Comparison of Current Models for Water-Saturated Sand by Inversion of Reflection Loss Measurements

Friday, January 24, 2003 4:00 p.m.

Dr. Marcia Isakson
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

An accurate model of sediment acoustics is critical to understanding shallow water sound propagation and the detection and classification of buried objects such as mines. Indeed, as SONAR becomes more important in shallow water operations, an accurate high frequency acoustic model for ocean sediments becomes crucial to its application. Several models exist for acoustic interaction with ocean sediments, including fluid, elastic solid and poro -elastic model representations, with and without interface roughness and volume scattering mechanisms. In this study, reflection data taken from a smooth water/sand interface are inverted using five different models. The models considered are the visco -elastic model, the Biot -Stoll model, the composite Biot -Stoll model, the effective density fluid model (EDFM) and the Buckingham model. Inversions were performed using a simulated annealing algorithm with OASR as the forward model. Each model is considered for its ability to produce realistic sediment parameters and its fit to the data. Inverted parameter predictions will be compared with broadband dispersion and attenuation data and conclusions will be drawn as to applicability of these models over a large frequency range.

Diver-Held Sonar: The Integrated Navigation Sonar Sensor

Friday, January 31, 2003 4:00 p.m.

Nathan Crow
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

Applied Research Laboratories has developed a diver-held sonar system for the U.S. Navy’s Naval Special Clearance Team One. This system, called the Integrated Navigation Sonar Sensor (INSS), was designed to find mines in the very shallow water zone (water depths from 10 ft to 40 ft). In addition to functioning as a sonar, the INSS is also part of a long baseline navigation system and thus allows divers to swim to a series of predetermined waypoints, search the area for moored and bottom mines, and mark the positions of mine-like objects. Once the diver has completed the mission, the data can then be transferred to a computer where the maps and stored images can be combined with those from other divers and then passed up the chain of command for analysis. The INSS system uses advanced motion-detecting sensors to allow the diver to form a high-resolution image by manually panning a simple single-beam sonar. This presentation will discuss the difficulties encountered detecting and classifying targets in the VSW environment, the differences between older MCM sonars and the INSS, problems inherent in long baseline navigation, and system enhancements sponsored by the Office of Naval Research.

Design and Remediation in Environmental Noise Control

Friday, February 7, 2003 4:00 p.m.

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

JEAcoustics is an acoustical consulting firm specializing in architectural acoustics, mechanical, and environmental noise and vibration. Two of our recent cases involving environmental noise control are discussed in this seminar. The first involves an air-cooled chiller with rotary screw compressors installed at a new hospital. The compressor generated a distinct and disturbing tone at 117 Hz not only in patient rooms but in neighborhoods several blocks away. The required noise control, 5 to 8 dB of attenuation, was determined by perceived annoyance according to Composite Noise Rating acceptability levels. Six different mitigation proposals involving mechanical and acoustical modifications are discussed, including installation of pulse diffusers, acoustic louvers, and discharge attenuators. The second case involves an industrial research and development facility that incorporated engine test cells. The facility planned to relocate from an urban environment with moderately high ambient noise levels to a semi-rural community with quiet ambient conditions. To satisfy building code, the new noise contributions had to be limited to 5 dBA above the ambient environmental noise level. Design considerations focused on tonality, unbalanced frequency spectra, intermittency, and other annoyance factors. This case study reviews muffler, silencer, barrier, and directionality characteristics utilized in the noise mitigation solution to achieve acceptable sound levels and smooth, balanced spectra at the receivers.

Case Studies in Acoustical Consulting

Friday, February 14, 2003 4:00 p.m.

Jeff G. Schmitt, P.E.
VIAcoustics
http://www.viacoustics.com

Jeff G. Schmitt is the principal consultant of JGS Consulting, he is a 1983 UT graduate in acoustics and, until 1995, he served as the President of Acoustic Systems, an Austin based manufacturer of acoustical enclosures. He now practices as an independent acoustical consultant in a variety of areas. This presentation will highlight several projects worked on over the past year, including ones at Caterpillar Equipment Company, NASA Glenn Research Center, National Instruments, and XM Satellite Radio. These projects will be used to illustrate a variety of acoustical consulting specialties, including isolation of acoustic spaces, calibrated measurements, ISO quality systems, design of acoustic test software, and organizing acoustics programs for industry.

Acoustic Streaming Produced by Standing Waves

Friday, February 21, 2003 4:00 p.m.

