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Application of Visualization Technology Based on GIS

Dan Zheng

School of Hope college of Southwest Jiaotong University, Chengdu 610000, China

zhengdan1020@163.com

Abstract

GIS has been widely used in the field of meteorology by virtue of its powerful spatial data collection, storage, management, analysis, and display capabilities. Based on the application of GIS technology in the field of meteorology at home and abroad, this paper analyzes the current deficiencies in the use and expression of meteorological data, and proposes a GIS-based automatic weather station data conversion and visual expression method to realize the visual expression of the spatial characteristics of meteorological data , On the GIS platform, complete the design of the automatic weather station data visualization system, rich data query and expression methods, and organically combine weather detection information with geographic environment information, which is conducive to the more refined development of weather services.

Keywords

GIS; SQL Server; meteorological observation data; visualization.

1. Introduction

With the rapid development of meteorological modernization, a large number of modern meteorological detection equipment such as automatic meteorological observation stations, Doppler radars, and meteorological satellites have been put into business use, and the large amount of meteorological detection data acquired is a mixture of time and space. Meteorological information has the characteristics of multiple types, long time series, and large amount of data. It has both temporal changes and obvious geostatistical or spatial distribution characteristics, and its spatial characteristics are well integrated with GIS systems. The values of elements detected by automatic meteorological stations (such as precipitation, pressure, temperature, wind, etc.) are closely related to their geographic location and altitude, and have obvious spatial distribution characteristics. Geographic Information System (GIS) is a new technology combined with database technology It provides an effective tool for the management, analysis and expression of this massive spatial data. The combination of meteorological data and spatial analysis technology makes the meteorological information display system more vivid and concrete [1-2]. This article combines the application requirements of automatic station data, relying on SQL Server2019 bit database, C# as the development language, and the development platform to design and implement a GIS-based automatic weather station information visualization system. The system is efficient and easy to use, and achieves rapid data. Query statistics, visual expression of meteorological information and other functions.

2. The status quo of GIS technology application in the field of meteorology at home and abroad

Geographic Information Technology (GIS) is a new interdisciplinary field describing, storing, analyzing and outputting spatial information. It is a general technology for analyzing, simulating and reproducing various phenomena and processes with spatial characteristics. It

has a very powerful integrated management function of spatial information. , Which can provide powerful spatial data analysis and management capabilities for the networking, spatialization, and standardization of meteorological information management [3-4].

Foreign meteorological departments continue to research and develop GIS technology, and so far have realized the application of GIS technology from the initial data sharing to the development of higher spatial analysis and other meteorological applications; on the GIS platform, NCAR and ESRI have cooperated to establish meteorological Data model; many foreign scholars have developed a series of meteorological application systems based on GIS, such as: Stefanescu V[5] developed a flood forecasting and decision-making system based on GIS technology, and realized real-time flood information with the help of GIS spatial analysis, display, and WebGIS technology Update, release and share to provide information support for meteorological disaster monitoring and early warning.

Judging from the current situation in China, the application of GIS in the meteorological industry has achieved practical results. The applications mainly include time-space integration of massive meteorological data management, meteorological data display and analysis, meteorological data release and sharing, spatial analysis and auxiliary decision-making. aspect. In terms of meteorological applications, such as: FY-3 meteorological satellite ground application system is a combination of GIS and RS, which can generate various remote sensing monitoring products through human-computer interaction, and provide tools for professionals to further in-depth remote sensing data analysis and statistics; Domestic meteorological departments have used GIS to manage massive amounts of meteorological data, realized the storage of discrete meteorological data, grid data and element data based on GIS, and established meteorological thematic spatial databases; MeteoGIS developed by the China Meteorological Administration has also initially solved the problem of meteorological information in GIS Visual expression in.

