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Application of two-arm welding robot control system based on PLC

Bin Li

Technician College Of Liaocheng City

binlee12@163.com

Abstract. Understanding the current industrial production process, forklift manufacturing line of symmetrical groove workpiece welding link emerged a lot of problems, such as waste productivity is getting higher and higher, practical work efficiency is getting lower and lower, the work intensity of the department staff is getting greater and greater, the requirements of welder skills become higher. In order to solve these problems scientifically, Chinese scholars proposed a two-arm industrial robot which can realize automatic workpiece welding. Based on the understanding of the status quo of the application research of welding robots, combined with the design thinking of the dual-arm welding robot control system based on PLC as the core, the application effect of this control system is discussed from the perspective of practical application, in order to improve the automation and intellectualization level of our industrial field, and ensure the quality and efficiency of production and manufacturing workpiece.

Keywords: Double-arm welding robot; Hardware control; Control system; Electrical control; PLC.

1. Introduction

As a highly automated welding technology equipment, welding robot is an important symbol of the innovation and development of modern science and technology. It breaks through the traditional rigid automatic operation mode of welding and puts forward a new way of flexible automation. In the steady development of social economy and science and technology, welding robot mainly uses robots to replace the traditional manual welding mode, which is also the inevitable trend of the development of welding manufacturing industry in the new era. The welding robot technology researched and manufactured in China is later than that in the United States and Japan. It first appeared in the 1970s and was spontaneously researched by universities and research institutes in the early stage. Until the mid-1980s, there was no industrial robot in China. [1-3]In foreign countries, as a very mature industrial product, industrial robot has been widely used in the automobile industry. By comparing and analyzing the domestic and international economic development situation, we know that at present, the development and manufacturing of industrial robots are included in the development plan. While focusing on the research of industrial robots, robot technology and application users are combined together, and the practice research pays more attention to the application direction. Nowadays, common arc welding robot systems are mainly divided into the following parts: First, robot ontology. This structure is usually the use of servo motor to drive the six-axis joint manipulator, which includes the transmission mechanism, driver, joint, mechanical arm, internal sensor and many other contents, its purpose is to accurately ensure the end of the manipulator to achieve the required position and movement trajectory; Second, robot control cabinet. This structure belongs to the nerve center of the whole system, which contains the computer hardware and software and special circuits, mainly responsible for processing all information and control actions during the working period; Third, weld the power system. This structure includes a number of welding power supply and special welding gun, etc. Fourth, welding sensor and system safety protection equipment; Fifth, welding fixture.

Because welding robot can replace human work in high risk environment, so in the study of control system application problems, but also consider the robot injury accident. Nowadays, in the working state of welding robot, it is important to ensure that the field staff will not enter the movement of the safe range of the area, which is also an important principle of welding robot safety management. At the same time, after making clear the particularity of the work of welding robot,

the following management measures should be put forward: first of all, to install protective guardrail for welding robot and peripheral equipment, to avoid staff entering the dangerous area, causing accidental injury; Secondly, the plug type electrical contact switch should be set at the entrance of the safety barrier, and the safety circuit of the welding robot is effectively connected. If the safety door is opened, the robot controller will cut off the driving power of the robot, and the robot will stop working immediately; Finally, the safety circuit of the welding robot and the safety circuit of the production line are connected together. In case of emergency in the production line, the production workers can directly press the emergency stop switch in any area to stop the robot.[4-6]

In this paper, on the basis of understanding the research status of welding robot technology, mainly discusses the PLC as the core of the dual arms welding robot control system design ideas, and then combined with practical cases to verify the analysis, accurate judgment of the application effect of this technology, in order to provide effective basis for the welding robot control system application research in the new era.

