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Retraction

Retracted: Optimization Path and Design of Intelligent Logistics Management System Based on ROS Robot

Journal of Robotics

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] R. Wu, "Optimization Path and Design of Intelligent Logistics Management System Based on ROS Robot," *Journal of Robotics*, vol. 2023, Article ID 9505155, 9 pages, 2023.

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Research Article

Optimization Path and Design of Intelligent Logistics Management System Based on ROS Robot

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With the rapid development of the Internet of Things (IoT), the logistics and transportation industry is booming. At the same time, with the advancement of AI technology, intelligent logistics is also gradually emerging, and the purpose of intelligent logistics is to use different types of automatic guided transport machines to replace people to handle and move products. At the same time, with the help of big data, cloud computing, artificial intelligence, sensor technology, and other technologies, we can achieve logistics automation. However, the current logistics robot creation platforms are diverse, which makes intelligent logistics robots diverse in variety and wide in application and also makes the creation and use of robots more challenging. Robot Operating System (ROS) is an open-source software platform that supports programming in multiple languages and has excellent adaptability. In addition, most of the currently used path planning focuses on a single target point, which is insufficient to support the current needs of multitasking in intelligent logistics. Therefore, this paper aimed to design an intelligent logistics management system based on ROS robot and proposed to use the A-star algorithm to calculate the shortest path of the robot so as to achieve the optimal path. In the simulation experiment, 20 ROS robots were selected and divided into two groups. In the logistics warehouse of different transportation nodes, 20 ROS robots were set up to transport goods of different weights in the experiment, and the transportation data were collected at last. The final simulation results have shown that the power consumption and response delay performance of the ROS robot are good, and the logistics transportation speed is significantly improved. In addition, compared with the traditional transportation method, the daily transportation weight of each robot is up to 310.1% and the monthly profit is up to 171%, which shows that the intelligent logistics management system designed in this paper is more efficient in logistics and transportation and can bring more profits.

1. Introduction

With the popularity of IoT and the rise of intelligent logistics, the logistics industry's dependence on industrial robots has increased. Because industrial robots are compact and adaptable to the environment, they can complete various activities better than humans, such as working in highly polluted, hot, or cold environments. The ROS platform makes the development and testing of robots significantly more efficient, supports multiple programming languages, and includes a wide range of functional packages. It is an open-source operating system, and all source codes will be open to the public for free use by users. Therefore, the use of ROS is beneficial for people to continue their research and learning. In addition, ROS can be used to realize the modular architecture of logistics robots on a single platform, realize the sharing of open-source components, facilitate multi-language programming, and shorten the development cycle of robots. If the scientific research of ROS intelligent logistics transportation robot is used, researchers can improve the efficiency of cross-platform communication and development. In addition, path planning is the benchmark for determining the amount of robot intelligence, which is crucial for robot positioning and navigation. Therefore, the research on the related technologies of the intelligent logistics robot path optimization platform is very important for the field of intelligent logistics management.

Regarding logistics management, some scholars have carried out related research on it. In order to calculate the efficiency of logistics management, Liu Y used case analysis and bibliographic analysis methods and used GIS spatial analysis technology to analyze the management efficiency of logistics under the 5G Internet of Things, but he lacked the understanding of management methods [1]. On a strategic level, Marzantowicz identified areas in which logistics management has changed due to the use of smart technologies. He also established the assumption that modern supply chain management is superior to classical logistics management methods based on intelligent logistics, but it lacks the design of logistics supply chain network [2]. Levans understood from a time perspective that logistics and managers were racing to transform their operations into a seamless digital supply chain network, but with less practical application of their network [3]. However, Yuen et al. used the IoT outbound logistics knowledge management system to monitor environmentally sensitive products and predict the quality of goods, but lacked the description of its application effect [4]. Therefore, Yang et al. introduced the workflow and application effects of the intelligent logistics supply chain management system in the management of medical consumables [5]. However, although the above research has obtained some theoretical results, the effect in practical application is not ideal, and it cannot significantly improve the efficiency of logistics management.

