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Unsteady adjoint for large eddy simulation of a coupled turbine stator-rotor system CHAITANYA TALNIKAR, QIQI WANG, Massachusetts Inst of Tech-MIT, GREGORY LASKOWSKI, GE Aviation — Unsteady fluid flow simulations like large eddy simulation are crucial in capturing key physics in turbomachinery applications like separation and wake formation in flow over a turbine vane with a downstream blade. To determine how sensitive the design objectives of the coupled system are to control parameters, an unsteady adjoint is needed. It enables the computation of the gradient of an objective with respect to a large number of inputs in a computationally efficient manner. In this paper we present unsteady adjoint solutions for a coupled turbine stator-rotor system. As the transonic fluid flows over the stator vane, the boundary layer transitions to turbulence. The turbulent wake then impinges on the rotor blades, causing early separation. This coupled system exhibits chaotic dynamics which causes conventional adjoint solutions to diverge exponentially, resulting in the corruption of the sensitivities obtained from the adjoint solutions for long-time simulations. In this presentation, adjoint solutions for aerothermal objectives are obtained through a localized adjoint viscosity injection method which aims to stabilize the adjoint solution and maintain accurate sensitivities. Preliminary results obtained from the supercomputer Mira will be shown in the presentation.

Chaitanya Talnikar
Massachusetts Inst of Tech-MIT

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