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Design of Control And Monitoring System For Pneumatic Manipulator

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ABSTRACT.*The control and monitoring system is mainly used to carry the objects by pneumatic manipulator. The main content of this paper is about using PLC programmable controller to control the moving object of the mechanical arm, and using configuration software to realize the detection of its work. Finally, we can produce a pneumatic manipulator model that can realize autonomous control and autonomous monitoring.*

KEYWORDS: *Pneumatic Manipulator PLC;Programmable Logic Controller; King View Monitoring System*

1. Introduction

Pneumatic manipulator is an automatic control device used to reproduce some movements and functions of human hands and arms. It can perform a series of simple operations such as grasping, carrying, placing objects in specified positions according to specific programs. Originated in the late 1940s, research on its first start from the oak ridge national laboratory research carry nuclear material remote manipulator. Robotic arm technology gradually developed into a modern new technology in the field of automatic control, involving mechanical, electrical, hydraulic technology, sensor technology and computer technology such as comprehensive, as a new discipline [1].

In 1968, a mechanical casting company in the United States developed Unimits, a numerical control demonstration and reproduction type of mechanical arm. In the same year, the company also developed Versatran, a mechanical brand that can realize point position and trajectory control. These two mechanical arms laid the foundation for the development of many manipulators in the future [2]. However, China's robotic arm research and development began in the 1970s, at this time, China mainly to introduce technology [3]; In the 1990s, the development of China's mechanical arm entered the application period, and many companies, such as Shanghai Kema Automotive Equipment Co. LTD, Qingdao Oudixi Electric Co.

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LTD etc. could produce corresponding functional mechanical arm according to the needs of users.

This paper is about a pneumatic manipulator handling model that can realize autonomous control and autonomous detection based on previous research results. It will realize the lifting of objects from A to B. The handling process is basically completed by a combination of stretching, lifting, rotating, clamping, loosening of the manipulator. The control system and the monitoring system are respectively controlled and monitored by PLC and King View.

2. Structural Design of Pneumatic Mechanical Arm

In combination with the design requirements and the functional requirements of each part, the mechanical structure is designed as follows:

The mechanical structure of the mechanical arm is composed of four modules: rotating base (including rotary cylinder), lifting mechanism (including mini gas MI 25x75-S-CA), telescopic mechanism (including mini cylinder MA 20x50), and mechanical claw (end-effector includes needle cylinder CIPB 15 x 15 B). The final assembly effect is shown in Figure 1：

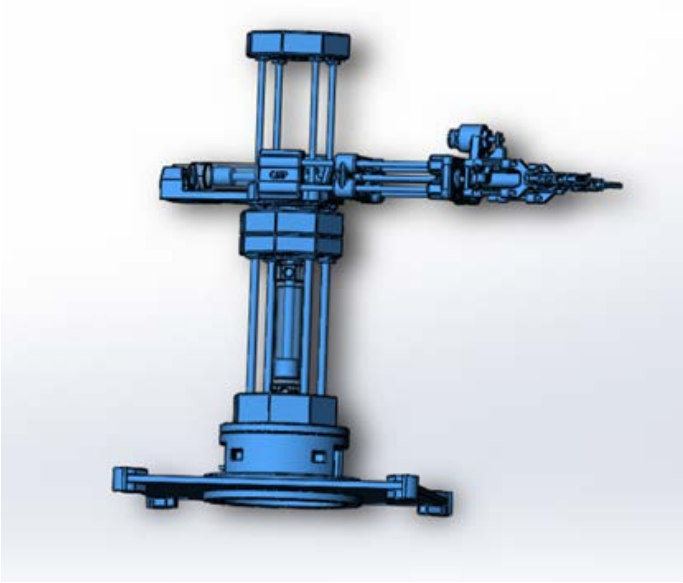

Figure. 1 Solidworks diagram of pneumatic mechanical arm

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The manipulator action process to be realized in this design is as follows: "the initial position starts to start, and the manipulator is completed to extend, clamp the workpiece, rise, rotate clockwise, descend, relax the workpiece, retract and reset ". As shown in Figure 2:

