Vibration Monitoring: Gearbox identification and faults detection

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Abstract

This thesis is devoted to the application of novel techniques to the identification and quantification of faults in gearboxes starting from vibration signals. In general, this kind of *abduction* can be considered a form of Non-Destructive Testing (NDT), whose scope is to increase the reliability of complex and expensive machines switching from programmed maintenance to preventive maintenance regimes based on such Vibration Monitoring (VM). The problem is then to perform a *data mining* on the available datasets so as to *recognize the patterns* and extract the useful *diagnostic information*.

Two parallel philosophies have been developed so as to comply with both *intermittent* and *continuous monitoring* of machines. The first allows the use of high-level signal processing techniques not only able to disclose the presence of a damage, but also the type, severity and location. The drawback is that the decision stage is usually not automated but left to a trained operator. In the second case, fast, real-time running statistical and machine learning algorithms can be used to trigger an alarm in case of *detection of damage*, leaving the quantification and localization of the damage for a further, more detailed analysis. Two methodologies are proposed by selecting from the literature the most suitable algorithms able to meet both the needs while ensuring model interpretability and satisfactory diagnostic results. These have been developed on theoretical modelled signals and on laboratory signals from a test rig at the DIRG lab (Dynamic & Identification Research Group test rig for high-speed aeronautical bearings) and later tested and compared on real signals from an aeronautical gearbox (SAFRAN aeronautical engine from the SAFRAN Contest, Conference Surveillance 8, October 20-21, 2015, Roanne, France) and from windmill gearboxes (Italian windfarm composed by six multi-megawatt wind turbines).

Keywords: Gearbox, Gear, Bearings, Vibration Monitoring, Damage Detection, Machine Diagnostics, Non-Destructive Testing, Data Mining, Signal Processing, Pattern Recognition, Machine Learning, Surveillance 8 SAFRAN aeronautical engine, Italian windfarm.

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