

Development of Control System of Three-Servo Pillow Packaging Machine

Zhiyong Gao^{1,a}, Songzhe Pan^{1,b} and Mengying Lin^{1,c}

¹Wenzhou Polytechnic, Wenzhou, 325200, Zhejiang, China.

^agzzy_2003@126.com, ^b928917804@qq.com, ^clinmengying450@163.com

Abstract

To solve the problems of poor versatility and low automation of traditional pillow packaging machines, a three-servo pillow packaging machine control system is proposed. This system is based on the PLC (Programmable Logic controller) core, using the PLC electronic cam control technology and the servo system and photoelectric detection control system, to achieve the three-axis synchronization function of the pillow packaging machine. Tests have proved that the control system has a high degree of automation, convenient operation, simple structure, and smooth running.

Keywords

Pillow Packaging Machine; PLC; Servo; Electronic Cam.

1. Introduction

With the development of the social economy, the packaging industry is developing rapidly as a supporting industry for food, medicine, daily necessities, etc. Pillow-shaped packaging machines are suitable for packing pillow-shaped tables, blocks, and granular products[1]. Automatically accomplish packing, making, filling, cutting, sealing, and counting[2-3]. The pillow-shaped packaging machine occupies an important position in the packaging industry and is one of the important pieces of equipment in the packaging industry[4-5].

This paper proposed a PLC-based three-servo pillow packaging machine control system to solve the problems mentioned above. The system uses PLC as controlling core, MCGS as human-computer interaction, combined with the servo system and photoelectric detection technology to achieve the three-axis synchronization function of the pillow-type packaging machine. The system improves the adaptability, operating accuracy, and speed of the packaging machine while ensuring the high working efficiency of the pillow-shaped packaging machine.

2. The structural design of the pillow packaging machine

The structure of the pillow packaging machine mainly includes a feeding mechanism, a film feeding mechanism, a vertical sealing mechanism, a transverse sealing, and a cutting mechanism. The system structure is shown in Figure 1.

The feeding mechanism includes conveyor belts, conveyor chains, partitions, and feeding shaft servo motors. The partitions are arranged at equal intervals on the conveyor chain along the conveying direction, so the materials can be conveyed at equal intervals.

The Film feeding mechanism mainly consists of a film feeding shaft, unwinding shaft, tension control system, guide roller, and edge correction system. The tension control system includes a magnetic powder brake and a tension controller. The film feed axis servo motor cooperates with the tension control system and other devices in the film feed mechanism to control the conveyance of the packaging film.

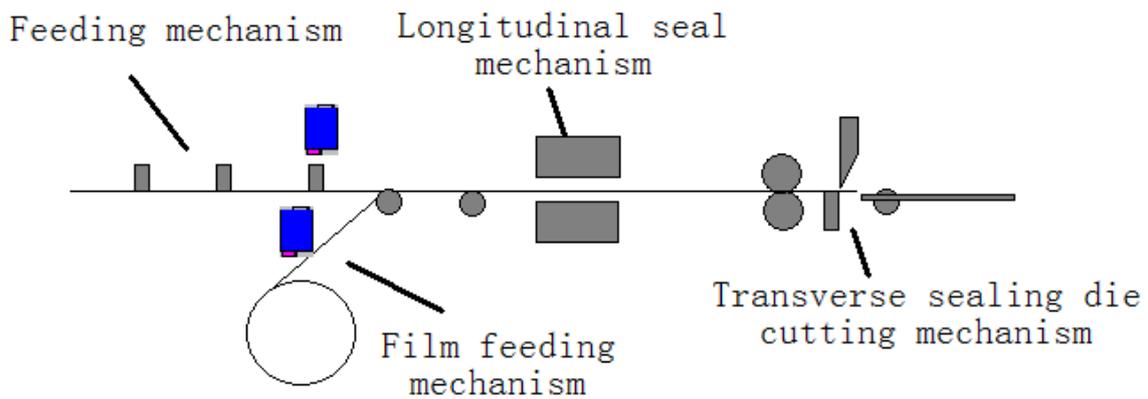


Figure 1. The structure of the pillow packaging machine

The longitudinal sealing mechanism is driven by a servo motor to longitudinally heat seal the formed packaging film. The longitudinal sealing mechanism has a traction function, which can pull the packaging bag to the transverse sealing and cutting mechanism.

