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Evaluation of principal component analysis and neural network performance for bearing fault diagnosis from vibration signal processed by RS and DF analyses

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ABSTRACT

In this work, signal processing and pattern recognition techniques are combined to diagnose the severity of bearing faults. The signals were pre-processed by detrended-fluctuation analysis (DFA) and rescaled-range analysis (RSA) techniques and investigated by neural networks and principal components analysis in a total of four schemes. Three different levels of bearing fault severities together with a standard no-fault class were studied and compared. Signals were acquired from bearings working under different frequency and load conditions. An evaluation of fault recognition efficiency was performed for each combination of signal processing and pattern recognition techniques. All four schemes of classification yielded reasonably good results and are thus shown to be promising for rolling bearing fault monitoring and diagnosing.

1. Introduction

Mechanical vibrations can be detected by displacement, velocity and acceleration sensors. Since these signals present random characteristics, one can treat them statistically and correlate the vibration signal characteristics to the behavior of the system under consideration.

The easiness on vibration signals handling enables the application of analysis techniques for predictive maintenance of industrial equipments, avoiding losses from production shut down, which is relatively expensive.

The application of vibration analysis on predictive maintenance can be extended to fault diagnosis of various machine components. Bearings require close attention during the inspection as malfunctioning of these elements causes increased machine vibrations, which can lead to failure.

Nowadays, there are several techniques used to detect defects in bearings. The spectral and envelope analyses are two of the most commonly applied techniques in the industry [1,2]. Spectral analysis consists of using Fourier transform on vibration signals collected from bearings in work regime, aiming to identify vibration frequencies for comparison to characteristic frequencies obtained from known defective conditions. The technique of the envelope is not so different from the previous one unless the signal collected is filtered by mathematical manipulation. Other more robust techniques are also used such as time–frequency techniques [3].

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