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Adjoint-based minimization of the sound radiated by a Mach 1.3 turbulent jet JEONGLAE KIM, DANIEL BODONY, JONATHAN FREUND, University of Illinois at Urbana-Champaign — A control optimization using the adjoint of the perturbed and linearized Navier–Stokes equations is applied to a simulation of a Mach 1.3 turbulent jet to reduce its radiated sound. The solution of the adjoint system provides gradient information for a minimization algorithm to circumvent the flow complexity and reduce the sound directly. Comparisons between the loud and the perturbed-but-quiet versions of the same jet are examined to identify sound mechanisms. The overall algorithm is designed such that the control can be optimized with degrees of freedom comparable to that of the numerical discretization or with constraints on its spatial or temporal profiles to reflect hardware limitations. The large-eddy simulation of the uncontrolled, baseline jet is carried out in curvilinear coordinates using a non-dissipative high-order finite-difference. The far-field sound is computed using a Ffowcs Williams and Hawkings surface. Turbulence and far-field sound statistics agree with experimental data. An unconstrained optimal control reduces the sound cost functional by 17%. The far-field sound is reduced at all angles with a maximum reduction of 2.7dB in the peak radiation direction. Constraining the control in actuator-like zones shows a similar result. Optimizations are ongoing.

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