On Computation of the Biot Coefficients

Wednesday February 18, 1987 1:00 p.m.

A. Bedford
Applied Research Laboratories
and
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The University of Texas at Austin

The Biot equations remain the most promising approach for predicting the propagation of acoustic waves in marine sediments and other saturated porous media. However, the equations contain coefficients that depend upon the frequency and the fabric, or microstructure, of the porous medium. Until these coefficients can be determined as functions of frequency and the structure of the material, it will not be possible to confirm that the Biot equations can provide accurate comparisons with experiment. In this seminar, some historical perspective on the equations will be given, and recent research on determining the coefficients in the equations as functions of frequency will be described.

A Review of Equivalent Circuit Modeling Methods for Characterizing Piezoelectric Oscillators

Wednesday, February 25, 1987 1:00 p.m.

R. Lowell Smith
Texas Research Institute, Inc.

For many years the broadly analogous behavior of resonant mechanical structures and electrical circuits has been recognized and exploited. Usually the direction this takes is to allow the methods of electrical network analysis to be brought to bear on mechanical and electromechanical problems. Two-terminal electrical immittance measurements are routinely interpreted in this way to obtain the piezoelectric coefficients of transduction materials and a variety of figures of merit of fully articulated transducers. In spite of competitions from bond graph formalisms and finite element analysis, equivalent circuit modeling remains a powerful tool for modal analysis and the characterization of transduction processes. Lumped and distributed attributes, viscous losses, inertial clamping effects, mode coupling, structural features, electrical tuning, and other (than immittance) measurement scenarios all have very natural equivalent circuit modeling descriptions.

On the Nearfield of a Parametric Array

Wednesday, March 4, 1987 1:00 p.m.

J. D. Sample
Applied Research Laboratories

Nearfield effects stand in the way of using parametric arrays to accurately measure the acoustic directivity of noise sources in multipath environments. Understanding these effects may lead to a technique of compensating for or eliminating them. Using the theory developed by M. F. Hamilton, J. Naze Tjøtta, and S. Tjøtta for the nonlinear interaction of gaussian beams, we have constructed a model to investigate the nearfield effects on the difference frequency produced by a piston source and a gaussian pump. The technique is valid for any arbitrary monochromatic, directive source.

Acoustics in Architecture: Acoustical Renovation of The First Presbyterian Church in Greensboro, North Carolina

Wednesday, March 11, 1987 1:00 p.m.

Richard E. Boner
Boner Associates, Inc.
Consultants in Acoustics and Communications

The First Presbyterian Church is a Gothic structure constructed circa 1920. During its first 65 years, it developed a reputation of mediocre acoustics for speech and for various forms of music. A study was undertaken to develop recommended changes to interior finishes, and to design a sound system suitable for reinforcement of both the spoken word and music. Aesthetic and psychoacoustic considerations resulted in an unusual sound reinforcing system design. Following implementation of the design, further investigations indicated significant improvement in speech intelligibility and musical quality. Although a significant increase in room reverberance was obtained , the results did not conform to classical reverberation theory.

Seismic Imagery (and Some Inversion)

Wednesday, March 25, 1987 1:00 p.m.

Milo M. Backus
Dave P. Carlton Professor of Geophysics
The University of Texas at Austin

Some examples of “conventional” seismic imagery will be shown. (1) A regional deep sea line recorded by the research vessel U.T. Fred Moore illustrates the full sedimentary column and oceanic basement, and a reflecting zone within the ocean (seismic systems operate in the 15-60 Hz band). (2) A commercial high density 30 survey illustrates a Gulf of Mexico salt dome and the surrounding disturbed sediments. (3) A commercial seismic data grid illustrates the anomalous reflectivity versus angle response of gas-filled reservoirs. Conventional imagery, with its associated propagation velocity model, can be viewed as a first iterate in inversion.

Computer-aided modeling (or generalized linear inversion) has been intensively used in “whole earth geophysics,” and should become increasingly important in exploration. In this approach, a quantitative earth model is tested by comparison of the actual data, with synthetic data computed on the basis of the earth model. The model is then perturbed and refined in detail until a “plausible earth model compatible with the observations” is achieved. The answer is not unique, and the “final” model is very dependent on interpretive input and control (either explicit or implicit).

This last approach can be applied to a full set of observations (in principle), or to any reduced set of data, such as travel times, amplitudes, or full waveform data. from a selected target zone. Two examples investigated by students in Project SEER at U.T. illustrate the approach.

Interaction of a High Intensity Laser Beam with the Water Surface

Wednesday, April 1, 1987 1:00 p.m.

