Handling optimization Framework for Railway Container Terminal based on Vehicle Interconnection

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Abstract. This paper introduces the background and significance of the study on the dispatching optimization of railway container terminal and analyzes the advantages and feasibility of direct loading and unloading, followed by the function layout of the railway container terminal expounded, with the purpose of this paper analyzed separately on three operation processes. The key technology of the Internet of vehicles is briefly introduced. Finally, the overall process of this paper is depicted with five main steps in detail, which are acquiring vehicle networking data, platform development, algorithm implementation, MCU control and solid model display.

1. Introduction
In recent years, with the proposal of the Belt and Road Initiative, trade between China and the countries along it has gradually increased. The opening of central and European trains also makes container railway freight volume larger. In the context of the advantages and developments described above, the study of container rail transport has profound implications.

For this problem, scholars at home and abroad have not stopped to study, and have achieved a lot of research results in the formation plan, vehicle flow path, etc. [1-3] Research on the layout optimization of the station and the optimization of resource scheduling are also increasing. Aiming at the fuzzy queuing system of the gate of the railway container terminal due to the uncertainty of the arrival time of the railway container terminal and the container truck, Lin et al. put forward a mathematical programming model to minimize the unit cost of the queuing system, calculated the upper and lower bounds of the objective function, constructed the membership function to minimize the unit cost of the system, and obtained the maximum of the railway container terminal. The optimal service rate of a gate in a fuzzy environment [4].

Previous studies mainly focused on the optimization of gantry crane operation dispatch, and related studies were limited to the "train-yard-container truck" mode. There is less research on the "train to truck" direct loading and unloading mode with higher efficiency. The main reason is that the arrival time of the truck is uncertain. In recent years, with the development of Internet and vehicle networking technology, and the promulgation of relevant policies, it is possible to obtain the location of the container truck and predict the arrival time. It will be an important research direction in the future to optimize the loading and unloading operation dispatch of railway container yard station based on the arrival data of the container truck connected with the network of vehicles.

Based on these, this paper mainly studies the operation scheduling problem of rail gantry crane under the uncertainty of arrival time of container truck, obtains the dynamic information of container
truck arrival through vehicle network, establishes the operation scheduling optimization model of rail gantry crane considering the dynamic arrival of container truck at the railway container terminal, designs relevant algorithms to solve the model, and then improves the "truck-train" performance. The number of direct loading is increased, and the loading and unloading times of containers are reduced. It is of great theoretical and practical significance to increase the ratio of direct loading and unloading and to improve the dispatching efficiency of the railway container terminal.

2. Functional Layout of Railway Container Terminal

Railway container terminal is a professional railway freight station which provides container service. It is also an important node and regional logistics centre of railway container transportation network. The terminal assumes the functions of arrival and unloading of containers and trains, as well as the functions of inspection, maintenance, clarity and maintenance of containers and vehicles. The information management system is provided, and the functions of temporary storage and empty container allocation are also provided. Based on the above functions, the terminal is equipped with complete facilities, in addition to handling facilities, there are supporting service facilities and management system. Therefore, the functional layout of the central station is divided into three areas: the main operation area, auxiliary operation area and service area. The layout is shown as figure 1.

![Schematic representation of a railway container terminal](image)

Figure 1. Schematic representation of a railway container terminal

The objects of storage and handling in the railway container terminal are the arrival container, the sending container and the transfer container. Different objects correspond to different operation processes. The above three kinds of container correspond to the arrival container operation process, the sending container operation process and the transfer container operation process.

1) Arrival container operation
The arrival container refers to the containers which are transported to the terminal by trains. The arrival container operation refers to the container unloading operation carried by the gantry crane. There are three main types of unloading operations: temporary storage containers at main yard, waiting for container trucks to load; unloading special containers, international containers or empty containers to trucks, and then unloading from trucks to auxiliary storage areas; unloading from trains directly to trucks. As far as the proportion of the three processes, the first is the largest, the second is the second, and the third is the least. This paper hopes to increase the third proportion and optimize the operation of Rail Gantry Crane by introducing real-time information of vehicle network.

