

The Design of Digital Servo-Position Control System Based on LM629

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Abstract—The paper is concerned with the digital design of the system of servo-position control for medium-low power DC motor. The paper will be focused on the digitization design of the system. Principle of PWM will be given first in this paper. According to the theory of PWM rules and the knowledge of computer control technology, the paper will design the digital servo-position system that has a good characteristic of stability and dynamic response.

Keywords— motor control; PID; PWM; LM629; LMD18200

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1. INTRODUCTION

DC motor has a good characteristic of linear speed control. With simple control method, we can obtain higher power efficiency and approving dynamic response. Because of the above reason, the DC motor is widely applied to the engineering practice. A simple digital control system of DC motor will be designed in this paper.

The rest parts of the paper are organized as follow. In Section II, the basic knowledge of traditional method of DC motor control, and its ntages and advantages will be presented. The reason for why the digital system is needed will be introduced. In section III, design process will be detailed presented how to complete the design of the digital control system. In section IV, conclusion will be given.

2. PROBLEM STATEMENT

With the development of modern science and technology, the performance requirement of control of DC motor is always increasing continuously. The characteristic of stability and dynamic response gets more and more important. How to enhance the performance of control system in the engineering practice is paid more attention. It is the main objective to enhance the performance of stability, dynamic response and precision especially in subtle industry^[1].

The traditional method of control for DC motor is analog. All regulators are based on operational amplifier. Analog system is clear in conception, and easy to comprehend for beginner. But the control law in

analog system is based on hardware. So the line of system is complex, and the universal of system is bad. The stability of system is always influenced by temperature and the performance of devices. With the development of computer control technology, the digital system attracts more and more attention. In the characteristic of stability, and universal, the digital has more advantages than the analog. This paper will discuss a digital control system that overcomes the disadvantages of analog^[2].

3. SOVE THE PROBLEM

The core of digital system is microprocessor. It has a good characteristic of standardization, and its cost is low. The stability of system is not influenced by temperature. The control law is based on software. The system can realize complex control method. Besides, the digital system has the function of data storage, communication and fault diagnosis that the analog system can not realize. Because the digital system can only accept digital signal, so the system has the characteristic of digitization and discredization.

This paper adopts the principle of PWM to control the DC motor of medium power via PID control algorithm. And use LM629 (motion-controlling chip), LMD18200 (driving chip for DC motor) and C8051 (single chip) to complete the main functions of system. The system also has the fuction of communication with the upper computer. The following will introduce the digital system detailedly^[3].

3.1 Some Basic Principles About PWM

- PWM is the abbreviation of Pluse Width Modulation. PWM can adjust the armature voltage via adjusting the width of digital pluse by switching the power transistor on or off. . It is a effective method to control the analog system by the digital output that produced by microprocessor or appropriate chip such as LM629^[4].

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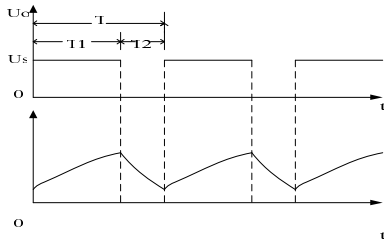


Figure 1. Schematic diagram of PWM

- LM629 is a motion-controlling chip made by NS. LM629 can be controlled by digital signal. And this chip can realize the control law of PID.
- A digital system can easily be constructed by one single chip, one LM629, one power driving chip (this paper we use LMD18200 to construct the digital system), one photoelectric coded disk and one DC motor [5].

3.2 According to our choice of PID control algorithm, the appropriate chip and the PWM principle diagram, the design of the core of the system as follows:

- The appropriate chip LM629 has many powerful functions such as the output of PWM, the realization of PID control algorithm.
- It has 32 bits register of position, velocity, and acceleration 16 bits programmable PID controller. The chip can communicate with the single ship.
- The value of register can be set by single chip.

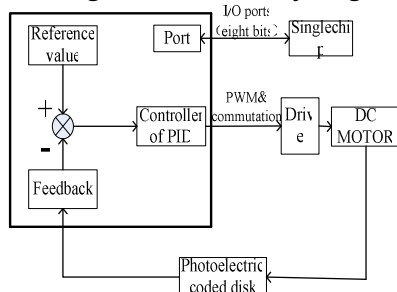


Figure 2. System chart of LM629

3.3 Design Of The system

Hardware

1. microprocessor

This paper adopts C8051 as the microprocessor which is a analog and digital mixed-signal chip. The instruction set of chip is compatible with 8051's. The chip has four 16 bits register of timer/counter, one UART, 256 bytes of RAM, 128 bytes special registers (SFR), and I/O ports of 4 bytes [6]. C8051 will be responsible for the initialization of LM629, and communicate with the upper computer in this paper.

2. LM629

LM629 is a motion-controlling chip which is the core of the digital system. The chip is responsible for the stability of the system. The control algorithm is done by it. The chip accepts

instruct or data from the C8051, such as the instruct of start or stop, and the data of the parameters of control algorithm.

3. LMD18200

LMD18200 is a integrated chip for the driving of DC motor made by NS. The chip is appropriate for medium-low power DC motor which can be responsible for the bipolar/unipolar and reversible PWM control. The functions of this chip is as follows: rated current 3A, peak point current 6A, supply voltage 55V, rated output current 2A, rated output voltages 31V [7]. The chip can realize the control of PWM via accepting the signal of PWM.

