RESEARCH ARTICLE

Flipping design of "centralized to scattered" cargo lifting equipment based on intelligent transportation logistics services

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Abstract: New quality productivity empowers intelligent logistics technology innovation and enhances supply chain management efficiency. Considering the overall effect of logistics efficiency, in response to the drawbacks of traditional operations such as manual unpacking and unloading or equipment lifting and dumping during the process of "converting bulk goods to container transportation", which are prone to rope breakage and cross safety between humans and machines, and have low efficiency and high cost, we have innovated the flipping design scheme of "centralized to scattered" cargo lifting equipment, including two parts: automatic opening and closing of containers and flipping and opening technology. Through digital and intelligent design, we have achieved automation and standardization of automatic opening and closing of containers for unloading operations, effectively improving work efficiency, eliminating safety hazards, and having good comprehensive effects and promotion value.

Keywords: Smart logistics; Logistics services; Process planning

Citation: Ye Mei, 2024. Flipping design of "centralized to scattered" cargo lifting equipment based on intelligent transportation logistics services. Journal of Smart Cities, 9(1): 1-7. http://doi.org/10.26789/JSC.2024.01.001

Fund Project: 2022 Shandong Province Vocational Education Teaching Reform Research Project "Research on Cultivating the Craftsmanship Spirit of Vocational College Students in the Digital Economy Era" (No. 2022263). The 2024 Logistics Education Reform and Research Project Plan of the Logistics Education Guidance Committee of the Ministry of Education, titled: Research on the Construction of the Curriculum System of the Port and Shipping Logistics Professional Group (No. JZW2024150). The 2022 scientific research project of Qingdao Port Vocational and Technical College, titled "Smart Port Operation Ecology Research" (No. QDGW2022S02).

1 Introduction

The digital economy has become a new economic development model, widely and deeply developed worldwide. New quality productivity is a new type of productivity driven by innovation, with six major characteristics: technological innovation driven, deep integration of informatization and digitization, knowledge intensive, emphasizing the core role of knowledge and intellectual resources in the composition of productivity, green environmental protection, cross-border integration and innovation driven, and service-oriented. This is well reflected in the technological innovation application of smart logistics supply chain. [1]

The integration of virtual and real drives the development of smart ports [2], accelerating the supporting services of smart logistics [3]. Visualization and intelligence of the homework process, energy consumption, and efficiency improvement provide high-quality transportation solutions for containerized transportation. Containers are used for the transportation of goods such as grain, coal, chemical raw materials, building materials, garbage, and food. Global multimodal container transportation has given rise to the

trend of "bulk containerized transportation", with a broad application prospect. In order to better achieve the loading and unloading of container bulk cargo, users will use a container flipping platform to flip the container. The operator needs to climb up and turn the handle of the box door lock to open the box door. After loading, the operator needs to climb up again to close the box door of the container. Therefore, the safety factor of operation is low and there are significant safety hazards. When unloading, the rapid outflow of goods from the container and the pouring force borne by the door can easily cause injury to the operator. At the same time, most existing container flipping platforms are only designed with an opening device for the container door, which can only open the lock rod of the container door, but still cannot achieve container closure, and the degree of automation is extremely low. It can be seen that the process of unpacking, unpacking, and picking up goods in this "loose to loose" operation consumes a lot of energy, poses significant safety hazards, and is inefficient, which does not match the high efficiency and quality of smart logistics. Therefore, there is an urgent need to innovate a fully automated container door opening and closing "centralized to decentralized" technology [4-7] to solve the above problems.

2 Design principle of "centralized to scattered" process

Based on the school enterprise cooperation and industry education integration platform, after three years and hundreds of experiments, we have innovatively developed a flipping design for "centralized to scattered" cargo lifting equipment that is suitable for smart transportation logistics services. This design achieves automatic opening and closing of containers for bulk cargo, making "centralized to scattered" smooth and unobstructed. The technical principle presented in this design is related to the field of container door opening and closing technology, and a container automatic door opening and closing structure is disclosed, including a container door body and a work frame. The outer surface of the container is equipped with two door rods, both of which are equipped with handles. The automatic door opening and closing structure of the container is controlled by workers to extend the first electric telescopic rod fixed on the outer surface of the fixed frame until the fixed part is located in the middle gap between the handle and the container door body. The motor drives the fixed part to rotate, causing the handle to open under the drive of the fixed part. At the same time, the second electric telescopic rod extends and contacts the door rod. At this time, the hydraulic rod then operates to drive the two doors of the container to open, achieving the goal of opening the container. Open and close. Improve the level of automation while avoiding the dumping force caused by the rapid outflow of goods from the container during unloading, which can easily cause injury to operators.

