Integrating BIM and IoT technology in environmental planning and protection of urban utility tunnel construction

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Abstract

This study integrated the building information model (BIM) and the Internet of Things (IoT) technology, planning the implementation plan of environmental protection of utility tunnel construction project, through information technology for utility tunnel project design, before construction, construction stage and other applications, the applications including: 1. Project site environmental dust monitoring and automatic sprinkler dust falling control system; 2.Based on real-time meteorological data site Environmental and temperature monitoring ; 3. Based on BIM visual prototype system development. Finally, the application of BIM and IoT technology in urban utility tunnel construction and development environment and application benefits, as well as the follow-up development direction of recommendations.

Key words: utility tunnel, building information modeling (BIM), Internet of things (IoT), environmental protection

1.Introduction

China's urbanization process has accelerated in recent years, the scale of municipal infrastructure has also expanded. Among them, the application of underground integrated pipe gallery in urban infrastructure construction is increasing. The application of the underground utility tunnel in urban construction can not only improve the utilization of urban underground space, alleviate the road traffic pressure and the lack of urban infrastructure, reduce the repeated excavation of roads, and realize the intensive management of various municipal pipelines. It has played a role in promoting the development of urban construction [1-2].

However, with the construction of more and more utility tunnel projects, many environmental pollution problems have also been brought about, such as air pollution caused by various factors in the construction process, construction using large mechanical equipment, and large transportation vehicles. Transporting the surrounding environment has serious consequences. In response to the many ecological and environmental problems in the construction of utility tunnel projects, it's required to continuously improve environmental protection work and actively promote the concept of environmental protection with the tremendous opportunity of modern urban transformation [2-4].

In order to explore the environmental protection in the construction of the utility tunnel project, this study combines the BIM technology and the IoT technology into the construction of the utility tunnel, and utilizes the advantages of BIM technology and IoT technology to form an environmental protection and planning for the utility tunnel. The implementation plan, together with the enterprise, develops an environmental monitoring system for the utility tunnel project based on BIM visualization, and uses information technology to reduce the environmental pollution brought about by the construction process of the integrated pipe gallery, and helps the utility tunnel to be improved and upgraded.

2.Advantages of Integrated BIM and IoT

The "3D virtual reality model" application built by BIM around the digital information of buildings runs through the whole life cycle of building project engineering. With the means of Internet of Things technology, real-time, uninterrupted collection, perception, supervision and control of building "environment and status information" The change". The relevant parameters are collected into the database dual system through the mobile network, which can form a continuous and traceable dynamic monitoring record. These parameters and records will provide real-time data update for the "static BIM model" [3].

For the application research of BIM and Internet of Things in underground engineering, applied the BIM technology and the Internet of Things technology to develop the underground construction safety integrated control integrating automatic monitoring and real-time warning. The technology is convenient for timely and effective construction control and emergency measures to ensure construction safety [4]; and investigate the content of tunnel operation and maintenance management, and proposes a tunnel engineering intelligent operation and maintenance management platform based on BIM and Internet of Things technology to make the model The information is closely integrated with the dynamic database, and the tunnel operation and maintenance is visualized, intelligent and integrated, which greatly improves the management level and work efficiency [3-5];

Nowadays, the comprehensive application of the combination of BIM technology and Internet of Things technology is still in the trial stage. The main application research direction is concentrated on construction safety

management and operation and maintenance management, and the application of environmental protection based on BIM and Internet of Things technology in engineering construction process [6]. There are still few studies. This paper will propose an implementation plan based on BIM and Internet of Things technology in environmental protection through the actual case of BIM application in a utility tunnel in Xiamen city, China, and cooperate with contractor to develop the prototype of the automated safety information system based on BIM visual integrated pipe gallery engineering. Reduce the environmental pollution caused by engineering construction through information technology.

3. System Function Planning with BIM and IoT in Construction Environment Protection

This study proposes the prototype of the BIM visual integrated pipe corridor engineering automation information system. The system architecture diagram is shown in Fig.1. The system architecture mainly includes four levels, space information, application layer and data layer. The space information function is mainly BIM 3D information. The model establishes the BIM 3D model through the engineering drawings. This model integrates the component attribute information and related materials of the project. The model not only refers to the construction project but also the surrounding environment model of the project; the application layer mainly refers to the technology based on the BIM 3D model. The application function, including automatic detection of spray dust reduction system, gate opening detection and limited space operation detection; while the data collection function includes data acquisition data and open data, data collection mainly uses PIR sensor, oxygen detector, temperature and humidity detector, IoT sensing devices such as dust detectors, open data refers to data connected to the weather information systems.