Professor Mark Hamilton
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

Acoustic streaming is the steady flow that is generated by momentum transfer associated with the attenuation of sound. In a standing wave, shear stresses in the viscous boundary layer along the side walls of an acoustic resonator produce a series of counter-rotating streaming vortices. The outer vortices, first described by Rayleigh, are the dominant streaming patterns observed in wide channels. In narrow channels, having widths that are comparable to the acoustic boundary layer, a second set of streaming vortices dominates the steady flow, rotating in directions opposite those of the Rayleigh vortices. Channels this narrow are required for efficient heat transfer in thermoacoustic engines, while acoustic streaming acts to reduce this efficiency. The presentation will review some of the history surrounding the study of acoustic streaming. New solutions will be presented for acoustic streaming in channels of arbitrary width. Channels formed by either parallel plates or cylindrical tubes are considered, with viscosity, thermal conductivity, and the dependence of viscosity on temperature are taken into account. Measurements of acoustic streaming made recently at Penn State will also be discussed.

Nonlinear Surface Acoustic Waves in Crystalline and Thin-Film Systems

Monday, March 3, 2003 4:00 p.m.

Dr. Ron E. Kumon
Department of Physics
University of Windsor, Windsor, Ontario, Canada
http://cronus.uwindsor.ca/units/physics/home.nsf/welcome?OpenForm
http://cronus.uwindsor.ca/

The linear and nonlinear properties of surface acoustic waves (SAWs) in crystalline and laminated media are significantly different from those of SAWs in an isotropic half-space. Selected numerical results are presented for the propagation of initially monofrequency, finite-amplitude SAWs in a variety of surface cuts and directions in several nonpiezoelectric, cubic crystals and thin-film systems. Measurements of pulsed waveforms in the (001), (110), and (111) surface cuts of crystalline silicon obtained by collaborators at University of Heidelberg are shown to be quantitatively reproduced by the calculated results. In thin-film systems, the combination of nonlinear harmonic generation and frequency dispersion induced by the film can cause complicated harmonic evolution, including spatial growth and decay cycles in some cases. Moreover, simulations indicate that the effects of large residual stresses in thin films may significantly affect small- and finite-amplitude SAW propagation in these systems.

Organizational Acoustics

Friday, March 7, 2003 4:00 p.m.

Jeff G. Schmitt, P.E.
VIAcoustics
http://www.viacoustics.com

Jeff G. Schmitt is a 1983 UT graduate in acoustics and, until 1995, he served as President of Acoustic Systems, an Austin based manufacturer of acoustical enclosures. Since starting his own independent consulting firm he has worked with a variety of large and small companies to build acoustical laboratories and integrate acoustical technology into their products, services and business support structure. During his 20 years as a manager and consultant he has gained a unique perspective into how organizations deal, or fail to deal, with acoustics as a business issue. This presentation will focus on two areas. The first concerns tips on organizing an acoustics program for the acoustical engineer. It will be shown how quality systems methods defined by ISO standard 17025 are used to create the foundation and organizational structure for an acoustics program. The second focus is on integrating acoustics into the business for the non-engineer. The roles of sales, marketing, finance and management, which are common struggles associated with dealing with acoustics as a business issue, are discussed. The presentation will draw on materials used to teach these concepts to engineers and support personnel in training seminars offered regularly by the speaker.

Case Studies in Architectural Acoustics and Noise Control

Friday, March 21, 2003 4:00 p.m.

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

Two case studies will be presented involving architectural acoustics and noise control issues at the Denton A. Cooley Texas Heart Institute Building in Houston . Very late in the construction phase the hospital management decided to convert an unused atrium, designed originally as a purely aesthetic space, into an area for receptions and meetings that may require the use of amplified sound. The meeting function of the atrium required an acceptable acoustical environment yet one that would not produce unacceptable noise levels in adjacent patient rooms. Design considerations focused on mechanical background noise, reverberation time, and wall transmission losses. In the second case study, the architect designed a round auditorium with four conference rooms arrayed across the back, separated from the auditorium by operable partitions which allow auditorium seating expansion when opened. The acoustical challenges were to design diffusive and absorptive surface finishes to avoid focusing from the round shape, provide good speech intelligibility, and to encourage beneficial reflections into the expansion rooms when the operable partitions were open.

Sound Propagation and Scattering in Bubbly Liquids Across the Resonance Regime

Monday, March 31, 2003 4:00 p.m.

