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Research on the application of intelligent production line process control system based on the Internet of Things

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Abstract. In the construction and development of modern society, the traditional artificial production line operation mode, has been unable to meet the needs of enterprise development, research scholars in the study of the Internet of things as the core of the intelligent production line process control system. The whole system design not only references a lot of advanced technology theory, but also has remote control and automatic assembly and other unique functions. On the basis of understanding the theory of Internet of Things technology, this paper mainly discusses the components of intelligent production line process control system, combined with practical cases to study the system application effect. The final results show that the internal functions of the system are in line with the current production and transportation needs of enterprises, and can solve the problems existing in the traditional production line process control.

Keywords: Internet of Things; Intelligent production line; Process control; Artificial intelligence; Intelligent manufacturing.

1. Introduction

The Internet of Things is regarded as the third information technology revolution after computers and the Internet. At present, the industrial concept centering on the Internet of Things and artificial intelligence has gradually formed in the world of science and technology. [1-3]Enterprises in various fields have proposed automated production solutions according to their own needs. It is proposed to use digital factory for whole-cycle production control, which can not only improve practical work efficiency, control the probability of failure, but also obtain more significant economic benefits. In essence, intelligent manufacturing uses the unique advantages of computer modeling simulation and information communication technology to comprehensively improve the design and production process of products.

From the perspective of overall development, intelligent production line process control system has the following advantages: First, technological innovation. In the processing of parts, the traditional production process control, the use of bar codes and other labels with line-of-sight constraints for identification, the overall design should choose intelligent radio frequency identification technology and electronic labels to store information, with the characteristics of automatic update of identification information and identification information, to ensure the dynamic interaction between the staff, machinery and items, and finally achieve accurate control. Second, automatic production line. Under the guidance of intelligent algorithms, robots at different stations can work cooperatively. In the Internet of Things system, only one management device needs to be set to control all the operating systems, truly realizing the intellectualization and full automation of the manufacturing process. Third, function modularization. The overall system design will realize functional modularization, which contains the content of identification code and processing module, can quickly replace the failure module in the overall operation process, to ensure that the practice of production activities can be orderly; Fourth, science uses "machine for man". In the intelligent production line process control system, Baxter robot belongs to the processing center, which can simulate the grasping action of the robot through modeling and simulation, so as to improve the work efficiency and work quality.[4]

Understanding the current intelligent production line model, it can be known that it is mainly divided into three modules, the specific process is shown in Figure 1 below:

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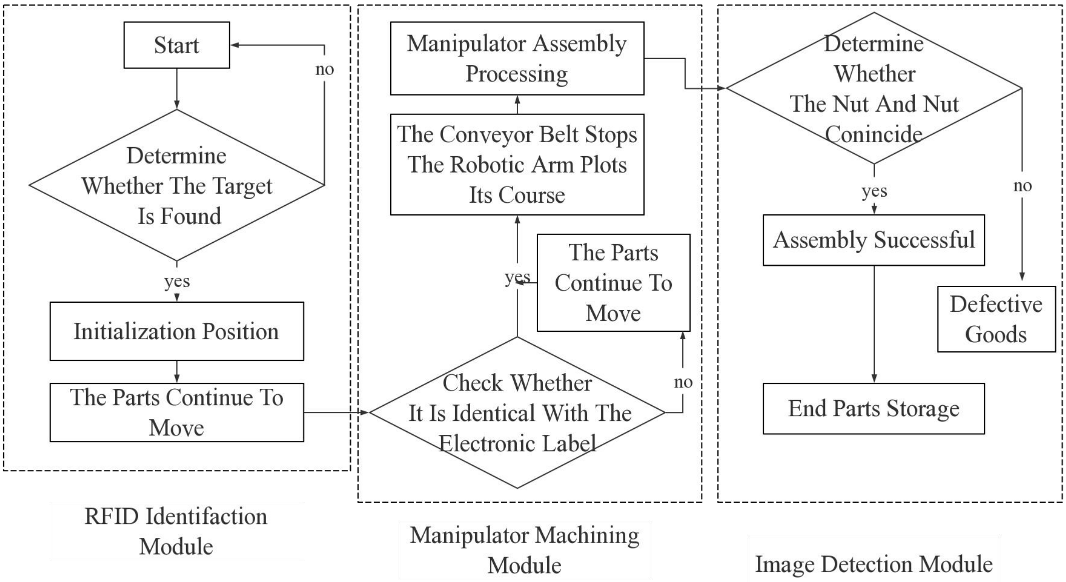