The transverse sealing and cutting mechanism is driven by the transverse axis servo motor, and its function is to heat-seal and cut the packaging bag that has been longitudinally heating sealed. As shown in Figure 1, the transverse sealing and cutting mechanism has a single cutting knife, and it will run one circle every time the longitudinal sealing mechanism is executed at a bag length.

3. The electronic control system design of the pillow packaging machine

The electrical control system of the pillow packaging machine includes PLC, MCGS human-computer interaction, servo system, temperature control system, and photoelectric detection system, shown in Figure 2.

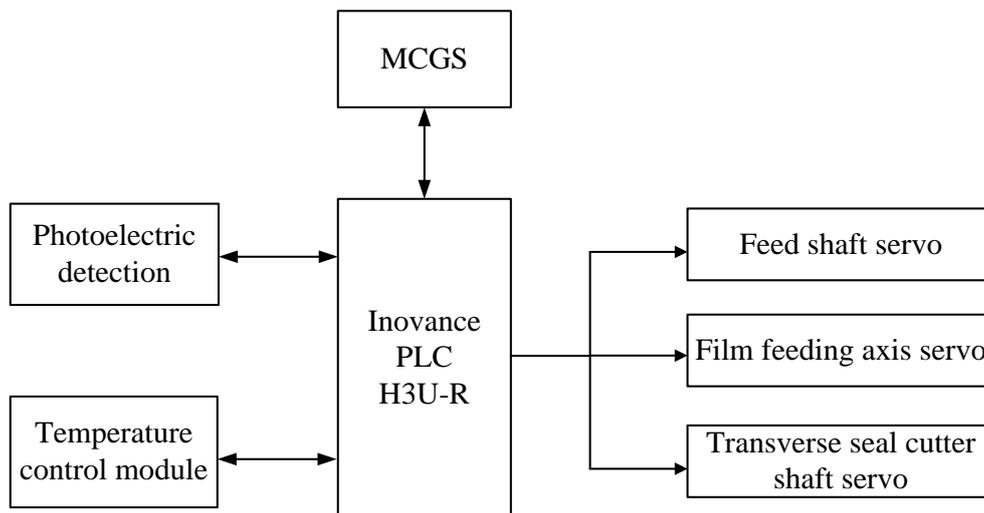


Figure 2. The electronic control system of the pillow packaging machine

The system adopts Inovance H3U-R series PLC as the controlling core. The PLC has a three-axis electronic cam function, which can control the feed axis servo, film feed axis servo, and transverse sealing cutter axis servo respectively according to the cam curve that had been set, and realize the synchronous operation of the three axes. The functions of MCGS human-computer interaction contain the parameter setting, data monitoring, temperature parameter setting, and alarm prompts of the pillow packaging machine system. Furthermore, to facilitate the management, the system has three levels of authority, and different authority corresponds to different operation functions. The

temperature control system consists of two independent temperature controllers, which are used to control the temperature of the transverse seal and the longitudinal seal respectively.

Material position detection and film color mark detection are included in the photoelectric detection. The material position detection ensures the position between the material and the packaging film, and the film color mark detection is used to detect the position of the film color mark point in real-time. Based on the detection information, the position of the transverse sealing cutter shaft can be adjusted to reduce the position deviation of the film caused by stretching and mechanical transmission, hence, ensuring the accuracy of the cutter position.

4. The software design of pillow packaging machine

The software control flow of the three-servo pillow packaging machine is shown in Figure 3. Before running the packaging machine, materials and films need to be placed, and the corresponding parameters, including transverse and longitudinal sealing temperature, packaging bag length, material length, and running speed, need to be set in the MCGS human-machine interface. When the sealing temperature reaches the set value, the packaging machine can be officially started, the material detection and film color mark detection start to work, and the servo motor runs at the same time. Each time the film feeding axis servo runs a bag length, the feeding axis servo runs a material length, and at the same time the transverse sealing cutter axis runs one cycle. The three-servo motors operate according to the set electronic cam curve to ensure the synchronous operation of the three-axis servo.

