Sensitivity of predicted barrier attenuations to errors in specifying ground plane geometry

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and field habitats. While most studies of environmental acoustics and their effects on animal communication are concerned with the range of sound propagation, the stability of sound propagation is also important. Some characteristics of long distance vocalizations may be adaptations to fluctuations in sound propagation. [Partially supported by NSF.]

10:30

SS9. Sparse planar microphone array for estimating bearing to near-ground sources: system considerations. G. Kirby Miller and Fred E. Babian (GTE Sylvania Inc., PO Box 188, Mountain View, CA 94042)

The maximum likelihood bearing estimator has been simulated on a computer and has been used to examine the effects on performance of both environmentally imposed conditions and system parameters. The imposed conditions include source spectra, ambient noise spatial character, wind, temperature, and array tilt due to terrain. The system parameters include microphone position error, channel amplitude match, channel phase match, operating frequency band, number of microphones, size of array, number of azimuth bins, and number of delay line taps. The results of this study indicate that a passive acoustic bearing estimation system for ground sources should be able to achieve an accuracy of a few degrees under most conditions.

10:45

SS10. Attenuation of noise by diffraction at a barrier edge. G. A. Daigle, T. F. W. Embleton, and J. E. Piercy (Acoustics Section, Physics Division, National Research Council of Canada, Ottawa, Canada K1A 0R6)

Traffic noise attenuated by a barrier alongside a highway was measured with microphones positioned above an asphalt surface 15 and 30 m behind the barrier. The sound levels were analyzed to obtain the average sound pressure levels per ⅓-octave band. An idealized experiment was also performed using a barrier 2.5 m high and 17 m long erected on a flat asphalt surface. Sound pressure levels from a point source were measured for various source and receiver positions. Certain features of these measurements were presented at the last meeting in Los Angeles where the effects of atmospheric turbulence were discussed. The same measurements will now be compared with two versions of classical Kirchhoff–Fresnel diffraction theory which is currently used to predict the attenuation of noise by barriers. This comparison shows that the sound levels behind the barrier are higher than widely used diffraction theories by 1 to 3 dB at all frequencies—and, surprisingly, by 2 to 10 dB when compared with a theory that should be more precise. The largest discrepancies occur at the shorter source to receiver distances. An alternative diffraction theory as well as an empirical correction to Kirchhoff–Fresnel theory are offered which show good agreement with all the results. [Work supported by NSERC grant to Carleton University.]

11:00

SS11. Model measurements of diffraction loss due to barriers. Jean Nicolas,[a] T. F. W. Embleton, and J. E. Piercy (Division of Physics, National Research Council, Ottawa, Canada K1A 0R6)

Propagation of tone bursts from a point source have been studied in a reverberant chamber 8.5 × 14 × 7 m. The insertion loss of a 30-cm-high barrier has been measured directly over the frequency range 1 to 10 kHz using first arrivals. Preliminary results show discrepancies with predictions from theory similar to those found by outdoor measurements described in the preceeding paper.

[a] Also Mechanical Engineering Dept., Sherbrooke University, Que., Canada.

11:15

SS12. Experimental and theoretical comparisons of the normal coordinate, Helmholtz-Kirchhoff, and Macdonald solutions for diffraction by a half-plane; application to a finite barrier. Gary M. Jebsen[a] and Herman Medwin (Department of Physics and Chemistry, Naval Postgraduate School, Monterey, CA 93940)

The Biot–Tolstoy (BT) normal coordinate solution to the problem of diffraction by an infinite half-plane is compared to the usual approach based on the Helmholtz–Kirchhoff integral formulation. The two are shown to differ significantly for the simple case of coincident source and receiver (backscatter), with the advantages of the BT formulation shown by laboratory measurements. The application to shadowing by a barrier is discussed and it is found that the "image in the barrier" which is part of the Macdonald method does not have to be added to the BT solution. The time domain BT solution is used to construct the diffracted pressure field in the shadow near a barrier corner (infinite quarter-plane). The use of multiple diffractions in the time domain to predict the effect of finite barrier thickness is described. [Work supported by ONR.]

[a] Also: David W. Taylor Naval Ship R and D Center, Bethesda, MD 20084.

11:30

SS13. Diffraction by absorbent wide barriers. Sabih I. Hayek,[a] Matthew A. Nobile (Applied Research Laboratory, The Pennsylvania State University, University Park, PA 16802), and Robert P. Kendig (Cambridge Acoustical Associates, 54 Ridge Ave. Extension, Cambridge, MA 02140)

Wide barriers of a trapezoidal shape are investigated analytically and experimentally. The analytic model for the diffracted pressure is basedon the geometrical theory of diffraction. The incident ray is considered to undergo double diffraction, once at each of the edges of the two back-to-back wedges of the trapezoidal barrier. Thus, the second ray from first wedge to the second must graze the upper surface of the wide barrier. For the double diffraction calculations, the analytic solution for the diffraction by an absorbent single wedge, as originally developed by Malyuzhinets, is used. However, his solution breaks down on the surfaces of absorbent wedges. A correction solution was thus developed for rays that graze the surface of an absorbent wedge, facilitating a model for an absorbent wide barrier. Experiments on ⅕ scale models of hard and absorbent wide barriers were also conducted inside a gymnasium, where harmonic point sources as well as incoherent A-weighted line noise sources were used. The prediction of the analytic models and the experimental data compare favorably for point to point propagation. [Work supported by National Cooperative Highway Research Program—National Research Council.]