In order to effectively improve the efficiency of logistics management, some scholars have proposed the use of ROS robots to achieve intelligent logistics management and improve management efficiency. Petac studied the characteristics and uses of ROS, providing a complete set of tools and basic architecture, allowing developers to launch applications with higher abstraction, but the architecture cannot be controlled in real time [6]. Delgado et al. proposed a real-time control architecture for controlling service robots and non-real-time ROS packages; however, this architecture cannot integrate management [7]. Rovida et al. have researched and developed an autonomous task execution framework and a knowledge integration framework in ROS to provide support and reference for key ROS components, but the architecture lacked the necessary monitoring layer [8]. Hu et al. proposed a ROS-based runtime verification method called a multilayer robot monitor to monitor whether the operation of a robot swarm violates a given temporal property [9]. Although these methods have promoted the development and application of ROS robots to a certain extent, their application in intelligent logistics management is not mature enough, so it needs to be further improved and applied.

In order to further improve and use the application of ROS robot in logistics management, this paper adopted the A-star algorithm to optimize the transportation path of ROS robot. It designed an intelligent logistics management system and then simulated the system from various aspects through two sets of experiments. The test results have shown that in the first set of experiments, the transport path length of the ROS robot is between 16 m and 37.9 m, and the single transport time is between 7.8 min and 18.9 min. The average power consumption of the robot is about 3.6 kW, the average response delay is about 132 ms, the average transport weight of each robot is about 22.64 tons, and the transport speed is increased by 27.7% to 85.1%. In the second set of experiments, the transport path length of the ROS robot is between 22.8 m and 44.6 m, and the single transport time is between 13.2 min and 37.7 min. The maximum power consumption of the robot is 3.18 kW to 6.23 kW, the response delay of the robot is 152 ms to 297 ms, the transportation weight is above 33.52 tons, and the logistics transportation speed is increased by 11.7% to 24.4%. Overall, the intelligent logistics management system designed in this paper can effectively improve logistics speed and bring greater benefits.

2. Design of Intelligent Logistics Management System

2.1. Logistics Management System. Intelligent logistics can effectively reduce logistics costs and solve the problem of excessive logistics costs. As one of the key equipments in the intelligent logistics system, the robot plays an increasingly important role in the logistics business [10]. In order to realize a fully automated logistics mode, smart logistics combines a variety of cutting-edge sensors and information reading devices to automatically collect external information. It optimizes changes through information fusion and selects optimal operating parameters. In order to improve the scientificity and efficiency of logistics management, the system selects the best distribution route, product flow direction, and warehousing equipment through professional geographic data analysis functions [11, 12]. The implementation of transportation management mode mainly solves the problem of distribution mode, supply, and demand balance. The main goal of the distribution model is to reduce inventory and transportation costs while maintaining the effectiveness of product flow and the quality of service. To this end, the logistics management system should be considered from many aspects, and the hierarchical design and management should be carried out [13]. The logistics management system should also fully consider factors such as robot capacity, commodity demand, and the distance between the logistics center and the customer so as to maximize the reduction of commodity distribution costs or shorten the transportation path so as to minimize the cost of logistics companies.

In the logistics management system framework designed in this paper as shown in Figure 1, it includes the execution layer, the transport layer, and the management layer. The execution layer is mainly composed of multiple ROS robots and industrial computers. It is the main layer for logistics cargo transportation and the source of data. The transmission layer is to transmit the data in the logistics and collect it to the management and control layer, and the management and control layer analyzes and processes the transmitted data to make corresponding decisions.

In the intelligent logistics management system designed in this paper, RFID technology is used to identify and label the pallets, cargo spaces, and shelves to form a data carrier, which is convenient for reading or writing related item data information, and at the same time, it is transmitted to the computer for processing. The ROS robot is used as a handling tool, and the label is used as a positioning label for multiple vehicles as well as a data carrier [14, 15]. At the