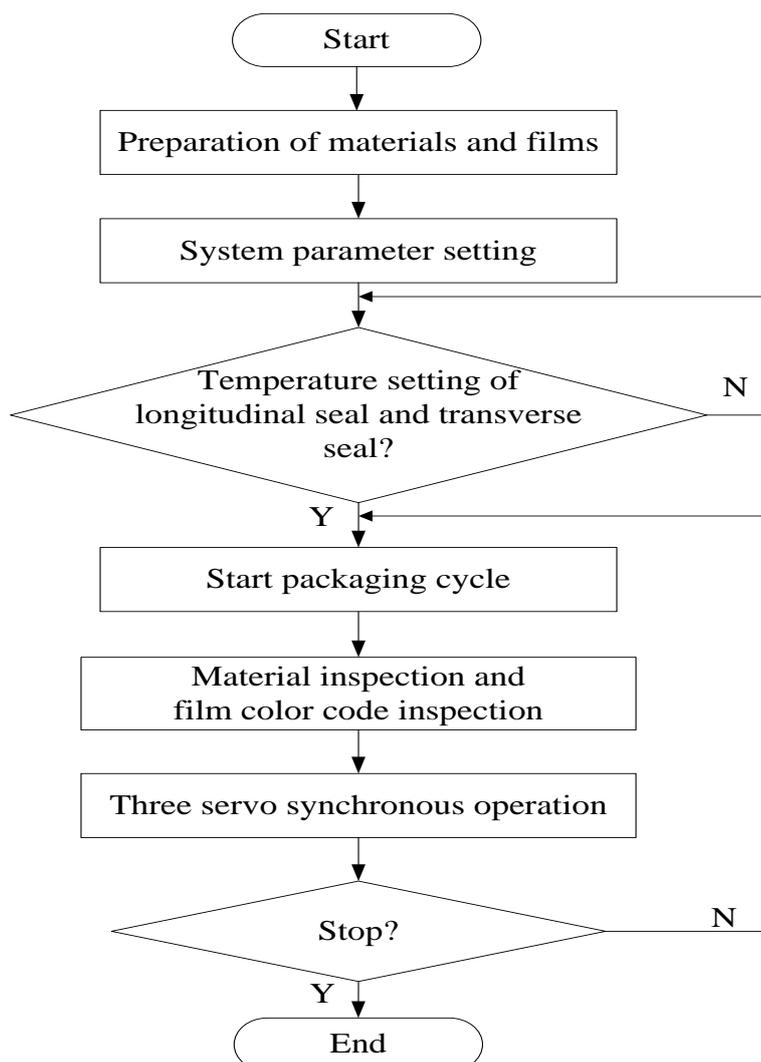


Figure 3. The software control flow of the pillow packaging machine

5. Conclusion

A PLC-based three-servo pillow packaging machine control system was proposed in this paper, aiming to improve the problems of poor versatility and low automation of traditional pillow packaging machines. This paper introduces the overall design schemes of the three-servo pillow packaging machine system, including structural design, electronic control design, and software design. The three-axis synchronization function of the pillow packaging machine is implemented by adopting the PLC controlling core, the MCGS human-computer interaction combined with the servo system, and the photoelectric detection device.

It is proven by the test results, the system is satisfied with the control requirements of the three-servo pillow packaging machine. Furthermore, compared with the traditional pillow packaging machine system, the system is more efficient and operable, which can significantly improve production efficiency and save labor costs.

Acknowledgments

Key project of Wenzhou Polytechnic (No. WZY2020011).

References

- [1] Niu Li & Ding Haibo. (2020). Control system design of pillow type automatic packaging machine based on PLC and motion module. *Industrial control computer* (07), 151-153 doi:
- [2] Chen Yalin. (2020). Control system design of three servo pillow packaging machine. *Packaging and food machinery* (01), 61-63 doi:
- [3] Chen Mingxia & Zheng Yifeng. (2017). Characteristic design of electronic cam of pillow packaging machine based on PLC and servo. *Packaging Engineering* (23), 167-171 doi:10.19554/j.cnki.1001-3563.2017.23.035.
- [4] Gao Xue & Yuan Fei. (2019). Design of pillow packaging machine control system based on STM32 and PLC. *Packaging and food machinery* (03), 19-23 doi:
- [5] Yun Shanqi, Xu Shixu, Wang Wei, Wang Peng & Zhang Jianxin. (2020). Control system of pillow packaging machine based on electronic cam flying shear. *Control Engineering* (10), 1776-1780 doi: 10.14107/j.cnki.kzgc.20190528.