Research on Automatic Control System of Bulk Terminal Based on Application

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Abstract. Due to the wide variety of cargo types, the shape of the cargo has caused great obstacles to the intelligent management of the bulk cargo terminal. Now most bulk cargo terminals operate in the traditional manual warehouse operation mode and data collection, but the traditional manual warehouse operation mode and data collection method have been difficult to meet the fast and accurate requirements of warehouse management. In this study, based on the key technical characteristics and existing problems of the bulk code automatic control system, combined with the requirements of the production site, the intelligent production prototype system of the bulk cargo terminal based on the mobile phone application is designed. Some unnecessary human involvement in the process can be reduced through the mobile phone application, so that the safety of production data is reliably guaranteed. The bulk cargo terminal application can manage inspection operations, maintenance operations, and on-site operations in real time, and can supervise the operations of field personnel in real time. The total capacity of equipment and cargo warehouses, as well as current inventory and cargo owner information can be intuitively applied through the application. This application can achieve intelligent management of the production operations of bulk terminals.

1. Wharf control technology and information intelligence technology

The automatic control technology is an intelligent control system that integrates advanced information technology, data communication transmission technology, electronic sensing technology, control technology and computer processing technology to establish a real-time, accurate and efficient intelligent control system. The automatic control system is the core of port bulk cargo handling operations, introducing advanced automatic control technology to achieve the purpose of monitoring the entire production process by using computers, mobile terminals and other equipment.

In recent years, with the gradual increase of transportation volume, the automatic control technology has also been continuously improved. Ports of Rotterdam, Hamburg, and some major ports in Singapore and Japan have successively realized data sharing of loading and unloading vessels in automated ports [1-2]. More ports around the world began to develop their own information networks and the application of Internet of Things technology [3]. In recent years, more and more bulk terminals have combined information technology and control technology as an important means of management change, and have achieved certain results in business process optimization, efficiency of transportation operations, and collaboration among various departments[4]. The information intelligence technologies[5-6] used in bulk terminals are as follows:

1.1. Browser/Server architecture
The Browser/Server (B/S) architecture is what is commonly referred to as the browser and server architecture. This architecture is based on the Client/server (C/S) architecture and has been modified with Internet technology. The C/S architecture still needs to be installed on the personal PC to install the corresponding operating software for work processing. After the integration of Internet technology, most of the business processing logic is stored on the server side, and users can browse through anytime and anywhere. The device can be used to complete the required operations, and at the same time, it is convenient to operate from the server side for system update or general maintenance, thereby achieving high information sharing. In this way, the actual use of the Browser/Server architecture is more convenient than the C/S architecture, and the scope of use is expanded, and the workload for the maintenance of many clients and the cost of use are reduced.

1.2. Radio Frequency Identification Technology
Radio frequency identification (RFID) is a kind of automatic identification technology. It performs non-contact two-way data communication through wireless radio frequency, and uses the radio frequency method to read and write the recording medium, thereby achieving the purpose of identifying the target and data exchange. Radio frequency identification technology automatically identifies target pairs and records the required data in a contactless and unattended state.

1.3. Geographical Information System
Geographic Information System (GIS) can combine geospatial data with computer technology. GIS provides users with real-time dynamic geographic information data through technical processing based on geospatial data. With the increasing demand for market management in the market, GIS technology is introduced to realize the collection and distribution of goods that can be regulated.

1.4. Global Positioning System
In the information management of bulk cargo port ports, the reference of global satellite positioning system (GPS), GIS and RFID technology will enable accurate positioning of the working machinery in the real-time operation of the terminal, and master the situation of automobile transportation and railway transportation. As well as port inventory and cargo management, we can fully integrate and monitor the positioning and optimize the overall business process of the bulk terminal.

2. Demand Analysis of Automatic Control System for Bulk Terminal
Under the new normal, competition in the port industry has intensified, and shipowners and shippers are looking for ways to improve the efficiency of loading and unloading bulk unloading terminals. In recent years, the newly constructed bulk cargo terminal is developing in the direction of specialization, large-scale and high-speed loading and [7]. The bulk cargo terminal constructed in the early stage is also gradually being reformed [8], breaking the traditional concept and the constraint of traditional technology on development, and utilizing new theory, new technology, efforts to improve the production efficiency of bulk terminals, reduce the operating costs of terminals [9-10], and improve the economic benefit and competitiveness of bulk terminals.

