Master project, 2021-2022

— *Study of the effect of the manufacturing imperfections on the vibro acoustic behaviour of an electrical machine—*

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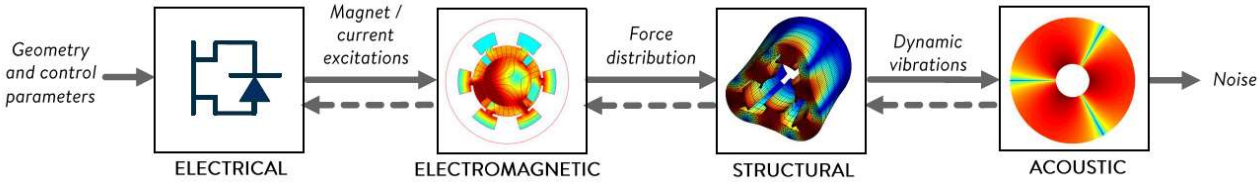
Context

Electrical machines are widely used in "consumer" applications or in industrial environments with many human operators. They generate vibrations leading to audible noise during their operation. As a result of new regulations or for comfort, vibrations and the resulting acoustic noise are increasingly becoming additional key elements that must be controlled from the design stage. Vibrations and noise can have mechanical, aeraulic and electromagnetic origins. For many applications, it turns out that electromagnetic noise is a major source, especially at low speeds [1]. The electromagnetic forces depend on the structure of the winding, the behavior of the ferromagnetic materials and the supply currents [2]. To predict noise and vibrations of electromagnetic origin, it is necessary to be able to determine [3] first the distribution of the electromagnetic field inside the electrical machine via an electromagnetic model, which will provide the distribution of forces being applied on the inner stator surface, then the vibratory behavior, produced by the electromagnetic forces, via a mechanical dynamic model and finally the resulting acoustic noise.



Besides, the manufacturing process introduces dispersions according to the designed electrical machines. We can cite, for example, dimensional and material variability, eccentricities, assembly forces, differences in polarization of the poles, power supply and control ... [4,5]. All these imperfections, which are rather random in nature, have an influence on the spatial and temporal distribution of the electromagnetic forces. They lead to the appearance of additional harmonics enriching the spectrum [6] and therefore become sources of additional vibrations and noise. The effect of manufacturing process impefections should also be taken into account during the design phase, as some topologies can be more robust to tolerances compared to others.

Objective

Based on the expertise of each partner, this project focuses on the development models of the dynamic behavior of magneto-mechanical electrical machine accounting for imperfection of the manufacturing imperfections. This work will be carried out between the LAMIH, expert in the field in mechanical engineering, the L2EP, expert in the field of electrical engineering and the company EOMYS, expert in the field of vibro acoutic and electrical engineering.

A PhD in the continuity of the master subject will start in september 2022.

Description of the work

First, a state of art on the application of uncertainty quantification to evaluate the effect of manufacturing imperfections on the behavior of an electrical machine. Then, a model of the magneto vibro acoustic behavior of an electrical machine will be developed based on a user-friendly, unified, flexible simulation framework for the multiphysic design and

optimization of electrical machines and drives provided by the PYLEECAN project (https://www.pyleecan.org/) and also the platform OPENTURNS (https://openturns.github.io/www/index.html#) dedicated to the treatment of uncertainties.

Key words

Electrical Machines, Magneto Vibro Acoustic, Uncertainty Quantification, Numerical Simulation

References

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