ISSN 2616-5767 Vol.5, Issue 1: 16-21, DOI: 10.25236/AJETS.2022.050104

Application of Numerical Control Technology in Intelligent Robot Machinery Manufacturing

Caijun Liu

Zaozhuang University, Zaozhuang, Shandong, 266700, China

Abstract: *The advent of the "intelligence" era is driving the modernization and informatization development of the manufacturing industry. In particular, the development and application of intelligent robot numerical control technology provides information technology support for the development of the machinery manufacturing industry, and is an important focus for the future development of the machinery manufacturing industry in the new era. Guided by the development of information technology, the development and application of intelligent robot numerical control technology creates good technical conditions for the development of the machinery manufacturing industry and realizes efficient and high-quality manufacturing. Based on the background of intelligent manufacturing, this paper designs a robot group control intelligent manufacturing system, and studies the application of numerical control technology in intelligent robot machinery manufacturing.*

Keywords: *Numerical control technology, Intelligent robot, Manufacturing*

1. Introduction

Intelligent robot numerical control technology is a kind of numerical control technology with a relatively high degree of intelligence and automation formed by applying intelligent robot technology on the basis of the original numerical control technology,which not only makes up for the shortcomings of the original numerical control technology, but also improves the intelligent characteristics of the numerical control technology[1]. The application of intelligent robot numerical control technology can realize the construction under harsh working conditions and complex working conditions, which plays an important role in improving manufacturing quality and manufacturing accuracy.

At present, the intelligent robot numerical control technology has been widely used in the machinery manufacturing industry and has achieved positive results. However, to realize the functional design and application design of the robot group control intelligent manufacturing system involves a lot of knowledge, it is difficult to realize, there are problems such as long development cycle, the degree of knowledge integration is relatively complicated[2].

Therefore, this article takes the intelligent manufacturing as the background, and designs the robot group control intelligent manufacturing system with the machining of mechanical workpieces as the entry point. This article studies the application of numerical control technology in the field of intelligent manufacturing, solves the communication problems, management problems and control problems of each unit, and explores the application of intelligent robot numerical control technology in the field of mechanical manufacturing.

2. Research on overall design and structure of intelligent manufacturing system

2.1 System overall design scheme and function

This system takes the machining of mechanical workpieces in the factory or school workshop as the entry point, and designs the master station unit, machine tool loading and unloading unit, numerical control processing unit, slave station unit, information management unit, etc.Each unit has a corresponding function. Relying on the cooperation of each unit in the system, the automatic transportation, automatic processing, automatic detection, automatic compensation and final automatic storage of mechanical workpieces are completed to realize intelligent manufacturing.

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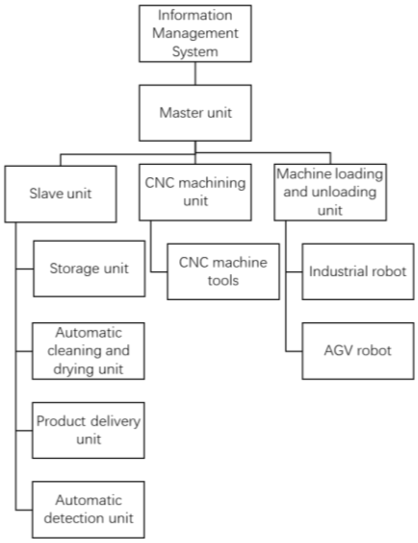

Figure 1: Diagram of the system strcutre

2.2 System master station and slave station communication design

The normal operation of the system needs to solve the communication mode and signal transmission between the master station and the slave station based on various communication, data acquisition technologies, and the use of logic programming technology. The system adopts the PROFIBUS communication method between the master station and the slave station[3].

The master station is the core controller of the system, which exchanges information cyclically with the slave stations, and controls and manages each unit. The system uses S7-300 PLC as the master station for control. The S7-300 PLC is equipped with a Profibus-DP interface with integrated functions. The Profibus-DP bus passes through the RS-485 communication protocol (called H2 bus). Twisted wire is used as the transmission medium to connect other equipment, and the longest achievable communication distance is 9.6KM when using shielded twisted pair cable, and the longest communication distance when using optical cable is 90KM. The transmission rate is 9.6K~12Mbps, and multi-site connection is supported at the same time. A bus segment can connect up to 32 sites or active network components. The S7-300 PLC can also be connected to the DP bus through the communication processor CP. Moreover, the master station can be expanded to control the whole process of the system, thereby completing PROFIBUS fieldbus control and real-time monitoring of the entire robot group control intelligent manufacturing system.

The slave station collects the input information of the instructions issued by the master station, and at the same time feeds back the output information to the master station, that is, exchanges all data with the master station that configures it. The slave station can be used as an independent unit to execute the program. At the same time, in order to exchange data with the master station in real time, a specific area is separately delineated in the slave station memory as a shared data area for communication with the master station. When setting the slave station, it is necessary to make the settings in the hardware configuration in advance, that is, define the addresses of the data input area and output area in the master station and the slave station respectively. The input and output area provided by the slave station to the master station is not the actual I/O module address, but the shared data area (I/O image area) specially designated by the slave station for communication[4]. In this system, S7-200 PLC is used as a slave station for control. The slave stations in this system mainly include storage units and conveying units. Each slave unit completes specific work tasks, and completes various operations and processing sequentially in the manner of feeding and warehousing.

