Review:

Manuscript Title: A Surrogate Based Optimization Framework to analyse Stall Induced Vibrations

Paper: wes-2022-79

In this study, a surrogate-based optimization framework is implemented to explore the behavior of the wind turbine blades' stall-induced vibrations (SIV). SIV is vital for large and flexible wind turbine blades and needs to be accounted for during the design studies. However, due to the high computational cost associated with the aeroelastic simulations, the presented surrogate-based approach for optimization accounting SIV is significant to the wind energy community.

The authors have implemented Gaussian Process Regression (Kriging) model as surrogates and implemented the Delaunay Triangulation method to select the samples and improve the accuracy of the surrogates. As a case study, the IEA 10MW turbine was selected with five variables to define the inflow conditions- wind speed, yaw angle, vertical wind shear, wind veer, and atmospheric temperature. Furthermore, the sensitivity analysis was also carried out to identify the influential variables. Based on the results, the yaw angle was found to be the most significant variable, whereas the temperature had the least influence on SIV.

The manuscript is well-written and includes the appropriate references. However, the manuscript can be improved by addressing the following comments. Therefore, the reviewer recommends for **Major Revision** of the manuscript in its current form.

The comments that might help improve the manuscript are given below:

<u>Major Comments</u>

1. The computational cost associated with each simulation or response function (damping ratio) evaluation should be included.
2. The threshold used for the termination of the exploration phase is provided as $\epsilon = 0.8$ in Line 266. Generally, the value of R^2 used for surrogate modeling is 0.95-0.99. The author needs to provide reasoning for selecting this value of 0.8.
3. The sentences in Section 4.3.3, line 284-286, are unclear.

   > *"For every predicted minima, the corresponding Delaunay simplex with the closest centroid is identified, and 285 the value of the target function is evaluated at the vertices of the simplex. A threshold is then set on the average of the vertices values. The predicted minima that do not meet this criteria are regarded as possibly false, and are not considered as samples for the next round."*

   a. What does false mean here? Does it mean inaccurate? The reasoning for not utilizing the already evaluated responses at these predicted minima even though it does not satisfy the threshold needs to be appropriately explained.
4. This study presents a sampling approach based on exploration and exploitation by utilizing the Delaunay triangle, which is one of the main contributions, as mentioned in lines 61-63. The performance of this approach has been compared with expected improvement-based

EGO. It would be better for the readers to see the actual comparison of the main application problem related to the SIV of wind turbine blades presented in this study.

5. Multiple runs of the presented approach are provided for analytical problems; however, it is not provided for the main application, which is the optimization regarding the SIV. The algorithm's robustness to initial samples and runs should also be demonstrated for the main application problem.

6. The authors should also shed some light regarding the non-monotonic convergence of the damping ratio in Figure 8-b. For example, what optimizer (algorithm) was used, and does the non-monotonic convergence trend depend on the optimizer?

7. In Section 5, the influence of variables on SIV is studied using Sobol Indices-based global sensitivity analysis. While the first-order and second-order Sobol indices are provided, it's recommended to also include the total order Sobol Indices that includes information regarding the individual and mixed-order interactions/ contributions of the input variables.

Minor Comments:

1. The sentence in Line 268 is repeated exactly in Line 278. Need to paraphrase.
   "As we try to study a larger dimension space with few points, even after achieving satisfying accuracy of the surrogates in the exploration phase, the minima predicted by the surrogate model and the actual minima may not be the same."