Resonance Detection of a Multipole Permanent Magnet Generator with a Magnetoelastic Model

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Abstract
During the last few decades engineers have been designing wind turbines of increasing size seeking lower values of cost of energy (CoE). Coupling FE models with in-house tools is a powerful means to customize models, increase computation capabilities and enhance designs. The present work explains a computation method to couple a surrogate model of air-gap magnetic forces to a FE based multibody model of a permanent magnet generator. The resulting coupled simulations are aimed to capture resonances and instabilities bursting in high amplitude vibrations during no-load start-ups.

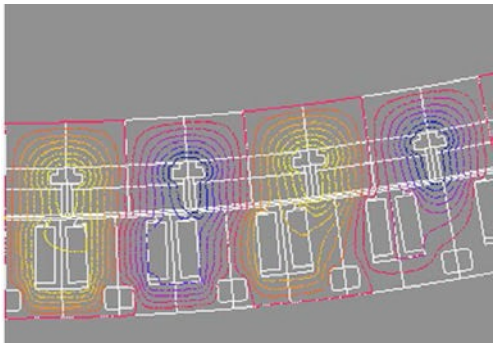

Figure 1: Electromagnetic flux and forces computation with FEM based software FLUX.

The method is applied to comprehensive model of an off-shore wind turbine permanent magnet multipole generator running in no-load conditions. The magnetic forces are computed beforehand using the commercial 2D FE magnetic simulator FLUX, including non-linear magnetic loads among stator teeth and rotor magnets. The structural model of both rotor and stator are modelled by means of the commercial FE based flexible multibody tool SAMCEF. Finally, a coupled model is created by putting together Super-Element representations of the structures and a user-defined loads model based on a surrogate model of the magnetic FE results. By doing this, structures are simplified to as many nodes as the number of interacting elements, that is rotor magnets and stator teeth, and the user-defined force is stretched to connect all stator and rotor elements and assign magnetic forces to each element at every time step according to azimuthal position and air-gap.

By coupling an in-house surrogate model of magnetic forces to the FE structures in a time discretized integration scheme, the exchange of coordinates and forces between models is done with non-converged magnitudes and therefore a simultaneous convergence and dynamic equilibrium is guaranteed at every time step.

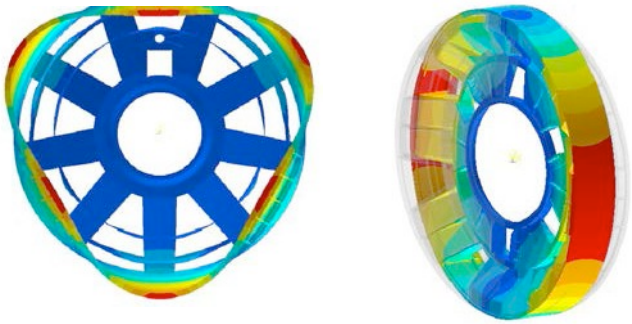

Figure 2: Superelement modelling to capture the structural behaviour of stator (left) and rotor (right).

References

[1] Géradin, M., Cardona, A. Flexible multibody dynamics: a finite element approach, Wiley 2001.

[2] SAMTECH, S. A. Samcef user manual 14.1. LMS Samtech.