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Design and Implementation of WebGIS-based Self-driving Tourism Service System

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Abstract: *Taking Sichuan Province, a region abundant in tourism resources, as a case study, this paper designs and implements a web-based self-driving tourism service platform using Node.js and JRE as runtime environments, Vue as the front-end framework, PostgreSQL and PostGIS for database construction, and SuperMap iServer as the map server. The system's core functionalities include scenic spot information queries, visualized resource distribution displays, single-destination self-driving route planning, and multi-destination route planning. Comprehensive testing demonstrated stable operation and excellent performance across all system features.*

Keywords: *WebGIS, Map services, Tour planning, Self-drive tourism, SuperMap*

1. Introduction

Sichuan Province is endowed with rich tourism resources, which annually draw a substantial number of self-driving tourists[1,2]. Self-driving tourism has witnessed a growing prevalence because of its flexible itinerary planning[3]. Nevertheless, the existing tourism systems mainly serve group tourists or individual travelers relying on public transportation, and the information related to self-driving tourism only accounts for a minor part of their functions[4–6]. Consequently, the development of a specialized tourism service system designed to satisfy the requirements of self-driving tourists has become especially significant.

As the leading geographic information system software provider in China, SuperMap GIS has witnessed the extensive application of its software series across multiple sectors, including natural resources, digital cities, smart cities, and tourism management[7]. It has consistently contributed to the informational construction of key domains both at home and abroad. In the present scenario where self-driving tourism systems remain scarce and the nation strongly encourages the utilization of domestic software, this research develops a B/S architecture self-driving tourism service system based on SuperMap GIS technology. The objective is to offer convenient information services for self-driving tourists and thus significantly promote the diversified development of the tourism economy.

2. System Requirements Analysis

2.1. Functional Requirements Analysis

The system is specifically designed for self-driving tourists, who exhibit substantial requirements for map positioning, tourist attraction information, route planning, and local information throughout their travel. The analysis will be carried out from two dimensions: functional requirements and data requirements.

(1) Functional requirements

Map Query and Positioning Function: The system supports keyword searches for tourist attractions and can accurately pinpoint their exact locations.

Spatial Distribution of Tourist Attractions: The system is capable of displaying the spatial layout of

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tourist attractions within the region from a global perspective, aiding tourists in gaining a comprehensive understanding of the overall distribution of these attractions across the area.

Route Planning Function: The system supports users in inputting their departure point, intermediate stops, and destination to achieve intelligent route planning for multiple locations.

Information Integration: The system is capable of compiling data on tourist attractions and travel tactics, which users can access at their convenience.

(2) Data requirements

The implementation of the system, as dictated by the functional requirements, must be based on the following geographic information data: the electronic base map of Sichuan Province, the multi-level administrative division vector data of Sichuan Province, the transportation network data of Sichuan Province, and the tourist attraction vector data of Sichuan Province.

2.2. Technical analysis

The system utilizes a lightweight B/S (Browser/Server) architecture, with core functionalities primarily hosted on the server side. Users can seamlessly access all features through a web browser, without the need to install any software.

The system has been developed using Java. To ensure a user-friendly and visually appealing interface, the Vue framework has been adopted for the front-end development. For the configuration, deployment, and development of map services, SuperMap iServer is utilized. The database solution integrates PostgreSQL and PostGIS, which support the storage and management of spatial data.

3. Self-driving Tourism Service System Design

3.1. System Architecture Design

The self-driving tourism service system offers core functionalities, including resource inquiry, spatial visualization, and route planning, tailored for tourist cities. As depicted in Figure 1, the system architecture is segmented into three layers: the user layer, the logic layer, and the data layer.

