Mechanical Design and Improvement of Computer Automatic Production Line

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Abstract. The mechanical design amelioration of automatic production line can intelligently adjust the production rhythm of the production line on demand, control the rhythm of production scheduling according to the production process requirements, and establish a modular design mode, so it has important research value. Based on this, this paper first analyses the mechanical design principle of the automatic production line, then studies the computer control system of the automatic production line, and finally gives the amelioration measures of the mechanical design of the automatic production line.

Keywords: Mechanical Design, Automatic Production Line, Computer

1. Introduction

With the continuous development of social mass production, all walks of life, especially the manufacturing industry, rely more and more on the automatic production line. The automatic production line not only depends on a higher level of mechanical design, but also has higher requirements for the intelligent degree of the production line. The rapid progress of info tech, represented by computer, has also brought better assistance and support to the popularization and development of automatic production line [1]. On the one hand, the utilization of computer tech in automatic production line can significantly ameliorate the control accuracy and production efficiency of automatic production line; On the other hand, the utilization of computer tech can greatly reduce the dependence of automatic production line on mechanical design. Therefore, computer tech is more and more widely used in automatic production line.

With the integration of mechanical design amelioration and computer tech, the automation production line can further release its advantages and benefits of intelligent and automation, and reduce the shortcomings and problems existing in the mechanical design structure and matching level of traditional production lines. The use of intelligent and info tech in the automation production line also releases the dependence of production line on operators, reduces the labor intensity of workers, and saves the cost of labor. The use of computer tech in the automation production line has significantly released the vitality and calculation of the production line, while improving the high-efficiency transportation capacity of raw materials, but also strengthening the process control ability of the production process of components.
In addition, with the continuous expansion of social mass production demand and scale, as well as the continuous rise of labor costs, intelligent automatic production line has become an important part of the relevant industries. The mechanical design amelioration of automatic production line can adjust the production rhythm intelligently and on demand, control the rhythm of production scheduling according to the requirements of production process, and establish a modular design mode. Computer automatic production line is especially suitable for flexible production. According to the market demand, it could adjust the production sequence and beat of different products independently, reduce the idle rate of production equipment, and ameliorate the modular processing level of automatic production line.

In a word, with the help of computer tech and mechanical design amelioration, it could realize multi variety and small batch customized production, especially with the help of computer intelligent algorithm; it could schedule the production of automatic production line and ameliorate the flexibility of automatic production [2]. It can be seen that the integration of computer tech and mechanical design amelioration can ensure the efficient cooperation between various mechanical structures and subsystems in the aspects of production scheduling, production process and modular design of automatic production line, and accelerate the efficient cooperation of production units to complete production tasks. Therefore, it is of great practical value to study the mechanical design amelioration of automatic production line.

2. Mechanical design principle of automatic production line

2.1. Definition and composition of automatic production line
As a production system with independent control device, automatic production line is mainly use the workpiece storage and transmission device to connect the special automata and auxiliary mechanical equipment. The automatic production line consists of drive system, transmission system, actuator and control system. Among them, the drive system, as the power source of automatic production line, has a variety of drive forms. The transmission system can transfer the power and motion to the relevant actuator or auxiliary mechanism to complete the specified process action [3]. Secondly, as a system to realize automatic operation and auxiliary operation, the execution structure of automatic production line is closely related to the control system. Control the drive system, transmission system, actuator, etc. of the automaton, distribute the motion to each actuator, make them coordinate action according to time and sequence, so as to realize the process function of the automaton and complete the automatic production.

2.2. Characteristics and utilization of automatic production line
In the whole production process of automatic production line, the automatic production line does not participate in direct process operation, but only comprehensively observes and analyzes the operation of production system, and its automation degree depends on the degree of manual participation in production. Automatic production line is usually used for products with certain production cycle, large batch, and workpiece structure which is convenient for transmission, automatic feeding and unloading, positioning and clamping, automatic processing, assembly and inspection [4]. In addition, automatic production line is often used in the production scenarios where the product structure is complex, the processing process is too many, it is difficult to operate or even cannot guarantee the quantity and quality of the products, as well as the processing methods, means, environment and other factors, which are not suitable for the production with automata.

2.3. Typical types of automatic production line
The typical types of automatic production line include straight line type, curve type, closed ring type and branch type. Among them, the linear type connects all kinds of automatic machine processing equipment and devices into an automatic line arranged in a straight line by the transmission device according to the requirements of the product processing tech [5]. The workpiece goes online from one
end of the automatic line and goes offline from the other end. The typical structure of the sequential parallel combination automatic line is shown in Figure 1. Secondly, the workpiece of curve type automatic production line is transmitted along the zigzag line, and the others are the same as the linear type. The workpiece of closed loop automatic production line is transported along the ring or rectangular line.

