Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Adjoint sensitivity analysis of time averaged quantities for unsteady flows[1] QIQI WANG, MIT — Sensitivity analysis is an essential gradient for data assimilation, aerodynamic design, uncertainty quantification and optimal flow control. In particular. the adjoint sensitivity analysis method has been shown to solve very high dimensional optimization problems typically found these applications. This talk focuses on recent developments in extending adjoint sensitivity analysis to unsteady flows. The adjoint equation of unsteady flows must be integrated backwards in time. Each backward time step must use the flow solution at the corresponding time. As a result, the entire time history of the flow solution must be either stored or recalculated. The invention of checkpointing schemes provides an economic solution to this challenge. In particular, the dynamic checkpointing scheme makes this solution more practical for computational fluid dynamics problems. In unsteady flows, the quantities of interest are often long time averages. We demonstrate that sensitivity analysis of these long time averaged quantities poses significant new challenge. A novel windowing scheme is developed to compute correct sensitivity for periodic unsteady flows, such as in laminar vortex shedding. Initial investigation of sensitivity analysis of chaotic unsteady flows, i.e., transitional and turbulent flows, is also discussed.

[1]This work is supported by a subcontract of PSAAP program at Stanford awarded to MIT.

Qiqi Wang
MIT

Date submitted: 12 Aug 2011 Electronic form version 1.4