Practical Considerations for Active Noise Cancellation Systems

Friday, January 27, 2017
4:00 p.m. in ETC 4.150

Dr. Harold A. Cheyne
Cirrus Logic, Inc.
Austin, TX
www.cirrus.com

Modeling and designing a feedback or feedforward active noise cancellation (ANC) system using linear system theory has been standard practice for decades, but what impacts do real-world mechanical packaging, component substitutions, or manufacturing tolerances have on the performance of such systems? This talk will review simple models for feedback and feedforward ANC systems, then use those models to explore ways of gaining insight into specific practical considerations and their effects on the noise cancellation of the system.

Exploring the Modern Arctic

Friday, February 3, 2017
4:00 p.m. in ETC 4.150

Dr. Jason D. Sagers and **Dr. Megan S. Ballard**
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

The Arctic Ocean is experiencing profound changes in both ice coverage and ocean stratification. These changes can have significant implications for sound propagation and ambient noise generation in the region. These issues are relevant to the local undersea soundscape and to the operational needs of the U.S. Navy.

The Canadian Basin Acoustic Propagation Experiment (CANAPE) is a multi-institutional effort sponsored by the Office of Naval Research. Its focus is on characterizing acoustic propagation conditions in the modern Arctic environment over a one year period. The experiment is investigating various aspects of the acoustic environment, including spatial and temporal fluctuations of the acoustic field, the spatial and temporal distribution of ambient noise, the effects of ocean stratification and dynamic processes on underwater sound propagation, and the effect of attenuation and scattering from sea ice.

In the fall of 2016, a research team from the Applied Research Laboratory spent four weeks aboard the RV Sikuliaq deploying acoustic and environmental moorings on the Chukchi Shelf. Some initial acoustic and environmental measurements were acquired using ship deployed instruments. This presentation discusses conditions in the modern Arctic, the experimental objectives of CANAPE, and experiences and initial results of the deployment cruise.

Imaging Tissue Mechanical Properties Using MRI and Ultrasound

Monday, February 13, 2017
2:00 p.m. in ETC 3.112

Dr. Matthew D. J. McGarry
Department of Biomedical Engineering
Columbia University
http://orion.bme.columbia.edu/ueil

For centuries, physicians have exploited variations in tissue mechanical properties to detect disease through manual palpation. In fact, the first indication of diseases such as breast cancer is often a self-detected hard lump in the background of softer healthy tissue. Elastography is a quantitative imaging technique which can produce maps of the mechanical properties of tissue, enabling repeatable and precise spatially resolved measurements of a wide range of organs. A mechanical stimulus is applied to deform the tissue, and the resulting motions are measured using either motion-sensitized MRI or ultrasound cross-correlation. Extracting the underlying mechanical property maps requires selection of a mechanical model, which is used to solve an inverse problem through a non-linear inversion (NLI) approach. The inverse problem is often ill-conditioned – success depends on sufficient data quality, careful algorithm design and effective regularization. This talk focuses on development of accurate and robust elastographic inverse problem algorithms using biomechanical models such as viscoelasticity, poroelasticity, and 1D pulse wave propagation. In vivo applications in brain and arterial diseases are presented.

Receiver Biases in the Perception and Interpretation of Acoustic Communication Signals

Friday, February 17, 2017
4:00 p.m. in ETC 4.150

Professor Michael J. Ryan
Department of Integrative Biology
The University of Texas at Austin
and
Smithsonian Tropical Research Institute
Balboa, Panama
http://www.sbs.utexas.edu/ryan

An underlying assumption of neuroethology is that our sensory, perceptual, and cognitive systems have evolved under selection to give us an accurate representation of the world around us. This is especially true in animal communication, in which it is assumed that receivers have evolved to accurately extract the most information from communication signals. This assumption need not be true as the brain evolves to perform many tasks and its function cannot always be optimized for all domains. These issues are especially relevant to acoustically-guided mate choice, in which it is often assumed that receiver responses are optimized to choose the best mates. We know, however, that various sensory, perceptual, and cognitive biases also influence what “sounds good." I will review how peripheral auditory tuning, Weber’s Law, cocktail party effects, nonlinear interactions among auditory and visual modalities, and irrational choice all bias what choosers find attractive in the acoustic signals of their mates.

