Research on Auxiliary Construction Management and Control of Substation Digital Design Results

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Abstract
Based on the whole process of power grid construction, on the basis of the popularization of digital design technology and the background of digital power grid construction, this paper studies the construction quality and schedule assistance technology of power grid construction, and uses automated tools, digital files, and standardized processes to provide construction sites. Support services to realize various business requirements such as progress visualization, safety and intelligent management and control, dynamic quality tracking, and lean cost management and control, making actual engineering information traceable, controllable, and predictable.

Keywords-*component; digital; grids; transfer; construction*

1. Introduction

Since the State Grid promoted the three-dimensional design of power transmission and transformation projects in 2018, the three-dimensional design results based on GIM (Grid Information Model) standard data have become more and more mature. A large number of engineering applications and data accumulation have been carried out in electrical engineering design technology. At the same time, with the rapid development of artificial intelligence technology, the rapid modeling of highly dynamic and complex power scenes based on 4D (three-dimensional space + time) vision and spatial distance perception technology provide technical support for construction site safety management and control. The combination of 3D design results and 4D vision technology is extended to the construction stage of power transmission and transformation projects, to improve the digital and intelligent level of engineering construction management and control, and to explore the application of "GIM + 4D vision" technology in the whole life cycle. assets, and give full play to the direction and trend of digital empowerment of traditional industries.[1]

2. Research status

3D digital design has gone through several decades from its proposal to its gradual improvement and then to its general acceptance in the engineering construction industry. The practice was initially dominated by a few smaller pioneer countries, such as Finland, Norway, and Singapore, followed by some early practitioners in the United States. After a long period of deliberation, collision checking based on 3D digital design has gradually become mainstream in the United States and has an impact on the practice in other countries, including China.

In terms of software tools for space management, Autodesk's Revit software is widely used in construction, structure and electromechanical fields; Bentley products are used in factory design (petroleum, chemical industry, electric power, medicine, etc.) and infrastructure (roads, bridges, municipal, water conservancy, etc.) etc.) field has an indisputable advantage; Dassault's CATIA is the world's most high-end mechanical design and manufacturing software, with a near-monopoly market position in aviation, aerospace, automotive and other fields, applied to the engineering construction industry, whether it is for complex shapes or super large Compared with traditional architectural software, scale building has obvious advantages in modeling ability, performance ability and information management ability.

During the "Eleventh Five-Year Plan" period, the Chinese government organized and implemented a special project on manufacturing informatization to promote the development of design digitization, manufacturing equipment digitization, production process digitization, management digitization, and

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enterprise digitization. Digital manufacturing technology has been widely used in my country. : First, the promotion and application of CAD/CAPP/CAE/CAM, which has changed the traditional design, production and production mode, and has become an important technical feature of the development of my country's modern manufacturing industry; the second is the popularization and application of MRP/ERP; the third is the promotion of CIMS The fourth is network construction. In recent years, the rapid development of Internet technology and the rapid development of enterprise networks. At present, digital manufacturing technology is developing deeply in my country.

In recent years, State Grid Corporation has gradually developed from plane CAD to 3D modeling-aided design and digital design in digital design. In this process, 3D space management is the focus of all units. At the same time, the formulation of relevant engineering digital design results standards is also being carried out simultaneously.[2]

At present, the three-dimensional design of power grid is developing rapidly and becoming mature, but the transformation from three-dimensional design results to on-site auxiliary construction is still blank in China at this stage. The current 3D design results are limited to 3D geometric models and attribute information, and have not yet formed an auxiliary means for guiding the quality and progress of the entire power grid construction site.

3. Application of digital model in construction site

Fig.1 substation model

Source：From myself

Construction progress monitoring and safety control during the construction phase are the most critical and core elements that affect the quality of the project and ensure the safety of life and property. At present, in terms of construction progress monitoring, it mainly relies on manual methods to conduct on-site inspection records. However, the data at the project construction site is rich and the amount of information is large. Only relying on manual collection is time-consuming and labor-intensive, especially the highly complex dynamic process in the construction stage is difficult to capture and reflect. There is a lack of efficient visual supervision of the progress of the project; in terms of safety management and control, accidents such as electric shocks, equipment damage, and falling injuries caused by insufficient space distance or crossing the boundary frequently occur, which has become a major problem that plagues construction site management. Manual monitoring Due to the lack of manpower, the deviation of naked eye observation, personnel fatigue, personnel distraction and other reasons, the loopholes in the monitoring have repeatedly appeared, providing an objective breeding ground for the occurrence of accidents.

Considering the accumulation of existing cutting-edge technologies and the practical needs of progress monitoring and safety control during the construction process, it is necessary to develop and construct a 4D construction progress monitoring and safety control visualization platform in combination with the 3D digital design results. Based on the "GIM+4D vision" technology, establish a mapping mechanism between virtual models and real on-site 3D point clouds, realize the connection between off-site GIM models and 3D point cloud data, and develop artificial intelligence distances based on SLAM, edge computing, 4D visual perception, etc. Perception algorithms and systems have two core functions of 4D visualization of project progress monitoring and intelligent safety management and control on construction sites, striving to solve problems such as time-consuming and laborious progress monitoring in construction processes and frequent loopholes in construction site safety management and control, and improve the level of intelligence in construction process supervision [3].

