Design and control of condom delivery system

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Abstract. At present, in the domestic condom manufacturing industry, the method of the pinhole detection of the condom is the electric test, and because of the uncertainty of the attitude before the electric test of the condom, the automatic electric test cannot be carried out. In order to solve the attitude and order of the condom, the automatic electric test is realized. In this paper, a transfer system based on the Mitsubishi PLC controller is put forward based on the physical property of the condom, and the mutual action of the various sensors and the air cylinder is used to achieve the aim of the research. The delivery system solves the problem of disorder and overlap of condoms, realizes automatic detection, reduces labor cost, and provides an effective system for the transportation of flexible materials.

1. Introduction

With the development of domestic automation technology, the automation technology of condom manufacturing is gradually mature. In the condom manufacturing industry, safety inspection of condoms is a crucial step. In order to ensure the quality of the products, each condom must be tested for pinholes before the product packaging process, and the packaged condoms should be sampled[1-2]. Pinhole detection includes two methods: water leakage test and electric test[3]. The electric test is divided into wet test and dry test. Pinhole detection includes two methods: water leakage test and electric test. The electric test is divided into wet test and dry test. The main detection method used at home and abroad is the dry test test. The principle is shown in Figure 1. Because the condom has insulating properties, the condom can be placed on the metal mold with self-rotating function to make the condom completely close to the conductive adhesive, so that the condom can be fully tested. Under the action of high pressure, when the condom has a pinhole, the circuit is looped. The signal receiver will display the condom as a defective product[4-5]. The pinhole detection method has simple technology and high detection rate, and is widely used by most domestic enterprises.

In the dry test, the safety jacket needs to be manually put on the metal mold, and after the electrical inspection is completed, the automatic product quality classification and detachment is performed by the detachment device. In the domestic dry detection process, the steps of electrical inspection and detachment are basically automated, but the condoms are disordered, stacked, and have different postures before the test, so that the work of fully automatic detection of condoms cannot be successfully completed. The steps of putting a condom on a metal mold are completely done by hand, and the research on the condom delivery system is minimal.

Aiming at the physical properties of condoms, this paper proposes a transportation system based on Mitsubishi PLC controller. The transportation system consists of three parts: feeding mechanism,
transportation mechanism and material installation mechanism. The system effectively solves the problem of disorder, overlap and the like of the condom, so that the condom maintains the posture consistency and order before the electric inspection, thereby achieving the effect of the automatic electric inspection.

2. Analysis of physical properties of condoms

Today's condoms are usually made of latex or polyurethane, and most condoms are made of latex. The subject of this study was a latex condom with a nominal width of 52 mm (nominal width is the length after constriction at the opening of the condom) and a thickness of 0.04 mm. (As shown in Figure 2) The condom is mainly composed of a rubber band, a body made of latex and a seminal vesicle. The diameter of the seminal vesicle is 10 mm, and the rubber band is large in diameter, thick in thickness and strong in rigidity with respect to other parts.

3. Design of condom delivery system

3.1 Feeding mechanism

Since the condom is a flexible material, the attitude in the loading bin is uncertain, making it impossible to use the robot arm for grasping to transport the material to the transport mechanism. As shown in Figure 3, this study proposes a mechanical mechanism based on pneumatics. The front end of the mechanical mechanism is equipped with two air pipes (with air pressure sensor) with suction and air blowing functions, and a air cylinder with free expansion and contraction in the middle. During the feeding process, the air pipe is in an inhaled state, and the mechanical mechanism moves 120 degrees back under the action of the motor (as shown in Figure 4). When the air pipe sucks the condom in the loading box, the Mitsubishi PLC controller receives the signal from the air pressure sensor, the mechanical mechanism stops moving back and then rotates to the top of the transport mechanism, the air cylinder extends, and the trachea acts as a blowing action to transport the condom to the transport mechanism.
The mechanical mechanism is simple and low in cost, and effectively solves the problem that the condom can not be transported by using the mechanical arm in the charging trough, and the working period can be set to 3 seconds in the conveying process, which can reduce the accumulation of the condom on the transport mechanism.

3.2 Transportation mechanism

According to the physical properties of the condom, this study designed a mechanism with an intermediate gap of 15 mm (as shown in Figure 5). When a single condom is transported to the mechanism through the feeding mechanism, it presents an indeterminate posture such as lying down, folding, and twisting. As shown in Figure 6, When the mechanism makes continuous vibration and reciprocating motion many times (as shown in Figure 7), the seminal vesicle will fall through the gap of the mechanism, so that the rubber band of the condom is stuck at the upper end of the gap of the mechanism, and the sleeve is vertically downward, completely stretched, and can make the condoms consistent.

As shown in Figure 6, in order to solve the order of condom queuing, the shipping mechanism is equipped with a number of laser sensors and air air cylinders. When multiple vertically suspended condoms move to the position of the first three air cylinders, the first three air cylinders will stretch out and block a forward condom alone, while the fourth air cylinder will make an action to block the condom moving forward behind it. After the condoms under the first three air cylinders are grabbed by the material installation mechanism for electrical inspection, the fourth air cylinder will make a contraction action to keep the condom hanging vertically in the back moving forward, and if there is a flat condom moving to the position of the fourth air cylinder, the fourth air cylinder will make a repeated telescopic action to stamp it off.
3.3 Material installation mechanism
As shown in figure 8, when condoms have been lined up in an orderly manner under the action of the carrier, the Mitsubishi PLC controller uses the signal of the laser sensor to control the cylinder at the lower end of the carrier to capture the condom. Since the air cylinder at the lower end of the conveyor is equipped with a pressure sensor, the controller controls the motor to rotate 180 degrees according to the feedback pressure signal, and places the grabbed condom on the No. 1 air cylinder in figure 9.

As shown in figure 9, when there is a condom on the No. 1 air cylinder, the No.1 air cylinder rotates 180 degrees under the action of the motor, and then the No.1 air cylinder extends to place the condom in the middle of the four air claw (the air claw model is shown in figure 10), finally, the four air claw installs the condom in the metal mold for electrical inspection.

4. The conclusion
In view of the disorder, accumulation and posture of condoms, this paper proposes a delivery system according to the physical properties of condoms. The delivery system is controlled by Mitsubishi PLC controller, and combined with the mutual action of various air cylinders and sensors, which effectively solves the problems of automatic installation materials and detection due to the uncertain posture of condoms. The design results meet the requirements of the design task, and also provide a design method for the flexible material delivery system.

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