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COMPUTING FLOWS AROUND FLEXIBLE BOUNDARIES USING SIMPLE COMPUTATIONAL GRIDS

ABSTRACT

Many applications in science and engineering involve dynamic interactions between flow fields and flexible boundaries (e.g., flapping wings, heart valves, interfaces between different fluid phases). Solving these problems computationally is challenging because (i) the boundaries undergo large deformations, and (ii) flow variables may be discontinuous across the boundaries. I introduce the Correction Function Method (CFM), a general framework that produces accurate and robust discretizations of such problems using simple computational grids. This is possible because the computational grids are not required to conform to the geometry of the boundaries. Instead, the CFM estimates smooth extensions of the flow variables across the boundaries, such that standard discretizations can be applied. The novelty of this framework is that these smooth extensions are defined as solutions to Cauchy problems in the vicinity of the boundaries. The framework is completed by a numerical scheme to solve these Cauchy problems that is accurate, efficient, and robust with respect to the arbitrary shapes the boundaries may assume under deformation. This framework can also greatly simplify the task of grid generation for complex configurations (flexible or static), potentially eliminating a significant bottleneck in the practice of numerical simulations of fluids.

BIO SKETCH

Alexandre Marques is a Postdoctoral Associate at the Aerospace Computational Design Laboratory at MIT. He obtained a PhD in Aerospace Computational Engineering at MIT, MSc in Aeronautical and Mechanical Engineering at ITA (Brazil), and BSc in Aeronautical Engineering at ITA (Brazil). He specializes in Computational Fluid Dynamics (CFD), and performs fundamental research on accurate embedded grid methods, data-driven models, and multi-fidelity stability analysis. Prior to his postdoc position at MIT, he worked at the R&D division of Embraer in industry applications of CFD and Computational Aeroelasticity.

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