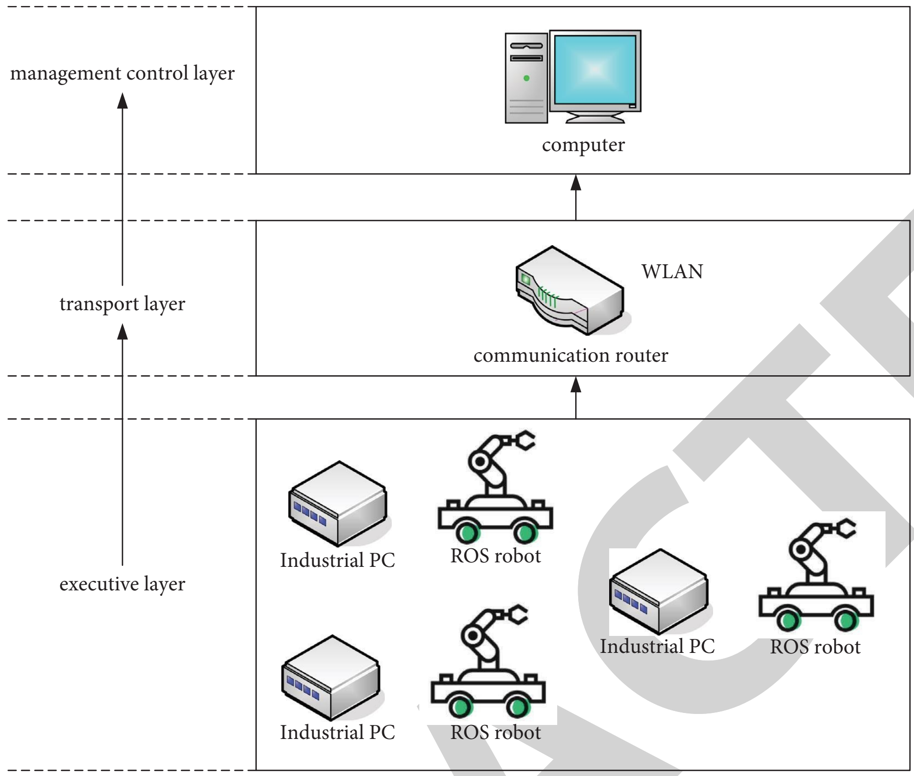

Figure 1: Framework of intelligent logistics management system.

same time, the system performs robot management, route management, monitoring management, and task management on the established user management system by digitizing the warehouse environment. Handling multiple transport robots in the warehouse would reduce the labor required by the company and improve the efficiency of the logistics system, the speed and precision of logistics transportation, and the competitiveness of the enterprise [16, 17].

2.2. ROS Robot. Intelligent logistics transportation robots have developed into a key component in this field, which is essential for processing procedures in production, express delivery, e-commerce, and other economic sectors. Intelligent logistics and transportation robots prioritize autonomous navigation, and path planning is an important part of autonomous navigation [18, 19]. The structure of the ROS robot system used in this paper is shown in Figure 2. The system mainly includes a controller, an encoder, a motor, and a deceleration mechanism. The ROS robot carries out logistics transportation under the command of the controller, and the controller completes the control of the machine motor under multiple industrial encoders and acoustic wave devices, and the motor will perform deceleration operations under the action of the DC deceleration mechanism. The encoder can realize coordinate conversion by calculating the mileage of the robot and then transmitting it to the computer for processing.

In addition, some problems may be encountered in the operation of ROS robots. For example, path planning does not take into account different operating environments. This method often fails to consider enough aspects, the overall situation and the situation encountered in actual operation, resulting in accidents, including collisions and traffic congestion during operation, of which these problems can be largely solved by using online scheduling. Among them, the collision mainly includes the opposite collision: when the two vehicles are driving in the opposite direction, no conflict resolution method is adopted, and the two vehicles have traffic jams and collisions. Chasing collision: the rear car is faster than the front car, the rear car will chase and overtake the front car, and if there is no solution, the rear car will collide with the front car. Node collision: there are overlapping sections in the path planning of two vehicles, and the running time is the same, which will cause node conflict. When the current resource is competed by two vehicles at the same time, resource conflict will occur. Online scheduling considers many factors. After many approaches are developed, online scheduling can provide an effective solution; therefore, the whole system will operate more safely and consistently. Considering the problem of traffic conflicts in operations and avoiding frequent occurrences in the future, online scheduling is a method that needs to be used in intelligent logistics management systems [20, 21].

However, different scheduling theories emphasize different perspectives. Shortest driving route scheduling states that while the overall driving path is kept as short as possible across all activities, the shortest path must be planned for each job. Nonetheless, it may result in higher shipping costs and longer overall shipping times. Minimum travel time scheduling states that all activities must take the least amount of time to complete, which usually includes actual