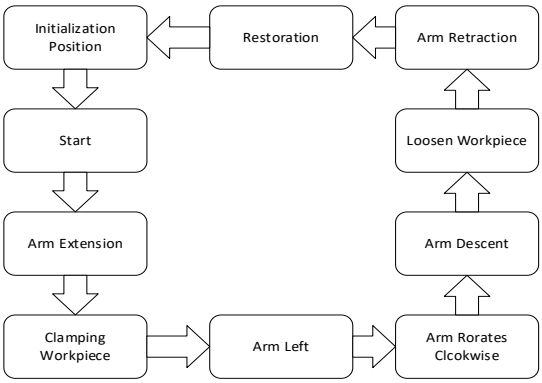

Figure. 2 Flow chart of movement of pneumatic manipulator

3. Design of Pneumatic Manipulator Control System

The chart of PLC control system is shown in Figure 3. If the start button is pressed, the automatic program will be executed, and each action will be executed to determine whether the interrupt button is pressed. If the automatic program is not pressed to continue execution, the output signal will be corresponding to the output signal.

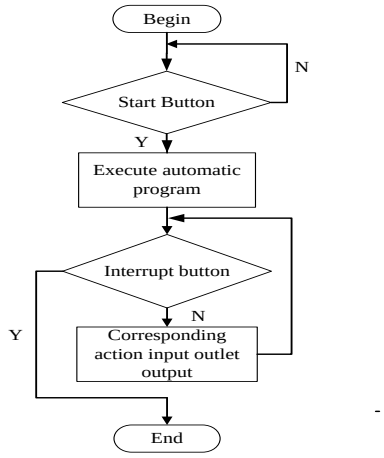

Figure. 3 Flow chart of PLC control system

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3.1 Software Selection and Interface Design of the System

This design choose Japan Panasonic electrician's modernization, function strong small FP - XO series PLC programmable controller, the communication with the cooperation of the plug-in, offers a variety of interface point a connect with unit, and a standard interface for UBS is convenient to realize the communication between PLC and PC, the PCS of ladder diagram program is transmitted directly to the programmable controller.

The SELECTED PLC model is FP-XO L40MR, and the main unit has RS485 communication port, controlling I/O points with 24 inputs and 16 outputs, which can meet the task requirements.

According to the proposed location task requirements, the I/O allocation table is shown in Table 1.

Table 1. I/O interface allocation

Input signal			Output signal		
Serial number	Input element	Input adress	Serial number	Output element	Out adress
1	Strat key input	X0	1	Drive the lift cylinder down	YA
2	Breaking the arm movent	X1	2	Drive telescopic cylinder to retract	YB
3	Breaking the arm movent	X2	3	Restoration	YC
			4	Initialize	Y4
			5	Drive telescopic cylinder out	Y5
			6	Pneumatic clamping cylinder clamping	Y6
			7	Continue to clamping	Y7
			8	Drive the left cylinder upward	Y8
			9	Clockwise rotation	Y9

3.2 Programming and Simulation of the Control System

Create new files in FPWIN software according to PLC selection. Then, start according to the initial position, complete the position control requirements of extending the mechanical arm, clamping the workpiece, ascending, clockwise

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rotation, descending, relaxing the workpiece, retracting, and resetting, and carry out simulation debugging. As shown in Figure 4.

