Dynamic Update Exploration and Discussion of Basic Geographic Information Data Based on Multi-Source Data Fusion

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Abstract. Basic geographic information data is an important part of natural resources investigation and monitoring, and the basic guarantee for realizing the management function of "two unifications". Aiming at the problem of low integration efficiency caused by different types of geographic information data, this paper proposes to carry out a comprehensive dynamic update research on geographic information data. Using unified database templates, extraction specifications, extraction processes and fusion warehousing standards, the dynamic update of geographic information data is studied on the integrated production platform, which greatly improves the efficiency of data fusion, so that the application value of geographic information data can be maximized.

Keyword. multi-source data; monitoring of geographical conditions; Integrate into storage; Dynamic updates

1. Introduction

In recent years, the basic geographic information data has become increasingly rich, and at the same time, under the continuous innovation and development of computer and surveying and mapping geographic information technology, the acquisition methods of multi-source geographic information data have also been expanded, and the results obtained have also shown diversified characteristics. In addition, the Ministry of Natural Resources undertakes two responsibilities of "unified exercise", namely, "the unified exercise of the rights of natural resource right holders, the exercise of land space, ecological protection and restoration, focusing on solving the problem of insufficient rights holders and overlapping spatial planning," and realizing the integrated protection of "mountains, forests, fields and grasslands", systematic restoration and comprehensive rectification. Geographic information data will play an important role in data support and guarantee, providing a valuable data source for the integrated management and protection of "mountains, forests, fields and lakes".

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2. Classification of multi-source data

2.1 Paper map

All kinds of paper maps constitute the main body of the data, in the use of these data, generally according to the topic to classify them, now in the production process, the main map data used are: first, a series of scale topographic maps, it is the basis of basic geographic information, in general, need to be comprehensively plotted on these topographic maps, and the content of some other data plotted on the paper map. Second, in 1998, the Xi'an Bureau of Surveying and Mapping used the 1:500,000 traffic volume database to revise various thematic maps and produce a new version of the traffic volume map of each province, which can be used to supplement the traffic volume of small and medium-scale maps. Third, marine maps, important materials for the revision of marine map elements, are all uniformly printed by the Navy Publishing Company[1]. The chart revision system is complete, timely, and authoritative. The commonly used nautical chart scale is 1:200,000, 1:500,000, 1:1 million, and the chart tile is not carried out according to the conventional topographic map tiling method, but uses the Mercator projection method to carry out arbitrary tiling in the drawing area. Fourth, the compilation of various maps, such as the "Standard Geographical Names Atlas of Political Regions of the People's Republic of China" jointly compiled and printed by the Xi'an Bureau of Surveying and Mapping and the Ministry of Civil Affairs, includes all the geographical names and residences of townships and towns in China, and is the most authoritative atlas, which includes the names of cities, counties, villages and communities in various parts of China, and can be used as supplementary materials for the annotation of places of residence and geographical names.

2.2 Map vector data

Through map vector data, the rapid collection of basic geographic information is realized, and the required data processing and transformation work is realized. However, from the existing various map libraries, electronic maps and other aspects, its development status is not satisfactory. For example, around 1980, updating a map database was a very difficult thing to do, and it was much more difficult than building a database[2].

The calculation formula for collecting map vector data is usually related to measurement and coordinate conversion. Here are some common calculation formulas:

Distance calculation: In the collection of map vector data, it is often necessary to calculate the distance between two points. The formula for distance calculation can vary depending on the selection of the Earth model[3]. The following is the formula for calculating spherical distance (in longitude and latitude coordinates):

$$D=R * \arccos (\sin (lat1) * \sin (lat2)+\cos (lat1) * \cos (lat2) * \cos (lon2- lon1)) \quad (1)$$

Where, d represents the distance between two points, lat1 and lat2 are the latitude of the first point and the second point respectively, lon1 and lon2 are the longitude of the first point and the second point respectively, and R is the Earth radius.

Area calculation: When collecting map vector data for polygonal areas, it may be necessary to calculate the area of the area. The formula for area calculation can vary according to the Map projection method used[4]. The following is a simplified formula for area calculation (taking the plane coordinate system as an example):

$$A=0.5 * | (x1 * y2+x2 * y3+...+xn * y1) - (y1 * x2+y2 * x3+...+yn * x1)| \quad (2)$$

Among them, A represents the area of the polygon area, (x1, y1), (x2, y2), (xn, yn) is the vertex coordinates of the polygon.