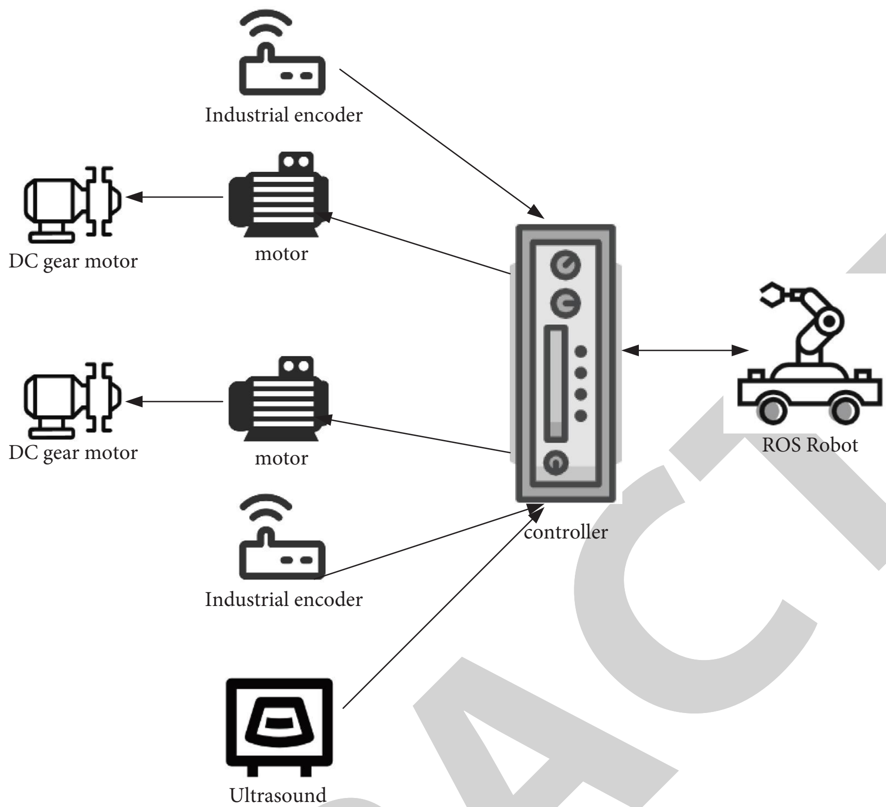

Figure 2: The structure of the ROS robot system.

route travel time and waiting time for conflicts or emergencies. The optimal allocation scheduling is that the allocation of each warehouse location should be different to ensure the effective use of resources and prevent resource waste [22, 23]; otherwise, the remaining quantity may sit idle, wasting resources and driving up logistics costs. On the contrary, if the number is too small, the job wait time will be too long. It will reduce the overall efficiency of the system, resulting in poor performance of the logistics system. In order to determine if the amount of logistics warehouse space is optimal, it is therefore important to check the task level and utilization of this warehouse area in most cases. Of course, the goal of logistics management is to reduce overall costs without reducing overall efficiency. According to the concept of least cost, logistics systems always prefer the cheapest option. The shortest total travel path, shortest total travel time, and ideal volume are all used to reduce system cost and increase productivity, maximizing benefits [24, 25].

2.3. A-Star Algorithm. At present, there are few path optimizations for multiobjective points in the research of path optimization, and most of the available path planning algorithms only consider one starting point and one destination point, such as the ant colony algorithm, particle swarm algorithm, and classification algorithm. However, as industrial production lines become more complex and diverse, the study of multiobjective point path optimization will become more important. The A-star method has received a lot of attention and has a wide range of applications because it has a simple procedure and is easy to implement [26]. Therefore, this study adopts the A-star method to optimize the robot's transportation path.

The A-star algorithm is an efficient shortest path search method. This paper uses this algorithm to optimize the path of the designed intelligent logistics system so as to reduce the logistics transportation time of ROS robots and improve the efficiency of logistics management. The path optimization method of the algorithm can be expressed by the path estimation function:

$$f(n) = k(n) + v(n). \tag{1}$$

Among them, $k(n)$ represents the actual estimated value from the starting point to the node n where the robot is located and $v(n)$ is the best estimated value from n to the target node.

When the A-star algorithm finds the shortest path, it often uses a variety of distances for calculation. Assuming that the coordinates of the logistics transportation target position of the ROS robot are (x, y) and the current position is (u, v), then when using the Chebyshev distance calculation, $v(n)$ is

$$v(n) = \max(|x-u|, |y-v|). \tag{2}$$

The maximum absolute value of the difference between two location coordinates is called the Chebyshev distance, which is a unit of measure in a vector space, a measure derived from the uniform norm, and a hyperconvex measure.

