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Design of DC Motor Speed Control System Based on PWM Control

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Abstract

DC motor needs to meet the special requirements of production process automation system. The traditional speed control system has certain defects. This paper uses PWM control technology, which can realize digital signal control analog signal, and can greatly reduce the cost and power consumption. In this paper, the hardware and software of the system are designed. STC80C51 chip and L298 full bridge driver chip are used to process pulse and output control signal to control motor speed. The digital tube displays the speed level, and controls the positive and negative rotation of the motor and the speed increase and decrease of the motor by pressing the key. The design not only improves the use efficiency of the single chip microcomputer, but also has certain anti flying ability.

Keywords

STC80C51; DC motor; PWM control; Digital tube.

1. Introduction

1 The principle of DC motor speed control system is relatively simple. The speed can be changed by changing the voltage of motor to realize four quadrant operation. The most commonly used method to change the voltage is PWM. Adjusting the input duty cycle of the motor can control the average voltage and speed of the motor. The traditional speed control system has some defects: the analog circuit is easy to drift with time, which will produce some unnecessary heat loss and sensitive to noise. The above defects can be avoided by using PWM technology. In modern industrial production, motor is the main driving equipment. At present, there is KZ-D drive system in DC motor drive system, which replaces F-D system. With the development of power electronic technology, DC motor speed regulation gradually changes from analog to digital, especially the application of single chip microcomputer technology makes DC motor speed regulation technology enter a new stage Energy, high reliability has become the trend of its development.

2. Overall Scheme of the System

2.1 Speed regulation of DC motor

According to different excitation modes, DC motor can be divided into self excitation and separate excitation. The mechanical characteristic curves of different excitation modes are different. The speed control of DC motor is divided into two methods: armature control method and magnetic field control method. Comparing the advantages and disadvantages of the two methods, for the magnetic field control method, its control power is small, and it is easy to be limited by the saturation of the magnetic pole when driving at low speed, and it is limited by the structure of commutation spark and commutator when driving at high speed. Therefore, the magnetic field control method is not suitable, armature control method is more commonly used in motor speed regulation. Armature control is to add the control voltage signal to the armature of the motor to control the speed of the motor when the excitation voltage remains unchanged. It is widely used in motor speed regulation, among which pulse width modulation is widely used. The concept of pulse width speed regulation is to use a fixed frequency to control the power on or off, and to change the average voltage by changing the "on" and

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"off" time in a cycle, that is to change the "duty cycle" of the voltage on the armature of the DC motor, so as to control the motor speed.

2.2 Overall system diagram

The system uses 80C51 to control the output data. PWM signal is generated by PWM signal generating circuit and sent to DC motor. The AC data of DC motor is sent back to MCU through speed measuring circuit, filtering circuit and a / D conversion circuit, and PI operation is carried out, so as to realize the control of motor speed and direction and achieve the purpose of DC motor speed regulation.

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2 PWM speed control system of main control circuit: PWM is realized by software based on single chip microcomputer. Duty cycle is an important parameter in PWM speed regulation system. When the power supply voltage is constant, the average value of armature voltage is taken as follows:

1) Fixed width frequency modulation method: keep unchanged, only change t, so that the period also changes. 2) Width modulation frequency modulation method: keep t unchanged, only change, so that the period or frequency will also change.

3) Fixed frequency width modulation method: keep the period T (or frequency) unchanged, and change and t at the same time. When the frequency of the control pulse is close to the natural frequency of the system, it will cause oscillation. Therefore, it is not appropriate to use the fixed frequency width modulation method to change the duty cycle, thus changing the voltage at both ends of armature of DC motor. The control program is divided into software delay method and counting method. The idea of software time-delay method is: first calculate the duty cycle (t (1) / T, and then electrify the motor for M unit time t (0) by cycle, so m = t (0) / T (1). Then the power is cut off for s unit time, so s = t (2) / T (0). Changing the value of M and s changes the value of duty cycle. The principle of counting method is: first calculate the number of unit delay m, as a fixed value stored in any storage unit. When the power supply is equal, the times of power on unit time are calculated and compared with the memory content. If the count value is equal to the given value, the motor will be cut off; if not, the control pulse will be output.

PWM (pulse width modulation) pulse width modulation is used for speed regulation. The working principle is to change the duty cycle by generating rectangular wave to achieve the purpose of adjusting pulse width. The definition of PWM: pulse width modulation (PWM) is a very effective technology to control analog circuit by using digital output of microprocessor. It is widely used in many fields from measurement, communication to power control and transformation. The value of analog signal can be changed continuously, and the resolution of time and amplitude is not limited.

