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Investigation of an Optimal Control Approach in the Context of Compressible Boundary Region Equations. OMAR ES-SAHLI, ADRIAN SESCU, Department of Aerospace Engineering, Mississippi State University, MOHAMMED AFSAR, Department of Mechanical Aerospace Engineering, Strathclyde University, YUJI HATTORI, MAKOTO HIROTA, Institute of Fluid Science, Tohoku University — High-amplitude freestream disturbances, as well as surface roughness elements, trigger streamwise oriented vortices and streaks of varying amplitudes in laminar boundary layers, which can lead to secondary instabilities and ultimately to transition to turbulence. In the present work, we aim at deriving and numerically testing an optimal control algorithm in an attempt to reduce the growth of these streamwise vortices and eventually mitigate the frictional drag in a compressible boundary layer. We analytically reduce the compressible Navier-Stokes equations to the boundary region equations (BRE) in a high Reynolds number asymptotic framework, based on the assumption that the streamwise wavenumber of the streaks is much smaller than the cross-flow wavenumbers. Then, we utilize the method of Lagrange multipliers to derive the adjoint compressible boundary region equations, and the associated optimality conditions. The wall transpiration velocity represents the control variable, whereas the wall shear stress or the vortex energy designates the cost functional. We report and discuss results for different Mach numbers, wall conditions, and spanwise separations.

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