Application of Digital Twin Technology in Storage Management of Power Equipment

Lijiao Wang*, Hui Hao, Lijun Wang, Chuan Zhang

Lijiao Wang：pxwanglijiao@126.com

Hui Hao：nmghaoh@163.com

Lijun Wang：wanglijun_1014@163.com

Chuan Zhang ：zc8901@126.com

Tianjin Richsoft Electric Power Information Technology Co.,Ltd. Dongli District of Tianjin

Abstract. Digital twin is a digital model of physical objects, and digital twin technology is the base for building intelligent demonstration warehouse. In this paper, digital twin technology is used to build the digital spatial infrastructure of the reservoir area and create a unified data model with the graph as the core. The entity and entity relationship constitute the twins of the real world, realize the digitalization of warehouse management, promote the integration of equipment data and business data of each subsystem in warehouse management, create a visual, simulated and analyzable digital management mode, and effectively realize the intelligent and digital management of warehouse operations. Through the implementation of the results, the warehouse management ability is effectively improved in the digital twin virtual space, and the management is refined, the decision-making is scientific and the service is efficient, which promotes the cost reduction and efficiency improvement of warehouse logistics management.

Keywords: digital twin, digital management, intelligent operation, warehouse management.

1 Introduction

At present, the digital wave represented by new technologies such as Internet of Things, big data and artificial intelligence is sweeping the world. The application of digital technology and the development of digital economy are affecting or even subverting the traditional pattern of supply chain industry and promoting industrial upgrading. Digital twin is a digital model of a physical object, which can evolve in real time by receiving data from the physical object, so as to be consistent with the physical object in its whole life cycle. Digital technology has been applied in the construction of power equipment operation base. Although the warehouse management system has been set up and the information management of the turnover warehouse has been initially realized, there are still some practical problems in the integrated construction of inspection, storage and distribution, such as insufficient collaborative sharing of processes, inconsistent data standards, insufficient lean degree and poor information quality. At the same time, there is no effective monitoring means in monitoring the operation, energy

consumption, personnel and equipment status of the warehouse area. Although the warehouse control system has realized the management and scheduling of inventory locations and materials, it cannot effectively realize the optimization and decision-making of operation and maintenance management based on system data.

Digital twin technology is an advanced technology that combines physical objects with their digital models. Through real-time simulation and monitoring of digital models, it can achieve full lifecycle management and optimization of physical objects. In the field of power equipment warehousing management, the application of digital twin technology can help improve the reliability, safety, and efficiency of equipment, and provide more accurate prediction and decision support. In this study, the digital twin technology is used to optimize the design of power equipment warehouse management system, realize digital management of all warehousing links from a panoramic view, strengthen the integration of equipment data and business data of each subsystem, create a visual, simulated and analyzable digital management mode, effectively realize the intelligent and digital management of warehouse management operations, and promote the cost reduction and efficiency improvement of warehouse logistics management.

2 Analysis of the current situation of storage management of power equipment

Warehouse management mainly refers to the process of management, organization and control of warehouses and materials stored in warehouses, and its purpose is to improve the economic benefits and management level of enterprises [1]. With the rapid development of society, warehousing management is constantly developing and upgrading. Modern warehousing is not a "warehouse" or "warehouse management" in the traditional sense, but a modern logistics activity that uses self-built or leased warehouses or sites to store, handle and distribute goods, and plays a unique role as a resource provider in the supply chain [2]. At present, the strategy of warehousing management is still in the stage of "passive receiving". Although warehouse managers can make basic preparations for warehousing according to the delivery plan, two-dimensional warehousing display can't show the actual situation of warehousing, which affects the efficiency of warehousing and lack of rational use of warehouse resources [3]. Taking the elevated warehouse as an example, the reasonable layout of warehouse materials involves many factors such as the volume, weight and throughput frequency of materials, and the current plane management system is difficult to meet the needs. In the aspect of effect display, the existing digital twin display effect is poor, and most of them are static 3D models, so it is difficult to show the real situation of field operation and realize real-time interaction and data display with business systems. It can't help the staff to carry out fine real-time monitoring, nor can it support the rapid monitoring and management of managers[4].