The centralized and decentralized door opening and closing technology scheme is an automatic container door opening and closing structure, including a container door body and a working frame. The outer surface of the container is equipped with two door poles and handles, and the working installation is fixed with hydraulic poles and two No.1 rotating shafts. The output end of the hydraulic poles is rotatably equipped with two No.2 rotating shafts, and the outer surfaces of the two No.2 rotating shafts are fixedly connected to push rods. The two push rods are fixedly installed with No.3 rotating shafts away from the outer surface of the No.2 rotating shafts. The outer surfaces of the two No.3 rotating shafts are rotationally connected to fixed frames, and the outer surfaces of the two fixed frames are rotationally connected to the outer surfaces of the two No.1 rotating shafts. The outer surfaces of both fixed frames are fixedly installed with No.1 electric telescopic rods and No.2 electric telescopic rods. The output end of the No. 1 electric telescopic rod is fixedly installed with a motor, and the output end of the motor is fixedly installed with a fixing piece. The output end of the No. 2 electric telescopic rod is fixedly installed with a connecting block.

Using the above technical solution, workers place the work frame at the bottom of the container, making the fixed frame close to the container door. At this time, the first electric telescopic rod fixed on the outer surface of the

fixed frame is controlled to extend, so that the motor and fixing parts are close to the handle, until the fixing parts are located in the middle gap between the handle and the container door. The motor drives the fixing parts to rotate, so that the handle opens under the drive of the fixing parts. At the same time, the second electric telescopic rod extends and contacts the door rod. At this time, the hydraulic rod operates again, causing the first, second, and third rotating shafts to operate synchronously, driving the distance between the two fixed frames to increase, and driving the two doors of the container to open. As workers can remotely control the automatic opening and closing of the container, the hydraulic rod can operate again, causing the first, second, and third rotating shafts to operate Operate the structure, Thus achieving the goal of opening and closing containers, improving automation, and avoiding the rapid outflow of goods from the container during unloading, as well as the risk of injury to operators caused by the pouring force borne by the door. The outer surface of the connecting block is movably connected to the outer surface of the door post, and the outer surface of the fixing component is movably connected to the outer surface of the handle.

Using the above technical solution, the outer surface of the connecting block is actively connected to the outer surface of the door post, and the outer surface of the fixing piece is actively connected to the outer surface of the handle. After the first electric telescopic rod is extended, the motor drives the fixing piece to rotate, causing the handle to open under the drive of the fixing piece. At the same time, the second electric telescopic rod extends and contacts the door post. At this time, the hydraulic rod operates again, driving the distance between the two fixed frames to increase, and driving the two doors of the container to open. The external part of the fixed frame is equipped with a controller, and the motor, hydraulic rod, No.1 electric telescopic rod, and No.2 electric telescopic rod are electrically connected to the output end of the controller.

Using the above technical solution, a controller is installed on the outside of the fixed frame. The motor, hydraulic rod, No.1 electric telescopic rod, and No.2 electric telescopic rod are electrically connected to the output end of the controller, making it easy for workers to operate the controller and control the relevant structures to operate, achieving the effect of automatically opening the container door. At the same time, the controller can be equipped with a data recording module, which uses the JPS positioning system to record the time and place of opening the container, facilitating subsequent tracking and tracing. Multiple ground wheels are uniformly installed on the lower surface of the work frame.

By adopting the above technical solution, multiple ground wheels are uniformly installed on the lower surface of the work frame, which facilitates workers to control the work frame and drive the overall structure to move, increasing the flexibility of the container's automatic door opening and closing structure.

3 Implementation of automatic door opening and closing technology process design for "centralized to scattered"

The structural principle is shown in Figures 1, 2, 3, and 4. According to the diagram, explain the implementation process of this homework process.

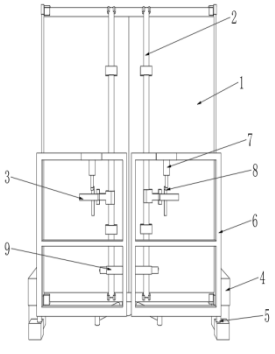

Figure 1 Overall Automatic Door Opening and Closing Technology

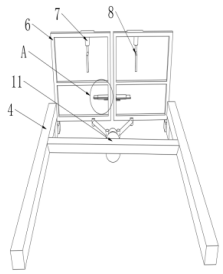

Figure 2 Partial automatic door opening and closing technology

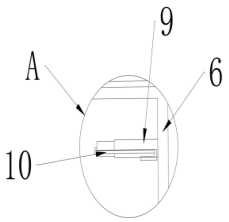

Figure 3 Details of Automatic Door Opening and Closing Technology

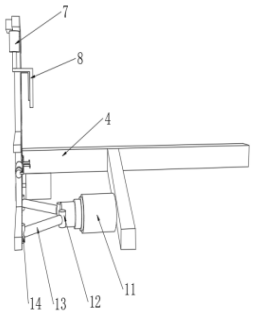

Figure 4 Corner pieces of automatic door opening and closing technology for boxes

In the figure 1. Container door body; 2. Door pole; 3. Handle; 4. Work frame; 5. Number one shaft; 6. Fixed frame; 7. No.1 electric telescopic rod; 8. Fixed parts; 9. No.2 electric telescopic rod; 10. Connection block; 11. Hydraulic rod; 12. Second shaft; 13. Push rod; 14. Third axis.

