LABORATOIRE D'ELECTROTECHNIQUE ET D'ELECTRONIQUE DE PUISSANCE DE LILLE

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MEC MODELING OF ELECTRICAL MACHINES FOR DESIGN BY OPTIMIZATION

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Context

To design, you need models and an optimization process. To be usable, the model must be flexible and fast. Models with Magnetic Equivalent Circuit (MEC) offer a generic solution. Modeling and optimization on the same platform provide the flexibility needed for the design process. There are few tools to find shapes and topologies for electrical machines. This is why we want to develop a modeling tool dedicated to electrical machines and adapted to design by optimization and topological optimization.
A Jeumont Electric structure will be taken as a test case.

Objective

The objective is to develop a specific modeling tool for machines and adapted to topological optimization [1].
A Cartesian XY version of a MEC model exists [2], it will be necessary to adapt this model to the specificities of round electric machines [3]: symmetry, curvature, saturation, rotor displacement,…
The model will provide the gradient of the design variables using the adjoint method for the classical quantities of the electric machines: Energy, torque, induction, fem

Expected results

- Development of the model: MEC Electric machine
- Comparison with Jeumont Electric simulations / measurements: accuracy and computation time
- Validation on particular cases for the MEC model (rotation, ...)
- Tests and validation of the calculated gradients.
- Detailed writing of the solutions found for the calculation of the gradients.

Keywords

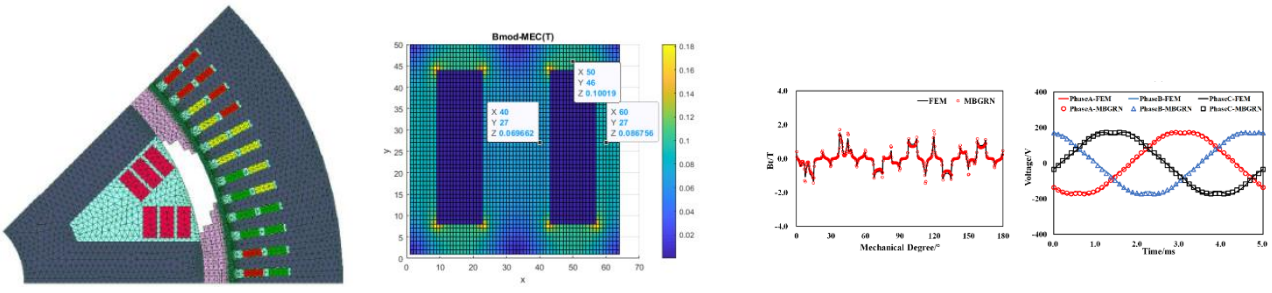
magnetic equivalent circuit (MEC); electric machine, design by optimization, topology optimization,

References

[1] *MOHAMODHOSEN Bilquis, GILLON Frédéric, TOUNZI Abdelmounaïm, CHEVALLIER Loïc "Topology Optimisation using Nonlinear Behaviour of Ferromagnetic Materials" in The International Journal for Computation and Mathematics in Electrical and Electronic Engineering (COMPEL), 09/2018*

[2] *D. FU, J. GONG, Y. XU, F. GILLON and N. BRACIKOWSKI, "Coupled Circuit and Magnetic Model for a Transverse Flux Permanent Magnet Linear Motor," in IEEE Access, vol. 8, pp. 159274-159283, 2020, doi: 10.1109/ACCESS.2020.3020258.*

[3] *Shuo YANG, Yacine AMARA, Wei HUA, and Georges BARAKAT " Development of a generic framework for lumped parameter modeling »," Open Physics 2020; 18: 365–373*



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a/ *b/* *c/*

Figure 1. Magnetic structures modeling – a/ Synchronous generator [1], b/inductance, and c/ flux density in the airgap and voltage obtained with the machine rotation [3].