Figure 1 Model structure diagram of intelligent production line

First of all, RFID identification module. This module is an electronic tag for reading and writing parts. It is mainly used to obtain the basic information and geographical location of parts, which will be directly fed back to the robot arm for subsequent processing operations. At the same time, various information of parts will be updated to accurately record the processing of parts. Secondly, the processing module. This module is the core content of intelligent production line process control, which is mainly used to assemble and process the basic parts on the conveyor belt. In the assembly and production, various technology should be fully considered. Finally, the image detection module. This module is mainly used to test whether each process is completed normally, which is an important link to ensure the production efficiency and quality of parts. According to the analysis of widely used machine learning and visual detection technologies, this project mainly uses deep learning convolutional neural network coding for detection and analysis.[5-7]

On the basis of understanding the application advantages of the Internet of Things technology and according to the application research status of the intelligent production line process control system in recent years, this paper mainly discusses the functions and main components of the intelligent production line process control system with the Internet of Things as the core, and finally analyzes the feasibility and effectiveness of the system combined with experimental cases.

2. Method

2.1 System Structure

The intelligent production line process control system with the Internet of Things as the core is mainly divided into five parts. The specific design is shown in Figure 2 below:[8-10]

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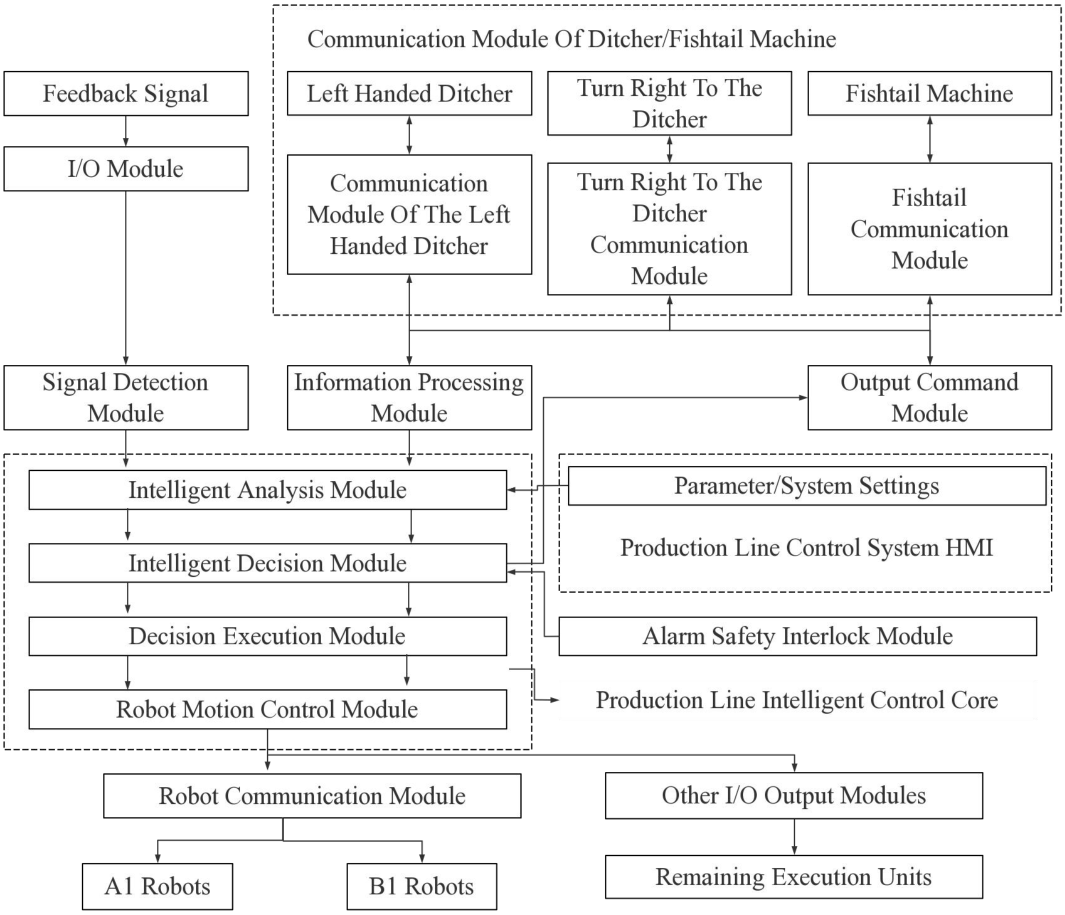

Figure 2 System structure diagram

Based on the above analysis, it is found that the overall module includes automation, CNC production equipment, communication development, design and implementation, intelligent control core of production line, human-computer interaction, robot control and communication, auxiliary control and execution unit. The communication module of the system design can ensure the orderly communication of the equipment inside the production line, and all the production information and machine state will be collected by the information processing module; The intelligent core analysis module and decision management module can optimize the automatic production process according to the machine information and system setting information obtained. Communication module interface will issue control instructions to the robot, and finally complete the production control work of the entire production line. If the system is faulty or abnormal during operation, then the control center will directly issue instructions to the eight production equipment, alarm after stopping operation, or give other instructions to the management staff.

