Imaging Elastic Target Responses in Bistatic Sonar

Friday, January 20, 2012 9:00 a.m. in the
Applied Research Laboratory Auditorium
10000 Burnet Rd, Austin TX

Shaun Anderson
George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology

The development of low-frequency sonar systems, using a network of autonomous systems in unmanned vehicles, provides a practical means for bistatic measurements (i.e. when the source and receiver are separated) allowing multiple viewpoints of the target of interest. Low frequency sonar is of interest because it allows for subcritical bottom insonification required for buried object detection. Additionally time-frequency analysis, in particular Wigner-Ville analysis, takes advantage of the time dependent evolution of the echo spectrum to differentiate a man made target (e.g. elastic spherical shell, or cylinders) from natural clutter of the similar shape (e.g. rock). For example, a fluid loaded thin spherical shell has a scattering response containing a characteristic energetic feature, which is known as the mid-frequency enhancement that results from antisymmetric Lamb-waves propagating around the circumference of the shell. This presentation will discuss the benefits and complications associated with bistatic measurements and imaging of the elastic target response and apply this knowledge to a numerical model and experimental data set.

Forensic Acoustics

Friday, January 27, 2012 4:00 p.m. ETC 4.150

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Due to the proliferation of audio recording devices in the military, law enforcement, and the civilian community, there has been an increase in the number of recorded gunshot sounds submitted for forensic analysis. A gunshot sound is composed of one or more discrete acoustic transient events. The two primary acoustic events are the muzzle blast (bang) and the ballistic shockwave (crack). The acoustic event characteristics depend on their source generating mechanisms, and vary according to the firearm make, model, barrel length, and the specific ammunition characteristics. Forensic gunshot analysis deals with a single recorded shot lasting for a fraction of a second. These acoustic events are usually high intensity, often up to 160 dB SPL, are highly directional, and are often recorded in high distortion environments. Forensic gunshot analysis must take into account variations in the source generation characteristics and the sources of distortion for these recorded acoustic events in order to answer these fundamental forensic questions: Is this event a gunshot? Are two events from the same firearm? Who fired first? To illustrate the complex nature of the analysis, this presentation will cover gunshot data

collected in a pristine controlled environment and the data collected in a forensic environment. Several microphone array systems used for acoustic source localization are also described.

Abatement of Low Frequency Anthropogenic Underwater Noise Using Tethered Encapsulated Bubbles

Friday, February 3, 2012 4:00 p.m. ETC 4.150

Dr. Kevin M. Lee and Dr. Mark S. Wochner
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The University of Texas
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Collections of bubbles cause significant dispersion and attenuation of underwater sound near the individual bubbles' resonance frequencies and can be used to abate low-frequency anthropogenic underwater noise. Such effects have been reported for large encapsulated bubbles with resonance frequencies below 100 Hz [J. Acoust. Soc. Am. 127:2015 (2010)] and significant attenuation due to bubble resonance phenomena and acoustic impedance mismatching was observed in experiments using a compact electromechanical acoustic source [J. Acoust. Soc. Am. 128:2279 (2010); J. Acoust. Soc. Am. 129:2462 (2011)]. We describe a method of shielding either a noise source or a receiver using screens or curtains of large encapsulated bubbles. This method was applied to two distinct types of real-world noise excitation: continuous wave noise radiated by a vibrating marine vessel and impact noise from marine pile driving. Experimental results show that significant noise reduction ranging up to 40 dB can be attained using this method. Finally, the commercialization aspects of this work are discussed as we describe our own experience in transitioning this research from basic science to a commercial technology.

"Dead Spots" of the Electric Bass Guitar

Friday, February 10, 2012 4:00 p.m. ETC 4.150

Alex Mayer
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Vienna, Austria
http://www.bias.at

"Dead spots" of an electric bass guitar correspond to notes which decay much faster than average. Previous analysis and investigation of this phenomenon concluded that neck resonances are solely responsible for causing the accelerated decay. This presentation will discuss some further research in this area performed by both Werner Grolly, a professional bass player and a masters student at the Institute for Musical Acoustics in the University of Music and Performing Arts Vienna, and the author.

