Review of Recent and Ongoing Developments in the Acoustic Treatment of Aerosols

Friday, January 31, 1997 4:00 p.m.

Karl Martin
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

Acoustic agglomeration is the use of high intensity sound to cause aerosol particles to stick together. It is a process with applications in pollution control and bulk materials handling. The acoustic agglomeration effect has been known for some time, but is only recently beginning to be explained. Several theories have been proposed, the most prominent being ortho-kinetic effects, mutual scattering and radiation pressure interactions, and acoustic wake effects. These theories will be reviewed and discussed in light of recent results in the literature. Recent work in acoustic agglomeration at the University of Texas has focused on a novel process known as acoustic filtration. This process uses a standing wave to force aerosol particles to migrate to certain, fixed points in a closed chamber. These particles form disks which levitate and act as filters by capturing more particles. Measurements will be presented which quantify the effectiveness of acoustic filtration versus previous implementations of acoustic agglomeration, and which characterize the development of the disks in detail.

Mode Extraction from a VLA Using Singular Value Decomposition

Friday, February 21, 1997 4:00 p.m.

Tracianne Neilsen
Department of Physics
The University of Texas at Austin
http://www.ph.utexas.edu

A method is developed for extracting the depth-dependent mode functions from single-frequency measurements on a vertical line array as a source moves out in range. A matrix of the complex pressure field versus receiver depth and source range is formed, and the cross-spectral density matrix (CSDM) is computed. A singular value decomposition (SVD) is performed on the CSDM to obtain the orthonormal eigenvectors and the eigenvalues. Rearrangement of the normal mode equations reveals that under ideal conditions, the eigenvectors correspond to the mode functions and the eigenvalues are proportional to the modal source excitation and wavenumber. When two or more eigenvalues are nearly equal, the eigenvectors are not unique, and the correct mode functions are linear combinations of the eigenvectors. Other complications arise when the pressure field is not sampled adequately in depth or range. The procedure is applied to simulated data for a Pekeris waveguide and a realistic geoacoustic profile. Extracted mode functions from sources of opportunity are intended to be used for geoacoustic inversion of the sound speed profile and bottom properties.

Noise Control and Engineering Acoustics at Boeing

Monday, March 3, 1997 4:00 p.m.

Dr. Milton Lumpkin
Manager, Noise Engineering
737/757 Programs
Boeing Corporation
Seattle, Washington
http://www.boeing.com

At Boeing, the Noise Engineering and Noise Laboratory organizations employ approximately 160 people to insure that Boeing aircraft set world class standards for low noise emissions. Our scientists, engineers, and technicians work to reduce the noise radiated by, the airplane both inflight and on the ground; we also minimize (subject to cost and weight constraints) the noise inside the airplane, both inside the passenger areas and also on the flight deck. An overview of our programs, staff, noise control technology, predictions and analysis techniques, and laboratory facilities will be presented.

Forensics and the Acoustical Engineer

Tuesday, March 4, 1997 4:00 p.m.

Robert Bruce
Collaboration in Science and Technology, Inc.
Houston, Texas

No abstract available.

Experimental Studies with N Waves from Sparks

Friday, March 28, 1997 4:00 p.m.

Professor Wayne M. Wright
Department of Physics
Kalamazoo College
Kalamazoo, Michigan

Weak sparks in air can be used to generate intense, short-duration acoustic transients that resemble N waves. Measurements made with wide-band capacitor microphones have confirmed theoretical predictions of amplitude decay and waveform elongation with propagation distance. These waves have made possible a number of studies of reflection and diffraction of transient signals, as well as modeling of the propagation of sonic booms through the atmosphere. Emphasis of the talk will be on practical considerations that affect this experimental work.

Second Harmonic Generation in Sound Beams Reflected from and Transmitted through Immersed Elastic Solids*

Wednesday, April 2, 1997 3:00 p.m.

Brian J. Landsberger
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

This seminar reports a theoretical and experimental investigation of finite amplitude sound beams reflected from, and transmitted through, isotropic elastic solids immersed in liquids. Attention is focused on the fundamental and nonlinearly generated second harmonic components in the beam as functions of incidence angle. The theoretical model is based on angular spectrum theory, and it describes second harmonic generation in sound beams radiated by arbitrary sources and incident on the solid at arbitrary angles, including mode conversion at the fluid-solid interfaces. Experiments were performed in water with an ultrasonic sound beam incident on either an aluminum or acrylic block. Extensive measurements of the reflected and transmitted fields were made at angles of incidence for which strong non specular phenomena are observed. These angles are associated with generation of interface or evanescent waves and are characterized by rapid variations in the phases of the reflection and transmission coefficients. Theory and experiment are in close quantitative agreement in all cases, especially comparisons of side lobe structures in the diffraction patterns. These appear to be the first such comparisons for second harmonic generation in solids. The close agreement indicates that similar comparisons of theory and experiment can be used to determine the nonlinearity coefficients for the solid.

