Design of Automatic Packaging Palletizing Robot Control System in Shoe Product Back Packaging Line

Zhongbao Ji

Wenzhou Vocational and Technical College, Wenzhou 325035, China

14644404@qq.com

Abstract

In order to improve the production efficiency of packaged goods, reduce the production cost, based on the full analysis of the basic structure and working process of the packaging palletizing robot, man designs a control system of PLC and palletizing machine based on touch screen. Man can realize controlling and real time monitoring of palletizing robot by touch screen, and adopts FAM3PLC as control system core of palletizing robot. According to the needs and work-flow of packaging palletizing work, the robot software programming is completed. The actual operation results show that the palletizing robot control system has the following advantages, for example high reliability, strong stability, strong scalability, and easy maintenance, etc.. The control system can meet the actual needs of shoe product stacking operations, and is of great significance for improving product packaging efficiency and reducing production costs.

Keywords

Robot; Palletizing; PLC; Touch Screen.

1. Introduction

Palletizing, as an emerging technology, has been widely used in industrial automation. Palletizing is to put some regular shape objects, such as boxes, bags, etc., according to a certain pattern placed on the pallet in order to achieve the material handling, storage, loading and unloading, transportation and other logistics activities. At present, palletizing robot has been applied in various industries with the rapid development of industrial automation technology, such as machinery manufacturing, food, beverage, chemical industry, warehousing, logistics, etc.. Palletizing robot has become indispensable automation equipment in the process of industrial automation production. Most of the digital stacking robots used in our country are imported from abroad, so it increases the production cost of enterprises, and heteronomys in key technologies of palletizing robot. In recent years, great progress of palletizing robot technology in our country has been made in the development and research, but compared with the developed countries, the palletizing robot in China has low generalization degree, high cost and poor stability. In addition, there are still many gaps in the performance of robots and the level of intelligent automation and key components and the core technologies of control systems.

Based on the analysis of the working principle and the mechanical structure of the palletizing robot, according to the functional requirements and technical requirements of the robot, the control system of palletizing robot is developed. In hardware system, the hardware design of palletizing robot control system is completed by using touch screen as upper computer, PLC as slave machine and servo drive technology. In software system, according to the program flow chart of palletizing robot, each function subroutine of the robot is written. The man-machine interface design enables the robot to exchange information with the outside world, the transmission of control commands and the feedback of the robot information are realized through the man-machine interface.

2. A Brief Introduction of Palletizing Robot

2.1 The working principle of palletizing robot

The palletizing robot has four independent degrees of freedom. They are respectively driven by four AC servo motors, which can be divided into three parts for analysis: rotation of the whole mechanism around the machine frame, the rotation of the gripper around the wrist, motion of parallel four bar linkage. The mechanism Chart of Palletizing Robot is shown in Figure 1, O- the waist center of the robot, setting coordinate system XO 'Y; A point- the hinge point of robot screw slider seat and rod AE, AC in horizontal direction, the horizontal movement along the X axis is driven by AC servo motor; B point- the hinge point of the screw slider and BD in the vertical direction of the robot, the vertical motion along the Y axis is driven by the AC servo motor; the angle θ between the rod AE and the X axis.

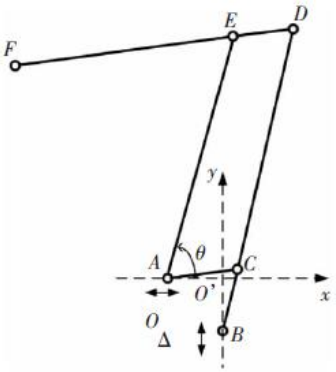

Figure 1 Mechanism Chart of Palletizing Robot

2.2 The overall structure of palletizing robot

The palletizing robot has four degrees of freedom, two moving pairs, two revolute pairs. The overall structure is shown in Figure 2. They are driven by four AC servo motors respectively, the bottom of the robot body is the base. A waist structure on the engine base drives the robot to rotate, that is driven by an AC servo motor. The servo motor drives the gripper to rotate around its own axis to adjust the position of the object placed on the tray. The other two servo motors control the horizontal and vertical motions of the robot respectively. The two motors control the ball screw by controlling the synchronous belt pulley, so that the slider moves along the lead screw to realize the horizontal or vertical movement of the robot gripper. This design can meet the requirements of fast motion, accurate positioning and driving large inertia load. The palletizing robot adopts the linkage mechanism, which makes the robot have the characteristics of compact structure, good stability and high bearing capacity.

