Wind Energ. Sci. Discuss., author comment AC1
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Reply on RC1

Alessandro Fontanella et al.

Author comment on "Model-based design of a wave-feedforward control strategy in floating wind turbines" by Alessandro Fontanella et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-9-AC1, 2021

Dear Referee,

Thank you very much for your comments and feedback.

Much of the work about floating wind turbine control carried out so far focus on the interaction between blade pitch controller and platform pitch motion, and how to avoid the negative-damping issue. The Authors are grateful to the Referee for introducing this topic in the discussion, and believe that clarifying how the pitch controller tuning relates with wave disturbance rejection makes the research more interesting for both the scientific community and industry.

Concerning the first comment, about the effect of detuning on the effectiveness of the wind turbine controller against wind and waves:

In case of original gains, wind loads are inside the CPC bandwidth: at the controller cut-off frequency the wind spectrum is around 3% of it's maximum value. Wave loads are just above the cut-off frequency (how much above depends on the sea state). The CPC with original gains rejects the wind disturbance, but is ineffective against wave. In case of detuned gains, the bandwidth is shorter: the wind spectrum is 18.6% of its maximum value at the controller cut-off frequency. Moreover, the disturbance sensitivity in the controller bandwidth is increased as the rotor-speed tracking performance is degraded. Hence the controller is less effective against the wind disturbance. The capability or rejecting wave loads is not influenced much by detuning. This is exemplified by the figure attached to the answer, where the typical PSD of wind and waves (rescaled) is compared to the sensitivity of the feedback pitch controller with original and detuned gains. In conclusion: the feedforward controller complements the feedback CPC, and targets wave loads. Therefore, its benefits are weekly related to the tuning of the feedback controller.

Concerning the third comment, about the effect of detuning on rotor speed oscillations and fatigue DEL:

The effectiveness of CPC with detuned gains is decreased, but detuning is needed to make the floating system stable without modifying the structure of the FB controller. The bandwidth of the FB controller, and hence its effectiveness against wind turbulence, could be increased by means of NMPZ-compensation [doi: 10.1049/iet-rpg.2012.0263], where pitch control is used in combination with dynamic generator-torque. Another possibility is to replace the FB controller with a more complex multivariable controller [doi:10.1088/1742-6596/753/9/092006]. Both these techniques can be used in synergy with feedforward control to further improve the floating wind turbine response to environmental loads.

Finally, concerning the comment about the wrong reference, the Authors found that reduced-order modeling of an FOWT rotor is also discussed in "Multibody modeling for concept-level floating offshore wind turbine design" [Lemmer 2020, https://onlinelibrary.wiley.com/doi/abs/10.1002/we.2408], with a greater level of detail than in "Robust gain scheduling baseline controller for floating offshore turbines", currently cited in the manuscript.

Please also note the supplement to this comment:
https://wes.copernicus.org/preprints/wes-2021-9/wes-2021-9-AC1-supplement.pdf