

Design of and Research on underground pipeline system in campus based on 3DGIS

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Abstract. The underground pipeline of campus is an extremely complex and huge system, and the traditional pipeline management mode can no longer meet the requirements of campus development and planning. The 3D geographic information visualization method can accurately describe the location and distribution information of various pipelines and spatial features, which can better serve the management of underground pipelines on campus. This paper designed overall framework and technology framework of underground pipeline information system, the system is satisfied with the PC, Web, mobile terminal and other multi-client access. In this paper, the key technology points of underground pipeline system construction on campus are comprehensively analyzed, and the feasibility of the technology is verified by combining with the practical application of underground pipeline system in lanzhou university.

1 Introduce

Campus underground pipeline is similar to urban underground pipeline, which is an extremely complex and huge system [1], including water supply and drainage system, power supply system, thermal system, communication system, all kinds of pipelines, etc.. Due to its age, all kinds of underground pipelines in the old campus crisscrossing and complex spatial relations [2] are more complex than municipal pipelines, and the traditional pipeline management mode can no longer meet the requirements of campus development and planning. GIS can accurately describe the location and distribution information of spatial features, provide powerful spatial retrieval and analysis ability, and can better serve the management of underground pipelines on campus.

Based on 3DGIS technology, this paper designed the overall framework of the underground pipeline information system on campus, and used the front and back separation technology to realize a set of code framework, which is satisfied with the access of multiple clients such as PC terminal, Web terminal and mobile terminal. This paper analyzes the key technology points of underground pipeline system construction on campus, and further verifies the feasibility of the technology by combining with the practical application of underground pipeline system in lanzhou university.

2 The system design

2.1 System framework design

According to the management requirements of underground pipelines on campus and the design principles of the logic framework of the information system, the 3D underground pipeline system on campus is composed of resource layer, data layer, platform service layer, application layer, client layer, standard specification system and operation and maintenance guarantee system, as shown in figure 1.

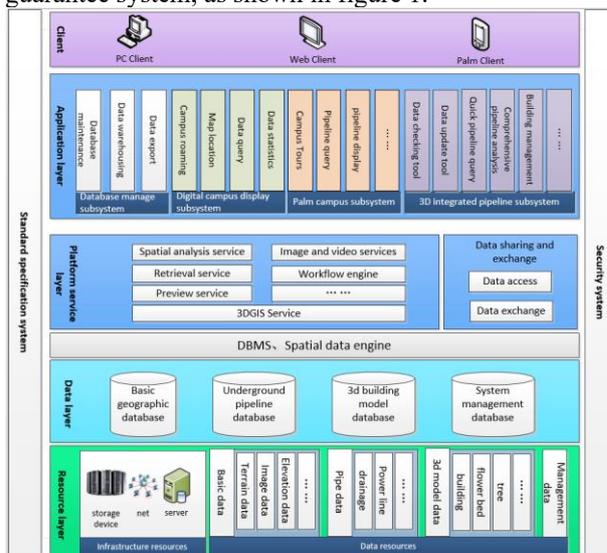


Fig. 1. System framework

Resource layer: (1) Infrastructure can be subdivided into hardware facilities, network and communications. Hardware facilities mainly include network, host (server)

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and so on. Use virtualization and clustering techniques to consolidate all resources into a single reusable resource pool. (2) The data resources include digital topographic map, remote sensing image data, digital elevation model, pipeline data (water supply, drainage, industrial, heating, electric power, communication, etc.), 3d model data (campus buildings, road surface, flower beds, sketch, trees, light pole, parking), etc. (3) System management data includes user, log, system operation and other data information.

Data layer includes four entity databases: (1) basic geographic database; (2) underground pipeline database; (3) 3d building model database; (4) system management database, etc.

The platform service layer mainly includes 3D GIS service, form engine, search engine, workflow engine, preview service and so on.

Application layer includes four subsystems: database management subsystem, digital campus display subsystem, palm campus subsystem, 3d integrated pipeline subsystem.

The client layer includes users of various departments, and the client forms (PC, browser and mobile terminals).

Formulate relevant information standard system, including information collection, consolidation, information storage and other aspects. Establish the operation, maintenance, management and security system for the project, from technical measures, security system, to ensure information security and reliability and continuous operation of the business.

2.2 Technical architecture design

The overall technology architecture adopts the design idea of microservice architecture and the current mainstream.Net technology line, which meets the requirements of cross-hardware platform and cross-operating system. The system technical architecture is shown in figure 2.