Non-Reciprocal Sound Propagation in Acoustic Metamaterials

Friday, March 3, 2017
4:00 p.m. in ETC 4.150

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

Metamaterials are artificial materials with properties well beyond what are offered by nature, providing unprecedented opportunities to tailor and enhance the interaction between waves with materials. In this talk, I will discuss our recent research activity in the area of acoustic metamaterials that can largely break reciprocity relying on external bias in the form of linear or angular momentum, and/or on nonlinearities. By spinning air in an acoustic cavity, it is possible to realize an acoustic circulator with applications for sonars and medical imaging devices. The non-relativistic Fresnel-Fizeau effect at the basis of these mechanisms can be boosted employing zero-index acoustic metamaterials, due to their large phase velocity. Arrays of these elements can provide exciting possibilities to mold sound transport, with analogies with the physics of topological insulators. In a different scenario, suitably designed asymmetric nonlinear resonators can realize isolation in passive systems. In this talk, I will describe these phenomena and provide physical insights on the operation of optimal devices based on these principles.

When Distinguishing Between Geoacoustic Sediment Models, are Sound Speed and Attenuation Enough?

Friday, March 10, 2017
4:00 p.m. in ETC 4.150

Anthony L. Bonomo
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

There exist many geoacoustic models used to study ocean sediments. Most of these models have been developed to ensure agreement with measured compressional sound speed and attenuation data. Is this agreement enough? This talk will seek to answer that question with respect to sandy sediments and explore the additional ways the physical validity of geoacoustic models can be vetted. In particular, the impact of shear waves and how reflection and scattering measurements can be used to further vet these models will be discussed.

CAT: High-Precision Acoustic Motion Tracking

Friday, March 24, 2017
4:00 p.m. in ETC 4.150

Wenguang Mao
Department of Computer Science
The University of Texas at Austin
http://www.cs.utexas.edu

Video games, Virtual Reality (VR), Augmented Reality (AR), and Smart appliances (e.g., smart TVs) all call for new ways for users to interact and control them. We have developed a high-preCision Acoustic Tracker (CAT), which aims to replace a traditional mouse and let users play games, interact with VR/AR headsets, and control smart appliances by moving a smartphone. Achieving high tracking accuracy is essential to providing an enjoyable user experience. To this end, we have developed a novel system that uses audio signals to achieve mm-level tracking accuracy. This system allows multiple speakers to transmit inaudible sounds at different frequencies. Based on the received sound, this system continuously estimates the distance and velocity of the mobile phone with respect to the speakers in order to continuously track it. At its heart lies a distributed Frequency Modulated Continuous Waveform (FMCW) that can accurately estimate the absolute distance between a transmitter and a receiver that are separate and unsynchronized. We have further developed an optimization framework to combine FMCW estimation with Doppler shifts and Inertial Measurement Unit (IMU) measurements to enhance the accuracy, efficiently solving the optimization problem. We have successfully implemented our system on a mobile phone. Our evaluation and user study show that our system achieves a high tracking accuracy and ease of use using existing hardware.

Homogenization and Modeling of Nonlinear Acoustic Metamaterials Containing Hyperelastic Inclusions

Friday, April 7, 2017
4:00 p.m. in ETC 4.150

Stephanie G. Konarski
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

Metamaterials are composite materials whose behavior originates from engineered sub-wavelength structures rather than from the inherent properties of its constituents. With metamaterials, it is possible to achieve effective material properties which are unattainable with conventional materials, such as negative stiffness and negative density. In order to study this effective behavior and how these properties impact other phenomena of interest, such as wave propagation, homogenization techniques are necessary. But what is homogenization? A brief introduction to homogenization with respect to linear elasticity and acoustics is first presented. Then, an overview of acoustic metamaterials with emphasis on static elements displaying structural negative stiffness due to mechanical instabilities is discussed. Finally, an augmented homogenization method that accounts for nonlinearity on micro- and macroscopic scales is presented. This homogenization method demonstrates that quadratic and cubic nonlinearity exists on the

macroscale for an effective medium consisting of a continuous background material containing hyperelastic inclusions.