Professor Preston Wilson
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

For sonar-based naval operations to be successful in shallow water, significant knowledge of the acoustic behavior of the ocean surface, the water column, and the ocean bottom is required. Natural and artificial processes produce bubbles throughout this environment. Understanding the acoustics of bubbly media is therefore a necessity. For air/water mixtures, asymptotic propagation theory and experiment at frequencies well below individual bubble resonance (IBR) are in agreement. Due to high attenuation encountered near IBR, measurements in this regime are difficult. Consequently, the full theory remains largely unverified. A novel impedance tube was constructed and used to make measurements of phase velocity and attenuation in mixtures of air bubbles and water in the vicinity of IBR. These experiments and comparison of results with existing theory are described. Acoustic scattering from bubble clouds, which form beneath breaking waves, is also important. For frequencies well below IBR, an acoustically compact bubble cloud can be modeled as a compressible sphere. The monopole scattering strength depends only on spherical cloud volume and void fraction, not bubble size distribution or cloud shape. Measured bubble cloud target strengths agree with this theory up to but not above the clouds monopole resonance frequency. To further understand scattering from these objects, and to investigate the validity of the effective medium scattering theory for higher order modes, laboratory scattering experiments were performed using geometrically well characterized bubbly-liquid targets. Broadband measurements of scattering from bubbly-liquid-filled latex tubes are presented and compared with a multi-mode effective medium theory.

Effects of Acoustic Fields on Tissues Containing Gas Bodies

Friday, April 4, 2003 4:00 p.m.

Dr. Diane Dalecki
Department of Biomedical Engineering
University of Rochester, Rochester, New York
http://www.bme.rochester.edu
http://www.rochester.edu

Tissues known to contain gas bodies are particularly susceptible to damage from exposure to acoustic fields. Lung and intestine contain gas bodies naturally and studies have demonstrated that ultrasound can produce damage to these tissues. In response to low frequency acoustic fields, the lung acts as a resonant gas body. In addition to tissues possessing gas bodies naturally, tissues containing gas-based ultrasound contrast agents are also susceptible to damage from pulsed ultrasound and lithotripter fields. Studies with laboratory animals indicate that the presence of contrast agents in the vasculature can increase the extent of ultrasound-induced hemolysis, vascular damage and effects on cardiac rhythm.

This lecture will discuss the bioeffects of acoustic fields in tissues that contain gas naturally or after the addition of ultrasound contrast agents.

Is There a Perfect Marimba Bar? The Art and Science of Bar Tuning

Friday, April 11, 2003 4:00 p.m.

Professor David Peterson
Department of Mathematics
University of Central Arkansas, Conway, Arkansas
http://www.uca.edu/divisions/academic/math
http://www.uca.edu

Vibrating bars have been extensively studied and the theory is well understood. But unlike a vibrating string, mode frequencies are not integer multiples of the fundamental. By carving a bar in various ways it is possible to tune several modes, most commonly to the ratio 1:4:10. Using a Timoshenko beam model it has been shown that tuning three modes can be accomplished with parabolic arches, and so bars can be tuned to desired frequencies by manipulating two parameters. My interest in bars began when I assigned a mathematics research student the task of tuning bars by making two symmetrical cuts. So, is there a perfect marimba bar? In practice, each bar has a different shape (two similar cuts won't do it) . The selection of bar material (wood or fiberglass), tuning objectives, methodology (for the most part mode frequencies can only be lowered and they are not independent), playability, and visual appearance makes instrument building an art.

Tour of Bass Concert Hall

Thursday, April 17, 2003 4:00 p.m.

Adam Dudley
Technical Coordinator/Audio Supervisor
Bass Concert Hall
The University of Texas at Austin
http://www.utpac.org

A technical tour of Bass Concert Hall will commence at the loading dock entrance on the back (west) side of the building. The tour will describe how the technical team configures the auditorium and sound systems for a particular performance, and it will include a walk-through of the auditorium, orchestra pit, and sound and amplifier rooms.

Seismic SONAR for Landmine Detection

Friday, August 29, 2003 4:00 p.m.

Professor Tom Muir
Jamie Whitten National Center for Physical Acoustics
University of Mississippi
and the U.S. Naval Postgraduate School, Monterrey, California
http://www.olemiss.edu/depts/ncpa
http://www.olemiss.edu
http://www.nps.navy.mil

Over 100 million landmines are buried in over 60 countries, worldwide, killing or maiming over 25,000 innocent humans each year, mostly women and children. Present detection techniques that work (bayonets and metal detectors) are primitive and slow. Ground penetrating radar is plagued by false targets and plastic mines. A new method utilizing seismic interface waves that travel along the soil-air boundary has been developed by the speaker and his colleagues. “Baby earthquakes,” consisting of Rayleigh waves, are sent out by vibrational source arrays on the ground. These waves propagate to the targets, reflect from them, and return to seismometer array receivers. The range and bearing to suspected targets is determined. Confirmation of target type is made from detection of the target’s mechanical resonance modes in received echoes.

