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Topic: Coupled fluid-structure interaction of offshore wind turbines

Much effort, both in research and engineering, is needed to achieve the goals for increased electricity production from offshore wind turbines in the coming years. Advanced simulation tools will definitely be necessary.

The need for dynamic numerical simulation software is increasing as the size of of commercial wind turbines is increasing. Modern design tools should model the entire wind turbine construction, and full CFD simulations are required for detailed investigations of wind turbines where simpler tools based on static simulations are inadequate.

Furthermore, with a structural model of the wind turbine it is possible to determine material loads in the various wind turbine components as a function of time. Almost all structural models are based on classical beam theory. A common trend is to include non-linear structural dynamics in the code.

Accurate modelling of wind turbines requires coupled fluid-structure interaction (FSI), but such simulations have traditionally been considered computationally too expensive to carry out. However, with more powerful computers and better solution techniques based on isogeometric analysis, such simulations become a far more attractive alternative. A key feature in isogeometric analysis is to use the same set of basis functions for both the geometry and the analysis, i.e. the solution space for the dependent variables.

The main focus of my work is to build a working FSI simulation model based on isogeometric analysis for an offshore wind turbine. This model can then be used to investigate aerodynamic flutter as this is highly relevant for fatigue and thus blade damage. Furthermore, it is of interest to investigate how wake operation affects the loading of the wind turbines.