When calculated using Euclidean distance, it is

$$v(n) = \left(\sqrt{x-u} + \sqrt{y-v}\right)^2. \tag{3}$$

When using the Manhattan distance, it is

$$v(n) = |x-u| + |y-v|. \tag{4}$$

Since repeated paths should not appear at the same time in path planning, resulting in transportation conflicts, each node can be visited at most once at the same time. Assuming that the length of the ROS robot transportation path is represented by D, then

$$D_r = \sum_{i=1}^{n}\sum_{j=1}^{n} L_{ij}X_{ij}. \tag{5}$$

Among them, i and j represent two nodes, L is the distance between the two nodes, and r represents the target path, and

$$X_{ij} = \begin{cases} 0, \text{when any other robot visits the node,} \\ 1. \end{cases} \tag{6}$$

In addition, in order to prevent conflicts at the same time, it is assumed that the time difference between two ROS robots about to pass through the same node is t', and the minimum distance for two ROS robots to collide is s', so that the robots do not conflict, and they need to meet the following:

$$T = t' < \frac{s'}{v}. \tag{7}$$

Among them, v represents the current travel speed of the ROS robot.

When T does not satisfy the above formula, T is set to 0, and then the robot passing through the node stops moving forward, so as to avoid conflicts.

3. Results of Simulation Test of Logistics Management System

3.1. Simulation Design and Related Data of Logistics Management System. The logistics management system includes not only ROS robots but also various sensors, computer systems, and databases. This part of the tools and equipment used in the experiments is shown in Table 1.

Then, this paper divides 20 ROS robots of the same model into two groups for simulation experiments by simulating a square logistics storage warehouse with a length of 40 meters and a width of 40 meters, including the test of the robot's transportation path, transportation weight, and performance, as well as the calculation of profit. The parameter settings of each group of experiments are shown in Table 2. The weight of the first group of goods is 10 kg, including 40 logistics warehouses, and the weight of the second group of goods is 20 kg, with only 20 nodes.

Transport route comparison: in order to optimize the transportation path, which will shorten the transportation time of the robot and improve the transportation efficiency, this paper summarizes the single average transportation path length and transportation time of each ROS robot. The test results are shown in Figure 3.

Table 1: Related equipment for simulation experiments.

Code	Device name	Types
E1	Development platform	ROS
E2	Transportation robot	VGA
E3	Computer CPU	Intel core i7
E4	Computing system	Win 10

Table 2: Simulation experiment parameter settings.

Groups	1st group	2nd group
Number of ROS robots	10	10
Goods weight	10 kg	20 kg
Number of transport nodes	40	20

Figure 3(a) shows that in the first set of experiments, the transport path length of the ROS robot is between 16 m and 37.9 m, and the single transport time is between 7.8 min and 18.9 min. The overall average path length is about 26.5 m, the average single transportation time is 14.4 min, and the path optimization effect is relatively good. As shown in Figure 3(b), the transport path length and time of the ROS robot increased in the second set of experiments. Among them, the path of the No. 3 robot is the longest, 44.6 m, and the path of the No. 9 robot is the shortest, 22.8 m; the fastest single transportation time is 13.2 min, and the slowest average transportation time is 37.7 min. The overall average path length is about 34 m, and the average single transit time is 23.9 min. Compared with the first set of experiments, the average transport path length increased by about 7.5 m, and the single transport time was increased by 9.5 min. The reason is that the number of transport nodes is reduced, the robot has fewer routes to choose from, the waiting time increases, the weight of the transported goods increases, and the speed and action delay of the transport also increase, but the average path length path is less than 40 m, indicating that the optimization effect is good.

ROS robot performance: in order to use the robot for logistics management more stably and safely, it is necessary to analyze the performance of the ROS transport robot. Therefore, this paper conducts a statistical analysis from the response delay and power consumption of the robot, and the results are shown in Figure 4.

In Figure 4(a), the power consumption of robot no. 8 is relatively lower, which is 2.72 kW; the power consumption of robot no. 4 is higher, which is 4.47 kW; robot no. 3 has a shorter response delay of 96 ms; robot no. 5 has the longest delay of 179 ms. The average power consumption of these robots is about 3.6 kW, and the average response delay is about 132 ms. In Figure 4(b), the maximum power consumption of the robot is 6.23 kW, and the minimum is 3.18 kW. The response delay of the robot is up to 297 ms and the shortest is 152 ms. The robots of the second group of experiments have increased power consumption and delay, which are related to the weight of the transported goods of the second group of robots mentioned earlier. The weight of

