Research on Visual Management system of Power Transmission Line based on two-dimensional GIS

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Abstract. In view of the imperfect construction of power transmission line visualization system, this paper studies the power transmission line visualization system based on open source GIS engine openlayers. At the same time, it makes full use of VUE, JavaScript front-end technology and express framework, Node.js, MariaDB, GeoServer and other server technologies to realize the two-dimensional GIS solution based on open source openlayers, which has a certain application value for two-dimensional GIS visualization management in the field of transmission lines. This scheme can meet the daily application needs of power grid transmission lines, and greatly facilitates the management of power grid transmission lines.

1. Introduction

This study is mainly based on the collected transmission line management data, through the technical research on data fusion and efficient retrieval of multi-source heterogeneous transmission line data, to further improve the level of data sharing and spatial analysis ability, and to build a transmission line visualization system of Guizhou Power Grid based on openlayers. Realize the unified management of massive data such as transmission line equipment and risk sources in Guizhou Province, and comprehensively enhance the management department's ability to manage and control the channel risk and the surrounding environment of the equipment.

With the support of computer graphics and geographic information theory, the research and development of geographic information software has been developed by leaps and bounds. Geographic information software is usually used in various industries in the way of public service. at present, common geographic information software is usually based on hypermap and Arcgis development package for secondary development, but as a mature commercial geographic information software, it usually requires higher hardware configuration and higher R & D cost. When choosing the technical route, this system fully takes into account the lightweight and economic benefits of software services, so this paper uses the front-end two-dimensional openlayers-based GIS framework, open source GeoServer as the GIS data server, combined with mature and efficient front-end technology to build the system.

2. Technical architecture

In terms of system architecture, the system adopts the architecture of B/S, which has the following advantages:
(1) the client does not need to install software, and the maintenance cost is low. As long as the user is in the private network deployed by the system, the user can access and process the business through any browser.

(2) the system has strong expansibility, and the function of the system can be simply increased by adding or modifying pages.

(3) Cross-platform support. Users can deploy the system on Linux and Windows mainstream operating systems, and can also be accessed in Linux and Windows operating systems where browsers are installed.

The front-end technology of the system mainly includes VUE, JavaScript, openlayers and echarts. VUE serves as the front-end general framework, integrates and integrates front-end resources; openlayers, as the front-end two-dimensional POI development engine, is responsible for rendering and managing two-dimensional image base map, vector base map, GIS information and special effects; and echarts, as the front-end chart tool, is responsible for displaying and managing all kinds of chart information in the system.

The server technology of the system mainly includes express framework, Node.js, MariaDB and GeoServer. Express is a lightweight Web framework based on Node.js, which integrates all other technologies on the server; MariaDB, as a system database, is responsible for storing user data, all kinds of account data, etc.; GeoServer is used to publish image map data, vector map data and POI data.

The technical architecture of the system is shown in figure 1.

![Platform technical architecture](image)

Fig. 1. Platform technical architecture.

3. Key technology

3.1 Client service
Openlayers is an open source WEB GIS front-end development tool. Many companies have built a map development engine using openlayers. Developers can customize and develop personalized GIS software through the strong extensibility of openlayers. The working principle of Openlayers is that multi-layer is regarded as a Map container, and the core of the container is map layer data source, map (or vector) layer and layer style, map operation method and so on. The basic elements of vector layer can be divided into point, line and surface, and the transmission line information is displayed jointly by POI vector layer and map layer. The version of this project is openlayers v5.3.0.

3.2 Map service
In this paper, GeoServer is used as a map publishing tool. GeoServer is a map server based on Java, which supports users to publish map data and can add, delete, modify and query map data. It is convenient for GeoServer developers to carry out research and development of two-dimensional GIS. Among them, GeoServer supports map, image data and vector data in terms of data types, and the version used in this project is GeoServer2.17.1.

3.3 Database platform
This project uses MariaDB to manage server-side data, which is an important branch of MySQL and is fully compatible with MySQL. In addition, MariaDB is a universal database management system with certain expansibility. MariaDB supports a large number of use cases through pluggable storage engine.
4. Platform implementation

The functional architecture of the platform is divided into three layers, namely: application layer, data layer and basic layer. The main functions of the application layer include: (1) basic functions of GIS; (2) statistical analysis; (3) information display; (4) data management; (5) system management. The functional design is shown in figure 2.