4D project progress visualization monitoring: Based on SLAM (Synchronous Positioning and Mapping) technology, an autonomous modeling system for complex power scenes is developed to support rapid true color modeling of spatial 3D data on the construction site during the construction process. Collect data from factors such as progress and key goals, and define data in chronological order, map, generate and superimpose the virtual 3D design model and actual construction 3D point cloud data to complete the size, height, distance, depth, angle, etc. of real construction objects High-precision intelligent measurement enables real-time remote monitoring of project progress and construction quality. At the same time, relying on the construction platform, it supports the formation of a complete set of completion information, which can play or invert the 4D animation of the real construction process in chronological order, so that the problems existing in the construction can be traced back, and the quality problems in the construction process can be traced back. No omission visual monitoring.

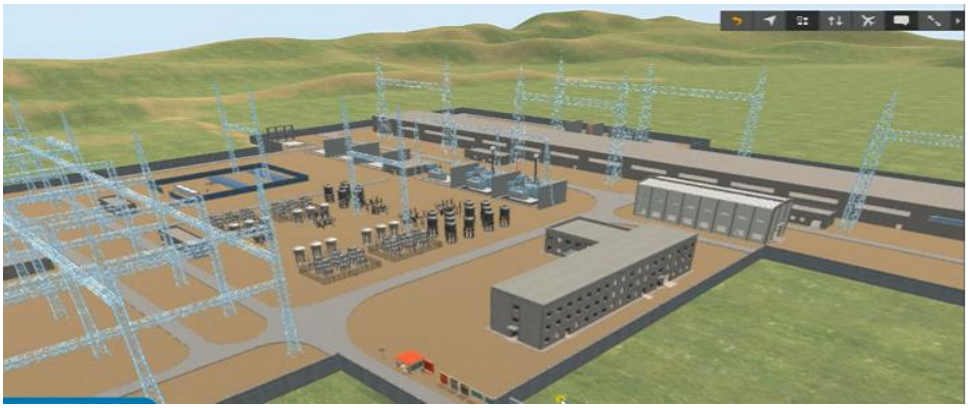

Fig.2 Construction progress management chart
Source：From myself

Intelligent safety management and control on construction sites: Based on edge computing, the interaction mechanism between intelligent monitoring devices on construction sites and remote platforms, rapid 4D modeling technology for on-site work space locations, and deep learning technology for rapid identification of 4D scene targets based on distance segmentation, research and development The 4D spatial distance sensing edge system realizes rapid positioning and highly robust identification of machinery and personnel, as well as distance sensing between targets and working areas, charged objects, and protection targets, as well as spatial management and control rule reasoning and alarming. The developed intelligent monitoring device on the construction site can, in accordance with the requirements of the State Grid Corporation of the State Grid Corporation of China, the State Grid Corporation of the People's Republic of China on the Safety Risk Identification Assessment and Pre-control Measures for Power Transmission and Transformation Project Construction Safety Risk Identification and Pre-control Measures. Monitoring and identification work, timely reminder of safe distance information. Especially in the spatial distance perception and logical reasoning of objects such as line erection height, sag, lamps, tools, vehicles, operators, and dangerous areas, and personnel's own behavioral norms and wearing norms, such as smoking, calling, wearing helmets, The identification of seat belts, wearing insulating gloves, etc., as well as operation in the area with points, safe distance perception of different voltage levels, and reasoning alarms form a systematic safety management and control intelligent auxiliary mechanism.

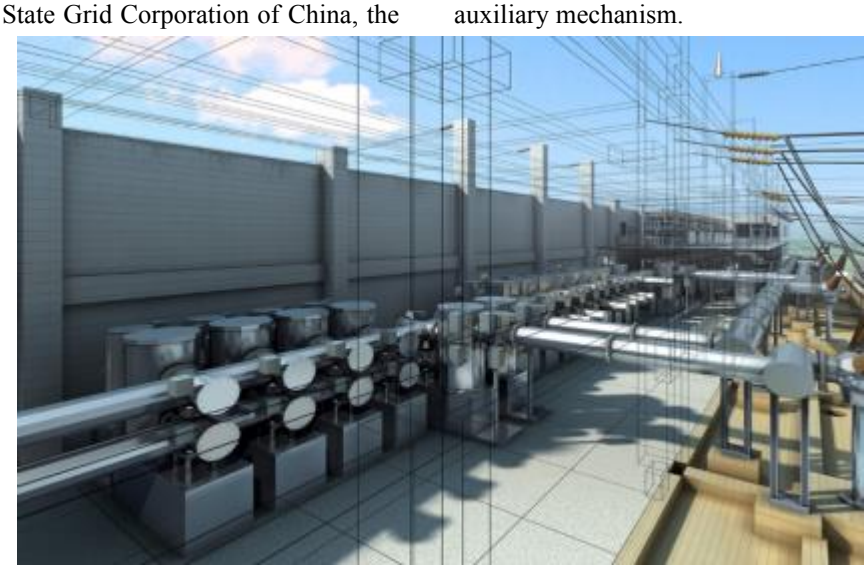

Fig.3 transfer digital model
Source：From myself

4. Conclusion

Since State Grid promoted the 3D design of power transmission and transformation projects in 2018, the 3D design results based on GIM (Grid Information Model) standard data have become more and more mature. A large number of engineering applications and data accumulation. At the same time, with the rapid development of artificial intelligence technology, the rapid modeling of highly dynamic and complex power scenes based on 4D (three-dimensional space + time)

vision and spatial distance perception technology provide technical support for construction site safety management and control. The combination of 3D design results and 4D vision technology is extended to the construction stage of power transmission and transformation projects, to improve the digital and intelligent level of engineering construction management and control, and to explore the application of "GIM + 4D vision" technology in the whole life cycle. assets, and give full play to the direction and trend of digital empowerment of traditional industries.

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