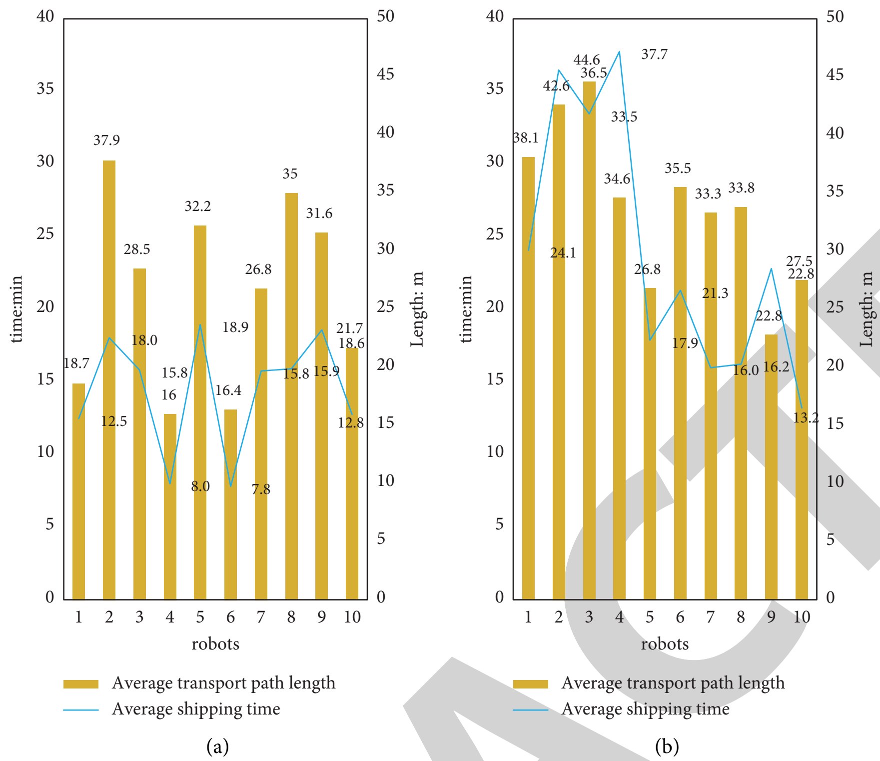

Figure 3: Transport path comparison. (a) The first set of experiments. (b) The second set of experiments.

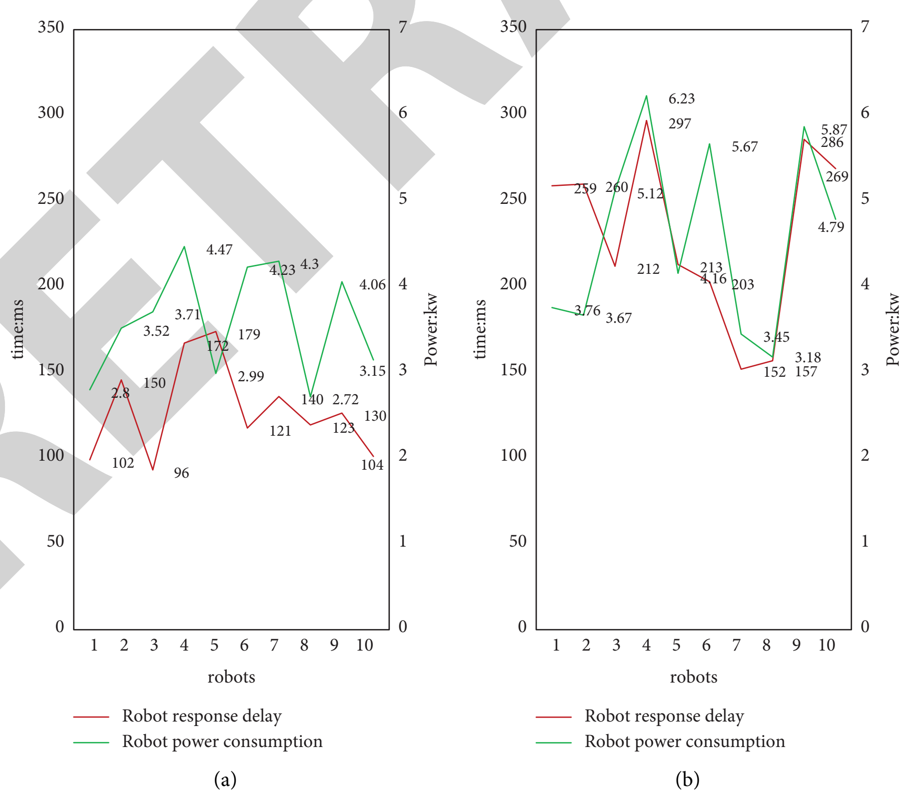

Figure 4: ROS robot performance. (a) The first set of experiments. (b) The second set of experiments.

