Advances in Computer Science Research, volume 62
2nd Joint International Information Technology, Mechanical and Electronic Engineering Conference (JIMEC 2017)

# Research On Optimal Picking Route Of Storage Robot Based On Large Scale Logistics Warehouse

*Yi-peng LI, Di Wang**

***School of Information and Safety Engineering, Zhong nan University of Economics and Law, Wu Han 430073, China***

**Keywords:** storage robot, picking route, tunnel.

## Abstract

In the distribution center, picking operation time is about 40% of the total operating time. Therefore, optimizing the order picking operation has an important influence on the improvement of the efficiency of the distribution center. The advent of storage robots essentially breaks the efficiency problem of traditional manual methods. This paper will take some picking routes as examples and analysis the relationship between storage robot and picking route. And we have used simulation experiment to find out the best method under different conditions, to help distribution center and managements find the correct choice of the path matching.

## 1 Introduction

Data display, through the current computer control technology, the robot will "lift" the shelves full of goods and send them to different areas, such as picking area, storage area, and packing area. The efficiency of this method is 2~4 times higher than that of the traditional way. So here comes the question, products that appear on an order is usually not entirely on one shelf, so it is better to have a few robots to complete an order or to have a robot return in the shelf area several times. So the storage robot studied in this paper is the same as the order picking person. After finishing an order, the robot will return to the picking area, instead of "lifting" shelf to the picking area.

## 2 Picking route design

Path planning is an important problem in the research of storage robot. Its goal is to find a collision free path for a mobile robot in an environment with obstacles. The path planning problem can be solved by calculating a path in the free displacement space. This path can be relative to any feasible free path in the working space. But it is different from the dynamic programming method to obtain the shortest path, but refers to the mobile robot to make a comprehensive judgment of the static and dynamic environment. So that they can make intelligent decisions.

The path planning of storage robot mainly solves three problems:

1. The storage robot can move from the initial point to the target point.
2. Using a certain algorithm to make robot steer clear of obstacles and pass through some points that must be passed.
3. Try to reduce the robot walking distance to improve the picking efficiency.

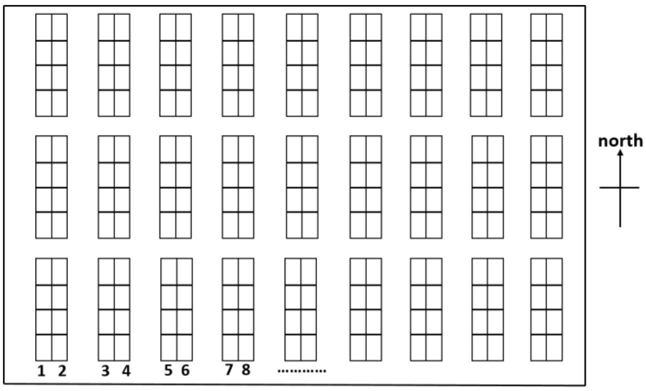


Figure 1:Shelf deployment of logistics warehouse

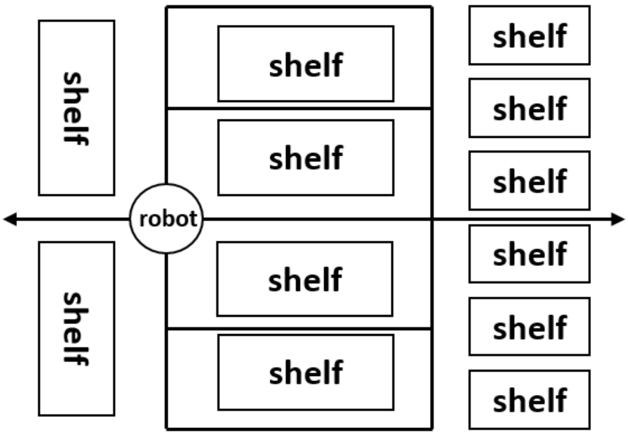


Figure 2: Storage robot route diagram

## 3 The following will introduce and contrast a variety of heuristic sorting paths combined with storage robot

### 3.1 Crossing path

When using this strategy, the robot enters from one end of the storage tunnel, picking up items on the shelves on both sides of the roadway at the same time, finally it will leave from the other end of the tunnel. The path of the robot walking is similar to the S type. Robot will go through all the tunnels that contains goods. If one tunnel doesn't has the goods the storage robot wants, the robot will skip this tunnel. The walking path of this sorting strategy is shown in Figure 3.