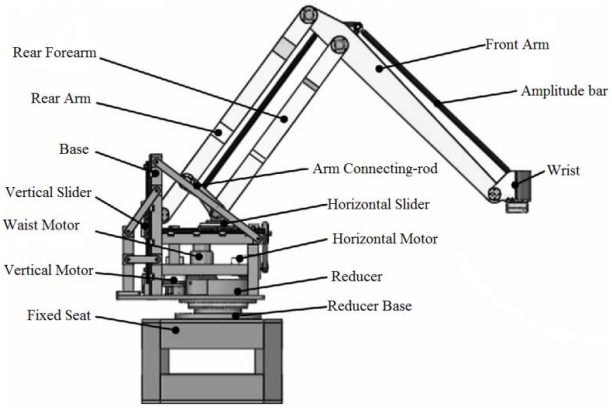

Figure 2 Summary Structure of the Palletizing Robot

3. Hardware Design of Control System

Because of the high reliability, stability and portability of PLC, it can adapt to complex working environment, programming is relatively simple, so PLC has been widely used in industrial automation. According to the structural characteristics and control function requirements of four degrees of freedom palletizing robot, a control system of palletizing robot based on PLC is designed. The touch screen is used as the upper computer, and is used to complete input palletizing parameters and display the running state of the robot. A set of operating interface which is similar to the teaching box is designed on the touch screen, and it is used instead of the teaching device, which can realize the reappearance of the teaching track. The lower machine uses PLC+ multi-axis motion control module to realize the servo control of the four axis palletizing robot, and drive servo motors to complete palletizing task of palletizing robot. At the same time, the PLC modules of I/O are used to realize the signal acquisition and control of other equipment in the pipeline, such as conveyor belt, pallet conveyor, etc.. The control structure based on PLC+ motion control modules has many advantages, such as strong versatility, strong anti-interference ability, effective operation in complex environment, low cost, simple programming, strong scalability and short development cycle, etc.. The hardware structure of the control system is shown in Figure 3.

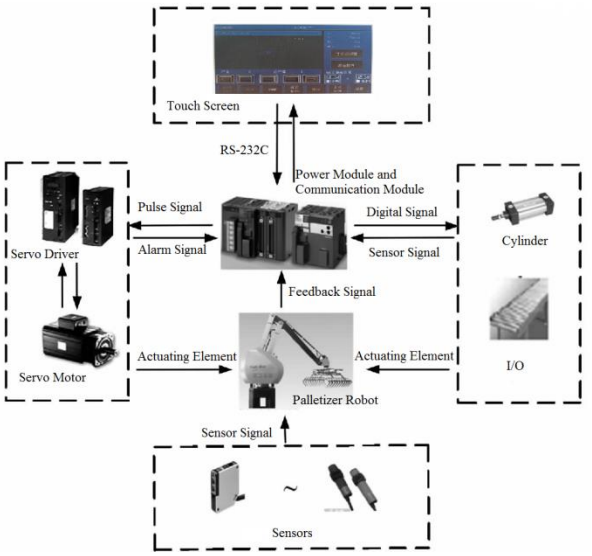

Figure 3 Hardware Structure of Control System

3.1 Type selection of PLC function module

At present, palletizing robot is designed with four degrees of freedom. In order to facilitate the future increase of robot joint number and pipeline related controlled parameters, so the module PLC is selected, whose main components are CPU module, power module, positioning module, basic I/O module and communication module. When the robot system is extended, it only needs to add the corresponding functional modules on the original system, and then the function can be added. Therefore, the design is low cost and high efficiency.

CPU module

In order to improve the palletizing efficiency of the robot as much as possible, the processing speed of selected CPU is high, and can supports the addition of multiple functional modules. After comparing the CPU modules of PLC, the CPU module F3SP59-7S is chosen.

Positioning module

Position control module is the main module of four axis synchronization control for palletizing robot. Position control module F3NC34, through the sending commands by the CPU module, generates the corresponding positioning trajectory, and output the corresponding command in the form of pulse. The position control module controls the angle of rotation of the servo motor through the number of pulses output, and controls the speed of the motor through the pulse output frequency. At the same

time, the encoder feedback information to CPU for judgment and analysis. Thus a closed-loop control system is formed. The position control module control diagram is shown in figure 4.

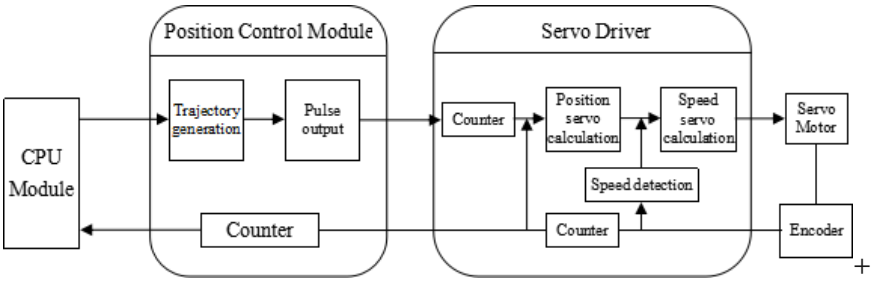

Figure 4 Control Principle of Position Control Module

3.2 Touch screen selection

In the packaging palletizing robot control system, the touch screen is used as the upper computer, and the HMI designed by touch screen makes the palletizing robot system more versatile, more intuitive and easy to operate. After using touch screen technology to replace the original mechanical button, the user only need program in touch screen to transfer data with the lower machine through the touch screen button, then it can realize sending real-time operation instructions to the lower computer. Touch screen MT6070IH is selected.

