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Aerodynamic Modeling Using Flight Data at 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 wind tunnel values and the maximum likelihood estimates. Validation was also carried out by comparing the response of measured motion variables with the response generated by using estimates a different control input. Next, NGN method was applied to real flight data generated by executing a well-designed quasi-steady 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.

Keywords : parameter estimation, NGN method, linear and nonlinear, aerodynamic modeling
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