Design of Intelligent Remote Control System for Bottle-Making Robot

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Abstract. An intelligent control system of 9-degree-of-freedom full-servo bottle-making robot was developed based on multi-DOF robot controller, with an aim to realize the full-automatic intelligent flexible manufacturing of glass bottles and improve the level of automation and intelligence of bottle-making equipment. Based on TCP/IP technology, the relative function model, such as the system of remote image monitoring, remote network control, fault diagnosis, production correction and other functions of the bottle-making robot is designed to realize the remote control and maintenance development of the bottle making process, then the "Internet +" function of the bottle-making robot is realized.

1. Introduction

Recently, the Chinese bottle-making machine technology has been improving greatly, contrast to the other countries. Its symbol is the success of the development of full-servo drive bottle-making machine [1]. With the requirements for the production of small batches of multi-variety products, the market needs a bottle making machine with stronger flexibility, higher speed, more accurate and intelligence [2, 3]. The bottle-making robot changes the traditional bottle-making machine model with the help of robot technology. By using modern control technology and robot technology, the functional mechanisms such as parallel switch mechanism of initial mold, funnel mechanism, air-breathing mechanism, turning mechanism, parallel switch mechanism of forming mold, forward blowing mechanism, multi-function 3-DOF bottle-clamping mechanism and so on can be solved by the concept of robot control. For the mechanical mechanism, the truss robot, 3-DOF serial robot and SCARA robot technology are be used to meet the requirement of more changes in the bottle-making

Process, such as bottle-swinging and bottle-pulling [4]. In this paper, the intelligent control system of 9-DOF full-servo bottle-making robot is developed. The intelligent flexible manufacturing of glass bottles was realized by using the characteristics of teaching, programmability and high flexibility of the robot, and the automation and intellectual level of bottle-making equipment is improved. The Internet technology is also used to design the intelligent control system, including the function models of the remote image monitoring, remote network control, fault diagnosis, production correction and other functions of the bottle making robot, with an aim to realize the remote control and maintenance development of the bottle making process, and the "Internet +" function of the bottle making robot is

realized, so as to improve the efficiency of bottle making, to reduce work cost and to reduce the labour strength.

2. The Composition of the Bottle-making Robot Control System

As shown in Figure 1, the control model of the bottle making robot is mainly composed of a planning module, a coordination module, a sensing module, a reaction module, a selection module, an execution module and a conflict processing module, etc. [5, 6]. Their main work contents are as follows.

1) Coordination Module it is responsible for the abstract behavior of nodes, including overall planning and management. The global or local knowledge sources are activated according to the external working state stored in the sensing module. If successful, the activated knowledge sources are pushed into the planning module, which can obtain load and source information from the sub-agent to maintain the correct information table. According to this table, the knowledge source is allocated to the agent by using the allocation algorithm. When the source cannot be activated according to the corresponding external information, the information is transferred from the storage to other nodes.

2) Sensing Module Its main function is to receive and translate information from the storage. In order to improve interoperability and information flow management, information flow protocols and communication methods at two levels are defined. The First one is the load information description standard, followed by the communication protocol standard language, indicating the transmission address, transmission and reception methods.
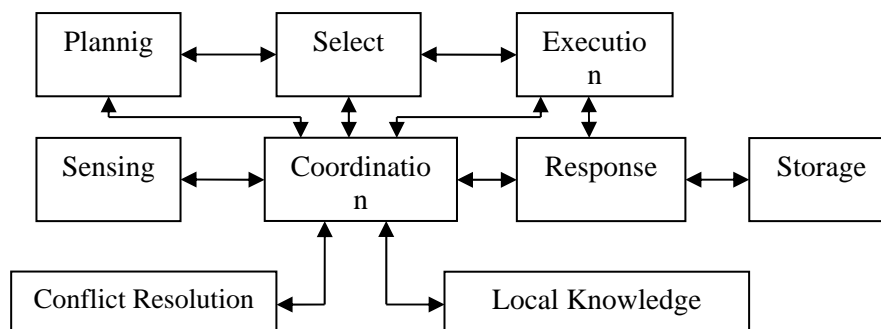
3) Response Module it is responsible for sending the control instructions of the agent planning process. When the task completion capability is insufficient, the task is assigned to other agents or written to the memory for further processing.

4) Planning Module According to the information in the reaction module, combined with the processing method provided by the knowledge source, the problem solving plan is carried out in the planning module.

5) Select Module The planning step was selected in the planning module to transfer the optimization set of the problem into the execution module.

