Design of Geographic Entity Database of 3D Real Scene About Xi'an City

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Abstract: New fundamental surveying & mapping and the construction of 3D real scene construction have set off a new wave in our country. As one of the pilot cities of new fundamental surveying & mapping, the Xi'an pilot closely focuses on the six pilot tasks approved by the Ministry of Natural Resources to carry out real construction of 3D real scene about Xi'an city. As an important part of the whole life cycle of geographic entity data, the geographic entity data database stores and manages multi-source heterogeneous data from the upstream production update system, builds the association relationship between geographic entity data, and assembles derivative 3D standard products and application products as required, providing continuous data blood for the "The Service Platform of 3D real scene about Xi'an city ". This paper mainly studies the design of the Xi'an geographical entity database, including the overall design, logical design, management system design, etc. It takes the geographical entity as the core and the geographical entity ID code as the link to realize the multi-source heterogeneous geographical entity data polymorphism organization and management.

1 INTRODUCTION

Global digital development is accelerating, 'space-time information, positioning and navigation' service has become an important new infrastructure. As a standard product of new fundamental surveying & mapping, 3D real scene provides a unified spatial positioning framework and analysis basis for digital China. It is an important strategic data resource and production factor for digital government and digital economy. Recently, in China, the new fundamental surveying & mapping and 3D real scene rise gradually. Shanghai, Wuhan and other cities as a pilot city have been approved. In order to actively respond to the call and accelerate the pace of achieving this goal, Xi'an city submitted an application, and were approved as a new fundamental surveying & mapping pilot city by the Ministry of Natural Resources on November 9, 2020. Around the six tasks, Xi'an pilot will establish a new fundamental surveying & mapping database, and build a real three-dimensional Xi'an city service platform, also form a set of policy standards, carrying out three demonstration applications and six types of knowledge service. Finally, '1+1+1+3+6' pilot results will be completed.

According to a series of standard documents issued by the Ministry of Natural Resources, such as 'new fundamental Surveying & Mapping Database Construction Technical Guide', 'The Construction Technical Outline about 3D Real Scene of China', 'The Database Construction Specification about 3D Real Scene', With geographical entities as the unit, the establishment of a 'multi-functional, on-demand assembly' time-space database has become an important pilot content.

2 DESIGN GOAL

Based on the Xi'an pilot implementation plan, according to the new needs of urban natural resource management and urban informatization development, The geographic entity database about the 3D real scene of Xi'an and its management system with the characteristics of 3D, entities and semantics are established. Also, this database has the following characteristics, such as ground underground

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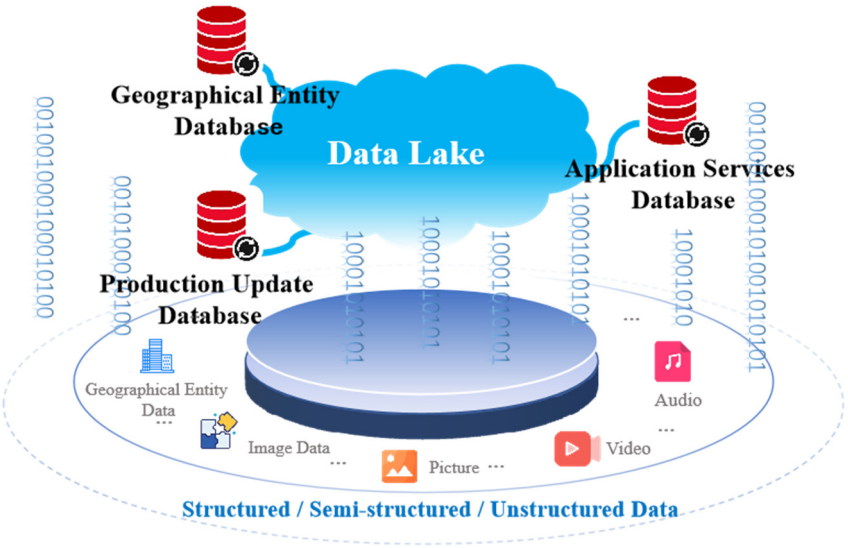

Figure 1: The ' Data Lake ' System of 3D real scene about Xi'an.

integration, indoor and outdoor integration, two-dimensional and three-dimensional integration, and spatial information and attribute information integration.

3 OVERALL DATABASE DESIGN

The database of 3D real scene about Xi'an using the technology of data lake and data warehouse integration (Fig.1), converge the time-space information including full space, full elements, the whole process. Also, this information is real, three-dimensional and sequential. The management system can build a knowledge graph among geographical entities to help intelligent applications, and also can achieve a database of multiple functions, as needed to assemble a variety of standardized products and the thematic products. It is deployed in the internal network environment of Xi'an Surveying & Mapping Institute, through the private cloud for centralized storage, physical isolation with the external network. Data is transmitted through the service platform application library deployed by the ferry machine to the external network.

