Discussion on Intelligent Upgrading Technologies of Hairun Container Terminal

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Abstract. Aiming at the intelligent upgrading of Hairun Terminal, this paper focuses on analyzing the influencing factors of the intelligent upgrading of container codes. And the maturity of application technology and the degree of influence on production were systematically introduced, and the intelligent upgrading technical scheme suitable for Hairun Terminal was put forward. Besides, the key points and difficulties of the upgrading were analyzed. This research has guiding significance for the intelligent upgrading of traditional container terminals at home and abroad.

Keywords: Traditional container terminal, Intelligent upgrading, Handling process.

1. Introduction

The yard operation equipment is the core of the management and operation of the equipment and materials of the container terminal, the key link of the storage and transportation capacity of the terminal, and the key factor affecting the production and operation of the terminal [1-3]. With the rapid development of automation and intelligent technologies, the application of emerging technologies in ports has gradually deepened. It is the general trend that port production and operation automation will finally realize intelligence.

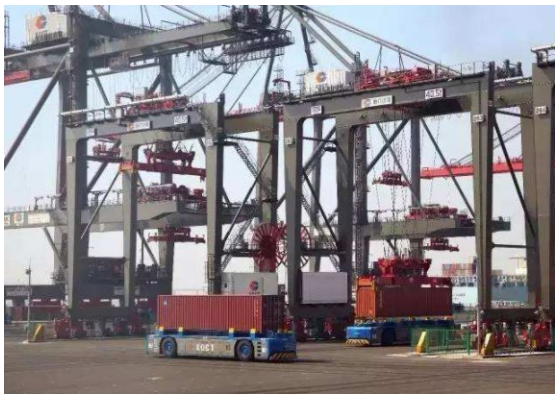


Figure 1. the first fully automated container terminal in China

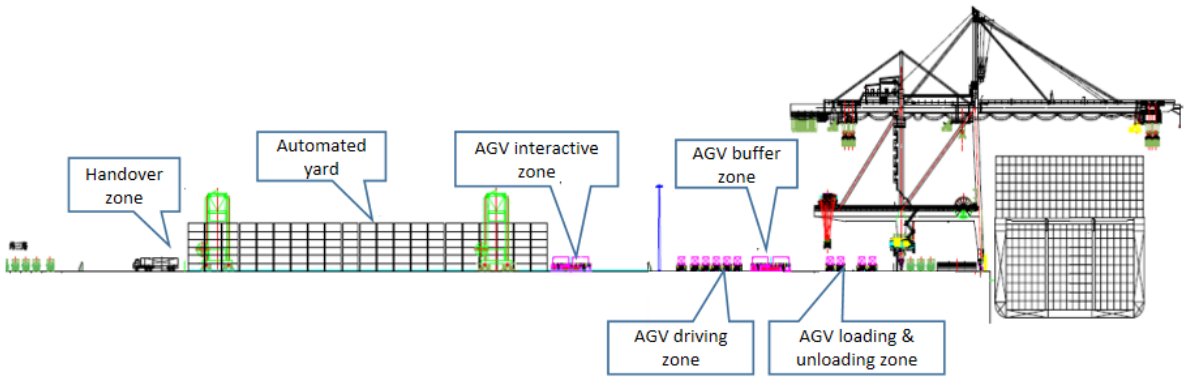
In March 2016, with the opening of Xiamen Yuanhai Automated Terminal, it marked the beginning of a fully automated container terminal in my country. Under the background of the continuous development of computer technology, artificial intelligence technology and internet technology, the unmanned operation of the container terminal has already become a reality and gradually reflect the advantages of system efficiency under the blessing of artificial intelligence and other technologies. With the rise of the concept of "the fifth-generation ports", domestic ports have accelerated the layout of "smart ports", continuously strengthened innovation and upgrading, and have improved the application of new technologies and equipment such as artificial intelligence and 5G in the field of port equipment. The construction of smart ports and the intelligent construction of equipment are also regarded as the key to enhancing the core competitiveness of ports. Thus, it helps to reduce logistics costs, and to improve logistics efficiency, and intelligent upgrading of traditional terminals is an important way to reduce port staff and increase efficiency. At present, in addition to the new automated terminals, smart gates, quayside cranes remote control, RTG remote control, etc. have been popularized to varying degrees in container terminals, Internet of Things knows as IoT

technology, big data technology, cloud computing technology, GIS, etc. Information technology which have been fully integrated with port production still needs in-depth integration during process of terminal operation.

