# Design of highly integrated automated warehouse control system based on artificial intelligence

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**Abstract:** The modern production system has higher and higher requirements for logistics modernization. As an important part of the modern logistics system, the automated three-dimensional warehouse is more and more widely used. Based on the application and development requirements of modern logistics, this paper focuses on the management and control technology of automated warehouses, and uses the artificial intelligence theory to optimize the cargo space. The experiment proves that the management technology is convenient and efficient to use, and the performance is stable in actual use, which is worth promoting.

## 1. Introduction

Modern logistics has caused profound changes in the production system of enterprises and has become an emerging so-called "third profit source."[1] Modern enterprises continue to withstand the pressures of smaller and more frequent product orders, changing product demands and rising service values. [2] Managers urgently need to take measures to adapt to the increasingly demanding warehouse management and flexible operations to enable enterprises and warehouses. Logistics, information flow, and control flow are more efficient. [3, 4] Under the requirements of these changes, the modern logistics system has developed rapidly on a global scale, and its development level has become one of the important indicators to measure the modernization of a country's production system.

The artificial intelligence method shows powerful functions in solving combinatorial optimization problems and is fully applied in various fields. Many scholars have studied artificial intelligence for many years and constructed a large number of heuristic algorithms based on artificial intelligence. [5] The taboo search method belongs to a local search method of artificial intelligence, which has a good effect on route optimization and is closest to the optimal solution. Based on the theory of biological evolution, the genetic algorithm has good adaptive performance and is not strict with the conditions. [6] It is suitable for solving complex combinatorial optimization problems. At the same time, the calculation time is greatly shortened, which is a promising method. Therefore, this paper uses the artificial intelligence method to optimize the warehouse control system.

This paper will analyse the composition, classification and function of automated warehouse under the background of "modern logistics", combine computer technology, communication technology and information technology, focus on the management and control technology of automated warehouse, and use artificial intelligence theory to carry out goods. Bit optimization. For the database-based automated warehouse management information system, according to the requirements analysis, system design, programming steps, design and development of an automated three-dimensional warehouse management information system prototype. The research content involves the functional decomposition, architecture selection, database design and system programming and implementation of the automated three-dimensional warehouse management system.

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## 2. Automated warehouse analysis

### 2.1. Automated warehouse classification

The Automated Warehouse is a complex integrated automation system with seven classification forms. It is precisely because of its diversity of classification that it can serve a wide range of industries and promote the development of automated warehouses.

The whole type means that in addition to storing goods, it can also be used as a supporting structure of a building. The mobile shelf type is composed of electric shelves. The shelves can be walked on the track, and the control device controls the closing and separation of the shelves. The common automated three-dimensional warehouse system uses radio frequency identification technology. Its composition is shown in Figure 1. The goods are automatically identified by fixed readers or handheld readers installed at the entrance and exit of the warehouse to realize real-time query of detailed information of goods.

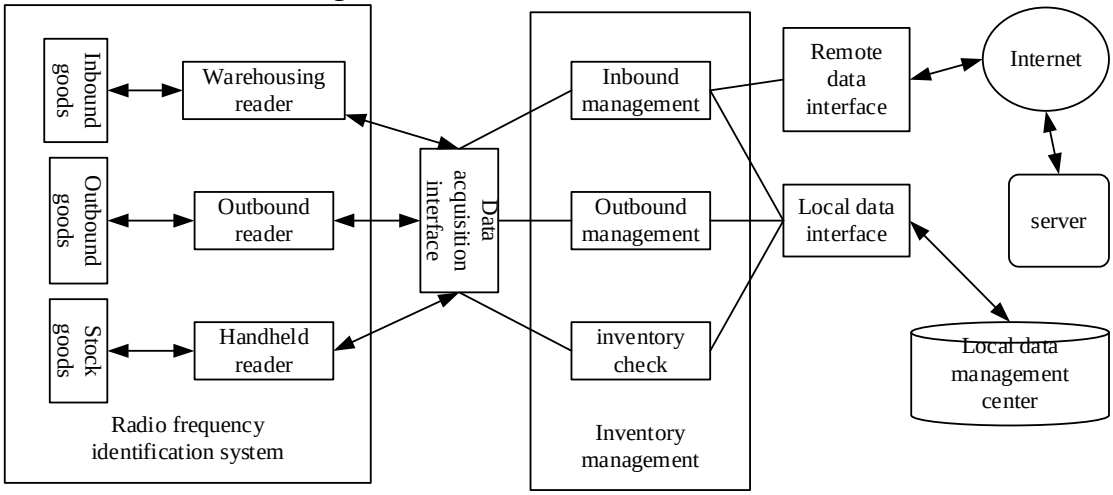


Figure 1 Structure diagram of automated stereoscopic warehouse control system using radio frequency identification

