WES 2020-93

Overview

Generally, this paper is improved, but it still needs some further improvements before publication. Overall, what is the point of the work? It is a huge effort to bring dynamic analysis inside of a conceptual design optimization process. Would an approach using static analysis be able to capture the effects on constraints and allow for similar exploration of the design space without the heavy computation? The key for showing this paper is value is that including the in situ dynamic analysis adds realism that a static analysis would lack and thus drives the designs differently.

The results of section 4 essentially show limitations of the problem formulation (i.e. it is missing critical design constraints). Recasting these oversights as a good thing (i.e. that they suggest truss spar solutions) is spurious. The paper is doing spar not truss-spar optimization – the conclusion that the optimization hints towards superiority of truss-spar configurations is not justifiable. Instead of this, there should be some discussion on what using the computationally costly dynamic analysis has provided. It's still not clear to me and this is core to the paper.

Additional high-level notes:

- It is not clear until section 3.3 what you are actually doing in the study. Saying modular / fully integrated / multi-fidelity optimization etc is abstract and obfuscates what you are doing. Please in plain language both in abstract and introduction say what you are doing succinctly – something like: "In this study, we perform conceptual design optimization for a FOWT spar with *in situ* aero-hydro-elastic simulations."
- Please have a native English speaker due a detailed edit if possible. There are still various parts of the paper that are hard to read / difficult to understand because of the English grammar problems. There are many typos and grammatical errors. Apologies that I do not have time to go through all of them.
- The paper is still very long – some of the text is run-on discussion. An editor could also help with clarity of message and brevity. Having short, concise and clear text and messaging is always better.

More detailed notes by section follow below.

Abstract

- The first sentences talk about a multi-fidelity approach from conceptual to detailed design but only the results for the conceptual design are discussed in the abstract (and paper as far as II can tell)

Introduction

- Small floating wind farms – you mean first generation commercial floating wind farms? Small is ambiguous
- Semi-subs are also deployed. Arguing spar is most mature is not necessarily true and not so important to the paper
- Figure 1: I don't think it is good to show low resolution graphics from other papers… instead, create your own graphic that illustrates the basic features of the most common topologies for spars
- Sentence in lines 53 to 61 is a long run-on sentence and is hard to read. Please break it down and make sure it is clear
- "aimed and obtained", "aimed to be obtained"… rephrase, this is not clear

- What is in and out of scope should be brought up at the end of the introduction– i.e. the lack of inclusion of the mooring system. The scope of the paper is still unclear by the time I get to the end of the introduction – it is confused by the promise in the abstract for the multi-fidelity framework.

Forming the basis for innovative floater configurations

- A table of properties – initial and final – could help in section 2.2
- Section 2.3 is unnecessarily verbose – can you use tables and simplify the text? Section 2.3 and should be combined into section 3, and then streamlined and shortened as section 2.3 has everything to do with the problem set-up

Optimization problem

- See notes on 2.3 – interweave the 2.3 points into section 3

Fully modular and automated design optimization

- The paragraph on DLCs can be truncated. Since you are using the IEC, just state that you are using DLCs x,y,z from standard a,b,c. The audience is very familiar with the design standards and you don't need to explain them.
- In section 3.3.2 there is far too much detail on the optimizer. For a simple structure as a spar, there are many studies that show gradient-based algorithms work well. I do not think you should try to argue that the system is so complex you must use GA or that GA is actually the best choice. Rather, say that for this study you simply used the Gas as these were available in the framework. Future work may look at alternative algorithms and further improvement of the optimization implementation. GA algoirithms are also well known – there is again far too much detail explaining the algorithm. Simply point to a reference on the algorithm is fine. What should be detailed is your specific parameterization of the algorithm (i.e. population size, etc) which you do. A short paragraph would be enough.
- Optimization algorithm section is a bit of a strange label. The optimization algorithm is the GA. What you describe in 3.3.3 is your optimization workflow.
- Section 3.3.3 is the first section where it is really clear what you are actually doing in the optimization. Consider bringing this forward to the introduction and abstract but state it plainly, something like this:
    - "In this study, we use in situ aero-hydro-elastic simulations to support conceptual design optimization for a FOWT spar."
- Can you say anything in terms of how often simulations fail? I imagine it could be a lot.
- I do not think you need equations 5, 6 or 7 at all… this is trivial information about how optimization works in general

Results

- 31 days!!! That is a heck of a lot of time… and you are not converged at all? It is hard to tell because in figure 4 you start with the initial population which has a much larger spread in performance compared to the subsequent populations.
- For figure 4 it would be nice to see the lables in terms of the formal expression rather than design variables so the reader gets a better feel for what they are without having to refer back
- I wouldn't refer to the final design as the "selected optimum" – you know its not optimal. Say instead the best performing individual from the final population
- Description of what plot colors mean should be in the caption, not in the text.
- Same thing for figure 5, label the plots with the formal expression and not the constraint function variables
- Same thing in table 6, use formal expression for DVs, constraints and objective function

- It is not clear if “these individuals” as in line 401 on page 4.2 are from the first generation or final generation. As they obey the constraints (as far as I can see), they are from the final population? Make sure that it is explicit. How did you select these individuals? Is it random? And is their ordering random? Their objective function performance is wildly different- if it were ordered from lowest to highest
- In figure 6, you can see that there are a lot of really weird designs. It is quite easy to implement basic manufacturability constraints for example which would help avoid getting such weird designs. Having such weird results undermines to a degree the overall credibility of the work – this is dangerous as an industry person looking at these results would likely be very dismissive of the work.
- The comparison of the design results to figure 7 also is strange. Truss type spars are different than what you are modelling. There are simulation tools out there to design such things, but saying that your spar framework can help identify structures like truss that could be sought is a big leap… its also a big leap to draw a link between the example designs and the two truss spars from the literature. I don’t think you can do so based on the results you have.
- “one and only objective function” is strange wording… just say objective function. Delete the entire first sentence of section 4.3 – this is how basic optimization works and does not need explanation.
- There is a lot of redundancy in section 4.1 through 4.3 – you can much more quickly get to the point around the final best performing individual and eliminate making overreaching statements about the capability.
- The basic issues with the final design related to lack of constraints related to manufacturability and/or structural analysis should have been corrected before publication as they are easy to implement and appear in various prior studies (for example tower, jacket and monopile optimization from NREL, Stuttgart, and elsewhere). I do not think rebranding it as hinting towards truss spar solutions is justifiable. If the paper were to do truss spar optimization it should do it and would need to reformulate the model to account for the truss elements – in other words, it would be an entirely different study. **Instead of focusing on the truss, please expand on what using the dynamic analysis in situ has added in value compared to using static or quasi-static analysis**.

Discussion

- Recommend shortening substantially the discussion section. They are far too detailed. Every paragraph in the section including the bulleted paragraphs can be shortened likely by half. Be clear and concise.
- The lines from 605 on overstate things. It would be better to say that future work will incorporate constraints on stress, buckling and manufacturability to ensure that the designs are realistic but also allowing for the exploration of a wide range of novel concepts.
- I don’t think you need to speak to LCOE optimization unless you are going to speak to the elements across LCOE that the spar design impacts… i.e. where the couplings will be that require a more holistic approach

Conclusion

- The last sentence is still an overreach… what can you conclude from this work? In one to two sentences