Comment on wes-2021-73
Anonymous Referee #2

Referee comment on "Influence of Wind Turbine Design Parameters on Linearized Physics-Based Models in OpenFAST" by Jason M. Jonkman et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-73-RC2, 2021

This paper describes a method to study the effects of variations in design parameters on a linearized system and an operating point (or sets of linearized systems and operating points). The paper provides an example using a mass-spring-damper system to illustrate this method and also provides a case study using direct evaluation and interpolation techniques for parameter variations. We recommend some major and minor revisions to improve the quality of this article.

General/Major Comments:

- An example including (equality) constrained algebraic states and an explanation if the methodology can be extended to inequality constraints would be helpful. General references or examples within the context of the wind turbine system would be useful throughout the paper. As an example, stating and elaborating (possibly with references) that "Mooring line tensions are representative of an algebraic constraint state because of <explain>" would be beneficial to the reader and provide context for the various aspects of the turbine that are being linearized.
- The use of large matrices throughout the text is tedious. It would not detract from the impact of the paper to simplify them into a more concise format and/or move many of the full matrices to an Appendix. Further, it might also be better to move the entirety of Section 2.3 to an Appendix as the examples used in the rest of the paper do not depend on the results of this section.
- Including some sort of nonlinearity in the dynamics of the example problem in Section 3 would be useful; perhaps a nonlinear dashpot. Moreover, having a non-zero steady-state goal might also be helpful.
- Better justification/discussion of the assumptions made when simplifying the equations would enable readers to more clearly understand the methodology presented. Again, references to the wind turbine system would be appropriate in these justifications. Some instances where further justification and explanations would be useful include:
  - In equation (9), \( \Delta u_{\text{op}} \) is set to zero, which might not always be the case. Further explanation/justification is needed here. This also conflicts with the fact that inputs of one module can be outputs of another module.
  - Equation (10) is derived from Equation (8) without giving insights why this path is
taken and what is achieved in doing so.

- It is not immediately clear whether the assumption that \( |dZ/dz| \) is nonzero is a strong assumption or trivial, especially considering that no example is given of \( Z \) in the illustrative example.
- Include more references to the existing literature with respect to linearization tools and methodologies for wind turbine systems.

Additional/Specific Comments:

- Make it clear that the example analytical parameter study in Section 3.2 is not addressed in theory and is instead a "baseline" fully exact representation. The definitions of \( A(\Delta p) \) etc. labeled "exact" do not match the definitions given in Section 2.3, so either the definition should be made more generally, or they should not be referred to as the same variable.
- The equations presented in the summary observations (equation (24) in Section 3.4) should be presented in the relevant section earlier.
- The point in the Observations section (Section 2.4) that, given the presence of constraints, “much of the algebraic manipulation to define the parameterized linear state-space matrices must be implemented in a post-processing step” is very relevant to Section 2.3. As such, we would recommend that this remark should be made in the introduction to Section 2.3.
- It is not clear, particularly to readers not familiar with OpenFAST, what the line “The first three items in this summary deterred us from implementing the theoretical approach outlined here directly within OpenFAST” implies. It reads as though the testing that the authors claim to have carried out in the abstract was not in fact executed, even though wind turbine simulations were indeed completed via WEIS.
- Some numbered equations with multiple lines are difficult to distinguish from adjacent numbered equations. Either combine some lines in these equations so that it is clearer which equation numbers correspond to those equations (and also so that they take up less vertical space), or separate equation groups with text, or enumerate each equation line (e.g., (19a), (19b), etc.).

Corrections:

- Equation (4):
  - typo – should be \( u \) instead of \( y \)
  - the equation is referenced several lines before it appears in the text which is confusing
  - the note below the equation contains grammatical errors