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Optimization of dynamic roughness elements for reducing drag in a laminar boundary layer TARANEH SAYADI, Department of Aerospace Engineering, University of Illinois at Urbana-Champaign, PETER SAYADI, Department of Mathematics, Imperial College London — Roughness elements can serve as controllers in both laminar and turbulent regimes to, for example, reduce the skin friction or drag. In this study, adjoint-based optimization is employed to extract the optimal shape of roughness elements for reducing drag, in a laminar setting, given an initial condition. The roughness elements considered here are of the dynamic type, varying both in space and time, which allows control over the spatial distribution of the roughness but also the inherent timescales of the flow. Dynamic roughness is modeled here using the linearized boundary conditions previously introduced by McKeon (2008), where the no-slip and impermeability boundary conditions are replaced by stream-wise and wall-normal distributions at the wall. The adjoint equation is then implemented using the discretized approach by Fosas *et al.* (2012). This approach is particularly efficient, since the linearized operators are computed simply by using the local differentiation technique, without explicitly forming the resulting matrices for both forward and adjoint operators. Using the described framework we investigate the effect of the initial condition on the spatial distribution of the roughness elements and their variation in time as the drag coefficient is minimized.

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