Sliding wire detection system of electric lock screw tool based on motor characteristics

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Abstract: This paper presents a sliding wire detection system of electric screw locking tool based on the characteristics of motor. The system can judge whether the screw has sliding wire through the current change of motor during normal operation, and realize the real-time detection and alarm of sliding wire. The system has the advantages of high sensitivity, low cost and high accuracy. It can be widely used in automatic assembly and other fields.

1. Introduction

The electric screw locking tool is a device that uses the motor to drive the screwdriver head clamped by the clamp to rotate to lock the screw \cite{1}. It is an automatic tool and is often used in life and production practice. However, in practice, it is found that the sliding wire sometimes appears when assembling the screw with this tool, but it is difficult to find this sliding wire in the process of assembly. If the sliding wire is not found and treated in time, the sliding wire will cause poor assembly, which will seriously affect the product quality \cite{2}. From the perspective of physics, there are several reasons for the "sliding wire" of screws: first, excessive force or deviation; Second, the device is worn too much; Third, the material quality is too poor. At present, the existing slip wire detection system mainly uses the torque (moment) sensor to measure the change of torsional force when installing screws to detect whether there is slip wire. This system has two disadvantages: 1) the cost of torque sensor is often high; 2) The installation of torque sensor will change the overall structure of the tool and increase the volume, weight, inertia and complexity of the tool. This change can not meet the production needs in some occasions. For the above reasons, many enterprises hope to develop a simple and low-cost sliding wire detection device for electric lock screw tool, which can realize real-time detection and alarm of sliding wire \cite{3}. In order to solve the above problems, this paper provides a sliding wire detection system and method based on motor characteristics, which can realize real-time detection and alarm of sliding wire.

2. design principle

2.1. Design ideas

The schematic diagram of sliding wire detection system of electric lock screw tool based on motor characteristics is shown in the following figure; Under normal conditions, at the initial stage of locking
the screw\cite{4}, the torque is small and the motor load is small, so the current is also small\cite{6}. With the progress of the screw entering the nut, the torque becomes larger, the motor load becomes larger and the current becomes larger, and then gradually tends to be stable; Once the sliding wire occurs, the output torque decreases sharply, the motor output power decreases rapidly, and the current decreases accordingly. Therefore, whether there is sliding wire can be judged by the change of current during normal operation of the motor.

Figure 1 schematic diagram

2.2. Image expansion

Stm32f103c8t6 control core is adopted, including a / D conversion module, clock pulse generation module, buffer module, comparison module and counting module; In principle, the system adopts 12 / 24V power supply, which can be powered by DC voltage stabilization. It can convert the voltage to 5V and 3.3V through the step-down chip, which can supply power to the nixie tube and the single chip microcomputer respectively. The system can drive the motor by the motor. The chip iport port is connected with the ADC port of the single chip microcomputer to process the detected current, which is displayed by the nixie tube, and the system judges whether the current is too large, The alarm is carried out by the alarm circuit. The hardware circuit diagram is shown in Figure 2;

Figure 2 Circuit diagram
3. System design
At the beginning of the system, the current wire of the motor is connected to the analog input terminal of the A / D conversion module, the first digital output port of the A / D conversion module is connected through the buffer module and the second signal input terminal of the comparison module, the second digital output port of the A / D conversion module is connected with the first signal input terminal of the comparison module, and the signal output terminal of the comparison module is connected with the signal input terminal of the counting module. The signal output end of the counting module communicates with the signal input end of the alarm system and post-processing system; The motor switch is connected with the control end of the motor and the clock pulse generation module, the first pulse output end of the clock pulse generation module is connected with the buffer of the A / D conversion module and the external clock pulse input end of the comparison module, and the second pulse output end of the clock pulse generation module is connected with the reset signal input end of the buffer module, the comparison module and the counting module, Determine whether there is sliding wire through the current change of the motor during normal operation, as shown in Figure 3, the structure diagram of a sliding wire detection system of electric screw locking tool based on motor characteristics;

![Figure 3 System diagram](image)

4. Working process

4.1. The analog quantity of current is converted into the digital quantity of reaction current value
The motor switch is closed, the motor starts to run, and the clock pulse generation module starts to work; The clock pulse generation module sends clock pulses to the A / D conversion module, cache module and comparison module every other time. After receiving the first clock pulse of the clock pulse generation module, the A / D conversion module converts the analog quantity of motor current into a digital quantity reflecting the current value.

