ISSN: 2414-1895 DOI: 10.6919/ICJE.202207_8(7).0078

Design of High-speed Motor Speed Monitoring System

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Abstract

Speed measurement is an important technology in modern industrial production, and the complex and changing external environment has put forward higher requirements for the design of motor speed monitoring. Based on the non-contact monitoring and measuring environment, it is proposed to use microcontroller to measure the real-time rotational speed of DC motor by photoelectric sensor, use microcontroller as the measuring control chip, use photoelectric encoder to measure the real-time rotational speed of motor, set the adjustable speed alarm value by key, the real-time rotational speed of motor can be displayed on LCD1602 screen simultaneously, and finally use buzzer and LED light to alarm. The design includes system hardware device selection, hardware circuit design, system software debugging, and finally realizes the function of motor speed monitoring and overspeed alarm. This design has certain significance for high-speed motor speed monitoring in non-contact environment.

Keywords

Microcontroller; Motor; Optical Encoder; LCD Liquid Crystal Screen.

1. Introduction

Speed monitoring is an important measurement parameter for high-speed motors, flywheels and other devices [1]. Most of the traditional rotational speed measurement is contact and requires external connection line, while photoelectric rotary encoder has become a hot direction for rotational speed monitoring due to its advantages of no contact and high accuracy, while microcontroller has become a primary choice for rotational speed measurement chip due to its low price, low operation difficulty, wide range of applications and high stability [2]. In this design, the photoelectric rotary encoder is used, and it is easy to measure the real-time rotational speed of the high-speed motor by using the extremely strong processing ability of the microcontroller for pulse signals and applying the fully digital display module, which is reasonably utilized.

2. Overall Design Idea Diagram

2.1 Idea Design

The overall design idea is to pick up the feedback photoelectric signal from the rotor operation through the photoelectric rotary encoder, the signal is sent to the internal microcontroller for processing after the frequency rectification and frequency multiplication process, at this time the key can set the alarm value when the system is running, and then the internal driver circuit of the microcontroller will send the processed information to the LCD liquid crystal display for display, the overall design block diagram is shown in Figure 1.

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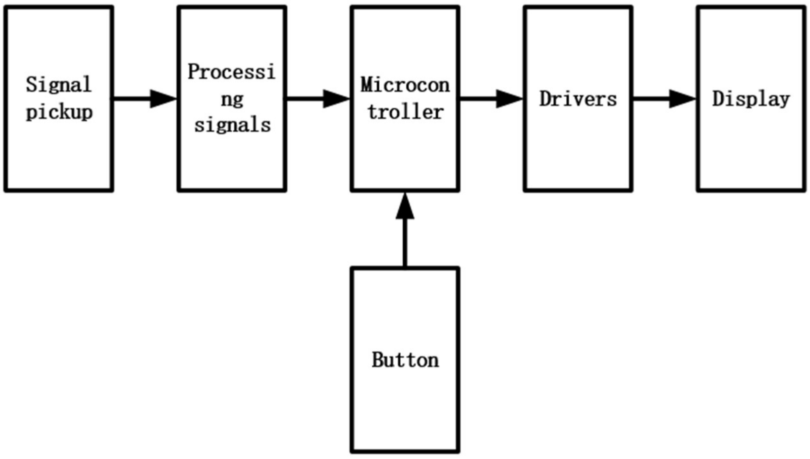

Figure 1. overall design block diagram

2.2 Control Chip Design

The main controller module STC12C5A60S2 is a new generation of 51 series microcontroller developed by STC, combining the old version of the ordinary 8051 microcontroller in the original various functions to improve and technical breakthroughs, belonging to the evolutionary version of high operating speed, ultra-low power consumption of the 8051 microcontroller. An additional communication port, STC12C5A60S2 is based on the 51 core of the 51 microcontroller memory space, running speed are greatly improved, cost-effective, low-cost, and easy to grasp, running speed is about 10 times faster than the ordinary version of the 51 microcontroller [3]. This chip includes eight 10-bit A/D digital-to-analog conversion, 60K high-capacity ROM, two timers with PWM function, two clock sources inside and outside, 8-12MHz when the supply voltage is 3V, and 11-15.5MHz when the supply voltage is 5V [4], and the control chip is shown in Figure 2.