Nicholas P. Chotiros
Applied Research Laboratories
The University of Texas at Austin

The interaction of a short high intensity laser pulse with the surface of water is investigated. The reaction is similar to an explosion. The process of sound generation is modeled as an impulse response problem. Experimental observations of the surface deformation and acoustic output have been made. Results of experimental investigations indicate that the process is not a simple one, involving both physical and chemical reactions.

Nonlinear Effects in Focused Sound Beams II (The Sequel)

Wednesday, April 22, 1987 1:00 p.m.

Timothy S. Hart
The University of Texas at Austin

Past research into the behavior of focused sound beams has failed to account for situations in which the effects of both nonlinearity and diffraction are strong. A numerical solution of a parabolic, nonlinear wave equation that accounts for nonlinearity, diffraction and absorption simultaneously has been adapted for application to focused, finite amplitude sound beams using a phase shaded planar source to model a focusing source and a transformation that allows the region of integration to follow the convergence of the focused beam.

Results obtained from the solution cover a wide range of variance of the absorption, nonlinearity and focusing gain of the system and include the time waveform of a highly nonlinear wave progressing through the focal region, power curves for individual harmonics showing the transfer of power through the focal region, and the appearance of additional sidelobes in the beam patterns of the harmonics in the focal plane.

Active Vibration Damping Using Distributed Actuators

Wednesday, April 29, 1987 1:00 p.m.

Deborah A. Summa
Department of Mechanical Engineering
The University of Texas at Austin

Active vibration control techniques to date apply point sensors and actuators to continuous systems. Such techniques, while adequate, require excessive signal conditioning and involve approximations which often result in modal truncation. Continuous film transducers allow the possibility of vibration control with less signal processing, and no modal truncation. Such transducers also allow for spatially-varying, as well as time-varying, control action. Current work focuses on simultaneous optimization of spatial and time-varying control functions for application to a variety of systems.

Parametric Study of a Laser-Generated Acoustic Signal

Wednesday, May 6, 1987 1:00 p.m.

Luis J. Gonzalez
The University of Texas at Austin

The generation of underwater sound by a moving high power laser pulse is numerically investigated. The acoustic wave is induced by thermal expansion of the water caused by heat imparted by the laser. The numerical predictions are based on a time domain approach.

Properties of the received acoustic signal, such as maximum and minimum periods and time to peak amplitude, are defined. These properties are examined as the source parameters, (e.g., the velocity and modulation frequency of the laser) and the source-receiver geometrical parameters (e.g., the initial range and angle between the source and receiver) are varied. This information enables us to quantitatively determine which signal properties are most and least sensitive to parameter variations. In addition, this information allows us to identify response patterns of the received acoustic signal. These results could prove to be very useful, if the thermoacoustic source is ever employed as an underwater communications device.

Bothered by Kidney Stones? Try Lithotripsy

Wednesday, September 9, 1987 12:00 p.m.

David T. Blackstock
Department of Mechanical Engineering
and
Applied Research Laboratories
The University of Texas at Austin

Lithotripsy is a medical procedure by which focused shock waves are used to break up kidney stones. In the most commonly used lithotripter, the shock is generated by an electric spark at one focus of an ellipsoidal reflector, and the patient is positioned so that the kidney stone is at the other focus. The procedure is carried out in a water bath. The focused pressure pulse is a very short (about 1 μs) spike of amplitude as high as 1300 atm, followed by a longer duration negative phase of magnitude of order 100 atm. As many as 3,000 shots are used to break up a single stone.

Discussed in this report are the spark source, focusing effects, the pressure waveforms (and their measurement by a PVDF hydrophone), and cavitation.

Environmental Acoustics, Acoustics Education, and the Acoustical Society of America

Wednesday, September 16, 1987 12:00 p.m.

Professor Wayne M. Wright
Kalamazoo College
Kalamazoo, Michigan

For about 20 years the Acoustical Society of America has been carrying out a variety of programs in environmental acoustics, including community education to inform lay public about problems in noise and noise control, consulting with city councils, state legislatures, and federal agencies about noise ordinances, and encouragement of tutorial articles on various aspects of environmental acoustics. For example, one of the special programs was an assessment of the effect noise pollution resulting from Alaskan offshore oil prospecting would have on whales in the Barents Sea. Another area in which the Society has been active is acoustics education, particularly at the graduate level.

Dr. Wright will discuss some of the educational projects of the ASA. Society programs in the area of environmental acoustics will also be reviewed, and ways in which YOU can affect the future will be suggested.