There are two door rods 2 installed on the outer surface of the container, both of which are equipped with handles 3. Hydraulic rods 11 are fixedly installed on the outer surface of work frame 4, and two No. 1 rotating shafts 5 are fixedly installed on the outer surface of work frame 4. The output end of hydraulic rod 11 rotates and installs two No. 2 rotating shafts 12. The outer surfaces of the two No. 2 rotating shafts 12 are fixedly connected to push rods 13, and the outer surfaces of the two push rods 13 are fixedly installed on the third rotating shaft 14 away from the second rotating shaft 12. The outer surfaces of the two No. 3 rotating shafts 14 are fixedly connected to fixed frames 6, and the outer surfaces of the two fixed frames 6 are respectively connected to the two No. 1 rotating shafts 5. The outer surface is connected by rotation, and the outer surfaces of the two fixed frames 6 are fixedly installed with the first electric telescopic rod 7 and the second electric telescopic rod 9. The output end of the first electric telescopic rod 7 is fixedly installed with a motor, and the output end of the motor is fixedly installed with a fixing piece 8, The output end of the second electric telescopic rod 9 is fixedly installed with a connecting block 10, and the outer part of the fixed frame 6 is equipped with a controller. The motor, hydraulic rod 11, first electric telescopic rod 7, and second electric telescopic rod 9 are electrically connected to the output end of the controller, and multiple ground wheels are uniformly installed on the lower surface of the work frame 4. Workers control the work frame 4 to drive the overall structure to move, increasing the flexibility of the container's automatic door opening and closing structure. The work frame 4 is placed at the bottom of the container, and then the fixed frame 6 is close to the container door 1. At this time, because the motor, hydraulic rod 11, first electric telescopic rod 7, and second electric telescopic rod 9 are electrically connected to the output end of the controller, it is convenient for workers to operate the controller and control the fixed frame. Extend the No.1 electric telescopic rod 7 fixed on the outer surface of 6, so that the motor and fixing component 8 are close to the handle 3, Until fixing component 8 is located in the middle gap between handle 3 and container door body 1, the motor drives fixing component 8 to rotate, causing handle 3 to open under the drive of fixing component 8. At the same time, the second electric telescopic rod 9 extends and contacts door rod 2. At this time, hydraulic rod 11 operates again, synchronizing the operation of the first shaft 5, the second shaft 12, and the third shaft 14, driving the distance between the two fixed frames 6 to increase, and driving the two doors of the container to open. At the same time, the controller can be equipped with a data recording module, which uses the JPS positioning system to record the time and place of opening the box, making it easier to track and trace the source in the future. The use effect is better.

The working principle of this device is as follows: two door rods 2 are installed on the outer surface of the container, and the outer surface of both door rods 2 is equipped with handles 3. Hydraulic rods 11 are fixedly installed on the

outer surface of work frame 4. The output end of hydraulic rods 11 is rotatably installed with two No. 2 rotating shafts 12. The outer surface of the two No. 2 rotating shafts 12 is fixedly connected with push rods 13. The outer surface of the two push rods 13 is fixedly installed with No. 3 rotating shafts 14 away from the outer surface of No. 2 rotating shafts 12. The outer surfaces of the two No. 3 rotating shafts 14 are fixedly connected with fixed frames 6. The outer surfaces of the two fixed frames 6 are fixedly installed with No. 1 electric telescopic rod 7 and No. 2 electric telescopic rod 9. The output end of the electric telescopic rod 7 is fixedly installed with a motor, and the output end of the motor is fixedly installed with a fixing piece 8. The output end of the second electric telescopic rod 9 is fixedly installed with a connecting block 10. At the same time, a controller is set outside the fixed frame 6, The motor, hydraulic rod 11, No.1 electric telescopic rod 7, and No.2 electric telescopic rod 9 are electrically connected to the output end of the controller, and multiple ground wheels are uniformly installed on the lower surface of work frame 4. The worker controls work frame 4 to drive the overall structure to move, increasing the flexibility of the container automatic door opening and closing structure. The work frame 4 is placed at the bottom of the container, and then the fixed frame 6 is placed close to the container door body 1. At this time, because the motor, hydraulic rod 11, No.1 electric telescopic rod 7, and No.2 electric telescopic rod 9 are electrically connected to the output end of the controller, it is convenient for the worker to operate the controller. The worker controls the first electric telescopic rod 7 fixed on the outer surface of fixed frame 6 to extend, making the motor and fixing component 8 close to the handle 3. Until fixing component 8 is located in the middle gap between handle 3 and container door body 1, the motor drives fixing component 8 to rotate, The handle 3 is opened under the drive of the fixing component 8, and at the same time, the second electric telescopic rod 9 extends to contact the door rod 2. At this time, the hydraulic rod 11 operates again, driving the distance between the two fixed frames 6 to increase, and driving the two doors of the container to open. Compared with related technologies, the container automatic door opening and closing structure provided in this design has the following beneficial effects: it can achieve the opening and closing of the container, improve the degree of automation, and avoid the rapid outflow of goods in the container during unloading, as well as the risk of injury to operators caused by the pouring force borne by the doors.

