Study on the Application of Intelligent Gates in Bulk Cargo Terminals

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Abstract. By using the integration of vehicle identification, in-car face recognition, unattended weighbridge and other functions, the identification of vehicle and occupant information, automatic weighing and collection of trucks can be completed by Intelligent gates. Which can not only avoid the occurrence of human input error rate, reduce staff and increase efficiency, but it can also realize the intelligent passage of bulk cargo terminal trucks.

Keywords: Intelligent gates · Bulk cargo terminals · Applications

1 Introduction

Following the rapid development of the port economy, the scale and cargo throughput of the breakbulk terminals are expanding, and the volume of cargo transported in and out of the port is increasing day by day. As the throat of the port, the gates have a direct impact on the operational efficiency of the breakbulk terminals. The traditional development mode has not been able to adapt to the new development requirements of breakbulk terminals in the new era, which has seriously restricted the improvement of port efficiency. Therefore, the research on the application of intelligent gates in bulk cargo terminals is of great significance to promote the quality change, efficiency change and power change of bulk cargo terminals, and to achieve higher quality, more efficient, more sustainable and safer development.

2 Disadvantages of Traditional Bulk Cargo Terminal Gates

Compared to container terminals, breakbulk terminals are more complex and varied. The characteristics of the materials loaded and unloaded at break-bulk terminals are diverse and complex, so the intelligence of break-bulk terminals faces greater difficulties [1, 2].

The main problems faced by traditional bulk cargo terminal gates are as follows.

(1) The gates are relatively rudimentary and functional. There is no more advanced computer systems, wireless terminal systems, manual identification systems, CCTV (closed-circuit television) systems, etc.

(2) Trucks at the gates for vehicle verification, weighing, data entry and other gate operations rely on manual identification of license plate numbers, manual data entry, on-site inspection, etc. This not only makes the data poorly accurate, but also makes the operation inefficient [3].

(3) There is a wide variety of goods, so adopting manual counting methods can lead to a high error rates.

(4) Uncertainty about the human factor leads to low labour rates and a serious waste of human resources.

(5) The traditional management method makes it impossible to have real-time access data and weighing data at the gates, and does not facilitate the sharing of information resources within the unit.

The above problems directly slow the speed of gate passage and increases the error rate. Therefore, it is particularly important to improve the intelligence of the gates at breakbulk terminals in order to increase the efficiency of breakbulk terminal operations.

3   Bulk Cargo Terminal Intelligent Gate System Component

3.1   Intelligent Gate Equipment

According to the actual requirements of the bulk cargo terminal gates and the construction objectives of the system, the overall system architecture of the intelligent gates is designed as shown in Fig. 1.

(1) Basic perception layer: this part is to provide software and hardware support for the operation of the application system as well as front-end information resources access. Which including LED display, face recognition, license plate recognition system, electronic weighbridge, electronic road gate traffic light, etc.

(2) Processing and control layer: This part ensures the smooth acquisition, processing, transmission and analysis of data resources in order to achieve the goal of decision support. Including PLC controllers, gate industrial controllers, gate switches, etc.

(3) Information release layer: This part can use visual equipment for display, distribution, timely detection of problems and automatic alarm. This includes the back end by the gate server, gate monitoring center, customs server, etc.

3.2   License Plate Recognition and Face Recognition Systems

The gates are equipped with special HD cameras to capture the license plates and drivers. When a vehicle enters the gate, the vehicle detector will send a command to capture the vehicle plate and compare the captured image with the pre-set black and white list in the database to decide whether to lift the lever and release the vehicle. If the requirements are met, the lever will be automatically raised and lowered, and if not, the alarm will be prompted, which can solve the problem of undocumented vehicles entering the port area. Meanwhile, through the vehicle face recognition function, the driver's image inside the vehicle will be collected to solve the problem of undocumented motorists entering the port area.
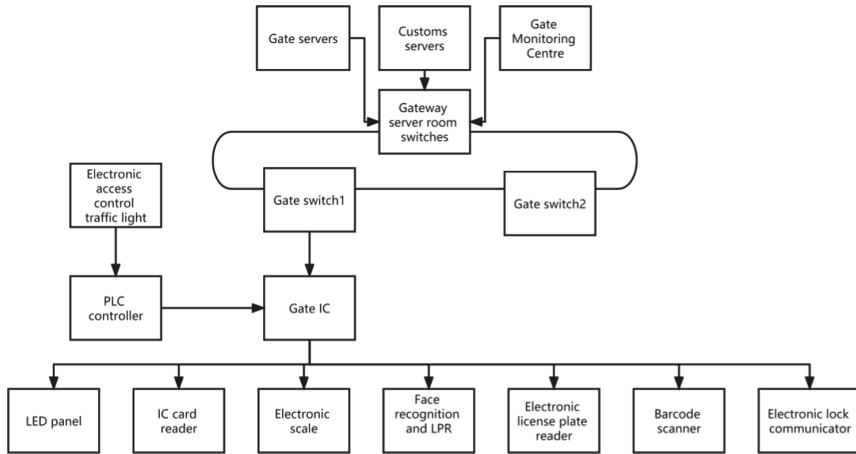
Fig. 1. Intelligent gate system equipment

The system combines traditional control technology with new technologies such as face recognition, vehicle recognition, IoT sensors, video analysis, etc. Through unified vehicle and personnel information collection, identifying and capturing images of people or vehicles entering and leaving the gate area, intelligent management such as informatization, comprehensive research and judgment, advance warning and equipment linkage [4] can be realized.