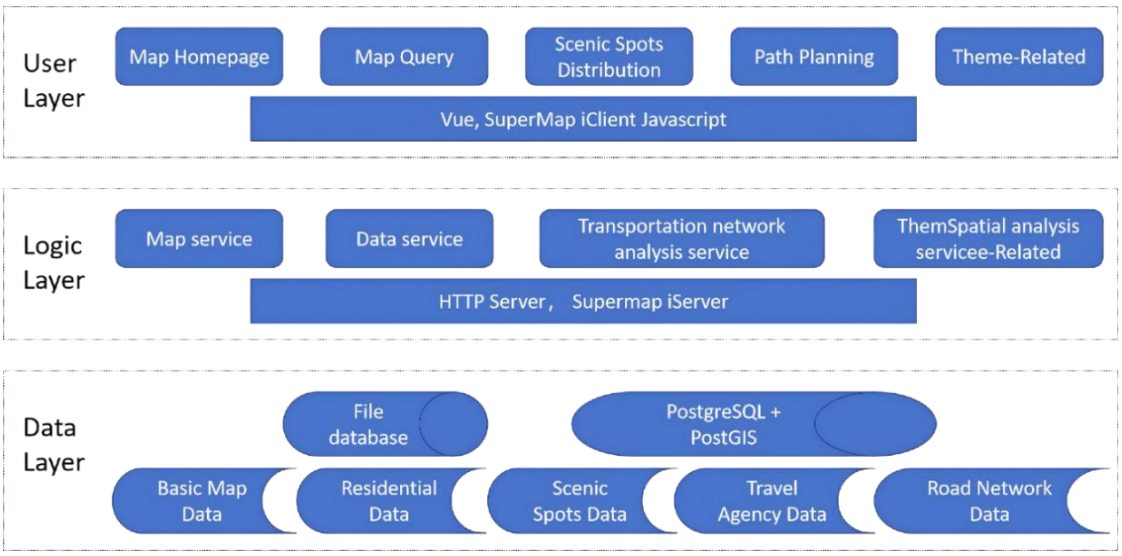

Figure 1: Self-driving travel service system architecture.

(1) User layer

The user layer corresponds to the client side. The system employs Vue and SuperMap iClient JavaScript technologies to develop five core modules: 'Map Homepage', 'Map Query', 'Scenic Spots Distribution', 'Path Planning', and 'Theme-Related'. Users can send data or map service requests to the server through their browser, receive and process the returned results, and then display them to the user.

ISSN 2616-5872 Vol.7, Issue 5: 70-76, DOI: 10.25236/AJEE.2025.070509

(2) Logic layer

The logic layer comprises the server and business layers, encompassing the HTTP server and SuperMap iServer. The web service processes client requests and dispatches map service tasks to SuperMap iServer. Subsequently, SuperMap iServer retrieves data from the data layer, processes the data, and returns the task results to the HTTP server. Ultimately, the HTTP server delivers these results to the user layer.

SuperMap iServer supports the release of REST services and OGC-compliant services through multiple data sources. The REST services offer GIS interfaces as resources, featuring maps, data, analysis, and 3D functionalities. The system has deployed four services using SuperMap iServer, as detailed in Table 1.

Table 1: Map service instances released by the system.

Service types	Service instances
Map service	map-SiChuan/rest
Data service	data-SiChuan/rest
Transportation network analysis service	transportationAnalyst-SiChuan/rest
Spatial analysis service	spatialAnalysis-SiChuan/restjsr

(3) Data layer

The data layer comprises a file database, a PostgreSQL database, and its plugin, PostGIS, which includes essential geographic data necessary for the implementation of system functionality. This encompasses "Sichuan Basic Geographic Information Data," "Residential Data," "Scenic Spots Data," "Travel Agency Data," and "Road Network Data." PostgreSQL is a robust object-relational database management system, whereas PostGIS supports the storage and construction of spatial data, allowing for operations on relatively complex spatial data using concise SQL language. The data layer's role is to handle data requests from the logic layer and to provide the required data back to the server within the logic layer.

3.2. System Function Design

Based on user requirements, the system's functionalities depicted in Figure 2 are primarily categorized into five modules: "Map Homepage", "Map Query", "Scenic Spot Distribution", "Path Planning", and "Theme Related".

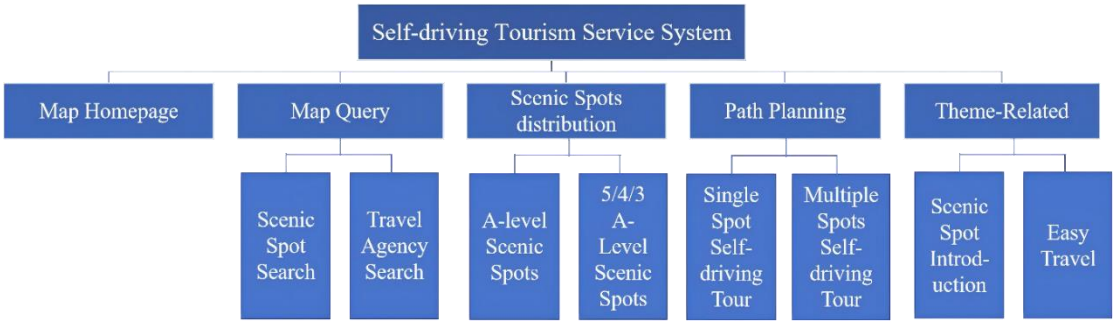

Figure 2: System Function Modules.

