Implicit-Explicit (IMEX) Time Integration for Multi-Physics: Application to ALE-based CFD Simulations

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ABSTRACT

In strongly coupled multi-physics problems, managing the interaction of multiple time and length scales is crucial for the stability properties and the efficiency of the overall numerical scheme. In this work, we focus on the multi-scale nature in time. By selecting a time step size for a particular simulation, the component time scales are separated into slow and fast modes. While in general stability requirements of the fast modes demand the use of implicit time integration schemes, the slow modes may be treated with explicit schemes to leverage efficiency. We address the multi-scale-in-time nature of coupled multi-physics problems by IMplicit-EXplicit (IMEX) Runge-Kutta time integration schemes [1, 2] aiming at high-order time integration.

In this presentation, we focus on the application of IMEX time integration schemes to incompressible and compressible CFD problems described in an arbitrary Lagrangian Eulerian (ALE) frame of motion [3]. Starting from the discussion of the multiple time scales, we outline the design of the IMEX time integration procedure. We examine the mesh motion scheme for the ALE grid and its capability of handling large mesh distortion. Numerical examples will be shown to demonstrate accuracy and efficiency of the proposed solution scheme for some representative problems.

REFERENCES