The general automated three-dimensional warehouse is used for storing goods at a normal temperature and humidity environment with a temperature of 0 to 40 ° C and a humidity of 45% to 85%. Other special environment-type automated three-dimensional warehouses are generally used in environments such as anti-virus, anti-pollution and anti-radiation.

### 2.2. Basic work flow and parameter calculation

Automated warehouse operations include four steps: warehousing, picking, outbound, inventory, and reporting. The relevant parameters are calculated as follows.

Hasty scale calculation. Using the total length, width and height of the shelf, excluding the operation control room, the conveying system, etc., the overall size of the warehouse can be determined, and the total area calculation method is:

$$S = \frac{m}{qa} \qquad (1)$$

S is the total area required for the warehouse, a is the area utilization rate, m is the warehouse cargo storage rate, and q is the cargo storage capacity per unit area of the warehouse.

The formula for m is:

$$m = \frac{EK}{30} t \qquad (2)$$

E is the monthly maximum cargo access of the three-dimensional warehouse, K is the design maximum storage percentage, and t is the average inventory period of the goods in the three-

dimensional warehouse.

The formula for calculating q is:

$$q = rH \tag{3}$$

H is the height of the other side of the goods, and r is the stock of goods.

## 3. Genetic algorithm

The research on the optimization problem of automated three-dimensional warehouse is of great significance to improve the efficiency of modern logistics system, optimize the industrial structure of modern production system, and improve the advanced nature. The structure design of the cargo information data table refers to the use of the frequency of the inbound and outbound to guide the distribution of goods. This chapter will further study the optimization of the cargo space.

Genetic algorithm is essentially a direct search method that does not depend on specific problems. The basic idea is based on Darwin's theory of evolution and Mendel's genetics. Darwin's theory of evolution believes that each species is more and more adapted to the environment in its development. The basic characteristics of each individual of the species are inherited by future generations, but the offspring will produce new changes that are different from the ones. Only those who adapt to the environment can change the environment. The individual characteristics can be preserved, that is, the survival of the fittest.

In the calculation of the location allocation, first select the species by initializing the population, and use the norm to measure the difference between the chromosomes in the population:

$$d_s = \left\| S_{mi} - S_{ni} \right\| = \left[ \sum_{j=1}^{n} \left( S_{mij} - S_{mij} \right)^2 \right]^{\frac{1}{2}} \tag{4}$$

$$d_E = \left\| E_{mi} - E_{ni} \right\| = \left[ \sum_{j=1}^{n} \left( E_{mij} - J_{mij} \right)^2 \right]^{\frac{1}{2}} \tag{5}$$

S is the two chromosomes in the population of the centre of gravity, and E is the two chromosomes in the population in the case of the frequency and time of the cargo. It can be seen that the larger d is, the worse the similarity is. It is guaranteed that there are large differences between chromosomes, which can ensure that the genetic algorithm can search for the global optimal solution.

## 4. Control system of automated warehouse

### 4.1. Automated Warehouse Control System Design

The automated three-dimensional warehouse control system is divided into three aspects from the functional composition: executive layer, control layer, and management layer. At the same time, the operation information is fed back to the control layer, and the control layer dynamically analyses and allocates the inbound storage space according to the real-time cargo position information to ensure the safe, reliable, correct and efficient operation of the system. The management layer is an automated three-dimensional warehouse system and enterprise information integration function. The interface data is used to interface the warehouse data with the enterprise ERP system, which can manage the information flow and coordinate the normal operation of the system equipment from the enterprise.

Among them, the dynamic allocation of the inbound and outbound cargo space, the operation of the inbound and outbound operations, and the interface of the control system are three functions.

The inbound and outbound warehouse is executed by the stacker. The basic parameters are shown in Table 1.