The database mainly includes geographic entity achievement database, 4E standardized product database, IoT perception database and governance database. The specific data types stored in each database are as follows:

(1) The geographic entity achievement database is used to store the full amount of data after quality inspection, including four categories of geographic entity data.

(2) The 4E standardized product database is used to store the products derived from the achievement sub-database according to the needs, including the combined aggregation entity set, the stepless map expression, the terrain level 3D real scene products and the city level products.

(3) The IoT sensing data database is used to store real-time sensing data of natural resources, urban IoT sensing data and Internet online capture data, which are associated with sensor entities to provide dynamic geographic scenarios.

(4) The governance data database is used to store the supporting data needed in the data governance process, including metadata, data dictionary, index data, entity management data, as well as system management, security authentication, rights management, and log records for the entire database operation and maintenance support.

4 LOGICAL ARCHITECTURES

According to the classification of geographic entities in Xi'an pilot, the achievement database of geographic entity database can be divided into four sub-databases: object entity sub-database, geographic unit sub-database, geographic scene sub-database and spatial grid sub-database. The data

contained in each sub-database is as follows (Fig.2):

(1) The ground feature entities database includes seven sub-databases: water system, residential area and facilities, transportation, integrated pipeline, landform, vegetation and soil, and place name and address entities.

(2) The geographical units database includes eight sub-databases: administrative division unit, landform unit, natural and cultural protection zone, fundamental geology unit, social comprehensive management unit, land and sea unit, planning unit and real estate unit.

(3) The geographic scene database includes seven sub-databases: DOM, TDOM, DEM, DSM, oblique photography 3D model, 3D laser point cloud, panoramic image (street view).

(4) The spatial grid database includes three sub-databases: The latitude and longitude, the plane grid, and the three-dimensional grid.

