Robust Shape Optimization of Electric Machines

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a Bachelor's thesis | Master's thesis | Seminar topic
Study field: Computational Engineering | Electrical Engineering | Mathematics

Description

Due to the growing importance of e-mobility, the efficient simulation and optimization of electric energy converters, in particular electric machines, is becoming increasingly important. In the manufacturing process of these electric machines imperfections and small deviations from the nominal design can occur. In the worst case, these imperfections can lead to a significant decrease in quality or even failure of the machine. To avoid this, the machine can be optimized robustly, i.e., considering the deviations in the machine design [1]. Robust optimization aims to find a machine design which is robust in terms of deviations from the nominal design, i.e., to find an optimum in terms of a goal function J which does not deteriorate significantly for small changes in the design parameters p, compare Fig. 2. In this project an electric machine is simulated using isogeometric analysis and the shape of the machine shall be optimized robustly considering uncertainties, using uncertainty quantification methods like the Monte Carlo method.

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Work plan

- Literature study on robust optimization
- Modelling an uncertain deviation, e.g. uncertain magnetization or shape
- Implementation of robust optimization given code for nominal shape optimization
- Application of the robust shape optimization to a machine model

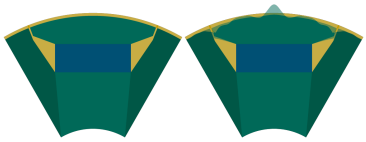

Figure 1: Original (left) and optimized (right) design of a rotor of a permanent magnet synchronous machine using nominal optimization [2].

Prerequisites

Basic knowledge of the finite element method, interest in numerical methods and Matlab programming

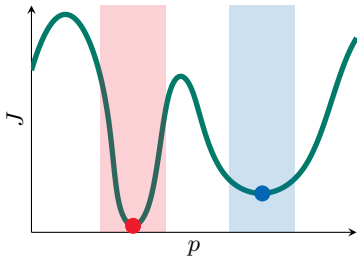

Figure 2: Two local optima, the red optimum is not robust, the blue optimum is robust.

References

[1] Zeger Bontinck et al. "Robust Optimization Formulations for the Design of an Electric Machine". In: *IET. Sci. Meas. Tech.* 12.8 (Aug. 2018), pp. 939–948. ISSN: 1751-8822. DOI: 10.1049/iet-smt.2018.5235. arXiv: 1712.01536.

[2] Melina Merkel, Peter Gangl, and Sebastian Schöps. *Shape Optimization of Rotating Electric Machines using Isogeometric Analysis*. Aug. 2019. arXiv: 1908.06009.