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ANALYSIS AND DESIGN OF LOGICAL DIFFERENTIAL CONTROL LAW

Abstract

Characteristic model-based intelligent adaptive control (CMIAC) method has been sucessfully applied in more than ten kinds of plants to be controlled in aerospace and industry, such as the reentry of shenzhou spacecraft, and Rendezvous and docking. The controller of CMIAC is mainly composed of golden-section adaptive control law, logical integral control law and logical differential control law. Practical application results show that this method has obvious advantages in the aspects of robustness, dynamic performance and noise suppression. In fact, logical differential control law has great effects on system dynamic response, and its noise suppression capability can be very strong if properly designed.

In order to improve the dynamic performance of the control system, and attenuate the flexible vibration and liguid sloshing of large communication satellites, logical differential control law was first proposed in CMIAC. Compared with linear derivative control law, logical differential control law is a kind of nonlinear control law and its paramters can automatically change with system outputs, so that it has strong noise suppression capability and can improves system dynamic performance greatly.

A kind of double-loop controller with two types of logical differential control law was first designed to suppress the measurement noise in the control system, and afterward, other types of logical differential control law come out. But up to now the design of logical differential control law is commonly by experience or trial and error method.

This paper firstly analyzes the differential gain coefficient and the index coefficient, which are the hard core of the logical differential control law. By adjusting these coefficients, great effects could be made on the control strategy. Secondly, by defining a type of sensitivity function, the rules of sensitivity variation with respect to the input signals are obtained. The sensitivity function achieves the least value in some region. Based on this understanding, a set of controller parameters for the logical differential control law is selected. To testify the validity of the selected parameters, some simulations are made together with the traditional differential control law for comparation. Simulation results show that, whether the measurement noises are the same or much worse, the performance of the control law with the new parameters is much better than that of the traditional control law. For instance, control precision and flexibility vibration suppression can be improved by more than two times, and the response time is only half of that of the traditional method.