In this system, the master station (S7-300 PLC) and the Kawasaki industrial robot in the loading and unloading unit of the machine adopt I/O communication. Kawasaki industrial robot general I/O (input/output) signals can be distributed through AS language programming[5]. Then in the reproduction mode to run the program, these signals are output to the port, or input from the port. They are all connected to the dedicated I/O board of the Kawasaki robot controller. There are different pins on the terminals of this dedicated I/O circuit board as the input/output signal ports of the robot, and the ports correspond to the robot programming language one by one. Kawasaki industrial robots use AS

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robot language to program and edit programs for general I/O signals, and use AS robot language to process general I/O signals. The data exchange process between the master station and the slave station communication area is shown in Figure 2.

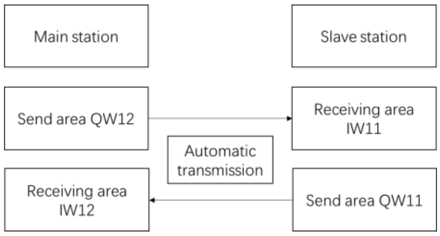

Figure 2: Data exchange process between the master station and the slave station

2.3 The logical action design of the CNC machining unit of the system

In the CNC machining unit, the communication between the CNC machine tool and other equipment and the processing of logic signals are mainly completed by the PMC of the CNC system, and the processing of the workpiece is completed by the CNC program of the CNC machine tool. The process design of the CNC machining unit is shown in Figure3.

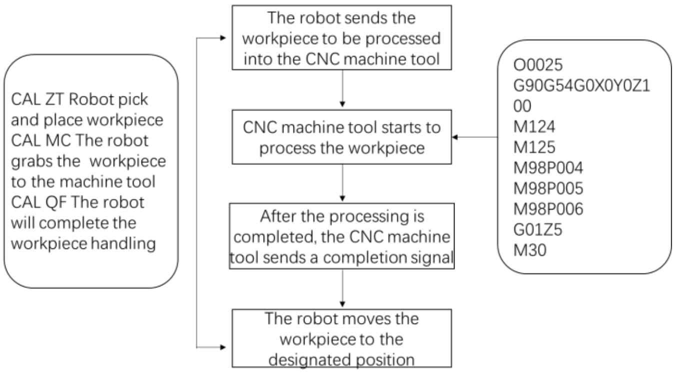

Figure 3: Flow chart of CNC machining unit

After the CNC machine tool processing, it needs to send a completion signal, and the processing of this signal is completed by the PMC inside the CNC machine tool. PMC is used as the sequence controller of numerical control machine tool to control the logic signal of numerical control machine tool. PMC is embedded in CNC. PMC numerical control machine tool peripheral signals such as relays, machine tool travel switches, sensors, machine tool operation panel buttons and other switching signal states as conditions, control according to the logic language that realizes editing, and finally output signals to control the actuator. In the numerical control processing unit PMC not only needs to process the processing completion signal of the numerical control machine tool, but also needs to receive the command signal from the robot or other units. The logic flow of the CNC machining unit is shown in Figure 4.

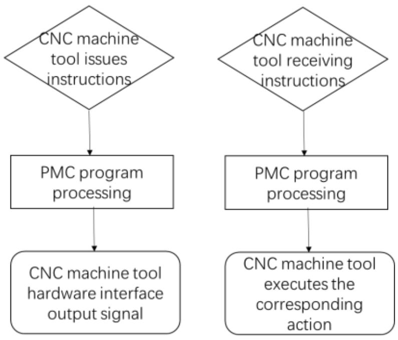

Figure 4: Logic flow chart of CNC unit processing unit

The PMC program adopts the ladder diagram language program, which converts the symbolized ladder diagram program into a certain format (machine language). The CPU decodes and calculates it, and stores the result in RAM and ROM. The CPU reads at high speed. Each instruction stored in the memory, execute the program through calculation.

2.4 The functional design of the loading and unloading unit of the system machine tool

According to the characteristics and instructions of the Kawasaki robot programming language AS, a section of AS language program is written on the computer or the teaching pendant to control the robot to make a set of actions to grasp the workpiece.

The loading and unloading unit of the machine tool accepts output signals sent by other units, executes corresponding actions after processing by the robot program, and outputs instructions to other units at the same time. Receiving and outputting signals are mainly realized through industrial robot hardware interface and robot program. The action flow design of the loading and unloading unit of the machine tool is shown in Figure 5.