Acoustic Scattering from an Elastic Tube Filled with Bubbly Liquid

Friday, September 12, 2003 4:00 p.m.

Professor Preston Wilson
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

Sonar operation in shallow water is complicated by interaction with the sea surface. One difficulty is accounting for scattering from near-surface bubble clouds, which are generated by breaking waves. This problem has been addressed in the literature for low frequencies. An acoustically compact bubble cloud can be modeled as a compressible sphere, where the scattering strength depends only on spherical cloud volume and mean void fraction, not the bubble size distribution or cloud shape. This hypothesis was experimentally tested using freely rising artificial bubble clouds [J. Acoust. Soc. Am. Vol. 92, 2993-2996 (1992)]. The low frequency monopole target strength of the cloud agreed with this effective medium theory, but higher frequency results did not. To resolve the issue, laboratory experiments were conducted using bubbly liquid targets with well-defined shape. Measurements of scattering from a bubbly-liquid-filled latex tube are presented and compared to an effective medium theory. Results indicate that the effective medium approximation remains valid well above the cloud’s monopole resonance frequency and up to 1/5th the individual bubble resonance frequency, once cloud shape is considered. At higher frequencies, knowledge of the bubble size distribution becomes important, greatly increasing the problem’s difficulty.

Discovery of a New Signal Technology Providing Nondispersive Wave Propagation on Electrical Transmission Lines as well as with Acoustic Waves in Lossy Media

Friday, September 19, 2003 4:00 p.m.

Professor Robert H. Flake
Department of Electrical and Computer Engineering
The University of Texas at Austin
http://www.ece.utexas.edu

A nondispersive propagating waveform has recently been discovered. This special signal, called Speedy Delivery (SD), can theoretically be transmitted in many different categories of lossy, dispersive media without change in shape or propagation speed. The extremely high SD signal shape fidelity and constant propagation speed have been demonstrated experimentally in various cables, including coaxial and TWP electrical interconnects. The nondispersive propagation property of the SD signal is predicted from the mathematical wave solutions of the lossy, frequency dependent parameter telegrapher's equation, for acoustic plane waves in viscous media, and for the propagation of sound in a chemically reactive fluid composed of two or more constituents (such as sea water). The propagation of this signal, showing that its shape is preserved in a common coaxial cable, will be experimentally demonstrated during the presentation and compared with the normal dispersive shape distortion experienced by a rectangular pulse in the same cable. The experimental propagation of the acoustical variety of the SD waveform has not yet been attempted.

Statistical Model of Beam Distortion Due to Inhomogeneities in Tissue Harmonic Imaging

Friday, October 3, 2003 4:00 p.m.

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

Tissue harmonic imaging (THI) is a new imaging technique in medical ultrasound. The images are created from the nonlinearly generated second harmonics produced when ultrasound propagates inside the body. For many patients, THI improves image resolution by reducing phase distortion due to the inhomogeneities in the body wall, reverberation in this layer, and artifacts due to side lobes. This study was conducted to quantify the improvement provided by tissue harmonic imaging in the presence of an inhomogeneous body wall layer. The layer is approximated by a thin phase screen located directly in front of the source, and the random phase distribution across the screen is characterized by its variance and correlation length. For a Gaussian source function, an integral solution can be derived for the mean intensity of the second harmonic in the target plane. This statistical solution reveals clearly the separate contributions due to the undistorted and scattered components in the beam. The solution is verified by comparison with ensemble averages of direct numerical simulations of beam propagation through sample phase screens. Overall good agreement is achieved. Experiments performed with circular piston sources,

and etched plastic plates to introduce phase distortion, support the theoretical model.

Source Localization with Passive Line Arrays

Friday, October 10, 2003 4:00 p.m.

Dr. Frank Boyle
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

An acoustic line array's finite aperture can be used to localize sources of detected acoustic signals in range as well as azimuth. Two passive localization methods have been explored, including (1) a range focusing method wherein images formed at different focal ranges are compared, and (2) a parallax ranging method wherein ranges are computed by triangulation using images from spatially separated subarrays. The latter method is generally more effective, particularly for long range sources. An important component of both methods is an image processing technique, related to the Hough Transform, that enhances acoustic images for feature extraction. The presentation will include a discussion of the influence of array geometry. An array's geometry will affect the structure of ambiguities that can produce erroneous source location estimates. A two-dimensional beam pattern can be used to model the ambiguities and assess the array's effectiveness. Possible techniques for assessing array geometry from available sources of opportunity will be introduced.

Detection and Classification of Right Whales in the Bay of Fundy Using Independent Component Analysis

Friday, October 24, 2003 4:00 p.m.