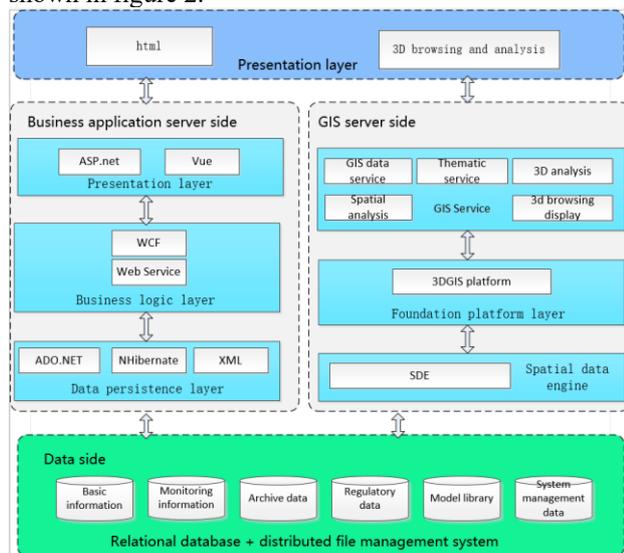


Fig. 2. Technical architecture

In the technology system, the application support platform adopts the core technologies such as

WebService[3], AJAX[4], NHibernate[5], EXTJS and persistence layer framework, which not only guarantees the advancement of technology but also considers the practicability of technology. At the same time, the component development technology is adopted to make the independent business components be organized together to form a complete business system through Webservice, XML and other loosely coupled communication methods. Data Access Object (DAO) is used to Access the database; asynchronous task is used to handle long time requests; O-R Mapping technology is used to ensure the scalability of the public database; XML and Webservice are used as the Data publishing standard.

2.2.1 Platform and secondary development tools

Advanced Visual Studio[6] was adopted as the integrated development environment, and the project was further developed based on the mature 3D GIS-Ark[7] platform and Microsoft SQL Server database platform.

3D GIS-Ark is an advanced and mature 3D geographic information platform independently developed by changjiang space company. Based on OpenGL, the platform is a 3D GIS platform with independent intellectual property rights formed through years of continuous research and development. It has innovatively solved some technical difficulties and successfully applied in many water conservancy and hydropower projects, which has a good maturity and application value. The platform is designed with a three-layer logical structure, including data layer, service layer and platform layer. Each layer provides developers with rich secondary development interfaces, which can be formed by basic data management, 3D services provided by the service layer, and service support for the upper layer applications. The application service provides interactive operation roaming, fixed-path flight browsing, indoor positioning, layer object management, property display and other functions, and provides relevant GIS calculation, measurement and analysis tools on the 3D platform.

2.2.2 Back-end development framework

NHibernate+EF6+WCF framework is adopted in the back-end development. NHibernate is a.net based object persistence class library for relational databases, which can free developers from the original boring SQL statement writing and focus on the development of business logic. Entity Framework[8] USES abstract data structure to transform every database object into an application object (Entity), so that the E/R model of the database is completely transformed into an object model. Windows Communication Foundation[9] is a series of application frameworks developed by Microsoft to support data Communication. It combines HTTP and FTP related technologies and is a best practice for developing distributed applications on Windows platform.

2.2.3 Front-end development framework

Currently, mainstream front-end development frameworks include angularjs, react and vuejs[10], among which vuejs is a set of progressive framework for building user interface, which is a popular front-end development framework at present. Unlike other heavyweight frameworks, Vue is designed for bottom-up incremental development. Vuejs also provides a series of plug-ins, such as vue-router and vuex, to facilitate data management and routing control and greatly improve development efficiency.

3 Key point study

3.1 Comprehensive collection of campus spatial information

Based on the actual needs of school management and planning, project team should refer to “Technical specification for urban underground pipeline detection and survey[11]”, national and related standards of surveying and mapping, meet the development trend of digital campus, make full use of advanced technology and equipment, build a comprehensive 3D database (including basic geographic data, pipeline data and 3d model data).

3.2 Multi-disciplinary work in concert

The underground pipeline survey involves the general survey of water supply, rainwater, sewage, heat, gas, power supply, street lights, telecommunications and other pipe networks. Besides, the data database and system construction should be completed by making full use of the existing data (new, abandoned and dismantled) of underground pipelines in the campus. Digital campus construction includes data compilation, digital elevation model making, ground 3d landscape model making, data warehousing, system development and integration, etc. This work involves many specialties, various processes and high technical requirements. Before work, therefore, the project team should make detailed work plan and quality assurance plan, formulate BGF survey of underground pipeline, data warehousing and so on. All work should be standardized and carried out in a process to ensure the smooth implementation of the project.