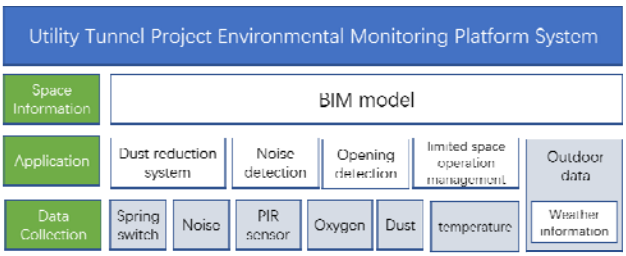

Fig. 1

4.Case study

4.1 Establish the utility tunnel BIM model

The BIM information model is the basis of this implementation, and the subsequent applications are based on the BIM model. It is drawn according to the design drawings provided by the A/E firm, simulates the shape and space scene of the utility tunnel in advance in the computer, and integrates the relevant information and information of the integrated pipe gallery into the model, so that the model and future construction The utility tunnel remains consistent. Building a BIM information model requires not only accurate representation of the utility tunnel body and the construction of the surrounding environment of the utility tunnel according to the situation of different projects is shown in Fig.2, such as road model, unincorporated pipeline model, subway model, etc.

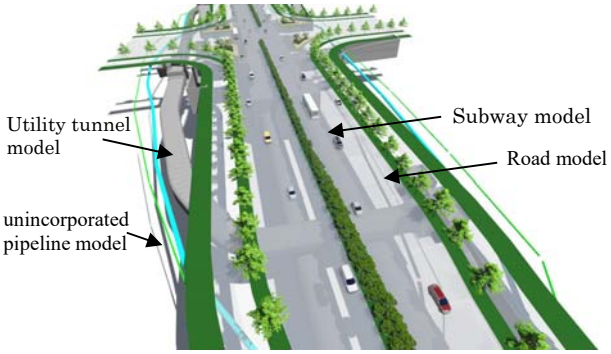

Fig. 2 Schematic diagram of the construction of utility tunnel project

4.2 Application in BIM and IoT in Utility Tunnel Construction Environment Protection Planning

BIM technology and IoT technology are integrated, each of which plays different roles. It can open up the interface between reality and virtual, entity and data, realize the monitoring and data collection of environmental indices in the process of project construction, and then combine BIM model data to complete effective Site management and operational behavior. System platform and real-time data monitoring system are shown in Fig. 3 and Fig 4.

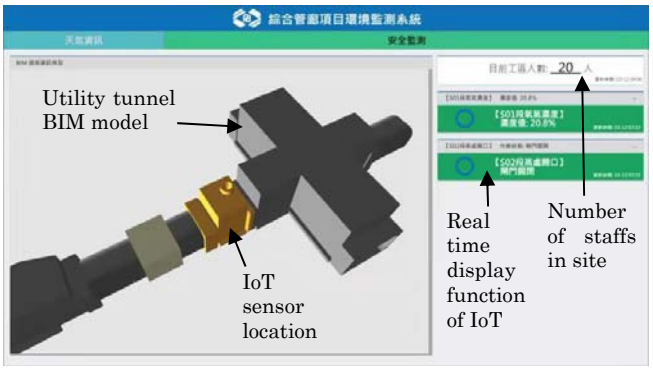

Fig. 3 BIM and IoT in utility tunnel construction environment protection system platform

Fig. 4 Real-time data monitoring system

3.2.1 Automated spray dust reduction system

At the construction site, dust has become an important source of pollution. With the implementation of green building and green construction concepts, dust and dust have been constructed as the key monitoring targets in the construction process. Nowadays, the spray dust reduction technology at the construction site has been developed to a certain extent. The spray dust reduction technology mainly absorbs and settles the dust particles through tiny atomized particles to suppress the PM1.0 or PM2.5, thereby reducing dust and dust. However, at present, the spray dust reduction system at the construction site is mostly controlled by the manual opening and closing state. It is opened during the construction process, and the shutdown is closed. It is impossible to accurately and timely judge whether the site needs to open the dust reduction measures, which is easy to cause waste of water resources. The targeted measures are not strong, and the dust reduction measures cannot be effectively implemented. The utility tunnel project belongs to linear engineering, which has the characteristics of long project length, many dust spots in the project, and multi-deformation of dusting position. In order to form a comprehensive utilization system of spray dust reduction measures and improve the pertinence and application effect of dust reduction measures, this study introduces BIM and IoT technology.

