A survey of DSP methods for rotating machinery analysis, what is needed, what is available

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1. Introduction

The analysis of non-stationary noise and vibration signals on rotating machinery is commonly performed through the use of specialized digital signal processing (DSP) techniques. DSP methods developed primarily for rotating machinery analysis are called order tracking techniques. The analysis of non-stationary conditions requires additional information, as compared to steady state conditions, for accurate results to be obtained. This additional information is usually presented in the form of a tachometer signal measured on a reference shaft of the machine. An order is a time varying phasor that rotates with an instantaneous frequency related to the rotational frequency of the reference shaft, as shown in Eq. (1). It can be seen that the rotating phasor will contain a frequency that varies as the period of rotation, or r.p.m., varies: XðtÞ ¼ Aðk; tÞ sinð2piðk=pÞt þ fkÞ; ð1Þ where Aðk; tÞ is the amplitude of order k as a function of time, fk is the phase angle of order k; p is the period of primary order in seconds, t is time, and k is the order being tracked, where k ¼ 0 (DC offset) and ko0 (negative frequencies). Multiple orders are normally present in a dataset acquired from an operating machine. These orders may be described mathematically by a summation of time varying phasors. Order functions can be generated by any rotating input on an operating machine and may vary in amplitude and/or frequency as a function of time. This amplitude varying property causes errors in any type of order tracking analysis. All order tracking techniques consider the amplitude of an order to be semi-constant over the analysis period used to estimate the amplitude and phase of the order. This assumption can cause considerable errors in the analysis.