PLC Control System Design for PVC Floor Detecting and Conveying Device

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Keywords: PLC, PVC floor detecting and conveyance device, Ladder diagram, Hydraulic lifting platform, Floors layered multiple stacking.

Abstract. Traditional PVC floor detecting is done by workers’ handwork, which is hard and inefficient. So studying and designing a set of control system which is based on PLC for PVC floor detecting conveyor device. The PVC floor detecting conveyor device consists of loading, conveying and unloading and other parts. To make the whole system works in a coordinate and controllable status. Firstly, by using double layer hydraulic scissors lift to realize the lifting and stratified translational control of lifting platform; secondly, with the use of photoelectric switches, counters and other components, station transport algorithm helps the process of PVC floor detecting conveyor; Finally, according cutting control requirements of stacker, the PLC auto-control and speed optimization can be done by layered multiple stacking. Thus automated loading, conveying and unloading process are come true, greatly reducing the labor intensity and improving production efficiency.

Introduction

With the quick development of economy and technology in china, computer technology, microelectronic technology and automatic control technology has also been rapid development, especially the programmable logic controller (PLC) technology has entered a new age. It has a simple and convenient programming, strong control functions, easy to implement mechatronics and other advantages. At present, many domestic and foreign scholars use PLC in machinery manufacturing, iron and steel, petroleum, chemical, textile, building materials and other industries. PLC technology was used in document [1] to control conveyors and sorting machines, which realizing the sorting and transmission for large and small balls; A five degrees of freedom ingredients manipulator which based on PLC was developed in document [2], the manipulator used PLC as the control core and a control technology combining electrical control and pneumatic control, realizing various functions of the cup action required in automatic batching process. Document [3] showed that PLC system can be used to realize the control of temperature in the design and construct of heating system. Additionally, A rapid and economical manufacturing method was developed in document [4], which combining PLC module and three-axis CNC milling machine to manufacture spiral bevel gears.
Existing PVC floor detecting is done by workers’ handwork, which will cost a lot of labor and time. Therefore, a kind of PVC floor detect equipment is designed in this paper, including hydraulic double scissor lift, conveyance system and stacker. This paper utilizes PLC, combined with trip switches, photoelectric switches, counters and other component, to design the control system for PVC floor detecting and conveyance device, making it an effective control for the process of PVC floor’s loading, conveying and unloading. So, this detect equipment can achieve rapid and efficient detecting for the PVC floor.

**Detecting Process of PVC Floor**

The specification of PVC floor is $200\text{mm} \times 1210\text{mm}$, 5mm thickness, 2.3kg per piece, PVC floors to be detected are placed on a layer board, there are four piles of PVC floors on the layer board and each pile has 160 PVC floors. PVC floor detecting process is divided into flare detecting and flat detecting which shown in Figure1.

![Figure 1. Schematic diagram of PVC floor detecting.](image)

Schematic diagram of PVC floor detecting is shown in Figure 1. The specific structures include pneumatic lifting plate 1, operator 2 and 10, conveyor belt wheel 3, photoelectric switch 4, 7 and 12, lifting plate with air cylinder drive 5, roller bed with motor drive 6, positioning baffle 8, 9, 11, and 14, unloading stacker 13, lighting 15, waste station 16. There are four pile of PVC floors waiting for being detected in the hydraulic lifting platform 1, flare detecting is done by operator 2 in the front of the hydraulic lifting platform 1. The floors were put on the belt 3 to convey after the flare detecting. It will be delivered to the lifting plate 5 by conveyor; Lifting plate is driven under the action of the cylinder’s moving up and down. When the number of PVC floor through the light sensor 4 reaches 16, counter displays and transmits digital signal 16, pneumatic piston back, lifting plate 5 drops, PVC floor is transported to positioning baffle 14 at the action of roller bed 6. At the time of the PVC floor goes through the light sensor 7, pneumatic piston out, and lifting plate 5 rises. The operator 10 starts the flat detecting (rollers in front of the operator 10 are used for flat detecting, without a motor drive), waste is placed on the waste table 16. After detecting a stack of floors are transported to positioning baffle 11 under the action of roller bed 6, light sensor 12 passes signal to unloading stacker 13, unloading stacker 13 begins to unload.
Control System Design for Hydraulic Lifting Platform

Loading Control Requirements for Hydraulic Lifting Platform

Hydraulic lifting platform is the overall moving scissor mechanism [5][7]. It can not only move up and down, but also can move back and forth. The control process can be achieved manually, and can be automatically run as well. In the initial state, there are four pile of PVC floors on the hydraulic lifting platform. For ease of operation in detecting and loading, the hydraulic lifting platform is placed 1 meter below the horizontal plane.

Firstly, the operator carries out flare detecting with the PVC floor which is nearest to the conveyor belt then loading floors to conveyor belt. If the thickness of PVC floor is half of each pile, about 80 pieces. The operator controls the hydraulic system with buttons to enable the lifting platform advancing some distance to the conveyor direction; he loading the second pile of PVC floors next, the loading thickness on the conveyor belt is as same as the first pile, then he secondly controls the hydraulic system with buttons to enable the lifting platform advancing some distance. At this time, the advancing part of the lifting platform extends below the conveyor belt directly; Then after the operator loads the third and fourth pile of PCV floors like the above method, in this time the operator presses the button to control the lifting platform back to the starting position and increase the height of platform, then the operator loads the remaining first pile of PVC floors, in accordance with this order, the loading process will be finished finally.