Table 1. Stacker running basic parameters

| Parameter | Value |
|---|---|
| Horizontal running speed | 80m/min |
| Vertical running speed | 25m/min |
| Vertical running acceleration | 0.15m/s2 |
| Horizontal running acceleration | 0.5m/s2 |
| Number of shelves | 8 |
| Number of shelves | 36 |
| Location width | 1050mm |
| Cargo height | 1150mm |

The stereo warehouse warehousing mode can be divided into three categories according to different operating modes: single instruction cycle mode (SC), dual instruction cycle mode (DC), and mixed operation mode. When the inventory queue and the pick-up queue are empty and the other has an operation unit, a single-instruction cycle operation is performed. The single instruction cycle mode is an operation instruction for separately executing the inbound or outbound operation according to the operation queue, and the single execution is performed into the library or the outbound process during the operation cycle; the double instruction cycle is to execute a pair of operation instructions at a time according to the goods queue, and the pair is inbound. And out of the library composition, the operation cycle process is performed together with a pair of instructions. The following diagram is drawn according to the different SC and DC modes, as shown in Figure 2.

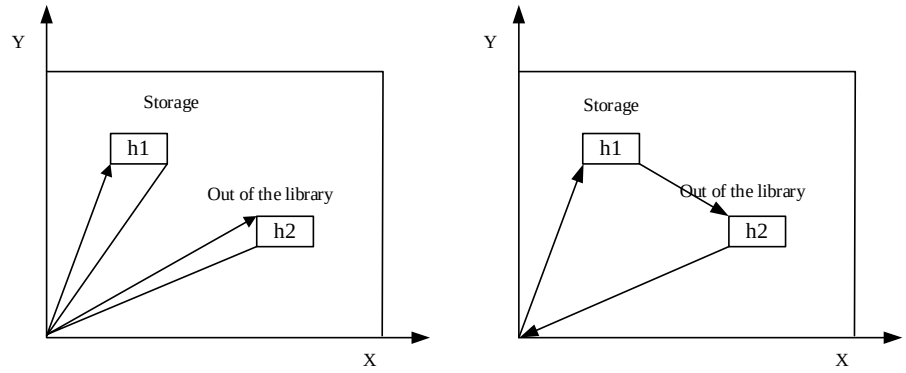


Figure 2. Stacker operation mode

The warehousing principle must be referred to during the warehousing operation. It mainly involves the distribution, time and efficiency of the warehousing. In the convenience of reference to the storage, how to improve the efficiency of warehousing is the realization of the basic operation of the warehousing. The problem solved; according to the actual operation, there are mainly partitioning principles, uniformity principles and efficiency principles:

### 4.2. Application of three-dimensional warehouse control system

The entrance and exit operation of a three-dimensional warehouse of a pharmaceutical company is automatically carried out by the control system to the console by the delivery operator to set the storage order number through the control panel. In the actual operation of entering and leaving the warehouse, in the case of less inbound and outbound cargo units, it is more effective to use a single inbound and outbound operation, and it is more effective to use the mixed inbound and outbound mode when the amount of inbound and outbound cargo units is relatively large. The statistical information of the raw material in and out of the library DC instruction is shown in Table 2:

According to the data analysis, in the case of a large number of unit operations, the control system performs optimal control and can improve the work efficiency and save the running time. It can be concluded from the above table data that the operation using the DC command can save 11.5% of the time consumption compared with the SC instruction. The algorithm design of the automated three-dimensional warehouse control system has more application significance for the

goods entering and leaving the warehouse.

Table 2. Raw material in and out of the library DC operation instruction statistics information table

| Type | Name | Number |
|---|---|---|
| Storage | Yam | 80 bags / 20 units |
| Storage | Licorice | 40 bags / 20 units |
| Storage | Huang Wei | 40 bags / 10 units |
| Storage | Safflower | 200 bags / 50 units |
| Out of the library | Walnut | 80 bags / 20 units |
| Out of the library | Chalk | 80 bags / 20 units |
| Out of the library | Motherwort | 40 bags / 10 units |
| Out of the library | Duckweed | 80 bags / 40 units |
| Statistics | Time: 30min | Cycles: 100 |

## 5. Conclusion

Automated warehouses are becoming more and more popular, and they play an increasingly important role in various industries. With the advancement of modern technology and the maturity of automation technology, the efficiency of automated warehouses using modern technology will inevitably increase. This paper designs and develops and controls the control system of Jidong Pharmaceutical Automated Warehouse. It has carried out a serious research on the control system of the auto-stereo warehouse and the data docking of the ERP system, especially the core component stacker PLC. The design of the control system. The experiment proves that the developed system has a good application effect and has a high promotion value.

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