Combining the traditional bulk terminal control system with Internet technology is the key to the transformation and upgrading of bulk cargo terminals. Like electricity, the Internet can inject a new capability into all walks of life, enabling industries to revitalize in the environment. This innovative development model is to use the Internet platform and information and communication technologies such as big data, Internet of things, cloud computing, etc. to combine the Internet with traditional industries to create a new economic ecosystem. The combination of the Internet and the port industry can effectively integrate logistics resources, optimize operational processes, improve production efficiency, and ensure stable, healthy, efficient and sustainable development of the port. The accumulation of big data is very important for the optimization of the terminal management system.

With regard to the research status of production control systems for bulk terminals, with the wide application of network technology [11], information systems and electronic equipment, the infrastructure application and external service level of bulk cargo terminal companies have been continuously improved, but compared with container terminals, the information construction of the
bulk cargo terminal started late, and the support and attention to the information construction was not good due to the complexity of the goods, the different specifications of the warehouse, and the complicated loading and unloading process. Especially in the construction of production systems, there have always been systems in which each management link operates independently, resulting in data such as ship dynamics, shipping assignments, freight plans, warehouse conditions, tally and other links that cannot be shared in real time. Through investigation and analysis of China's multi-bulk terminals, most of the bulk cargo terminals have been in operation for many years. Now there is no complete production system to support the company's overall production process. Managers cannot control the current production status and control the overall situation. Management can no longer be applied to the management needs. In response to various issues and the needs of all parties, companies have also begun to study the differences between independent management systems and integrated management systems covering multiple production processes. Some companies have also begun on-site real-time data collection applications.

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In order to speed up the port modernization, it is necessary to design a higher performance port management and control integration system, which is embodied in the system integration, simplified operation, real-time monitoring, and intelligent query. Management information system is an integrated human-machine system that adopts advanced information technology and hardware equipment collection. It collects, stores, transmits, maintains, updates and uses information data through human-oriented. It supports enterprise grassroots operation and middle layer, it can improve business quality and efficiency, and optimize corporate strategy. We hope that we can design a system that can achieve the function: Before the ship arrives at the port, the system automatically generates dispatching information and generates relevant ship work tickets. After the ship arrives at the port, the ship work ticket is automatically sent to the production automatic control system. The automatic control system automatically handles the cargo flow according to the received ship work ticket. After the ship work ticket is completed, the job report is automatically generated and sent to the production information dispatching system.

This high-performance management and control integration seamlessly connects the production automation control system, production information dispatching system and office automation, avoids the obstacles of information exchange between various systems, fully realizes all information automation, and greatly enhances the competition of the port. The production and operation control system of the modern bulk terminal should first meet the basic process control and fault monitoring requirements, and also cover the whole process of production operation control and operation management of the bulk cargo terminal. The system fully embodies the concept of “integrated management and control”, further improves the production management level and productivity of the terminal, and realizes the production and operation system of bulk cargo terminal with low energy...
consumption, low failure, high efficiency and high safety. Bulk terminal production operation management is a complex project involving all operations of the terminal. This requires detailed knowledge of all business knowledge of the terminal in the demand research and business analysis stages, and in-depth consideration of issues and summary analysis. Based on business processes, the focus is on planning and analyzing the various businesses involved. We conducted many investigations on China's Tianjin Port, Xiamen Port and other bulk cargo terminals, communicated the business process of the loading and unloading process, and clarified the inspection and maintenance plan. Based on the design principle of management and integration, the control system can receive and confirm the information management system. The operation plan, the equipment condition, and the equipment maintenance plan, and the loading and unloading process selection and process operations based on the inspection results and the maintenance results. In the automatic operation mode of the central control room, all the process operations of the control system should be in accordance with the operation plan instructions. Correlation, all operations in the execution plan, equipment status, flow, process failure, workload, food situation and other data should be recorded and sent to the information management system. The monitoring operation screen should automatically display the plan number, plan content, completion status and fault status of the current job execution.

The information and reports generated in the actual production operation of the control system are transmitted to the information management system, and the related data is processed and processed to form a data file, and the information management system is constructed based on this. According to the analysis and comparison of the needs of collecting major users, the production control information management system should have at least the following functions.

2.1. Production Management System
The production management system transmits the data in various production processes in real time through actual production schedule, ship planning monitoring, production process scheduling, and real-time processing of various problems in the production process, which plays a key role in the information system. The key to the production business system is the optimization and safety of the entire production process. This requires a large amount of real-time data collection in the production process, and timely processing of real-time information, while maintaining the two-way interoperability between the production management layer and the process control layer. The two layers receive the corresponding information data and feed back the relevant results and generate related instructions.

