NEURAL PARTIAL DIFFERENTIATION FOR PARAMETER ESTIMATION OF FLEXIBLE AIRCRAFT DYNAMICS

Rajesh Ayilliath Kuttieri
Chief Manager (Design)
Aircraft Research and Design Centre
Hindustan Aeronautics Limited
Bangalore-560 037, India
Email : rajesh.ak@hal-india.com

Manoranjan Sinha
Associate Professor
Department of Aerospace Engineering
Indian Institute of Technology Kharagpur
Kharagpur-721 302, West Bengal, India
Email : masinha@aero.iitkgp.ernet.in

Abstract

Although the parameter estimation methodologies had been successfully applied for the rigid aircraft dynamics, the aircraft with high degree of flexibility poses challenges to determine the appropriate aeroelastic models for inclusion in the parameter estimation algorithms. Application of the neural networks for the aerodynamic modeling and parameter estimation of an aeroelastic aircraft (or flexible aircraft) is addressed in this paper. A neural network with the scaled conjugate gradient learning algorithm is used for modeling lift and pitching moment coefficients. The partial differentiation of the neural network output is carried out for the estimation of equivalent parameters of an aeroelastic aircraft. It is demonstrated that a reasonable model and estimates of the equivalent parameters for the aeroelastic aircraft are possible with the neural partial differential method by using the measured motion and control variables, without any need for postulating the coupled equations of motion or initialization of the parameters to be estimated. The proposed approach reduces the large number of parameters for aeroelastic aircraft dynamics into fewer equivalent parameters, and this methodology does not require the measurements of the elastic deflections or their derivatives. The neural partial differential method is applied to the simulated flight data of an aeroelastic aircraft for the longitudinal dynamics. The performance of the neural partial differential approach is compared with the estimates obtained from the other methods like classical estimation methods, analytical computation, and values given in the literature for rigid body modeling. The performance is also validated by comparing the measured lift force and pitching moment coefficients with the neural predicted and neural reconstructed coefficients using the estimates obtained through the neural partial differential approach.

Paper Code : V68 N4/927-2016.