Figure 2. STC12C5A60S2 Chip

2.3 Rotary Encoder Design

The encoder has 6 control lines, of which the machine line VCC and encoder GND and VCC are connected to independent power supply 5V. encoder A phase is connected to the P32 pin of the microcontroller for measuring the rotation speed of the motor, encoder VCC and GND are connected to +5V power supply and ground respectively, meanwhile the processor will control the I/O port through P32 to get the current pulse information of the measured motor and calculate the current The current rotation speed will be calculated. This high-speed motor speed monitoring system design will use the speed module FC130SA code disk speed motor to complete, the motor comes with a coding circuit, the motor rotation will send out 334 pulse cycles, the motor code disk has 334 black and white interval grating, when the infrared tube on the module emitted infrared ray hit the grating blank, the infrared ray will return to be received by the receiver and output a pulse, when the infrared ray hit the grating blank, the infrared ray will return to be received by the receiver and output a pulse. When the infrared rays hit the black grating, the infrared rays will not be received and there will be no pulse output. When 334 pulses are detected continuously, it means that the current speed measuring motor

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has worked for one revolution, and the speed measurement is performed by the above principle [5], and the rotary encoder is shown in Figure 3.

Figure 3. Rotary Encoder

2.4 Overall Design

The design of this high-speed motor speed monitoring system mainly includes several parts such as microcontroller system, relay system, LCD display, buzzer circuit, power supply circuit, motor, etc. The overall block diagram of the system is shown in Figure 4, and the overall schematic diagram is shown in Figure 5.

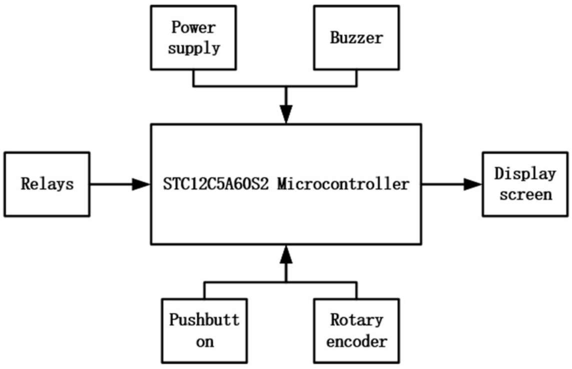

Figure 4. Overall system block diagram

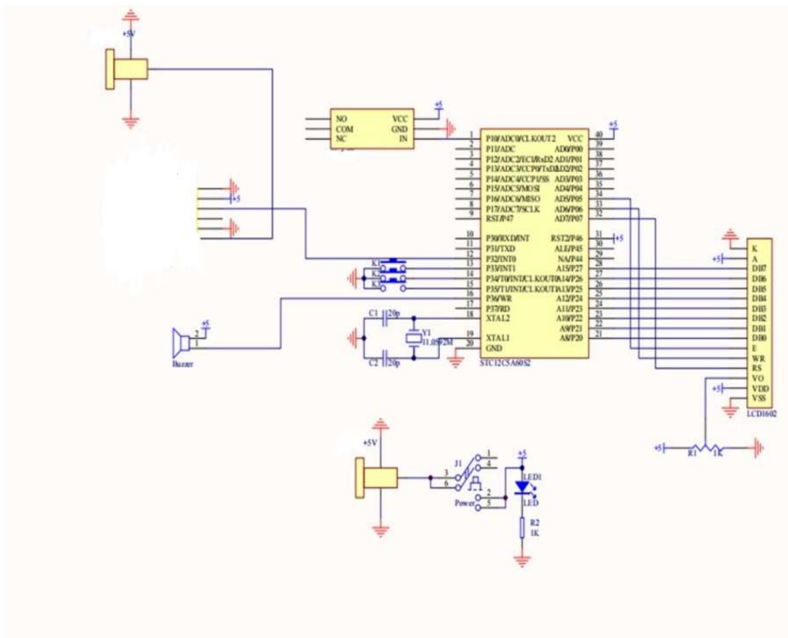

Figure 5. Overall design schematic diagram

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2.5 System Software Design

The system uses more modules, so the software programming method uses modular programming to realize the software control functions of individual modules, and then combine each module to use jointly. In each module programming software C function first to the module used in the function and global variables first defined, including the timer, counter, interrupt program and other detailed software programs, through the keil 51 system program burned into the microcontroller system, the software part also basically meet the design requirements, the microcontroller application must be developed and debugged to use, the current development tools are programmer and emulator two [6]. Using keil4 software for software programming, in the software programming, first of all, according to the hardware design of the I/O port, to the system module to define the microcontroller control of the I/O port, the following figure is the system software I/O port allocation software programming interface, I/O allocation interface as shown in Figure 6.