3 From Digital Twin to Digital Twin Warehouse

3.1 Digital Twin

The concept of Digital Twin comes from the word "digital twin", which is also called digital mirror image and digital mapping [5-6]. The concept of Digital Twin first appeared in 2003, and was put forward by Professor Grieves in the course of product lifecycle management at the University of Michigan [7]. The mirror space model put forward by Professor Grieves is the earliest conceptual model of digital twin [8]. In 2009, the U.S. Department of Defense introduced the concept of Digital Twin into the health maintenance of space vehicles [9], and defined it as a simulation process integrating multiple physical quantities, multiple scales and multiple probabilities. Based on the physical model of the aircraft, a virtual model with complete mapping was built, and the whole life cycle process of physical objects was described and reflected by using historical data and data updated by sensors in real time. After that, with the expansion of digital twin technology in intelligent manufacturing, smart medical care, smart city, smart grid and other fields. Digital Twin is a feasible technology to get through the physical world and the information world. It can realize the same mapping in the information world through digital simulation of the physical world, realize the functions and services in simulation, operation monitoring, product design and so on, and truly realize panoramic visualization, real-time monitoring and dynamic adjustment in the information world.

3.2 Digital Twin Storage Features

The intelligent warehouse construction of power enterprises under the smart supply chain system must build an intelligent operation management platform, devote to the communication of all business data, and cooperate with advanced management mechanism to realize the digital transformation of the whole chain and whole scene of the supply chain. Digital twin warehousing is an accurate mapping of the physical entities in the warehouse and the process entities of warehousing operations in the information world, and it is a digital expression of all the elements in warehousing management. It mainly includes the inherent resources and storage equipment in the warehouse, such as shelves, materials, personnel, AGV robots, shuttle cars, large lifting equipment, etc. Through simulation, simulation and modeling, the digital information acquisition of these elements aims at visualization, intelligence, networking and integration, and takes the whole business processes of sample sealing, delivery and warehousing of sampled materials as the core, so as to create a real-time integration of digital twins and business information, integrate various management systems, build a digital twin application platform integrating monitoring, early warning, diagnosis and analysis, and build a visual monitoring of warehouse inventory status, storage materials, shelf simulation and so on.

All physical elements in the process of warehouse management are mapped to the information virtual world in a two-way real way. Through the highly realistic description and simulation of hardware equipment, personnel and work flow in the process of power equipment warehousing management, the multi-dimensional elements such as all elements, behavior activities and process rules in physical warehousing management activities are modeled through virtual reality, augmented reality, mixed reality, simulation and digital modeling. The

physical world interacts with the information world in real time. During the warehousing operation, all the activity data will be perceived in real time and transmitted to the digital twin information platform. According to the data obtained in real time, the information platform simulates and optimizes the operation of physical warehousing, and adjusts and controls the actual warehousing operation in real time, so as to realize the real-life visual display of physical warehousing activities on the digital twin platform.digital twin warehouse management operation flow chart as shown in Figure1.
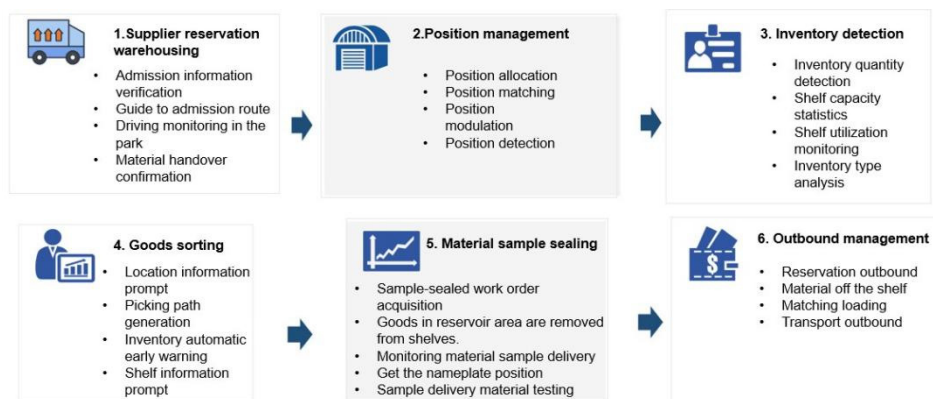