2.2 Monitoring System

All machine equipment product processing, production, maintenance, fault information collected feedback to the central control system, directly input into the database, can facilitate the department staff on the basis of comprehensive analysis and comparison calculation, truly realize the monitoring and management of intelligent production line process control. By downloading the machining parameters, production indicators and optimization programs of the machinery from the central control system to the CNC machinery, the development goals of optimal scheduling and coordinated management and control can be truly achieved. Normally, the functions of the monitoring system mainly involve the following points: first, all newly developed CNC systems are connected together for comprehensive control; Secondly, establish the quality monitoring database in line with the intelligent production line; Thirdly, collect production data, monitoring data and

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maintenance data of all mechanical equipment; Fourth, study the data information of different stages, pay attention to combine different situations, evaluate and grade the safety and quality situation; Fifth, the classification of intelligent production line safety failures, including mechanical failures, electrical failures, software failures, normal, maintenance and other types, through careful division and effective processing, can further improve the efficiency of intelligent production line, reduce the probability of safety failures; Sixth, unified management of internal staff, pay attention to optimize their mechanical operation ability and fault analysis ability; Seventh, planned and controlled the production process of mechanical equipment, dynamically adjusted the working details of the entire production line, and comprehensively optimized the functions of process control; Eighth, build a network control system, requiring managers to check the working process of the intelligent production line anytime and anywhere, understand the production needs of various customers, and put forward production opinions and control commands through online remote control.[11-15]

3. Result analysis

In order to scientifically verify the control effect of my research system on the production process, on the basis of clarifying the overall system composition and application module, the system is applied to a food production activity, the production process of the enterprise is controlled together, and the control effect is finally discussed and analyzed. In the production of food, the temperature should be controlled at about 35 degrees Celsius. Prepare eight production equipment, install two temperature sensors for each production equipment, and ensure that the sensors are located in different areas of the equipment. At the same time, the collection performance of the research system in this paper is tested, and the initial operating temperature of the equipment machinery is collected. Finally, the perceived results of 16 acquisition nodes are obtained and compared with the actual temperature. The specific results are shown in Table 1 below:

Table 1 Comparative analysis of perceived results and measured temperature

Node number	Measured temperature	Acquisition temperature	Temperature difference	Node number	Measured temperature	Acquisition temperature	Temperature difference
1	20.0	20.2	0.2	9	21.4	21.6	0.2
2	20.2	20.2	0.0	10	21.5	21.5	0.0
3	20.5	20.4	0.1	11	20.5	20.3	0.2
4	20.4	20.3	0.1	12	20.6	20.5	0.1
5	20.8	20.6	0.2	13	20.2	20.4	0.2
6	20.6	20.6	0.0	14	20.0	20.0	0.0
7	21.0	21.0	0.0	15	21.5	21.4	0.1
8	21.0	21.0	0.0	16	21.6	21.5	0.1

Combined with the above table, it is found that there is a small gap between the perceived temperature and the measured temperature obtained by the research system, which proves that the information obtained by the research system is highly accurate and can be used as an important basis for subsequent research. In the process of system control and control, the collected information is regarded as the basis and can be effectively transmitted to the specified location through the transport layer.

In addition, in order to verify the control effect of the system, to adjust the temperature on the basis of the existing temperature, the main statistical analysis of the heating effect of eight equipment, the actual temperature to reach 45℃, every rise of 5℃ is a stage, a total of five stages. During the statistical analysis of the heating process, steady-state error results in different temperature stages are shown in the figure below:

