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CHALLENGES OF INTEGRATING ADJOINT SIMULATIONS IN INDUSTRIAL TURBOMACHINERY MDO

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The design of turbomachinery creates a strong demand for the simultaneous optimization of multiple blade rows with regard to different disciplines including aerodynamics, aeroelasticity and solid mechanics. Established gradient free methods, typically surrogate based methods, have been successfully applied to the optimization of single blade rows and pairs of adjacent rows, typically featuring in the order of 50 design variables per blade row. Gradient free methods are challenged by the increased number of design variables from simultaneous optimizations of many rows.

To combine the practicability of surrogate modelling with the large information source of adjoint gradients, we have been employing gradient enhanced surrogate modelling methods for some time [1], where direct gradient enhanced kriging has been most successful [2]. While reducing the number of objective evaluations the update of the surrogate model becomes a bottleneck in larger design spaces due to the factorization of a significantly larger correlation matrix. We describe our current activities to enable gradient based surrogates for the optimization in multi-row design spaces, by exploiting sparsity in the dependency of objectives on design variables and improving the surrogate model fill-in regarding gradient information.

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