Insight into the Origin and Early Evolution of a Novel Vocal Organ in Birds

Friday, April 14, 2017
4:00 p.m. in ETC 4.150

Professor Julia A. Clarke
Department of Geological Sciences
The University of Texas at Austin
https://www.jsg.utexas.edu

From complex songs to simple honks, birds produce sounds using a unique vocal organ called the syrinx. Located close to the heart at the tracheobronchial junction, vocal folds or membranes attached to modified mineralized rings vibrate to produce sound. Syringeal components were not thought to commonly enter the fossil record and the few reported fossilized parts of the syrinx are geologically young. Data on the relationship between soft tissue structures and syringeal three-dimensional geometry are also exceptionally limited. We described the first remains, to our knowledge, of a fossil syrinx from the Mesozoic Era, which are preserved in three dimensions in a specimen from the Late Cretaceous (approximately 66 to 69 million years ago) of Antarctica. Enhanced-contrast X-ray computed tomography (CT) of syrinx structure in twelve extant non-passerine birds, as well as CT imaging of the Vegavis and Eocene syrinxes, informs both the reconstruction of ancestral states in birds and properties of the vocal organ in the extinct species. The lack of other Mesozoic tracheobronchial remains, and the poorly mineralized condition in archosaurian taxa without a syrinx, may indicate that a complex syrinx was a late arising feature in the evolution of birds, well after the origin of flight and respiratory innovations.

Use of Compression and Shear Waves to Evaluate Methods of Inhibiting Earthquake-Induced Soil Liquefaction

Friday, April 21, 2017
4:00 p.m. in ETC 4.150

Julia N. Roberts
Department of Civil, Architectural and Environmental Engineering
The University of Texas at Austin
http://www.caee.utexas.edu

The 2010-2011 Canterbury Earthquake Sequence in the Christchurch, New Zealand, region is responsible for 185 fatalities and an economic loss of NZ$40 billion (approximately 20% of New Zealand's GDP). An estimated one-third of the damage to infrastructure was caused by soil liquefaction, a phenomenon in which loose, saturated soils experience a total loss of shear strength and behave more like a liquid than a solid. To rebuild a resilient city that can withstand future earthquakes, the New Zealand Earthquake Commission (EQC) funded an extensive program of full-scale field trials to evaluate the efficacy of various ground improvement methods intended to inhibit the triggering of soil liquefaction under residential structures and low-rise buildings; these ground improvement methods included: (1) Rapid Impact Compaction, (2) Rammed Aggregate PiersTM, and (3) Low-Mobility Grout Columns.

Custom-built equipment and unique testing techniques were used to measure compression and shear waves in situ for the purpose of evaluating the soil's baseline susceptibility

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Bianisotropy in Passive Acoustic Metamaterials

Wednesday, April 26, 2017
3:30 p.m. in ETC 7.111

Caleb F. Sieck
Department of Electrical and Computer Engineering
The University of Texas at Austin
http://www.ece.utexas.edu

Metamaterials are composite materials whose dynamic microstructure results in macroscopically observable properties beyond those available in nature. The emergence of metamaterials has enabled unprecedented control of electromagnetic, elastodynamic, and acoustic wave propagation and has led to technologies including invisibility cloaks, super- and hyper-lenses, and subwavelength bandgaps. These effects are made possible through the hidden degrees of freedom afforded by the dynamic microstructure. Analytically, the macroscopically observed parameters are the result of a dynamic homogenization procedure. Recent research has demonstrated that dynamic homogenization results in constitutive relations that are coupled, which is not the case for most traditional materials. This effect, referred to as bianisotropy, is well-known in electromagnetism. However, the analogous effect in elastodynamics and acoustics, often referred to as Willis coupling, was demonstrated rather recently. This talk explores the analogs between bianisotropy in electromagnetism, elastodynamics, and acoustics and the consequences of neglecting these effects on the physical interpretation of acoustic metamaterial (AMM) parameters. The analogs provide a qualitative understanding of the origins of bianisotropy in AMMs, and a source-driven, multiple scattering homogenization procedure explicitly relates bianisotropy to microstructure asymmetries and nonlocal effects. Additionally, it is demonstrated that neglecting bianisotropy in one-dimensional AMMs may result in parameters that do not satisfy restrictions based on passivity, reciprocity, and causality.