A Study of Reflection and Refraction of Waves at the Interface of Water and Sea Ice

Wednesday, September 23, 1987 12:00 p.m.

Professor Ching H. Yew and X. Weng
Department of Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin

The sea ice is modeled as a transversely isotropic brine saturated porous medium in accordance with the model proposed by Schwarz and Weeks [1977]. The reflection and refraction of waves at the interface of water/ice are studied. Our numerical results indicate that the porosity of the ice has a noticeable effect on the wave reflectivity. Its effect, however, becomes small when the grazing angle of the incident wave becomes small. The existence of a thin and porous ice skeleton layer on the ice medium further reduces the reflectivity. The reduction of reflectivity becomes more distinct as the frequency of the incident wave is high. Numerical results point out that, in addition to the porosity, the ice layer thickness is the most dominant property influencing the under ice wave reflectivity. The calculated results show a qualitative agreement with the in situ experimental results by Yang and Votaw [1981].

A Frequency Dependent Ray Theory

Wednesday, September 30, 1987 12:00 p.m.

Dr. Terry L. Foreman
Applied Research Laboratories
The University of Texas at Austin

Practical computational procedures for obtaining ray theoretical solutions to the inhomogeneous Helmholtz equation $\nabla\Psi + k^2\Psi = S(r,\omega)$ make resort to a well-known approximation. A computational method is presented which enables one to trace rays without resort to the ray theory approximation provided a solution to the Helmholtz equation is already available. In other words, given a solution to the Helmholtz equation, the exact rays for that case can be computed. The new ray theory therefore serves, not as a computational method, but as a new method of displaying solutions to the Helmholtz equation. Exact ray diagrams are constructed for several cases using this technique. The resulting ray diagrams usually bear little resemblance to the corresponding classical ray diagrams. It is shown that the discrepancy is attributable to the nature of the classical ray theory approximation, which proves in most cases not to be a small perturbation. Some of the properties of the exact rays which distinguish them from their classical counterparts are: (1) The ray trajectories depend on the source frequency and on the boundaries. (2) The exact rays intrude into shadow zones impenetrable by classical rays. (3) The field is finite at caustics. (4) Lastly, the exact rays never exhibit multipathing, which is the hallmark of classical ray diagrams. The contrasts between classical and exact ray theory are demonstrated and explained.

Is Temporal (Periodicity) Information Really Used by the Auditory System?

Wednesday, October 7, 1987 12:00 p.m.

Professor Dennis McFadden
Department of Psychology
The University of Texas at Austin

For about two decades we have known for certain that the peripheral auditory system does accurately encode information about the temporal periodicity of the acoustic waveform. Long before (and since) that demonstration, auditory theorists had appealed to the use of such temporal information to explain various psychoacoustical findings, especially various aspects of pitch perception. However, the proposal that the auditory system uses periodicity information has never been directly tested. Two versions of possible underlying mechanisms for extracting periodicity information from the firing patterns of primary auditory fibers will be presented and examined for implications of their existence. Then, a series of psychophysical experiments will be presented and examined for evidence of those implications. In the end, we will find no experimental support for the use of periodicity information by the auditory system in a variety of monaural tasks.

Noncollinear Interaction of a Tone with Noise

Wednesday, October 14, 1987 12:00 p.m.

Steve Lind
Department of Mechanical Engineering
The University of Texas at Austin

The noncollinear interaction of a tone with noise is investigated experimentally in an air-filled rectangular duct. A low frequency band of noise in the (0,0) mode interacts with a high frequency pure tone in the (1,0) mode. A quasilinear theory for the noncollinear interaction of two pure tones is generalized to predict the sum and difference frequency sidebands of noise created around the high frequency tone. When two pure tones interact, the resulting sum and difference frequency sound oscillates in space with a periodicity that depends on the frequencies and interaction angle of the primary waves. The band of low frequency noise is thus upshifted to sidebands whose spectral shapes are scalloped in appearance. The scalloping becomes more pronounced with range from the source, and increasing the interaction angle reduces the overall levels of the sidebands. Theory and experiment are shown to be in good general agreement.

Interaction of a Sound Beam with a Two-Fluid Interface

Wednesday, October 21, 1987 12:00 p.m.

Dr. Jacqueline Naze Tjøtta and Dr. Sigve Tjøtta
Department of Applied Mathematics
University of Bergen
Bergen, Norway
and
Applied Research Laboratories
The University of Texas at Austin

The reflection and transmission of a real sound beam at the interface between two homogeneous and dissipative fluid layers is considered. Numerical results are obtained by using a Fast Fourier Transform algorithm. For the transmitted field they show that, at a given incident angle, the direction and displacement of the beam depend critically on the absorption coefficient, and on the distance between the source and the interface.