(1) Map Homepage

Upon starting the system, it automatically loads the regional map, utilizing both the administrative division map and the remote sensing image map as base maps. Users can freely switch between these two base maps, and the map supports zoom and pan functionalities for more flexible viewing and usage.

(2) Map Query Module

Scenic Spot Search: Users can search for relevant scenic spots by entering keywords. The search results will be displayed in the center and highlighted on the map.

Travel Agency Search: Users can search for travel agency information across various administrative regions on the map.

ISSN 2616-5872 Vol.7, Issue 5: 70-76, DOI: 10.25236/AJEE.2025.070509

(3) Scenic Spots Module

A-level Scenic Spots: Create a heatmap using the spatial location data of all A-level scenic spots, and enable the adjustment of parameters like heatmap radius and blur radius.

5/4/3 A-Level Scenic Spots: Analyze the distribution of A-level scenic spots across various grades within the region using bubble charts, radar charts, and other visual formats.

The spatial distribution heat map and statistical charts of the scenic pots can be configured with map elements to generate thematic maps, which can then be exported in image format.

(4) Path Planning Module

Single Spot Self-driving Tour: The system is capable of automatically generating corresponding guide routes based on the user's specified departure and destination. Users can search by entering keywords or by selecting locations directly on the map to determine the departure and destination.

Multiple Spots Self-driving Tour: Under the current plan, users can select several attractions, and the system will generate a guide route that encompasses all chosen points of interest. The route starts at the first attraction and follows the sequence in which the user has added them. Users can access detailed guide steps for each attraction point.

(5) Theme Related Module

Scenic Spot Introduction: The information about the scenic spot is presented in card format. Users can click on it to view a detailed introduction featuring images and text, which also includes a link to the official website of the scenic spot.

Easy Travel: Integrate popular travel apps and guide websites into a card format, allowing users to download the app or visit the site with ease.

4. Self-driving Tourism Service System Implementation

This study implements various system functions utilizing Sichuan's tourism resource data. The primary system functions have been achieved mainly using SuperMap iServer.

Figure 3 depicts the functional interface of the map homepage, which employs administrative division maps and remote - sensing imagery as base layers. Users are able to switch between different types of base layers by clicking the "Vector/Imagery" toggle button. The interface is equipped with zoom controls in the upper - left corner for the purpose of adjusting the map scale. Moreover, users can utilize the left mouse button to drag the map for panning. These core functionalities and controls are uniformly applied across other pages, guaranteeing a consistent and user - friendly experience across the entire platform.

