

Design of Rotational Damping Test Device for Engine Spindle

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Abstract: The engine spindle rotation damping test device designed in this paper can detect whether the engine rotor system rotates well. As the core component of a miniature turbojet engine, the operating state of the rotor system directly affects the engine's operating state and service life. This design uses the STM32F407 microcontroller as the control core, and collects the engine speed and current value per unit time through the current sensor ACS712 and Hall speed sensor. The results show that the design can directly display the engine's rotational damping characteristics, ensure the safety of engine test run, and provide guidance for engine condition parameter binding.

1. Introduction

The safety inspection of the rotor system of the micro turbojet engine is an indispensable part in the safety inspection of the engine, because as the core component of the micro turbojet engine, the operating state of the rotor system directly affects the engine's operating state and service life. [1]

In reality, due to factors such as manufacturing and assembly errors, the rotor is unbalanced, by which the rotation damping of the main shaft is caused. Therefore, it is an important indicator for detecting whether the engine rotor system is in a good rotation state [2-3]. It is a good parameter affecting entire test process of engine start-up, normal operation, and stop.

At this stage, most of damping tests also depend on artificial experience. Because the damping of the engine's main shaft rotor system is completely determined by the manufacturing and process of parts, the technology gap between parts and components is large, and the skills of assembly workers are uneven [4-5]. Coupled with the late start and foreign technology blockade, the performance index of miniature turbojet engines is low, so it is necessary to measure the rotational damping to ensure the normal operation of the rotor system.

2. Working principle

This article provides an engine spindle rotation damping test device. It uses advanced sensors, intelligent damping algorithms, big data and other technologies to calculate the static and dynamic damping values of the engine by detecting the engine's speed and current value to ensure the proper rotation damping of the spindle in the cold state. The process is operated after assembling and before test to ensure turbojet the engine rotor system work well to avoid accidents during commissioning.

Engine main shaft and motor are supported by engine main shaft. The shaft is fixed on the slider by the bearing to ensure that the engine deviates from the position due to the reverse thrust when starting. In the system operating phase, the coupling is driven by the start of the motor to drive the simulated engine main shaft. The multiple sets of small magnets mounted on the engine and the Hall

linear sensor assembly are used to detect changes in the magnetic field to obtain the engine's value of the operating parameters. Through the change of parameters, the damping conversion formula is used to obtain the damping coefficient of the internal rotor of the engine, which is shown as Fig.2.

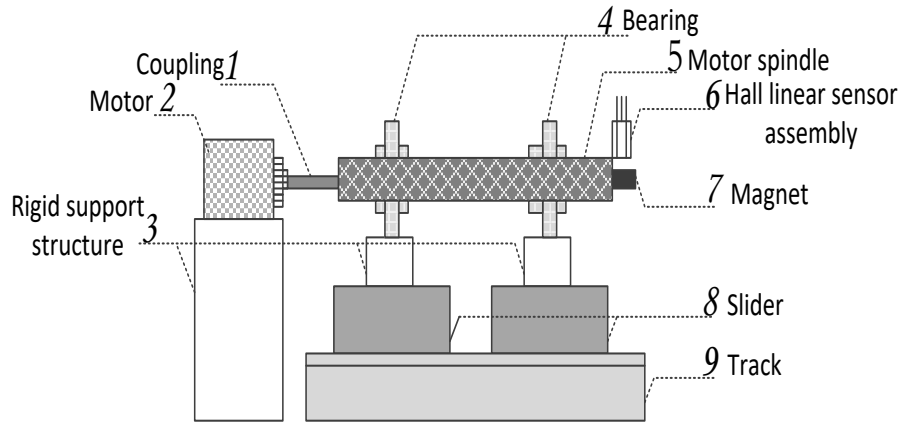


Figure 1. Mechanical structure

3. Hardware design

This design uses the STM32F407 microcontroller as the control core. By transplanting the UCOSII real-time operating system to the system, the drive circuit constructed with the TB6612FNG driver module and the key system are used to drive and control the start and stop of the starter motor and speed regulation, through the current sensor ACS712 and Hall speed sensor to collect engine speed and current value per unit time.

According to the characteristics of damping, the maximum value of static damping is equivalent to the maximum static friction force. According to the law of conservation of energy, just measuring the electromagnetic force of the starter motor at the instant of starting can get the static maximum damping. After the rotation speed of the simulation object is gradually increased by the starter motor, the rotation speed of the simulation object can be measured by the Hall element amplification circuit. through the PID control module. The speed of the simulation object is stabilized at the rated starting speed (5000r / min), when the simulation object enters a self-sustained running state. The main control unit stops the starting motor through the drive circuit, and then calculates the damping coefficient according to the figure of merit method and the viscous damping model, dynamically damping the average value. It also displays the damping value in real-time on the LCD. The field technicians use the internal damping value of the engine to control the engine operation. Make a judgment on the performance of the engine, and provide guidance for engine condition parameter binding. The above hardware design is shown as Fig.2.

