Research and Application of 3D Simulation Technology for Water Resources Digital Twin Platform

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Abstract: The physical simulation software and digital twin technology play a very important role in building a digital twin platform for water resources, which provides the necessary support to realize digital mapping and intelligent simulation of water resources production and operation. In order to promote the coordinated and efficient operation of different types of water modeling and the intelligence of watershed and water project governance processes, this project will carry out the research and application of process architecture and core technologies for water 3D simulation. The results of this project will provide the theoretical basis and technical support for the development of digital twin technology in the field of water resources in China and contribute to the development of water resources in China.

Keywords: Water Digital Twin Platform; 3D Simulation; Simulation Technology

1. Project Overview

Currently, the whole country is worried about the status quo of industrial software (such as EDA software for chip design) which is 30-40 years behind the international level, and everyone from the country to the people is looking forward to break this deadlock. The developed analog and digital twin technologies and their related products are engineering application software. A series of independent innovations have been formed in large-scale simulation algorithms, automatic design software with simulation and artificial intelligence technology, and process optimization technology with the integration of simulation and big data, and a multi-disciplinary and multi-field multi-user platform of simulation and digital twin technology has been built on this basis. All technologies and products are domestically produced and independently developed, which can help change the dilemma of having to use foreign software for key and major product development, in line with the national policy of independent and controllable, domestic substitution. It has a broad application prospect in industrial production, scientific research and equipment operation, etc. For example, our EMC simulation system can be used as a "virtual flow chip". However, our software market is currently dominated by foreign companies such as ANSYS, Altair, Dassault, etc., which account for a negligible percentage of the market. The current situation is worrisome. The digital twin technology is based on simulation, combining artificial intelligence, big data, Internet, virtual reality and other cutting-edge digital technologies, which will open up a whole new market for the application of simulation technology.

2. The water digital twin 3D simulation overview

2.1 The requirements of three-dimensional simulation of the visualization model

2.2 3D entity visualization

First, with basin-level simulation capabilities. Connected to the upper system, using watershed data, the real-time conditions of the water bodies around the water conservancy project or even the entire watershed are visualized in large scenarios to meet the needs of applications such as flood control and water resources scheduling and utilization. Second, it has the ability to seamlessly integrate the details of the presentation. The visualization model can not only reproduce the grand and open river landscape, but also show some features of the equipment components, and all the elements at all levels

should be able to be expressed in the same scene, that is, the project includes only one digital twin environment in which various simulations and emulations are performed. On this basis, the multi-level real-time drawing technology is used to achieve a seamless integration of large scale watershed panorama and equipment detail drawing. Third, the ability to represent water bodies with a sense of realism. On this basis, a multi-factor synergy-based watershed visualization modeling method is established to precisely regulate the flow velocity, water level, color, transparency and other characteristics of the main areas, so as to achieve a multi-factor synergy-based watershed visualization modeling purpose[1].

2.3 Abstract information visualization

For some abstract data, such as entity attributes and summary information, they should be visualized directly according to their data characteristics, such as points, lines, and surfaces, as well as dynamic effects, such as dynamic icons, such as dynamic flow field lines.

2.4 Business scenario visualization

The visualization simulation is combined with the actual business application scenarios. For example, in the safety of the reservoir, the monitoring information and the corresponding mathematical modeling methods are used to simulate the landslide; in the reservoir operation process, the water quality prediction results of the reservoir operation process are used to simulate the reservoir operation process; with the safety of the project as the goal, based on the safety analysis and calculation of the dam body, the deformation of the dam body is simulated under various conditions, etc.

2.6 The application of three-dimensional simulation technology needs

With the main line of scene digitization-intelligence-accuracy-scene precision, it provides real-time drawing and visualization support for "four predictions" and other special functions, realizes multi-dimensional, multi-temporal and spatial scale high-precision digital maps of water conservancy projects, and achieves real-time interactive response, low latency stability and scene realism. At the macro level, it provides simulation support for basin weather, atmosphere, rainfall and other prediction information; at the meso level, it provides simulation support for water storage and flooding in reservoirs; at the micro level, it provides simulation support for the internal mechanism of dams and the operation of hydroelectric facilities. For this reason, it needs to be improved according to the special needs of the "four precautions" business, according to different practical situations, such as: real-time process simulation for flood control, "scenario - countermeasure" simulation for the occurrence of emergencies, and weather simulation for enhancing the realism of the scenario. In 3D virtual simulation applications, 3D objects need to be drawn visually, application scenarios need to be drawn visually and business data need to be drawn visually. In the process of drawing, each scene can be drawn accordingly, and each scene can be drawn separately and dynamically. Business data visualization drawing is based on the 3D spatial grid model as the digital foundation, and the specific attributes of application scenes and business data as the basis for positioning and overlaying business data in a unified 3D space, so as to unfold the display of various attribute information and business state information of management objects in a multi-dimensional collection[2] .

3. Water digital twin 3D simulation case study

This project is intended to take Shenzhen's "public-clear water connection" as an example, connecting Gongming Reservoir, Qinglingyi Reservoir and Dongshen Water Supply, using Dongjiang and Xijiang to jointly transfer water to enhance Shenzhen's emergency water supply, improve the level of water protection for Shenzhen residents and industries, meet the needs of Longgang District's "dual water sources", and provide conditions for it to provide emergency water supply to Hong Kong. In the project implementation process, based on the digital twin simulation technology system of water conservancy, the "Gongqing Survey and Design Information System" was built, and the GIS and BIM data throughout the project life cycle were used as the core to develop data integration, light weighting and business applications to support the whole project life cycle. In the planning stage, besides using the digital twin scenes as the base map for planning, the system can also overlay and analyze the land planning, roads and environmentally sensitive areas traversed by different proposals based on the spatial analysis function, and combine them with information such as engineering volume for proposal comparison. In the design phase, BIM models of project design results can be quickly connected and overlaid and seamlessly

stitched with 3D data of real scenes in the surrounding areas to visualize the effect of the project before and after completion. During the construction process, the 3D geological model can be cut along the direction of the project line to visualize the rock stability distribution, fracture zones, and the relationship with intersecting buildings, etc. It can also provide support for the complex geological conditions involved in the project construction by providing functions such as component information query and individual observation in the BIM model. In the watershed-scale water resources digital twin system, there is a large-scale water information access and invocation problem. Based on this, the distributed storage of data and dynamic access to services enables efficient, on-demand, on-demand requesting, loading, and releasing of data resources, maximizing the efficiency of data resource use without affecting simulation results, and providing the possibility of large-scale, high-quality digital twin applications. This project is intended to take the "Han River Digital Twin" system as the research object, and to provide powerful support for flood control and water supply in the Han River basin.

4. Conclusion

Water resources digitization, networking and intelligence are the keys to water resources digitization. In this paper, the author centers on the specific needs of water resources digital twin construction and develops a detailed design of the overall framework and technical route of the twin platform simulation and simulation, which will address a series of core technical issues such as efficient data services and spatial analysis and simulation simulation for water resources, high fidelity data cloud rendering technology for water resources, and finally form a set of water resources digital twin simulation and The complete chain of technical solutions for water resources simulation. Continuously improve the universality and commonality of 3D virtual simulation technology in the field of intelligent water resources, and extend it to the digital twin of various water resources projects.

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