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基于极限性能要求的电液负载模拟器多刚度与非线性复合数学模型

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Complex Mathematical Model of Electro-hydraulic Load Simulator Including Multi-stiffness and Nonlinear Factors in Ultimate Performance Research

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摘要 揭示了传统模型的建模精度是影响电液负载模拟器极限性能研究的主要问题。分析并建立了多刚度与非线性复合数学模型，引入了基于舵机安装刚度、负载刚度、力矩传感器刚度、加载马达轴刚度的多刚度模型；合成了伺服阀的流量非线性、系统的饱和与摩擦等非线性环节；并与传统线性模型进行了比对分析与仿真实验，验证了模型的精确性。结果表明复合数学模型更真实而且精确地表征了系统物理情况，为系统结构参数优化设计和控制策略研究提供了理论基础。

关键词： 液压 电液负载模拟器 模型 非线性系统 刚度 极限性能

Abstract: Ultimate performance research of electro-hydraulic load simulator is affected by the fact that the traditional model lacks adequate precision. Therefore, a complex mathematical model of electro-hydraulic load simulater is built which includes a multi-stiffness model and several nonlinear factors. The multi-stiffness model is based on the stiffness of aircraft actuator, load, torque sensor, and loading motor shaft. Nonlinear factors are considered in the system, such as saturation, friction, and the nonlinear flow characteristics of the servo valve. Through simulation and analysis, a comparison is made between the traditional model and the complex model. Based on the results of simulation and experiment with the input of load profile to the electro-hydraulic load simulater, the complex mathematical model is proved to be more accurate in reflecting the real physical situation of the electro-hydraulic load simulater system. The proposed model may be of theoretical value to the optimization of design of structure parameters and the research on control strategy.

Keywords: hydraulics electro-hydraulic load simulators models nonlinear systems stiffness ultimate performance

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