2. Methods

2.1 Design Ideas

Robot is a kind of "flexible" machine, which has some functions of human or biological. For example, industrial robot manipulator simulates the function of human arm, and walking robot simulates the lower limb movement function of human and animal. Advanced robots can use sensors to understand the external environment or "internal body" state and changes, and can even make their own logical reasoning, judgments and decisions, which is the so-called intelligent behavior of robots. The welding robot studied in this paper needs to use auxiliary equipment and control system to orderly complete welding operations, so the overall system design includes controller, robot, welding power and related device control, remote control workstation, etc., as shown in Figure 1 below:

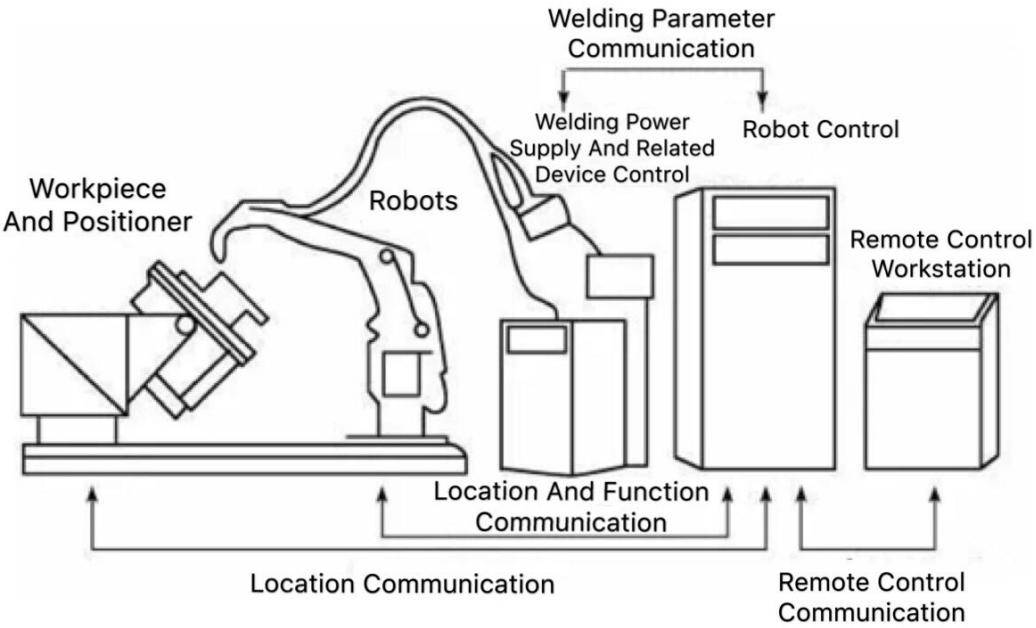

Figure 1. System schematic diagram of welding robot

According to the analysis of the application requirements of the welding robot control system, it is known that the welding workpiece should be installed on the welding platform, so that the control system can detect the installation of the welding workpiece. After determining that the workpiece

installation meets the requirements, the output signal can be used to effectively control the effective movement of the robot arm holding the welding gun in X and Y directions. After the system finds that the robotic arm has moved to the specified area, the controller can output signals to control the arc of welding. At this time, the control platform can move in a straight line to effectively weld the weld. When the welding platform moves to the end point, the control system outputs signals to control the platform to stop running and close the arc at the same time. At this time, the workpiece is welded. At the end of the welding work, the controller shall control the welding arms, recover them in the direction of Y to X axis, and run them to the initial position for replacement.[7-9]

2.2 Hardware Control

The control system of the two-arm welding robot will regard PLC as the core content of the overall control operation. The specific design is shown in Figure 2 below:

