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

Master project, 2020-2021

— Data Assimilation for Digital Twin of Electrotechnical Products —

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Context

The availability of electrical machines used for energy production and mobility is of upmost importance and monitoring is necessary for early diagnostic of failure. One of the challenges for diagnostic is the variability introduced in the machine signature by the manufacturing processes. Digital twin (DT) of the machine can provide an insight of its health.

Data assimilation (DA) is used for DT calibration and evolution along lifespan thank to high-fidelity models and online measurements. However, DA requires the knowledge of the co-variance of parameters and observations that are difficult and expensive to assess. Moreover, one DT per machine is not affordable for small machines devoted to mobility, as they are numerous.

Current state of the art in this field

Many studies are related to data assimilation in various fields of science but very few deals with electrical machines. In [Bacchus], the co-variance of the machine parameters and observations were not considered and the co-variance matrices were taken as identity.

Objective

This master project will study the data assimilation techniques and apply them to calibrate a digital twin of one electrical machine and a digital twin of several machines belonging to the same product.

Work steps

- State of the art of data assimilation for electromagnetic devices: examples, approaches, formulations, and algorithms
- Study, measurements and dismantling of one electromagnetic device: a small 1-phase transformer
- Modelling of the transformer with the finite element method and get familiar with its parametric model in Opera3D
- Implementation of the data assimilation with Matlab Optimization Toolbox and assumption of co-variance matrices equal to identity
- Study of the co-variance of the machine parameters and observations
- Data assimilation taking into account the co-variance matrices of machine parameters and observations

Key word

Data assimilation, digital twin, optimization, finite element model, electromagnetic device

References

[Bacchus] A. Bacchus, A. Tounzi, J.-P. Argaud, B. Bouriquet, M. Biet, L. Macaire, Y. Le Menach, "Estimation of FEM Model Parameters Using Data Assimilation and Its Application to an Electrical Machine", IEEE Transactions on Magnetics, Vol. 52, No. 3, March 2016