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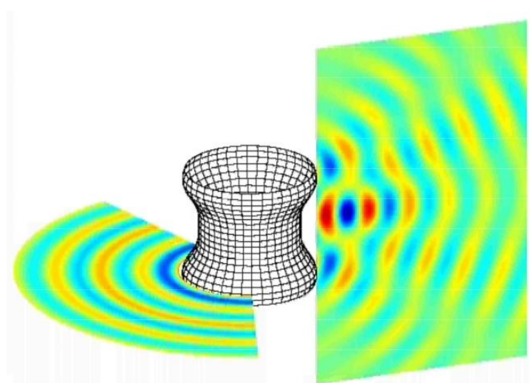
Vibroacoustic characterization of a drivetrain



Main objectives

Characterize the vibroacoustic behavior of a drivetrain:

- analyse currents, vibrations and radiated sounds,
- explore the physical link between electrical quantities and stator radial vibrations,
- highlight the vibroacoustic influence of the implementation of the motor control law.

Context

The process on which the experimental data has been acquired is described in figure 1. It is

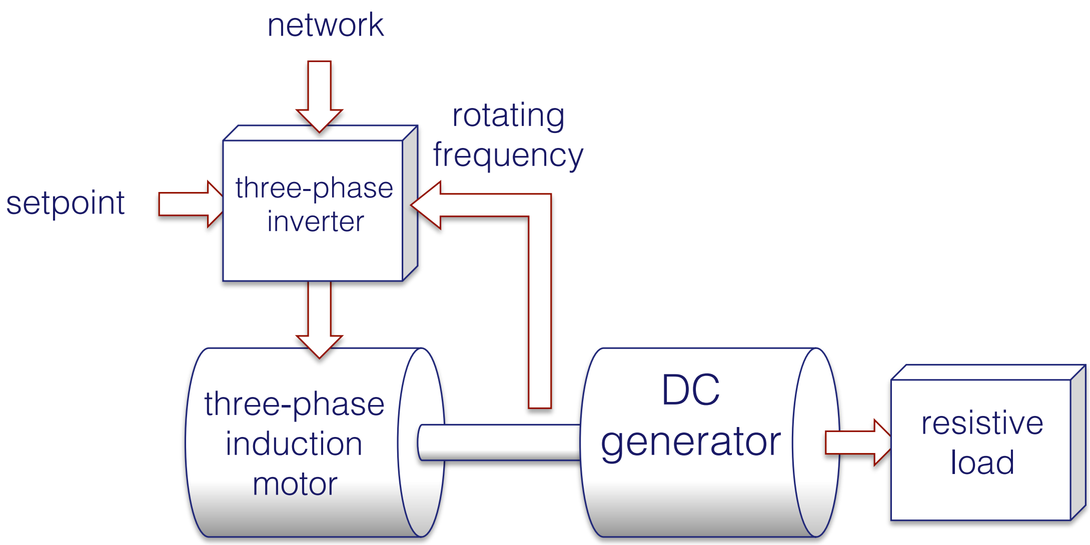


Figure 1: Structure of the whole process

composed of a 5kW 2 pole pairs three-phase induction motor, supplied by a three-phase variable frequency inverter. This engine drives a DC generator supplying a resistive load and therefore applying to the motor shaft a load torque proportional to the resistance value. The setpoint of the whole process is the motor rotating frequency chosen by the user.

A closed-loop control law is applied to the engine through the variable frequency inverter to make the drivetrain rotates at the specified frequency. This control law is implemented in the inverter following two different strategies:

- pulse-width modulation strategy (PWM frequency of 5 kHz),
- hysteresis or "bang-bang" strategy.

For the same operating conditions, the waveforms and spectral contents of the stator currents and the vibroacoustic behavior of the drivetrain is different for each implementation strategy. Therefore, it is interesting to analyze how such a strategy influences the vibroacoustic behavior of the whole drivetrain.

One stator current of the engine, as well as its stator vibrations and the sound near the drivetrain are measured through sensors and an acquisition system, and are the data that can be used to characterize the vibroacoustic behavior of the drivetrain.

Project

1 Objectives

Characterize the vibroacoustic behavior of a drivetrain:

- analyze the measured quantities and compare the results obtained for the 2 implementation strategies,
- compare the contents of currents and vibrations to explore the physical link between electrical quantities and stator vibrations,
- describe the vibroacoustic influence of the motor control law implementation.

2 Hints and additional stuff

The available data was acquired with a constant rotating frequency set to 95 rd.s^{-1}, and a constant mechanical load. This means that the whole process was running under stationary operating conditions. The different datasets are stored in 2 files which correspond to the 2 implementation strategiess:

- File `pwm.mat`: control law implemented following a pulse-width modulation strategy,
- File `hyst.mat`: control law implemented following a hysteresis strategy.

Each dataset is composed of one stator current of the engine, its stator vibrations measured in the radial direction and the sound radiated by the drivetrain. The sampling frequency was set to 25600 Hz.

Begin your analysis with the PWM implementation which signatures are easier to understand.

Once you have understood the effect of the implementation on the vibroacoustic behavior of the drivetrain, you can use the physical model relying stator currents and vibrations together with optimal filtering technics in order to estimate vibrations and sounds with a electromagnetic origin, *i.e.* only due to stator currents.