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REDUCED ORDER MODELS FOR INTERDISCIPLINARY OPTIMIZATION OF A COMPRESSOR BLADE

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Despite intensive research on multidisciplinary design optimization (MDO), the presence of multiple disciplines still poses challenges, especially for large-scale industry applications [1]. First, MDO requires results from multiple disciplines, which can be prohibitive in terms of CPU time in case of large simulation-based problems. Second, interdisciplinary coupled responses increase complexity and additionally raise the computational cost. Lastly, the integration into company structures impedes the application, as departments often focus on a single discipline and have little multidisciplinary expertise.

The first problem is commonly overcome by surrogate models exploiting data-driven regression models or reduction techniques such as proper-orthogonal decomposition. These fast but less accurate low-fidelity models are usually combined with high-fidelity simulations for each discipline [2]. To solve the second problem, we propose a multi-fidelity framework, which is *inter-* instead of *multi-*disciplinary. The main discipline is treated as a high-fidelity model, while one or more side disciplines are represented by a low-fidelity model only. Thereby, a high accuracy can be preserved for the main discipline. The fast evaluations for the side discipline enable a *weak* coupling of the disciplinary responses at a low computational cost. Once the low-fidelity model is trained, the incorporation of the side discipline only slightly increases the cost of a single design evaluation. Addressing the last problem, the competences of disciplinary teams can be maintained. Nevertheless, design decisions can be supported by additional information from the respective other discipline.

To illustrate the proposed approach, an industry-scale optimization problem is solved. A turbomachinery compressor blade is optimized with regard to structural objectives (static/dynamic), while maintaining the aerodynamic performance. Various reduced order models are compared concerning their prediction accuracy of the aerodynamic responses. Especially for an expensive side discipline like aerodynamics (CFD), the optimization speed-up is significant compared to a purely high-fidelity MDO, yet yielding a similar optimized blade design. The design nearly fulfills the aerodynamic goals, in contrast to a purely structurally optimized blade. Hence, the design process requires less iterations between the two disciplines.

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