Aeroelastic Modelling and Predictive Control of a 20-MW Offshore Wind Turbine

- The main objective of the investigation is to review and identify ways to model the dynamic response and feedback control response of very large HAWT, in particular the 20MW reference wind turbine, under external gust and turbulence.
- Scaling laws on very large HAWTs lead to more flexible turbine blades, significant vibrations and increased susceptibility to atmospheric disturbances. Better numerical models for the dynamic response of these very large turbines are necessary for the design, control and reliable operation of these turbines in the future.
- Working with the Nanyang Technical University (NTU), we aimed to capture the unsteady viscous effects at the aerofoil-level, flow separation, dynamic stall, as well as unsteady spanwise interactions, including tip effect, blade-wake interactions, as well as axial induction, all in the same simulation. For this purpose, we proposed a vorticity-based correction to capture medium- to long-range unsteady spanwise aerodynamic interactions, for an otherwise 2D strip-theory model. The correction is described by spanwise vortex rings whose strength is identified by the conservation of vorticity, and can be conducted with only a small computational overhead.

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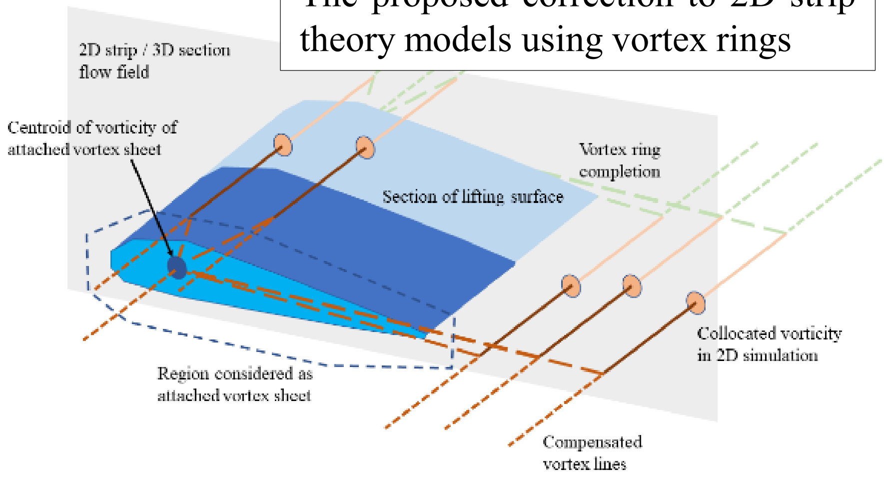
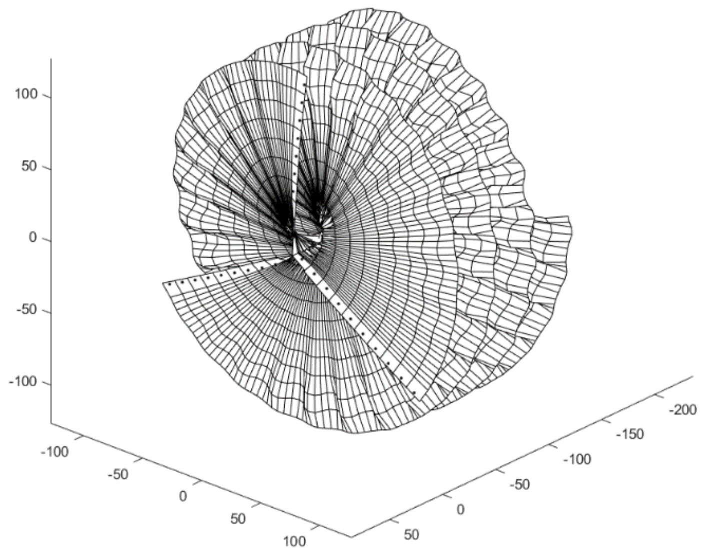
- The NTU team shared their experience in implementation of such a numerical scheme, and provided their turbine model for numerical comparison. Atmospheric boundary layer simulations were also shared to provide realistic disturbances to the model



The proposed correction to 2D strip theory models using vortex rings



Far-field wake behind a wind turbine. The model also includes a near-field 2D vortex panel model with partial dynamic flow separation

- The method is now used to improve the accuracy of wind turbine aeroelasticity simulations using a reference 20MW turbine under external gust and atmospheric turbulence as a part of ongoing work on the subject. The results led to the inclusion of the method in an upcoming journal article where the findings will be presented. Further works are underway to apply the method to other similar aeroelastic systems.

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