

# **The Design Scheme of The Control System of The Automatic Warehouse**

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**ABSTRACT:** The article analyzes the main form and working principle of the automatic stereo warehouse stacker, according to the stacker and functional requirements of the process adopts the servo control system, walking positioning, communication function and the protection function of the module design and illustrate application of Siemens S7-300 PLC in the system.

**Keywords**–*Stereoscopic Warehouse; Stacker; Control System; PLC*

## **I. INTRODUCTION**

Automated warehouse is a top shelf (system tray) based on store supplies, with automated equipment (stacking machine, conveyor and sortation systems) access, computer monitoring and management system and. It is mainly composed of three parts: goods access and transportation system, cargo storage system, control and management system. In addition, there are power supply system, cargo weighing system, fire alarm system and other facilities.

Stacker is the warehouse key from carrying heavy equipment, material storage efficiency depending on the working efficiency of the stacker, usually reflect stacker performance fit and unfit quality indicators: running speed, lifting speed, fork speed, positioning accuracy, safety, vibration and noise. To make the crane more efficient and efficient operation, it is needed to design the control system of the stack machine reasonably, and to integrate with the innovation and improvement of a number of techniques to achieve the purpose of improving the performance of the crane.

## **II. SINGLE MAST STACKING MACHINE**

Mainly consists of the rack, running mechanism, lifting mechanism, fork lift truck, truck, electric equipment and safety protection device, etc.. It is the main task and access cargo operations between the transmission line and the designated location. In this process, by three motors (immediately go motor, lifting motor and fork motor) to control the stacker in the tunnel 3D motion, PLC as the field controller real-time monitoring stacker running status and ready to accept from computer storage tasks.

In order to meet the requirements of the automatic warehouse storage, the control system of the stacking crane has the following functions:

Motion control: the level of walking speed, loading and landing speed, cargo fork telescopic speed adjustable.

Positioning control: the stacking machine at a certain speed to the target location and positioning accuracy.

Communication function: communication between PC and ground control PLC.

Protection function: with perfect mechanical, electrical and software security protection.

According to the control mode of the roadway type stacking machine, the operation tasks are determined, and there are three kinds of control modes, which are automatic, semi-automatic and manual. In the automatic control mode, the task information is provided by the host computer, including the target location Job content.

### **III. CONTROL SYSTEM DESIGN**

#### **3.1 Hardware System Components**

The research object of this paper is the linear operation of the ground bearing type single pillar roadway stacking machine, the control system mainly includes the host computer, PLC controller, servo driver, motor and all kinds of sensors.

#### **3.2 Function Design of Control System**

Motion control, in the process of operation of the stacker, with frequent fast starting, braking, and in the running process of do efficient and safe transportation and movement of the stacker control put forward very high request, namely three directions of movement to run fast, accurate positioning and good stability, especially along the horizontal tunnel (direction running long distances, so it needs to speed close to the target position, again low speed running in place.

Positioning control, the positioning accuracy of the stacker requirements are very strict, otherwise, the fork access of goods, due to the accumulation of errors, may cause collision or other accident, the general requirements of the error is less than 2mm. At present, many methods are widely used in the positioning of the stacker, according to the working principle, generally can be divided into absolute addressing and relative addressing. The commonly used absolute addressing method, encoder positioning BPS barcode positioning, laser ranging, relative addressing in the application site positioning is widely recognized. Comprehensive comparison of the methods of positioning accuracy, reliability and the actual situation, the system uses the following address.

In the horizontal direction, the laser ranging and positioning method is adopted. The laser distance measuring instrument mounted on the stacking machine is constantly changing with the moving of the stacking machine in the tunnel, and the distance between the reflecting plate which is installed on the ground, so as to realize the dynamic distance measurement in the process of high speed operation. PLC reads the data from the laser range finder to control the direction of the horizontal direction.

The vertical direction, by addressing chip positioning method. Corresponding to each shelf in the stacker position on the installation of addressing chip, photoelectric switch in installation on a loading platform, follow lifting cargo platform movement. PLC by reading the signal pulse count addressing chip and photoelectric switch overlap generated, positioning control in vertical direction.

Communication function, the upper monitoring computer sends operation instructions to the stack machine, including a library, storage, start, stop and so on, and the crane needs to monitor the information to the host computer. Because the crane moves back and forth in the tunnel, the PLC and the ground main control PLC are used for wireless Ethernet communication, the expansion of the method is convenient and the cost is low, and the system is reliable and safe. The master control PLC is connected with the upper control computer through PROFIBUS-DP, which is a kind of special bus designed for industrial control, which has high transmission rate.

Protection function, in the design of control system, the safety factor of each method is considered. Should have the following three kinds of protection function:

Interlocking protection. Fork not in or are accessing goods, movement of the horizontal and vertical direction is locked; stacker horizontal and vertical direction is running, stacker positioning is not accurate, safety insurance system is activated, inventory when the corresponding location goods and pick up the corresponding location no cargo fork movement is locked.

Limit protection. To detect whether there is a super wide phenomenon of the goods, when the stacking machine close to the level of the limit or the loading station close to the lifting limit, automatically cut off the corresponding motor power supply.

Broken chain protection. In the lifting chain of the end of the installation of exercise protection switch, when the chain rupture or relaxation occurs, the trip switch signals, automatically cut off the motor power, stacking machine stop working.

### **3.3 Control Software Design**

Stacking machine PLC is the core part of the control system, and the motion control and condition monitoring of the stacking machine is completed by PLC. This system chooses the S7-300 series CPU314C-2DP of SIEMENS as PLC, the product itself has 24 point DI/16 point DO, 4 channel analog input /2 channel analog output, and can expand multiple modules, fully meet the needs of control.

In the software design of the control system, the PLC control program should be based on the operating characteristics of the crane, using modular design method, easy to debug and maintain. The main program mainly completes interlock protection, limit protection, broken chain protection and overload protection, and other basic functions, also need to design the alarm subroutine, level walking subroutine, vertical lifting subroutine, subroutine of access goods, alignment adjustment subroutine, subprogram communication etc..

In an automatic storage as an example, the working process of stacking machine PLC, stacking machine in tunnel starting position, fork is located in and above no goods, the limit switch not overrun, stacker fork out will be equipped with a pallet goods after receiving the fork to, stop fork; stack stack machine level walking and loading platform lifting at the same time, arriving at the target location detection location if there are goods, confirmed that no goods extension fork will be the tray location closed after the fork to a, stop fork; stacker self-test after enter the standby state, a job.

## **IV. CONCLUSION**

In this paper, the control system of the stacking crane is described in detail, and the design method of each module in this system is introduced. It is proved that the system is safe and reliable, and the operation efficiency is high.

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