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Identification of complex sound sources produced by gear units

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ABSTRACT

Noise source visualisation represents an important tool for technical acoustics. Many techniques of noise source visualisation have been developed, based on a specific noise source in a specific type of acoustic environment. A new visualisation method of complex noise sources is presented, using an acoustic camera and a new algorithm. Different transient acoustical phenomena can be noted. Additionally, a new family of biorthogonal wavelets is applied to determine fault in gears. The new wavelets are a generalisation of biorthogonal wavelet systems. Smoothness is controlled independently in the analysis. For the optimisation of the synthesis bank, discrete finite variation is used. Differentiability is measured, for which a large number of vanishing wavelet moments is necessary, in favour of a smoothness measure based on the fact that a finite depth of the filter bank tree is in most case related to practical applications.

1. Introduction

The main goal of maintenance is to maintain a technical system at the most favourable or still acceptable level. To evaluate the condition of a technical system, it is required to collect, analyse, compare and process data. Maintenance costs can be decreased, reliability of operation improved, and frequency and complexity of damages can be reduced. Precise data, however, must be acquired and properly processed to control mechanical systems effectively.

Gear units are of various types and sizes and consist of a housing, toothed wheels, bearings and a lubricating system. They are most commonly used machine parts or couplings. Durable damages are often caused by geometrical deviations or unbalanced component parts or by material fatigue, which results from damages caused to roller bearings or due to the engagement of a gear pair.

Methods for measuring sound and noise are often used to obtain data about a gear unit. Then certain tools are used to analyse the collected data [1,2]. It is, naturally, required to define the features that indicate the presence of damages and/or faults.

A method for visualising a complex noise source on the basis of an acoustic camera and an analysis method based on digital signal processing are presented.

Wavelet smoothness and regularity (e.g. vanishing wavelet moments) for wavelet-based image compression and signal denoising are presented [3–8]. Although the analysis algorithm involved influences filter selection and related characteristics of corresponding wavelets, some form of smoothness is considered to be of importance.

A new family of biorthogonal wavelets is used to identify faults in gears. The new wavelets are based on a generalisation of biorthogonal wavelet systems. For the analysis, smoothness is independently controlled. A discrete finite variation is used

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