

# Realization and Application of Stability Condition of Electromechanical Transmission System

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**Abstract:** In the electromechanical transmission system, the most critical thing is the coordination between the load performance of the motor and the mechanical performance of the motor, so as to achieve the stability of the electromechanical transmission system, so that the electromechanical equipment can achieve a stable working state. This paper analyzes the realization and application of the stability of electromechanical transmission system, in order to provide theoretical basis for the development of this field, so that electromechanical transmission system can be applied to a wider range of production fields.

**Keywords:** Electromechanical transmission system, Stability condition, Application.

## 1. Introduction

In the current production, electromechanical transmission system has a wide range of applications, and its stability is directly related to the quality and efficiency of mechanical engineering. To start from the needs of today's society, to seek more stable and reasonable stability of electromechanical transmission system. In view of the stability of electromechanical transmission system, MCU is selected as the automatic control system to control the direction of motor speed to effectively realize its stability, in order to improve the production efficiency and create higher economic benefits.

## 2. Stability Conditions for Linear Systems

Under the influence of the initial disturbance factors of the system, the transition process of the linear control system will decay and tend to return to zero with the slow progress of the operation cycle, and such system state is called asymptotically stable. If the system is disturbed by the initial disturbance factors, the transition process in the system will diverge gradually with the change of real time, then it can be judged that the system is unstable.

### 2.1. Necessary and Sufficient Conditions for System Stability

The transfer function of the system

$$G_b(s) = \frac{X_0(s)}{X_i(s)} = \frac{G(s)}{1+G(s)H(s)} \quad (1)$$

Characteristic equation of the system:  $1+G(s)H(s)=0$

The root of this equation is called the characteristic root of the system.

If all the characteristic roots of a system fall on the left end of the [S] plane, it shows that the system plane is complete and stable. Otherwise the system is unstable.

### 2.2. System Stability Judgment Basis

The most common way to determine the stability of a

system is in the form of Rous criterion, Hurwitz criterion and Lyaphov criterion, all of which are determined by the mathematical model of the system. Among them, the ROTH criterion and Hurwitz criterion can judge the stability of the system according to the characteristics of the system, different from the other two forms, the Lyard spectrum Ruff is judged according to the energy change of the system.

## 3. Motion Formula and Stability Condition of Electromechanical Transmission System

### 3.1. Motion Formula of Electromechanical Transmission System

The motion formula of electromechanical transmission system is as follows:

$$T_M - T_L = J \frac{da}{dt} = J \frac{2\pi}{60} \frac{dn}{dt} \quad (2)$$

Where  $T_M$  represents the output torque of the motor (N.m); Where  $T_L$  stands for load torque (N.m);  $J$  denotes the rated moment of inertia of rotational load (kg.m<sup>2</sup>);  $N$  indicates the running speed (r/min).

Under these conditions, when  $T_M = T_L$ , the phenomenon of the state is called "steady state".

System dynamic time:  $T_M > T_L$ ,

$$T_d = J \frac{d\omega}{dt} > 0 \quad (3)$$

That is,

$$\frac{d\omega}{dt} > 0 \quad (4)$$

Then the transmission system is accelerating the movement; When the  $T_M < T_L$ ,

$$T_d = J \frac{d\omega}{dt} < 0 \quad (5)$$

That is,

$$\frac{d\omega}{dt} < 0 \quad (6)$$

It can be seen that the electromechanical transmission system is in the process of deceleration. Therefore, according to the dynamic equation of the electromechanical transmission system, the output torque of the motor and the load torque are compared, which can be used as the speed index of the transmission system.

### **3.2. The conditions Necessary for the Stability of the System**

(1) there must be a cross between the mechanical property curves of the motor and the machine tool (that is, the balance of the traction system);

(2) After being disturbed, it should be able to return to the original equilibrium state, that is, when the rotational speed caused by the interference increases,  $T_M < T_L$ .

