APPLICATION OF NEURAL BASED METHOD FOR AERODYNAMIC MODELING USING FLIGHT DATA AT LOW AND HIGH ANGLE OF ATTACK

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Abstract

The paper presents the modeling of linear and nonlinear longitudinal aerodynamics using real flight data of Hansa-3 aircraft gathered at low and high angles of attack. The Neural-Gauss- Newton (NGN) method has been applied to model the linear and nonlinear longitudinal dynamics and estimate parameters from flight data. Unsteady aerodynamics due to flow separation at high angles of attack near stall has been included in the aerodynamic model using Kirchhoff's quasi-steady stall model. NGN method is an algorithm that utilizes Feed Forward Neural Network (FFNN) and Gauss-Newton optimization to estimate the parameters and it does not require any a priori postulation of mathematical model or solving of equations of motion. NGN method was validated on real flight data generated at moderate angles of attack before application to the data at high angles of attack. The estimates obtained from compatible flight data using NGN method were validated by comparing with the wind tunnel values and estimates obtained from Maximum Likelihood (ML) and Least Squares (LS) methods. Validation was also carried out by comparing the response of measured motion variables with the response generated by using estimates in a different control input. Next, NGN method was applied to real flight data generated by executing a well designed quasisteady stall maneuver. The results obtained in terms of stall characteristics and aerodynamic parameters were encouraging and reasonably accurate to establish NGN as a method for modeling nonlinear aerodynamics from real flight data at high angles of attack. The stall characteristics parameters were used to represent the stall hysteresis using flight data pertaining to high angles of attack.

Keywords: Parameter estimation, Neural Gauss-Newton method, Linear and Nonlinear