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Dynamic Flow Modeling Using Double POD and ANN-ARX System Identification STEFAN SIEGEL, US Air Force Academy, JÜRGEN SEIDEL, KELLY COHEN, SELIN ARADAG, THOMAS MCLAUGHLIN — Double Proper Orthogonal Decomposition (DPOD), a modification of conventional POD, is a powerful tool for modeling of transient flow field spatial features, in particular, a 2D cylinder wake at a Reynolds number of 100. To develop a model for control design, the interaction of DPOD mode amplitudes with open-loop control inputs needs to be captured. Traditionally, Galerkin projection onto the Navier Stokes equations has been used for that purpose. Given the stability problems as well as issues in correctly modeling actuation input, we propose a different approach. We demonstrate that the ARX (Auto Regressive eXternal input) system identification method in connection with an Artificial Neural Network (ANN) nonlinear structure leads to a model that captures the dynamic behavior of the unforced and transient forced open loop data used for model development. Moreover, we also show that the model is valid at different Reynolds numbers, for different open loop forcing parameters, as well as for closed loop flow states with excellent accuracy. Thus, we present with this DPOD-ANN-ARX model a paradigm shift for laminar circular cylinder wake modeling that is proven valid for feedback flow controller development.

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