Firstly, according to the division of the construction area of the integrated pipe gallery project and the working range of the spray dust reduction system device, the layout of the BIM model is simulated, and the rationality of the arrangement of the spray dust reduction system is checked and optimized according to the site conditions to reduce the cost and save resources as shown in Fig. 5; Then, through the Internet of Things equipment dust monitor to monitor dust and other particulate matter in the air, as shown in Fig. 6, the dust monitor has the characteristics of continuity, and can monitor the air quality condition of the scene around the real time. The dust monitor monitoring data is connected with the spray dust reduction system. When the air quality is not up to standard, the system will issue a warning on the BIM model and automatically open the spray dust reduction system in the corresponding area to achieve the purpose of automatic control of the spray dust reduction system. Not only improve the efficiency of use, but also greatly reduce the waste of water resources.

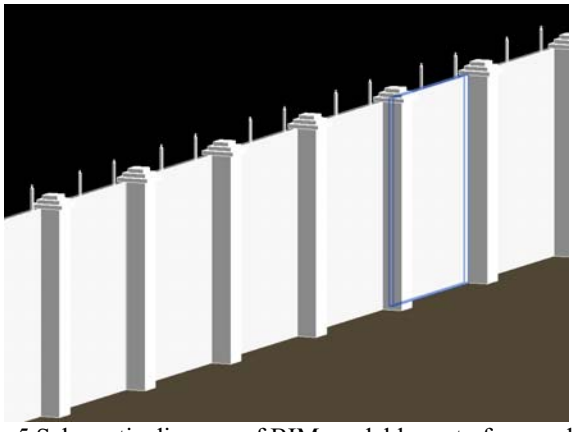

Fig. 5 Schematic diagram of BIM model layout of spray dust reduction system

Fig. 6 Dust pollution monitoring real time data

3.2.2 Weather forecasting function

During the construction of the project, the construction site is often not protected in time due to the weather, and the preventive measures are not in place, resulting in loss of the project site, which leads to downtime and delays in the project construction period. In this study, by connecting the data of the local meteorological station of the project to the system, the meteorological information can be obtained in real time on the system as shown in Fig. 7. When heavy rain or bad weather conditions are about to occur, the system will promptly warn the technicians on site. You can get the news in the first time, and inform the project personnel to do security protection work in advance. The responsible persons of various departments implement equipment accidents and preventive and control measures to prevent various safety hazards caused by the bad weather and the construction site and even the office and living areas. And the occurrence of accidents, to ensure the safety of construction personnel and machinery of the project department, and to reduce the losses caused to the life and property of construction workers due to weather.

Fig. 7 Weather forecasting data

4.3 Limited space management and other application

BIM and IoT technology not only can monitor and control the external environment of the utility tunnel, but also has important applications in the internal monitoring of the utility tunnel, such as gate opening detection and limited space operation detection. The gate opening detection is mainly the real-time measurement and control of the opening of the pipe gate. The IoT sensing device detects the opening and closing state and opening degree of the gate, so that the gate can be controlled and controlled remotely and the gate automatic control and system linkage can be realized on the system. The automatic collection and transmission of image information can intuitively understand the operating conditions of the gate and the surrounding environment, so as to better ensure the safety inside the utility tunnel.

In confined space operations, there may be dangers such as toxic and harmful, flammable and explosive gases, and lack of oxygen. If the precautions are not in place, poisoning, suffocation, fire, explosion, etc. may occur. Therefore, a series of protective measures are required before working in a confined space. Through the BIM model, the location and surrounding structure of the confined space can be found in the

model, and then all-weather monitoring is performed through the IoT sensing device, and the data is reflected in the model in time to strengthen the work environment monitoring and strengthen the operation link management. Provide technical support. If the operator is in danger during the operation, the environmental change status information can be delivered in time, and relevant measures can be taken to ensure the personal safety of the operator and prevent the accident from expanding.

5. Conclusion and Future Suggestion

The investment and development of infrastructure construction is accompanied by the impact of the environment. How to reduce the impact on the ecological environment is an issue worthy of discussion. This study integrates BIM and IoT technologies to develop a BIM based visual utility tunnel environmental monitoring system. The environmental protection and planning of the utility tunnel project provides a new direction and has important application value. Future Suggestion can be combined with actual project schedule planning for project management functions, as well as for integrated management of different roles such as personnel and construction vehicle etc., to achieve the further management benefits.

Acknowledgement

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