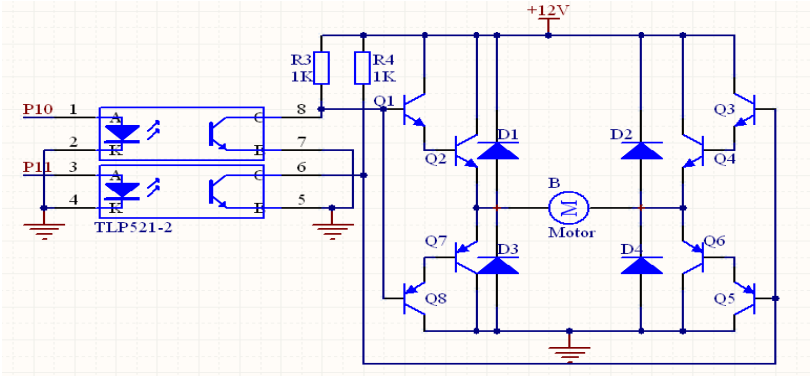

Fig. 1 circuit of motor PWM drive module

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In Fig.1, the PWM circuit is composed of a complex transistor and an H-type bridge circuit. The four transistors can be divided into two groups according to the diagonal combination: whether the two input terminals control whether the transistors are on or off. The function of the four diodes in the circuit is to prevent the transistor from producing improper reverse voltage, as well as the protection of excessive current at both ends of the motor and the current on the transistor.

In the experiment, the voltage of the control system is 5V power supply. Therefore, if the base of the composite tube is directly controlled by the control system, the maximum controlled voltage is 5V. There is a voltage drop in the triode itself. The voltage at both ends of the motor is about 4V, which seriously weakens the driving force of the motor. Therefore, we can use tlp521-2 optocoupler integrated block to isolate the control part from the motor driving part. The driving current of the optocoupler is increased by a triode at the input end, and the motor driving part is driven by an external 12V power supply. In this way, the isolation between the modules is improved, and the driving current is greatly enhanced.

3. Commissioning

3.1 Software

For a system, without the support of hardware, it is meaningless, but if there is no software, the application range of hardware will be greatly limited. The design of software is very important in most systems.

In this design, the programmable device is STC80C51, and the programming language is assembly language. The software design includes several aspects: digital display, motor driver subroutine.

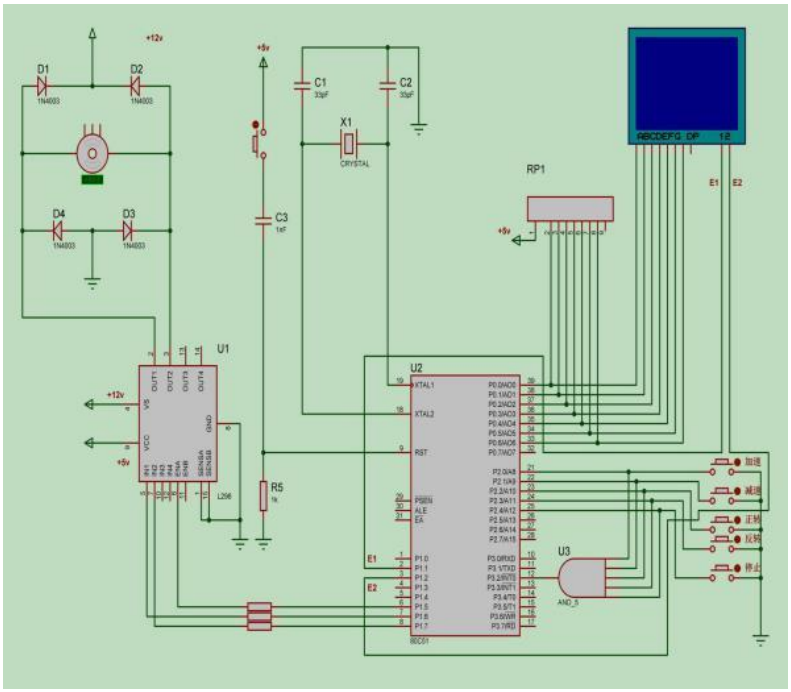

Fig.2 hardware schematic diagram

In order to let the digital tube display the number, the software control is needed, and the binary code is required to realize the control of the luminous section of the digital tube. Tab: DB 0c0h, 090h, 0a4h, 0b0h, 99H, 92h, 82H, 0f8h, 80h, 90h digital tube display uses dynamic scanning: dynamic scanning is based on the visual persistence principle of the human eye, as long as the scanning frequency is not less than 24Hz, the human eye can not feel the flicker of the display. The 24 Hz scanning pulse of the system is provided by the corresponding peripheral circuit. The key to the design of dynamic scanning

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circuit is that the bit selection signal should correspond with the displayed data one by one in sequence, so the synchronous pulse signal must be provided in the circuit.