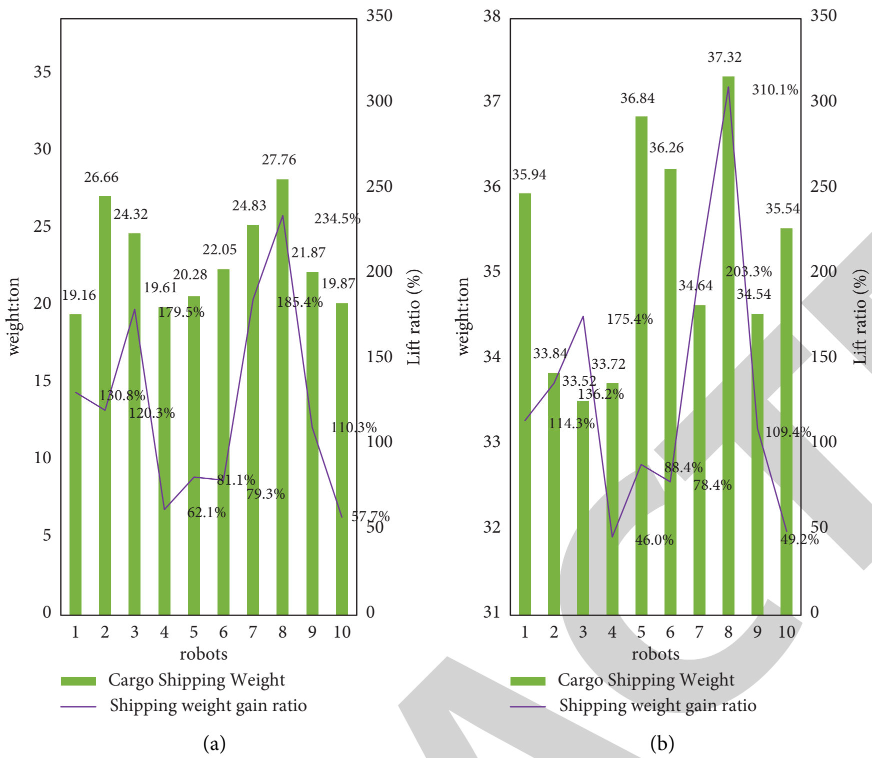

Figure 5: Changes in logistics transportation volume. (a) The first set of experiments. (b) The second set of experiments.

the robot in the first group of experiments is only 10 kg, while the weight of the second group is 20 kg. Therefore, the power consumption and delay of the second group of robots are increased. However, the robot performance of both groups was stable and in good condition.

Changes in the volume of logistics and transportation: changes in the quantity or weight of cargo transported can more intuitively reflect the gains brought by robotic transport. This paper summarizes the daily cargo transport weight and the transport weight lift ratio of the two groups of experiments, and the results are shown in Figure 5.

In Figure 5(a), the daily weight of goods transported by the robot ranges from 19.16 tons to 27.76 tons, and the overall average transport weight is about 22.64 tons. Compared with traditional transportation methods, the daily transportation weight of robots increased from 57.7% to 234.5%. In Figure 5(b), the No. 3 robot with the least transport capacity reaches 33.52 tons, and the No. 8 robot with the largest transport capacity reaches 37.32 tons. The daily transport weight of the robots in this group of experiments has increased from 46% to 310.1%. This shows that the use of ROS robots for transportation can significantly increase the daily logistics transportation weight.

Logistics management effect: in this paper, the purpose of using ROS robot to design an intelligent logistics management system is to improve logistics speed and company profits. Therefore, in the end, this paper compares the two groups of experiments with traditional transportation methods and obtains the ratio of the improvement of the transportation speed of goods to the company's profit. The results are shown in Figure 6.

Figure 6(a) shows that, compared with the traditional transportation method, the daily transportation speed of the first group of ROS robots has increased by at least 27.7%, the largest by 85.1%, and the monthly profit has increased by the smallest by 39% and the largest by 171%, among which the improvement of No. 8 robot is the most obvious. After investigation, it was found that the response delay of No. 8 robot is low, and the daily cargo transportation weight is relatively large, which may be the reason for its large improvement. As can be seen from Figure 6(b), in the second set of experiments, the logistics transportation speed increased the minimum by 11.7% and the maximum by 24.4% and the monthly profit increased the minimum by 32.2% and the maximum by 75.7%. Among them, the profit of the No. 10 robot has increased the most. From the above, it can be seen that the single transportation time of the No. 10 robot is the shortest, which may be the reason for its greater profit increase. In general, the logistics speed and monthly profit both increase in direct proportion, which shows that the ROS robot logistics transportation management system designed in this paper can effectively improve the logistics management effect.