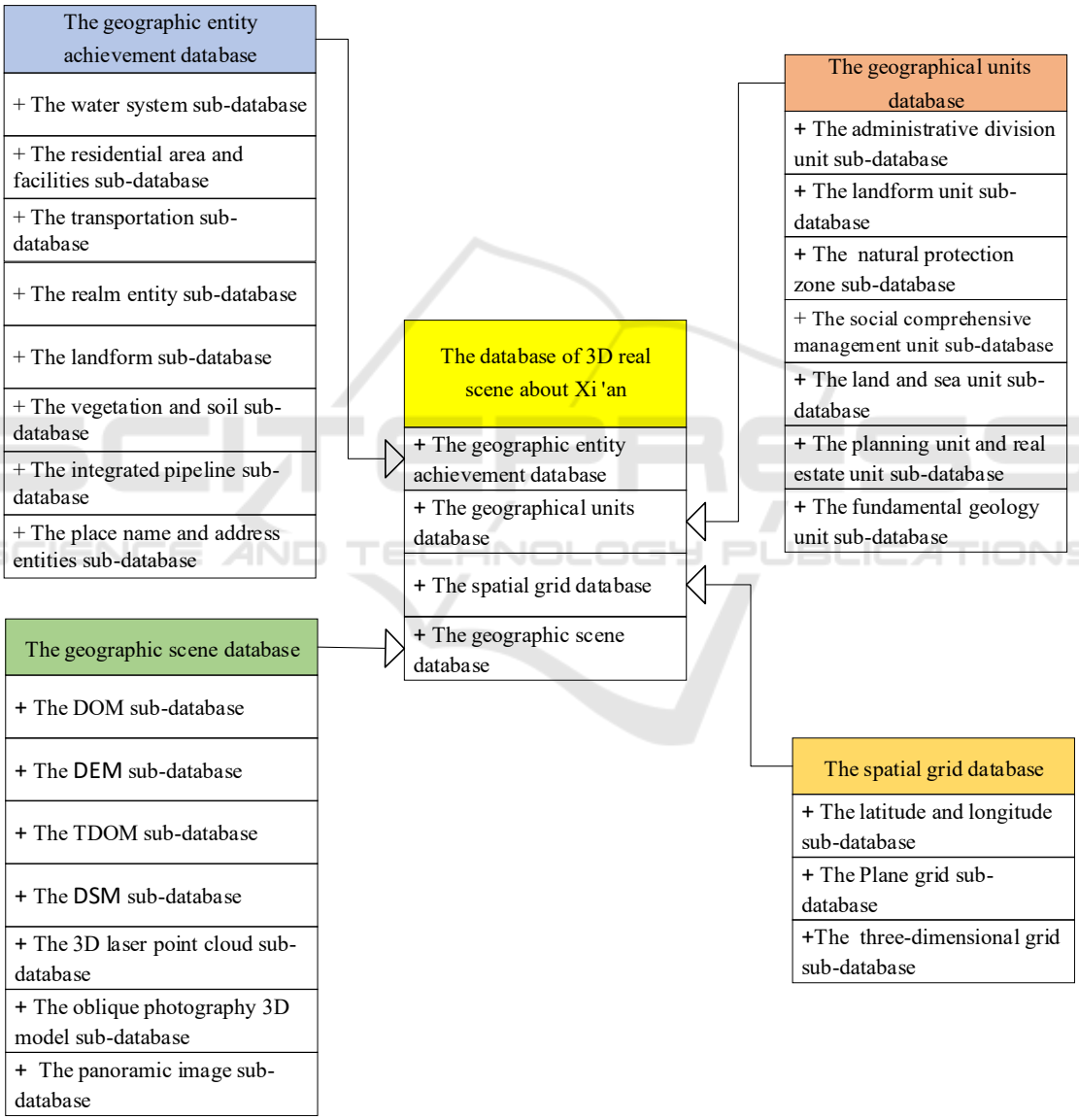

Figure 2: Logical architecture of geographic entity database about Xi'an city

5 MANAGEMENT SYSTEM FUNCTION DESIGN

The geographic entity database management system (DBMS) of 3D real scene about Xi'an city is used to establish, use, update, manage and maintain the geographic entity database. Ensuring the security of database and management system, the database is controlled uniformly to effectively manage massive heterogeneous data and keep the database data current. At the same time, the history and version of the data are reasonably organized to meet the application requirements of high availability, high throughput and random read and write of database data. Through unique spatial identity coding, fast coarse positioning, efficient retrieval and attribute attachment of geographic entities are realized. Using two-three-in-one visual graphical interface to achieve geographic entity data browsing and query, multi-user concurrent access control and recovery database. The main function modules of the database management system are shown in the Fig.3.

(1) Database configuration module

The connection information of the database can be created and configured, and the connection information can be managed. Also, metadata templates can be created, edited and managed. Users can create metadata templates according to business requirements and establish the relationship between metadata and entity data. At the same time, data dictionaries can be created, edited and managed, including entity classification dictionaries, entity relationship dictionaries, etc. The functions of the common spatial geographic data format conversion and the coordinate conversion are developed to ensure that data can be in and out of the database.

(2) Database building module

Entity data is checked before storage, including organizational structure standardization inspection, naming specification inspection, attribute value filling specification inspection, primitive topology relationship inspection, etc., to ensure data integrity, logical consistency, spatial accuracy and attribute accuracy.

While the entity data is stored in the database, the geographic entity object is given a unique identity code calculated according to the geographical location. The geographic entities are linked to related two-dimensional data, three-dimensional data, IOT sensing data, industry management and other multi-source data through this code.

(3) Asset management module

All data assets through the asset directory are visually displayed, and the target data of concern can be quickly located. The status quo and use of all data assets can be classified and counted, and then the changes in asset information and asset statistics details can be found out. After statistical summary, the final report can be generated.

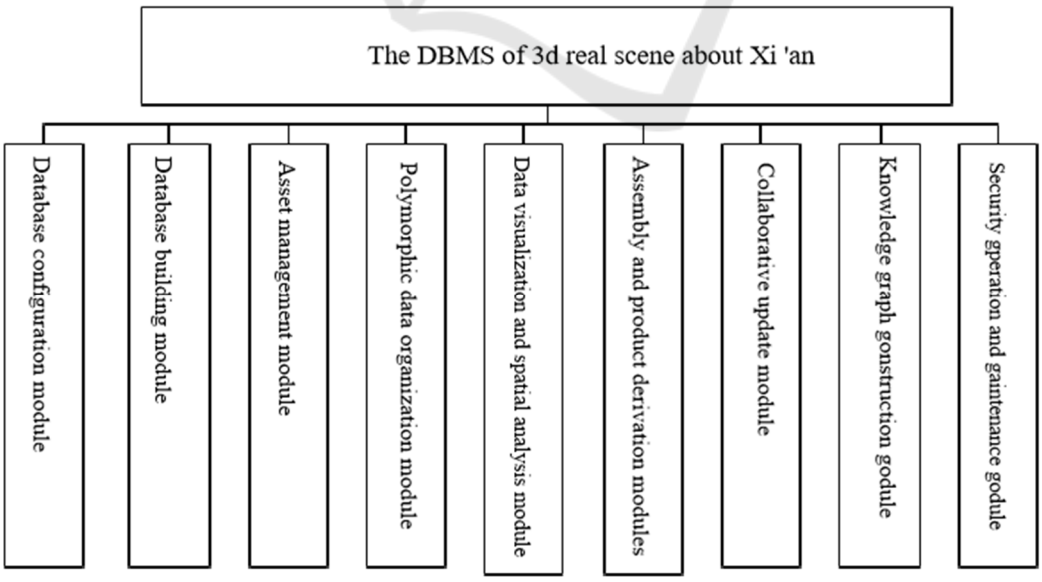

Figure 3: The functional module of DBMS about Xi'an city.