3. Automatic weather station data

Automatic Weather Station (Automatic Weather Station, AWS) is an unattended ground weather observation station that can automatically observe, report or record regularly. It can conduct 24h real-time observation of up to 54 meteorological elements and collect meteorological data It is an important data source and key reference object in the business operation process of the meteorological department [6]. Automatic weather station data improves the timeliness of observation data, increases the time and space density of observation data, and plays an important role in the monitoring and early warning of small and medium-scale weather systems [7].

Meteorological data can be obtained through various observation methods, so there are many types and formats of meteorological data, and the amount of data is huge. According to different observation methods, meteorological data can be divided into three categories: station observation data, raster data, and feature data. Meteorological data is essentially geographic information, and meteorological elements without geographic location are meaningless. In the meteorological database, a hierarchical data organization method is used to manage spatial data, that is, one layer only manages one element[8]. Conventional stations mainly observe temperature, humidity, wind direction (speed), air pressure, etc. The table structure is shown in Table 1.

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Table 1 Site observation data table structure

Field Name	Field Type	Field description
StationID	Character type	Station No
SDataTime	Time type	Observation time
Tmax	Numerical	Maximum temperature
Tmin	Numerical	Minimum temperature
Pave	Numerical	Average air pressure
...	...	...

There are many observation items and high frequency of observation data of automatic weather stations, which are massive data. As an important management system of the meteorological information sharing platform, the meteorological database is used to manage massive amounts of meteorological data from different business tracks with different spatial information and attribute information, and to provide data services for major institutions. The observation data of conventional stations and encrypted stations are converted into GIS-compatible raster data after spatial interpolation, satellite and radar data, etc., which can realize the spatial expression of discrete observation data. It can be seen from the application flow chart of GIS meteorological data (Figure 1) that various meteorological data are extracted and converted into GIS meteorological data through the data preprocessing system (ETL), and then the GIS meteorological data is stored in the spatial database. , To provide a good data foundation for GIS visualization expression [9].

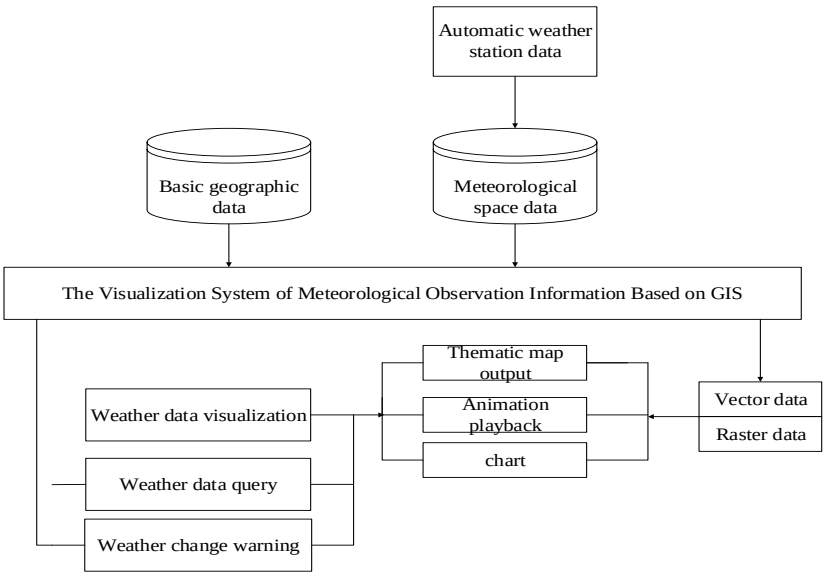

Figure 1 Flow chart of GIS weather data application

At present, the application of automatic station data has the following problems:

(1) Observation data is stored in text files, and data statistics, calculations and tabulations need to be completed manually, and data application efficiency is low;

(2) Data reception, storage, processing, and It is easy to cause data loss and unacceptable phenomena when used on one computer;

(3) Most of the existing meteorological systems do not use GIS technology, the graphics function is weak, the data presentation form is single, and the implementation method is not flexible. Simple and intuitive;

(4) Observation data is not combined with spatial information, and the spatial characteristics are not clear. To this end, GIS technology and database technology are used to provide a stable and fast platform for massive spatial data, and to combine meteorological survey data with

spatial analysis technology to provide weather forecasters with a visualized environment for meteorological data analysis.