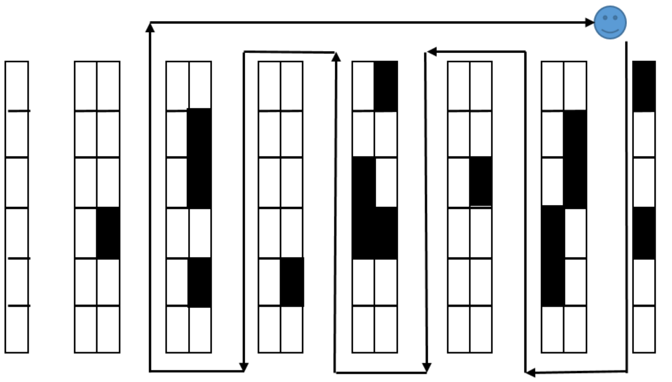

Figure 3: The diagram of the crossing path

In this method, the number of tunnels is divided into odd and even two cases. When the number of tunnels which the goods to be chosen are in is even, the robot must pass through each tunnel to select goods. When the number of tunnels is odd, except the last chosen tunnel, others are must be passed through. Therefore, the walking distance in this way is totally dependent on the number of tunnels in the goods distribution.

### 3.2 Returning path

In this path, if there is a need for the goods to be chosen in the tunnel, the storage robot will enter the tunnel and choose the goods. After picking up the goods on both sides of the roadway, the robots will leave from the tunnel in the direction it comes in.

As same as the crossing path, storage robots are only required to enter the tunnel containing the goods that need to be picked, other tunnels can be skipped. The walking path of this sorting strategy is shown in Figure 4.

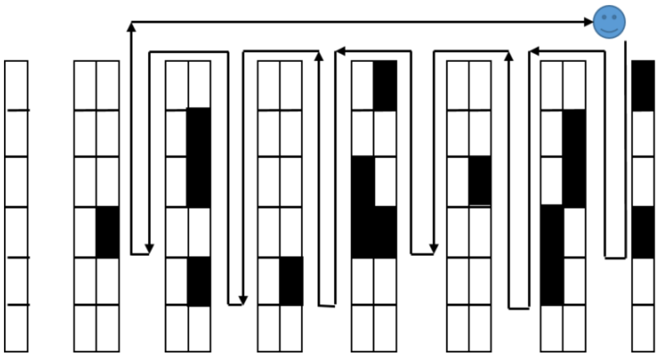

Figure 4: The diagram of the returning path

In this method, in order to maximize the decrease of the picking distance, the distance from the selected goods to the position the robot entered should be as short as possible. And the location of the tunnels containing required goods should be concentrated as far as possible. That is to say, if the distribution of the selected goods presents a trend towards one end of the shelf, the return path is shorter, so that the use of such a strategy to reduce the walking distance is even more obvious. But in reality, the distribution trend of goods is often not so obvious.

### 3.3 Middle rotary path

This path divides the area into two parts, before and after, from the midpoint of tunnels. The storage robot enters from one end of the roadway. Robot will go through the first part of the tunnels firstly and then go into the second part. The walking path of this sorting strategy is shown in Figure 5.

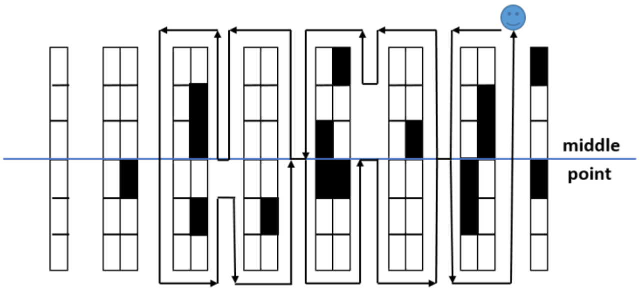


Figure 5: The diagram of the middle rotary path

When applying this kind of strategy, if the goods are concentrated on the distribution of the two ends of the shelf, the distance of the picking process is shorter.

### 3.4 Path of maximum gap

This path is similar with the middle rotary path, the main difference is that the distance between the two tunnels is the biggest gap but not the middle point. The so-called gap means the distance between two adjacent chosen positions in the same tunnel, the distance between first picking position and the front transverse channel, the distance between the last chosen position and transverse channel. Maximum clearance is the maximum distance between the three cases. If the maximum clearance is the distance between two adjacent chosen positions, then the storage robot will select the strategy from the channel two channel; otherwise, the strategy that returns from the former side or the back is selected. The walking path of this sorting strategy is shown in Figure 6.

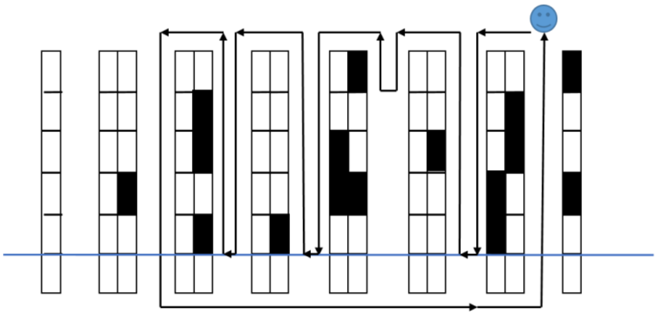

Figure 6: The diagram of the path of maximum gap

## 4 Analysis and conclusion of the experimental results

### 4.1 The contrast between the four strategies

According to the formula:

$$S = T * V \qquad (1)$$

Due to the speed (v) of storage robots is unchanged, assuming that the picking speed of the robots is unchanged, so the shortest distance (s) the way, the shorter the time (t), the higher the relative efficiency (e). I take the balance car instead of storage robot in the playground to do simulation test and put four English books to 2*2 as a shelf, the length of the six shelves is a channel, and set up a simulation warehouse. In the case of a given commodity position unchanged, I change the type and quantity of the orders. The results are shown in Figure 7.

