Jordan University of Science and Technology

Nonlinear State Dependent Riccati Equation Controller for 3-DOF Airfoil with Cubic Structural Nonlinearity

Authors: Tariq Taha Darabseh

Abstract: In this paper, Limit Cycle Oscillations (LCOs) of a Two-Dimensional (2-D) airfoil with cubic structural nonlinearity in the plunge Degree of Freedom (DOF) are investigated. The aerodynamic loads are modelled using the unsteady Theodorsen?s theory. Wagner function and Jones? approximation are used to transform the unsteady aerodynamic loads from frequency domain into time domain. The aeroelastic differential equations are solved using the routine ODE45 in MATLAB to get the system response. Both subcritical and supercritical LCOs are observed in the 3-DOF airfoil with structural nonlinearity in the plunge DOF. Such LCOs are undesirable phenomena and should be suppressed within the flight envelope. A nonlinear state feedback controller is designed to minimize the amplitude of LCOs presented in the considered nonlinear aeroelastic system. The State-Dependent Riccati Equation (SDRE) approach in combination with Kalman filter technique is used to design a controller for the 2-D airfoil with trailing edge control surface (flap). The forces and moments produced by this flap?s action are used to stabilize the system and suppress the existence of LCOs. The efficiency of the proposed nonlinear controller by the SDRE and Kalman filter in suppressing the existence of subcritical and supercritical LCOs are verified by the numerical simulation results.