2) Sending container operation
The sending containers are containers that transported to the terminal by trucks and wait for loading. There are three main types of sending container operations, which are: from trucks to main yard for temporarily dispatch; from frontal crane to auxiliary storage area, and then transferred to main
yard by trucks; or directly loaded to train. As far as the proportion of the three processes is concerned, the first is the largest, the second is the second, and the third is the least. This paper hopes to introduce the information of vehicle networking, increase the proportion of the third one, and optimize the operation of Rail Gantry crane.

3) Transfer container operation

The transfer container refers to the container which is transported by train to the railway container terminal for unloading and waiting for loading. There are two main types of transfer container operation processes: the transfer container operation from gantry crane to main yard and the transfer container operation from arriving train to sending train.

Up to now, the railway container terminal cannot get the vehicle location information in time and then predict the arrival time, which makes the direct loading and unloading ratio lower. With the development of Internet and vehicle networking technology, it is possible to predict arrival time. Therefore, the third part of this article will focus on the technology of Internet of vehicles.

3. Application of Vehicle Interconnection

The time for container trucks to reach the terminal is the key to this paper. Its core technology is related technologies of vehicle interconnection. For the vehicle networking, this paper mainly discusses three aspects: definition, basic structure, the relationship with this paper.

3.1. Definition

Vehicle networking was first proposed at the "Vehicle Networking" seminar in 2010. The Strategic Alliance for technological innovation of vehicle networking industry defines vehicle networking as follows: Vehicle networking is based on intranet, inter-vehicular network and vehicular mobile internet. According to the agreed communication protocol and data exchange standard, information is transferred between the vehicle and the vehicle, the vehicle and the roadside infrastructure, the vehicle and the external network so that an integrated network of intelligent traffic management, intelligent dynamic information service and intelligent vehicle control can be realized. [5]

3.2. Basic structure

Vehicle networking can be divided into three layers: perception layer, network layer and application layer. Perception layer: The perception and collection of the vehicle's own information and traffic conditions, including the collection of vehicle operating conditions, transportation conditions, weather conditions and so on. It involves wireless sensing and GPS positioning technology. Network layer: Integrating the data acquired by the perception layer, providing information transfer services for the application layer, realizing the purpose of long-distance communication and remote control. It involves 2G/3G/4G and other wireless mobile network, satellite communication network and other technologies. Application layer: realizing the communication function of human-machine interaction. Through the data processing and analysis from the perceptual layer, the vehicle driving information and traffic information are obtained. Provide related services for individuals, enterprises and governments. [6] The vehicle networking framework is shown as figure 2.

![Vehicle networking framework](image-url)
3.3. Application in railway container terminal

For this paper, the perception layer is container truck. GPS positioners, sensors and related equipment equipped with container trucks collect the location of the truck, speed, surrounding road conditions and weather information and send them to the cloud processing centre. Cloud processing centre is the network layer, after receiving data, data cleaning is the next step, which most valuable information can be got from this process. The cloud platform then collated the data into standard data format and passed it to the application layer. The application layer obtains the data by API interface, and then reprocesses the data, so as to get the relatively accurate time when the container truck arrives at the railway container centre station.

It is the key of this paper to get the location information and predict the time of arrival through the Internet of vehicles. Use the relevant API interface provided by "Zhong Jiao Xing Lu" to get the required data. The platform's data are real-time, massive and multi-dimensional. In terms of real time, the platform dynamically collects data once on average for 2-30 seconds. In terms of data volume, the platform covers 95% of the freight cars. At the same time, the platform provides real-time road conditions of the National Road network, weather conditions of each section and prohibited traffic area and other multi-dimensional industry data. Through this platform, we can get all the required data. In terms of data processing, the platform also has powerful technology. Using Hadoop distributed framework, Kafka message queue, store real-time computing, ES search and other technologies, the accuracy of predicting the arrival time of container trucks can be guaranteed.

