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A Certified Model Reduction Approach for robust optimal control with PDE constraints.

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We investigate 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 given performance level. These quantities are computed from the magnetic vector potentials obtained by the magnetostatic approximation of Maxwell's equation. Our optimization problem is governed by an elliptic partial differential equation and due to manufacturing, there are uncertainties in material and production precision. We introduce a robust optimization problem that accounts for uncertain model and optimization parameters. The resulting optimization problem, utilizing the robust worst-case formulation, is of bi-level structure. The solution of this problem may involve the solution of several Partial Differential Equations and, for this reason, we introduce a model reduction technique in order to approximate the problem efficiently. In particular, we propose a goal-oriented model order reduction approach in order to avoid expensive offline stages and to provide a certified reduced order surrogate model for the parametrized PDE which then is utilized in the numerical optimization. Numerical results are presented to validate the presented approach.