The talk will first present an overview of the history of the electric bass, as well as some aspects of the instrument's components and assembly. The vibration of six different bass guitars was measured using several analysis techniques. These include modal analysis of the neck, and measurements of the decay

time for each note after excitation by a custom mechanical device. In addition, optical vibration analysis of the whole instrument performed with an electronic speckle pattern interferometer will be presented. New conclusions drawn from these measurements will indicate the need for further study of the cause of dead spots.

Parabolic Equation Solutions for Wave Propagation in Elastic and Poro-Elastic Media

Friday, February 17, 2012 4:00 p.m. ETC 4.150

Dr. Adam M. Metzler
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The University of Texas at Austin
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Parabolic equation (PE) techniques are very efficient and can provide accurate solutions for range-dependent wave propagation problems. These techniques are particularly useful for propagation in elastic and poro-elastic media. For elastic media, range dependence is handled through a single-scattering correction [E. T. Küsel et al., J. Acoust. Soc. Am. 121, 808 (2007)] which accurately treats interfaces between two solids. For problems with large parameter contrasts, further accuracy and efficiency are gained by subdividing vertical interfaces into a series of two or more scattering problems. An example waveguide that includes the generation of a Rayleigh-like interface wave is presented in both the frequency and time domains. For poro-elastic media, Biot theory is used to construct a system of equations suitable for parabolic equation techniques. A previous PE solution for poro-elastic media [M. D. Collins, et al., J. Acoust. Soc. Am. 98, 1645 (1995)] does not produce accurate solutions for layered environments. A solution based on an approach for elastic media is generalized for the poro-elastic case which yields a more accurate and capable PE. Another variable formulation with horizontal interface conditions that contain no depth derivatives higher than first-order is introduced which should aid in the treatment of range dependence. For range independent problems both new solutions are superior to the original for environments containing layered poro-elastic media.

Light, Sound, nanoAction: Nanoprobes and Ultrasound-Guided Photoacoustics

Friday, March 2, 2012 4:00 p.m. ETC 4.150

Prof. Stanislav Y. Emelianov
Associate Chair for Research
Department of Biomedical Engineering
The University of Texas at Austin
http://www.bme.utexas.edu

A quantitative morphological, functional and molecular imaging technique capable of visualizing biochemical, pharmacological and other processes *in vivo* and repetitively during various stages of tumor progression and cancer treatment is desired for many fundamental, preclinical and clinical applications. Recently, we introduced several ultrasound-based imaging techniques capable of visualizing anatomical structures and functional information about the tissue. Furthermore, targeted contrast agents were developed to enable the cellular and molecular sensitivity of the developed imaging techniques.

In this presentation, combined ultrasound and photoacoustic imaging augmented with imaging contrast nanoagent will be introduced. Specifically, ultrasound-guided photoacoustic (USPA) imaging to simultaneously obtain the anatomical and molecular map of tumor *in-vivo* will be presented. An example using gold nanospheres (AuNPs) functionalized to target cancer biomarker (e.g., EGFR) will be given. Furthermore, we will demonstrate the role of USPA imaging in therapy planning, guidance and monitoring. For example, image-guided photothermal therapy of cancer using targeted metal nanoparticles will be discussed. Finally, design and synthesis of contrast nanoagents with properties desired for cellular/molecular USPA imaging will be presented and discussed.

The presentation with conclude with the discussion of advanced developments in morphological, functional and molecular USPA imaging. Applications of the nanoparticle-augmented USPA imaging ranging from macroscopic to microscopic visualization will be presented, and future directions will be described.

Noise Propagation from a Fully Expanded Mach 3 Jet: Crackle and Nonlinear Features

Friday, March 9, 2012 4:00 p.m. ETC 4.150

Woutijn J. Baars
Department of Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin
http://www.ae.utexas.edu

The high-intensity noise radiated by an unheated, fully expanded, Mach 3 jet is investigated experimentally. The shock-free supersonic jet encompasses Mach wave radiation that is the most prominent component of turbulent mixing noise. Additive to that, an unsteady noise component is present known as “crackle.” Pressure time waveforms are acquired along a grid in the (x,r)-plane to quantify several metrics of the far-field sound. The overall sound pressure level (OASPL) topography reveals a highly directive sound propagation path emanating from the post-potential core region at x/Dj = 20 and along 45° from the jet axis; this coincides with the Mach wave radiation angle. Various metrics for quantifying the degree of crackle and nonlinear features in a time-averaged sense are computed and include the skewness of the pressure derivative. Each metric is shown to produce a slightly unique propagation path, albeit they all follow a similar trend as the OASPL. The distributions support the theory that crackle is formed from local shock formation at the noise source, as opposed to nonlinear propagation effects that manifest themselves over a larger spatial domain. A second effort focuses on quantifying the short-time intermittent behavior of crackle, which is believed to consist of groups of N-wave type structures. A custom shock wave detection algorithm is applied and was compared to wavelet power spectra for validation. Statistics from the intermittent time of the crackle footprint are presented and reveal a high dependence on the location of observation.

