A Control System Based on ARM and Motion Controller
for Arc Welding Machine

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Abstract. A control system based on ARM and motion controller for arc welding machine is studied, and in the movement process, starting point and ending point detecting function are used in order to increase applied field of the system. In addition, process control module is incorporated into the system to save teach point and specify arc welding processing parameters including the speed, the weaving frequency and the amplitude of weaving and etc.

Introduction

Arc welding as a traditional welding method has a number of successful applications in the field of welding, this shows its strong vitality and broad prospects. In our country most application of arc welding robot are joint robot introduced from foreign company. Structure of this kind of robot is not applicable for some deep cavity welding, therefore developing a kind of arc welding robot suitable for deep cavity welding has a broad market prospect.

This paper designed a five axis arc welding robot control system. Advantages of this robot is the large stroke, low cost and could weld workpiece which has deep cavity.

Hardware structure of the system

The control system hardware platform is mainly composed of a motion controller board and its peripheral circuit. The motion controller board includes a ARM chip and two pieces of four axis motion control chip. ARM chip is LPC3250, The chip is the hardware platform of the operating system. It integrates LCD controller, touch screen controller, Ethernet controller, standard universal asynchronous transceiver, USB controller with peripheral chip to realize display and communication [1]. The motion control chip is PCL6045B, The chip communicates with ARM through the I/O bus. Through Receiving the motion command It control interpolation motion servo system [2].

The system controls the two pieces of PCL6045B as the peripheral of LPC3250, and the PCL6045B occupy the address space for the static memory of external memory controller (EMC). EMC has a total of 4 chip selects for the static memory, and the two pieces of PCL6045B chip occupy chip select 1 and chip select 2 respectively [3]. In order to realize the 5 axis linkage the two pieces of PCL6045B chip need synchronous motion. So trigger signals CSTA and synchronous stop signal CSTP of the two PCL6045B is respectively connected together to realize synchronous motion, and synchronous starting and synchronous stop signals can be sent by LPC3250 by writing instruction. LPC3250 and PCL6045B connection diagram is shown in Figure 1.
Software component

The motion controller software system is composed of the operating system, drivers and application program. Microsoft Corp embedded operating system Windows Embedded CE 6 is selected as the operating system of the motion controller. According to the hardware structure this paper customize the operating system using the system development tool Platform Builder for CE 6, so we can get operating system kernel image for this controller, burning it to the nanflash we can finish the installation of operating system. System driver includes the driver of PCL6045B and the general driver such as display driver and communication driver etc. The general driver process have been added to the operating system in kernel customization. The driver of PCL6045B is loaded by the device manager. The application program consists of two parts: the human-computer interface and the dynamic link library of the motion controller function.

Realization of The PCL6045B driver

At present, Windows Embedded CE 6 provides four kinds of device driver model, two of them are dedicated to the Windows Embedded CE 6, which is the device driver and stream interface driver, the other two models from other operating system, namely the universal serial bus driver and the network driver interface specification driver\(^4\). The PCL6045B driver is developed using stream interface driver model.
Preparation of stream interface driver program is to achieve its entrance point function, i.e. XXX_Close, XXX_Deinit, XXX_Init, XXX_IOControl, XXX_Open, XXX_PowerDown, XXX_PowerUp, XXX_Read, XXX_Seek, XXX_Write, where XXX is the device prefix, the device manager in the registry by prefix to identify equipment, this paper use PCL as the prefix of the system of the device name\(^5\).

Device manager initializes the PCL6045B function by calling PCL_Init(). this function first calls function MmMapIoSpace which allocates interrupt register and the virtual address of PCL6045B, configures EMC control registers and memory configuration registers; Then call the function KernelIoControl which applies system interrupt value to the system for PCL6045B, and call the RegisterWindowMessage register interrupt message. So the system can read and write the PCL6045B register through operating the virtual address of PCL6045B and response to the chip interrupt message by creating a thread. The Application reads and writes the register of PCL6045B by calling the function DeviceIoControl(), so as to realize the control of the PCL6045B.

In order to make the program more structured, easier to transplant and maintenance, operation details of the LPC3250 on the PCL6045B are encapsulated into functions, The functions are PCL6045B function library. The library consists of eight basic read-write function, they encapsulate the read-write operations of PCL6045B register, other library functions communicate with PCL6045B driver through the basic read-write function, to realize the parameter configuration, interpolation, position and speed change etc. This library is packaged in a dynamic link library, the library also includes driver loading and unloading function.

Application program design

Application program design mainly includes the design of human-computer interface, functional module and motion command Translation. This paper realizes man-machine interface by Visual Studio 2005 powerful interface editing function, and realizes the PCL6045B function library by calling the motion command. The design of function module is introduced in detail below.

The seam finding

The seam finding function is a sensing and control function, it Compute the position deviation by the method that the wire tip point contact surface of workpiece. Due to the workpiece surface rust, The seam finding sensor using 220V voltage breakdown of workpieces. In order to ensure the safety of personnel, this paper adds high resistance in the circuit, so that even if the operator direct contact wire in the seam finding process will not cause electric shock accidents.

In the actual production, since the error in the course of processing and assembling, it is difficult to ensure the consistency of workpiece. Through the seam finding function the system can realize that the same kind of workpiece can teach once and then mass produce, thereby improving the production efficiency.

Design and implementation of the process control module

Process control module is used for setting and adjusting parameter of welding processing and the welding path teaching. The process parameters includes welding speed, the frequency and amplitude, as shown in Figure 2.

According to their different functions the teaching process divided the welding process point into different types such as safe point, process point, approach point, start point and end point etc, and record the coordinate values. Teaching point type and coordinate values and welding technology parameters is saved as the process file in the XML file, the operator can build process file each for different workpiece in the man-machine interface.
Experiment and conclusion

The arc welding robot accuracy are detected using a portable three coordinate measuring machine. The robot move from (0,500,100,45,0) to (1000,600,200,45,30) along a straight line, the error is shown in Figure 3. (The abscissa is the X position, the ordinates are X, Y, Z position error and the error of the laser axis vector in the projection of the X axis of I, in the projection of the Y axis of J, in the projection of the Z axis of K).

Arc welding robot is shown in Figure 4, the equipment is used in welding the hydraulic press frame. In the process of actual welding system error is mainly from the seam finding. For seam finding reference point is produced by teaching, this gives the system introduced the personnel operating error, otherwise from wire contacted with the workpiece to the current breakdown workpiece found seam detection signal requires a certain distance, the distance is related to surface corrosion degree and the cleanliness, it also caused the seam error. The workpiece welding verifies that the equipment meet the requirements of welding process. The welding result is shown in figure 5. This equipment has been applied in the factory at present, this proves that performance of the arc welding robot control system based on ARM and motion control chip meets the practical application of arc welding.
References

[1] Ligong Zhou. ARM-Based Embedded System Basic Tutorial (In Chinese). Beijing: Beijing University of Aeronautics & Astronautics Press (2008).

[2] Peiqing Ye, Hui Zhang. PCL6045B Motion Control and CNC Application (In Chinese). Beijing: Tsinghua University Press (2007).

[3] Guangxi Xinhua-Joint Laboratory Fengbao edited. Development of the Embedded Linux System Based on LPC3250 (In Chinese). Beijing: Publishing House of Electronics Industry (2010).

[4] Douglas Boling. WINDOWS CE 6.0 Developer Reference (In Chinese). Beijing: China Machine Press (2009).

[5] Junhua Ye, Xuemei XU, Shuai Huang et al. Computer Engineering & Science, (2009).31(6): 136-141.