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Research on Stepper Motor Control System based on Single Chip Microcomputer

[1, a]WANG Xiaohua
[1]Institute of Applied Electronics, Chongqing College of Electronic Engineering, Chongqing, 401331
[a]12934236@qq.com

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Abstract. The research content of this paper is to design a set of step motor control system which is relative simple, economic, but the function is more complete, adaptable, easy to operate, high reliability, can organically combine electronic technology, SCM technology and motor control technology together. This paper briefly describes the development of stepper motor, application, as well as the common control system used in the program, the common drive technology, but also analyzes the working principle of the stepper motor. At last, the hardware and software design of the whole system is put forward.

Introduction

Stepper motor, also known as pulse motor or stepping motor, its application development has been about 80 years of history. It can be said that the stepper motor is inherently a discrete motion device, is a purely digital control motor, stepper motor is driven by external control pulses and control stepper motor phase winding turns on or off, so that the motor produces step movement. That is to give an electric pulse signal, the motor will turn an angle or forward step, the output angle, speed and input pulse, The frequency has a strict proportional relationship between the load capacity range with the power supply voltage, load size, environmental conditions and other changes in the case of non-overload, the motor speed, stop position depends only on Pulse frequency and pulse number, and not subject to changes in load, while the stepper motor only periodic error without accumulation of error, high precision stepper motor in a wide frequency range by changing the pulse frequency to achieve the transfer Speed, quick start and stop, forward and reverse control, which is the most prominent advantages of the stepper motor.

At present, with the development and change of electronic technology, control technology and motor body, the interface between traditional motor classifications are more and more blurred. For the traditional Stepper motor, stepper motor can be simply defined as: According to the input pulse Signal, each time to change the excitation state to advance a certain angle or length, if not to change the excitation state to maintain a certain position and the static motor. From the broad sense, the stepper motor is a pulse signal control by the brushless DC motor, but also can be seen as in a certain frequency range and pulse frequency synchronous motor. Stepper motor has its own characteristics, summed up:

1) It can be used for digital signal directly open-loop control, the entire system is simple and cheap.

2) Directly receive digital signals, do not have digital-analog conversion, easy to use.

3) Displacement corresponds to the number of input pulse signals, not long-term accumulation of step error, can be composed of relatively simple structure but also has a certain precision of the open-loop control system can also require higher accuracy when the composition of closed-loop control system;

4) Brushless, motor body parts less, high reliability;

5) Easy to start, stop, forward and reverse and speed.

6) Stop, can have self-locking function.

7) Large range of step angle selection and can be selected in dozens of angle to 180 degrees in a large range. In the case of small steps, usually in the lower speed under high torque operation, and it

can not directly drive the reducer Load operation;

8) Speed can be a wide range of smooth adjustment. At the same time with a controller to control several stepper motor can make them fully synchronized operation;

9) Can not be directly used ordinary AC power drive.

Stepper Motor Control System

Stepper motor control system is a complete organic whole, by the motion control system and operation control system composed by the operating system to complete the operator's motion into the motion control system can accept the electrical signal, the motion control system with the response , Complete the specified action.

The stepper motor is a numerically controlled motor, the biggest characteristic of which is controlled by the input pulse signal, that is, the total rotation angle of the motor is determined by the number of input pulses, and the motor speed is determined by the pulse signal frequency. It has input pulse and motor shaft angle Proportional to the characteristics of the pulse signal into angular displacement, that is, to a pulse signal, the stepper motor to rotate an angle and it is very suitable for single-chip control.

System Hardware Design

The system consists of power supply, display (instruction), MCU (MCU), key circuit, watchdog circuit and motor drive circuit, etc. The system uses parallel control, single-chip interface line to control the stepper motor drive circuit. The keyboard as an external interrupt source, set the stepper motor forward, reverse, grade, stop and other functions, the use of interrupt and query methods to call the combination of interrupt service routine to complete the best stepper motor control, monitor timely Displays the status of forward run and reverse run speed.

AT89C2051 is a simplified version of the AT89C51 (only 20 pins) but still has a powerful function.AT89CZO51 is a ZKB flash with a programmable, easy to use, easy to use, Low-voltage, high-performance, 8-bit COMS microcomputer that uses ATMEL's high-density non-volatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin structure, making the AT89C2051 A powerful microcomputer that provides a highly flexible and cost-effective solution for many embedded control applications.

AT89C2051 provides the following standard features: ZKB flash memory; 128 bytes RAM; 15 1/0 lead; two 16-bit programmable timer/counter; a 5-vector 2 interrupt structure; 1 full-duplex UART port; A precision analog comparator and on-chip oscillator and clock circuit. In addition AT89C2051 can be reduced to O frequency static logic operation design, and supports two optional software power saving mode. Idle mode to stop the CPU work, but allows The RAM, timer/counter, serial port and interrupt system continue to operate. The RAM contents are saved, but the oscillator stops and all other components work until the next hardware reset.

