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TOWARDS FSI SIMULATION OF FLEXIBLE 2D ROTOR BLADE SECTIONS

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Coupled fluid-structure interaction (FSI) simulations of wind turbines have traditionally been considered computationally too expensive to carry out. However, more powerful computers and better solution techniques based on isogeometric analysis, can make such simulations viable.

An important goal in isogeometric analysis is to represent the geometry exactly on the coarsest grid. Development has firstly been motivated by the need for simplifying building detailed analysis models from CAD representations [1]. Secondly, once an initial mesh has been constructed it is advantageous to avoid further communication with the CAD geometry system. A key feature of the isogeometric approach is therefore to use the same set of basis functions for both the geometry and the analysis. An attractive feature of isogeometric analysis is using non-uniform rational B-splines (NURBS) for representing complex, smooth geometrical shapes. The solution per-degree-of-freedom accuracy is usually better for isogeometric analysis than for low-order finite elements.

Accurate modelling of wind turbines requires coupled fluid-structure interaction (FSI) simulations. Wind speed and air flow influence the motion and deformation of the wind turbine blades. At the same time, the motion and deformation of the blades influence the air flow. For fluid-structure interaction the structural elasticity problem will eventually be coupled with the incompressible Navier-Stokes equations.

As a first step towards coupled fluid-structure simulation of wind turbines, we present the results from the implementation of two-dimensional fluid-structure interaction in an isogeometric framework. The work presented here includes results from our isogeometric FSI solver for the FSI2 benchmark problem suggested by Turek and Hron [2]. Incompressible flow past a fixed circular cylinder with an elastic flag is therefore investigated and the results are compared to Turek and Hron. Particular focus is placed on the coupling algorithm which transfers loads from the fluid formulation to the structural formulation and displacements and velocities from the structural formulation to the fluid formulation.

Furthermore, applications to offshore wind turbines are emphasized. In particular we investigate simulations of sections of wind turbine blades with flexible trailing flaps.

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