served as the mass points. This approach is able to localize structural damage using only a small training set on data generated by a finite elements model, and exhibits excellent interpolation and extrapolation. Extending the hybrid neural network approach, a method is proposed for solving for the external forces applied to surface-mounted sensors, from vibrating machine components. The derived forces will then serve as inputs to the signal phase change feature extraction routine. It is hoped this method will train well on small data sets and reduce ambiguities due to signal multipath effects.

[See NOISE-CON Proceedings for full paper.]

3:40

1pSP4. Passive low-frequency acoustical method of nondestructive testing of the energetic systems. Leonid M. Gelman (Dept. of Nondestructive Testing, Natl. Tech. Univ. of Ukraine, 37, Peremogy pr., Kiev, 252056, Ukraine)

The new preventive passive low-frequency acoustical method of nondestructive testing of the energetic bladed systems is considered. The proposed method is based on reception, processing, and estimation of parameters of the energetic bladed system's own acoustic noise in a low-frequency range (0.002–50 kHz) with the usage information about rotation frequencies of rotors. The method includes the following procedures: (1) detection of the narrow-band acoustic signals on the background of interference; (2) identification of the detected acoustic signals; and (3) estimation of testing date and decision acceptance of the state of the energetic bladed system stages. The method allows for acceptance of the state at the appropriate stage of the energetic system in maintenance when the stage is in a normal state, or when the stage is in a state before damage. Experimental results are presented. The proposed method represents one of the approaches to efficient energy use and conservation.

4:00–4:20 Break

Contributed Papers

4:20

1pSP5. Nonstationary chaos in acoustic emission from lathes. Satish T. S. Bukkapatnam (Dept. of Industrial and Manufacturing Eng., Penn State Univ., University Park, PA 16802), Akhlesh Lakhtakia, and Soundar R. T. Kumara (Penn State Univ., University Park, PA 16802)

Acoustic emission (AE) signals have tremendous promise for monitoring machining processes, but current understanding of AE generation is very limited. In addition, existing techniques to analyze these signals are inadequate. Presented here is a new approach to analyze AE signals based on thorough characterization of the dynamics underlying the signals. The signals were collected from extensive experimentation on five different lathes, performed under various cutting conditions, with different tool–work combinations and sampling rates. First, a battery of statistical tests was applied on the collected AE signals. Tests revealed that AE in turning is chaotic with fractal dimensions ranging between three and six. But owing to nonstationarity, chaos was not clearly revealed in the lag plots. Next, the transients were quantified, based on a compact representation scheme that was developed—called *suboptimal wavelet packet representation*—that captured all salient features of the AE signals. This representation scheme was used in developing a neural network-based estimator for on-line monitoring of tool wear.

4:40

1pSP6. A method of minimizing interference in Wigner–Ville distribution and its application in acoustics and vibration signals. Youn-Kyu Park and Yang-Hann Kim (Ctr. for Noise and Vib. Control (NOVIC), Dept. of Mech. Eng., KAIST, 373-1 Science Town, Taejon-shi, Korea)

One of the major advantages of expressing signal of interest in terms of Wigner–Ville distribution is that one can see how energy of signal varies with regard to time and frequency. On the other hand, a major drawback of this method is that it also displays ''signal interference,'' therefore one has to have *a priori* knowledge about the signal. Otherwise, one cannot distinguish true and false information from the distribution. This paper addresses the idea to reduce such signal interferences. The idea simply comes from a hypothesis that there could be a domain on which the interference could be more realizable than the time-frequency axis, which is the Wigner–Ville domain. In fact, there can be four different quadrants. The ambiguity function of the Wigner–Ville distribution is examined, which can be regarded as the mirror image of the distribution. What was found is rather useful—the interferences which appear in the Wigner–Ville distribution tend to be located at the center of the ambiguity function domain. Several simple signals were examined. Based on this theoretical analysis, attempts were made to develop a kind of window that can effectively eliminate the interferences, which is, in fact, a ''rotating window'' in ambiguity function domain. Several numerical simulations reasonably confirm the proposed idea. Various acoustic and vibration signals are now under investigation to demonstrate the ability of the method.

[See NOISE-CON Proceedings for full paper.]

5:00

1pSP7. Exploitation of vibration and noise signals cyclostationarity in condition based maintenance. Karel Vokurka (Dept. of Phys., Tech. Univ. of Liberec, Halkova 6, CZ-461 17 Liberec, Czech Republic, karel.vokurka@vslib.cz)

A traditional approach to the analysis of vibration and noise in condition based maintenance of machinery is to assume stationarity of the measured signals. However, in the case of machinery working cyclically (e.g., gearboxes, engines, turbines) the generated vibration and noise are basically nonstationary (cyclostationary). This feature, in the traditional approach partially suppressed by continuous time averaging, can be exploited to give more detailed information on the condition of the monitored machinery. To achieve this, periodic time averaging is used. In this paper, the second-order statistical characteristics of the cyclostationary signals are considered. These are double correlation functions, double autospectral densities, and instantaneous autospectra. The disadvantage of these statistical characteristics is their greater complexity. However, they yield a more detailed description of measured signals. Another advantage is a greater immunity to interfering signals. Algorithms for computation of the characteristics will be presented. Theoretical conclusions will be demonstrated on a concrete example of vibration data measured on a passenger car gearbox. [Work supported by the Grant Agency of the Czech Republic.]

[See NOISE-CON Proceedings for full paper.]