The Discussion on Application of Underground Pipeline 3D Information System in College’s Repair Project

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Abstract: A university campus has a high population density. When the construction workers repairs and reconstructs underground pipelines, they must complete the construction as soon as possible to reduce the impact on the work and study of teachers and students. The underground pipeline 3D information system can display the spatial location and attributes of the underground pipeline intuitively, providing the construction workers with operational guidance to ensure that the repair is carried out in an orderly manner.

1. Introduction
In 2014, the General Office of the State Council issued the “Guiding Opinions on Strengthening the Management of Urban Underground Pipeline Construction” (Guobanfa [2014] No. 27), requiring the cities to complete a general survey of underground pipelines by the end of 2015 and establish a comprehensive management information system [1]. At present, the 3D information systems for underground pipelines have been established in many cities across the country, making the management of underground pipelines a big step towards digitalization and informationization. As an important part of the city, universities are concentrated in personnel and regions are relatively independent. The repair projects will have a great impact on teachers and students during the actual work. Especially for the projects involving the maintenance of underground pipelines, the pipelines are not visible, which makes the construction more difficult, the construction period is longer, and the impact is even more serious. In addition, underground pipelines play the role of material transmission, energy supply and information exchange, which are the material guarantee for the normal operation and development of the universities. Therefore, it is necessary for us to find out the situation of the underground pipelines on the campus and establish an underground pipeline 3D information system, which would not only provide guidance for the decision-making and implementation of the pipeline project, ensure the normal operation and development of the universities, but also help the universities’ information construction.

2. Current status of pipeline repairs in universities
The current situation of the underground pipeline repair projects in colleges may be as follows:
Current status of pipeline repairs

2.1. Missing data and insufficient accuracy
For some colleges with a long history, due to the long history of construction and historical reasons, it may be impossible to find As-built drawings, letting alone the drawings of the underground pipelines\(^2\). In the past, the data are mostly stored in the form of paper drawings, charts and so on. Even if there are drawings and charts, it was inevitable that some of them would get lost during the process of preservation and circulation, resulting in incompleteness of the drawings and materials. In addition, due to the changes of pipeline construction, drawing and later repair and reconstruction at that time, some old pipelines were not accurate enough and were inconsistent with the current situation\(^3\). Nowadays, the memories of older workers are often used as a reference in the construction of these pipelines and the older workers are considered as “live drawings”. However, as the older workers retire one by one, the data is at risk of being lost.

2.2. Many types of pipelines and decentralized management
As an important part of the campus infrastructure, the underground pipelines in colleges and universities has developed into a multi-category, multi-ownership, multi-management and complex pipeline network for water supply, drainage, heat, power, gas, communication and so on. These pipelines are professionally classified and managed by different departments, and some are even managed by external units. In the process of repairing and updating the pipelines owned by each unit, there is a lack of coordination, and each unit is in charge of its own affairs, so the information sharing of pipelines cannot be achieved. Due to the intricacies and overlapping of pipelines, it is easy to cause damage to the surrounding pipelines during the maintenance and excavation of a single pipeline, which increases the maintenance cost and construction difficulties. In addition, due to the scattered management and lack of unified planning, the phenomenon of “the road is just finished today, and the excavation will come tomorrow” is often caused\(^4\).

2.3. Not updated in time
Some colleges and universities do not pay enough attention to the archiving management of repair projects, and the archiving data are not timely submitted. For the construction of underground pipelines, the construction personnel often do not timely carry out measurement and prepare as-built drawings after the completion of the project, so the pipeline information cannot be updated in time. Especially for minor maintenance projects, due to the lack of archiving requirements, the pipeline data is missing or incomplete.

2.4. Scattered data and poorly systematic
The underground pipe network is intricate and composed of different professional pipelines. Professional pipelines are often classified by the relevant professional designers to draw drawings. For example, the water network diagram is in the water supply and drainage diagram, the power grid diagram is in the power diagram, and there is a lack of summarized pipe network diagram, which leads to scattered pipeline data and poor systematicness. Even for the same construction area, it is necessary
to consult the pipeline data of different periods and different projects, which will cause difficulties to consult the data and affect the construction schedule.