Nonlinear Acoustics of Rock

Friday, March 30, 2012 4:00 p.m. ETC 4.150

Professor Lev A. Ostrovsky
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Numerous experiments show that Earth materials, such as rock and soils, can have anomalously strong vibroacoustic nonlinearity which is characterized by hysteresis (memory) in the stress-strain dependence, and often a long relaxation time (slow time). However, only relatively recently, oscillations and waves in such media began receiving a systematic study. Elastic wave propagation in such media has many peculiarities; for example, the amplitude of the third harmonic is proportional to the square (not cube!) of the fundamental harmonic amplitude. In general, “non-classical” properties of such materials are of structural origin; they have a complex “mesoscale” structure including grains, microcracks, fluid-filled contacts, etc. Here we outline some relevant experimental data and theoretical models. The latter include nonlinear waves in grainy media where nonlinearity is caused by the inter-grain contacts (Hertz-Mindlin model), and in media with hysteresis. Recent research refers to the “slow time” phenomena which we describe based on a thermodynamic approach. Some applications are also discussed briefly.

Nonlinear Ultrasonic Methods for Nondestructive Damage Assessment in Structural Materials

Tuesday, April 3, 2012 2:00 p.m. ACES 2.302

Prof. Jianmin Qu
Chair, Department of Civil and Environmental Engineering
Walter P. Murphy Professor
Northwestern University
http://www.northwestern.edu

Ultrasonic nondestructive evaluation (NDE) techniques have been used extensively for inspecting and monitoring various engineering structures and components. The vast majority of these ultrasonic NDE techniques utilize only the linear behavior of the ultrasound. These linear NDE techniques are effective in detecting discontinuities in the materials such as cracks, voids, interfaces, inclusions, etc. However, they are incapable of assessing the state of damage before visible cracks are formed. On the other hand, our recent work has demonstrated that nonlinear ultrasonic NDE techniques offer the potential to characterize and quantify early stages of damage in metallic materials subjected to fatigue loading, and in cementitious materials under alkali-silica reaction (ASR) conditions.

After presenting the general principles on which various nonlinear ultrasonic NDE techniques can be developed, examples of using nonlinear NDE methods for assessing fatigue damage in metals will be described. It will be shown that nonlinear ultrasonic measurements can provide quantitative inputs to determine the material state and measure damage in structural materials.

Remote Characterization of the Mechanical Properties of Ocular Tissues

Friday, April 20, 2012 12:30 p.m. CPE 2.216

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

A new approach to measure the mechanical properties of soft tissues is presented. Quantitative measurements of the mechanical properties were achieved by model-based reconstruction. These highly localized measurements provide detailed information about the viscoelastic properties of a sample. Minimum invasiveness maintained the inherent characteristics of a tissue sample so that more realistic measurements are possible. A laser-induced microbubble, created by focusing a single nanosecond laser pulse with a custom-made objective lens, was created at desired locations inside a tissue sample. An acoustic radiation force was generated by a low frequency transducer to displace the microbubble. A custom-built high pulse repetition frequency (PRF) ultrasound system, consisting of two 25 MHz single element transducers, was used to track the dynamics of the microbubble. Reconstruction of the mechanical properties at the specific location in a tissue sample was performed using a theoretical model, which calculated the dynamics of a microbubble under an externally applied force in a viscoelastic

medium. The theoretical model and the high PRF ultrasound system were successfully validated in both gelatin phantoms and *ex vivo* bovine crystalline lenses. The laser-induced microbubble approach produced significant results, to be interpreted in tandem with physiological phenomena of animal crystalline lenses and vitreous humors. Age-related sclerosis of the crystalline lenses from bovine was clearly detected, which might be linked to changes in the crystalline. Location-dependent variation explained that the outer cortex and the inner nucleus had different mechanical properties. In the old and young porcine vitreous humors, age-related changes were not found. However, local variations of the mechanical properties were discovered, which may coincide with the different distributions of the molecular compositions. The laser-induced microbubble approach shows potential for future research into the origin of physiological phenomena and the development of inherent disorders in the eye.