Coordinate conversion: In the collection of map vector data, coordinate conversion is often required to convert coordinates from different coordinate systems to the target coordinate system. The formulas for coordinate conversion usually involve projection conversion parameters and coordinate system conversion formulas, which vary depending on the coordinate system and conversion method used.

It should be noted that the calculation formulas for map vector data collection can be more complex and diverse, depending on the target of collection and the technology used. In practical applications, suitable calculation formulas can be selected for data processing and analysis based on specific needs and the software or tools used.

2.3 Car GPS road data

Through the on-board GPS positioning system, road surface information can be obtained quickly and accurately. In 2000, the State Bureau of Surveying and Mapping used vehicle-mounted GPS to create a national traffic artery network database containing information on provincial and national roads throughout the country (township road data is being collected).

The calculation formula for vehicle GPS road data usually involves the calculation of position and direction. The following are some common formulas for calculating vehicle GPS road data:

Distance calculation: Vehicle mounted GPS can obtain the length of the road by calculating the distance between two location points. The formula for distance calculation can vary depending on the choice of coordinate system and Earth model[5]. The following is a simplified formula for calculating the distance of a planar coordinate system:

$$D=sqrt ((x2- x1) \wedge 2+(y2- y1) \wedge 2) \quad (3)$$

Among them, d represents the distance between two position points, and (x1, y1) and (x2, y2) represent the coordinates of the two position points.

Direction calculation: Vehicle mounted GPS can determine the direction of the road by calculating the direction between two location points. The formula of direction calculation can use Trigonometric functions to calculate the direction angle. The following is a simplified direction calculation formula (using longitude and latitude as coordinates):

$$\theta = \text{Arctan2 (sin (lon2 lon1) * cos (lat2), cos (lat1) * sin (lat2) - sin (lat1) * cos (lat2) * cos (lon2 lon1))} \quad (4)$$

Among them, θ Represents the direction angle between two position points, with lat1 and lat2 being the latitude of the first and second position points, and lon1 and lon2 being the longitude of the first and second position points, respectively[6].

It should be noted that the calculation formula for vehicle GPS road data may vary depending on specific application scenarios and algorithms. In addition, in car GPS systems typically consider parameters such as acceleration, heading angle, and position change rate to provide more accurate road data calculations. In practical applications, suitable calculation formulas can be selected for data processing and analysis based on specific needs and the vehicle GPS system used.

2.4 Remote sensing imagery

In recent years, with the continuous improvement of satellite remote sensing technology, satellite remote sensing data has higher resolution and richer information, which has become a hot spot in cartographic research [3]. Satellite remote sensing data has been widely used in the production of satellite image maps, and the updating and revision of various thematic maps, general maps, aeronautical charts, topographic maps, and the drawing of nautical charts in shallow seas are all new types of cartographic resources.

Remote sensing image acquisition involves multiple factors such as sensor parameters, platform motion, and Earth curvature. The following are some common calculation formulas for remote sensing image acquisition:

Spatial resolution calculation: Spatial resolution refers to the smallest spatial unit size that can be resolved in remote sensing images, usually measured in meters. [7]The calculation formula for spatial resolution is as follows:

$$SR=(GSD * H)/F \tag{5}$$

Where, SR represents the spatial resolution, and GSD is the Ground sample distance, that is, the actual distance corresponding to each pixel of the sensor on the ground; H is the height between the platform and the ground; F is the focal length of the sensor.

Band resolution calculation: Band resolution refers to the minimum wavelength unit size that can be resolved in remote sensing images. The calculation formula for band resolution is as follows:

$$BR= \lambda / \Delta\lambda \tag{6}$$

Among them, BR represents the band resolution, λ At the center wavelength, $\Delta\lambda$ Is the band width.

Time resolution calculation: Time resolution refers to the time interval between repeated observations of the same area by remote sensing systems. The calculation formula for time resolution is as follows:

$$TR=T/(N-1) \tag{7}$$

Among them, TR represents the time resolution, T represents the observation time span, and N represents the number of observations.

