Design of remote monitoring system for tablet coating equipment

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Abstract. Through the design of single-chip microcomputer control system, this paper makes full use of automatic control technology, computer technology, communication technology, network technology, instrument technology and software technology. Fuzzy control is used to realize production process automation. In the process of drug coating, the particle shape, particle moisture and spray gun mouth condition in the pot of the coating machine were detected on-line, and the control methods of air volume, steam volume and drug liquid volume needed in the production process were studied.

1. Introduction
In recent years, the coating technology has been developed rapidly, and the high-efficiency film coating machine has gradually replaced the traditional sugar coating machine as the mainstream pharmaceutical machinery in the pharmaceutical equipment industry [1-2]. In the 1950s, the first film coating machine in the true sense was developed and put into use in the United States. Under the Internet of things technology, the drug coating equipment will gradually develop towards the trend of intelligent and unmanned [3]. The O’hala technology company of Canada has developed a HVCC-3015 continuous intelligent film coating machine. In China, with the promotion of traditional Chinese medicine to the national development policy by the white paper issued by the State Council, higher requirements have been put forward for the unmanned and intelligent coating equipment of traditional Chinese medicine. However, at this stage, due to the poor data communication quality of the coating equipment, there are many problems in remote monitoring.

In this paper, sensor technology and Internet technology are used to transmit the parameters related to the working process of the coating machine to the equipment manufacturers in a timely, accurate and effective manner [4]. Engineers can monitor the key parameters of the coating machine and the production site in real time, carry out remote diagnosis and early warning of faults, and solve the problems in the bud. It is expected to diagnose and send out an alarm before the equipment may fail. The engineer can receive the corresponding alarm information through the terminal remotely and carry out corresponding operation. For the failure problems that need to be handled by the engineer on site, it will be more targeted, reducing unnecessary human and financial losses.

2. Composition of remote monitoring system for tablet coating equipment
The remote monitoring system of the coating equipment is mainly composed of three parts: monitoring and diagnosis of tablet coating machine, collection of on-line diagnosis information and remote diagnosis center system.

First: The monitoring and diagnosis of tablet coating machine includes sensor system, data acquisition system, industrial PC system, monitoring software system, etc.

Second: On-line diagnosis information collection includes on-line database, knowledge base, remote diagnosis experts, etc. And the database includes: a monitoring database, as the key database for real-time monitoring, is used to store and manage the collected signals; the other is the diagnosis center database, that is, the database for the whole fault diagnosis system, which stores and manages the equipment information and information resources monitored by all equipment.

Last: The remote diagnosis center is a device diagnosis service site set up by the diagnosis service provider on the Internet. It includes web server, database server, remote monitoring center service station, remote diagnosis workstation, image technology workstation, information collection workstation, etc.

3. Design and implementation of remote monitoring system

The system is composed of remote customer data acquisition system, database server, monitoring and diagnosis center server, which can remotely monitor the corresponding working status of the production equipment through the Internet 24 hours a day, by installing sensors at the corresponding key positions of the coating equipment to obtain the real-time running status information (speed, load, power, temperature, pressure, etc.) of the tablet production equipment. The information is input to the on-site monitoring computer through signal preprocessing and A/D conversion to realize continuous computer monitoring and make basic diagnosis [5-6]. The experts of the remote fault diagnosis center system diagnose the production equipment fault according to the information and feed back the diagnosis results to the enterprise in time, so as to help the maintenance personnel to eliminate the fault in a more targeted and timely manner.

The remote monitoring block diagram is designed as follows:

**Figure 1. Remote monitoring system block diagram.**

In the design of the remote monitoring system, it is necessary to study the safety and waste caused by misoperation in the production process, develop the alarm interlock device and alarm the misoperation. Specific contents: 1. Research and design of the arrangement and erection of the relevant sensor devices suitable for the process parameter detection of the coating machine. 2. Research and design of wireless transmission module and automatic control center system based on
MCU. 3. Research and development of remote fault diagnosis center system. 4. The completion of the system related software and data server.