Based on its own production needs and equipment characteristics, Hairun Terminal has carried out a fully intelligent upgrading project of traditional container terminals and achieved phased results.In this paper, the influencing factors of the intelligent upgrading of container codes were analyzed and the maturity of application technology and the degree of influence on terminal production were systematically introduced, and the intelligent upgrading technical scheme suitable for Hairun Terminal was put forward. Besides, the key points and difficulties of the upgrading were analyzed.

2. Influencing factors of intelligent upgrading of container code

The newly built container automation terminal is not limited by the existing terminal shoreline, yard conditions, operation equipment and production organization mode. The layout of the terminal and the type of equipment can be customized according to the needs of engineering construction and production technology. Take the Yangshan Phase IV automated terminal as an example. The total length of the automated terminal is 2,350 meters, with a total of 7 container berths, 26 quay cranes, 128 RMGs, and 120 automatic guided vehicles(AGVs). The yard adopts automatic RMG without cantilever and automatic RMG with cantilever on one side. The gauge is 31m, the lifting height is 19.75m, and the stacking height is 6 layers. Each container area of the yard adopts a double RMG arrangement. The seaside RMG adopts the fully automated operation mode for AGV operation, and the landside RMG adopts the automatic and manual confirmation operation mode for the trailer operation. The average annual throughput of Yangshan Port per 100 meters of shoreline exceeds 280,000 TEUs, which is about twice of the world average. The system process and equipment system of Yangshan Phase IV are shown in Figure 2.



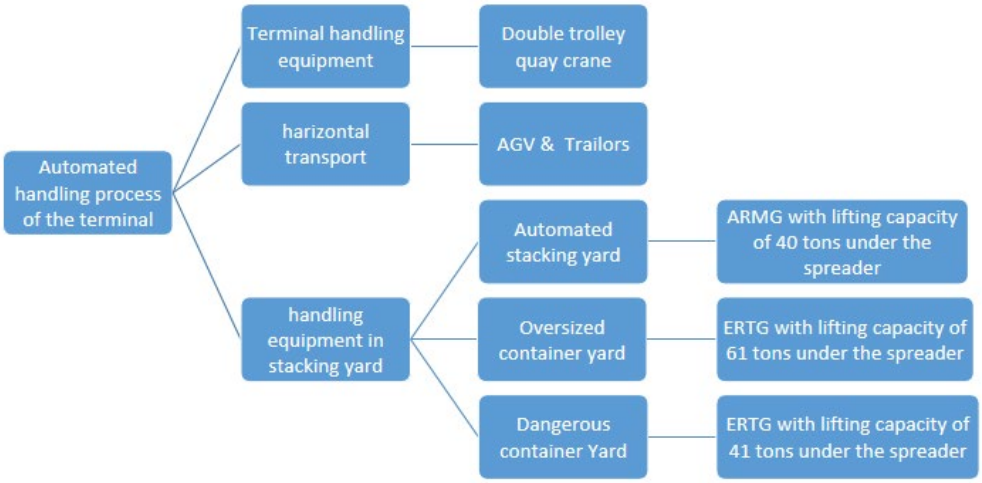


Figure 2. Process plan of Yangshan Phase IV automation

The existing traditional container terminal is different from the newly built terminal. It is affected by factors such as the terminal shoreline, yard layout, road traffic, yard conditions, equipment configuration and production process. To realize the intelligence of the container terminal, it is necessary to solve a series of problems. technical challenge. The main influencing factors and the problems that need to be solved are shown in the table 1 .

Table 1. main influencing factors and the problems during the intelligent upgrading of traditional terminal.