Fig.1. Digital Twin Warehouse Management Operation Flow Chart

4 Construction of digital twin storage system model

In order to meet the application requirements of digital twin of warehouse management and build a digital twin platform of warehouse management, firstly, a digital twin model is constructed, as shown in Figure2. The three-dimensional scene modeling content of the digital twin platform of warehouse management involves buildings, warehouses, sealed materials, testing equipment, transportation equipment, etc. The built three-dimensional visual model is maintained and managed through a digital twin model base. As the support service of the digital twin platform, the digital twin model can not only maintain and manage the digital twin model of core business such as warehouse management, but also continuously improve the existing model and expand the data resources of the model base according to the needs of different professional business scenarios, thus providing basic support for the digital twin model construction of all business scenarios in the future.
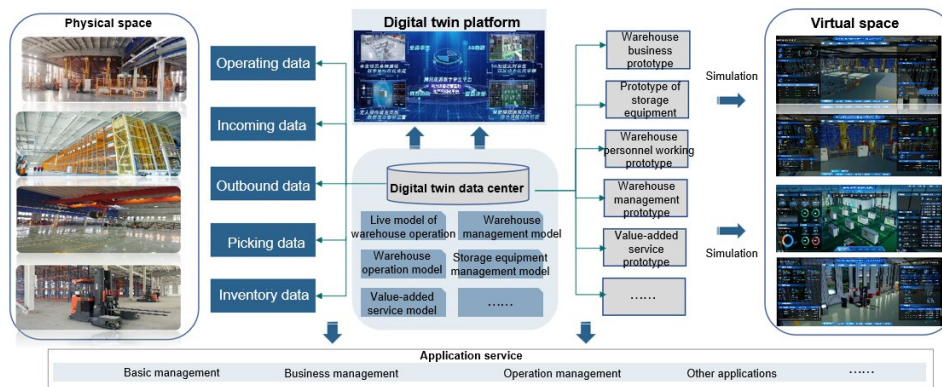
Fig.2. Digital Twin Warehouse Data Architecture

Three-dimensional modeling is carried out for the inventory position in the warehouse and the location in the ground pile area, and the shelf information of the location is presented in a three-dimensional way in the digital twin scene, which provides an intuitive data basis for the location management. Through three-dimensional visualization technology, the location information of the area, underground storage and three-dimensional storage in the power equipment operation base is presented in the three-dimensional scene, which eliminates the spatial blind area, makes the storage management more concrete and intuitive, eliminates the blind area of storage, and presents the state of idle storage to the three-dimensional model. The location model supports disassembly, scaling, rotation and multi-angle display.

5 Digital twin warehousing application

5.1 Warehouse Panoramic Visualization

The digital twin platform integrates various subsystems of warehouse, including warehouse management system (WMS), warehouse control system(WCS), video camera monitoring system, precise positioning system, logistics system, automatic rapid detection line, AGV intelligent device system, etc., to realize data fusion and sharing, and display concerned business statistical information in the form of dashboard such as statistical list or chart or curve on the visual interface; Data can be displayed statistically from different dimensions, including departments, regions, time, asset types, etc., to fully grasp the overall operation data of warehousing. Visualization of business monitoring data and environmental monitoring data can be realized through visualization of warehouse management, which can display data monitoring results in real time, quickly locate the monitoring results and provide data statistical analysis functions.

5.2 Inventory data management

By integrating the inventory management system of "inspection, storage and distribution" platform, the capacity statistics of materials in a single warehouse in 3D scene are made. The proportion information of goods is displayed by 3D model animation, color block filling and

statistical panel. The numerical dimension of statistics changes with the change of vision, displaying information such as job management, task order query, inventory query, order statistics report, abnormal behavior alarm (sluggish warning), etc. At the same time, relevant information can be queried in the three-dimensional scene, and materials and material positions can be quickly found and displayed. Data collection is carried out for goods on shelves and moving, and the running status of equipment, data changes of shelves and real-time feedback of panel data can be quickly obtained through the visualization system, so as to grasp the activity status of the warehousing and transshipment center in an all-round way and achieve multi-dimensional unification of supervision, maintenance and deployment[10].

6 Conclusion

The digital twin warehouse management studied in this paper realizes the simulation and simulation of the warehouse location state and the whole process of storing materials, loading and unloading, leaving warehousing operation, etc., and feeds back the simulation, diagnosis, analysis and monitoring results to warehouse managers, further promoting the intelligent management of warehouse data, and fully realizing the full reading of warehouse management data, full maintenance of information, high matching of materials and strong support for decision-making. In the future, with the mature application of digital twin technology in the field of warehousing management, it will promote the transformation of the management mode of warehousing management, make warehousing management more efficient, accurate and clear, further realize the automation, intelligence and practicality of warehousing management, and push warehousing management forward to the standard of "material visualization" in the international warehousing industry.

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