

# Investigation of the Influence of the Operating Parameters on the Magnetic Encoder Geometric Error Compensation

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## Abstract

The encoder is the only sensor needed to perform Instantaneous angular speed (IAS) analysis, an alternative technique used to monitor gears, bearings or other electro-mechanical elements. The encoder is subject to an intrinsic defect called Geometric Error (GE). Although it has various origins, GE can be simplified as being related to the variable angular size of every encoder segments forming the theoretically uniform pattern. As a result, GE introduces a cyclic perturbation observed on the spectrum of the estimated IAS. These perturbations exhibit a first order cyclostationary behaviour which replicates themselves in each revolution of the shaft. Since the impacted frequency channels can also be studied to monitor the health status of the shaft line, GE should be corrected for a better IAS estimation.

In this study, a rotation domain averaging based algorithm is developed to compensate the GE of the estimated IAS signals. The GE signature of a given signal is estimated and is used to compensate the GE of the other signals as well as itself. The term cross-correction is introduced to mention the correction of signals with each other's GE signature. The quality of the correction is analysed and is shown that it depends on several operating conditions. In other words, signals obtained for certain operating conditions are shown to be better at correcting GE than signals obtained for different operating conditions.

The developed algorithm is tested on a 2-MW wind turbine campaign which is instrumented with a magnetic encoder. These observations makes it possible to qualify the properties of the best GE corrector signals and dress an optimized correction algorithm suitable for any database. Since there were several interventions on the wind-turbine like re-installation of the encoder, gearbox change and gear defect, it is also possible to observe the influences of these interventions on the GE compensation. The results of this work are expected to be useful for gearbox operators as it represents a probable solution for early fault detection especially in demanding operating conditions.

**Keywords**— Instantaneous Angular Speed, Geometric Error, Magnetic Encoder, Cross-correction

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