WIND TURBINE GEARBOXES FAULT DETECTION THROUGH ON-SITE MEASUREMENTS AND VIBRATION SIGNAL PROCESSING

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Condition monitoring of wind turbine gearboxes has attracted an impressive amount of attention in the wind energy literature. This happens on one side for practical issues: it is estimated that wind turbines unavailability time is of the order of the 3% of the lifetime and that gearbox damages account for at least the 20% of it. On the other side, the condition monitoring of gear-based mechanical systems undergoing non-stationary operation is scientifically challenging.

On these grounds, the present work is devoted to the diagnosis of gearbox damages through a novel approach, designed exclusively for this study, based on on-site measurements and data post-processing. The main point of this method is the relatively easy repeatability, also for wind turbine practitioners, and its low impact on wind turbine operation: actually, the measuring site is not the gearbox, but it is instead the tower. Longitudinal and transversal accelerations are measured inside the tower at 7 and 2 meters above the ground.

A real test case has been considered: a multi mega-watt wind turbine sited in Italy and owned by the Renvico company (www.renvicoenergy.com). Measurements have been collected at the target wind turbine, where the fault was supposed occurring (on the grounds of oil particle counting analysis), and at a two reference wind turbines, that were supposed to be healthy. The data have been subsequently processed through a multivariate Novelty Detection algorithm in the feature space. The application of this algorithm is justified by univariate statistical tests on the selected time-domain features and by a visual inspection of the dataset via Principal Component Analysis.

The main result of this work is that the novelty index based on time-domain features (as for example the Mahalanobis distance), computed from the accelerometric signals acquired inside the turbine tower, proves to be suitable to highlight a damaged condition in the wind-turbine gearbox, which can be then successfully monitored.

This system is non-invasive with respect to wind turbine operation and the results of this study support that it can, in principle, enable to monitor also the damage evolution in time, establishing the foundations for further works on prognostics, which could optimize the wind turbines maintenance regimes, ensuring higher reliability and minimal down times.

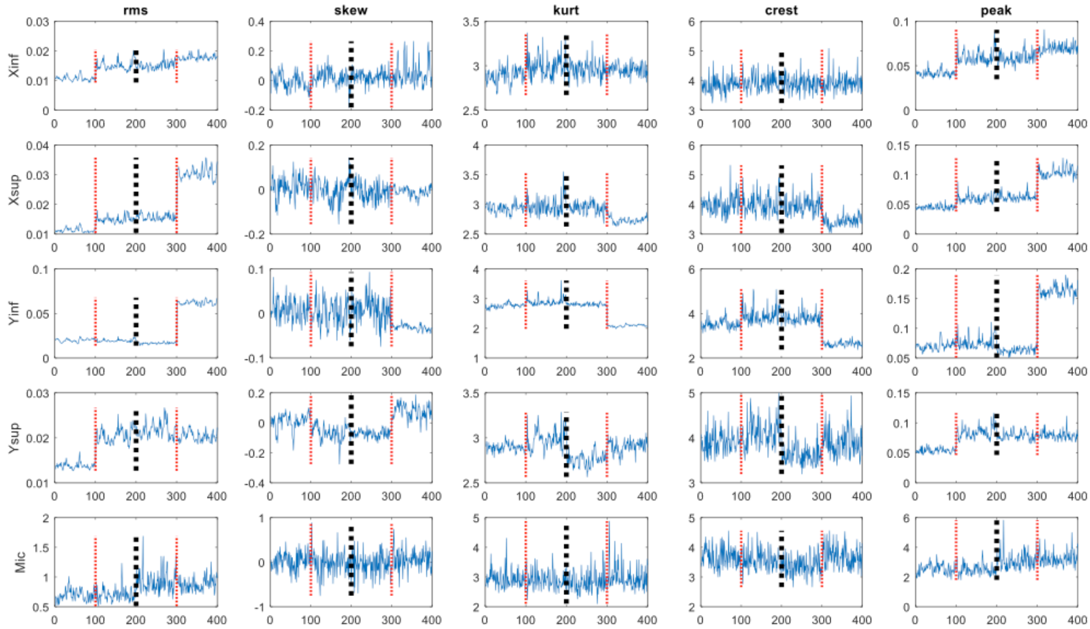

Figure 1: feature extraction. The samples 1-200 are used for calibration, the samples 201-400 are used (after the black line) are used for validation. Samples 301-400 belong to the damaged wind turbine.

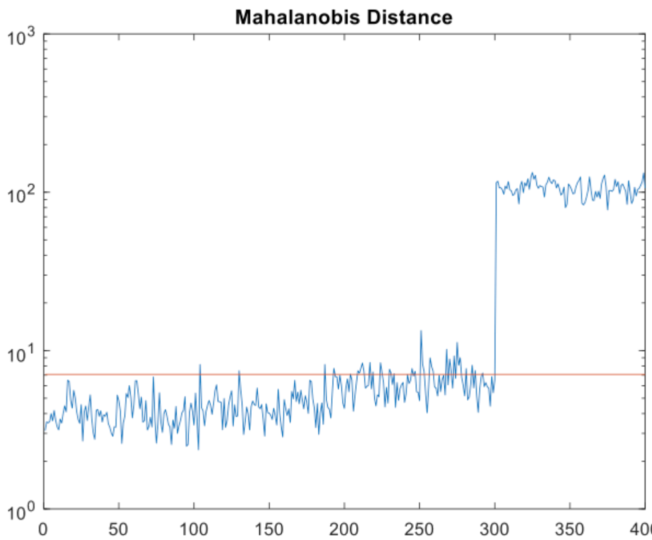

Figure 2: Mahalanobis Distance from thecalibration set (samples 1-200). Samples 201-300 are the healthy set used for validation, while samples 301-400 correspond to the damaged condition.