Research on Intelligent Optimization of Bulk Cargo Terminal Control System

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Abstract. Aiming at the problems of lagging automation and low informationization of bulk cargo terminals, this paper has optimized the control system of bulk cargo terminals, and improved the characteristics and functions of the control system. Based on the completion of the existing remote start and stop processes and equipment, the database, fault diagnosis and information management of the bulk cargo terminal control system are optimized, which improves the control efficiency and operability of the control system. The transformation and upgrading of the control system has played a good role in promoting the development and construction of smart ports.

1. Introduction
Due to the rapid development of China's foreign trade, the rapid growth of coal, ore and other bulk goods entering the port has put forward very high requirements for the control and management system of bulk cargo terminals. PLC technology and field bus technology are the most active new technologies in the field of control and automation. PLC technology and field bus technology integrate many technologies such as control technology, automation technology, digital technology, information technology, microelectronics technology, network technology, computer technology and system technology. Now PLC technology and field bus technology have become an important part of bulk cargo handling technology. On this basis, it is of far-reaching significance to develop and improve the comprehensive automatic information management of port enterprises and carry out the research of using expert system to realize system self-diagnosis. In the fields of industrial production process control, power system, computer integrated manufacturing, safe operation of nuclear power plants, port automation, comprehensive automation has been developed and applied[1-2]. Because there are many process variables in actual production, and various parameters have varying degrees of time variability and other characteristics, it is difficult to use mathematical tools or computer simulation to solve the problem. Automatic control and artificial intelligence should be used to combine model of design, control, management and decision-making[3]. Only by combining intelligence, integration and coordination can we obtain comprehensive benefits.

2. Analysis of development trend of port control system
The main trends of port development in countries in the contemporary world are the scientific port management, large-scale port scale, port production marketization, and diversified port services. The characteristics of port business information are concentrated in that the port information operation is large, the information type is complex and the consequences of data errors are serious, the realization of port intelligence, digitization and informatization has become the direction and goal of the development of various ports. In the 1990s, Spain proposed an electronic port, forming a prototype of
port informationization[4]. The computer integrated terminal operating system of the Singapore Port is a successful information management system[5], which is characterized by the ability to exchange information with many ports in the world, and the domestic seaport network, container network, fast connection and financial electronic data exchange in Singapore. European Rotterdam Port, Port of Hamburg, and some major ports in Singapore and Japan have successively realized the sharing of data and information on the loading and unloading of intelligent ports[6-7]. Subsequently, more ports around the world combined with the problems in the current technology, combined with their own advantages and launched the application of technologies such as the Internet of Things, big data, and data analysis. Ports in many countries have begun to work towards integrated services and integrated resources to achieve the goal of enhancing the international status and comprehensive service capabilities of ports. Most of the new construction projects of China port bulk cargo terminal company have realized the automatic control of the loading and unloading process and loading and unloading process, and the information management system has basically met the requirements of production, management, operation and service, and realized the requirements of port digitalization and informatization. However, there are still some deficiencies in the port intelligence and integration of management and control. Tianjin Port, Taicang Port, Luojing Port and Shenhua Huanghua Port have made a lot of leading experiments and attempts in this regard[8]. Shanghai Maritime University Yu Jing, etc. analyzed the hierarchical, logical and physical structure of the port bulk cargo flow system. With the continuous improvement of port management level, informatization and industrialization have become a consensus in various ports. Especially for bulk cargo terminals, their random variables and high system complexity greatly restrict the intelligent construction of bulk cargo terminals. Therefore, if bulk cargo terminals are to successfully implement modern port transformation, they will make full use of advanced technical features such as the Internet and big data to enable the various resources involved in port logistics to achieve wider interconnection and interconnection, and become the core competitiveness of China's bulk cargo terminals.

3. Characteristics of control system and realization of control function

3.1. Control system overview
This research control system combines technologies such as Wincc, PLC, servo control and industrial communication. The host computer monitoring system collects the information of the field control system to reflect the actual production conditions, and exchanges information with the management system, using control equipment to achieve the process of automatic start and stop, and data exchange with enterprise systems, improve production efficiency, create greater economic benefits, and have extremely important practical value in enterprise automated production control.

The remote control system is designed to solve the safe operation and data exchange of fully automatic production lines in the industry. Remote operators are of great significance to understand the operating status of the equipment, alarm information, and real-time position information of the equipment. The exchange of data between them and the optimization of the system's production resource allocation are of great significance to the control system optimization research.