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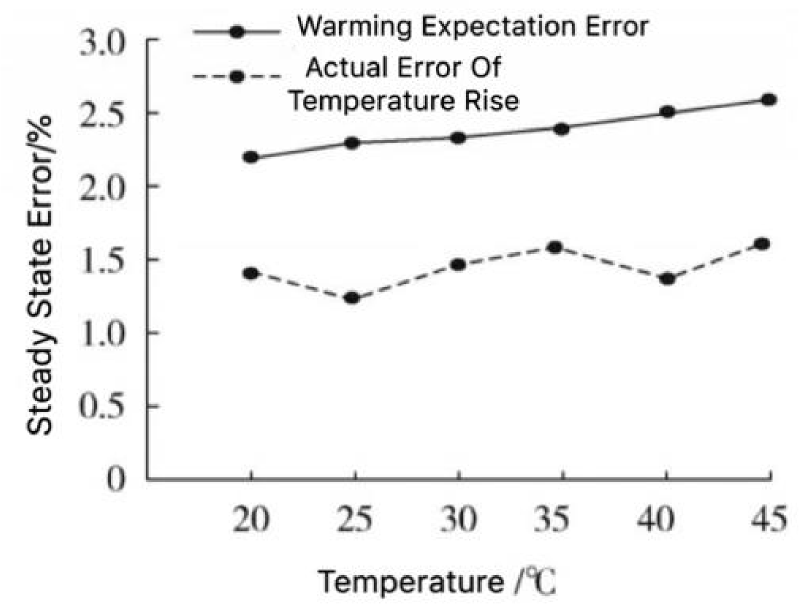

FIG. 3 Control results of system temperature rise

After the temperature reaches 45℃, the temperature should be cooled. The specific results are shown in Figure 4 below:

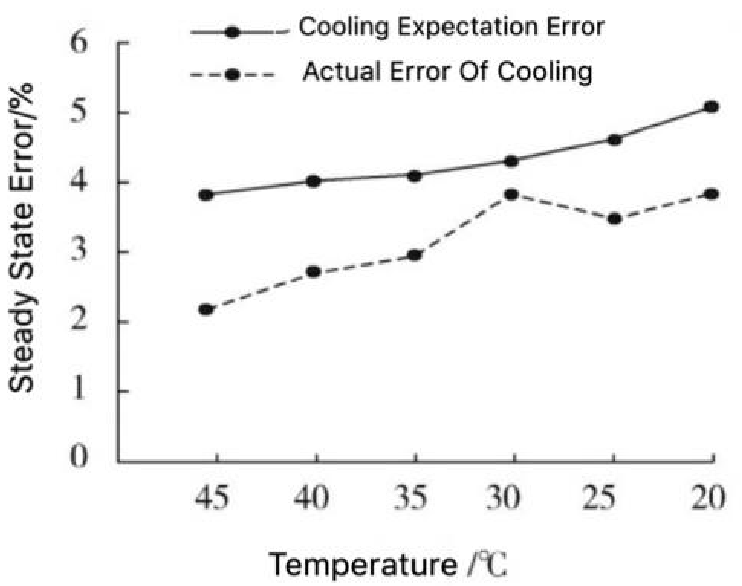

FIG. 4 Control results of system cooling

Based on the analysis of the figure above, it is found that in the five identity stages, the steady-state error is much lower than the expected error value, with the minimum error value of 1.25% and the maximum error value of 1.6%. As the error fluctuation range is relatively large, the temperature rise control performance is better, so the application effect of the research system in this paper is proved to be excellent. When the system is cooling down, the steady-state error changes obviously and presents a gradual upward trend on the whole. The minimum error value is 2.2% and the maximum error value is 3.9%, and the overall fluctuation is controlled within the prescribed range. From the overall research and test results, the application performance of the research system in this paper is strong, and can meet the requirements of temperature control during production within the specified range.

In order to further study the control effect of this system, assuming that the step signal is in a static state, the control effect of parameters KP, KI and KD before and after adjustment is compared

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and analyzed, and the control output results of the two are analyzed statistically, so as to measure the control level before and after the adjustment of various parameters, as shown in Figure 5 below:

