Answers to RC2 Comments

30th November 2022

Introduction

Please also mention that yaw misalignment is very important for power capture. This should be the primary goal of a yaw control system and one of the main drawbacks of an SPM system.

We completely agree, thank you very much for pointing out this. It has been mentioned in the new version of the paper.

L28: please cite where a free-yawing structure has been shown to reduce structural loads and be more specific about which loads are reduced.

Many thanks for the comment, the cite [Netzband, 2020] has been included in the revised paper.

L48: what is an important yaw response?

The expression has been removed in the paper, as it could be misleading.

L50: please revise this sentence. Although [a] SPM configuration helps to improve the...

The sentence has been rephrased.

Figure 3

I recommend using plain English in your legends and describing each case in the caption, so a reader can quickly search for results in the figures and captions.

Thank you for the suggestion, some legends have been updated and the description of the figures has been included in the captions.

I think that Figs 3 and 4 are very similar and could be shown side by side for a more interesting result.

Thank you, it has been done in the new version of the paper.

Figs 5 and 6

Please describe why it is important to look at each blade's individual contribution. These rose plots are not typical in wind energy papers, so some guidance on how to interpret them would be helpful to the reader. What information is this adding, compared to Figs. 3 and 4?

Figure 3 and 4 present the resulting aggregated rotor moments that have an impact in the global system dynamics, inducing a potential misalignment of the system. These plots present the effect of NWP and tilt on the moments. Figure 5 and Figure 6 provide a better insight of the physics that are causing the effect. Figure 5 shows the contributions of each blade and load component to the aggregated moment. As the contributions depend on the blade position, they are presented on an azimuthal representation, showing that at 90º (0º) these contributions are maximum (minimum). Figure 6 shows how these contributions cancel totally when tilt angle is 0, but a relatively small moment, constant with azimuth, remains if there is tilt. This moment is responsible for the effect studied in this paper. A better description of the logic behind these figures has been introduced in the revised paper, highlighting their adequacy for azimuth-dependent magnitudes.

Section 4

What are the parameters of the low pass filter? PID gains? More parameters make it easier to repeat the study.

With this article we want to demonstrate the ability of this IPC strategy to mitigate the yaw drift, hence specific parameters of the yaw-by-IPC loop are not considered necessary to replicate the study.

How were the gains tuned? Does the result change with wind speed?

The controller gains have been tuned using time domain simulation of the full nonlinear model. The system dynamics change with wind speed, hence some nonlinear control algorithm would be advisable, but a deeper analysis is necessary. An explanation has been added in the revised paper.

Section 6

The fact that it works is great, but the comparison shown (especially generator speed/power) is not quantitative. Is there a trade-off between IPC effort (tilt and yaw pitch angle) and yaw regulation/generator power? Near rated, where IPC costs power, is there some optimal effort vs. yaw regulation? Pitch actuation effort can be quantified with pitch travel and the number of direction changes.

First of all, it must be borne in mind that the yaw drift has to be mitigated to ensure the feasibility of this type of FOWTs. This is the main objective of the paper.
Besides, similar to other control problems, there is a trade-off between yaw regulation and IPC effort. In this case, the controller parameters have been tuned so that the platform yaw angle is maintained below 10º most of the time. Near rated wind speeds have not been simulated with the new control loop, but they will be further investigated in the future.

A more interesting comparison would be with no IPC and the standard mooring configuration: does it have less yaw motion and more power production? If it is nearly the same, then there is a nice argument for the SPM and no yaw actuator.

We agree. This comparison will be part of future work.

Have you optimized the gains to achieve the best possible yaw regulation? Is there an upper limit on the yaw regulation that can be achieved by IPC? This is the kind of thing I was hoping to learn from this article.

As explained above, controller parameters have been chosen so that yaw drift is maintained below 10º most of the time, which is thought to be an adequate range. The control is able to achieve tighter yaw limits, at the expense of greater IPC usage. The upper limit on the yaw regulation that can be achieved by IPC will, of course, depend on the turbine and floating platform used, but in general, the results shown in the paper are believed to be suitable for a 5 MW wind turbine.

Fig 13: I'm not sure this rose plot is the proper way to show these results. Some quantitative measures are provided above. Do the blades only need to vary from 16.5 deg to 17.5 deg? If a higher gain and larger IPC contribution were used, would the yaw motion vary less?

A temporal graph has been added and explained in the new version of the paper, in order to ease the understanding of the yaw-by-IPC. The attained yaw variation has been a trade-off with reasonable blade pitch limits and usage.

Fig 13: L235: why is it counterintuitive?

The expression has been removed in the paper, as it could be misleading.

I'd expect there to be more interesting trade-offs near rated and with misaligned wind/waves. What happens in these cases?

It has not been analysed in the current work, but will be examined in the future.