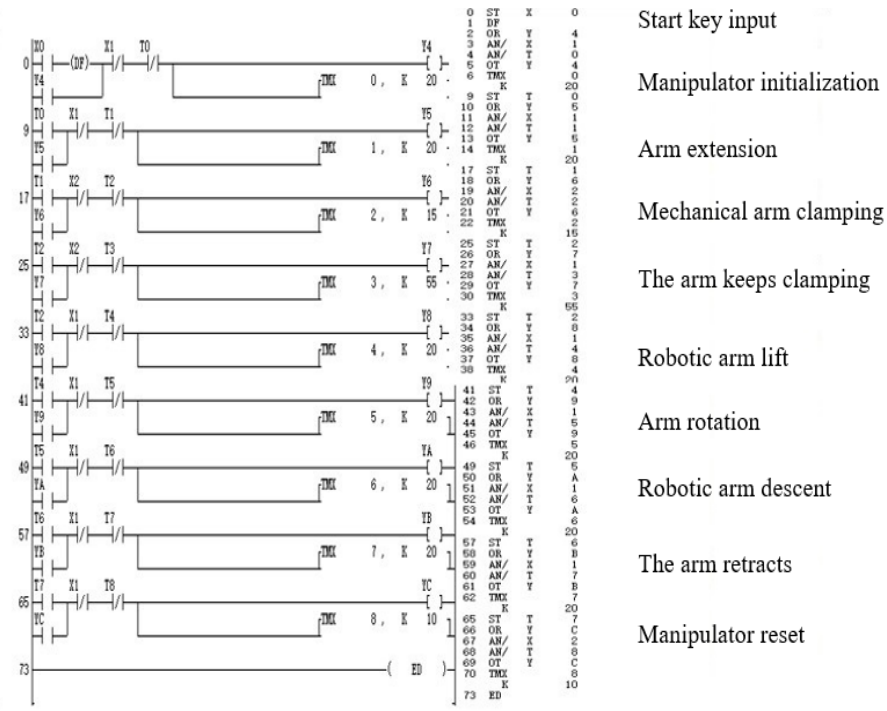

Figure. 4 PLCprogramming

After the simulation is confirmed correct, the program will be downloaded to the PLC, and the handling of objects will be completed according to the program.

4. Design of Pneumatic Mechanical Arm Monitoring System

"King view" is a flexible and reliable configuration software produced by Beijing Asia Control Company. The communication system established between King View and PLC has the advantages of fast speed and good real-time performance. It is mainly composed of project manager, project browser and screen operation system.

4.1 Design Process of Monitoring System

According to the actual operation of the manipulator, the flow chart of the robot arm in the King View monitoring system is designed, as shown in Figure 5:

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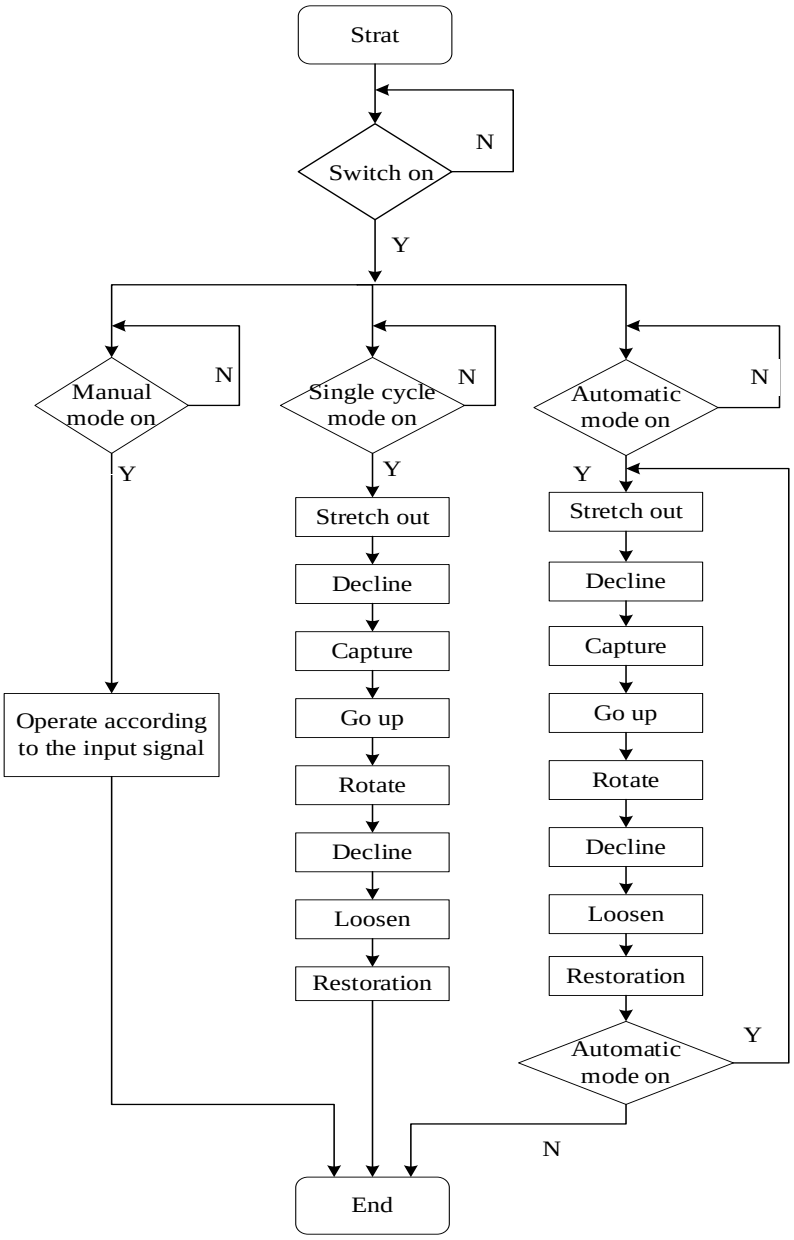

