

Aerospace Engineering Master's Defense

Longitudinal Stability of Twin-Fuselage Aircraft with Oscillations Due to Unattached Tails

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abstract

This thesis describes a longitudinal dynamic analysis of a large, twin-fuselage aircraft. The goal of the analysis is to predict the aircraft's behavior in various flight conditions. Starting with simple force diagrams of the longitudinal directions, six equations of motion are derived: three equations defining the left fuselage's motion and three equations defining the right fuselage's motion. The derivation uses a state-vector approach. Linearization of the system utilizes a Taylor series expansion about the trim point to analyze the aircraft for small disturbances about the equilibrium. The state transition matrix shows that there is a coupling effect from the moments caused by the two unattached empennages. The system is analyzed at multiple reference points. By analyzing the system at multiple reference points, a general flight envelope can be developed which will give insight as to how the aircraft will behave and the overall controllability of the aircraft. Four flight conditions are tested with published Boeing 747 data: take-off, climb, cruise, and post-separation with the payload. All four flight conditions contain unstable modes that imply unstable tail oscillations determined by the Routh-Hurwitz stability criterion and the eigenvalues of the system about the four equilibrium points.

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