioning and navigation have been greatly improved, the spatial distribution of the tourists in the whole OCT East have be optimized. This is an innovative attempt of LBS application in the Chinese scenic areas. The venue experiment and function test have been completed, and this LBS system also has been used in the management by OCT East.

5. Test and analysis of the module

5.1 Test setting

In the test platform, the server uses the operational system of Windows2003 Server, whereas the clients' terminals use the Windows Mobile6 operation system. The GPRS wireless telecom network is used and the bandwidth is 40-150Kbps.

The test constructs a framework of three-level server. There is a server on every level, and every server can register three users' terminals, among which one has the function of GPS positioning. GPRS wireless network is used for the connections among the servers, and the servers and users' terminals.

5.2 The content and methods of the test

The author's main experimental parts consist of two tests: the test of the function of the platform and performance test. The test of the function can also be called usable test, mainly testing whether the system has implemented the aims of the function design (see table 1 for examples of the function test).

Table 1 Function Test

Test item	Test requirement	Test steps
Users' management	The system administrator can maintain the users' information and all the information of the unit on the server.	The server end can enter the user interface to do the operations of adding and erasing.
Access configuration	The system administrator can conFig. the users' access on the server.	The server end can enter the configuration interface to do the operations of adding and erasing.
Users' register	The clients' end can only use the right name and password to login on the system, otherwise, error reminder will appear.	The clients' end inputs the IP of the server, user's name, password, and clicks to register.
Location share of information	The share of real-time location information within the units of access	The user of the unit of access starts the positioning function and the server starts service, and then the registered user can see the real-time location information of the unit of access in the e-map of the client's interface.
Application and approval of the access	The server's administrator's approval is valid if the user applies for the location information of the unit with no access.	The client's end enters the access application interface, chooses the applied unit and clicks yes, the server pops up tips. Click the tips to handle the application and click yes when finishing.
Integration of location information	At present, the system has realized GPS and hand plotting, so test only these two parts.	Click to do self-positioning, marking your own right position on the map.

The performance test includes such aspects as the stability, response rate, share of resources, packets loss rate of the operation of the LBS service platform. The key test is the test of the pressure of the server. Because of the limit of equipment staff, it is impossible to deploy a lot of clients to do the testing. Therefore, only the simulated method is adopted, and the aims are implemented through promoting the frequency of uploading and sending data and increasing the quantity of the data with the help of the limited equipments. There are nine users' terminals in all. In simulation, every machine uploads equivalent to 100 units of location information to the server every 5 minutes and records all the receiving and sending relevant information on the server and the clients' journals. After the testing, the related results can be calculated through the information on the journals.

5.3 The result and analysis of the testing

The function test, including User's management, Access configuration, User's log in, Information Share of Location, Access application and approval, Integration of location information etc, are done under the circumstance of stable signal path and low quantity of data. The results show that the system is able to correctly implement all functions.

In the performance test, the performance of the system was tested through the reserved switch of the system, and the server worked for 48 hours continuously and could operate stably (see table 2 for the result).

Table 2 The Result of the Performance Test

	Statistic data
Average packets loss rate	12% (peak flow:100Kbps，average flow: 17.4Kbps）
Maximum response time for the client's end	Less than 2S
CPU utilization ratio of the client's end	Maximum value is less than 30%
State of memory occupation	The maximum value of the server's end is less than 80M The maximum value of the client's end is less than 40M

The experimental results show: (1) the choice of telecom system, GPRS network is the data transmit plan for this article, which is very efficient. (2) the choice of telecom protocol, choosing user datagram protocol UDP as transit protocol can meet the needs of large quantities of data transmission, which will not affect the reliability of the system with so low packet lose rate for the location service system; (3) Before data

transmission, data compression technology is used, which is good for real-time promotion, reducing effectively the response time of the system and the average packets lose rate in transmission. The test has proved the reliability and usability of the application of the whole LBS platform in the services of the scenic spot.

6. Conclusion

For a long time there have been many problems something like too much the number of visitors, too large of the scenic areas, so difficult in transportation links, scenic capacity overload etc. in China. Through the case study about OCT East, it could be found: (1) The mobile positioning terminal and the computer network of the commanding center are integrated, forming LBS regional service web, which is applied to such business as shuttle monitoring and diverting the flow of people. (2) LBS embed in GIS platform can be made efficient management utility. (3) The performance and the function of the service model of LBS constructed has been tested, proving the model constructed fits the objective reality and feasible. This is useful for providing a reference case for other scenic spots and resorts in China. However, in order to ensure compatibility between GIS and RFID, novel paradigms targeted at improving security, flexibility and cognitivity of the segment should be considered.

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