It should be noted that the calculation formula for remote sensing image acquisition may vary depending on factors such as sensor type, platform motion mode, and acquisition parameters. In addition, in actual collection, it is also necessary to consider factors such as sensor characteristics and changes in the Earth's surface. In practical applications, suitable calculation formulas can be selected for data processing and analysis based on specific remote sensing systems and collection needs[8].

3. Key technologies

3.1 Multi-source data extraction

3.1.1 Extraction method

Multi-source data extraction refers to a method of superimposing, transforming and extracting multi-source data into basic geographic information data, which contains five aspects: unifying the coordinate system, establishing a database template, establishing a multi-source data structure, extracting fusion data, and extracting the change information in the data [9]. The specific process is shown in Figure 1.

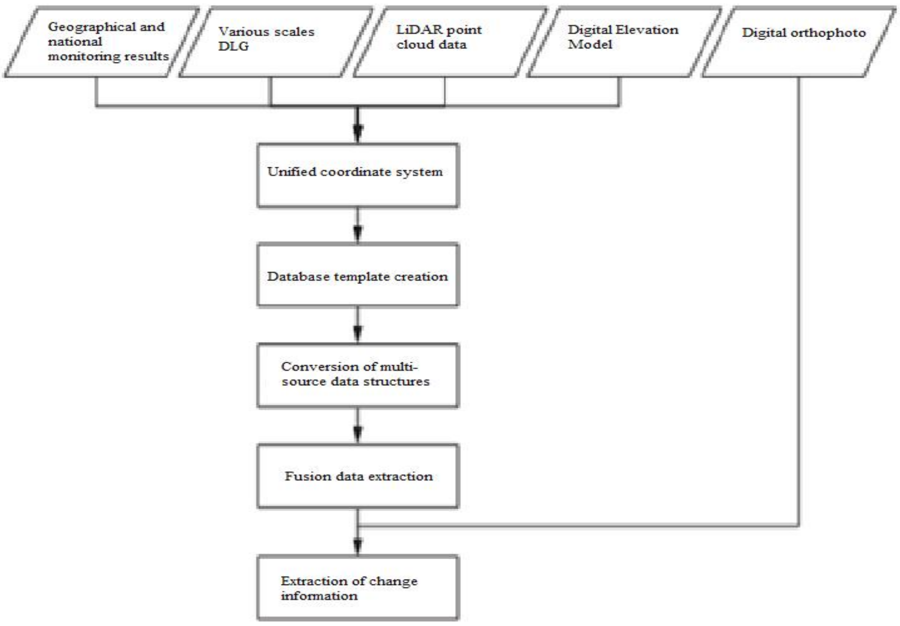

Figure 1 Multi-source data extraction flowchart

3.1.2 Extraction of main elements

Geographical national conditions refer to the analysis, research and description of national conditions from the perspective of geography, that is, the spatial changes of natural, biological and human phenomena on the surface of the earth, as well as their interrelationships and characteristics, as the most basic content. The geographical national conditions survey mainly collects natural and human geographical factors in all regions of the country, including vegetation cover, waters, deserts and bare land. Among them, the territoriality of human beings includes transportation networks, places of residence and infrastructure, and territoriality closely related to human behavior. Among them, DLG data contains 37 data layers of nine types, including orthophotos, thematic data, and production metadata associated with them. A digital elevation model is a reality model that represents the height of the earth's surface in a series of regular sequences of numbers. Among them, there are eight data sources, including water systems, settlements and infrastructure, roads and pipelines, realms and political regions, topography and landforms, vegetation and soil textures, and place names. Each element layer needs to be combined with geographic conditions, various scale DLGs, LiDAR point clouds, digital elevation models and other data for fusion extraction, and refer to digital orthophotos to extract them variation.

3.2 Data Consolidation

Because the extracted multisource geographic information data has different spatial associations, it needs to be edited appropriately. On this basis, based on the digital orthophotogram, the extracted basic geographic information data is edited, and the vector elements are input with attributes, including the editing and input of field mapping data and extracted multi-source metadata. The main ways to edit vector elements are: create new solids, trim line elements, disassemble polygon elements, patch hanging points, and patch pseudo-nodes. Attribute input adopts batch processing and human-computer interactive input methods, batch processing means that similar attributes that have undergone multi-source data structure transformation, such as name, national standard classification code, number of lanes, width, etc., can be used during data extraction. Other attribute information that needs to be manually judged together with the reference data can be entered by human-computer interaction such as type, number of layers, specific high value, angle, etc.