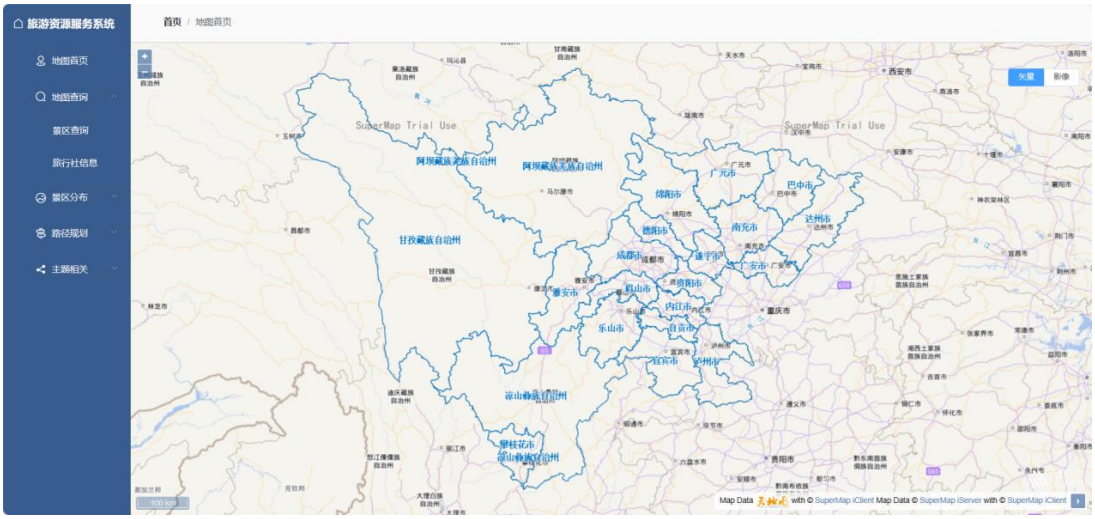

Figure 3: Map Homepage.

Figure 4 depicts the scenic spots search module. As illustrated, upon users entering the keyword, the system automatically retrieves all scenic spots with this term in their names and presents the results in a pop-up window. Users can simply click on any scenic spot name from the dropdown menu, and the map

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will instantly locate the area, zoom in automatically, and display detailed information about the site.

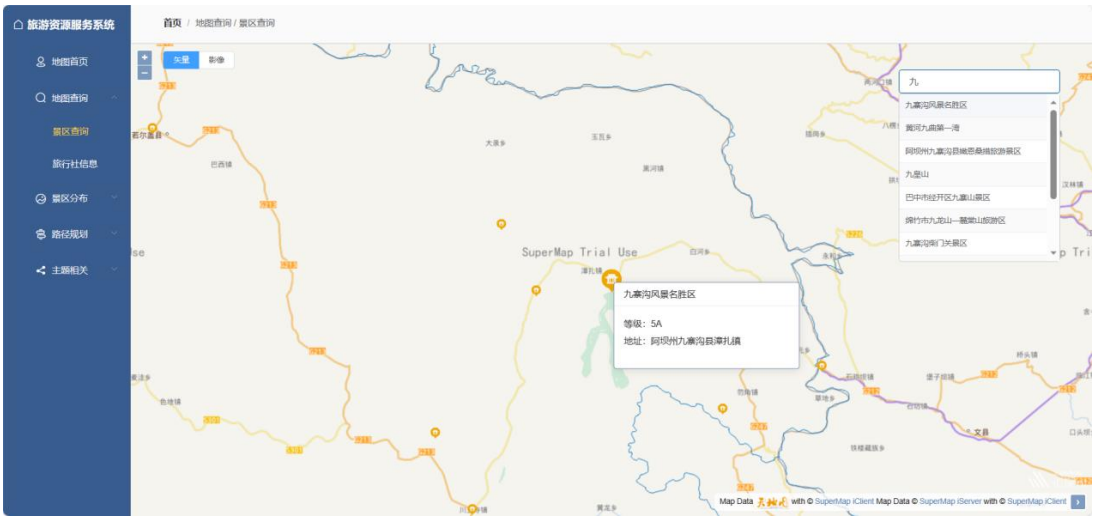

Figure 4: Search box query.

Figure 5 displays the heat map of A-level scenic spots in Sichuan Province. In the upper right corner of the page, there is a function panel containing a slider and a counter. Users can adjust the heat map's radius and blur radius by dragging the slider or clicking the "+" or "-" buttons on the counter.