3.3 Three dimensional management of total overground and underground coverage

The three-dimensional underground pipeline system should realize the three-dimensional management of the entire coverage of the campus in the inland and underground areas, and complete the subsystems of the three-dimensional integrated pipeline system, digital campus display system, palm campus system. Different subsystems. Different operating platforms and different user groups have different requirements for above-ground and underground 3d visualization, but they all need to provide intuitive, flexible and rich visualization

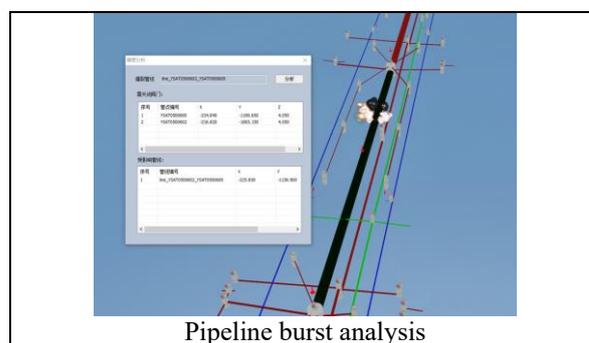
functions to satisfy the integrated management of ground buildings, various facilities and underground pipeline. Therefore, 3D geographic information service platform should satisfy 3D terrain visualization of large area, indoor-outdoor roaming function requirement. This paper adopts 3D GIS-Ark platform. This platform can well meet the requirements of campus management, can also integrate mainstream format of geographic information, can support the C/S and B/S and deployment of mobile end, can fully meet the needs of the campus underground pipeline information management system of project construction.

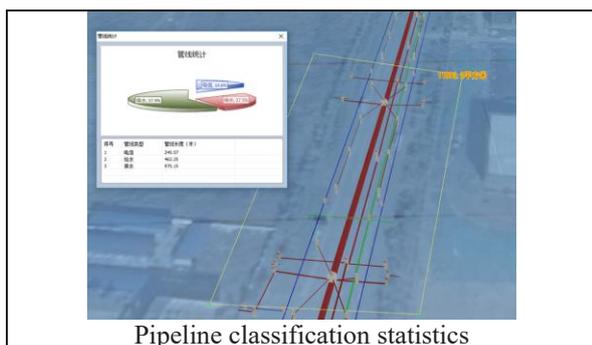
4 Instance

Based on the above design and key points, this paper constructs the underground pipeline management system of Lanzhou university. Lanzhou university[12] is a national key comprehensive university directly under the administration of the ministry of education. Lanzhou university underground pipeline management system can achieve high precision geographic data collection (basic control survey, topographic map surveying, image data acquisition, digital elevation model), underground pipeline survey, comprehensive and accurate understanding of university (all the campus underground pipeline basic situation). The system realizes the dynamic management of the pipeline, and improves the digital and information management level of the campus pipeline.

4.1 Three dimensional pipeline system

The system has the functions of data inspection tool, pipeline data update tool, 3d map operation, quick pipeline query, pipeline data statistics, pipeline comprehensive analysis, housing management, data printing, data management and basic analysis, system management module and so on. The operation of relevant functions is shown in figure 3.





Pipeline classification statistics

Fig. 3. System screenshot

4.2 palm campus

Based on lbs-map technology, the palm campus system realizes the display, positioning and query of campus pipeline information, supports the switch between 2d and 3d maps, and provides Android and IOS terminal application apps. Besides, this system provides a platform foundation for the realization of mobile digital campus. The operation of relevant functions is shown in figure 4.



Pipeline view

Navigation positioning

Fig. 4. System screenshot

5 Conclusion

Underground pipeline information management system integrated use of the three-dimensional geographic information technology and visual means, combined with the campus building, landscape, trees and related management requirements, to build digital campus subsystem, palm campus subsystem, three-dimensional integrated pipeline subsystem. According to user requirements, system can provide application software of multiple client (PC side, Web side, mobile side), realize the dynamic management of pipelines and related facilities.

Underground pipeline information management system can provide services for planning, construction and relevant departments, provide technical support for pipeline planning, emergency rescue, reconstruction and expansion decisions, lay a solid data foundation and

technology accumulation for the comprehensive implementation of digital campus and intelligent campus project construction.

Acknowledgments

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