Intravascular Imaging of Atherosclerosis

Tuesday, April 24, 2012 12:30 p.m. ACES 2.302

Prof. Antonius van der Steen
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Over the last decade, serious academic and industrial efforts have been made to further develop an intravascular ultrasound (IVUS)—a technology that uses an ultrasound transducer on the tip of a catheter which is advanced into the coronary arteries to produce a tomographic image of the vascular wall and atherosclerotic plaques. This lecture will focus on the development of technologies to identify unstable plaques characterized by a lipid core that is covered by a thin fibrous cap, which has been locally weakened by inflammatory cells. First, techniques of measuring the elastic properties of the plaque as a marker for plaque instability and measuring the vascularization in the plaque, which plays an important role in the pathogenesis of unstable plaque, will be introduced. Furthermore the role of combined ultrasound/light catheters to image the luminal plaque at a resolution of around 10 µm, while maintaining the full 3-D view, will be discussed. Furthermore photoacoustics and a combination of near-infrared spectroscopy and imaging will be presented. Technology development in the IVUS and integrated catheters, the imaging systems and the signal processing will be presented as well as their validation and the role of IVUS to image biomarkers in natural history studies and trials for the development of new cardiovascular drugs.

The Trouble with Bubbles: Diagnostic and Therapeutic Applications of Microbubbles in Medical Ultrasound

Friday, April 27, 2012 4:00 p.m. BME 3.204

Prof. J. Brian Fowlkes
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The University of Michigan
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http://www.bme.umich.edu

Ever wondered why bubbles repeatedly form on the side of a drinking glass and how this would ever relate to medical imaging? Why do Mentos make such a great explosion when dropped in diet Coke? How do you make the “Best Chips Ever?” The phenomenon of cavitation and some other popular bubble facts will be revealed in this presentation. Several groups in the engineering and medical schools of the University of Michigan are interested in the use of microbubbles for diagnosis and therapy. The interaction of bubbles with an ultrasonic field can be referred to as acoustic cavitation and small gas bubbles, either occurring naturally in the body or introduced as contrast agents, can potentiate this process. Ultrasound contrast agents based on stabilized microbubbles (<10 micron diameter) produce nonlinear signals that enhance blood flow detection, responding to specialized pulse sequences that suppress undesired tissue signal. These fragile microbubbles can also be eliminated from the imaging plane with modest acoustic fields to provide a method for measuring contrast replenishment and thus perfusion. However, at sufficiently high ultrasound intensity, microbubbles undergo inertial cavitation where the inertia of the fluid is so large that the bubble has difficulty resisting the collapse. The physical effects to tissue surround the bubble can range from very small hemorrhage sites to complete cellular disruption, termed Histotripsy, depending on the pulse parameters used. An additional method for microbubble introduction is to inject superheated perfluorocarbon droplets that when activated by ultrasound, vaporize to form gas bubbles in a process termed acoustic droplet vaporization (ADV). The droplets (<6 micron diameter) produce relatively large bubbles by ADV within tissue for vascular occlusion. The bubbles can also act as barriers and reflectors of ultrasound to shield or enhance acoustic fields. We will discuss the many uses of microbubbles in medical ultrasound, how such innovations are advancing both diagnosis and therapy, and how to keep your “favorite carbonated beverage” from going flat.

Acoustic Cloaking of Spherical Objects Using Thin Elastic Coatings

Monday, April 30, 2012 12:00 p.m. ETC 5.132

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For many years, the concept of cloaking has been a prevalent theme in science fiction and popular culture, from *Start Trek* to *Harry Potter*. It has not been until more recently that the topic of cloaking has received serious attention from the scientific community. This research has been driven by theoretical works describing how waves can be bent around an object, or alternatively, by applying a coating to the object which effectively cancels the scattered field. In this work, a detailed description of acoustic cloaking is put forth using a coating consisting of discrete layers, enabling the cancellation of the scattered field around the object. This particular approach has previously only been applied to electromagnetic waves, for which it was observed that cloaking could be achieved over a finite bandwidth using isotropic materials. An investigation is presented of the physical parameters necessary for, and the feasibility of, designing an acoustic cloak using a scattering cancellation approach for an elastic sphere using fluid and elastic layers. This work includes a detailed analysis of the different physical phenomena, including resonant and non-resonant mechanisms, that can be used to achieve scattering cancellation for a range of frequencies of interest, and which can be applied to a wide range of scattering configurations for which cloaking would be desirable. In addition to laying out a broad theoretical foundation, the use of limiting cases and practical examples demonstrates the effectiveness and feasibility of such an approach to achieve acoustic cloaking of a spherical object.