License plate recognition and face recognition systems can work around the clock without fatigue, and with a very low error rate, while adapting to low-speed vehicles and completing tasks during vehicle movement greatly improving the efficiency of passage.

3.3 Intelligent Unmanned Weighbridge

A smart, unmanned pumping station is set up on the gate side of the bulk cargo terminal, with metering data automatically uploaded to the back office. The specific functions and operations are as follows:

(1) Firstly, when the vehicle is loaded onto the weighbridge, the infrared card interface will detect whether the vehicle has arrived at the correct weighbridge position. If the vehicle is not parked correctly, the infrared card interface will notify the LED display of the vehicle position error message to let the driver correctly park the vehicle according to the information on display.
(2) After the vehicle is parked correctly, the infrared card position interface will notify the automatic weighing system that the weighing operation can be carried out. Which the system will receive the license plate number automatically identified by the license plate recognition system and the positioning tag information automatically identified by the positioning system and will display them on the LED display. The automatic weighing system will read the number plate number corresponding to the positioning tag from the license plate binding information and will compare it with the license plate number uploaded by the number plate recognition system.

(3) If the comparison is incorrect, the automatic weighing system will display the wrong information of the license plate number on the LED display and voice prompt the driver to disallow the weighing, the wrong weighing content (including license plate number, positioning label, weighing weight, etc.) and record them.

(4) If the comparison is correct, the automatic weighing system will read the weighing data and form an automatic weighing record (including vehicle plate number, positioning tag, weighing weight, etc.), while displays the correct weighing and vehicle plate number, gross weight, tare weight and net weight on the LED display, with a voice prompting the driver to finish weighing and automatically lifting the lever.

4   Application Example of Intelligent Gates

At present, Shandong Weifang Port bulk cargo channel gates have been intelligently upgraded and transformed, realizing "no drop-off at the port", providing a guarantee to improve the efficiency of port collection and dredging, as shown in Fig. 2. After the intelligent transformation of the gates, there is basically no traffic jam, which has greatly improved the efficiency of collection and transportation. The intelligent equipment at the gates can release the vehicles and officially enter the port after the information of vehicle license plate, customer and cargo information, and net weight information of the cargo is compared with the customs declaration information platform. After the upgrading of the gates, the time for vehicles to pass through the gates has been reduced from 2.5 min in the past to an average of about 30 s, increasing efficiency by more than 5 times and compressing the length of time vehicles are in port by more than 15%, thus ensuring efficient and effective port services. As shown in Figs. 2 and 3.
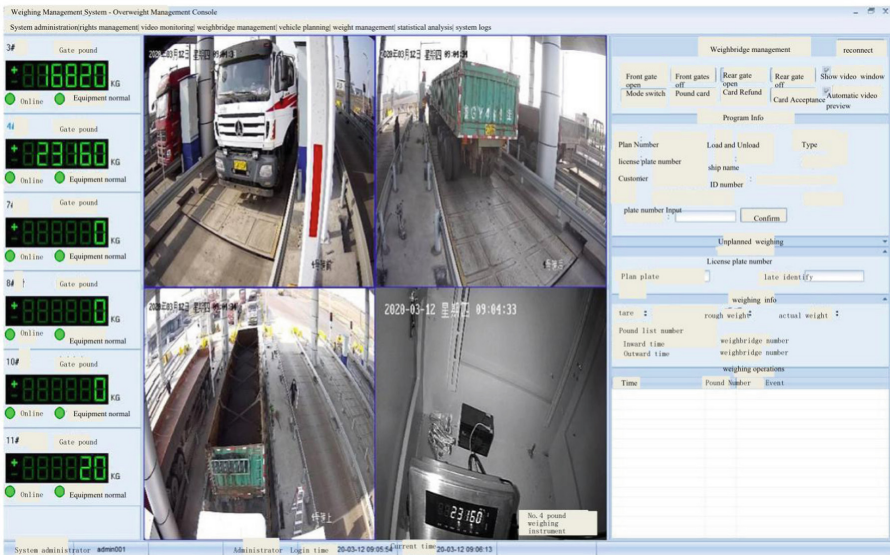

Fig. 2. Weifang port bulk cargo terminal gate backend interface [5]

Fig. 3. Weifang Port Bulk Cargo Gate

5   Conclusions

Intelligent gates are an important part of modern terminals. It can not only improving the speed of vehicles passing through the gates, but also providing technical data for the scientific management of the terminals. Especially for terminals with foreign vessels. In order to prevent smuggling and other illegal acts, the customs department will put forward higher standard requirements for intelligent gates. Using artificial intelligence, Internet+ and other technologies to identify vehicles intelligently, release efficiently and weighing accurately are the functions that must be achieved by intelligent gates at bulk cargo terminals in the future.

References

1. Sun Ju. Enhancing the intelligent application of dry bulk terminals[J]. China Water Transport: Second Half of the Month, 2019(1):2. (in Chinese)
2. Intelligent operation management and decision-making system for bulk cargo in inland ports[J]. Port Science and Technology, 2021(01). (in Chinese)
3. Xu Hao. Construction of intelligent gates at Ningbo Port Container Terminal[J]. East China Science and Technology: Academic Edition, 2012(4):1. (in Chinese)
4. Zhong Shiping. AI-Enabled, Deep Application of Entrance and Exit Control Technology in Smart City Construction[J]. China Security, 2019(7):5. (in Chinese)
5. The Paper. Shandong Weifang Harbor bulk cargo gates complete intelligent transformation, [EB/OL]. (in Chinese)