*Final oral defense of Ph.D. dissertation.

Forensics and the Acoustical Engineer

Friday, April 4, 1997 4:00 p.m.

Robert D. Bruce
Collaboration in Science and Technology, Inc.
Houston, TX

Acoustics and acoustical engineers have been at the center of attention in addressing some of our nation's important legal problems. For example:

- Was the 18 minute gap in President Nixon's dictaphone recording created deliberately or accidentally?
- How many shots were fired in Dealey Plaza on 23 November 1963?
- What did acoustics have to do with the two different judgments in the Rodney King cases?
- What do recorded sounds reveal about plane crashes such as TWA Flight 800 or the ValuJet crash?

Other examples of forensic acoustics will be discussed, including the following:

- Can a purchaser collect damages if a vendor's equipment violates noise specification?
- Can residential complaints about noise from nightclubs, racetracks, industrial facilities, and schools shut down the operation?
- Did the doctor hear an alarm and fail to respond to the emergency, or was the alarm turned down to a lower setting?
- Did the construction worker hear the back-up alarm before he was crushed by the truck, or did the alarm fail to operate properly?
- Did the driver of the automobile fail to yield the right of way to the locomotive because he did not hear the horn, or did the engineer of the train fail to sound the horn?

Community Noise Issues In and Around Austin

Friday, April 11, 1997 4:00 p.m.

Jack Evans, P.E.
JEAcoustics
Austin, Texas
http://www.jeacoustics.com

Commercial and industrial properties are often adjacent to residential properties. Land use compatibilities are poorly regulated in many communities, with neither rational noise zoning nor permissible continuous noise criteria in ordinances. Recent community noise issues in and around Austin will be discussed with regard to ambient vs.disturbed sound. levels, time of day for disturbance, and resolution or proposed solutions. Cases discussed will include:

(Former) Pulpo Loco in the Park: Austin: amplified music after 10:00 p.m.
HEB #8 Supermarket, Austin: truck dock noise between 8:00 p.m. and 8:00 a.m.
Southwestern Bell, Pflugerville: engine-generator noise after 10:00 p.m.

In one case, a business closed. In another, significant physical changes mitigated by noise are planned. In the third, zoning and permitting for a building expansion were affected by neighborhood noise considerations.

Audio Application of the Parametric Array

Friday, September 12, 1997 4:00 p.m.

Professor David Blackstock
Department of Mechanical Engineering
Applied Research Laboratories
The University of Texas at Austin
http://www.me.utexas.edu

“HyperSonic Sound” is American Technology Corporation’s commercial application of the parametric array to produce broadband audio sound (Business Week , 12-2-96 issue, pp.108-109). E.G.Norris demonstrated the device at the Penn State ASA Meeting [J.Acoust.Soc.Am. 101 , 3072(A) (1997)], but gave few technical details. An analysis of the device demonstrated is provided here. The primary fields are produced by sixty 40-kHz elements mounted on a ring, 4cm i.d., 7cm o.d., which produce an axial sound pressure level of 140dB at 30cm. The values given imply a Rayleigh distance of about 1.2m and a (primary) beamwidth of about 3 degrees. Estimated by the absorption length for the primaries, the interaction region is about 9m. Those who witnessed Norris’s demonstration can attest to the narrowness of the secondary sound (a synthesized musical melody) and apparent absence of sidelobes. However, the melody heard also exhibited distortion. Distortion may be predicted by recalling that when the primary wave is a modulated carrier, the secondary sound is (asymptotically) the second derivative of the modulation envelope squared. Prospects for reducing the distortion are discussed; see Yoneyama, et al., J.Acoust.Soc.Am. 73 , 1532-1536 (1983).

Acoustic Detection of Buried Objects by a Dolphin

Friday, September 19, 1997 4:00 p.m.

