Design and comparison analysis of powder metallurgy press manipulator

Hua Zhang¹, Liguo Zhang¹, Lei Zhao¹ and Lai Hu¹, ², ⋆

¹School of Electrical and Electronic Engineering, Chongqing Vocational and Technical University of Mechatronics, Chong Qing, China.
²School of Mechanical Engineering, Xi’an Jiaotong University, 28 Xianning Road, Xi’an, Shaanxi, P.R. China.

⋆Corresponding author: hulai0405@stu.xjtu.edu.cn

Abstract. In the powder metallurgy pressing process of a certain company, when processing sharp-angled parts, it uses the chute type reclaiming method, which will cause bumps on the workpiece. In response to this problem, an integrated reclaiming manipulator was designed. The overall structure of the manipulator, pallet silo structure, manipulator structure, robot servo motor selection calculation, reclaiming silo structure, pneumatic system, overall electrical control, PLC program, Detailed design of man-machine interface. Through the operation test, the reclaiming manipulator can well meet the needs of the enterprise, operate stably and reliably, reduce labor, improve product quality, and increase production efficiency.

1. Introduction
Powder metallurgy technology is a forming technology that uses metal powder as raw material to prepare metal materials, composite materials and various types of products through press forming, sintering and post-treatment processes [1]. Advanced manufacturing technology with the characteristics of energy saving, material saving, high efficiency and less pollution [2]. In the pressing process engineering, the parts processed in the press are taken out and the workpiece is usually pushed out by the automatic mechanism connected with the press mechanism, and the workpiece slides into the buffer bin through the slideway. This way of taking out will cause bruises and scratches on sharp-angle parts, resulting in unqualified parts and reduced production efficiency of used products. At the same time, it also belongs to non-standard equipment. In mechanical processing manufacturing enterprises, many non-standard machine tools and traditional assembly line equipment are gradually involved to improve the automation degree of production lines. Non-standard equipment Qian Qian is ten million, and China's research on non-standard equipment has not been formally incorporated into the real research system [3]. At present, the problems existing in the manufacturing of non-standard equipment in our country can be roughly divided into two points: first, the coordination between various plans is not strong enough; Second, the standard of the design process from "0" to "1" for non-standard equipment is not standardized [4]. Therefore, there is a need to set standard regulations in non-standard machinery, which include design standards, manufacturing standards, technical indicators and other factors. In this paper, an integrated non-standard manipulator is designed to meet the needs of enterprises in the material taking process of powder metallurgy press.
2. Structural design of retrieving manipulator

2.1. Overall structure
The manipulator consists of a tray bin, a base, a manipulator and a fetch bin, as shown in Fig. 1. The material taking manipulator adopts an integrated design, and the manipulator, the tray silo and the material taking silo are installed on the base to form a whole.

![Figure 1. Overall structure. 1 press; 2 pallet silo; 3 fetch silo; 4 manipulator; 5 base](image)

2.2. Pneumatic system analysis
After analyzing the overall mechanical structure, it is necessary to study the pneumatic system of the equipment. The pneumatic system diagram is shown in Fig. 2.

![Figure 2. Pneumatic system.](image)

The pneumatic system of the fetching manipulator is shown in Fig. 2. The cylinder is selected according to the load required by the cylinder of each mechanism, the operating air pressure environment, stroke, installation mode, buffer form and operating environment. The push rod cylinder is a standard two-way cylinder with a 2-position 5-pass single electronic control solenoid valve. The upper and lower cylinders are three-guide rod two-way cylinders, equipped with 2-position 5-pass single electronic control solenoid valves. The gripper sucker is a vacuum generator with filtration and is matched with a 2-position 2-way solenoid valve. The claw blows off the circuit, connects it to the suction cup, and cooperates with the 2-position 2-way solenoid valve.
2.3. Control flow analysis
Combined with the analysis of the overall mechanical structure and pneumatic control, the overall control flow must be studied. The overall control flow is shown in Fig. 3.

![Figure 3. Overall control flow.](image)

As shown in Fig. 3, the whole control flow is closed loop. The implementation of each previous step will restrict the development of the latter step.

3. Circuit analysis of non-standard manipulator equipment

3.1. PLC selection and program analysis
According to the requirements of the system architecture, on the premise of meeting the control requirements and ensuring stability and reliability, Xinjie XD5 series PLC hosts widely used in the market are selected. According to the requirements of input and output, 18 bits of digital input and 14 bits of digital output are selected, and RS485 communication mode is adopted for communication with HMI [5]. In order to expand and upgrade the equipment in the future, the XD532T4 host computer of Mitsubishi Company was selected, with 18 bits of digital input and 14 bits of digital output, compatible with RS485 communication and RS232 communication, and four pulse outputs of 100kHZ. And has good expansibility. At the same time, according to PLC model selection and program design, I/O allocation is set. As shown in Table 1.
Table 1. PLC control I/O definition.

| Input                                      | Output                                      |
|--------------------------------------------|---------------------------------------------|
| X0  Tray origin                            | Y0  Manipulator pulse                       |
| X1  Origin of manipulator                  | Y1  Manipulator direction                   |
| X2  Origin of reclamer                     | Y2  Lifting slide pulses                    |
| X3  Tray in place                          | Y3  Direction of lifting slide table        |
| X4  The upper and lower cylinders are in place | Y4  Pulse of reclaimer                     |
| X5  Claw vacuum                            | Y5  Direction of reclamer                   |
| X6  Manipulator front limit                | Y6  Claw vacuum                             |
| X7  Rear limit of manipulator              | Y7  Claw Blowing                            |
| X10 Lifting the front limit of the slide table | Y10 Loading and unloading cylinder         |
| X11 Limit after lifting slide table        | Y11 Push rod cylinder                       |
| X12 Start                                   | Y12 Red light                              |
| X13 Stop                                    | Y13 Green light                            |
| X14 Manual Automatic                       | Y14 Feeding Complete                       |
| X15 Emergency stop                         |                                             |
| X16 Press Complete                         |                                             |

3.2. PLC program design

PLC program has two parts, one is manual program and the other is automatic program. The program is written by combining ladder diagram with SFC flow chart programming [6]. The manual program is divided into data processing module, alarm module, manipulator control module, pallet silo control module, fetch silo module and reset module. The automatic program is designed according to the overall control flow. As shown in Fig. 4, a ladder diagram of partial data processing is shown.

4. Conclusion

The fetching manipulator uses the method of claw suction, which solves the problem of sharp-angle parts bruising well, and realizes automatic placement of workpiece matrix on the tray, thus reducing manual operation links. The integrated design is adopted. When the product is replaced under pressure, the material taking manipulator does not need to be adjusted greatly, and the material taking work can be carried out after being installed back to the original position. The fetching manipulator solves the actual needs of the enterprise, improves the production efficiency, reduces labor and reduces the cost.
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