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WIND ENERGY SCIENCE DISCUSSIONS

# *Interactive comment on* "Automatic controller tuning using a zeroth-order optimization algorithm" *by* Daniel S. Zalkind et al.

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The authors present an automated procedure for controller tuning for wind turbines. The procedure is based on the zeroth-order optimisation algorithm and many turbine simulations, subsequently, the optimal set of control parameters is computed. The procedure is applied to three different wind turbine control problems - generator torque control, blade pitch control and minimum pitch settings.

The paper is well-written. Automatic tuning of control parameters is definitely an interesting inter-disciplinary area, requiring expertise in optimisation, control and wind energy. I believe this work is relevant to the community, as the turbine size is getting better nowadays and the flexible turbine dynamics might not be fully captured in a



simplified model for model-based design. I listed some comments below.

Comments:

p1 l20: 'The wind turbine control tuning procedure is normally a manual process and often requires expert knowledge of the controller and turbine operation.'. This statement is not necessarily true. As the authors later pointed out in Appendix A, most of the tuning process is automatic and based on a simplified second-order rotor drive-train model. Can the authors elaborate on the term 'manual process'?

p1 l24: 'The simplest method to tune a controller using simulation information is to exhaustively search the design space and then make an educated design choice of the parameter.' I agree this might be a 'layman' approach but I think most of the people would use a model-based approach as described in your reference (Johnson et al. 2009). Your introduction section is written like for controller tuning that always requires solving an optimisation problem. Can the authors introduce the commonly used model-based methods (e.g. Johnson et al. 2009) in your introduction section?

p2 l26: 'Our approach to sampling the parameter space is based on stochastic approximation or "zeroth-order optimization,"...'. Can the authors justify why you choose this zeroth-order optimisation technique rather other optimisation techniques?

p3 l5: 'Instead of using a single cost function that attempts to account for all aspects of wind turbine design...'. Is this part of the sentence necessary? Can the authors provide the references that use a single cost function for the whole design?

p6 l9 & p7 l27: It seems the N_stage is used to determine the termination of the iterations. How did the authors determine this N_stage?

p9 Figure1: How many simulations did the authors run to generate the solid blue line?

p9 l5: 'The algorithm finds the optimal kfact and converges in 7 stages'. Is the number of stages determined by the settling function in (21)?

p9 l7: 'average power is increased by 0.67%, compared to kfact = 1': The power is indeed increased. Did the authors check other loads such as tower, blade and shaft torsion?

p10 l14: What is M(z)? structural loading of what components?

p12 table 2: Why N_stage are 7 and 12?

p14 table3: The M(z) are tower and max blade loads. Did the authors check the rotor speed performance? Also the shaft torsion and pitch activities? Why are these variables not considered in this case?

p15 Figure 4: How many simulations did the authors run to get the colour contour in the left of Figure 4?

p17 l14: 'However, we believe that a controller that constrains extreme events and maximizes power capture better reflects the overall wind turbine design goals.' Can the authors elaborate a bit on this statement? Does the statement imply that in the above-rated region, the regulation of rotor speed is less important as long as the rotor speed does not exceed its max value? Did the authors also investigate on loads of other turbine components to support this statement?

p18 l15: '...quantifying the relative importance between reducing peak loads...'. Which peak loads were the authors indicating?

p18 Section 3.3. This section investigates the optimal minimum pitch values in terms of loads and power. Would this optimal minimum pitch angle affect the result in Section 3.1 and 3.2? How did the authors ensure these tunings were decoupled? Wouldn't it be better if one single multi-objective optimisation problem is solved instead of three?

p20 Figure 7: What turbine is this? Is this not the NREL 5MW? The power seems much bigger than 5MW.

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