Various asymptotic formulas are also presented which allow for a physical interpretation of the numerical results.

Propagation of Acoustic Waves through Turbulence

Friday, October 30, 1987 12:00 p.m.

Dr. Philippe Blanc-Benon
Centre Acoustique
Ecole Centrale de Lyon
Ecully, France

Two specific investigations will be presented for the propagation of acoustic waves through velocity or temperature fluctuations in well-controlled laboratory conditions (2-D jet used along its span-wise direction or thermal plumes rising above a large heated grid). The results concern the attenuation of the coherent part, spectral broadening, space and time correlations, the variance and the probability density function of the fluctuations of the transmitted intensity. Comparisons are made with theoretical estimates based on a solution of the stochastic Helmholtz equation in the parabolic or paraxial approximation. These comparisons suggest that the entire spectrum of the turbulent fields has to be taken into account, as well as the particular shape of the incident wave (spherical source, Gaussian beam, or piston-like source).

The Effect of Unsteady Compression and Expansion Waves on a Compressible Boundary Layer

Wednesday, November 4, 1987 12:00 p.m.

Professor Dennis Wilson
Department of Mechanical Engineering
The University of Texas at Austin

The results of a theoretical investigation into the effects of finite amplitude acoustic disturbances or weak compression and expansion waves on compressible boundary layers will be discussed. These pressure disturbances, which are produced by combustion instabilities, are present in most combustors. The magnitude of the fluctuating component relative to the stagnation pressure varies from the low acoustic range (0.05%) to the weak shock range (5%). The frequencies range from a few hundred Hz for the longitudinal mode to a few thousand Hz for the transverse mode. A simple but accurate theoretical model which predicts the enhanced heat transfer and skin friction for a wide range of frequencies and magnitudes is presented. The formulation yielded an unexpected result in that an approximate analytical solution is possible for the laminar flow case.

The Calculation of Sound Fields Around Commercial Aircraft Engines

Wednesday, November 11, 1987 12:00 p.m.

Dr. Noel J. Walkington
Department of Mathematics
The University of Texas at Austin

The theme of my seminar will be the calculation of the forward sound field around high bypass ratio turbofan aircraft engines. These engines have large fans at the front which “chop” the inducted air, producing a forward propagating sound field. This low frequency sound is clearly audible when the aircraft is on its landing approach. Particular attention will be paid to the underlying physics and assumptions used, and their bearing upon how well posed the acoustic equations are. Such considerations play a key role in the success of any numerical procedure.

Interaction of a Row of Helmholtz Resonators When Excited by a Turbulent Boundary Layer

Wednesday, November 25, 1987 12:00 p.m.

Kevin P. Flynn
Department of Mechanical Engineering
The University of Texas at Austin

Experiments have been conducted to determine the interaction that occurs between resonators when excited by grazing flow. The orifices of ten cylindrical Helmholtz resonators were flush mounted across the span of a wind tunnel wall. Resonator cavities were imbedded behind the wall with a turbulent

boundary layer flowing on the outside. At certain airspeeds the boundary layer produces a strong cavity excitation. In addition, phase locking occurs between adjacent resonators and an enhanced response level is observed; both effects are a function of the spacing between resonators.

Inter-Noise 87 or Acoustic and Other Adventure in the Orient

Wednesday, December 2, 1987 12:00 p.m.

Dr. Elmer L. Hixson
Department of Electrical and Computer Engineering
The University of Texas at Austin

A brief travelogue and description of the immersion into Japanese and Chinese culture of a traumatized Texas couple, including looks at Acoustic Activity, will be presented. An overview of INTER-NOISE 87, September 14-17, 1987, Beijing, China will include a paper by Moryl and Hixson on Acoustic Energy Density. The rigors of a 30-hour return trip to Austin will not be presented.

Nonlinear Effects in Focused Sound Beams

Wednesday, December 9, 1987 12:00 p.m.

Dean Driebe
Physics Department
and
Applied Research Laboratories
The University of Texas at Austin

Some of the interesting nonlinear phenomena exhibited by focused finite-amplitude sound beams will be discussed. Linear, low-amplitude focusing will be reviewed with emphasis on a solution convenient to use in a quasilinear analysis. A parabolic wave equation is used to describe the nonlinear field. Numerical results for different choices of nonlinearity, focal gain, and absorption will be presented. Previous experimental results and a description of an experiment to he performed soon at ARL will be given. Some applications especially to acoustic microscopy will be discussed.