4. Control system software design

The software of palletizing robot control system requires not only trajectory planning, position and speed precise control, but also provides friendly man-machine system, and completes the corresponding fault diagnosis and alarm function. According to the hardware composition of palletizing robot, the whole control system software includes two parts: Man-machine interface modules programming of upper computer and PLC kinds of functional modules programming. The overall structure of the control system software is shown in figure 5.

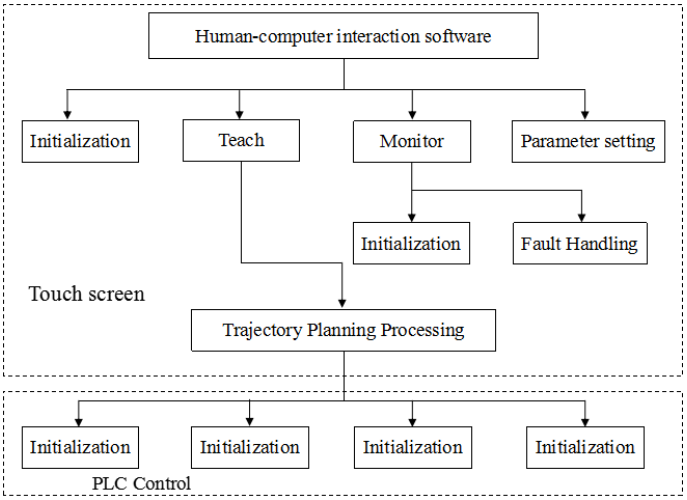

Figure 5 Software Structure of Control System

After the start button is pressed, the system is initialized, the gripper is reset to the top of the object grabbing position, then the conveyor belt moves. When the objects on the conveyor belt are in place, the conveyor stops moving, then the gripper falls to the crawl position. When the gripper has been moved to the gripping position, the gripper grasps the object. When the gripper rises to a certain height, the robot arms move together to carry the objects to the target position. When the gripper has been moved to the placement point, the handle opens the release,. Then the robot returns to its original position. In the process of carrying goods, if the limit switch of a shaft is triggered, PLC alarms, motors scram. Until the reset operation clears the alarm, the robot can start again. When someone enters the dangerous area of operation, buzzer alarms to remind paying attention to safety. When

someone detects a person entering the work area, the motor stops and the robot stops working until reset operation.

5. Conclusion

A packaging palletizing machine control system based on PLC and touch screen is designed, which takes the palletizing robot as the research object. The control and real-time monitoring of palletizing robot are realized by touch screen, and FA-M3 PLC is the core of palletizing robot control system. And according to the needs and workflow of packaging palletizing work, the robot software programming is completed. Through the actual prototype operation results, it can be seen that the packaging palletizing robot control system based on PLC can collect and control the field I/O quantity. The system can realize synchronous motion control of servo motor through the motion control module, so as to realize the accurate stacking of packaged goods. The test results show that the control system has high stability and strong scalability, easy maintenance, high precision stacking tasks to achieve robot.

References

[1] Zhang Zhi-qiang, Zang Ji-yuan, Yun Chao. Kinematics analysis and simulation
[2] of the hybrid stacking robot . Journal of Machine Design, (2010)27(11): 47-51.
[3] Cheng Li, Liu Yu-wang, Luo Hai-tao. Finite element modal analysis of 165kg welding robot . Machinery Design&Manufacture, (2012) (1): 147-149.
[4] Wang Zhan-jun, Zhao Yu-gang, Liu Xin-yu. Structural design and modal analysis of palletizing robot. Machinery Design&Manufacture, (2014) (8):147-149.
[5] Xie Ya-qing. Study of 5-freedom modular pneumatic manipulator based on PLC . Machinery Design&Manufacture, (2009) (1). 180-181.
[6] Sun Xiao, Zhou Hao. Design of quantitative packaging control system based on PLC for sample coal . Packaging Engineering,(2011)32(21): 76-78.
[7] Wang Jia-yin, Feng Xian-ying, Wang Xiao-bin. Development of precise quantitative packaging control system for reagent based on PLC. Modular Machine Tool & Automatic Manufacturing Technique, (2013) (10): 80-86.
[8] Li Zhi-mao, Chen Yong-xiang, Li Shuang-yue. The control system design and research of flexible cement packaging line . Machinery Design&Manufacture, (2016) (1): 169-171.
[9] Yi Lun-han, Zhen Guang-jiao, Yan Fang-tian. Design of loading robot control system based on PLC. Applied Mechanics and Materials, (2013) (10): 792-795.