4.2. Sliding wire phenomenon

4.2.1. Receiving pulse
The A / D conversion module converts the motor current analog quantity into the digital quantity reflecting the current value and transmits it to the first digital quantity output port of the A / D conversion module. After receiving the first clock pulse of the clock pulse generation module, the cache module reads it from the first digital quantity output port of the A / D conversion module and stores it in the cache module. The comparison module does not act after receiving the first clock pulse of the clock pulse generation module.

4.2.2. The comparator compares the digital quantity at the signal end
After receiving the second clock pulse of the clock pulse generation module, the A / D conversion module converts the analog quantity of motor current into a digital quantity reflecting the current value,
and transmits it to the first digital output port of the A/D conversion module; After receiving the second clock pulse of the clock pulse generation module, the cache module transmits the existing data of the cache module to the output end of the cache module, and then reads it from the first digital output port of the A/D conversion module and stores it in the cache module; After receiving the second clock pulse of the clock pulse generation module, the comparison module reads the second signal input of the comparison module from the output of the buffer module, reads the first signal input of the comparison module from the second digital output port of the A/D conversion module, and compares the values of the first signal input and the second signal input. If the value of the first signal input is less than the value of the second signal input, the output A of the comparison module outputs a pulse, otherwise the output B of the comparison module outputs a pulse.

4.2.3 the pulse generator ends sending pulses
After receiving the third clock pulse of the clock pulse generation module, the A/D conversion module converts the analog quantity of motor current into a digital quantity reflecting the current value and transmits it to the digital quantity output port of the A/D conversion module; After receiving the third clock pulse of the clock pulse generation module, the cache module transmits the existing data of the cache module to the output end of the cache module, and then reads it from the first digital output port of the A/D conversion module and stores it in the cache module; After receiving the third clock pulse of the clock pulse generation module, the comparison module reads the second signal input of the comparator from the output of the buffer module, reads the first signal input of the comparison module from the second digital output port of the A/D conversion module, and compares the value of the first signal input with the value of the second signal input. If the value of the first signal input is less than the value of the second signal input, the output A of the comparison module outputs a pulse, otherwise the output B of the comparison module outputs a pulse, and the operation is repeated until the clock pulse generation module no longer sends pulses.

4.2.4 sliding wire
Each time the counting module receives a pulse from the output terminal A of the comparison module, it will add one. Each time it receives a pulse from the output terminal B of the comparison module, it will reset the counter and count again. In this way, until the counting module reaches the set value n, the counting module outputs a pulse to the alarm system and post-processing system. At this time, the current values of N motors show a downward trend. If the load of the motor of the electric screw locking tool drops sharply, it indicates that there is a sliding wire phenomenon.

4.3 stop working
When the motor switch is disconnected, the motor stops running, the clock pulse generation module no longer sends clock pulses to the A/D conversion module, cache module and comparison module, and the A/D conversion module, cache module and comparison module stop working; At the same time, the clock pulse generation module sends reset pulses to the cache module, comparison module and counting module, all the input and output data inside the cache module and comparison module are cleared, and the counter is reset. As shown in Fig. 4, the work flow chart of electric screw locking tool based on motor characteristics is shown;
5. Conclusion
This paper presents a sliding wire detection system of electric screw locking tool based on the characteristics of motor \[^7\]. Through the current change of motor in normal operation, we can judge whether there is sliding wire, and realize the real-time detection and alarm of sliding wire. It has the advantages of high sensitivity, low cost and high accuracy.

Acknowledgments
National Science and Technology Major Project (No.2017ZX04011010)

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