

Design of Speed Control System based on PID

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Abstract

This paper designs a speed control system based on PID algorithm. It is composed of motor, encoder and driving circuit, Arduino MCU, Bluetooth, etc. Arduino MCU is used as the main controller, and app inventor 2 is used to write mobile phone app. The target speed and PID parameters can be set in the mobile app, and the motor response curve and related parameters can be displayed in real time.

Keywords

Arduino single chip microcomputer, PID algorithm, Appinventor2.

1. Introduction

Motor speed control based on PID algorithm is a typical training project of speed measurement experiment in sensor course. The difficulty of PID control is the parameter tuning of the controller, and the key of parameter tuning is to correctly understand the influence of each parameter in the control system. In the traditional experiment, due to the limitation of the experimental equipment, the PID calculation program is fixed in the intelligent regulator, students shall connect the circuit according to the fixed experimental steps, which is not a favor to the students' self-design and secondary development. The experimental results are abstract, which leads to the unsatisfactory experimental results. In this paper, the design of speed control system based on PID algorithm can improve the speed measurement accuracy and shorten the experiment time of the original speed measurement and control experimental platform.

2. Design of system framework

The speed control system based on PID control algorithm is shown in the figure 1. The hardware circuit of the system consists of motor and encoder, drive circuit, Arduino MCU and Bluetooth module. Software programming mainly includes two parts: 1. The Arduino program of data processing and PID calculation received from Bluetooth of mobile phone in arduinoide software; 2. Mobile App which can send data and draw PID curve on mobile phone in appinventor 2 software.

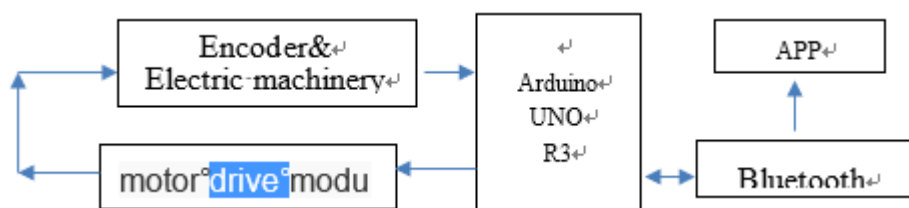


Fig. 1 System block diagram

3. Design of hardware circuit

3.1 motor and coding circuit

This design uses Marlboro to FC130SA motor with 334 line AB phase encoder at the tail, where B phase is used as an output. The PWM signal output by MCU controls the speed of motor in motor

driving module. In the timer timing time, external interrupt is used to count the falling edge of the coded motor output pulse to obtain the current speed.

3.2 Two way H-bridge stepping motor drive module

When PWM signal is used to adjust the speed of the motor, the load capacity of Arduino is too weak to be directly output to the motor, so the motor drive module is needed. The bidirectional H-bridge stepper motor driver module L298N can drive two DC motors at the same time. In this design, a circuit is used.

3.3 Design of bluetooth circuit

Bluetooth module is used for wireless transmission. After each Bluetooth device is paired successfully, Bluetooth can be used as a serial port regardless of the Bluetooth internal communication protocol. Design of Bluetooth module uses hc-06, whose instruction is less than hc-05 and is easy to use.

3.4 Design of the main control system

Arduino mainly completes three main functions: counting motor pulse, calculating PID and receiving and processing text information. Arduino UNO digital pin 5, 6 outputs PWM signal to motor drive circuit pin in1, in2, motor-b output of motor drive circuit connects Marlboro to fc130sa motor +, motor -, the B-phase output signal of motor is connected to Arduino uno digital pin 3, and the motor output pulse number is obtained through external interrupt. TX and Rx of Bluetooth module are cross connected with TX and Rx of Arduino UNO.

