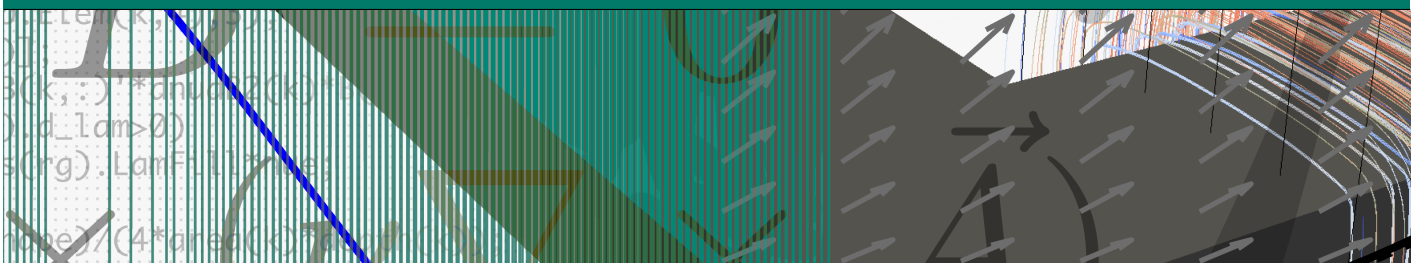
Importance Sampling for Failure Probability Estimation

TECHNISCHE UNIVERSITÄT DARMSTADT

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



Description

Deviations in the manufacturing process of electronic components may lead to rejections due to malfunctioning. Uncertain design parameters (i.e. geometrical and material parameters) can be modeled as random variables. Then, the failure probability of a realization can be estimated. A standard approach for estimating failure probabilities is a Monte Carlo analysis. In a Monte Carlo analysis a large number of sample points is generated according to a given probability distribution. The percentage of sample points not fulfilling some predefined performance feature specifications denotes the failure probability. In order to obtain a reliable estimation, a large number of sample points is required. This leads to high computing costs, since for each sample point a PDE must be solved, e.g. with the finite element method (FEM). Current research deals with the reduction of computational effort. Importance sampling is an approach to reduce the number FEM evaluations by generating sample points in critical regions with a higher probability.

Work plan

- Familiarization with the topics of failure probability estimation and Monte Carlo analysis
- Literature study on existing importance sampling approaches
- Efficient implementation of importance sampling in Python
- Evaluation and comparison with existing methods

Prerequisites

Basic knowledge of electromagnetism, stochastics and FEM, some experience with programming in Python, interest in electromagnetic field simulations.

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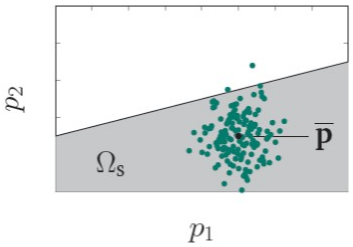

Fig. 1: Monte Carlo analysis for a problem with two uncertain parameters p_1 and p_2.

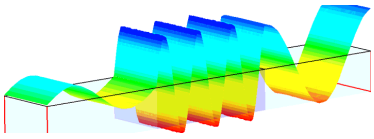

Fig. 2: Waveguide with possible design uncertainties.

CEM