4 Advantages and Benefits Analysis

4.1 Advantages and benefit analysis of the plan

The "centralized to scattered" flipping hanger consists of the main body of the hanger and the flipping frame. When lifting the container, the conical sleeve of the door handle sleeve component is first placed on the door lock rod of the container, and the hydraulic cylinder extends to drive the upper hanger to move on the main beam through the guide groove, causing the two upper hangers to separate and drive the flipping frame to move outward, causing the container to flip outward separately. Due to the longer distance between the two upper hangers, when the hanger frame is flipped to a certain angle, the door lock rod rotates 90 °. Under the impact of the cargo inside the container, the container door is opened, and the loose cargo inside the container can flow out. The main innovation of the automatic "centralized to scattered" flipping crane is that it can use existing container loading and unloading bridges for loading and unloading; Wireless remote control and automatic opening of container doors for unloading; Improve the efficiency of bulk cargo loading; Effectively reducing various costs; Improve the safety of production processes; Expansion function: attract more bulk cargo customers.

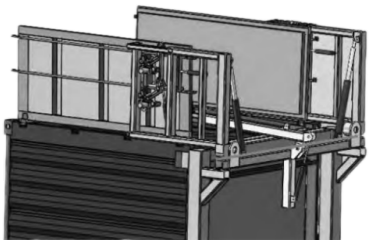

Figure 5 Schematic diagram of the three-dimensional mechanism for automatic opening and closing of container boxes

Figure 6 Realistic picture of fully automatic "centralized to scattered" automatic door opening and closing technology operation

4.2 Analysis of the application benefits of the plan

To verify the application effectiveness of the "centralized to scattered" cargo lifting and flipping equipment, from January to June 2022, a total of 21000 TEUs of bulk cargo of 513800 tons were completed at Rizhao Port in Shandong Port, creating a revenue of 6.02 million yuan. The resulting siphon effect has led to cooperation agreements signed with multiple enterprises to handle various types of bulk cargo such as alkali powder, grain, petroleum coke, sulfur, urea, etc., creating broad space for the growth of port bulk cargo throughput and market share expansion.

Calculate based on homework statistics. Each 20 foot container carries 25 tons of bulk cargo, and 370 TEUs are required for loading and unloading every 10000 tons of bulk cargo. Before the implementation of the new process, the labor cost was 6120 yuan/10000 tons, and the vessel docking cost was 490500 yuan/10000 tons. A total of 513800 tons of goods were processed, with a total cost of (6120+490500) * 51.38=25516335.6 yuan.

After the implementation of the new process of "scattered to centralized", the labor cost has been reduced to 475 yuan per 10000 tons, and the cost of vessel docking has been reduced to 159200 yuan per 10000 tons. Therefore, the total cost of handling 513800 tons of goods is (475+159200) * 51.38=8204101.5 yuan. Through comparison, a total cost savings of 25516335.6-8204101.5=117312234.1 yuan were achieved. It can be seen that the economic benefits after implementing the new process are significant. At the same time, homework efficiency has been greatly improved, safety accidents have been greatly reduced, labor costs have been saved, and overall benefits are continuing to increase. In the future, technological upgrades will be carried out, and process optimization and reengineering will be implemented. The new business models created by the development of container door opening and closing technology, production organization, and supporting services driven by the "scattered to centralized" operation process will continue to develop, creating more high-quality employment opportunities and demonstrating social responsibility.

5 Conclusion

The usage scenario of the "scattered to collected" operation process requires supporting measures, including suitable container transportation for "scattered to collected" bulk goods, sufficient cargo volume, supporting technical scenarios, and strong soft environment support. The new quality productivity empowers the acceleration of smart transportation logistics, and the concept of smart ecology is deeply constructed. Based on smart transportation logistics services, the flipping design of "centralized to scattered" cargo lifting equipment will develop towards a more intelligent and collaborative direction. The connotation of container transportation operation standards will be richer and more humane.

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