(4) Polymorphic data organization module

Geographical entities can realize the expression of different historical time and different spatial forms with the unique identifier as the link. The stored geographic entity vector, image, 3D model data and other spatial form data are associated and organized by unique identification code, forming the comprehensive structural data that can find all data forms. The data generated in the whole life cycle of geographical entities from generation to loss is temporally managed.

(5) Data visualization and spatial analysis module

The target resource directory can be quickly located based on the search, and the target geographic entity is highlighted in the view area. Then click on it, in two-dimensional visualization interface display. At the same time, the scene data, such as DOM, TDOM, DEM, DSM and so on, can be queried and browsed, and can also be retrieved according to the specified spatial range. Geographic entity attribute information and knowledge graph information can be queried in the visual view area. Common spatial analysis functions such as spatial measurement, overlay analysis, and spatial statistical analysis can be performed.

(6) On-demand assembly and product derivation modules

The package assembly can be realized according to the themes of natural resources, transportation, water conservancy, civil affairs and other industries, as well as the themes of education, medical care and health. Also, the custom assembly can be realized by filtering according to the scope of interest, the address of interest place name or even semantic conditions. At the same time, terrain-level, city-level and component-level 3D products can be derived. Traditional topographic map products and national and provincial fundamental geographic entity products also can be derived through stepless mapping technology to achieve the goal that a geographic entity is only measured once.

(7) Collaborative update module

Through image change discovery and internet change discovery technology, the geographic entity targets to be updated is acquired, and the update collection is completed by means of the crowdsourcing software system. Before updating the entity, it is necessary to determine whether it is spatial information update or semantic information update. For the newly added geographic entity, the geographic entity needs to be initially encoded and then stored; For the updated and modified geographic entities, it is necessary to find the original geographic entity in the database, record its demise time, and then encode the updated geographic entity to ensure that it is not repeated with the data encoding in the entity library, and then store the updated geographic entity.

(8) Knowledge graph construction module

Using the ID card code as the unique identifier of the geographic entity, the data association is established through batch construction or human-computer interaction based on spatial relationships, generic relationships, and temporal relationships. Then, the geographic entity big data relationship graph is constructed and stored in the database. Search Interest Knowledge graph of geographic entities, you can flexibly click on the geographic entities on the map, linkage in the view highlights and query the relevant attribute information.

(9) Security operation and maintenance module

Users can be added, enabled, disabled, deleted by the system administrator, and different user types and functional permissions can be set. At the same time, it can set and manage the scope, content and usage time of users ' browsing and editing data. It supports task flow operation log and operation and maintenance monitoring log, and supports log query and export, which can be used as the basis and evidence for system security review. Full backup and incremental backup of database system can be carried out to deal with data loss caused by various accidents. Also, the monitoring, management and self-repairing of all software and hardware information in the distributed cluster system can be realized through the unified interface.

6 CONCLUSION

The geographic entity database of 3D real scene about Xi'an city is an important part of the national new fundamental surveying & mapping Xi'an pilot construction. Closely around the building requirements of the Ministry of Natural Resources, the scientific management of geographic entity data, efficient update, knowledge map construction, etc. have been explored, and ultimately achieve ' one library multi-functional, on-demand assembly ' goal. This Study will help the transformation and upgrading of fundamental surveying & mapping in

Xi'an, and provide reference, replicable and replicable experience for other new fundamental surveying & mapping pilots.

REFERENCES

Letter No.924 from the Ministry of Natural Resources of the People 's Republic of China on approving Xi’an as a pilot city for new fundamental surveying & mapping construction.

Natural Resources Office Letter No.1578, Technical Guide for Pilot Construction of New Fundamental Surveying & Mapping System Database [S].

Construction Technology Outline of 3D Real Scene about China [S].

The Database building Specification of 3D Real Scene [S].

Xi'an pilot Implementation Plan of national new fundamental surveying & mapping construction [R]. Xi’an: Xi’an Institute of Surveying & Mapping, 2020.

Preliminary design scheme of Xi’an pilot project of national new fundamental surveying & mapping construction (feasibility study report) [R]. Xi’an: Xi’an Surveying & Mapping Institute, 2021.

National new fundamental surveying & mapping construction Xi’an pilot fundamental geographic entity classification code [S].

National new fundamental surveying & mapping construction Xi’an pilot fundamental geographic entity data specification [S].

GB-T18578-2016, urban geographic information system design specification [S].