4. Handling optimization Framework

This paper intends to obtain the dynamic location information of the container truck through the relevant API interface provided by the freight train network platform, and predict the arrival time of the truck by combining the relevant information such as road conditions and weather. A series of related data are integrated through the software platform and sent to the MATLAB for algorithm implementation. The job scheduling process after operation is returned to the software platform. The platform is connected to the micro-controller module through serial port, and then the solid model is controlled by the micro-controller. The concrete realization framework is shown as figure 3.

This paper involves following technologies: vehicle networking platform to obtain data, software platform development, MATLAB algorithm implementation, MCU control and solid model display.

![Figure 3. The concrete realization framework](image)

4.1. Vehicle networking platform for data acquisition

The time when the container truck arrives at the railway container terminal is the key of this paper, which has a vital impact on the feasibility of the algorithm. With the increasingly stringent supervision of freight vehicles in China, the network platform of freight vehicles is developing day by day. The technology of obtaining the location and speed of the container truck through the existing vehicle network platform, the road condition and weather information of the truck driving section has been more perfect, and the data needed can be easily obtained through the standardized API interface. The data flow of vehicle networking platform is shown as figure 4.
4.2. Development of software platform
Software platform is a key part of this paper. It completes the acquisition of vehicle networking information, the vehicle networking data obtained from the analysis and prediction, get the container truck arrival time at the central station, transfer the analysis time to MATLAB, obtain the operation process calculated by MATLAB, and standardize the operation process output to the single-chip microcomputer module function. Because the Java language has the characteristics of versatility, high efficiency, platform portability and security, the whole software platform is to be developed and implemented in Java language. The data flow of software platform is shown as figure 5.

4.3. Algorithm implementation
MATLAB is widely used in data analysis, data visualization and algorithm development, and provides API interface adapted to Java, which is helpful to the development of software platform. So, this paper chooses MATLAB to implement the algorithm. In this paper, considering the arrival time of container trucks, we need to add the corresponding decision variables to the model, adjust the constraints and objective functions. Reconstruct the optimization system model of loading and unloading equipment dispatching under different loading and unloading modes when the arrival time of container trucks is known. Then, according to the attributes of the model, different algorithms are designed to solve the problem, and the algorithms that make the direct loading and unloading ratio maximum and the gantry crane traveling distance minimum are found. The algorithm is used to solve the scheduling plan and output the result to the software platform. The data flow of algorithm platform is shown as figure 6.

4.4. Single chip microcomputer control
The final results of this paper are displayed through solid models. The driver of the solid model needs the control of single chip microcomputer. By comparing the 8-bit, 16-bit and 32-bit micro-controllers on the market, 32-bit STM 32 micro-controllers based on ARM Cortex-M3 kernel are selected. STM32 as a high-performance single-chip microcomputer, its external pin characteristics, internal structure and other functions are closer to the paper expected. The data flow of SCM is shown as figure 7.
4.5. **Solid model displays**

The solid model is made up of standardized parts. Two motors control horizontal and vertical movement of hoisting hook models. Simulate the front and rear movements of the gantry crane through the car mounted below the model. Through the above facilities, three track movements of track gantry crane are realized. External sensors to obtain the location of the lifting hook, to avoid the horizontal movement of the lifting hook over the length of the main beam, vertical movement over the height of the door crane. Through the above equipment, the whole model has strong controllability and high precision, and can run the demo program more ideally to achieve the purpose of display.

5. **Conclusion**

In this paper, the main purpose of this paper is clarified through the detailed description of the layout function of the central station. Through the introduction of the whole process, 5 main processes are defined. And the key point, the technology of Internet of vehicles, is discussed further. Through this paper, the overall process of the paper is clearly explained, and the technical points of introducing the train network technology into the railway container terminal to improve the direct loading and unloading ratio are analyzed.

**Acknowledgments**

This work was supported by the Fundamental Research Funds for the Central Universities (grant number 2018JBM028), and the National Key Research and Development Program of China (grant number 2018YFB1201403).

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