Schematic diagram and drive circuit schematic diagram and the PCB layout of each part of the appendix in the drawing of the circuit, the full use of the Protel99SE, from schematic drawing to generate PCB layout is Protel99SE as a platform for the whole system design and development process More standard, greatly improving the efficiency. Finally, based on the hardware implementation, the design of the system design interface (see Appendix IV) .The lower part of the panel for the six input operation button; the top of the middle three seven-segment LED display; The left side of the central part of the button for the system to force the reset; the middle of the right two interfaces, the top of the motor drive interface, the bottom of the system SV power supply interface. The following is the LED indicator on the right side of the direction of the LED.

System Software Design

Control circuit is mainly the AT89C51 microcontroller, crystal oscillator circuit, address latch, decoder, EEPROM memory and programmable keyboard/display controller Intel-8279 and other

components. The microcontroller is the core of the control system, controlled stepper motor breakdown Speed, single-run line displacement, and start and stop control can be input from the keyboard, or through the host computer's serial communication interface set by the host computer. The status display provides the current power phase, phase current size, motor running time, forward and reverse run, current speed, line displacement and related count display. The main function of the microcontroller is to output the EEPROM stored in the subdivision of the current control signal for D/A conversion.

To interrupt the way in response to step pulse; IRZ130 fault signal received microcontroller P2.1. A program is an infinite loop program that executes sequentially. Whenever there is a step pulse signal input, it will produce a NTO interrupt, according to the breakdown of the settings and direction signals from the microcontroller sine table in the table to obtain the two-phase stepper motor winding current corresponding sine, will be found Value is written into the register of the digital-analog converter, and is output after D/A conversion. Subdivision drive the main control program to control the entire process flow, the main completion of the initialization process, interrupt mode settings, the counter work mode settings and related subroutine calls. Initialization includes 8279 various registers, 8279 display RAM, AT89C51 interrupt system and internal RAM and so on. In the AT89C51 the interrupt, the use of INTO, INTI, TO and TI these four interrupts, INTI for high priority, in the running state, when a stop button is pressed, then the work of NTI interrupt service routine will T0 off, So that the stepper motor to stop, T0 control step of each step cycle, the service program is basically only reset the timer and set the flag bit operation, and other operations are completed in the main program.

Stepper motor position control requires two parameters and the first parameter is the current position of the motor actuator parameters, that is, absolute position. The second parameter is the distance from the current position to the target position, and its function is to determine the end to determine whether the program reaches the specified end of the process, if the end to stop the pulse; otherwise, continue to move forward;

Single axis motion control the single axis has two basic motion types: jog movement, continuous motion. Jog is a manual control method, each press the keyboard to set any key or mouse, the computer receives the signal to send control words and initial value to the controller timer/counter, and immediately start the timer output a certain frequency square wave pulse, this pulse through the driver-driven stepper motor movement. After a delay time, prohibit timer reload timer constant, stop the output square wave signal, jog the end of the movement. Continuous movement, the controller output a certain frequency of the square wave, through the driver to start the stepper motor constant speed movement, until the operator to terminate the movement. Multi-axis motion control A number of motion axes in the form of touch-continuous movement. The timer/counter 1 outputs a square wave signal of a different frequency or the same frequency. The square wave signal is cyclically divided, processed, and amplified by the driver, respectively. Control two axes to a certain speed continuous movement.

Acceleration and deceleration module thinking is to start to start the frequency of operation, and then gradually accelerate to a certain frequency, the speed of constant speed to run. When it is about to reach the end point, it gradually decelerates, running at the starting frequency, and stops after completing the specified number of steps. This stepper motor can be completed with the fastest speed of the required number of steps, and without staggered. The trapezoidal velocity curve can be divided into three stages in time: the first stage is the acceleration phase, the moving axis accelerates to the maximum velocity Vx by the maximum acceleration AX; the second stage is the uniform motion phase, the moving axis The maximum speed of Vx uniform motion; the third stage for the deceleration phase, the minimum deceleration of the axis-Ax deceleration to a stop state.

Conclusion

This design of the stepper motor control system analyzed the mechanism, working principle, the access to the stepper motor control system related scientific literature. This system followed the practical, simple, reliable and low-cost principle, designed a structure which is very effective for

industrial production the stepper motor control system. Through the drive circuit analysis and the physical control of the actual detection, this paper will have inference meaning for the stepper motor control system development.

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