Dr. Brian R. La Cour and Mr. Michael Linford
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

A novel method of detection and classification for marine mammals is presented which uses techniques from independent component analysis to solve the blind source separation problem for right whales in the Bay of Fundy. Using the fundamentally non-Gaussian nature of marine mammal vocalizations and data collected on multiple hydrophones, we are able to separate right whale source spectra, up to an unknown scale, from ambient noise. This technique assumes that the array data is a linear combination of the source signals but does not require specific knowledge of the array geometry. A detector/classifier algorithm is demonstrated which compares the estimated source spectra against known right whale vocalizations.

Assessment of Mud Filtrate Invasion Effects on Full Waveform Acoustic Well Logging and Radial Profiling of Formation Elastic Properties

Friday, October 31, 2003 4:00 p.m.

Shihong Chi
Department of Petroleum and Geosystems Engineering
The University of Texas at Austin
http://www.pge.utexas.edu

Modern acoustic logging provides accurate descriptions of in-situ velocities of elastic waves propagating in rock formations. These velocities are used to calibrate surface seismic data and to estimate the strength of rock formations for wellbore stability analysis, hydro-fracturing, and sanding prevention. Integration of time-lapse acoustic logging and rock physics can be used to monitor fluid movements and to find bypassed hydrocarbon zones after production. Despite continued improvement in acoustic logging technology and interpretation methods of full waveform acoustic data, acoustic logs processed with current industry standards are often affected by formation damage and mud-filtrate invasion. Moreover, most of the amplitude information contained in borehole array acoustic waveforms is not being used for interpretation. We develop efficient, accurate, and robust algorithms for modeling wave propagation in fluid-filled boreholes in the presence of complex, near-wellbore, damaged zones. The new forward modeling algorithm is based on the generalized reflection and transmission matrices method. An inversion algorithm is also described to estimate radial profiles of elastic properties away from the borehole wall. The inversion algorithm is a Gauss-Newton method that makes use of normalized array full waveform data in the frequency domain. Assessment of mud-filtrate invasion effects on borehole acoustic measurements is performed through simulation of time-lapse logging measurements. By comparing the velocities extracted from waveforms in homogeneous and multilayered formations caused by mud-filtrate invasion, we evaluate the sensitivity of noisy acoustic logs to the presence of radial variations of fluid saturation. Validation and testing of the algorithms is performed against published results. Our studies indicate that the method of generalized reflection and transmission coefficients is stable and efficient for the simulation of wave propagation in boreholes surrounded by complex invasion zones. Mud-filtrate invasion effects are not observed on the P- and S- wave velocity logs for invasion lengths around 2-3 borehole diameters. The inversion algorithm indicates that radial profiles of formation density, and P- and S- wave velocities can be reconstructed from array waveforms data. Finally, a sensitivity study indicates the estimation of rock formation properties is robust whenever the borehole fluid properties are known a priori.

The Perception of Musical Sound

Friday, November 21, 2003 4:00 p.m.

Dr. Jean-Claude Risset
Composer and Director of Research at CNRS Laboratoire de Mcanique et d'Acoustique Marseille, France
http://omicron.cnrs-mrs.fr

Dr. Risset will give a talk on the perception of musical sound, with a number of sound examples on CD. He will elaborate on the progress in perception of musical sound brought by the exploration of the resources of digital sound synthesis (the process which permitted for the first time the manufacture of complex sounds with precisely specified physical parameters): simulation of acoustic instruments; auditory and musical illusions as "errors of the senses and truths of perception"; hearing as "auditory scene analysis" developed by evolution to yield information as the outside world. He may also discuss his "Duet for One Pianist" – interactive music in the acoustic domain – with some implications on the mechanics of the piano key.

Tour of Acoustic Systems

Friday, December 5, 2003 4:00 p.m.

Bill McKenna
Acoustic Systems
http://www.acousticsystems.com

This tour is a class field trip for Engineering Acoustics (ME 379N, EE 363N), but it is open to the public. Acoustic Systems, located in Austin, Texas, has been designing, manufacturing, and installing acoustical products since 1971. While Acoustic Systems does offer standard products, our focus is on custom designs, manufactured per customer specifications. Acoustic Systems is staffed by highly qualified sales professionals who work in tandem with a team of talented designers to provide responsive customer support throughout the design, manufacture and installation phases of every project. The company operates a state-of-the-art manufacturing facility and a NVLAP (National Voluntary Laboratory Accreditation Program) certified laboratory for the measurement of acoustic transmission loss, absorption and noise reduction. The test facility is used for ongoing analysis and improvements to Acoustic Systems' products as well as independent testing for companies throughout the United States.