## **4. The Principle of Motor Control is Realized by Single Chip Microcomputer**

Single-chip control motor is a way to realize digitalization. At present, the full digital control is gradually deputized by simulation. Pulse width modulation technology and frequency conversion technology are the two main technologies used in the current motor. Sensing technology is used to realize the stable control of electromechanical transmission system. Single chip microcomputer has a great influence on the motor, can simplify the control line, achieve complex control, with good flexibility and adaptability, and no zero drift, network operation, easy to communicate, is conducive to fundamentally improve the work efficiency, so as to create higher economic benefits.[1]

### **4.1. Motor Speed Control Principle Based on Single Chip Microcomputer**

The MCU control of the motor gradually from the analog control to the MCU microprocessor development, which leads to a kind of digital analog control situation; MOSFET and IGBT are used as the main power devices to realize the application of PWM pulse width modulation and frequency conversion technology in DC and AC speed regulation.

### **4.2. The Speed of the Motor is Controlled by Detecting the Sensor with Single Chip Microcomputer**

The closed-loop control of the machine is very demanding and precise. For example, the Angle and speed required by the motor itself, the angular displacement and linear displacement of the execution system in the control system. In order to make accurate measurements under strict control, it is necessary to have a high-precision detection sensor that can feedback the information of the system. Therefore, the detection of sensor is very important in the control of motor speed on single chip microcomputer.

## **5. The key technology of motor speed control by single chip microcomputer**

With the continuous advancement of science and technology and the advent of the digital era, digitization is the main direction of the technical reform in our country, and all walks of life are innovating technology.[2] The technology represented by single chip microcomputer is the main means and important form of digital technology. The three parts of the motor are respectively control, transmission and feedback, which takes the SCM as the core part. At present, motor speed regulation technology based on single chip microcomputer is the most widely used motor technology.

### **5.1. The Speed of the DC Motor is Controlled by a Switch Drive**

Most DC motor is to use the switch drive method to make the semiconductor power in the switching state, the use of PWM pulse width of the semiconductor power to speed.

### **5.2. By Controlling the Power Supply Frequency to Adjust the Motor Speed**

$n = 60 f/p (1 - S)$ ; N is the speed of motor; P is the number of magnetic poles of the motor; F is the supply frequency, and S is the conversion rate; Therefore, when P and S are fixed, the speed control of the AC asynchronous motor can be realized by changing the power supply frequency.

### **5.3. The Brushless DC Motor is Controlled by MCU**

Cygnalc8051 single chip microcomputer is used to control the current of armature in PWM format, so as to realize the control of Cygnalc8051 single chip microcomputer.

### **5.4. Control the Single Chip Microcomputer to Adjust the Motor Speed**

The speed of the stepper motor is transformed into angular displacement by the sensor, so as to produce angular velocity. When a pulse is transmitted to the stepping motor by the microcontroller, the motor rotates once, and then sends out a pulse signal, it can run again, so the cycle will produce some rotation; The shorter the distance between the two pulses, the faster the stepper motor. It can be seen that pulse frequency has a great influence on the speed of stepper motor. In the microcontroller control, a common control method is to adjust the timer constant in the interrupt service subroutine, so as to achieve the control of the speed.

## **6. Stability of Traditional Motor Systems in Future Applications**

In the manufacture of mechatronics, electric drive system is a very important equipment system. The PRODUCTS USING THE ELECTRIC TRANSMISSION system are: numerical control machine tools, robots, electronic computers, automatic flaw detection machines, CT scanning and color scanners, and wire cutting forming machines. These devices involve and apply other related technologies in the transmission system, such as mechanical technology, sensing technology, new technology of information analysis and processing, drive control electronic technology, software technology and so on. The application range of these

electromechanical transmission devices is very wide, but also can reflect the major enterprises in ensuring production efficiency, quality, to meet the needs of the whole society under the premise, in the design of production equipment, must effectively ensure the stability of the electromechanical transmission system of the product. Mechanical and electrical transmission system stability to long-term and sustainable development, must be innovative in technology, only in this way can promote the long-term and sustainable development of enterprises.

## 7. Conclusion

Mechatronic integration technology has been widely used in our country, among which mechatronic transmission is its key equipment system. As the main power and power source, motor plays a pivotal role in people's production and life. In

the electromechanical system, there are many factors are the basis of the drive system, from the electromechanical transmission system stability application prospect, the most important is to study and analyze and solve the practical stability problem. In order to bring long-term benefits to the society and economy.

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