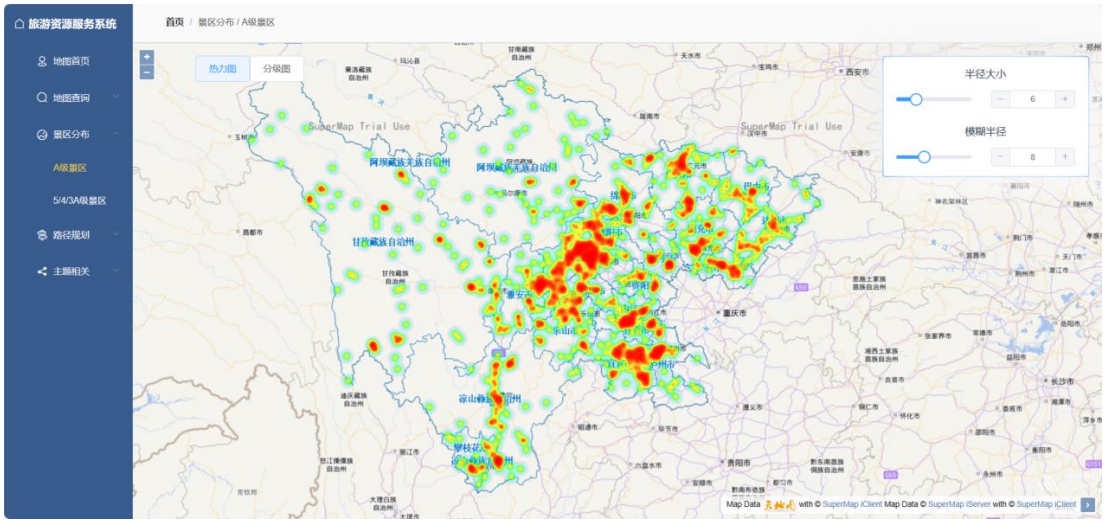

Figure 5: A-level scenic spots heat map.

Figure 6: A radar chart for the selected area's A-level spots.

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Figure 6 presents a radar chart that provides a statistical breakdown of scenic spots rated 5A, 4A, and 3A within the selected city, alongside their comparison to the provincial average across all cities. Interacting with the lines and markers on the radar chart by hovering over or clicking them activates corresponding animation effects. In the lower-right corner of the page, users can toggle between viewing 5A, 4A, and 3A-rated scenic spots. The panel subsequently displays detailed information, including the classification level, name, and address of the scenic spots within the selected prefecture-level city on the map.

Figure 7 illustrates the multiple spots self-driving route planning feature. Users can click the "Add Attraction" button on the panel to sequentially enter attraction names based on their desired number of stops. The system will then generate a navigation route that incorporates all selected attractions. Additionally, a route guidance panel on the right displays self-driving route options for multiple spots. Users can expand or collapse sections to view detailed driving instructions step by step.

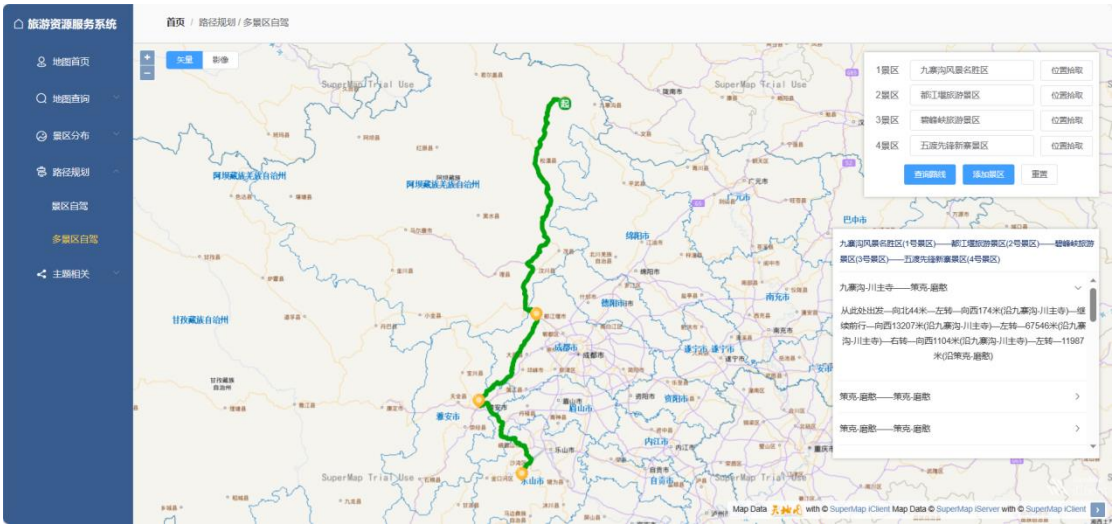

Figure 7: Planning routes for self-driving to multiple attractions.

5. Conclusions

This study develops a personalized system designed for self-driving tourists, addressing their practical needs by providing travel information and guidance. Utilizing SuperMap GIS technology, the system enables spatial queries related to tourist attractions' geographical locations, displays spatial distribution, and assists in route planning. It integrates GIS and tourism management features to help travelers comprehensively understand the spatial layout of attractions within their interest areas, conveniently gather travel information, and plan optimal routes. Developed using Sichuan Province's tourism resources as a case study, the system demonstrates high versatility and applicability to other tourist cities.

Acknowledgements

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