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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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This paper deals with a novel procedure for the automatic tuning of a wind turbine control system. In the presented approach, results from dynamic simulations are used to feed an optimization method which automatically designs specific control parameters. The whole procedure relies on a zeroth-order algorithm which generates and resolve samples in the proximity of a certain guess, in order to identify the best descent direction.

In my opinion, this is a very well presented work. The topic of automatic controller optimization is certainly hot in wind energy, especially for very large turbines and I believe the procedure highlighted in this paper could help finding novel ways to improve the performance of modern turbines.

The work is well organized and clear. The Authors give a detailed description of the algorithm as well as several examples in which the method successfully manages various control problems. In addition, results for several rotor sizes are given which contribute to extend the validity of their findings.

I have some comments here below:

Section 3.1:

-What simulations did you run at this step? Did you cover the whole range of speed below rated or just focused on a single wind speed? I raise this concern because, in highly flexible rotors, increasing wind speeds typically trigger increased torsional deformation, and I think your optimal solution could be somewhat influenced.

- I like your idea of testing the ZOO on separated control problems. This is very enlightening for what concerns the method, but I think it reduces the generality of the results. For example, in this application the optimization leads to an increase in power, but what about loads (and fatigue in particular)? In other words: if we consider a real application, would the power gain high enough to be convenient against (probably) higher loads?

- Perhaps I've missed something but, when you only require 2 samples for iteration aren't you basically going back to a standard gradient method with centered finite differences?

Section 3.2:

-This is, in my opinion, the weakest application (an interesting one, though!). it seems like the ZOO provides an expected solution (reducing the pitch frequency and increasing the damping), so that I'm not sure the results are actually worth the effort.

-In addition, a drastic reduction in the pitch actuation can have significant drawbacks: what about the torque? In my experience a slower pitch requires a faster torque to avoid severe power losses. Then: what about the power?

-Another concern is this: how the ’slower’ pitch reacts to dangerous situations (extreme gusts, faults and other conditions when a fast response is required)?

Section 3.2.2:

-I like the comparison between the ZOO and the grid search, however, i don’t think your example gives the full picture. First, the solution of the grid search depends on the grid itself, and thus, I think in your example the only example which actually makes sense is the example with 10x10 samples. In this view, Figure 6(f) clearly shows that the 6x6 and 8x8 cases are not ’converged’ to the real optimal solution. Looking at Figure 6(e) I dont’ even think the 10x10 case led to the ’real’ optimum. probably a further refinement of the mesh is required.

- Additionally, the effectiveness of the grid search depends on the complexity of the underlying function, so the example you provided gives only a partial conclusion. I would also like to see how the methods compare when tested on (perhaps) ’analytical’ functions of growing complexity.

Section 3.3:

- I think this is the most interesting example, as it deals with a very common problem of control tuning. However, i don’t personally like merit functions which are built from a linear combination of requirements, like in this case. What I don’t like is that, such a linear combination requires to define the weighting parameters of the various terms in the merit function. In this case, for example, you arbitrarily chose to set k=0.01, and this led to an optimal curve. But, if you change that value, you’ll probably obtain a family of curves. So, once again, what is the ’real’ optimum?

Figure 4:

- Please add (a,b,c,d) identifier in the various subplots.

Sorry for being so verbose, but I enjoyed this paper and I would like to raise some points to further discuss your approach.

Thank you for this contribution.

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Discussion paper