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Robust optimization using a second order approximation technique in parametrized shape optimization

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A nonlinear constrained optimization problem with uncertain parameters is investigated. It is adressed by a robust worst-case formulation. The resulting optimization problem is of bi-level structure. This type of problems are difficult to treat numerically. We propose and investigate an approximate robust formulation that employs a quadratic approximation. For an efficient realization in application problems we will mix the introduced framework with a linear approximation when appropriate.

The proposed strategy is then applied to the optimal placement of a permanent magnet in the rotor of a synchronous machine. The goal is to optimize the volume and position while maintaining a desired performance level. These quantities are computed from the magnetic vector potentials obtained by the magnetostatic approximation of Maxwell's equation with transient movement of the rotor. Permanent magnet synchronous machines can be described sufficiently accurate by this model. Hence we arrive at an optimization problem governed by a set of elliptic partial differential equations, where one PDE has to be solved for every rotor position.

Due to manufacturing, there are uncertainties in material and production precision. Here the introduced robust optimization framework comes into play and accounts for uncertain model and optimization parameters. To speed up the computation in the optimization process reduced order models are developed. Numerical results are presented to validate the presented approach.