3.3 Data fusion into storage

Multi-source data fusion and warehousing refers to the work of storing the collected and edited data into the new geographic information data in accordance with the data specifications in the new database. On this basis, a method based on multi-source data extraction is proposed, that is, the initial database of multi-source data is established, and the data fusion database is the unified integration of the initial database of multi-source data. Data integration and warehousing includes several steps such as data fusion, data storage, data connection, and data inspection [10]. The added element data needs to be merged to prevent the same element from appearing repeatedly. Among them, vector polygons and vector lines are fused with their related attribute information. For data generated from drawings, after each drawing is generated, images and attributes need to be edged to ensure continuity of fused inbound data. Before and after the integration data into the warehouse, some data inspection work must be carried out, and before entering the warehouse, the data should be checked to ensure that the information from various sources meets the basic requirements of the warehouse; After the integration into storage, the inspection is the final data check, in order to ensure the consistency of all aspects of standards and the complete accuracy of the data, the specific contents are: data integrity check, logical consistency check, position and attribute accuracy check, surface check, topological relationship check, etc.

4. Production solutions

4.1 Integration of production platform

Using the technical method of multi-source data fusion, the data generated by various field data (such as GPS, total station, electronic tablet, VirtuoZo, JX4, Mapmatrix, Inpho, Pat-B, etc.) is processed to realize CAD Direct editing and conversion of data in the system. By realizing seamless data exchange and storage update integration with existing geographic information data, the integration of image library and map ownership is truly achieved, which greatly improves the production efficiency of the project.

4.2 Gallery integration

Based on the integrated production platform, the use of bone line symbolization technology can accurately express the feature symbol without adding additional auxiliary entities, and the drawing of data can be well controlled, so the data in GDB or MDB format with general significance can be directly generated [11]. Based on the database, the chart is completely represented, which makes data processing more intuitive and convenient, and greatly reduces the risk of data errors caused by operation errors. In the whole process, the same set of data is used, which completely solves the problem of separation of library data and mapping data, and only one set of data is maintained, which can not only meet the storage standards, but also meet the requirements of drawing, so as to truly achieve the purpose of library integration.

4.3 Database dynamic update

Dynamic update module is a Web-based integrated spatial data management and update module, which uses direct access and update to the cloud database, so that the data update process and operation are simplified to the greatest extent, so as to achieve a lightweight data update method, to ensure that in the entire process of production and storage, the data is saved in the database format, so that it can well prevent data loss and accuracy loss caused by the transfer of data between different platforms and different formats As shown in Figure 2. On this basis, a method of multi-person online collaborative work is proposed, and automatic conflict detection technology is used to enable the work results of each node to be updated in real time. Based on the dynamic update module, from data generation to data warehousing and then to data update, a complete closed-loop system of data flow is formed, which ensures the status quo and accuracy of the managed database to the greatest extent, so as to provide data guarantee for the release and application of surveying and mapping related services[12].

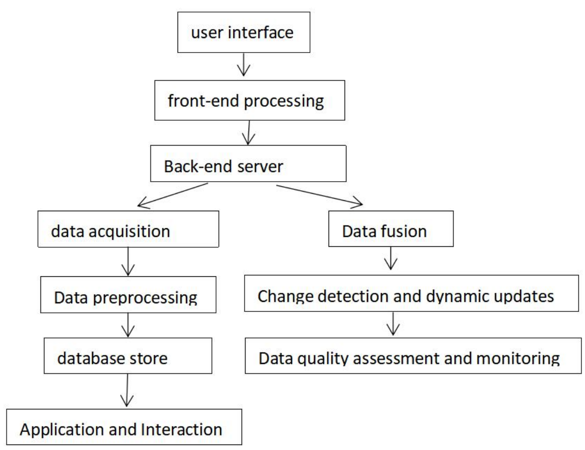

Figure 2 Schematic diagram of the dynamic update process of the database

5. Conclusion

In summary, in view of the actual needs of a wide range of multi-source geographic information data types, research on the extraction, integration and update methods of multi-source geographic information data is carried out to achieve rapid and efficient geographic information data integration, ensure the current trend of geographic information data, provide new ideas for the development of new geographic information data technology, and make geographic information data technology achieve greater development in national and social development.

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