Diagnostic and monitoring of rotating parts in vehicles

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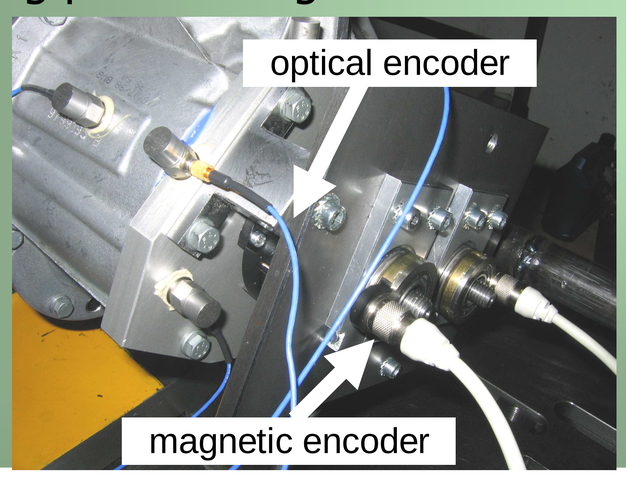
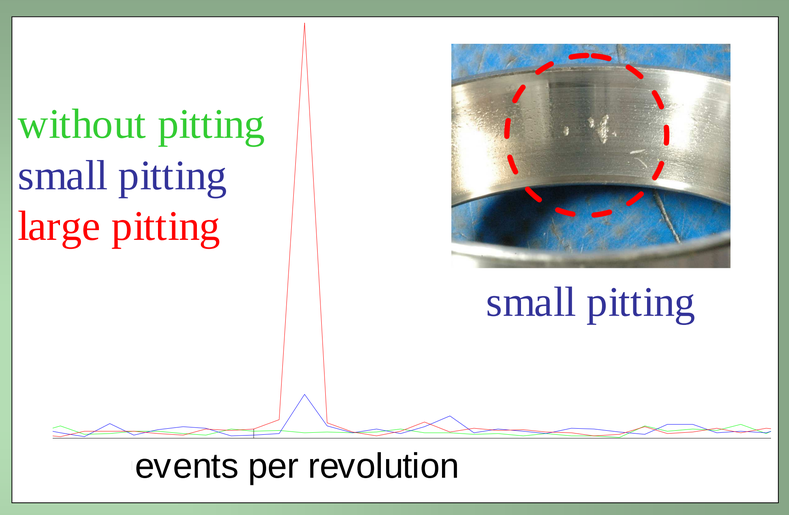
Abstract

By the help of a large experimental investigation on two different applications, we prove that localized defaults like pitting in bearing generate small angular speed fluctuations which are measurable with optical or magnetic encoders. We also emphasize the benefits of measuring instantaneous angular speed with the pulse timing method through an implicit angular sampling which ensures insensitivity to speed fluctuation. The tests performed on an automotive gearbox or on actual operating vehicle wheels also establish the robustness of the proposed methodology. By the means of a conventional Fourier transform, angular frequency channels cinematically related to the default periodicity show significant magnitude differences related to the damage importance. Sideband effects are evidently seen when default is located on rotating parts of the bearing due to load modulation. Additionally, slip effects are also suspected to be at the origin of enlargement of spectrum peaks in the case of double row bearings loaded in a pure radial direction.

Preliminary phase of project : validation of sensing concept

- Tests on automotive gearbox bench
- With optical or magnetic encoders
- For different operating conditions in speed, torque, engaged gear, ...
- using pulse timing method for measurement

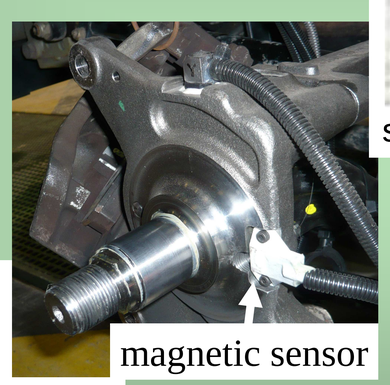


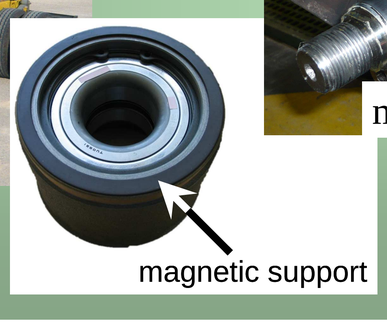


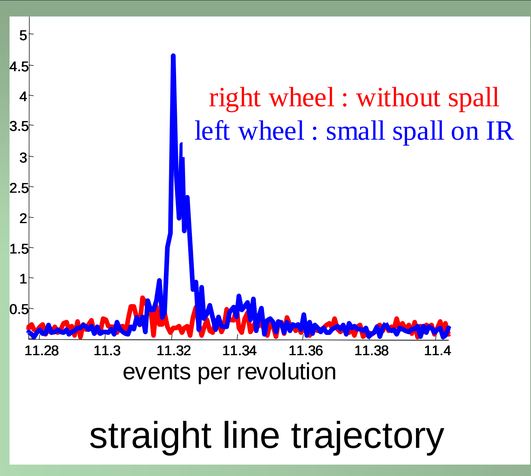
- Characterisation of encoder signature
- Validation of signal processing method
- Level of indicator follows the same trend as the size of the default

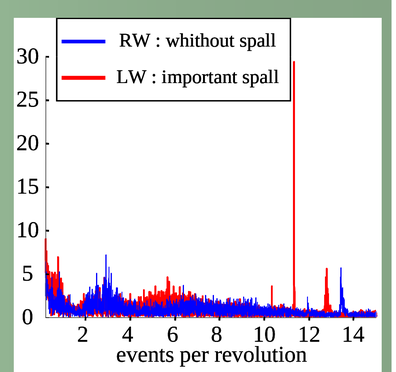
Fulfilment phase of project : industrial feasability

- Tests on an actual vehicle
- With ABS magnetic sensors
- Under realistic operating conditions : speed, engaged gear, load, turns, ...









- On double row tapered roller bearing with active sensor
- Without any adjustement during assembly
- With realistic defaults obtained through natural damage process

Main results

- Original measurement for bearing faults monitoring by angular sampling of Instantaneous Angular Speed
- With robust sensors providing good integration for mechatronic purposes
- Validated on actual vehicle under realistic operating conditions
- With primary and simple signal processing tools (FFT)
- Taking benefits of its insensitivity to speed fluctuations

Conclusions and perspectives

- Extension of phase difference measurement
- experimental investigation introducing a new way of sensing and interpretation of other signal processings
- fault detection remains even with poor quality encoder
- tested with low encoder resolution and with interpolation
- usable on other rotating machines with different kinds of encoders and for torsion

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