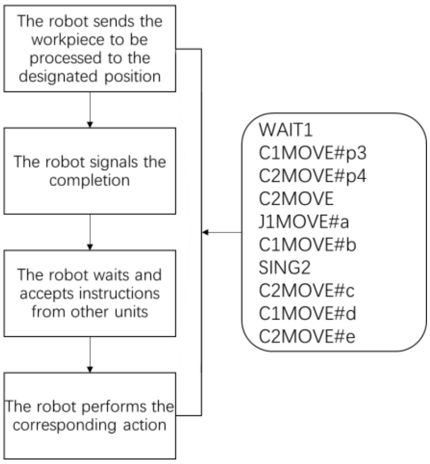

Figure 5: Flow chart of loading and unloading of machine tool

3. System function realization and case analysis

According to the system action flow chart, analyze the transmission of signals within the system. During the operation of the system, when the robot grabs the workpiece and reaches the pre-designated position, it needs to send a signal to the CNC machine tool, requesting the CNC machine tool to open the machine protection door. The following specifically introduces the signal transmission from the robot to the CNC machine tool.

(1) After the robot grabs the workpiece and reaches the pre-designated position, it sends a signal to the CNC machine tool: robot program statement (AS language);

(2) Check the robot hardware interface address. Since the robot directly uses the I/O communication method with the master station, it can be obtained from the drawing that the hardware interface of the robot output signa1 is OUT1, and the input signal of the S7-300 (master station) corresponding to the output of OUT1 is I0.4.

(3) Determine the input signal of S7-300 as I0.4, and design the logic program in S7-300PLC.

(4) According to the Profibus communication protocol between S7-300 and S7-200, the received signal of S7-200 corresponding to the output signal of S7-300 is V0.4, and the PLC program of V0.4 in S7-200 is as follows:

(5) Design the PMC program of the CNC machine tool: check the S7-200 output signal hardware interface address Q0.1, Q0.1 corresponds to the input signal of the CNC machine tool X0.1.

When the CNC machine tool signal Y6.4 is 1, the protective door is triggered to open the solenoid valve through the relay and the contactor, and the CNC machine protective door is opened. After

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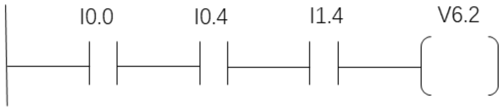
receiving the signal, the robot will automatically go to the CNC machine tool to grab the workpiece. The following specifically introduces the signal transmission from the CNC machine tool to the robot.

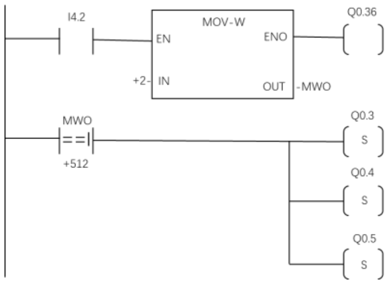
(1) After the protective door of the CNC machine tool is opened in place and the hydraulic chuck is released in place, it actively sends out the processing completion signal M24, and finally starts to output the signal Y6.0.

(2) The CNC machine tool and the slave station S7-200PLC adopt the I/O communication mode, check the hardware interface address of the CNC machine tool, and compare the address of the master station S7-200PLC to design the output signal of the CNC machine tool and the S7-200 input signal interface address.

(3) The CNC machine tool processing completion signal M24 The program is as follows:



(4) According to the Profibus communication protocol between S7-300 and S7-200, S7-200 output signal V6.2 corresponds to S7-300 input signal I4.2, I4.2 in S7-300 PLC program is as follows:



(5) The S7-300PLC output signal is transmitted to the robot, the S7-300 output signal is Q0.3, Q0.4, Q0.5, and the corresponding robot input signal is IN1, IN2, IN3.

(6) Robot hardware input signals IN1, IN2, IN3. It is written as 1001, 1002, and 1003 in AS language.

(7) Design the robot program: Wait (1001, 1002, 1003); the robot waits for three signals of 1001, 1002, and 1003.

JMOVE #a; After waiting for the condition to be reached, execute the movement instruction and finally reach the designated position a.

After the robot waits for the signal to arrive, the robot executes the movement instruction and arrives at the position to extract the workpiece, and the CNC.The workpiece processed by the machine tool is grabbed to the designated position to complete the grabbing work.

4. Conclusion

This system takes the machined workpiece as the entry point. Through the automatic measurement of the workpiece detection table, all the size data of the workpiece are uploaded to the master control, and the master control transmits the error size of the unqualified workpiece to the CNC system through calculation.The CNC system completes the automatic compensation of the workpiece error, and the robot sends the unqualified workpiece to the CNC machine tool for processing.Combining tool management, robot cells, and storage cells to realize a fully closed-loop process of processing, testing, automatic compensation, and reprocessing, embodying intelligent manufacturing. At the same time, the robot jaws are equipped with sensors and vision to ensure that they can automatically correct actions and re-grab them after an error occurs in the process of grasping the workpiece, which reflects intelligent handling.On the basis of the system control process, clarify the function of each unit, determine the action sequence of each unit, and design the action process of the system.This article provides theoretical support for the exploration of intelligent robot numerical control technology in the field of mechanical manufacturing.

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