4. System overall design

4.1. System structure design

The system uses .Net technology to realize the component-based secondary development of SuperMap, and uses core component modules such as data modules, map modules, data conversion modules, and spatial analysis modules to achieve full operation and processing of GIS spatial data. This component-based The secondary development method not only encapsulates the existing GIS basic operating functions and main module functions into the subject of the system, but can also add component space to realize the addition and application of new functions according to the needs of future development. Due to the large amount of data in meteorological applications, the spatial database uses SQL Server2019 to store the data. The system has a three-tier logical structure of C/S framework system, as shown in Figure 2, which are data processing layer, data storage layer and user operation layer. This three-tier C/S structure realizes the separation of business logic. Compared with the traditional two-tier C/S structure, the main advantages are: high security, high efficiency, and scalability.

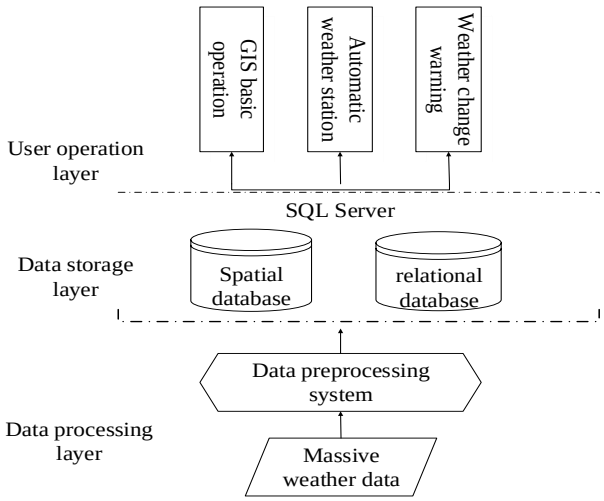

Figure 2 System structure diagram

Data processing layer: It mainly completes the process of efficient processing and conversion of massive meteorological data. Realization: (1) Real-time processing of automatic weather station data, extraction of useful information, and seamless conversion to the GIS platform. (2) The conversion of meteorological data into GIS data requires operations such as spatial analysis, surface analysis, and geometric clipping to obtain spatial surface data that can be used for querying various meteorological elements, so as to realize the spatial map visualization of the query result data.

Data storage layer: mainly constructs a spatial database and a relational database platform, and stores and manages data of different types of spatial data and basic geographic information data obtained in the data processing layer through GIS. In the data storage layer, various meteorological data are stored in GIS data format to realize seamless connection with basic geographic information data, providing a unified GIS data service platform for the spatial visualization of meteorological data.

User operation layer: Use the stored spatial data to realize GIS spatial visualization, query and other operations. At the user level, there are two main forms: (1) Obtaining meteorological data

in real time, visually expressing and superimposing display based on geographic information. The most basic principle is to ensure the real-time release of the result data; (2) Inquiry of meteorological elements. Various forms of user operations are not real-time, and based on the space weather data platform, the GIS-based query processing and display of various weather data elements are completed according to needs.

Through the above three-layer logical structure design, the foundation has been laid for the realization of the overall structure of the system C/S. Among them, the data processing layer and the data storage layer are used as the data service layer, which not only solves the fusion problem of various meteorological data and GIS, but also completes the efficient organization, storage and management of various meteorological data, and eliminates the difference between meteorological data and GIS. Data issues provide a data platform for the visualization of weather information based on GIS on the user side [10-11].

4.2. Main functions of the system

In addition to basic geographic operation functions such as zooming, measurement, management, and attribute query, the main functions of the system also include the following core functions:

(1) Data processing function: It mainly includes file decoding and storage, data statistics, quality control, etc. It adopts background automatic operation mode, which is conducive to real-time monitoring of the value of some meteorological elements and automatic weather station data update processing.