| Application layer | System management | User management | Authority management | Role management | Log management |
|-------------------|-------------------|-----------------|---------------------|----------------|---------------|
| Basic functions of GIS | Statistical analysis function | Information display | Data management | Data management function |
| Cartographic output | Statistical Analysis of Line Crossing | Superimposed display of thematic data of transmission lines | Basic geographic data | Map loading |
| Spatial attribute query | Buffer analysis | Lightning data display | Line vector data | Feature extraction |
| Element positioning | Statistical Analysis of Line Channel | Disaster thematic data display | Risk thematic data | Figure editing |
| Map browsing | Icing test data display | Icing test data display | System access data | Data loading |

| Data layer | Interface and service system | Data exchange service system | Data integration service |
|------------|-----------------------------|-----------------------------|-------------------------|
| Cross data | Remote sensing data         | Ice, pollution, thunder, wind, ground disaster |
| Traffic data | No-fly data               | Densely populated area data |

| Basic layer | Electric power intranet, communication network and local area network |

The basic functions of GIS include cartographic output, spatial attribute query, feature positioning, map browsing (including: map zooming, map dragging). The map browsing function is shown in figure 3. The layer filter is shown in figure 4. The length measurement is shown in figure 5 below. The area measurement is shown in figure 6 below.
Fig. 3. Home map display.

Fig. 4. Map layer screening and display.

Fig. 5. Length measurement.
The main functions of statistical analysis are line crossing statistical analysis, buffer analysis and line channel statistical analysis and so on. The cross analysis is shown in figure 7.

![Cross-analysis function display](image)

**Fig. 7. Cross-analysis function display.**

The information display function mainly includes transmission line thematic data overlay display, disaster thematic data display, lightning data display, icing detection data display. The thematic map of disasters is shown in figure 8.

![Disaster thematic map](image)

**Fig. 8 Disaster thematic map.**
Data management functions include basic geographic information data management, line vector data management, risk thematic data management, system access data management. Data management functions include map loading, map editing, feature extraction and data loading.

System management functions include: user management, role management, rights management, log management, login.

5. Conclusion
In this paper, based on openlayers and other front-end technology, the Guizhou power grid transmission line visualization system is developed, the result is clear, the function is perfect, and can directly display the information of Guizhou power grid transmission line, which has a certain guiding significance for the actual operation and maintenance work. The system reserves relevant development interfaces and has strong expansibility, which lays a foundation for the construction of smart power grid in the future.

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References
[1] He Y, Bi Z, Tian H, et al. Application of OpenLayers in marine information monitoring[J]. E3S Web of Conferences, 2019, 118(1):03006.
[2] Feng X., Pan C. Application of GIS Technology in Monitoring Precision Poverty Alleviation[J]. Beijing Surveying and Mapping, 2019.
[3] Huafeng L E, Dajun L I, Nie X, et al. Design and Research of On-line Monitoring and Management System for Radioactive Sources Based on OpenLayers[J]. Jiangxi Science, 2017.
[4] Morales, Emo, J. R. Santillan , and M. Makinano-Santillan. "NEAR-REAL TIME RAINFALL MONITORING IN THE CARAGA REGION, MINDANAO, PHILIPPINES USING OPENLAYERS API AND JAVASCRIPT." Asian Conference on Remote Sensing 2015.
[5] Rodriguez R M, Lesage S. GeoBolivia the initiator Spatial Data Infrastructure of the Plurinational State of Bolivia's Node[J]. Nano Energy, 2014, 9(2):383–391.
[6] A, Zavala Romero , et al. "An open source Java web application to build self-contained web GIS sites." Environmental Modelling & Software 62.Dec.(2014):210-220.
[7] Triezenberg P J , Hart P E , Childs J R . National Archive of Marine Seismic Surveys (NAMSS): A USGS-Boem Partnership to Provide Free and Easy Access to Previously Proprietary Seismic Reflection Data on the U.S. Outer Continental Shelf[J]. Quaternary International, 2014, 331(4):128-138.
[8] Flanagan D C, Frankenberger J R , Cochrane T A , et al. Geospatial Application of the Water Erosion Prediction Project (WEPP) Model[J]. Transactions of the Asabe, 2013, 53(2):1399-1411.
[9] Sillero N, Oliveira M A , Sousa P, et al. Distributed database system of the New Atlas of Amphibians and Reptiles in Europe: the NA2RE project[J]. Amphibia-Reptilia, 2014, 35(1):33-39.
[10] Flanagan D C, Frankenberger J R , Cochrane T A, et al. Geospatial Application of the Water Erosion Prediction Project (WEPP) Model[J]. Transactions of the ASABE (American Society of Agricultural and Biological Engineers), 2013, 56(2):591-601.
[11] He Y, Zhang D, Fang Y. Development of a mobile post-disaster management system using free and open source technologies[J]. International Journal of Disaster Risk Reduction, 2017.

[12] Liu W, Kyle P, Trey S, et al. Open Polar Server (OPS)—An Open Source Infrastructure for the Cryosphere Community[J]. ISPRS International Journal of Geo-Information, 2016, 5(3):32.

[13] Yu X W, Liu H Y, Yang Y C, et al. GeoServer Based Forestry Spatial Data Sharing and Integration[J]. Applied Mechanics and Materials, 2013, 295-298:2394-2398.