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Modelling for Feedback Control of Skin Friction Drag in Algebraic Growth BRYN JONES, ERIC KERRIGAN, Department of Electrical & Electronic Engineering, Imperial College, UK, AHMED NAGUIB, Michigan State University, East Lansing, MI, USA, JONATHAN MORRISON, Department of Aeronautics, Imperial College, UK — We address the following problem: given spanwise arrays of wall- mounted shear-stress sensors at upstream and downstream locations, obtain accurate estimates of the flow field above an array of actuators located between the sensors. The accuracy of these estimates is of crucial importance in the design of any closed-loop drag reduction controller. To achieve satisfactory estimates we employ feedback from the sensors in conjunction with a dynamic model, based on that of Luchini (2000), describing perturbation evolution within a laminar boundary layer. The novelty of this work lies in the derivation of a state-space model of sufficiently low order to enable Kalman filter synthesis. Rather than obtaining a reduced- order model via numerical methods such as balanced truncation (Zhou, Doyle, Glover; 1996), we employ a series of approximations based on the results of Andersson, Berggren et al. (1999), to derive a low-order model analytically. A Kalman filter is synthesised and tested on the algebraic growth region of the DNS of Zaki (2005). Despite the use of a low-order model and significant free-stream turbulence, the results demonstrate good performance of the filter.

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