Dr. Nicholas P. Chotiros
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

Acoustic buried object detection by a dolphin was observed by means of a hydrophone placed directly above the object. Dolphins are known to be adept at locating prey and objects that are buried in the sediment. This involves the detection and some level of identification of the prey. Since sediment is opaque, it is unlikely that vision is involved. It is likely that the dolphin uses sound to detect buried objects. Direct observation of the sound pulses arriving at the buried object provides information about the methods employed by the dolphin. The observations show that the acoustic pulses are broad band, spanning the frequency range from a few tens of kiloHertz to well over one hundred kiloHertz. Modeling of the acoustic penetration of such a broad band pulse indicates that it will change shape as it is transmitted through the water-sediment interface. The change will depend on the sediment type and signal grazing angle. As the pulse penetrates into the sediment, it will undergo further distortion due to the frequency dependence of acoustic absorption.

Noise Power Using Total Energy Density Measurements

Friday, September 26, 1997 4:00 p.m.

Professor Elmer L. Hixson
and
Matias Budhiantho
Department of Electrical and Computer Engineering
The University of Texas at Austin
http://www.ece.utexas.edu

Probability density functions for acoustic fields in a reverberant space are developed. Acoustic pressure is a one degree-of-freedom random process while velocity is a three degree-of-freedom process. The higher degree of freedom produces a lower variance. The models are verified by using a 4-microphone energy density sensor. Narrow band noise, two-tone, and single tone sources were used. Results lead to the recommendation that energy density be used for all sound power determination in reverberation rooms.

The Creation of Audible Sound from Ultrasonic Energy

Friday, October 3, 1997 4:00 p.m.

Joe Norris
American Technology Corp.
San Diego, California
http://www.atcsd.com

This talk is a follow-up on the practical implementation of the parametric array in air. It will be shown that the original experiments of Hermann von Helmholtz, regarding the creation of difference frequencies-or Tartini tones-by sounding two tones loudly in air, can be dramatically enhanced and applied to audio reproduction when using ultrasonic frequencies. Among the items discussed are the following: (1) The discovery of the phenomenon and more recent empirical findings. (2) Basic operating principles, parameters, and specifications. (3) Inherent benefits of the method and difficulties in the implementation. The reproduction of voice and simple music using the methodology will be demonstrated with a portable, low-power apparatus. Questions regarding the technology are welcome.

Aircraft Community Noise Reduction Research at Boeing

Friday, October 10, 1997 4:00 p.m.

Dr. Anthony Blackner
and
Dr. Belur Shivashankara
Boeing Corporation
Seattle, Washington
http://www.boeing.com

As air travel becomes more popular, the noise of airplanes for communities around airports has become a problem. If the impact of noise is to be diminished, the source levels have to be reduced. In this talk, we will discuss two sources: jet noise, which is important during take-off, and airframe noise, which is important during landing. Results from recent research for understanding and suppressing these noise sources will be presented.

3-D Auditory Display of Passive Sonar Data

Friday, October 17, 1997 4:00 p.m.

Suzanne Richardson
Schlumberger
Austin, Texas
http://www.slb.com

Submarine sonar operators typically use video and monaural audio outputs to locate obstacles, ships, and animals in the vehicle's path. Recently, the effectiveness of adding 3-D sound to sonar systems has been investigated. A system has been developed that converts sonar data collected by a hydrophone array into left and right ear signals, which provide accurate 3-D aural imaging of an underwater acoustical environment. The system incorporates a bank of FIR filters, which beamform the hydrophone data and simultaneously implement head-related transfer functions, to deliver the 3-D audio signals.

Modeling of Seismic Wave Propagation: Recent Trends and Future Directions

Friday, October 24, 1997 4:00 p.m.

Dr. Mrinal Sen
Institute for Geophysics
The University of Texas at Austin
http://www.ig.utexas.edu

Seismograms recorded at the earth's surface or in boreholes from earthquakes and manmade explosions are used extensively to infer the structure of the earth's deep interior. Thus numerical modeling of seismic wave propagation plays an important role in understanding the wiggles and obtaining meaningful images of the earth's subsurface. Elastic wave theory and linear elasticity is used for this purpose. Numerical methods allow for realistic models but are computationally very expensive. Fast analytic methods make several approximations and, at times, require use of very simplistic earth models. The real challenge is to develop techniques that are fairly accurate and are valid for realistic earth models. Although computation of 3D isotropic models still remains a challenging task, the new data show abundant evidence of anisotropy at all levels and at all scales of resolution. Semi-analytic approaches that make use of flat earth approximation are computationally feasible for anisotropic media. However, for general 3D models, finite difference solutions of elastic wave equations are applied. Development of 3D modeling algorithms that take into account material anisotropy requires use of parallel computers and adaptive grid refinement in finite difference calculations.

