Project title	Modeling drive train dynamics from online measurement data
Project number	TG3-22
Organisation	Chalmers University of Technology, Mechanics and Maritime Sciences
Project leader	Håkan Johansson
Other participants	Saeed Asadi (PhD student)
Report for	2016-10-01 – 2018-03-31
Participating companies	

Project description

The goal of this project is to investigate how SCADA and other sensors can be used to predict drive train dynamics during operation and its implication on drive train components' fatigue life for direct as well as indirect drive turbines. The main activities include developing drive train models using multibody dynamics formulation, validate this model using existing test rig in lab as well as existing wind turbine system simulation tools for direct and indirect turbines. Global sensitivity analysis will be used to quantify dynamic behavior with respect to different input parameters, as well as the influence of sensor data on fatigue loads on drive train components (main bearings and gearbox).

Results

The overall expected result from this project is an increased understanding on how different operation conditions affect turbine drive train dynamics; a model that can be used to evaluate measurement data as well as a proposal for suitable sensor placement strategy to determine drive train component loading. All these results can contribute in the work planned for the project proposal "Wind turbines under harsh operation conditions".

The specific results have been achieved to date

- Direct drive train modelling based on multibody dynamics
  - Model verified using ViDyn system simulations
  - Model to predict bearings damage index and main shaft deflection.
  - Evaluate effect from wind speed, turbulence intensity and incoming wind vertical inclination
- Global sensitivity analysis of a direct wind turbine drive train.
  - GSA of direct drive train with respect to structural parameters
  - GSA of direct drive train with respect and excitation wind parameters
- Prediction of gearbox motion
  - The developed model suggest that indeed different wind conditions and operating conditions can be deduced from optical measurement of gearbox motion.

These results are collected in three papers, two submitted for international publication.

Fulfilment of SWPTC's goals

The project addresses the common goal of the SWTPC to build up knowledge on wind turbine components focusing on high speed bearings and gearbox internal dynamics to facilitate design of optimal wind turbines and their drive train functional components. The modeling and evaluation of different operating conditions is of big value for the ongoing project "Wind turbines under harsh operation conditions"

Deviations from project plan

The validation using test rig has not been done and is currently not judged necessary as the modelling gives reasonable agreement with existing simulation models.

Publications

1. Asadi, S., Berbyuk, V., and H. Johansson, Global sensitivity analysis of high speed subsystem of a wind turbine drive train. *International journal of Rotating Machinery 2018:1-20, 9674364 **
2. Asadi, S. and H. Johansson, (2017), Multibody dynamic modelling of a direct wind turbine drive train. *Presented at Wind Energy Science Conference 2017.*
3. Asadi, S. and H. Johansson, (2018), Multibody dynamic modelling of a direct wind turbine drive train. *Manuscript of journal paper submitted for publication*
4. Asadi, S. and H. Johansson, (2018), Global sensitivity analysis a direct wind turbine drive train. *Manuscript of journal paper submitted for publication*
5. Asadi, S. and H. Johansson, (2018), Multibody dynamic formulation of a wind turbine indirect drive train with focus on gearbox modeling and motion. *Manuscript of journal paper in preparation*
6. Asadi S., *Wind turbine drive train system dynamics: Multibody dynamic modeling and Global Sensitivity Analysis.* PhD Thesis, Chalmers University of Technology**

*Work carried out before this project started, but completed and published during the time period of the present project

**Consists of an introduction and items 1,3,4,5 above.

External activities