6) Execution Module This module completes local planning or real-time response according to the information processing method of the planning module. In the process of information processing, the machining process can be dynamically adjusted through cooperation with other agents. After execution, the control instructions are sent to the response module.
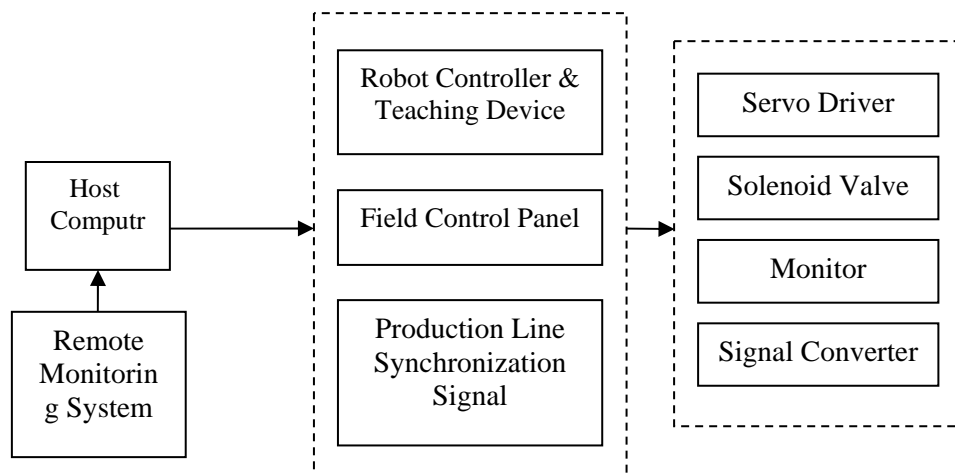
7) The Conflict Handling Module This module solves the potential conflict between the agents in the local computing. When the coordination module discovers incomplete and incorrect information and knowledge, different application criteria, different reasoning mechanism, different work objectives and so on, the conflict handling module will be started and make a new decision according to the priority.

Fig. 1 Intelligent control model of bottle-making robot

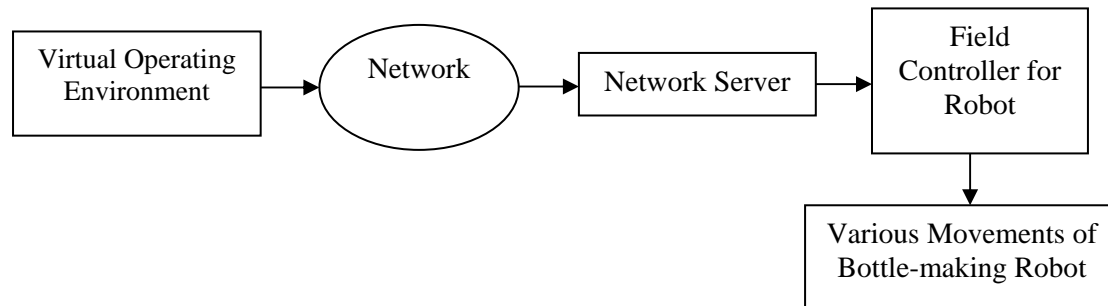## 3. Design of the Control System for Bottle-making Robot

The bottle-making robot is a typical multi-axis motion control device, and the multi-axis motion control scheme includes main controller, several motion control modules, several I/0 modules, communication module and teaching device [7]. The control system of bottle-making robot is developed according to the special process requirements of bottle making machine. As shown in Figure 2, it includes a single board multi-axis servo motion control, the special curve generation and function control in one board of robot motion controller. Then the flexible multi-axis programmable timing positioning curve motion control, I/0 process function control, communication and data processing functions could be realized. With the man-machine operation located beside the machine, each servo shaft could adjust the position of the initial and last position, determine the stroke, adjust the stroke in operation, activate the one-button positioning and other functions. The motion controllers are fixed on the same floor, and connected with the driver, the system synchronization signal, the field I/0 signal and the communication line of the host computer through the floor. A dozen-axis servo motion control unit and a cam curve generator unit are formed, that is, the working parameters of 7 groups and 9 groups of bottle making machines could be modified on the user interface of the host computer. The user interface of the host computer should be shared with other systems on the production line, and the modified data are transmitted to the corresponding robot control according to the address and data classification.

Fig. 2 The control system for bottle-making robot

4. Development of Remote Control Function Module for Bottle-making Robot

With the help of the network communication technology and the robot control technology, the autonomous control of the robot is designed to realize remote control of the robot and improve work efficiency [8, 9]. The remote control module of bottle making robot adopts the TCP/IP technology and takes HTTP as transport protocol. The Browser/Server mode of the client accessing the Web and the background database connected with the Web through the browser establishes a Web-centric remote monitoring and fault diagnosis system. The operators observe the operation state of the equipment through virtual operation environment and remote image monitoring. Through the man-machine interface to establish contact with the bottle-making robot control system, the operation command is transmitted from the man-machine interface to the controller via the network server. The controller converts the operation command into the machine command (pulse) to control the action of each actuator, as shown in Figure 3.

Fig. 3 Remote control function module for bottle-making robot

5. Conclusion

As the robot has the characteristics of teaching, programming and flexibility, the robot controller is regarded as the core part of intelligent control system of 9-DOF full-servo bottle-making robot to control the movement of swinging bottle and clamping bottle in the process of bottle-making. The technical upgrading of the glass bottle manufacturing line will be comprehensively improved the automation and intelligence level of the bottle making equipment. With the help of TCP/IP technology, the remote control module of the bottle making robot is developed, which has the functions of remote image monitoring, remote network control, fault diagnosis, production correction and other functions, and realizes the remote control and maintenance development of the bottle making process, and the "Internet +" function of the bottle making robot is realized. This system greatly improves the efficiency of bottle making, reduces work costs, and reduces the labor intensity.

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