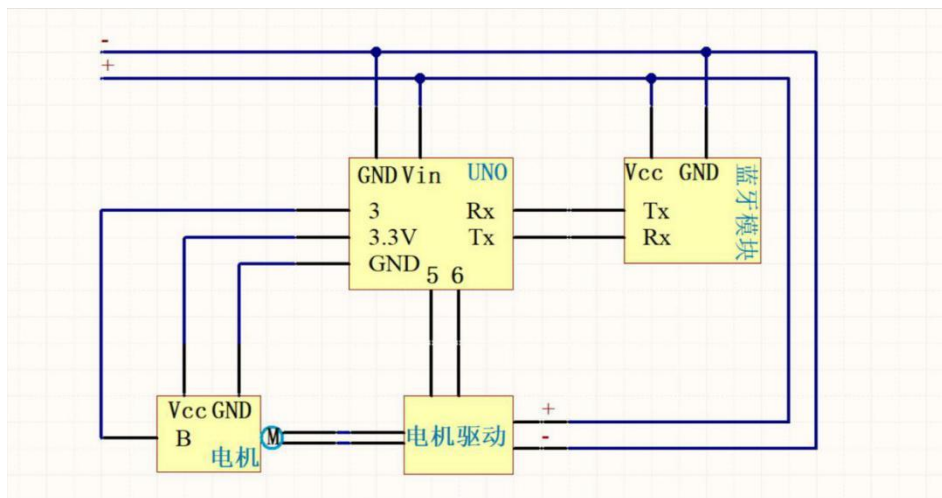


Fig. 2 System hardware circuit schematic diagram

4. Design of software

4.1 Program design of Arduino

The external interrupt pin 3 of MCU is connected with the B-phase output of motor encoder, and the pulse number of motor output is obtained by external interrupt. When the serial port receives the string sent by Bluetooth, the serial port interrupt will be triggered, the data will be stored in the buffer, and the data will be extracted from the buffer through the Serial-readString function. After receiving the string, the data treating function is activated to process the data to obtain PID parameters and speed target value. Here, in order to save the running time of the motor, a 10 s time limit is set. Timer 2 is used to sample the motor speed every 100ms, and the obtained PID parameters and speed target value are brought into the PID algorithm formula for calculation. Finally, the PWM value of the motor is obtained to control the motor operation, and the motor pulse number is sent to the mobile phone

through the serial port. When the sampling frequency reaches 100, that is, 10s, the motor stops running. The program flow chart is shown in Figure 3.

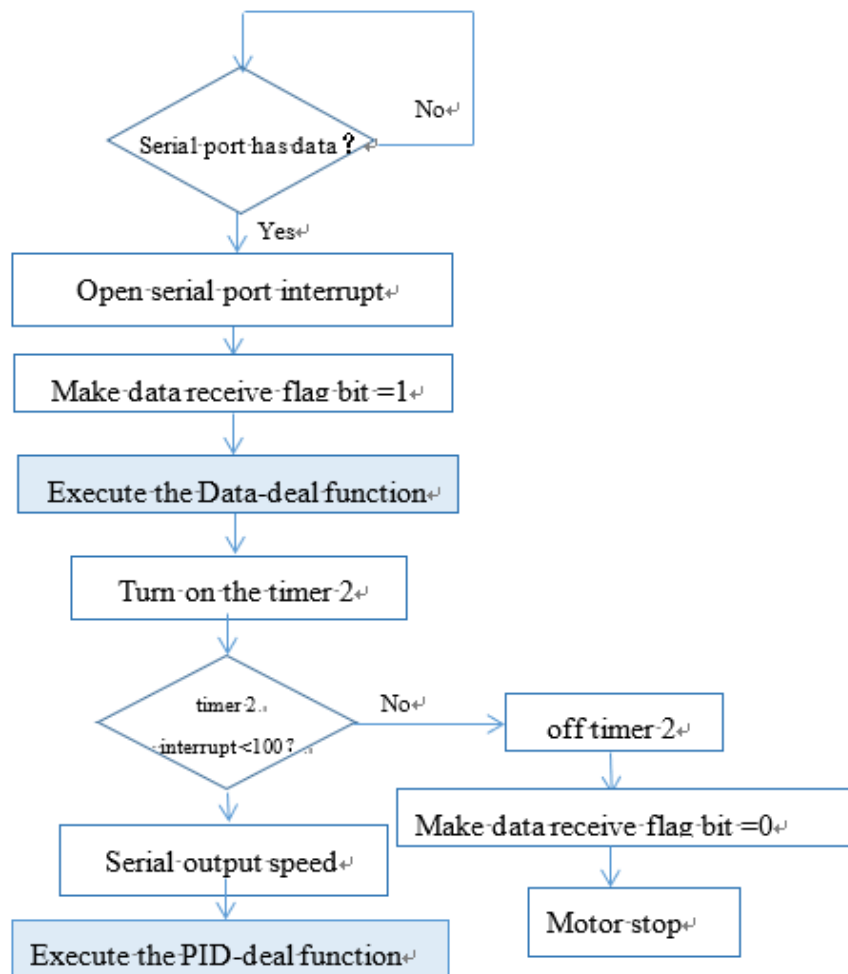


Fig. 3 low chart of PID speed control program

4.2 Program design of Appinventor2

4.2.1 sending program

The mobile app program includes two parts: sending program and receiving program.

