6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

AN EXPLICIT HIGH-ORDER DISCONTINUOUS GALERKIN FRAMEWORK FOR LOOSELY COUPLED FLUID-STRUCTURE INTERACTION

Nico Krais[1*] and Claus-Dieter Munz[1]

[1] Institute of Aerodynamics and Gas Dynamics, University of Stuttgart, Pfaffenwaldring 21, 70569 Stuttgart, Germany, {krais,munz}@iag.uni-stuttgart.de, nrg.uni-stuttgart.de

Keywords: *High Order, Discontinuous Galerkin, Fluid-Structure Interaction*

In recent years, high-order discontinuous Galerkin methods have gained increasing attention in the field of computational fluid dynamics, since they are promising a significant increase in both efficiency and accuracy compared to the low-order methods mainly used in the industry today.

In this work we present the extension of a CFD framework employing the discontinuous Galerkin spectral element method [1] to incorporate fluid-structure interaction. Due to the many advantages in practical computations, a loosely coupled approach is used here.

The coupled system consists of the fluid solver, the structure solver and a mesh moving algorithm. To facilitate the solution of the fluid dynamics equation in a moving frame, an Arbitrary Lagrangean Eulerian formulation is employed, while the mesh moving algorithm is based on the solution of a radial basis function interpolation. The structural model mainly used is a nonlinear beam formulation based on the geometrically exact beam theory [2]. This enables a significant reduction of computational effort compared to three dimensional structure models, while beam models play a significant role in a wide area of engineering problems, e.g. wind turbine blade or slender wing design.

The different computational domains use vastly different meshes and time integration procedures, making the use of coupling schemes both in space and in time necessary. Several schemes are presented and evaluated in their ability to represent non-linear interactions, with a special emphasis on the efficiency for high performance computing. The testcases presented include an oscillating beam structure excited by vortices in the wake of a bluff body, showing the ability to deal with large deformations and complex flow situations.

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