Laboratory Measurements of Sound Speed and Attenuation of Water-Saturated Granular Sediments

Tuesday, May 1, 2012 11:00 a.m. ETC 4.120

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The propagation of acoustic waves through water-saturated granular sediments has been widely studied, yet existing propagation models cannot adequately predict the speed and attenuation of sound across the range of frequencies of interest in underwater acoustics, especially in loosely packed sediments that have been recently disturbed by storms or wave action. Advances in modeling are currently dependent on experimental validation of various components of existing models. To begin to address these deficiencies, three well-controlled laboratory experiments were performed in gravity-settled glass beads and reconstituted sand sediments. To investigate sound speed and attenuation in the 0.5 kHz to 10 kHz

range, a resonator method was used to study reconstituted sand sediment. In the 200 kHz to 900 kHz range, a time-of-flight technique was used to determine the speed of sound and attenuation in monodisperse water-saturated glass beads, binary glass bead mixtures, and reconstituted sediment samples to investigate the effect of sediment inhomogeneity. A fluidized bed technique was used to vary the porosity of monodisperse glass bead samples from 0.37 to 0.43 independent of changes in other sediment physical properties and a Fourier phase technique was used to determine the speed and attenuation of sound. In aggregate, measured sound speeds showed positive dispersion below 50 kHz while negative dispersion was observed above 200 kHz for some samples. Attenuation measurements showed an approximately $f0.5$ dependence in the low frequency regime and an approximately $f3.5$ dependence for large-grained samples in the high frequency regime. The laboratory experiments presented in this work demonstrate that both sound speed and attenuation in idealized loosely packed water-saturated sediments cannot be simultaneously predicted by existing models within the uncertainties of the model input parameters, but the independent effect of porosity on sound speed can be predicted.

Predicting Acoustic Intensity Fluctuations Induced by Nonlinear Internal Waves in a Shallow Water Waveguide

Wednesday, July 25, 2012 10:00 a.m. in the
Applied Research Laboratories, Conference Room 6

Jason D. Sagers
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Many problems in shallow water acoustics require accurate predictions of the acoustic field in space and time. Oceanographic internal waves are known to introduce considerable temporo-spatial variability to the water column, subsequently affecting the propagation of acoustic waves. As a result, when internal waves are present, errors in model inputs can significantly degrade the accuracy of the predicted acoustic field. This work introduces a data-driven oceanographic model, named the evolutionary propagated thermistor string (EPTS) model, that captures the temporo-spatial evolution of the internal wave field along a fixed track, thereby permitting prediction of temporal fluctuations in the acoustic field.
Simultaneously-measured oceanographic and acoustic data from the Shallow Water 2006 experiment are utilized in this work. Thermistor measurements, recorded on four oceanographic moorings spaced along the continental shelf, provide the data from which the EPTS model constructs the internal wave field over a 30 km track. The acoustic data were acquired from propagation measurements over a co-located path between a moored source and a vertical line array. Acoustic quantities computed in the model space, such as received level and depth-integrated intensity are directly compared to measured acoustic quantities to evaluate the oceanographic model. It is found that the EPTS model possessed sufficient fidelity to permit the prediction of acoustic intensity distributions in the presence of nonlinear internal waves.