The four points mentioned above are the difficulties faced by the pipeline network repair projects in colleges and universities, which often lead to broken or damaged underground pipelines in the process of pipeline network maintenance and replacement, resulting in pipeline, communication interruption, sewage overflow and other accidents. At the same time, these difficulties also affect the construction schedule and waste of funds [3].

3. Underground pipeline 3D information system and its application

The main management object of underground pipeline 3D information system is underground invisible pipe network, including water supply pipeline, drainage pipeline, heat pipeline, power pipeline, gas pipeline, communication pipeline, pipe well and other pipelines. The system can provide users with an intuitive 3D visual view to accurately represent the spatial location of underground pipelines. At present, the underground pipe 3D information system based on GIS technology has become the development trend in the industry. It is mainly realized by two technical means:

- The visualization of 3D pipe network is realized by the 3D GIS development platform.
- The visualization of 3D pipe network is realized by using the 2D GIS platform and 3D visualization software [2].

3.1. Function Analysis of the system

According to the requirements of the development of informationization in universities and the construction of underground pipeline network, the underground pipeline 3D information system are supposed to have the following functions and requirements.

- **3D browsing and roaming:** to realize the function of the browsing of underground pipeline network and scene roaming of overground buildings in the first person and the third person.
- **Data query and statistics:** to query the pipeline, pipe well, pipe point, valve, etc(such as: diameter, material, pipeline type, depth, construction date and historical maintenance records). It should have statistical function.
- **Data management:** to maintain the basic data, realize the modification of pipelines, nodes, etc. To update the changes timely and realize dynamic management.
- **Spatial analysis:** to carry out spatial analysis of pipeline in 3D environment, such as gravity flow analysis, connectivity analysis, section analysis, blasting analysis and excavation analysis.
- **Measurement:** to realize the measurement of spatial position and size;
- **Network sharing:** to realize the network multi-account login and data sharing.
- **Output:** to output drawings, forms and other materials.
- **Friendly operation interface:** to realize simple operation, friendly interface and good man-machine interaction.

3.2. Application of the 3D system

A university completed the construction of the underground pipeline 3D information system based on the 3D GIS platform in 2013, realizing 3D visual management of the underground pipelines. At the
same time the relevant management regulations for underground pipelines are promulgated. They regularly updates and maintains abandoned, new, modified, and expanded pipelines each year. The establishment of this system effectively solved the bottlenecks and problems encountered in the previous construction process of the pipeline network and ensured the orderly progress of the repairing project. The advantages of the system can be summarized with three points:

- The system has realized the function of database management of underground pipeline. It solves the problems of missing pipeline data, inconvenient archiving, modification and insufficient precision by sorting and detecting of underground pipeline data.
- Combined with relevant management methods, the system realizes the unified management of underground pipeline. By checking the 3D view and historical records of underground pipe network, the pipeline that has reached the time limit can be "excavated once and replaced completely", which makes the repair and renovation project more planned, reduces the construction difficulty and saves the project funds.
- Pipeline repair information can be updated timely. We can directly view the location of underground pipelines and the information of surrounding pipelines by the system, and provide reference for construction workers.

![Image](image-url)

Figure 3. The underground pipeline 3D information system

4. Conclusion
The underground pipeline 3D information system can provide accurate, reliable, and intuitive underground pipeline data for the management, planning and construction of the college’s repair projects. It plays a significant guiding role in the decision-making and implementation of the repair projects and guarantees the normal operation and development of the college. At the same time, it effectively promotes the construction process of the college’s informationization.

References
[1] Li, Wp. Li, Zb. Yin, Dm. (2016) A brief discussion on the dynamic Management of Underground Pipeline Information in small and medium-sized cities. Urban Construction Archives, 06:43-44.
[2] Wang, F.(2013) Design and implementation of university college three-dimensional underground pipe network.
[3] Chen, L. Zhao, Dl. (2006) A summary of the Application of 3D Visualization Geographic Information system in Campus Underground Pipeline Management. Beijing surveying and Mapping,01:42-46.
[4] Wang, Jm. The preliminary study on Comprehensive Management of Underground Pipelines in small and medium-sized cities. Journal of Ningbo College, 14 : 22 -25.