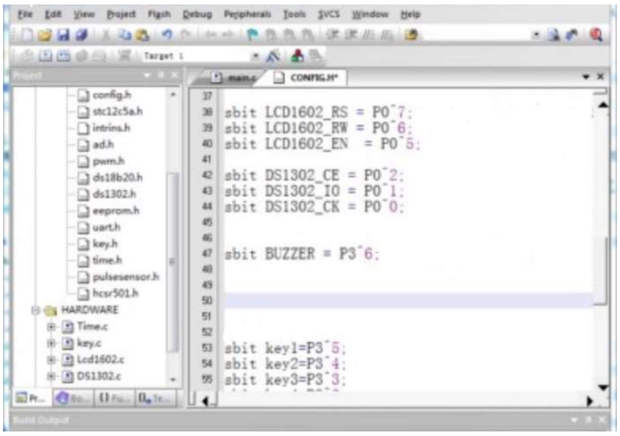


Figure 6. I/O assignment interface diagram

3. System Testing and Analysis

3.1 Image Acquisition

After the physical soldering can write the program, in general, write the program and debugging procedures are carried out together, welding the device and then the part of the program burned into the microcontroller, and then debug whether the part of the software function, if not, modify the program until the part of the function to achieve, and then the next part of the software writing, so that step by step each program one by one All written. When writing the program, in the absence of the LCD screen, you can use the serial debugging assistant to assist in completing the test of the function, in the use of the serial debugging assistant STC-ISP-15XX-V685F to assist in completing the test of the software function When the program is written, if you need to verify whether the data output from the program is the data you want, you can first verify through the serial port assistant, the verification method The console will display the required data in the receiving buffer of the serial assistant, and finally after the debugging is completed, the final complete hardware physical diagram is shown in Figure 7.

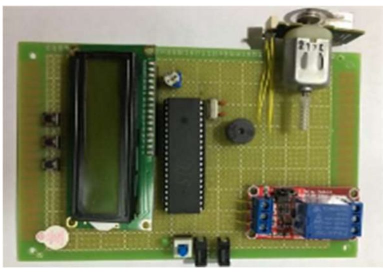


Figure 7. Complete hardware diagram

Volume 8 Issue 7, 2022
DOI: 10.6919/ICJE.202207_8(7).0078

3.2 Physical Testing

After burning the software program of the system into the microcontroller system, the power is turned on for physical debugging. After a series of debugging such as device welding, program writing, software debugging, and physical testing, the hardware system is connected to the power supply and the power switch is pressed, and the initial LCD screen displays the results as shown in Figure 8.

Figure 8. Initial LCD display results

In order to test the function of the system over-speed alarm, the initial speed of the system is about 3200r/min, the first time the alarm value is set to 3300r/min, you can see that the system is running normally, the buzzer will not alarm, later do two sets of verification experiments, change the alarm value of the system, set the alarm value to 3100r/min, the above operation can be seen in the system after the power is turned on, the buzzer alarm, by manually adding resistance to the motor to reduce the speed, the buzzer will no longer alarm, the experimental verification results are shown in Figure 9.

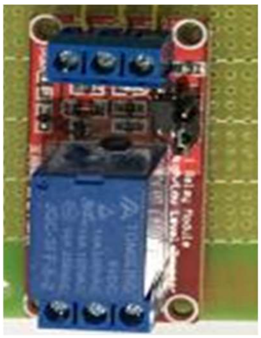
Scenario 1	Scenario 2
 Set alarm value	 Set alarm value
 Speed below alarm value	 Speed higher than alarm value
 Alarm light is not working	 Alarm light is working

Figure 9. Verification Testing

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Repeat the above operation, the alarm value set to 3000r/min can also be found to have the above conclusion, this physical commissioning to achieve the design requirements function.

4. Conclusion

The design uses a non-contact photoelectric sensor to monitor the motor speed through a rotary encoder, which has some significance for motor rotor monitoring systems that require no contact. It provides a new design idea for rotational speed monitoring in industry, and functions such as overspeed alarm can guarantee the safety of equipment as well as users. The overall design cost of the system is low, and it is believed that it can become a favored way in industrial production in the future, which has certain practical significance.

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