Fireground Acoustics

Friday, September 7, 2012 4:00 p.m. in ETC 4.150

Mustafa Z. Abbasi and Joelle I. Suits
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A trapped or injured firefighter in a burning building has a small window of time to escape safely. This seminar will present work underway to assist firefighters in these difficult situations using acoustics. Personal Alert Safety System (PASS) devices are currently used to signal the presence of a downed firefighter using an audible alarm. However, they do not always work effectively, and the nationally recognized standard for this technology allows for a range of signals. The purpose of this research is to establish a scientific basis for an optimized signal to be used throughout the U.S. fire service. The problem has been cast as a passive sonar problem, and historically, none of the terms used in the passive sonar equation for signal-to-noise ratio [SNR = SL − TL − (NL − RC)] has been scientifically studied for this application. Here, research on the PASS source level (SL), fireground background noise level (NL) and the effect of other personal safety equipment on the receiver characteristics (RC) are presented. A concurrent study seeks to understand the effects of fire, temperature gradients and smoke on transmission loss (TL) within burning structures. Results of experiments using laboratory-scale turbulent diffusion flames will be presented. Finally, a proof-of-concept active sonar navigation system is under development using a parametric acoustic source. Initial results on the detection of room boundaries through flames will be presented.

Hitting the High Notes: Integrative Biology of Acoustic Communication in Neotropical Singing Mice

Friday, September 21, 2012 4:00 p.m. in ETC 4.150

Dr. Bret Pasch
Section of Integrative Biology
The University of Texas at Austin
www.biosci.utexas.edu/ib

Many animals use long-distance acoustic signals to advertise their presence to a network of potential mates and competitors. A rich tradition of studies on acoustic communication in birds, anurans, and insects has provided important insights into disparate disciplines of biology through integration of proximate and ultimate levels of analysis. Here, we synthesize data on vocal ontogeny, hormonal control, and the adaptive function of Neotropical singing mouse (Scotinomys) vocalizations in an ecological context. Neotropical singing mice are diurnal insectivorous rodents that inhabit montane cloud forests throughout Central America. Adult males of two species commonly produce a rapid series of notes that sweep from ~ 43 to 14 kHz. I describe how vocalizations develop from pup isolation calls, how sex differences in singing arise during puberty and are modulated by androgens, and how vocalizations are used in mate attraction and male-male aggression. Between species, interspecific communication reflects underlying dominance interactions and contributes to competitive exclusion along altitudinal gradients. Accordingly, the auditory tuning of mouse brains differs between sympatric and allopatric populations to accommodate the ecological salience of song. Altogether, Neotropical singing mice are emerging as important species that permit comparisons to communication systems in traditionally more tractable taxa.

Fun with Musical Acoustics

Friday, September 28, 2012 4:00 p.m. in ETC 4.150

Dr. Thomas G. Muir
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Musical acoustics has fascinated the intellect of man since pre-historic time, when tunes were played on flutes made from feathers and of bone, as well as lyres made from yokes, turtle shell resonators, and gut strings. Some anecdotal comments are offered on the achievements of some great philosophers, scientists and engineers in the art of organology, the study of musical instruments, which include, for example, Pythagoras (550 BC), Galileo (1638), down through Wheatstone (1828), and many others. Recently, the availability of applications (apps) on smartphones, ipods, ipads, tablets and laptops has offered a wide assortment of very good tools for casual, and even professional use in musical acoustics. These apps include assets such as sound level meters, FFT and octave band analyzers, as well as signal generators and more, all offering opportunities unheard of by the masters, enabling the educated user to contribute to the art, which previously required laboratory facilities. Some examples of iPhone app results are given here through an experimental study of an American reed “pump” organ, recently restored by the author. These instruments, popular in the 19th and early 20th centuries, have long provided interesting pursuits involving their acquisition, restoration, history and musicology, as well as performance. Some acoustical curiosities of the author’s instrument are described, including mechanical design, means of sound production, reeds, reed spectra, stop types, and intonation. Recordings are played to demonstrate the tonal quality of the various stops and playing options, and video sound clips of professional artists playing restored instruments are presented.

Micromachined Microphones with In-Plane Directivity

Friday, October 5, 2012 4:00 p.m. in ETC 4.150

Michael Kuntzman
Department of Electrical and Computer Engineering
The University of Texas at Austin
http://www.ece.utexas.edu

Since being commercialized less than a decade ago, the microelectromechanical systems (MEMS) microphone market has seen dramatic growth, with 1 billion units shipped in 2011 and global shipments projected to reach 2.9 billion units in 2015. While low cost and robust, all current commercial MEMS microphones are omnidirectional. The signal-to-noise ratio (SNR) of MEMS microphones, while good enough for close-talking applications, is too poor to address advanced audio functionalities on the horizon. As a step towards realizing more innovative microphones that truly leverage unique design flexibility afforded by microfabrication, we will introduce piezoelectric microphones designed for in-plane figure-8 directivity. Topics will include description of the overall concept, microfabrication, and a presentation of directivity measurements on early proof-of-concept prototypes. A hybrid modeling method combining finite element analysis (FEA), modal analysis, and lumped element network modeling, which is capable of accounting for the dynamics of multiple vibration modes and multiple transduction ports, will be introduced.