Influencing factors	The Readiness of upgrading technology and the degree of impact on production
Remote control of STS	The technology is mature; the port has good application and the degree of impact is small.
Remote control of RTG	The technology is relatively mature, which mainly affects the stacking of RTGs, especially the remote control of RTGs with a 4-rope mechanism as the spreader is more difficult and has a great impact.
Horizontal transport equipment	The single machine technology is mature, mainly including automatic guided vehicles (AGV), intelligent container trailers (ICT) and intelligent guided vehicles (IGV). The application maturity in traditional container yards is not high, and the adaptability requires engineering inspection, which has a large impact.
Transport organization	The technical maturity is not high, and the site requirements are relatively high; the maturity of traffic flow and vehicle guidance and supervision technology needs to be verified, and the problem of mixed internal and external towing cannot be effectively solved, and the impact is large
Geographic information system	The technology is mature, but there is a lack of successful cases applied in traditional container terminals. The real-time information collection and algorithms in the intensive production area of containers and operation equipment need to be verified, and the impact will be large.
Intelligent management system	There are no constraints on the technology, and it is closely related to the production process, equipment performance and management level. It needs customized development, and the degree of intelligence and reliability needs to be further verified, which has a great impact.

3. Main upgrading direction and technical route

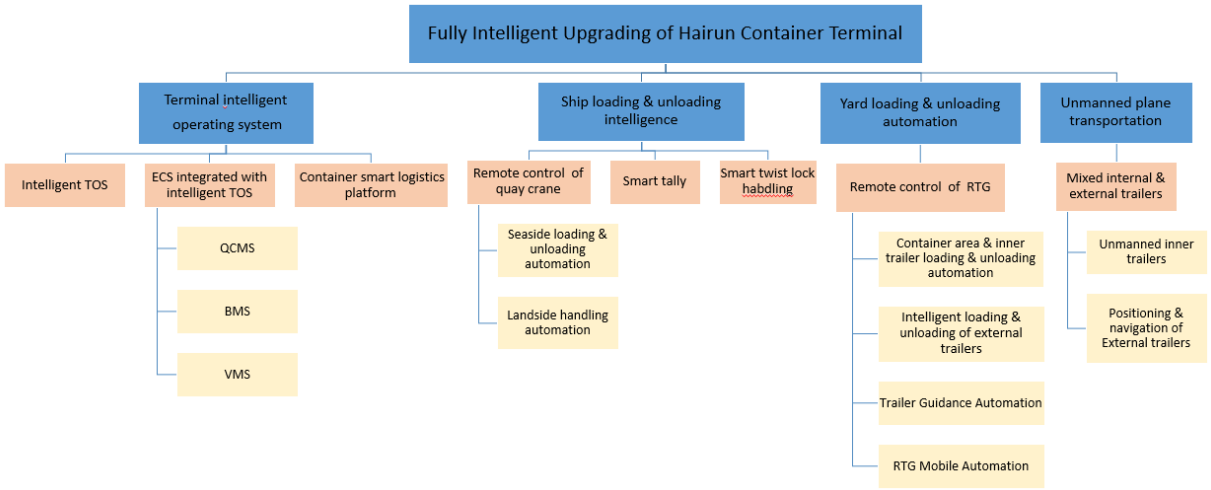


Figure 3. The composition diagram of the intelligent upgrading system

In view of the influencing factors of the intelligent upgrading of traditional container terminal production, the maturity and influence of upgrading technology, Hairun Terminal has determined a scientific and reasonable upgrading plan and put it into practice through a large number of demonstrations, verifications and technical deductions. Focusing on the general policy of

simultaneous production and simultaneous upgrading, Hairun Terminal has clarified the direction of the terminal's ultimate realization of fully intelligent production. In the process of upgrading, the intelligent management system (TOS) was taken as the core, the upgrading technology route of "one master and three passes" has been formed. Specifically, the "one master" is mainly based on the customized development of a new TOS system, and the "three passes" are mainly consisted of the key technologies of remote control of quay cranes, the key technologies of RTG remote control and the key technologies of unmanned plane transportation. Based on this, the system composition of the intelligent upgrading of Hairun Container Terminal is formed as shown in Figure 3.