The sending program sends the KP, Ki, KD parameters and speed target values setting at the mobile terminal. In the way of text sending, although sending text may be slow in speed, it reduces the program of data packaging, reduces the difficulty of programming, and sends more data with more flexibility. The program flow chart is shown in Figure 4.

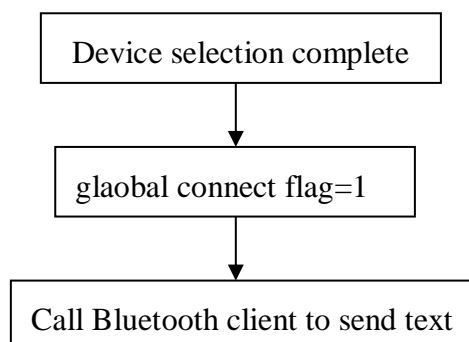


Fig. 4 Program flow of sending data on mobile phone

4.2.2 receiving program

After sending the PID parameter and the target speed value, the program clear the receiving list, and then query the counter to see if there is any data in the Bluetooth data cache. If there is any new data, read it and append it to the end of the receiving list. Then the drawing function is invoked in the timer. The drawing function is divided into two parts, one is to draw points, according to each speed value, the corresponding coordinates are marked in the form of dots; the other is to draw lines, and the adjacent points are connected by line segments. The program flow chart is shown in Figure 5.

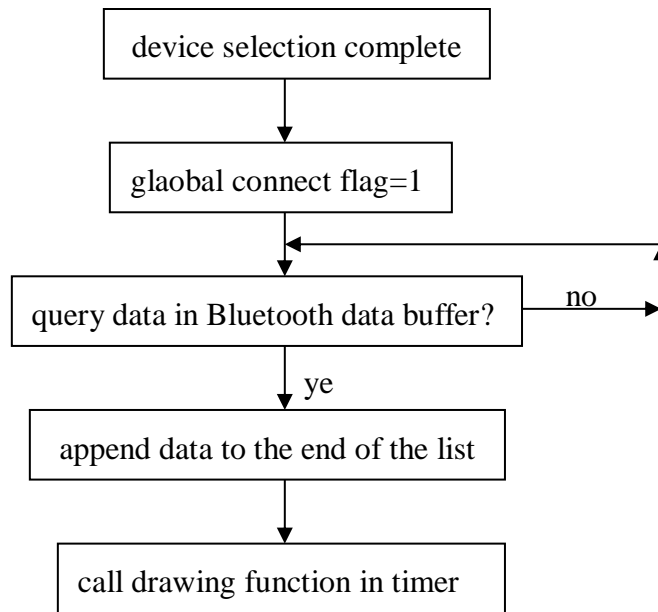


Fig. 5 Program flow of drawing PID curve on mobile phone

5. System tests

5.1 The method of PID parameter tuning

In this design, the trial and error method is used to adjust the parameters. Adjust the parameters according to the order of proportion, integration and differential. From small to large, find out the small overshoot KP; the integral time constant T_i changes from large to small, adjust KP appropriately; the differential time constant T_D changes from small to large, adjust T_i and KP appropriately. Try again and again until the speed meets the requirements.

5.2 Define the value of PID parameters

When the parameters KP: 0.1, K_i : 0.1 and K_d : 0.1, the response curve can achieve good control effect. The results are shown in Figure 6.

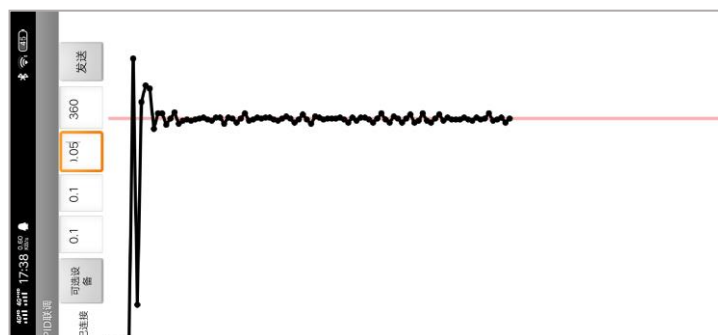


Fig. 6 Program flow of drawing PID curve on mobile phone

6. Conclusion

In this paper, Arduino and appinventor 2 software is used to complete the software and hardware design of the speed measurement and control system, which realizes the fast and accurate control of the speed. The research of speed regulation experimental platform based on PID algorithm is of great significance to the accuracy of speed regulation experimental platform, and to the automation, intelligence and simplicity of experimental equipment.

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