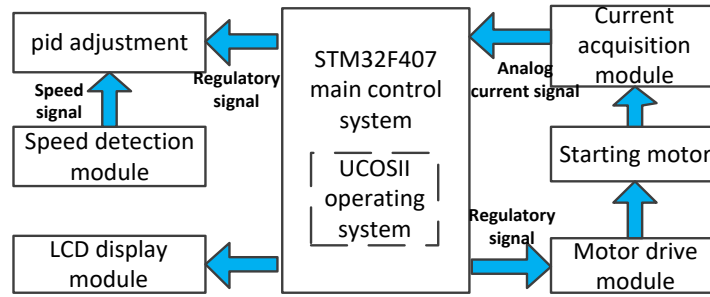


Figure 2. System block diagram

4. Software design

The functional block diagram of the overall module of the engine damping test program controls the start, stop, and speed change of the motor through motor driving and buttons. AD conversion of current simulation data, calculation of static damping, and other data are displayed by LCD. Hall speed measurement module counts the pulses, and converts it into speed and dynamic damping, the result of which is displayed. The motor speed of the PID control module is constant at 5000rpm. Finally, the UCOSII system transplanted on the STM32F407 is used to integrate the various modules and then complete the scheduling and distribution of the entire system, which is shown as Fig.3.

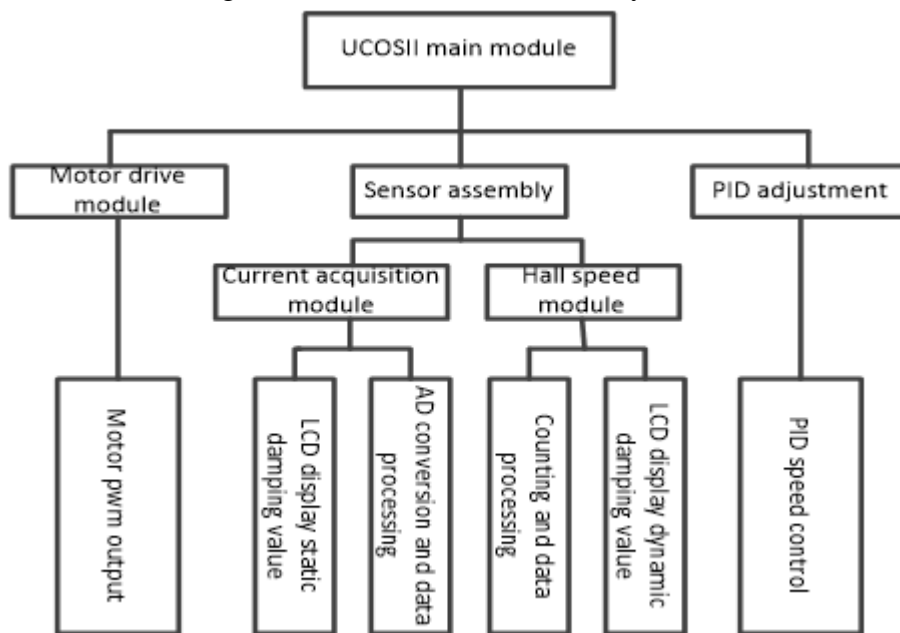


Figure 3. Functional block diagram of the overall module

After the system is initialized, the starter motor is driven by the drive module to drive the engine's main shaft to rotate. and the magnetic pole of the engine is detected by the Hall speed sensor to calculate the motor's speed to judge whether the engine starts normally. And then, the current value of the engine is detected by the current sensor, and the static damping value of the engine is obtained through the damping characteristics and the damping conversion formula. The main control chip stops the starter motor through the drive circuit, and detects the engine spindle speed through the speed sensor to judge whether it reaches 5000rpm. It should maintain this speed. We can get the dynamic damping value we want from the average speed of unit time.

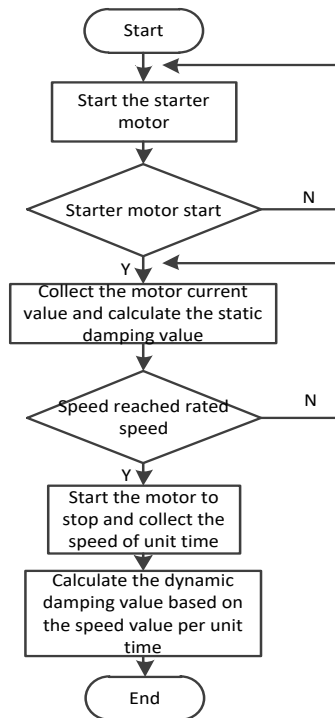


Figure 4. Program flow chart

5. Conclusion

Based on the existing engine cold stage detection technology, the design uses intelligent detection sensors, algorithms, big data and other technologies to comprehensively process and intelligently identify the collected engine operating condition information, and calculate the engine rotation damping to evaluate the internal rotor of the engine. The damping characteristics of the system can directly display the rotation damping characteristics of the engine, ensure the safety of the test run of the engine, and provide guidance for the binding of engine operating parameters. The device is easy to operate and reduces the cost of the engine cold car test phase. It can be directly mounted on the engine. The engine rotor system damping can be tested directly before the engine ignition starts. The LCD display is convenient for on-site technicians to judge the internal friction of the engine, and each module is made by a reasonable system architecture. Efficient coordination between them is achieved, and the total cost is reduced by circuit design. This design has certain research significance to ensure that the turbojet engine rotor system works well and avoids accidents during commissioning.

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