I / O Assignment and Hydraulic Principles

Mitsubishi PLC FX2N-32MR is used in control process to design lifting platform control system. I/O assignment and wiring principle of hydraulic lifting platform is shown in Figure 2.

![PLC Wiring Diagram of lifting platform.](image)

The functions of start button and stop button are achieved by controlling the energized and de-energized of motor control coil, which realizing the movement and stop of hydraulic drive motor; Automatic and manual transmission are two kinds of control modes on the control panel, control mode selection is done by auto-run button; Four directions of movement Up, down, front, back can be achieve for the platform by controlling the four electromagnetic coils
of the up-down solenoid directional valve and front-back solenoid directional valve, forward, backward, rise and fall movement buttons can control the on or off to the corresponding electromagnetic coils; Manual stop button can control the manual stop of platform by making the up-down and front-back electromagnetic coils loss of power; Auto-stop of platform can be achieved by using height positioning limit switch and anti-collision detection limit switch to making the up-down and front-back electromagnetic coils loss of power.

The rise and fall of lifting platform are driven by a hydraulic system, the hydraulic control system schematic of lifting platform is shown in Figure 3, including lifting tank 17, filter 18, pressure limiting type variable vane pump 19, motor 20, front-back solenoid directional valve 23, up-down solenoid directional valve 28, front-back movement hydraulic cylinder 24, up-down movement hydraulic cylinder 29, control valve 22, control valve 27, backpressure valve 25, backpressure valve 30, relief valve 21, anti-collision detection limit switch 26 and PVC height position limit switch 31. Motor drives pressure limiting type variable vane pump to push two hydraulic cylinders, making the lifting platform to complete the up, down, forward and back movement respectively; Two solenoid directional valve can reverse up-down movement and back-forward movement respectively; Two control valve are used to control the movement speed of two hydraulic cylinder respectively; Two back pressure valve are used for the pressure regulating of the oil; Relief valve is used for security; Filter is used for oil clean. The hydraulic control system schematic of lifting platform is shown in Figure 3.

![Figure 3. The hydraulic control system schematic of lifting platform.](image)

**Control System Design for Detecting Conveying Equipment**

In detecting conveying equipment, pneumatic lifting plate control system includes counter, two photoelectric switches, two proximity switches, two relays and a solenoid valve. Counter is used to count number of pieces of PVC floor repeatedly, as it is shown in Figure 1, photoelectric switch 4 is used to receive a signal every time the PVC floor goes through it and then passes to the counter; Photoelectric switch 7 is used to receive a signal every time the PVC floor goes through it and then the pneumatic lifting plate rises; The first proximity switch is used to control the falling height of lifting plate and the second proximity switch is used to control the rising height of lifting plate. Relays are used to receive the signals from the
photoelectric switch and the counter to control the reversing of solenoid valve, making pneumatic lifting plate rise or fall.

As shown in Figure 1, the station control of detecting conveying equipment is that, the counter counts a time every time the PVC floor goes through it. When the number comes up to 16, the counter normally open contact closes, the falling relay coil is energized and the contact is closed that solenoid valve is energized and pneumatic piston fall, the lifting plate stops falling at the position of the lower proximity switch. If PVC floors go through photoelectric switch 7 with the transport of rollers, the rising relay coil is energized and the contact is closed that solenoid valve reverses and pneumatic piston rise, the lifting plate stops rising at the position of the upper proximity switch.

**Control System Design for Unloading Stacker**

During the unloading process, motor drags the pulley to drive gripper to move forward and backward. If the motor is running at the same speed, there will be several situations. If the gripper moves forward and backward too fast, then the emergency stop in corresponding proximity switch position will cause the shaking of the entire spent; however, too slow speed will affect the efficiency of the production detecting which shown in Figure 4.

![Figure 4. Unloading control flow chart of stacker.](image-url)
So, it is necessary to optimize the speed of the motor control system. If every time gripper goes ahead or back from the reset proximity switch to the four unloading proximity switches accordingly, its speed will always change from accelerating, uniform, decelerating to stopping, making the gripper reach the correct position smoothly. In Figure 4, the control flow has included the speed optimization process.

Conclusions

The PLC control system design for PVC floor detecting and conveying device uses an overall moving scissor mechanism, the mechanism can not only be useful for the lifting of the floors, but also can conduct stratified translational control, which is convenient for worker to pick up the floors; station control in the conveyor system is useful for worker to detect the PVC floors; according to the requirements of the operating characteristics, the unloading system can not only conduct layered multiple stacking, but also further optimize the speed variation of the stacker unloading mechanism, reducing the vibration of the system. This system device has been used in PVC floor detection in Yi Hua Plastic Co., Ltd. of China, the practical application shows that, this system device can greatly reduce the labor intensity and improve test efficiency.

Acknowledgment

This research was partially financially supported by Science and technology support program of Jiangsu Province (BE2012080) and a joint research project of Jiangsu Province (BY2012179).

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