As a key part which connects quay cranes, RTGs, containers and collection & distribution of terminals, horizontal transportation equipment is the most critical factor in the container terminal production system. Whether it is suitable for the intelligent production process system requirements will directly determine the upgrading effect of traditional container terminals. In view of the influencing factors such as system algorithm, safety obstacle avoidance mechanism and horizontal transportation equipment selection in the current traffic organization design, Hairun Terminal adopts a phased implementation. The first phase focuses on solving the TOS main system and The key technologies for remote control of quay cranes and RTGs. and at the same time the unmanned production verification of plane transportation was carried out. thereby under the premise of ensuring the feasibility and safety of the intelligent upgrading of traditional container terminals, and a technically safe, economically feasible and uninterrupted production were explored.

4. Upgrading difficulties and risks

4.1 Continuous optimization and upgrading of TOS

TOS is the control center of the container terminal. To improve the operation efficiency of the entire yard, the TOS performance must be continuously optimized according to the loading and unloading process characteristics of the terminal. On the basis of continuously improving the existing functions of optimal task selection, equipment scheduling, and automatic tumbling, the macro yard allocation management function has been developed, and the traditional "stacking" mode has been changed to a "scattering" mode. Thus, equipment of the container terminal will taking advantage of the features that multiple devices can all participate in the operation after automation upgrading.the efficiency of the entire yard can be improved.

4.2 Yard loading and unloading process:

Different from various types of rail cranes with no cantilever, single cantilever and double cantilever which are mostly used in the new container terminal yard, Hairun Wharf adopts the automatic upgrading of tire crane to realize the automation of container loading and unloading in the stacking yard.

4.3 Transport Organization:

The traffic organization inside and outside the stacking yard is just like the blood vessels of the human body. Once the blood vessels are blocked, the overall function of the human body will be affected. When the traffic in the yard is organized, it is necessary to fully consider the traffic organization in the yard, as well as scientifically and reasonably to set the scheduling principle of the mixed traffic of internal and external trailers. Once the internal and external trailers interact, unified path planning can be achieved.and at the same time, unified scheduling of production operation areas along with unified navigation, traffic management, collaborative management, and complete safety management can be achieved [4, 5];

4.4 The connection between the intelligent gate and the production system

The intelligent gate is an important node the connecting between the container terminal and the external logistics. Automated container terminals require an intelligent gate system with separation of entry and exit and coordination of multi-level customs clearance. At the same time, the intelligent gate needs to integrate laser scanning, OCR, RFID technology, intelligently identify information such as the vehicle number, the box number, sizes, the box door direction, etc., can be automatically checked. when abnormal alarm signal can be given out. This is a prerequisite for the efficient operation of the port.

5. Summary

Practice has shown that automated terminals, especially intelligent terminals, have significant advantages in saving terminal labor costs, improving port throughput, reducing equipment energy consumption, and enhancing port image. The development of 5G, AI artificial intelligence and other technologies has vigorously promoted the intelligent process of container terminals. The state encourages the application of IoT, 5G, AI and other emerging technologies in smart ports through relevant policies and plans. Smart operation is the mainstream of the future development of container terminals, and intelligent upgrading is the evolution of traditional container terminals to higher-level production operation systems. Therefore, in the context of the great development of "Industry 4.0" and "AI+", it is necessary for traditional container terminals to undergo digital and intelligent upgrading.

Considering the general layout of the port, mature operation process, and limited production operation space of the traditional container terminal, it will inevitably face many industry difficulties and pain points in the process of intelligent upgrading. in order to find a way of upgrading that is most suitable for its own port area, it is necessary to carry out a large number of experiments, tests and verification based on its own characteristics, especially in terms of process layout optimization, intelligent equipment selection and traffic organization design. There is experience for reference, but it must be a mode of upgrading for the specific port.

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