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Linear systems theory and its relationship to ocean acoustics

Ziomek, Lawrence J.

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vibration. This model accounts for multiple frequency and multiple axes of vibration as well as the interactive effects of combined noise and vibration. The model has the unique capability of transforming individual components of a noise/vibration environment into subjective comfort units and then combining these comfort units to produce a total index of passenger discomfort and useful subindices that typify passenger comfort within the environment. This paper presents an overview of the model development including the methodology employed, major elements of the model, model applications, and a brief description of a commercially available portable ride comfort meter based directly upon the model algorithms. Also discussed are potential criteria formats that account for the interactive effects of noise and vibration on human discomfort response.

TUESDAY AFTERNOON, 27 NOVEMBER 1990 SENATE–COMMITTEE ROOM, 1:00 TO 4:50 P.M.

Session 3EA

Engineering Acoustics: Application of Systems Theory to Acoustics

Ilene J. Busch-Vishniac, Cochair
Department of Mechanical Engineering, University of Texas, Austin, Texas 78712

Robert D. Finch, Cochair
Department of Mechanical Engineering, University of Houston, Houston, Texas 77204

Chair's Introduction—1:00

Invited Papers

1:05

3EA1. Applications of higher-order spectra to some acoustics problems. Jerry M. Mendel (Dept. of Electrical Eng. Systems, Univ. of Southern California, University Park, SAL 300 MC-0781, Los Angeles, CA 90089-0781)

During the past few years there has been an increasing interest in applying higher-order spectra (statistics) to a wide range of signal processing and system theory problems. These statistics are very useful in problems where either non-Gaussianity, nonminimum phase, colored noise, or nonlinearities are important and must be accounted for. When signals are random processes, then cumulants are used as the higher-order statistics. When they are nonrandom, then moments are used. New methods have been developed that work either in cumulant or moment domains; in their multidimensional Fourier transform (i.e., "polyspectral") domains; or, even in inverse logarithmic (e.g., high-order "cepstral") domains. Applications of higher-order spectra to acoustics problems include transient signal reconstruction based on moving average, autoregressive, or autoregressive moving average models, when measurements are colored and Gaussian; detection of transient signals (in additive colored Gaussian noise); time delay estimation when measurement noises are correlated but Gaussian; and harmonic retrieval.

1:30

3EA2. Linear systems theory and its relationship to ocean acoustics. Lawrence J. Ziomek (Dept. of Elec. and Comput. Eng., Code 62Zm, Naval Postgraduate School, Monterey, CA 93943)

The purpose of this talk is to demonstrate the consistency and relationships between linear systems theory and the physics of propagation of *small-amplitude* acoustic signals in fluid media. Using the principles of linear, time-variant, space-variant filter theory and time-domain and spatial-domain Fourier transforms, derivations of the solutions of the linear, three-dimensional, inhomogeneous wave equation for (1) an unbounded isospeed fluid medium, (2) and unbounded fluid medium with speed of sound an arbitrary function of depth, and (3) a full-wave, pulse-propagation model for three-dimensional wave propagation in a Pekeris waveguide are presented. Characterizing a fluid medium as a *linear filter* is valid since this involves trying to solve the *linear* wave equation. Computer simulation results are presented. [Work supported by ONR, Code 11250A, and the Naval Postgraduate School.]

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Lawrence J. Ziomek

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