4. Upper computer

The system of this paper can be controlled the upper computer via the serial port of RS232. The system can complete functions such as the start of DC motor, the parameter passing of control algorithm.

According to the hardware introduced by this paper, the block diagram of system as follows:

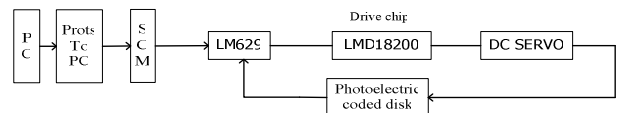


Figure 3. Block diagram of digital system

Software

The program of lower computer is mainly responsible for the initialization of system, communication with upper computer, passing the parameters of control algorithm of PID to LM629. The flow chart as follows:

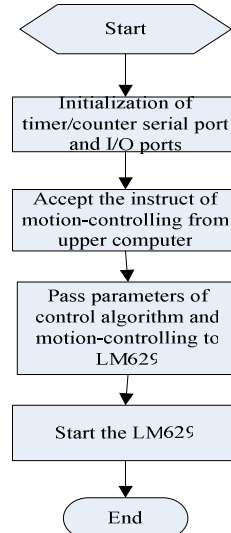


Figure 4. Flow chart of lower computer

The program of lower computer is developed by assembler language and by building block design.

The upper computer is responsible for communication with the lower computer which is designed by visual basic 6.0 based on the operating system MS..

The control algorithm of incremental PID is done by LM629 in this paper. The formula of control algorithm as follows:

$$u(k) = K_p e(k) + K_i \sum_{j=0}^k e(j) + K_d [e(k) - e(k-1)] + u_0 \quad (1)$$

K_p is the coefficient of amplifier; K_i is the coefficient of integrator; K_d is the coefficient of differentiator. In the formula, $K_i = \frac{T_s}{T_I}$, $K_d = \frac{T_D}{T_s}$ is sampling period. u_0 is the reference of controlled variable[8]. The control algorithm of incremental PID's detailed flow chart as follows:

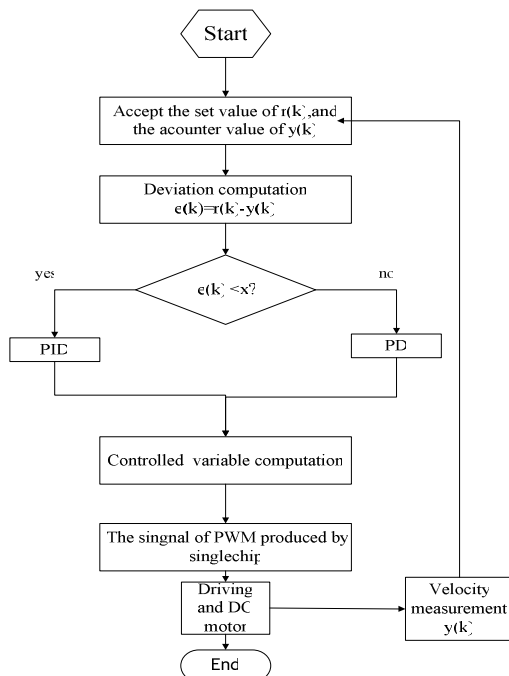


Figure 5. flow chart of control algorithm of

PID

At the end, we give the initializer of program of system as follows[10]:

Initializer:

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MOV XBR0,#00010110B
MOV XBR1,#00100100B
MOV XBR2,#01000000B
SETB
MOV PRT0CF,#01010101B
MOV PRT2CF,#00000000B
MOV P2,#0FFB
MOV OSCICN,#05H
MOV PCA0CPM0,#21H
MOV PCA0MD,#02H
.....

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4.EXPERIMENTS AND RESULTS

To illustrate the performance and the effectiveness of the servo-position digital control system, some simulations are conducted on the industrial field. After testing, the index of time-domain response, the stability of system can meet the requirement of industrial field.

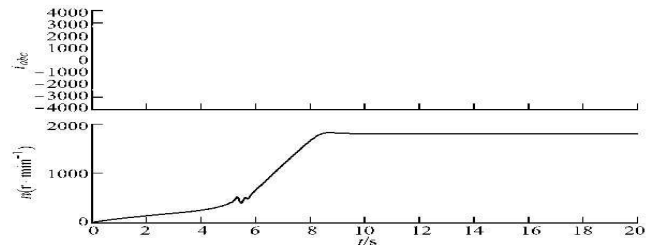


Figure 6. curve of DC motor speed

CONCLUSION

In this paper, we mainly introduce the hardware design of the digital Servo-position control system, the design of program is given priority to introduce. Traditionally, the analogy system is major means to control the DC motor. But the analogy system's stability is a big problem in engineering practice. Besides, the characteristic of universal of analogy system is bad. With the circuit manufacturing technology developing to high speed, high density and low-power, modern circuit design techniques have also taken place in a fundamental change. In this paper, we introduce the design of system based on integrated chip that has a good characteristic of stability and universal. The digital system can solve the problems we mentioned above. But there are also many problems that are needed us to research.

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