WEDM Tension Control Simulation Based on Matlab

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Abstract: The dynamic equations and simulation model of WEDM tension control based on cam mechanism are established. Using of simulation technique to imitate different types of profile curves signal, then simulate tension control with the signals. Analysis the simulation results. This method could design the profile of cam and reduce the cost.

Key words: cam mechanism; tension control; Matlab/Simulink

I. Introduction:

WEDM (Wire cut Electrical Discharge Machining), it is based on the galvanic corrosion of cutting liquid medium small gap pulse discharge material[1]. In the actual processing, due to the discharge electrode wire by working force, electrostatic force, electromagnetic force and friction in the process of working, etc, the value of tension is fluctuating, as result it affects the precision. So it is important to keep the tension of wire in a certain. However, the dynamic characteristics of the electrode wire is very complex, and the vibration of electrode wire is main reason causes the deterioration of the machining accuracy and surface quality. Currently there are Dong Xiaodong of Harbin Institute of Technology proposed wire system that realizes the constant tension control and constant speed control; Harbin Institute of Technology proposed by Zhang Zhiyong came up with the Fast-cutting Wire Electrical Discharge Machining wire constant tension control; Liu ZhiLong of Xihua University proposed bilateral constant tension tensioning mechanism. Based on the characteristics of the wire tension, the paper proposes tension control system.

II. Cam mechanism tension system

Cam mechanism has ease of use and flexibility, the use of a cam mechanism or in combination with other forms of organization, it can achieve almost all the kinds of movement styles in reliable, accurate and with compact structures. By studying the cam mechanism, design a WEDM tension system. The structure diagram is shown in Figure 1. The tension Sensor 5 measures the size of the wire tension through the controller processing system in response to the control cam 910, conditioning system wire tension variation, and the choice of the cam profile curve 910 is critical to the entire system.

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III. Dynamics model of cam mechanism

Usually cam mechanism can be simplified to two-dimensional dynamic model \cite{7}, and then you can get similar results in the actual project. In actual forces the wire is extremely complicated. Generally the diameter wire of WEDM is 0.18mm, the elastic modulus of molybdenum wire is $3.2 \times 10^{11}$ Pa \cite{3}. In this paper, wire and cam mechanism can be simplified, that the wire vibrates around the equilibrium position in up and down motion, thereby simplifying the kinematic model of spring-damping.

IV. Simulink simulation process

Suppose the camshaft has a large rigidity, the vibration is not considered, in accordance with an equivalent lumped mass, which is equivalent to three degrees of freedom dynamic model \cite{8}, shown in Figure 2, wherein the cam 910 is equivalent m1 lumped mass, m2 for the guide bar 920 equivalent lumped mass, m3 for cam pulley 941 and 942 equivalent lumped mass; k1 is the contact stiffness of 910 cam contact with 920 the guide bar, k2 is the tensile stiffness of the guide bar 920, k3 is the bending stiffness of swing link 930, k4 is equivalent spring stiffness; h is movement of cam 910 acts on the guide bar 920 displacement in theory. System equivalent mass and equivalent stiffness of the elements to obtain the following kinetic equation:

$$m_1\ddot{x}_1 = -k_1(x_1 - h(t)) + k_2(x_2 - x_1) \quad (1)$$
$$m_2\ddot{x}_2 = -k_2(x_2 - x_1) + k_3(x_3 - x_2) \quad (2)$$
$$m_3\ddot{x}_3 = -k_3(x_3 - x_2) - k_4x_3 - c_1x_3' \quad (3)$$

In Matlab, Simulink is used to model simulate and analyze dynamic multi-dimensional system of interactive tools. Through Simulink model can get information of detailed dynamic model and the exchanging information.
between the components and the subsystems. Using the simulink system set up the model by the formula (1), (2), (3) non-linear differential equations. Simulation flow chart shown in Figure 3.

Operations in simulink environment is as follows: Select new command in the file menu, according to the above equations constructs simulate model as figure 4. In order to achieve the movement of the cam mechanism \( h = h(t) \), using virtual signals. Firstly, create a function in matlab M-file editor (signal of \( h \)); then, choose the form workspace module library modules in the sources module library in Simulink Library Browser; Finally, input the appropriate command in matlab command window and it will add \( h \) variable to the workspace.

The basic type of cam curve are in three ways: double-stop curve, single-stop curve, non-stop curve [6]. Construction virtual signals of the three basic types of curves in matlab for simulation. \( x_3 \) is a displacement signal under three curves in Figure 5, and curve 1 represents the simulation result of the non-stop curve; curve 2 represents a single-stop curve; curve 3 represents a double-stop curve. The simulation shows that non-stop curve simulation results change dramatically, poor stability. Single-stop curve and double-stop curve have a more cyclical, showing similar features like sine curve, and the relationship between cycles (single-stop curve simulation period is twice double-stop curve simulation cycle.)

Figure 3 Simulation flow chart

Figure 4 System Simulation Model
In Matlab / simulink, establish dynamic model simulation of cam mechanism using three basic cam curve virtual signal. Generally requirements for wire tension control in 2-20N\(^5\). Set wire of WEDM total length 1-50m. The E = \sigma / \varepsilon, F = \sigma * A, then the simulation result can adjust 0.3110-15.552N, it is a wide adjustment. Taking into account the diversity of the actual cam curve, this article uses three basic types of cam profile curve, has a certain universality. But in the actual design process, it is not enough, and need further practical applications.

References