Figure. 5 Flow chart of Kingview manipulator

After entering the project browser interface, select "Equipment /COM2" in the directory tree to set the communication parameters, and select THE PANASONIC

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FP MODEL PLC to set the communication protocol parameters. Define the variables needed to monitor system design in the Data Dictionary in the directory tree of the project Browser interface. Then create the robot arm configuration monitoring system screen as shown in Figure 6 in the "Screen" in the Engineering Browser.

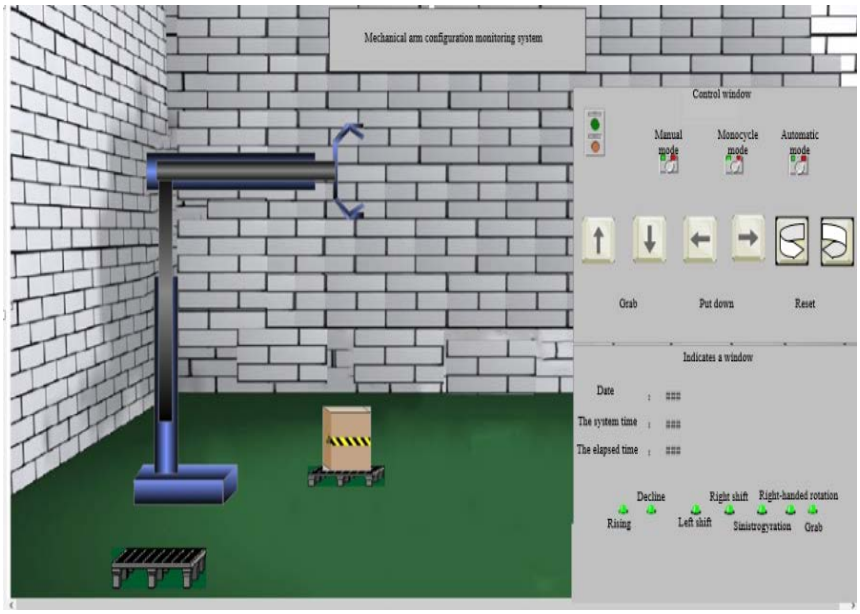

Figure. 6 Robot arm configuration monitoring system screen

The graphics, text and other elements in the screen of king View monitoring system are connected with variables to form corresponding relationships. Finally write command language program, is to screen for command to set the button in the system interface development such as the level of the mechanical arm, vertical movement and rotation motion, can press the button, click on the browser interface of the project directory tree "command language", choose the command language to write, to write command language.