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11:45

SS14. Sensitivity of predicted barrier attenuations to errors in specifying ground plane geometry. Matthew A. Nobile and James M. Lawther (Applied Research Laboratory, The Pennsylvania State University, University Park, PA 16802)

When the ground behind a noise barrier may be regarded as acoustically locally reacting, and where it has reasonably level topography, there is a plausible rationale for a traffic noise prediction model based on barrier diffraction of geometric image terms with coherent summation. Often in real life, however, even when sideline terrain surface is essentially plane, its plane is neither coplanar with the highway pavement nor even parallel to it. Defining the ground "plane" from measurements on the site, more-

over, is not a task likely to be done with great precision in normal noise assessment practice. The sensitivity of traffic noise level predictions to errors in ground-plane location then becomes of interest. In this connection a study has been made of a series of ground-plane configurations approximating to cases arising in practice. Each case has been perturbed systematically, and the resulting differences in predicted noise levels have been observed. It has been particularly of interest to note the decrease in sensitivities resulting from averaging over frequency and over a traffic line. [Work supported by FHWA.]

12:00

SS15. A new model for a noise barrier on a rigid ground plane. Matthew A. Nobile and Sabih I. Hayek (Applied Research Laboratory, The Pennsylvania State University, University Park, PA 16802)

Current models for the straight-edge noise barrier in the presence of the ground utilize the exact half-plane diffraction solution and replace the ground by source and receiver images. Although this model is generally successful, it does not account for "corner effects" (where the barrier meets the ground) which may become significant as the barrier height decreases. In this alternative model, the barrier of height h is replaced by a strip of width $2h$, while the ground is replaced by a source image only. The total field at the receiver is then the sum of the diffracted field from the source and the source image, respectively. Since a strip is an elliptic cylinder of unity eccentricity, there exists an exact solution in terms of Mathieu functions. The advantage over the half-plane model is that mutual coupling between the edges of the strip (in essence, the above "corner effects") is inherently accounted for. Results for several practical cases will be compared to existing model predictions and to recent experimental data.

FRIDAY MORNING, 22 MAY 1981 SALON RENAISSANCE, 8:30 A.M. TO 12:00 NOON

Session TT. Musical Acoustics III and Psychological Acoustics VI: Perception and Cognition

Annabel Cohen, Chairman

Division of Life Sciences, Scarborough College, University of Toronto, West Hill, Ontario, Canada M1C 1A4

Invited Papers

8:30

TT1. Introductory abstract. Annabel J. Cohen (Scarborough College, University of Toronto, West Hill, Ontario M1C 1A4)

The understanding of music perception and cognition is advancing on many frontiers. Technological, methodological, theoretical, and artistic developments have stimulated new areas for investigation and have placed longstanding issues in a new context. This session explores recent progress from a variety of perspectives: music theory, perceptual-cognitive and developmental psychology, brain research, and engineering psychoacoustics. Together the papers suggest the scope and potential of this multidisciplinary venture, and highlight foundational knowledge, fundamental questions, and future goals.

9:00

TT2. Varieties of musical cognition: A music theorist's view. William E. Benjamin (Department of Music, University of British Columbia, Vancouver, B.C., Canada V6T 1W5)

This paper develops the elements of a musical epistemology. The starting claim is that perception is inappropriate as a category of musical behavior, and that musical perception is, in fact, merely the demonstration of musico-cognitive competence. Three stages of musical behavior, which may be ordered to correspond to degrees of musical competence, are identified: one of informed listening, a second of interpretation, and a third involving the creative production of music. Musical competence is further delineated, in these stages, with respect to two levels at which musical cognition takes place, one grammatical and the other stylistic. This delineation leads to a discussion of the cognitive status of various experimental musics of the twentieth century. Finally, an attempt is made, in the light of ideas basic to the presentation, to define appropriate roles for scientific disciplines in the study of musical cognition.

9:30

TT3. Musical rules and pitch judgment. Lola L. Cuddy (Department of Psychology, Queen's University, Kingston, Ontario, Canada, K7L 3N6)

Observed psychoacoustic events are often incompatible with musical knowledge. The point has been made particularly in the realm of pitch theory. This paper will contend that it is *not* the case that musical