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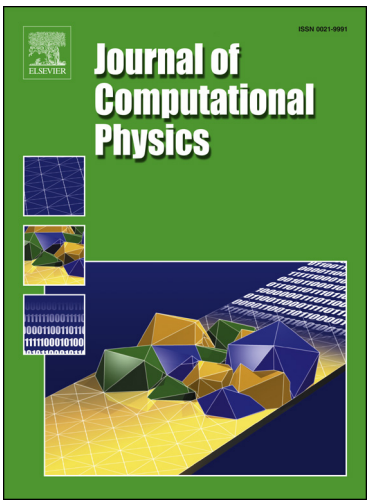

A framework for simultaneous aerodynamic design optimization in the presence of chaos

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A framework for simultaneous aerodynamic design optimization in the presence of chaos

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Abstract

Integrating existing solvers for unsteady partial differential equations into a simultaneous optimization method is challenging due to the forward-in-time information propagation of classical time-stepping methods. This paper applies the simultaneous single-step one-shot optimization method to a reformulated unsteady constraint that allows for both forward- and backward-in-time information propagation. Especially in the presence of chaotic and turbulent flow, solving the initial value problem simultaneously with the optimization problem often scales poorly with the time domain length. The new formulation relaxes the initial condition and instead solves a least squares problem for the discrete partial differential equations. This enables efficient one-shot optimization that is independent of the time domain length, even in the presence of chaos.

Keywords: simultaneous optimization, one-shot, unsteady flow, dual time-stepping, chaos, least squares shadowing

1. Introduction

This paper is motivated by aerodynamic design in the presence of massively separated flows. Important applications include launch vehicle design [1, 2], helicopter design [3, 4], designing highly maneuverable air vehicles

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