2.2. Equipment Management System
The equipment management system is mainly to track the whole life cycle of the whole terminal equipment, to supervise and control all aspects, and to grasp the energy consumption situation and formulate a standardization system. To build a digital, networked and intelligent decision-making platform for the facility management business to support the safe, stable, economical and efficient operation of the equipment.

3. Application Design and Research on Automatic Production of Bulk Terminal
3.1. Overall framework
Through the analysis of the status and demand analysis of the bulk control system of the bulk cargo terminal, this research developed an intelligent application program and developed the information management function module that is most needed in the field. The overall technical framework of the intelligent production application of the bulk cargo terminal is shown in Figure 1 is shown. The software system is structurally divided into a front-end and a back-end. The front-end is an application of the Andriod version. The back-end is a management system of the B/S architecture, which is then connected to the database system of Mysql. The front-end selection of the Andriod version is because the survey found that the Chinese dock construction workers basically use the Andriod mobile phone,
which can meet the needs of most staff. The front-end application is deployed on an Android phone or a custom handheld device and operated by port field maintenance personnel. The back-end management system is deployed in the cloud and is operated by network administrators. It is mainly used for job delivery and data maintenance. The database system of the bulk terminal production management system is deployed in the cloud and is responsible for storing all data records.

Figure 1. Overall technical framework

The application side is developed by JAVA language. The essence of Android is to add JAVA virtual machine Dalvik on standard Linux system, and build a JAVA application framework on Dalvik virtual machine. All applications are based on JAVA application framework. Android is mainly used in the ARM platform, but it is not limited to ARM. It can be run on the X86, MAC and other architecture machines through compiler control. Android is divided into four layers, from the upper layer to the lower layer are the application layer, the application framework layer, the system runtime layer and the linux core layer. The bulk terminal control management system application is written in JAVA language. Each application consists of one or more activities. The activity must be based on the Activity class. The activity is similar to the process on the operating system, but the activity is better than the operation. The process of the system is more flexible, and similar to the process, the activity switches between multiple states. Utilizing the cross-platform nature of JAVA, applications developed based on the Android framework can be compiled and run on any platform with an Android system installed. Each application of the automated control management system application involved in this research is followed by a series of services and systems, including:

a) Views: Rich and extensible views can be used to build applications, including lists, grids, text boxes, buttons, and even embeddable web browser.
b) Content Providers: It enables applications to access data from another application or share their own data.
c) Resource Manager: It provides access to non-code resources such as local strings, graphics, and layout files.
d) Notification Manager: It enables the application to display custom prompts in the status bar.
e) Activity Manager: It is used to manage the application life cycle and provide a common navigation fallback function.

3.2. Functional division of bulk cargo terminal applications

The application of this research design involves a complex project in many operations of the terminal. The system functions mainly include inspection management sub-module, maintenance management sub-module, field operation management sub-module, inventory management sub-module, grain monitoring and management sub-module. The business involved in the form query sub-module is the focus. The software application can be operated more clearly by module division. The software business module of the bulk terminal production management system application is divided as shown in Figure 2:
Figure 2. Software module division of port management system application

The bulk cargo terminal intelligent system application can conveniently and efficiently realize the information management of the production system. Through the production management system, the production schedule can be accelerated and the management efficiency can be improved.

3.3. Application background management system software architecture design

The accuracy of directional control is highly dependent on the electronic compass. The depth control depends on the depth sensor. The accuracy and update frequency of the sensor completely restrict the directional control accuracy. When an underwater platform with an electronic compass and depth sensor is subject to external interference, its accuracy will cause a large error. The sensor data needs to be filtered to improve the accuracy of the sensor.

The backend system of the application is developed in Python and uses the Python Flask web framework. The Python syntax is simple and clear, and one of its features is to force white space as a statement indentation. Python has a rich and powerful library. Flask is also known as "microframework" because it uses a simple core and uses extension to add other features. Flask does not have a database or form validation tool that is used by default. However, Flask retains the flexibility of amplification, which can be added with Flask-extension: ORM, form validation tools, file uploads, and various open authentication technologies. The software module of the background management system of the bulk cargo terminal production management system is divided as shown in Figure 3:

Figure 3. Software module division of the background management system

The function of each module is described as follows:
a) Inspection operation management: Through this module, it is possible to operate the checkpoints in the project. The operator can add or change checkpoints to facilitate the management of operations, including the management of patrol trackmaps.

b) Maintenance management: Through this module, network management personnel perform maintenance on additions, deletions, and changes to maintenance and maintenance work forms, maintenance and repair items, and project checkpoints. Includes management of the nurturing trajectory map.