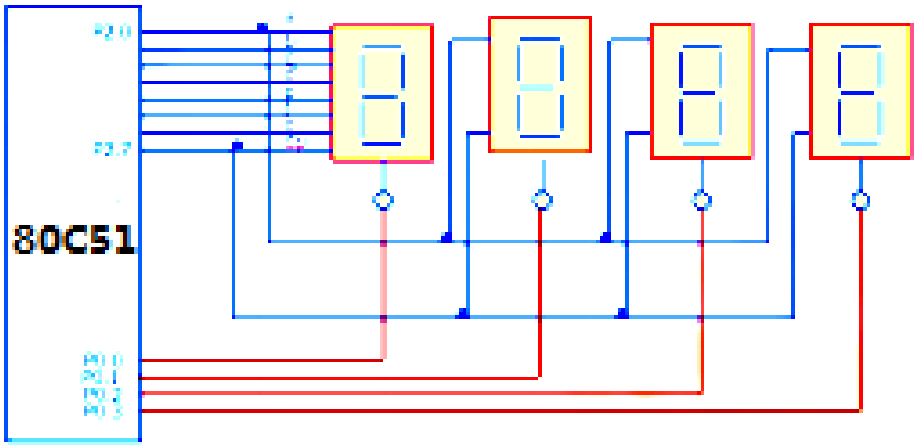

Fig.3 single chip microcomputer and led connection

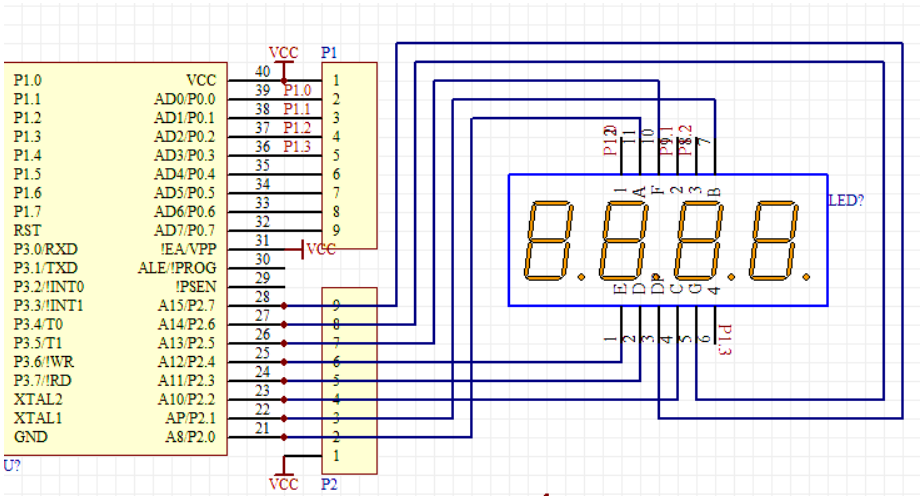

Fig.4 single chip microcomputer and led connection

Motor control subroutine is a cycle program, its main idea is to set the initial speed value, use the initial value and the value from the speed control system, and then use PI algorithm to output control coefficient to PWM generator circuit, change the duty cycle of waveform, and then control the motor speed. The program flow chart is shown in the figure. The software consists of a main program, an interrupt subroutine and a PI control algorithm subroutine. The main program is a cycle program. The main idea is that the data generated by the P1 port of MCU is sent to the PWM signal generating circuit, and then the PI algorithm is used to output the control coefficient to the PWM generating circuit to change the duty cycle of the waveform and then control the motor speed.

4. Conclusion

PWM technology is the most effective method in DC motor speed regulation. In this paper, the H-type bridge driving circuit based on PWM technology is used in hardware to solve the efficiency problem of motor drive. In software, a more reasonable system structure and algorithm are used to improve the efficiency of single-chip microcomputer, and has certain anti flying ability. The DC motor speed control system described in this paper is based on STC80C51, which is a low-cost single-chip microcomputer. There are many ways to adjust the motor by single-chip microcomputer. Compared with other methods of hardware or combination of hardware and software, the speed

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regulation process realized by PWM software method has greater flexibility and lower cost, and it can be used to adjust the motor It provides an effective way for the realization of simple speed control system

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Project Name: equipment development of industrial image surface defect detection and classification system based on deep learning.

Fund Project: Xi'an Aeronautical University (2020HX019).

Project Name: Research on LCL control stability technology of grid connected inverter.

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