Efficient estimation of electrical machine behavior by model order reduction

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***Abstract*—Multiple computation of numerical models of electrical motors are required for parameter variations. This leads to time consuming parameter studies, which can become unbearable if many parameters should be varied. One way to diminish these computational efforts is to apply model order reduction techniques. In this work the proper orthogonal decomposition is used and analyzed in the context of local and global loss estimation.**

***Index Terms*—Discrete empirical interpolation, iron losses, model order reduction, proper orthogonal decomposition.**

I. Introduction

Nowadays the loss estimation of electrical machines is performed in high detail to achieve realistic results in the design process [1]. On the one hand algebraic equations such as the IEM formula [2] are used to calculate very accurate losses out of isotropic simulations or geometric loss interpration of anisotropic hysteretic simulation can lead to good approximation of the loss behaviour. Nevertheless, to compare different designs a high number of simulations have to be performed. To cope with this computational effort model order reduction techniques enables to have an approximation of the machine behavior to compare different designs, for example in terms of losses and torque [3][4].

II. Proper Orthogonal Decomposition

The Proper Orthogonal Decompisition (**POD**) is based on projecting the full model into a subsystem by an projection operator Ψ. To evaluate Ψ the method of snapshots is employed, which collects solution vectors of the reference system to explore the solution space by application of an Singular Value Decomposition (**SVD**). To consider the nonlinearities the Discrete Emperical Interpolation Method (**DEIM**) is utilized [5].

III. Application

To depict the feasibility of the POD to produce reduced order models (**ROM**) is applied to an electrical machine (s. Fig. 1). In Fig. 2 the accuracy of the torque depending on the number of snapshots is denoted.

IV. Conclusion

In this research article the theoretical part of the nonlinear model order reduction is combined with a realistic example of technical relevance. A first evaluation of global quantities such as the torque is shown. Consecutively in the full paper a detailed analysis of the convergence and accuracy of the ROM will be discussed.

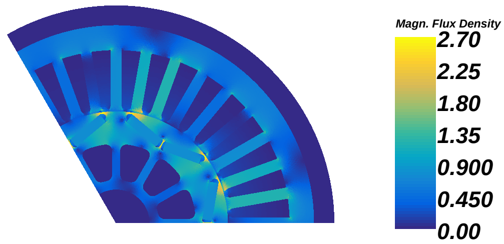

Fig. 1. Simulated machine at maximum speed.

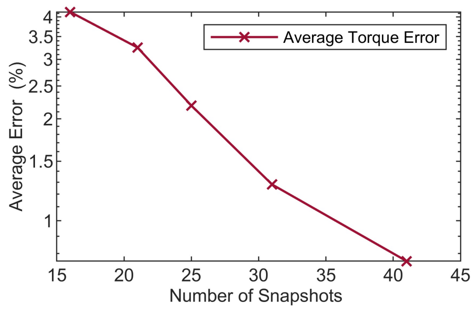

Fig. 2. Relative Error of Torque.

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