c) Field operation management: Through this module, network management personnel perform maintenance on additions, deletions, and changes to field operation forms, site project tables, and project checkpoints. Includes management of the on-site trajectory map.

d) Template library: For the above three job scenarios, a job template library is uniformly planned, and the administrator can set a copyable template for the job in the background, and then copy from the template for the specific job, thereby avoiding a lot of repeated operations.

e) Equipment management: Add, delete, and change the equipment to be inspected.

f) Inventory management: Network management personnel perform additions, deletions and changes to the storage situation.

g) Business form management: Unloading operation schedule, warehouse operation schedule, outbound operation schedule, work schedule, food inspection record form, monthly grain analysis and treatment table Carry out additions, deletions and changes.

h) User Management: Add, delete, and modify the user.

i) Mysql database management module: Generate, view, and print the QR code of the device.

j) Image processing module: The bottom layer supports the module, and generates the support modules required for the two-dimensional code and the track map.

k) APP Restful API: The underlying support module is used to provide a remote procedure call interface for the APP.

l) WEB Server: The underlying support module is used to provide WEB services for the background management system.

m) IM support module: The underlying support module is used to provide the underlying engine for instant messaging and expert systems.

4. Experimental Research on Attitude Control and Stability Adjustment Simulation

Bulk terminal intelligent management system application experiment detection

Based on the actual situation of the bulk cargo terminal and demand analysis of the production management system, the production system of the bulk cargo terminal production management APP was developed. The different functions of the APP are now tested experimentally. The experimental process is described below.

4.1. Detection login interface

After entering the username and password, go to the main menu page of the Port Warehousing Management System.
4.2. Inspection operation management.

After the user receives the need to execute a work plan, click on the job plan and enter the specific details page of the job. On this page, you can see a list of all the devices (or projects) that the job needs to be inspected, and the inspection. Schematic diagram of the route of the job. The project list includes the name, status, and completion status, as shown in the following figure.

![Figure 4. APP main interface](image1)

![Figure 5. APP inspection management interface](image2)

When the user obtains the device detailed information by scanning the two-dimensional code on the device, the check content required by the device/item will be listed in the work list, and the check-in information is recorded, and the corresponding scan time, location, and GPS information record are recorded, at the same time, the user can perform specific inspection/maintenance work according to the work list. The user checks the specific checkpoints one by one. For checking the normal checkpoints, the system can only record. For abnormal points, it will enter the specific problem record page, the user can fill in the report.

4.3. Other links management
The design principles of maintenance management, on-site operation management, inventory management, grain inspection, etc. are consistent with the inspection operation management, and the inspection and maintenance of the inspection points can be carried out.

4.4. Form query

After the user clicks on the form query module, there are six forms that can be found here, including: unloading operation schedule, warehouse operation schedule, down warehouse operation schedule, warehouse entry schedule, and warehouse release. After the user clicks on a specific form, they can enter the list of details of the form, where they can view all the contents of the form.

4.5. Software warehousing management system background management

The background management system can add, delete, and modify all data forms, and open the login interface of the background management. In addition to the input boxes such as the regular user name and password, the template can also be scanned and installed by the QR code. The job template library exists as a general work plan template common to inspection operations, maintenance operations, and on-site operations. Subsequent specific jobs can be copied from the previously designed job template library, thus avoiding a large number of repetitions when adding jobs later. Through the interface of this chapter, make a unified description of the addition, deletion and change of the background form.

5. Conclusions

In this study, the domestic and international status of the bulk control system of the bulk cargo terminal is analyzed in depth. In order to meet the needs of complex operations and large-capacity operations, it is necessary to integrate intelligent Internet technology with the traditional bulk cargo terminal control system, the needs of different companies are compared and analyzed, we study the technical problems that need to be solved in the operation of the control system of bulk cargo
terminals, develop intelligent production management applications, and strive to improve the production efficiency of bulk terminals and reduce the operating expenses of terminals. It improves the economic efficiency and competitiveness of bulk terminals. The system software application side is developed by JAVA language. The software system is structurally divided into front end and back end. The front end is an Android application of the Andriod version. The back end is a B/S architecture management system, which is connected to Mysql database system. The software system can realize inspection operation management, maintenance operation management, on-site operation management, inventory management, grain situation management, form query management, and expert community management. The function module can be used to operate the bulk cargo terminal production control system more clearly and efficiently. Through test and study, it is proved that the prototype system software APP can complete the above functions well, improve the safety of the bulk cargo terminal production system, and better avoid the occurrence of faults. When the fault occurs, the problem can be solved faster, so that the bulk cargo production control system can run efficiently.

6. References

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