Radiation Forces and Torques of Acoustic Beams

Friday, October 12, 2012 4:00 p.m. in ETC 4.150

Dr. Likun Zhang
Department of Physics and Center for Nonlinear Dynamics
The University of Texas at Austin
http://chaos.utexas.edu

Acoustic beams can exert radiation forces on objects, allowing, for example, manipulation of cells in suspension, assessment of viscoelastic properties of biological tissues, and targeted drug and gene delivery. The force is related to the interaction of the object with the acoustic field because of momentum transport associated with acoustic scattering and energy absorption. Acoustic beams can also carry orbital angular momentum such as the so-called acoustic vortex beams, which are characterized by a screw phase dislocation of the wave field around its propagation axis with a magnitude null at its core. When interacting with an object, the vortex field can transfer the angular momentum to the object, and hence exert torques on the object. The talk will present recent theoretical and experimental advances on negative radiation forces by non-diffracting beams, angular momentum transport of vortex beams, and associated radiation torques on objects. The realization of these beams and their fabrication will allow innovative applications especially for the manipulation of microparticles with acoustic beams of traveling waves, such as the concepts of acoustic tractor beams for pulling the particles or acoustic spanners for non-contact rotational manipulation.

Low Frequency *In Situ* Sediment Dispersion Estimates in the Presence of Discrete Layers and Gradients

Thursday, November 1, 2012 3:00 p.m. in ARL Auditorium

Dr. Charles W. Holland
Applied Research Laboratory
The Pennsylvania State University
http://www.arl.psu.edu

One of the difficulties in validating sediment models has been the lack of reliable low frequency dispersion measurements. A reflection method is presented that yields in situ dispersion without sediment disturbance over a broad range of frequencies and can explicitly disentangle frequency-dependent effects of vertical structure, e.g., layers and gradients. Measurements on the outer shelf from 300—3000 Hz show that dispersion is a strong function of depth in the sediment column. The depth and frequency-dependent results generally agree well with independent measurements on core data. Cohesive sediments in the upper few meters exhibit a nearly frequency-independent sound speed and a nearly linear frequency dependence of attenuation. In the lower part of the sediment column the sediments are more granular: the lowest layer exhibits an attenuation with a peak frequency at 1100 Hz, where its dependence below and above trends to f^2 and $\sqrt{f}$, respectively. While Biot theory predicts this dependence, its underlying physical explanation, fluid flow through interstitial pores, does not seem plausible for this sediment, due to the unreasonable permeability value required. Viscous Grain Shearing theory also predicts this dependence, but it is not known whether the parameter values are reasonable.

Topographic Effects in Earthquake Ground Motions: Insights Gained from Field Studies of Frequency and Predictable Mining Seismicity

November 9, 2012 4:00 p.m. in ETC 2.136

Professor Brady R. Cox
Department of Civil, Architectural and Environmental Engineering
The University of Texas at Austin
http://www.caee.utexas.edu/technical-areas/geotechnical-engineering.html

Topographic effects, in the context of earthquake engineering, refer to a commonly recognized phenomenon that causes amplification and frequency alteration in ground motions measured in the vicinity of atopographic feature (hillsides, ridges and canyons) relative to flat ground conditions. Although it is widely recognized that topographic amplification can elevate seismic hazard, there is currently no consensus on how to reliably quantify its effects. Lack of consensus has precluded development of acceptable guidelines on how to account for this phenomenon in practice, thus leaving an important factor contributing to seismic hazard unaccounted for in building codes. This presentation details experimental work from the first phase (Phase I) of a two-phase field study aimed at investigating topographic effects using frequent, shallow and predictable seismicity induced by underground longwall coal mining. A locally-dense array of ground motion instruments was used to capture over 50 seismic events on steep,

irregular topography above a coal mine in central-eastern Utah. Results from processing these ground motions indicate a regular pattern of amplification near the crest of a ridge of approximately 4 times the “base” ground motions within the frequency range of 1 – 2 Hz. The frequency range of topographic amplification is investigated relative to the shape of the 3D feature and its average shear wave velocity.