4.2 Test of Monitoring System

After the construction of King View, it entered the test stage. In the screen operation system, the upper computer monitored it. The monitoring results are shown in Figure 7 below:

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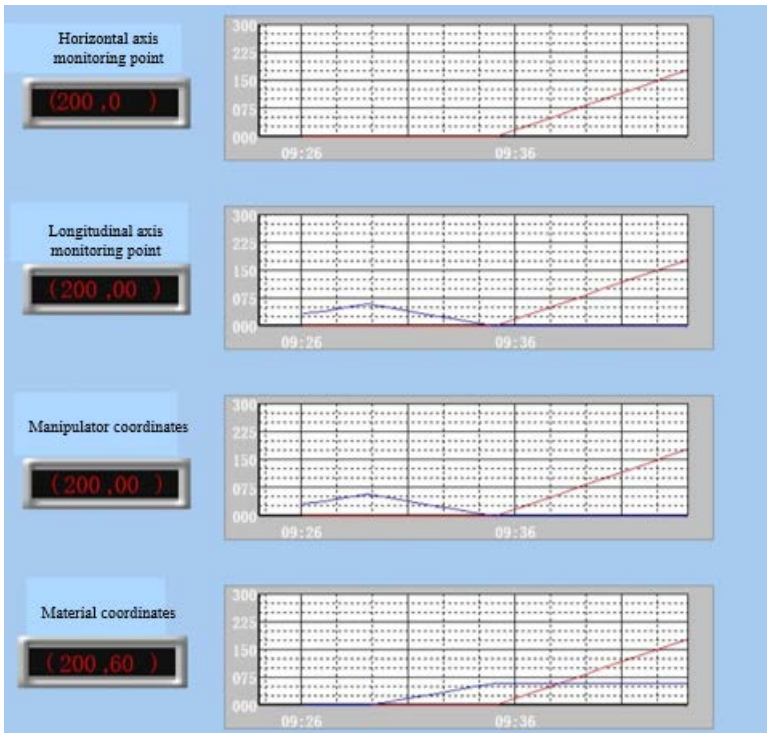

Figure. 7 Manipulator coordinates

Through the monitoring screen of the Upper computer of King View, it can be seen how the mechanical arm works, while the alarm window and data curve window reflect the working situation of the mechanical arm. The configuration monitoring system screen, data collection monitoring screen and data collection monitoring screen of the robot arm can be combined to complete the monitoring of the robot arm, namely, the following three parts can be completed：

(1) Realize the grasping and handling of objects by the mechanical arm. The screen of the configuration monitoring system of the mechanical arm can accurately reflect the skew and accurate grasping of objects, as well as reflect the movement mode of the mechanical arm.

(2) Realize alarm function. When the manipulator cannot follow the established route or grasp objects, the indicator light in the configuration monitoring system of the manipulator will remind the staff to deal with the fault in time.

(3) Realize the real-time monitoring of upper computer. King view can show the system design of PLC control manipulator in the form of animation.

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5. Conclusion

Through the design of the manipulator's structure, control system and monitoring system, this paper realizes the autonomous grasping and handling of objects by the manipulator. PLC control system and Kingview monitoring system are linked together, so that the manipulator can realize high quality and inexpensive working mode. The robot arm will replace a lot of manual work and improve work efficiency.

Acknowledgements

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References

[1] Bo Nan, Pneumatic Manipulator Control System Design based on PLC [J]. Internal Combustion Engine and Accessories, 2018 (19), p.100-102.
[2] Jie Chen. Development Prospect of PLC under new Technology Situation [J]. Mechanical Engineering and Automation, 2004 (04), p.84-85, 89.
[3] Chongli Huang. Design of sorting Manipulator [J]. Chinese Hydraulics and Pneumatics, 2010 (12),p. 94-96.