Sunfish Call Analysis: Shallow Water and Wavelet Transforms

Friday, October 31, 1997 4:00 p.m.

Dawn Johnson
Department of Zoology
The University of Texas at Austin
http://www.biosci.utexas.edu

Animals frequently need to communicate with each other in order to reproduce successfully. Many species of birds, frogs, insects, and fishes communicate using acoustical signals. In fishes the structure of the signals and the selective pressures acting on calling individuals are not well understood. Two technical difficulties stand out: (1) The fact that fish calls are often transient and low frequency (500 Hz) makes analysis difficult. (2) Most calling fish live in shallow water, an environment that makes predictions about signal degradation and attenuation difficult. In the preliminary work reported here, longear sunfish are studied as a model system for calling freshwater fish that live in shallow water. Wavelet transforms are used to examine the acoustic signals.

Qualifying the Cockpit Voice Recorder as a Structural Acoustic Measuring Instrument

Friday, November 7, 1997 4:00 p.m.

Stuart Rohre
Applied Research Laboratories
http://www.arlut.utexas.edu

and

Dr. Ronald Stearman
Department of Aerospace Engineering & Engineering Mechanics
The University of Texas at Austin
http://www.ae.utexas.edu

Both the Federal Aviation Administration and the Department of Defense are actively seeking methods of diagnosing structural conditions in aircraft. Although aircraft manufacturers have record numbers of new orders, it is clear that many existing aircraft will continue to be used for extended periods of time both in the defense and commercial sectors, and well beyond planned service life. Thus, cost effective monitoring and diagnostic methods are of extreme interest to the aviation community. Recent research has demonstrated that cockpit voice recorders can capture aircraft structural vibration information on recorder tracks which can aid in diagnosis of structural failure. Examination of recordings from different aircraft found signals that were directly related to engine speed changes and abnormal airframe vibrations. The transmission paths for these signals consisted of cockpit microphones and a fortuitous path that has been labeled “Latent Transduction.” The triboelectric effect was one possible source of latent signals. Rigorous steps were taken to evaluate the recorder and its signals versus Inter Range Instrumentation Group, (IRIG) Standards and Test Methods to qualify the recorder as a calibrated measuring instrument for frequency spectrum and time. Used with a real time analyzer, the cockpit voice recorder becomes a structural acoustic measuring instrument.

Rocket Noise: Source and Farfield Characteristics

Friday, November 14, 1997 4:00 p.m.

Dr. Sally McInerny
Department of Mechanical Engineering
University of Alabama
Tuscaloosa, Alabama
http://www.me.ua.edu
http://www.ua.edu

In this presentation, known characteristics of rocket noise are reviewed. These include low peak frequencies, a high radiation efficiency and a large angle of peak directivity relative to that of subsonic and supersonic jets. The extended source region and high temperatures in a rocket plume are discussed. Evidence is presented to support the contention that it is Mach wave radiation from the transonic region of the plume that governs the sound power. Properties of the noise measured in the farfield during rocket

launches are summarized. This high intensity noise is rich in shocks and the time domain data are positively skewed. Farfield noise spectra do not decrease with distance as would be expected on the basis of linear absorption theory. Signal processing techniques that have the potential to better distinguish the unique properties of rocket noise are briefly discussed, and the use of nonlinear acoustic propagation codes to better understand these properties is proposed.

Making the Highways Quiet

Friday, November 21, 1997 4:00 p.m.

Dr. Brian J. Landsberger
Center for Transportation Research
The University of Texas at Austin
http://www.utexas.edu/research/ctr

The adverse effects of traffic noise are a serious concern both domestically and internationally. In many urban places, highways have been lined with noise barriers on one or both sides in an effort to reduce the noise levels alongside the highway. Barriers are sometimes effective, often disliked and always expensive. Much effort has been spent toward modeling highway noise and noise reduction by barriers. In particular, accurately modeling the sound field outside of parallel noise barriers has proved to be a challenge. An alternative to protection by barriers is noise reduction at the source. For modern highway vehicles, the major component of traffic noise comes from tire-pavement interaction, which produces noise by several mechanisms. How much noise these mechanisms produce is greatly affected by tire and pavement design. The presentation will cover our current research toward (1) making the highways quiet through barrier modeling and design, and (2) identifying the noise generation and absorption characteristics of different tire and pavement types.