CONTROL-INFORMED WEC PERFORMANCE OPTIMIZATION

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Wave energy converter (WEC) designs to date—including Reference Model (RM) designs by the DOE and those submitted for the Wave Energy Prize—have followed a traditional design/build/test approach that requires potentially costly iteration. There are two significant shortcomings with this design approach: (1) WEC design theory builds on knowledge from naval architecture and offshore engineering, but fails to fully utilize design/analysis tools for oscillating systems (e.g., from electronics), and (2) current WEC design is ad-hoc, where designers clarify overarching system parameters to define the geometry of the device, then design a control system that is constrained by the hydrodynamics of that previously set geometry. More robust, analytical design approaches, utilizing optimization algorithms, have yet to take hold in the WEC development community, due to the lack of an efficient modeling/control design approach. This project seeks to overcome these critical issues in WEC design by creating a hybrid optimization system that simultaneously optimizes geometry and controls of existing WEC concepts. Highly-efficient model/analysis approaches which utilize pseudo-spectral methods to consider the dynamics of the entire system will be leveraged with this optimization system. At the top of Figure 1, the current ad-hoc process for the optimization of a WEC concept is shown. Here, a concept is matured through a trial and error process, where the design is tweaked and reanalyzed repeatedly via a manual loop. The resulting design is necessarily suboptimal. In the lower half of Figure 1, the proposed improved process is shown. We will benchmark existing WEC designs using our modeling approaches (including current LCOE, AEP, loading, and other objectives), and compare these values to the evaluation of optimal WEC designs found through our hybrid optimization approach. A better ability of how to address the maturation of a WEC concept, utilizing control and oscillating system design tools, will lead to better technologies, improved system performance, and will reduce dependence on prototypes and testing, which, in turn, will shorten the WEC maturation/design cycle and reduce development costs.

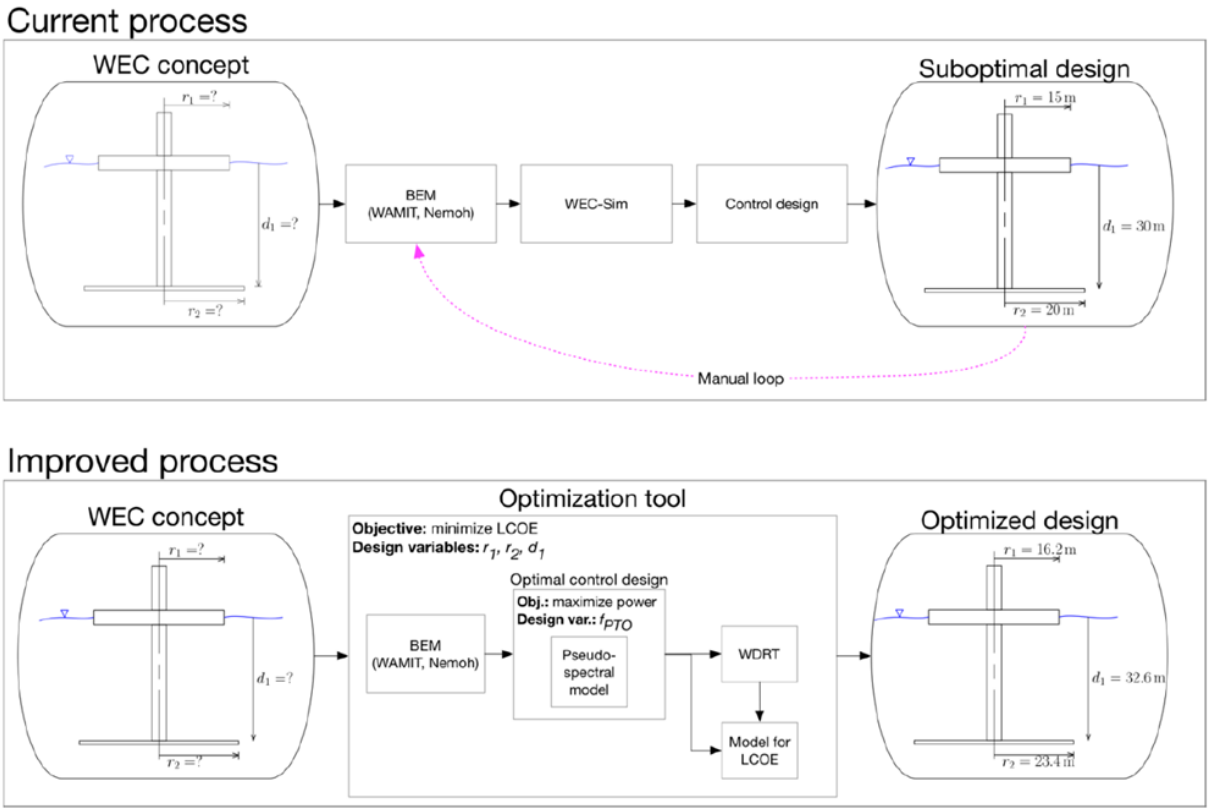

FIGURE 1. COMPARISON OF EXISTING AND PROPOSED WEC PERFORMANCE OPTIMIZATION PROCESSES. NOTE THAT EACH PROCESS STARTS WITH A WEC CONCEPT (IN THIS CASE, SOMETHING SIMILAR TO THE REFERENCE MODEL 3), WHERE THE DIMENSIONS ARE UNDEFINED. THE CURRENT PROCESS APPLIES A MANUAL LOOP AND ARRIVES AT SOME SUBOPTIMAL SET OF DIMENSIONS. THE PROPOSED PROCESS WILL UTILIZE AN OPTIMIZATION TOOL TO ARRIVE AT AN OPTIMIZED DESIGN