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论文

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### 非定常气动力对飞机飞行影响的拓扑分析

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### Topological Analysis on the Effects of Unsteady Aerodynamics on Motion of Aircraft

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摘要

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**摘要** 根据飞机六自由度运动模型和微分非定常气动力模型, 计算了周期轨道及平衡运动的拓扑结构图, 初步研究了非定常气动力对飞机飞行的全局影响, 并通过系统的导算子矩阵根轨迹、时域仿真及其灵敏度分析, 提炼出非定常气动力对飞机飞行影响的初步机理。结果表明, 非定常气动力对飞机平衡运动的振荡不稳影响明显, 可以改变其稳定特性, 延迟Hopf分叉的出现。对于稳定的周期运动, 由于增加了系统的阻尼耗散项从而减少了振荡幅度。

**关键词:** 非定常气动力 拓扑结构图 Hopf分叉 旋转阻尼

**Abstract:** To study the global effects of unsteady aerodynamics on aircraft motion, topological structure diagrams were computed, which were based on the 6-degree-of-freedom model of motion and an unsteady aerodynamic model of the derivative type, and include information of equilibria, periodic orbits, turn points, static bifurcations and Hopf bifurcations. The mechanism of effects was further abstracted by evaluation of the loci of the Jacobian matrix eigenvalues and by time-dependence simulations. As the results show, unsteady aerodynamics has great effects on oscillatory unstable motion and can delay the unstable trend and Hopf bifurcations. However, unsteady aerodynamics has little effect on monotonously unstable motions. Stable periodic motions such as wing rock and oscillatory spin tend to be suppressed or the amplitudes be lessened due to the rotational damping of the unsteady aerodynamic delay.

**Keywords:** unsteady aerodynamics topological structure diagram Hopf bifurcation rotational damping

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