3.1.1. PLC module features
The communication between PLC and inverter adopts the master-slave communication based on Profibus-DP network. Profibus network can adapt to the communication between field and unit-level network environment, and the transmission medium can be flexibly selected. It is widely used in industrial applications. PLC is the core of the entire monitoring system. During the communication, the pre-designed program realizes the collection and processing of analog and digital quantities, and at the same time adjusts the operation status of the shearer to effectively improve the work efficiency. Responsible for the collection and processing of equipment operation data, the generation of alarm failures, start-stop interlock protection, control command protection, communication with remote controllers, and control relay output to adjust the operation status of process equipment.
3.1.2. Human-computer interaction module features

Configuration software is a kind of industrial application software. As a software platform of data acquisition and monitoring system SCADA, it has powerful functions and plays a huge role in promoting industrial automation production. The early configuration software has a simple man-machine interface and a single function. With the development of related software technologies and control systems, the tasks handled by the configuration software are becoming more and more complex, and the realized functions are more comprehensive. The separation of hardware is conducive to promoting the development and development of configuration software. The maturity and centralization of the fieldbus technology greatly facilitates the interconnection of various devices, and the I/O driver software gradually develops toward the direction of standardization, providing a broader space for the development of configuration software in the field of industrial automation. This research uses the WinCC host system. The built-in communication system of Simatic WinCC includes a large number of communication components from Profibus to Ethernet, component-based automation CBA and Profinet technology, and wireless communication solutions. And Simatic WinCC contains different kinds of communication drivers for automation systems provided by different manufacturers. The WinCC system is composed of variable manager, graphic editor, alarm record, variable archive, report editor, global script, text library, user manager and cross-reference table, as shown in Figure 1.

![Variable Manager](Variable Manager) ![Graphic editor](Graphic editor) ![Alarm record](Alarm record)

Variable archiving ![WinCC system](WinCC system) ![Report editor](Report editor)

Global script ![Text library](Text library) ![User manager](User manager) ![Cross-reference table](Cross-reference table)

Figure 1. System network configuration diagram

3.2. Implementation of control functions

3.2.1. Process setting and optimization

The operator only needs to select the beginning and end of the process, and the control system can display a list of available processes. If there is a fault in the equipment in the selected process, the process cannot be started smoothly and the fault information is prompted to ensure the safety of the process.

3.2.2. Multi-process control

The control system can select multiple processes at the same time, and unloading and loading processes can be performed at the same time. When different processes are started, the interface can display unused colors for easy operation.

3.2.3. Chain control of process equipment

When starting the process, the end equipment starts first, and the other equipment starts in order from the end to the beginning. When all the equipment in the process starts normally, the loading and unloading operation starts. During the process startup, if the previous device is faulty, the devices behind it cannot be started, and an information prompt and sound and light alarm are issued. After the operator confirms, all the started devices are automatically stopped. When the process stops, the head equipment stops first, and then stops in order from the beginning to the end. The parking delay time is related to the length of the belt to prevent the material from accumulating on the belt. In the process of running the process, if a device has a slight failure, the system immediately sends out information
prompts and audible and visual alarms, and after confirmation by the operator, it can be shut down in order according to the normal shutdown sequence.

3.2.4. Measurement control and management
The belt scale communicates with the bus by sending control commands such as preparation, start, stop, and reset to the belt scale. It can also input signals such as operating status, fault status, and measurement data from the belt scale. By carrying out measurement and accumulation, when a certain belt is said to be faulty, the operation of the operation line is immediately stopped, and an information prompt and an audible and visual alarm are issued. The system can also display management information such as the loading and unloading volume of each work line in real time. By reading the measurement data of the belt scale, it is possible to record and display the information such as the arrival volume, inventory, and cargo type of each yard. The system can divide data such as ship unloading volume, entering volume, leaving volume, loading volume, loading online volume, inventory and other data, and send these data to the terminal operation management system through the computer network, and can also be read from the management system. Taking data such as ship schedule, ship unloading plan, and loading plan to guide monitoring activities.

4. Research on Intelligent Optimization of Bulk Cargo Terminal Control System
With the acceleration of the construction of smart ports, the speed of intelligent and intelligent construction of dry bulk cargo terminals has increased significantly. In addition to container terminals, the construction of smart ports also needs to vigorously improve the level of intelligence of dry bulk cargo terminals along the coast, and gradually realize the overall pattern of smart ports that are smart, green, safe and sustainable. This research is aimed at the bulk cargo terminal control system. On the basis of completing the existing remote start and stop processes and equipment, the database, fault diagnosis, and information management of the control system are optimized to improve the efficiency and convenience of the control system.

