FAULT DETECTION USING AR MODELLING TECHNIQUES

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ABSTRACT

The usage of spectral analysis for fault detection and diagnostics in real-time has been conservative due to concerns over large processing requirements, especially when large sample sizes and high sampling frequencies are used. In this work, it was shown how such concerns can be allayed, to a large extent, by AR modelling, as the AR method has enhanced resolution capabilities compared to the FFT technique even when small sample sizes are used and requires a sampling rate just slightly above Nyquist rate to give good parameter estimates. The usage of parametric method of AR modelling technique for fault diagnosis and prognosis is a relatively new concept in the field of condition monitoring.

In this work, a new methodology that combines Autoregressive (AR) modelling techniques and pole-related spectral decomposition for the detection of incipient single-point bearing defects for a vibration-based condition monitoring system was presented. Vibration signals obtained from the ball bearings of a dry vacuum pump run in normal and faulty conditions were used as the test signals and modelled as time-variant AR series.

The positions of the poles, which are the roots of the AR coefficient polynomial, vary for every frame of vibration data. It was found that as defects such as spalls and cracks start to appear on the ball bearings, the amplitude of the vibrations of characteristic defect frequencies increases.

This was seen as the poles moving closer to the unit circle as the severity of the defect increases. Simple statistical indicators such as the power and frequency of each bearing defect spectral component were extracted from the residual and position of the AR poles. These indicators can be effectively used for fault classification to distinguish between the no-fault and defective cases as the difference between them is significant.