WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Basic controller tuning for large offshore wind turbines" *by* K. O. Merz

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General comment

The paper presents a set of interesting investigations for the NREL 5 MW reference wind turbine. The paper is very well written. Complex issues are explained in a good way. However, there are three main issues, which weaken the paper:

1. The paper addresses several issues and thus tends to be a conglomeration of investigations. The investigation about the impact of the model fidelity on the closed-loop transfer function (Section 2) seems to be the most interesting, while Section 3-6 are less useful (see detailed comments below).

2. The paper focuses on the 5 MW reference wind turbine and then extrapolates the findings to (large offshore) wind turbines.

3. The most important finding is partly trivial ("the appropriate controller tuning is highly dependent on the aeroelastic model") and partly not correct ("therefore, no single ref-

erence controller can be defined, for use with all models").

a. One major task (if not the most important one) in model based controller design (most of modern control) is finding the appropriate controller design model. Thus it is trivial, that the control tuning is dependent on the model.

b. The question, if a controller can handle the uncertainties / simplification is addressed by its robustness (robust stability / performance). Thus, if a controller is robust enough, a single controller can be defined for use with all models considered in the robust design. The example of the instable controller is not a proof that no controller can handle all possible model fidelities of wind turbines.

Recommendation

The paper could be improved by

1. Focusing on the impact of the model fidelity on the closed-loop transfer function. Reducing / removing Section 3-6. The title should then be adjusted.

2. Stating more clearly that the findings are specific for the used reference wind turbine and explain the limitations of the findings.

3. Reformulating the most important finding.

Details Section 3 (Gain Scheduling)

Multiplying the gain after the integration and thus multiplying it to a non-zero-mean signal is an implementation error, since the controller is designed by shaping the linear closed-loop. Dedicating almost a full section to this issue seems to be exaggerated. Further, it can be assumed that most researcher have - knowingly or unknowingly - implemented the controller correctly. The instability issue when using a model with blade-torsion is interesting. However, to call into question other papers using the reference controller (with or without the implementation error) based on this investigation is very questionable.

Details Section 4 (wave-driven tower resonance)

Usually, notch filters for pitch and torque are used to avoid resonance (besides of the mentioned active damping). The recommendation to lower the low-pass filter cut-off frequency to a value well below the first natural frequency of the tower seems to be not very helpful, because the performance of the pitch and torque control loop should be reduced due to the increasing delay.

Details Section 5 and 6

Controller tuning based on multiplication of disturbance spectra and closed loop transfer function is smart. However, it is not really new and has been proposed before. Further, important measures such as DEL are not considered. Then, it is not clear, how the polynomial of 4th order has been obtained and why this order has been chosen (a simple interpolation might be more straight-forward to implement).

Less important issues

- It is not clear, if the spectra from Fig. 4 is obtained from a time domain simulation or by multiplication of the wind/wave spectra? Sorry, if I missed it.

- Why different linear models are used in Fig. 3 and 5 / Section 2.1 and 2.2? Is it only because of the stiff seabed in FAST? If so, might be helpful to mention it shortly, e.g. by "...0.24 Hz, see Fig. 3 and Section 2.1; the difference..."

- Units are sometimes missing, e.g. in eq.(14)+(15).

- Please consider to use vector-based graphs which might increase readability of figures.

- The Nomenclature is nice, but explaining the used symbols closer to the equations might increase the readability of the paper.