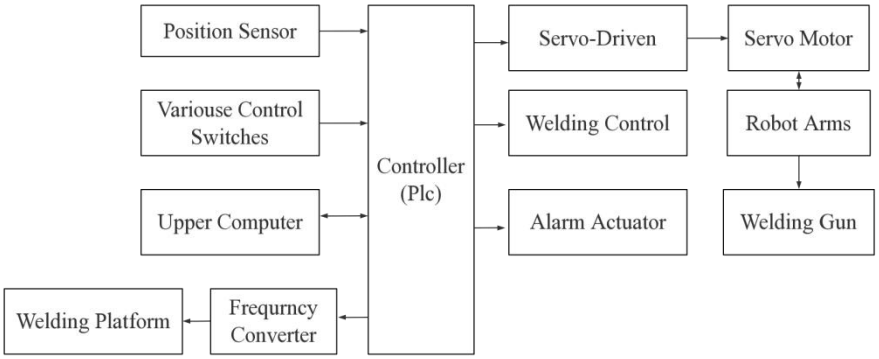

FIG. 2 Structure diagram of control system

Combined with the above analysis, we can see that the design structure and main functions of the control system of the two-arm welding robot are divided into the following points: First, controller. This part belongs to the control core of welding robot, which will affect the reliability of the whole system operation in the design and application. Second, position sensors. The sensor of the detection position of the control system includes the detection of the position of the workpiece, the position of the welding gun, the moving distance of the welding platform, etc. Third, control switch. The control switch set by the system is mainly used for mode conversion, emergency stop, effective start and other control; Fourth, the upper computer. This part will effectively monitor PLC data information through communication lines; Fifth, frequency converter and welding platform. PLC will effectively control the running state of the welding platform through the frequency converter. [10-13]

2.3 Monitoring Page

This design mainly uses the Kingview monitoring software, which includes the login interface, and only authorized users can enter this interface, as shown in the following figure 3:

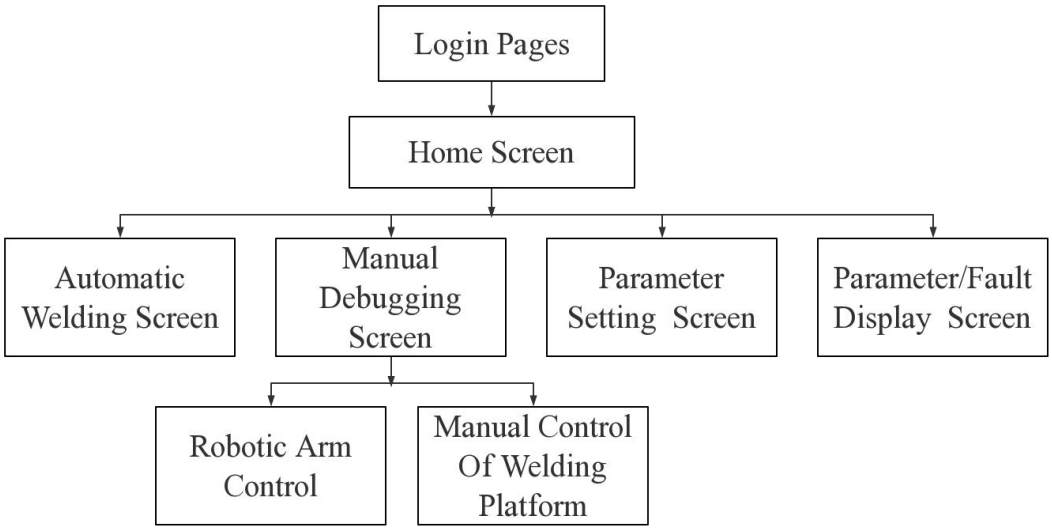

Figure 3 Flowchart of interface login

Managers can choose the automatic welding screen, let the system into the automatic welding process, through the operation of the screen in the open key for processing. When "On" is pressed, the system will automatically detect the installation status of the workpiece and wait for the welding key to be pressed. After the system detects that the workpiece has completed the installation work and the welding key has been pressed, the servo drive can be activated to manipulate the robot arm of the welding robot for effective movement. After pressing "Off", the system will enter the shutdown state.