The main problems in the realization of remote monitoring system:

- In the process of coating, display and alarm the blockage of the spray gun mouth, and automatically eliminate the blockage.
- The automatic detection and fuzzy control of temperature, flow and pressure of each parameter in the coating process of coating machine realize the automation of production process.
- Research on wireless sensor transmission module and automatic control center system.

4. Design of temperature control system for tablet coating equipment

The temperature control of the coating equipment "in pot", that is, the temperature control of the tablet during the coating process in the coating equipment. The "heat in pot" is completely determined by the air heat introduced by the air inlet system, so the temperature control is mainly to control the temperature of the air inlet system.

Because the temperature in the pot of the coating machine is a large lag object, the project adopts the control mode of the combination of fuzzy control and PID control to analyze and study the adaptive fuzzy PID control of the temperature in the process of coating tablets.

4.1. Analysis of temperature transfer function of coating equipment "in pot"

The electric power of the heater in the hot air cabinet of the coating machine used in the laboratory is 3KW, and the heating temperature range is from normal temperature to 150 ℃. When the air outlet temperature of the air duct is set to 100 ℃, during the heating process, we conduct sampling statistics for the air outlet temperature. The interval time of each group is 1s, and a total of 80 groups of data are sampled. The dynamic response curve of the air inlet system is obtained.

The dynamic curve is an obvious S-shape, and the temperature model is described as a first-order inertia pure lag response because of the characteristics of large inertia and large lag in the process of temperature change. Describe its transfer function as:

$$H(s) = \frac{k_A}{Ts + 1} e^{-ts}$$

$k_A$ is the system gain coefficient, $t$ is the lag coefficient and $s$ is the time coefficient. Through the method of determining the closed-loop response transfer function, the correlation coefficient of the transfer function is determined from the response curve through the mapping method, and the lag coefficient $t \approx 5$ is determined. In addition, in the step response curve, the slope obtained from 0.632 points of the curve is $1/T$, and $T \approx 7.3$. Get the transfer function:

$$H(s) = \frac{k_A}{7.3s + 1} e^{-5s}$$

4.2. Design of fuzzy PID control method

The input signal of fuzzy PID control is $x(t)$. After comparing with the set value, the control deviation $e$ and the deviation change rate $ec$ are calculated. These two parameters are used as the input parameters of the controller, and then the most appropriate parameters are output by the fuzzy controller and applied in the PID control. Then the feedback is carried out by the temperature detection device, and the final output is $y(t)$. Schematic diagram is shown in Figure 2:
Figure 2. Principle diagram of fuzzy PID control.

The temperature detection link is the coating equipment "in pot" temperature sensor DS18B20. DS18B20 continuously detects the real-time temperature in the coating process, and then compares with the set temperature to obtain the deviation $e$ and simultaneously calculates the deviation rate $e c$, which is applied to the PID controller. $\Delta k_p, \Delta k_l, \Delta k_d$ is the change after fuzzy reasoning and $k_p, k_l, k_d$ is the final parameter applied to PID control.

Figure 3. Work flow chart of fuzzy PID control.

The above process is carried out continuously in the coating process, and the relevant parameters can be modified online according to the influence of relevant external factors, so as to achieve the best control effect.
5. Conclusions
This system uses sensor technology, image technology and Internet technology to transmit the key parameters of the working process of the coating machine to the equipment manufacturer timely, accurately and effectively. Therefore, the equipment manufacturer can carry out real-time monitoring of the key parameters of the coating machine and the production site, carry out remote diagnosis and early warning of the fault, and solve the problem in the bud, which can provide reference for the equipment professional Guide or participate in solving problems in time.

This paper also analyzes the temperature control system of the coating machine and puts forward an improved fuzzy PID control method. Of course, with the development of 5G communication technology, more profound research is needed in remote data communication. The temperature control method of coating equipment should be more advanced with the development of intelligent control technology, making the control more simple and accurate. The remote monitoring software code needs to be further simplified and sorted out to make the monitoring software interface more concise and humanized.

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