![Diagram](image)

**Figure 1.** The structure of sequential parallel combination automatic lines

3. **Computer control system of automatic production line**

3.1. **Composition of computer control system for automatic production line**

The computer control system of automatic production line usually includes unit control level, workstation control level and equipment control level. Its basic control functions include task management and scheduling of each processing equipment in the unit, management and scheduling of logistics equipment in the unit and management of production line tool system [6]. The computer control system of automatic production line usually controls multiple machining centers or CNC machines, and realizes the automation of material flow and info flow on the basis of machining automation. The computer control system of automatic production line can also realize multi-layer computer control of automatic processing equipment, workpiece storage and transportation system and tool storage and transportation system.

3.2. **Functions of computer control system in automatic production line**

The computer control system of automatic production line has high flexibility, and can adapt to multi variety, medium and small batch production. The system can process different parts in mixed mode, and the operation of the whole system cannot be interrupted by partial adjustment or maintenance of the system. Secondly, the computer control system of automatic production line is controlled by multi-layer computer, which can be connected with the upper computer [7]. The computer control system of automatic production line has the main characteristics of flexible manufacturing and can adapt to multi variety production. In addition, the technological capabilities of the machine tools in the system are complementary and alternative to each other. Different parts can be processed in a mixed mode. Local adjustment or maintenance of the system does not interrupt the operation of the whole system.

4. **Mechanical design amelioration of automatic production line**

4.1. **Mechanical design of automatic production line**

The mechanical manufacturing system of the automatic production line uses the handling robot to carry materials, workpieces and tools, the assembly robot to complete the parts assembly of the equipment, and the measuring robot to carry out on-line or off-line measurement [8]. In the process of automatic manufacturing system of production line, in order to ensure the processing quality and normal operation of the system, it is necessary to detect and monitor the system operation status and processing process. In the automatic manufacturing system, the operation status that needs to be detected and monitored usually includes the tool info, equipment status info, operation status info, on-line dimension measurement info, unified safety info of the automatic production line, as well as the
simulation info including the numerical control program of the parts, the collision interference situation and the comprehensive simulation results.

4.2. Mechanical production efficiency of automatic production line

The automatic mechanical production process of automatic production line includes intermittent action type and continuous action type [9]. Among them, the characteristic of intermittent action type automatic machine is that the products are processed, transported and processed on the automatic machine intermittently and periodically, and its theoretical productivity is shown in Formula 1 below. Among them, \( t_p \) is the cycle time of the automata; \( t_k \) is the process operation time in the working cycle; \( t_r \) is the auxiliary operation time in the working cycle. In fact, the theoretical productivity of automata is the design productivity of automata, while the actual productivity of automata is the productivity shown in the process of using automata, and its actual productivity is shown in equation 2 below.

\[
Q_i = \frac{1}{t_p} = \frac{1}{t_k + t_r}
\]  

\[
Q_p = \frac{1}{t_k + t_r + t_a}
\]  

In addition, for the continuous action automatic production line, the work of product processing, transmission and processing on the automata is continuous, and the auxiliary operation time coincides with the process time, that is, it is contained by the process time [10]. The theoretical productivity is shown in equation 3 below. Among them, \( n_p \) is the rotation speed of the automatic mechanical turntable, and \( N \) is the number of product stations on the turntable.

\[
Q_c = \frac{1}{t_p} = \frac{1}{n_p \cdot N}
\]  

4.3. Amelioration of mechanical production design of computer automatic production line

The amelioration of mechanical production design of computer automatic production line can first reduce the idle and auxiliary operation time in the cycle, the basic process time and the time loss outside the cycle. Secondly, the productivity of the automatic production line can be ameliorated by improving the dimensional durability of the cutting tool or mold and reducing the adjustment time of the mechanical equipment.

![Figure 2. Synchronous motion cycle diagram of motion lag of automatic production line](image-url)
In view of the existence of various actual error factors, the synchronization design and space synchronization optimization of the motion lag of mechanical components are carried out to determine the motion offset of each actuator. The synchronous motion cycle diagram of motion lag of automatic production line is shown in Figure 2 above.

In addition, the automatic production line can also be optimized by adopting the electrical equipment control system that can meet the requirements of automatic operation and interlock protection, adopting the hydraulic and pneumatic systems that are convenient for maintenance, and strengthening the planned overhaul and maintenance of different equipment in the automatic machine or automatic line types.

5. Conclusion
In summary, the use of intelligence and info tech in the automatic production line, as well as the mechanical design amelioration of the computer production line, can significantly release the dependence of the production line on operators; reduce the labor intensity of workers, and save the labor cost of the production line. Through the analysis of the mechanical design principle of the automatic production line, this paper studies the characteristics and utilization of the automatic production line. Through the research on the computer control system of the automatic production line, this paper analyzes the amelioration measures of the mechanical production efficiency of the automatic production line and the amelioration measures of the mechanical production design of the computer automatic production line.

Acknowledgments
This research is funded by the Jingmen Science and Technology Plan Project. The name of the project is: Research and Development of Waste Gas Treatment Equipment for Coating Production Lines, and the project number is 2020YFYB051.

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