Mechanical Systems and Signal Processing 25 (2011) 416–430

Contents lists available at ScienceDirect

Mechanical Systems and Signal Processing

journal homepage: www.elsevier.com/locate/jnlabr/ymssp

Application of computed order tracking, Vold–Kalman filtering and EMD in rotating machine vibration

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ARTICLE INFO

Article history:
Received 23 December 2009
Received in revised form
28 August 2010
Accepted 2 September 2010
Available online 15 September 2010

Keywords:
Computed order tracking (COT)
Empirical mode decomposition (EMD)
Intrinsic mode function (IMF)
Rotating machinery
Vold–Kalman filter order tracking (VKF-OT)

ABSTRACT

This paper presents a study on rotating machine vibration signals by using computed order tracking, Vold–Kalman filtering and intrinsic mode functions from the empirical mode decomposition method. Through the sequential use of intrinsic mode function and order tracking methods, both speed synchronous and non-synchronous vibrations that modulate orders in rotating machine vibrations are distinguished, which is difficult when using each of the techniques in isolation alone. Simulation and experimental studies demonstrate the ability of extracting vibrations that modulate order signals through combining the techniques.

1. Introduction

Vibration signals from rotating machinery contain ample information for the diagnosis of machine faults, and it has been widely recognized that vibration signal analysis is an effective tool for condition monitoring. One of the key characteristics of vibration signals from rotating machinery is the strong influence that the rotational speed has on the observed signals. Non-constant rotational speed leads to the non-stationarity of the measured signal, which then becomes difficult to interpret. To deal with this, order tracking techniques have been developed. One of the main advantages of order tracking over traditional vibration monitoring techniques lies in its ability to clearly identify non-stationary vibration data, and to a large extent exclude the influences of the varying rotational speed.

Today there are several different classes of order tracking techniques available. For instance, computed order tracking (COT) uses a re-sampling procedure which leads to an order domain spectrum. This is often an effective order tracking method. However, COT does not have the ability to extract each order signal in the time domain, which in turn disposes of the opportunity to do a detailed study of each order signal. Besides, COT deals with the signal as a whole, and it is easy to neglect small changes in non-dominant signal components in a spectral map dominated by orders. However, it does provide an overall picture of composed signals in terms of orders and this makes it a very useful order tracking technique. Other order tracking techniques, such as Vold–Kalman filter order tracking (VKF-OT) or Gabor order tracking, assume sinusoidal waveforms to extract orders in the time domain. They overcome the shortcoming of the methods based on re-sampling and extract order signals in the time domain. However, this compromises the ability to extract changes in signals other than waves of a sinusoidal nature. In reality, few machine signals are purely sinusoidal. For rotating machinery, order signals are usually modulated by machine fault signals, which deform the original shape of the order waves from their

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doi:10.1016/j.ymssp.2010.09.003