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Multi-frequency periodic vibration suppressing in active magnetic bearing-rotor systems via response matching in frequency domain

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ABSTRACT

A method for multi-frequency periodic vibration suppressing in active magnetic bearing (AMB)-rotor systems is proposed, which is based on an adaptive finite-duration impulse response (FIR) filter in time domain. Firstly, the theoretic feasibility of the method is proved. However, two problems would be unavoidable, if the conventional adaptive FIR filter is adopted in practical application. One is that the convergence rate of the different frequency components may be highly disparate in multi-frequency vibration control. The other is that the computational complexity is significantly increased because the long memory FIR filter is required to match the transient response time of the AMB-rotor system. To overcome the problems above, the Fast Block Least Mean Square (FBLMS) algorithm is adopted to efficiently implement the computation in frequency domain at a computational cost far less than that of the conventional FIR filter. By the FBLMS algorithm, regardless of the number of the considered frequency components in vibration disturbance, the computational complexity would be invariable. Moreover, filter's weights in the FBLMS algorithm have the intuitional relation with signal's frequency. As a result, the convergence rate of each frequency component can be adjusted by assigning the individual step size parameter for each weight.

Experiments with the reciprocating simulating disturbance test and the rotating harmonic vibration test were carried out on an AMB-rigid rotor test rig with a vertical shaft. The experiment results indicate that the proposed method with the FBLMS algorithm can achieve the good effectiveness for suppressing the multi-frequency vibration. The convergence property of each frequency component can be adjusted conveniently. Each harmonic component of the vibration can be addressed, respectively, by reconfiguring the frequency components of the reference input signal.

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1. Introduction

With the development of the active magnetic bearing (AMB) technology, more and more attentions have been focused on the AMB for its advantages including no physical contact, no mechanical friction and no need for lubrication, etc. The AMB can not only provide the contactless supporting for the rotor, but also apply the real-time active electromagnetic force to control the rotor vibration. In recent years, there have been a great number of investigations into the use of the AMB to control the rotor unbalance vibration which only contains a single frequency component. Herzog et al. [1] used a narrow-band notch filter with inverse sensitivity matrix for the automation balancing without destabilizing the original loop. Beale and Shafai [2] introduced an automation balancing method which can obtain the Fourier coefficient of unbalance vibration by an iterative

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