In order to facilitate the system debugging, researchers added a manual debugging mode in the system. Only by selecting relevant keys in the main interface, you can directly enter the specific screen. A mechanical arm or welding movement platform can be operated independently or manually according to different screens, and the monitoring screen will show the working state of each part of the area. In the case of security failure in the system, the alarm will put forward sound and light alarm to the staff, and the monitoring screen will pop up fault information, convenient for the field staff to do a good job in emergency treatment.[14-15]

2.4 Software Design

The software design of the control system includes four parts, the first is the sequence control in automatic mode, the second is the effective control in manual mode, the third is the parameter processing, and the last is the fault processing. Normally, the control system mainly controls the welding work in automatic mode, and other procedures are incidental content. Among them, the sequence control process is very crucial. The specific steps involve the following points: First, the mechanical arms move in accordance with the X-axis direction; Second, the mechanical arms move in the Y-axis direction; Third, welding arc control; Fourth, welding on the mobile platform; Fifth, stop the platform movement to complete the arc closing work; Sixth, the mechanical arms move in the opposite direction of the Y-axis; Seventh, the mechanical arms move in the opposite direction of the X-axis; Eighth, return to the welding platform; Ninth, the welding platform stops running and the welding work ends.

3. Result analysis

In this research experiment, three-phase 220V -- 50Hz power supply is used, and the transformer is used to convert 220V AC power into 24V and 5V direct current, only to provide power for the control system. At the same time, the internal cable of the system is divided into two forms, one refers to the power cable, the other refers to the communication cable, the former is to provide help

for the control system, servo motor, etc., and the latter is the servo control system and the upper computer for effective communication. In the case that there is no problem in the power supply, the main task is to check the working state of the servo motor, judge the activities of each joint driven by it, and analyze whether all joints can move according to the predetermined requirements; In the case that the system coordinates are joint coordinates, the motion of all joints should be studied separately, and the names of all axes and pre-set operation keys and actual work should be clarified.

In the operation procedure, the operation content of the double-arm welding robot is transformed into robot language for description. The procedure of welding task is shown in Table 1 below:

Table 1 Program analysis of welding task

line numbers	order	function declaration	
001	MOVEP P002，130.00m/min	Robot origin position	Program point 1
002	MOVEP P003，130.00m/min	Move to the vicinity of the welding start position	Program point 2
003	MOVEL P004，130.00m/min	Program welding to start position	Program point 3
004	ARC-SET AMP＝150 VOLT＝18.2 S＝0.5 ARC-ON AreStart 1 PROCESS＝0	Welding started, the current was 150A, the (standard) voltage was 17.2v, and the welding speed was 0.5m/min.	
005	MOVEL P005，130m/min	Move to welding end position	Program point 4
006	CRATER AMP＝100 VOLT＝16.8 T＝0.03 ARC-OFF AreEnd1 PROCESS＝0	After welding, the current is 100A, the voltage is 16.v, and the delay time is 0.03s.	
007	MOVEP P006，130m/min	Move to a position where the workpiece does not collide.	Program point 5
008	MOVEP P007 130m/min	The robot move to that position where it does not collide with the workpiece return to the original point.	Program point 6
009	END	end	

By analyzing the final experimental results obtained, it can be seen that the two-arm welding robot can complete all operations in an orderly manner, accurately record all program points, adapt to the interference phenomenon caused by the environment faster, and truly meet the pre-set welding requirements. Therefore, Chinese scholars should continue to explore the PLC as the core of the dual arms welding robot control system, pay attention to the combination of different fields of application needs for optimization and innovation, only in this way to master more valuable theoretical knowledge and application technology. Chinese industrial robot began in the 1960s, and has been developed for more than 60 years, has been widely used in many fields, is the core content of manufacturing production research. In the future scientific and technological exploration, in order to better study the control system of double-arm welding robots, our country should increase the training of professional and technical talents, learn from the theory and technology grasped by other countries, and fully master the design structure of welding robots, only in this way can ensure the quality and efficiency of the final production and manufacturing workpiece.

Conclusion

To sum up, as an important part of modern industrial production and manufacturing, the control system of dual-arm welding robot not only has easy to operate man-machine interaction interface, but also has manual and automatic control modes. Therefore, in the development of modern science and technology innovation, Chinese scholars should continue to explore the main structure and application functions of the dual-arm welding robot control system, and pay attention to combining practical cases for research and discussion, in order to obtain a better dual-arm welding robot control system.

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