4.1. Optimization of real-time database
The theory of real-time databases is to study real-time transactions, real-time concurrency control and real-time task scheduling on the basis of relational databases. Real-time database is a branch of the development of database system, it is suitable for processing constantly changing and rapidly changing data and transaction processing with time limit. The composition of the Wincc database is shown below.

Figure 2. The composition of the Wincc database
Real-time data is data collected in real time from process control, control data sent to the process control system in real time, and intermediate data directly generated by performing various real-time calculations on real-time data. Real-time data is time-dependent, and as time goes by, the real-time data value becomes invalid. The main difference between the real-time database and the traditional database is reflected in the time characteristics. Traditional database management systems have only logical consistency constraints, while real-time databases also have constraints. There are four types of consistency constraints in the real-time database: data logical consistency, transaction logical consistency, data temporal consistency, and transaction temporal consistency.

4.2. Optimization of real-time database
In order to improve the level of informatization monitoring, it is essential to establish a Web-based data distribution system. The communication interface and authority are set in the central control system. Aggressive customers can access the authorized web server IP via Intranet from any location. After entering the internal account and password, you can log in to the human-computer interaction module and obtain the same full operation authority as the computer terminal in the control room. While monitoring the real-time status of the port bulk grain transportation system anytime, anywhere, you can also operate equipment and processes to fully realize the data release and status sharing of the real-time database.

4.3. Optimization of Expert System for Fault Diagnosis
Set up some detection points on the bus terminal of the Bulk Cargo Terminal to complete the collection of equipment status, use the status data in the real-time database and knowledge in the field, and combine the experience of maintenance personnel and experts to analyze the status of the equipment through the computer In order to determine the cause, nature and location of the fault, and propose maintenance and adjustment measures to solve the fault. The structure of the expert system is shown in Figure 3 below.

![Figure 3. Expert system overall plan](image)

There are many control elements such as various switches, contactors and relays in the belt conveyor control circuit. Through careful study of the circuit and analysis of the fault data of the control circuit, the detection points are set. These detection points basically include the key parts of the electrical and common faults in the actual operation. An expert system is a system that studies and processes knowledge. It interprets and reorganizes this knowledge based on the knowledge of domain experts, making it an intelligent computer program with domain expert level that can solve complex problems. Because the expert system has two characteristics suitable for complexity and empiricity, it is applied to the field of fault diagnosis, which makes the diagnosis more scientific and rational, and improves the accuracy and efficiency of problem solving. It is conducive to storing and popularizing the precious experience knowledge of experts, overcoming the contradiction of human experts in short supply, and because it is not affected by various disturbances such as environment and physiology, it is more reliable and more flexible than human experts.
4.4. Optimization of real-time information release function

The database driver receives the request of the program and calls the appropriate communication program to communicate with the database engine. The database local driver in the database engine executes the request of the program and returns the result to the requesting program. The biggest advantage of using technology is good versatility. User programs will not be modified a lot because of the different databases used. This may improve the efficiency of development and the importance of the program. Upgrading the system is also very simple. Through ODBC, you can choose the type of DSN to create, including users, systems, or files. Users and systems are stored in the registry. The system DSN allows all users to log in to a specific server to access the database, and the user DSN uses appropriate security authentication to restrict the database to specific user connections. The file DSN is used to obtain tables from text files, providing access to multiple users, and by copying the DSN file, it can be easily transferred from one server to another. It is also possible to directly display the reference provider, data source, user ID and password without referring to the DSN.

5. Conclusions

The control system of the Bulk Cargo Terminal needs to be integrated with the Internet, big data and other information technologies to complete the transformation and upgrade of the bulk cargo terminal. The project analyzed the characteristics and functions of the bulk cargo terminal control system based on the application requirements. Based on the completion of the existing remote start-stop process and equipment, this research optimizes the database of the bulk cargo terminal control system, adds functions such as fault diagnosis and information management, and the control system analyzes and determines the status of the equipment and the cause of the failure through the detection point. This research has optimized the functions of the bulk cargo terminal control system, it has certain promotion and application value, and has a promoting effect on the construction of intelligent ports.

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