(2) Data query function: The query function of the automatic weather station mainly includes direct query of routine observation live data such as temperature, humidity, wind, and pressure, and statistical query of daily value data and precipitation data. The multi-element query function in the automatic weather station query function (see Figure 3) mainly realizes the detailed data and statistical values of temperature, rainfall, wind speed, wind direction, and air pressure of a single station, as well as the average, maximum, and small values of the entire station query. statistics.

(3) Meteorological data visualization expression function: The graphical data query results mainly use GIS mapping method, superimpose basic geographic information data, form the effect of color pattern, realize the function of spatial distribution map, and the process of spatial distribution map is shown in Figure 4.

(4) Monitoring and early warning function: The system implements early warning for the three meteorological elements of high temperature, strong wind and heavy precipitation. When the warning value is exceeded, it will alarm in real time.

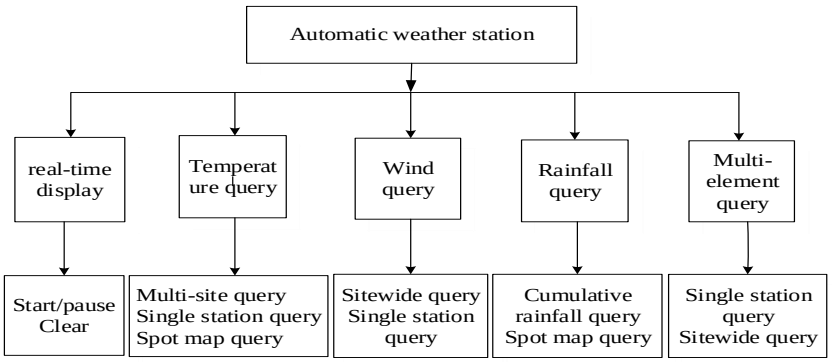

Figure 3 Automatic weather station query function

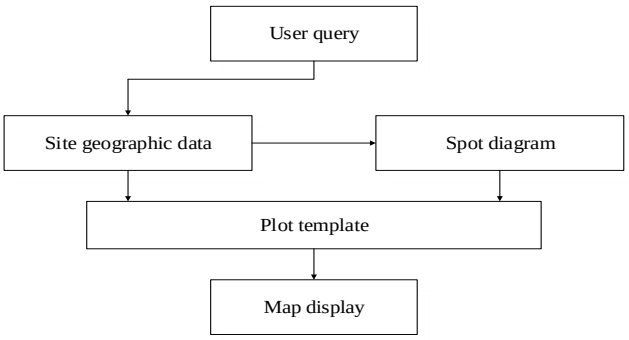

Figure 4 Process of spatial distribution map

5. Conclusion

This paper uses C# as the development language, SuperMap as the component GIS development platform, and uses SQL Server 2019 database management tools to develop and implement the design of a GIS-based weather detection information visualization system. The GIS method is used to visually display massive meteorological data based on space, which provides a new display method for the query, display and use of meteorological data. In terms of the visual expression of meteorological data, in addition to the traditional charting method, GIS thematic mapping technology is adopted to form a static or dynamic map expression, which realizes the expression of the spatial characteristics of meteorological data, and provides a wealth of map storage functions. The output and use of data provide the possibility to display meteorological information in a timely, accurate, omni-directional, and multi-perspective manner to provide better services for meteorological work.

The system has the advantages that traditional weather software does not have:

(1) It uses database technology to store various weather data, which is convenient for the query and use of weather data;

(2) It adopts GIS visual mapping expression, so that the visual expression of weather data has Better space characteristics can provide more effective information services for the meteorological industry;

(3) The weather warning function added according to the demand is relatively more comprehensive than the traditional system, which improves the efficiency of use and promotes the work of meteorological services. Develop towards refinement.

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