Research on Optimal Path Selection Based on WebGIS

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Abstract. With the continuous development of geographic information system technology, the ability to analyze and process various spatial information has been greatly enriched and strengthened. The optimal path analysis is the current research hotspot in spatial analysis. In this paper, Changsha City in Hunan Province was taken as an example to build an optimal path selection platform based on WebGIS. With the help of ArcGIS network analysis tool, network analysis data set was established for vector road data, and road length was selected as impedance factor to realize optimal path search.

1. Introduction
Optimal path search is widely used in network analysis, transportation, logistics distribution, resource scheduling, electronic navigation, forest fire prevention and other fields [1]. At present, the optimal path analysis methods can be roughly divided into two categories. One is based on the analysis of vector data, which establishes a network analysis model for vector road data, generates a geometric network by using the network analysis function of ArcGIS platform, and carries out analysis and processing based on the network analysis tools provided. It is published to the established WebGIS platform server, and the back-end of the system calls the interface to complete the shortest path query. This method is suitable for the case where the vector road data covers a comprehensive range and the factors affecting road cost are few. The other method is to conduct optimal path analysis based on raster data. Firstly, the weight of impact factors affecting path cost is determined, and the cost data set is obtained by calculating and superimposing raster data with tools. After the cost data set is published to the server, WebGIS system is also called by the back end to conduct optimal path analysis. This method is suitable for the situation that the terrain relief is large, the vector road coverage is not comprehensive and there are many factors affecting the road cost.

2. WebGIS related technology

2.1 Introducing WebGIS
WebGIS is simply the combination of Web and GIS, based on Internet technology and geographic information system, belongs to the interactive geographic information system. The B/S architecture is adopted, which allows the client to obtain geographic information data and request WebGIS services in the web browsing mode. The server provides the client with services and functions such as map browsing, data query and spatial analysis [2]. All kinds of GIS services needed by WebGIS technology are completed by accessing GIS server, which can support complex GIS operation under the condition of low client configuration, and make full use of the existing GIS resources. Because the client uses the Web browser that supports the standard HTML, calls the server to process through the calling
interface, only needs to render and display the returned operation results on the browser side, so the client has nothing to do with the platform, has good expansibility, applicability and is easy to operate and unified management.

2.2. Geospatial database

Geodatabase is an object-oriented data model. Its representation of geospatial features is closer to our understanding of the real world. Geographic database is the most advanced data management mode, which can describe and store different types of data such as vector, raster, TIN and network under a common model framework. It is based on the standard relational database (RDBMS), uses the standard relational database technology to represent the geographic information data model, and adds the spatial data management mode [3]. Organizes geographic data by hierarchical data objects. These data objects include Object classes, Feature classes, and Feature data sets.

All data in a Geodatabase is stored in an RDBMS, including the framework and rules for each geographic data set, as well as a simple attribute table. Geodatabase provides a data interface and management framework for ArcGIS to better manage and use geographic data, inheriting all available data types in ArcGIS and the methods of display, access, storage, management and processing.

2.3. Design of Geographic Information System Architecture Based on WebGIS

Geographic information system is a computer system based on geographic information, which can collect, store and manage geographic information data, and obtain important data by processing massive geographic data. 3D geographic information system can intuitively show the process of geographic data processing [4]. WebGIS-based geographic information system includes presentation layer, business logic layer, application layer and data layer. The architecture is shown in figure 1.

![System architecture diagram](image)

- Presentation Layer. Browser as the user interface, through HTML to the user to show the required information and functional interaction with the user. In this layer, it is necessary to complete the network docking with the server, download and cache the geographic information data of the GIS server, visual rendering based on ArcGIS and interaction with the application. The data returned by the WebGIS server is rendered and displayed.
- Web Service Layer. The Web services layer is responsible for receiving client user requests and uploading them to the WebGIS application server, as well as accessing and interacting with the interface provided by the server. The main functions of the Web services layer are session management, state management, log management and server-side script management [5].
- Business Logic Layer. Including GIS geographic information data in the layer and the data interface of the Web, the layer's mission is to respond to business requests [6]. On the one hand to the GIS server map data transmission, to the client browser to identify the order of the transmission, and
the 3d modeling of model format into format can be displayed on the page, and the model of longitude and latitude code displayed on the map. The other aspect is the processing of interface data.

- Data Service Layer. This layer includes map data and service data of GIS server, as well as source data of 3D modeling, such as image map data, road vector data, etc., and other data provided by third-party database.

3. Achieve optimal path selection

3.1. Experiments
Taking Changsha city of Hunan province as an example, the realization of the optimal path selection based on WebGIS, obtain the vector road data including highways, roads and sidewalks, etc., covering relatively comprehensive, as shown in figure 2, and the overall degree of relief in Changsha city is not big, suitable for network analysis model is established, using the network analysis function of ArcGIS platform to generate geometric network, release and call. The flow diagram is shown in Figure 3.

![Figure 2. Road data of Changsha](image)

![Figure 3. Flow diagram of experiment](image)
The road data in this paper is stored in the form of vector line element file. Firstly, the network data set is established, which is the basis of network analysis, including route elements, point elements, and the connectivity between them. Building a network data set for an existing road network can configure the level, impedance and constraints according to road attributes. It is often used for path analysis, service area analysis and resource allocation.

The existing road network is cut with the insertion nodes at 10m equidistance, and the intersecting roads are interrupted at the intersections with the help of the tool Planarize Lines to improve road connectivity.

The road length was selected as the impedance attribute of path cost in the network data set constructed on ArcCatalog, and the road material attribute should be added as the data set attribute during the network data set construction. With the help of Network Analyst tool in ArcMap, docking points can be added and optimal path can be obtained.

3.2. Publish and invoke
After publishing the established network analysis layer to the WebGIS server, the uploaded services can be queried in the management interface of ArcGIS server and the network analysis function can be turned on at the same time. The service supports invocation as GET/POST and returns a string of JSON data.

JavaScript language is used to call ArcGIS API for JavaScript interface to instantiate the network analysis object, add docking points that need to be passed, and query the optimal path. The results are shown in Figure 4.

![Image](Figure 4. Optimal path selection results Summary)

4. Conclusion
Taking Changsha City as an example, this paper realizes the optimal path selection based on WebGIS. In this way, customers can access directly through the browser side, which greatly reduces the load requirements for the client side, and unifies the management and access of resources by the server, thus improving the applicability of the system. However, for the influencing factors of optimal path selection, this paper only considers the case of small relief degree and perfect road coverage, and takes the road length as the influencing factor. Without considering the congestion of the road in different time periods, the next step can take the comprehensive record of the road length and the congestion degree in the current time period as the impedance factor to determine the optimal path.

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