Modeling the Generation and Propagation of Radially-Polarized Shear Waves in Tissue-Like Media

Friday, November 30, 2012 4:00 p.m. in ETC 4.150

Kyle S. Spratt
Applied Research Laboratories and Department of Mechanical Engineering
The University of Texas at Austin
http://www.arlut.utexas.edu
http://www.me.utexas.edu

In the past decade there has been an increasing interest in the optics literature regarding the unique characteristics of focused, radially-polarized light beams. Of particular interest is the existence of a longitudinal component to the electric field in the focal region of the beam, of comparable amplitude to the radial component and yet with a smaller beamwidth [cf. Q. Zhan, Adv. Opt. Photon. 1, 1-57 (2009)]. In the linear approximation there exists a direct analogy between these light beams and radially-polarized shear wave beams in incompressible elastic media, and hence we may interpret the results found in the optics literature as applying to low-frequency shear waves propagating through tissue-like media. Unlike a plane shear wave, such a radially-polarized beam is predicted to generate a significant second harmonic when propagating nonlinearly through a tissue-like medium, and we present an analytic solution for the second harmonic generated by a focused, radially-polarized shear wave beam with Gaussian amplitude shading. Lastly we consider the possibility of generating radially-polarized beams in an elastic half-space using a piston source pushing on the bounding surface of the solid. Using an angular spectrum approach to model such a source, we demonstrate how the near-incompressibility of tissue-like media, and the Poisson effect that takes place directly below such a piston source, can be exploited to generate a radially-polarized shear wave beam.

Turbulence as a Source of Jet Noise

Thursday, December 6, 2012 3:30 p.m. in WRW 113

Professor Jonathan B. Freund
Department of Mechanical Science and Engineering
Department of Aerospace Engineering
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We will review the underlying theory for how turbulence makes sound and use that to motivate detailed simulation-based investigation of jet noise mechanisms. High-fidelity sub-sonic noise prediction is particularly elusive because the wavenumber-frequency makeup of the turbulence is such that it does not directly couple with propagating wave equation solutions. This will be illustrated with a model two-dimensional mixing layer, which is perturbed into a quiet state based upon an adjoint-based optimization procedure. The potential for extension of this approach to engineering applications is discussed, including preliminary examples. Higher-speed jet noise is, in a sense, simpler because in this case the turbulence directly couples with the sound. However, the radiation is so strong that its generation and propagation involves important nonlinearity, which complicates its description. Recent high-speed-flow simulations will show some of the key features of these mechanisms.

ETS-Lindgren Acoustic Research Laboratory and Factory Tour

Saturday, December 8, 2012 1:00 p.m. at ETS-Lindgren

Dr. Douglas F. Winker
ETS-Lindgren
1301 Arrow Point Drive
Cedar Park, Texas
http://www.ets-lindgren.com/Acoustics

In 2002, ETS-Lindgren acquired Acoustic Systems of Austin, Texas, and in doing so, expanded their test and measurement capabilities to include the Acoustic Systems Acoustical Research Facility on Saint Elmo Road in South Austin. The latter had existed to serve outside clients and as a research and development branch for Acoustic Systems for most of its 30-year history. In 2008, the acoustic testing facility in South Austin was closed and the existing ETS-Lindgren Test and Measurement facilities in Cedar Park were expanded to include new world-class acoustic test chambers. Testing equipment, procedures, software, and quality systems of the old laboratory were all upgraded and implemented at the new Acoustic Research Laboratory. Reaccreditation in all test methods was completed in October 2008. The facility includes several state-of-the-art chambers for acoustic test services, including a hemi-anechoic chamber and two reverberation chambers, impedance tubes and supporting acoustic test equipment and software. The laboratory offers product noise emission testing and structural/architectural acoustic testing. See one of the attachments to this announcement for technical information on the facilities.

The tour is expected to last approximately two hours. Meet at the entrance to ETS-Lindgren on the south side of the building at the address provided above. Preceding the tour, starting at 12:30 p.m., there will be an Amy's Ice Creams social sponsored by the Austin Student Chapter of the Acoustical Society of America. All are invited. If you need a ride, contact Mustafa Abbassi, who is organizing a carpool that will depart from the loading dock behind ETC at noon. Also contact Mustafa if you cannot get to ETC on Saturday and need to be picked up.