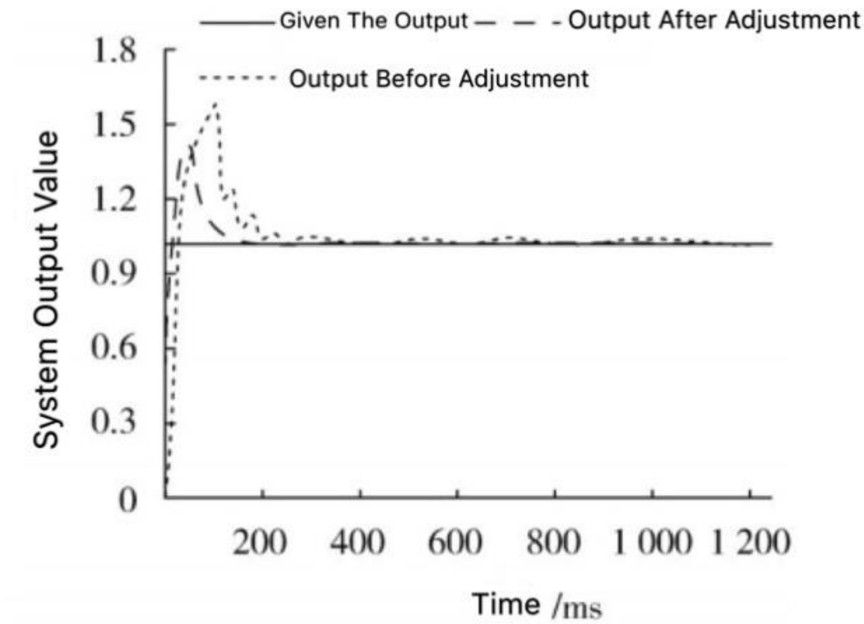

Figure 5 Output results in static state

The output before and after parameter adjustment under dynamic state is shown as the figure below:

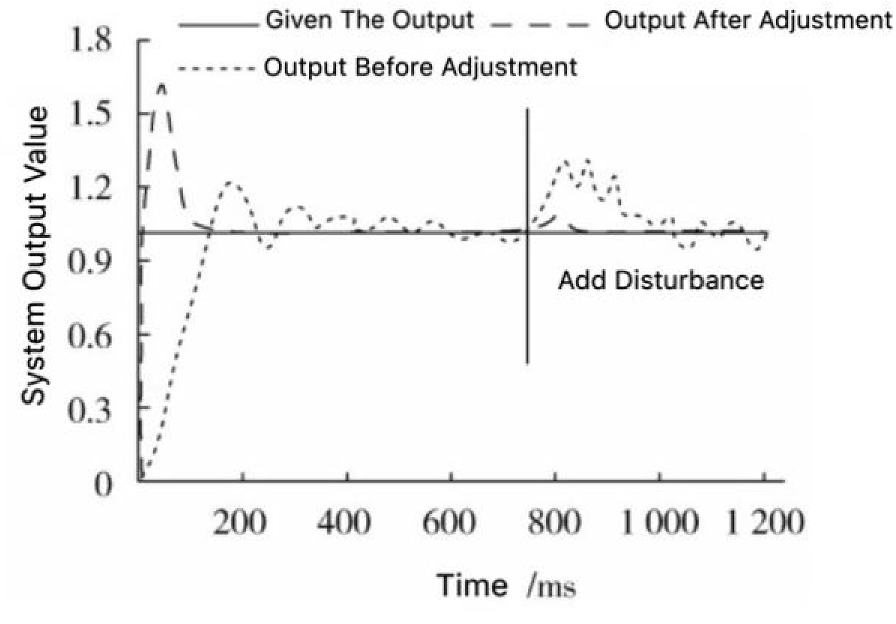

Figure 6 Output results in dynamic state

By comparing the output results under different states, it can be found that the output value of the system control results can quickly match the given output value. The temperature control level before adjustment is low, and the output result is unstable. In the dynamic state, the output value before parameter control fluctuates obviously, and the final output result obtained will be greatly interfered after step interference is added. After the parameters are effectively controlled, the system is in the process of dynamic operation, and the given output can be quickly matched by adaptive adjustment. In other words, after accepting step interference, the system studied in this paper can quickly realize self-adaptive adjustment and stabilize the given output value. This research result proves that the research system in this paper has a strong control level and can show

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its own adaptive performance and interference actions on the basis of adaptive adjustment of control parameters. Therefore, in the future research and development of science and technology, scholars in various fields should strengthen the application research of intelligent production line process control system with the Internet of Things as the core.

4. Conclusion

To sum up, in the era of big data, comprehensive control of the production process is a key link to ensure the manufacturing efficiency and application quality of products. Therefore, researchers have proposed a new application system based on the whole process and safety quality of the product production process, fully demonstrating the application value of the Internet of Things technology theory. Based on the analysis of the intelligent production line process control system with the Internet of Things technology as the core proposed in this paper, it can be seen that the overall system design can better meet the production and manufacturing requirements of various products. All modules can realize effective transmission between long distance and short distance on the basis of accurate identification and perception of information data collection, and finally accurately control the equipment temperature in the production process within the error range. Create a quality environment for the overall production activities.

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