Research of Aircraft Electric Brake Control System

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Abstract. This paper briefly introduces the full electric braking system’s general framework and working principle based on wheel slip ratio closed-loop control.

1. Introduction

Multi electric aircraft has been listed as one of the key technologies in China's aviation industry, and electric brake is an important component of multi aircraft. The electric brake is a completely different from the traditional model of the hydraulic brake, compared with the traditional hydraulic braking it has many advantages: because of electromechanical actuator taking the place of hydraulic actuating device, the leakage of hydraulic oil has completely avoided, it greatly improves the safety, while reducing the weight of the brake system. The braking torque feedback closed loop control is added to the control link, which significantly improves the antiskid performance and prolongs the service life of the tire and brake device. The modular and real-time online inspection function of the system makes the braking system easier to maintain and improves the aircraft survivability. The braking frequency of the electric braking system is obviously higher than that of the hydraulic brake system, and the braking efficiency is obviously higher than that of the hydraulic braking system. Because the full electric brake system has so many advantages, it is a historical necessity to develop a full electric braking system instead of the existing hydraulic brake system.

2. General Framework of Full Electric Brake Control System

The electric brake system mainly including anti-skid controller, motor driving device, electromechanical actuation device (EMA, Electronic-Mechanical, Acuator), wheel speed sensor and brake device etc, the electric brake system frame as shown in figure 1.

In the system, the anti-skid controller is mainly used for receiving the instructions which the driver sending through the brake pedals and the aircraft brake wheel's speed signal, outputing brake control signal which matching the driver's command, monitoring the working state of the brake system by the real-time online and sending it through the bus transmission to the electromechanical management system of aircraft, being showed in the cockpit. After acquiring real-time wheel speed (by wheel speed sensor), electromechanical actuator servo motor feedback current (said brake pressure) and other status information, the anti-skid controller calculates the brake pressure should be applied to the brake based on the calculation method of antiskid braking control law based on slip ratio, outputs the brake control signal to the motor driver. After the motor driver receives the signal, it drives the actuator servo motor through its internal power amplifier, and finally realizes the anti-skid braking function of the aircraft. In order to improve the reliability and security of the system, each motor driver has its backup drive system.
3. Working Principle of Full Electric Brake Control System

Working principle of aircraft electric braking system based on slip ratio:
During taxiing, when the aircraft needs braking, the pilot will brake through the brake pedal. During the whole taxiing, the real-time wheel speed from the axle continuously transmitted to the brake controller. First, the brake controller will calculate the current braking wheel’s slip ratio on the basis of slip ratio which brake control law calculation method. Second, the brake controller will compare the actual slip rate calculated and the actual slip rate’s allowed range given before under the current wheel speed. So the the brake controller will get the brake pressure feedback signal and use this for adjusting motor controller’s signal, then the electric brake actuator will output the brake pressure matching the the anti-skid controller’s given, thus the real-time brake torque will always be in the right range, finally the actual slip rate will always be in the allowed range. When the aircraft braking wheel drag tire trend, anti-skid system can quickly remove the brake pressure, avoid braking wheel into the tire, always give the brake wheel right brake pressure, finally the aircraft will be braked stopping, safe reliable and efficient.

According to the above requirements, the electric braking system should be constituted by three control link, followed by the current motor control, motor speed control, braking wheel speed slip rate control, the principle block diagram shown in figure 2.
4. **Concluding Remarks**

Aircraft electric brake technology is precisely because of its many incomparable advantages, it has become the inevitable trend of future development. With the rapid development of motor manufacturing, control theory and production level, all electric brake technology will be widely used in various types of aircraft in the near future. The U.S. A’s electric braking technology is unparalleled in the world, when we are still studying theory and exploring the production process, the electric brake system of B787 has been put into commercial operation with the aircraft. We still have a long way to go to build a world class aviation power. On the basis of the author's research and engineering experience for several years, this paper introduces a full electric braking system frame which is closest to engineering practice. On the basis of this architecture, the working principle and control technology of Brushless DC motor are also discussed. This article can be for the general reference to the industry, pointing out a direction for it, but also for the majority of technical interest in learning and drawing on.

**Reference**