Although this experiment tests the intelligent logistics management system designed in this paper from the aspects of transportation path, robot performance, transportation volume change, and profit improvement, this shows that the system has a good logistics management effect. However, there are still many deficiencies in this paper, and the research on the algorithm of path optimization is not deep enough. In addition, the introduction of ROS robot is not detailed enough. The test method of the experiment may need to be further improved.

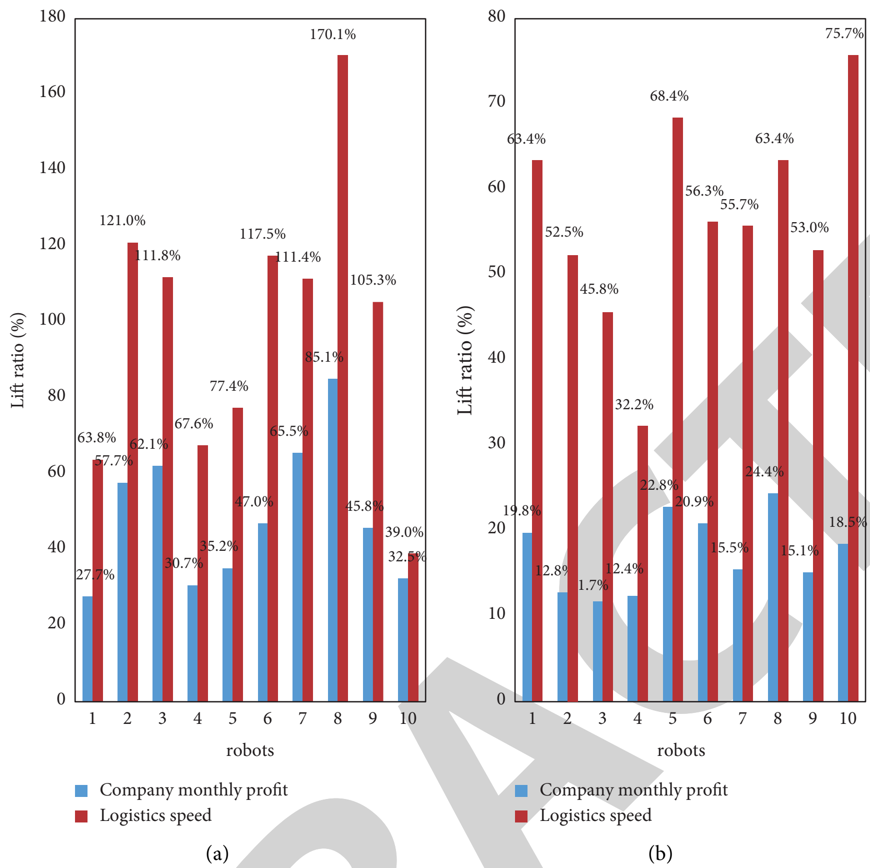

Figure 6: Changes in logistics management efficiency. (a) The first set of experiments. (b) The second set of experiments.

4. Conclusion

With the rapid development of e-commerce and IoT, customers' expectations for timeliness and transparency in logistics continue to increase, and the demand for the social and economic transformation of logistics management continues to grow. Therefore, the existing logistics management methods and technologies have been unable to keep up with the pace of times. Most of the domestic small- and medium-sized logistics enterprises currently lack the resources and professional knowledge required to meet the actual needs of logistics informatization, which has caused some obstacles to the standardization of domestic logistics management informatization. Combined with the characteristics of ROS robot, this paper designed and tested an intelligent logistics management system with an optimized path. It first started from the concept of intelligent logistics management and understood that the logistics management system should be considered from many aspects, and the hierarchical design and management should be carried out. Therefore, this paper designed a logistics management system from the execution layer, the transmission layer, and the control layer and introduced the structure and composition of the ROS robot used in this paper. Secondly, this paper describes the A-star algorithm for path optimization, and through simulation experiments, it is concluded that the path optimization effect of this paper is good and the performance of the ROS robot is stable, which can effectively increase the amount of transported goods, improve logistics speed, and increase profits. However, there are some deficiencies in this paper. For example, the research on the A-star algorithm is not deep enough, and the simulation experiments need to be divided into multiple groups and compared many times to draw more reliable conclusions. Therefore, this paper still needs to be further improved.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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