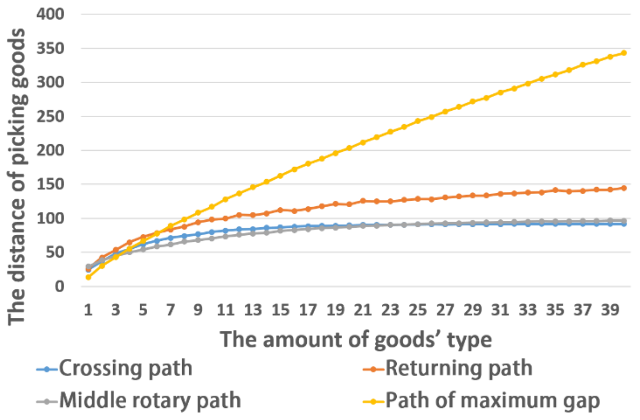


Figure 7: Data comparison of the four types

### 4.2 Analysis conclusions

(1) When the quantity of the goods in the order is increased from 0 to 40, the picking distance of the four kinds of paths is all increased, but the first three strategies' growth rate is faster in [0, 20] than in [20,40]. This is because with the increase in the number of product categories, more products appear in the same aisle or area, saving a lot of repeated moves.

(2) The distance of middle rotary path will be increased gradually with the types of goods increased. When the number of goods in the order is greater than 8, the picking distance of middle rotary path is the biggest in the four kinds of strategies.

(3) Crossing path and middle rotary path are better than returning path and path of maximum gap. The distance of crossing path and middle rotary path is both less than 100.

(4) When the number of goods in order is lower than 25, the middle rotary path is better than the crossing path, but the number is greater than 25, the crossing path is slightly better than the middle rotary path. But overall, the difference between the two is not big.

(5) As the results of the path of maximum gap and the other three strategies differ greatly, it may be that the amount of data is not enough or the result has some problems. The result need to be further improved.

### 4.3 Recommendations

Under the limited information (only the quantity of goods and orders). When the number of goods in the order between [0, 25], it is recommended to use the middle rotary path; when the order quantity is greater than 25, it is suggested to use the crossing path. This is the result of the comparison of the sorting path of the warehouse robot. Storage robots has reduced operating time and cost for distribution centers, the original manual handling and stacking, the manual management and the storage based storage operations are to the development of intelligent storage.

## Acknowledgements

This research was financially supported by the National Natural Science Foundation of China [No.71401180].

## References

[1] Bai Yin, et a. "A Thesis Submitted in Partial Fulfillment of the Requirements For the Degree of Master Engineering".

[2] BM Baker，MA Ayechew, et al. "A genetic algorithm for the vehicle routing problem", 2003, 30(5):787-800

[3] CHEN Li, AO Ri-ge-le, HUANG Liang, et a. "Logistics Distribution Center Study Solves the Order Picking Optimization Algorithm", [2014-11-25].

[4] LI Jian-bin, ZHOU Wei, CHEN Feng, et al. "Applied Optimal Strategies for Warehoouse Picking Routing in B2B", Logistics Engineering, F224, (2012).

[5] LI Xiao-chun, WANG Guo-qing, ZHONG Xue-ling, WANG Xiao-zhi, et a. "Order Picking in a Doublle Carousel System", Logistics Engineering, F252, (2012).

[6] Meng Chao, et a. "DESIGN AND IMPLEMENTATION OF WAREHOUSE MANAGEMENT STSTEM WITH AUTOMATIC OPTIMIZING PICKING PATH FUNCTION".

[7] WANG Xiong-zhi, WANG Guo-qing, et a. "A heuristics algorithm for the replenishment operation problem in distribution center", F235.4, 1000-678(2008)04-0050-07.

[8] WANG Yan-yan, WU Yao-hua, SUN Guo-hua,YU Hong-peng, et a. "Research on picking order batchng policy of a distribution center", F235.5, (2010).

[9] XUE Zhao-jie, MIAO Li-xin, YANG Peng, QI Ming-yao, et a. "Order Matching Problem Based on Ant Colony Algorithm", F235.9, (2011).

[10] ZHONG Ping, et a. "Line Based on the Dynamic Analysis of a Supermarket Warehouse General Layout Optimization Research", F251.1, 1674-4993 (2015)09-0060-04.

[11] Zhuo Li-qin, Han Shui-hua, et a. "Modeling and Simulation on Order Scheduling Optimization for Cigarette Automatic Sorting System", (2010).