Analytical and Computational Modeling of Mechanical Waves in Microscale Granular Crystals: Nonlinearity and Rotational Dynamics

Thursday, April 27, 2017
9:00 a.m. in ARL S103

Samuel P. Wallen
Department of Mechanical Engineering
The University of Washington
https://www.me.washington.edu

Granular crystals, which are ordered arrays of spherical particles in contact, have been shown to exhibit rich nonlinear dynamics stemming from contact forces and hold promise as a class of mechanical wave-tailoring media. In recent years, advances in self-assembly fabrication methods and laser ultrasonic experimental characterization have enabled the study of granular crystals composed of microscale particles. Initial studies have revealed differences between microscale granular crystals and their

macroscale counterparts; in particular, short-range adhesive forces between particles, which are negligible at macroscale, are several orders of magnitude stronger than gravity at microscale. In this talk, recent advances in analytical and computational modeling of microscale granular crystals will be presented, in particular concerning the interplay of nonlinearity, shear interactions, and particle rotations. Problems involving locally-resonant metamaterials, nonlinear localized modes, amplitude-dependent energy partition, and other dynamical phenomena will be explored. This work enhances our understanding of microscale granular media, which may find applicability in ultrasonic wave tailoring, signal processing, shock and vibration mitigation, powder processing, and other fields.

Listening to the Reef: Will It Help a Larval Fish Find Its Way?

Friday, April 28, 2017
4:00 p.m. in ETC 4.150

Andria K. Salas
Department of Integrative Biology
The University of Texas at Austin
https://integrativebio.utexas.edu

The combined acoustic behavior of soniferous organisms living on coral reefs produces a soundscape that is predicted to have a role in the settlement behavior of fish larvae. However, the distance at which acoustic cues may operate to influence navigation and habitat selection is unclear given the temporal and spatial variation in reef soundscapes, complexities of shallow water sound propagation, and uncertainties about the hearing abilities of larval fishes. We recorded the soundscapes of four coral reefs in Caribbean Panama for six weeks and predicted the sounds most likely to be used as cues by larval fishes by using knowledge of their hearing sensitivity. Using an individual-based model, we tested the relationship between the temporal characteristics of the acoustic cues and settlement success. We found that even short range, temporally variable cues produced at a low rate improved settlement success, suggesting these cues may improve the probability of survival under a broader range of conditions than has been typically considered. We are also investigating the role of the swim bladder in pressure detection by fishes, which will influence the distance to which these cues operate and thereby their potential ecological impact on fish populations.

Dolphin Sonar

Friday, September 8, 2017
4:00 p.m. in ETC 4.150

Dr. Thomas G. Muir
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

The remarkable behavior of dolphins, members of the Odontoceti (small-toothed whales), is known to have puzzled man since the early days of recorded history. Their ultrasonic echolocation capability is amazing and is continually being researched, but it is not yet fully understood. This talk briefly reviews the dolphin family, their acoustic physiology, and the history of research on their acoustic capabilities,

including hearing and ultrasound generation, and the previously known characteristics of their sonar. The author and his colleagues' experiments on the bottlenose dolphin (Tursiops truncatus) are also discussed, including the discovery of previously unknown ultra-high ultrasonic frequency components in their echolocation signals. Measurements were made on the time waveforms and frequency spectra of dolphin sonar transmissions, as well as their angular response in terms of beam patterns, as the difficulty of detection tasks were increased, for both stationary and free-swimming subjects. It was found that the animals increased their sonar transmit levels, their pulse repetition frequency, and high-frequency content of their transmitted signals, which were contained in increasingly narrow sonar beams. The results showed that the test subjects changed their sonar parameters toward higher-resolution capability, far beyond what has previously been reported, when the difficulty of target detection was increased.

Strategic Deterrence, Submarines, and Sonar

Friday, September 15, 2017
4:00 p.m. in ETC 4.150

Dr. F. Michael Pestorius
Former Executive Director
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

This talk will initially focus on the role played by the University of Texas Applied Research Laboratories in submarine sonar development. The talk will then consider the three legs of the US strategic nuclear triad with a brief overview of the three legs and nuclear release procedures. We will then consider the development of nuclear submarine technology and the US ballistic missile submarine force. The talk will track the development of US nuclear submarines and to a lesser extent the development of British, French, Russian and Chinese nuclear submarine forces.

What are Otoacoustic Emissions and Do They Help with Everyday Listening?

Friday, September 22, 2017
4:00 p.m. in ETC 2.136

Professor Dennis McFadden
Department of Psychology
The University of Texas at Austin
http://liberalarts.utexas.edu/psychology/index.php

Most normal-hearing ears make sounds, known as otoacoustic emissions (OAEs). Several common forms of OAEs will be described. There are large individual differences in the strength of these sounds from the cochlea, but they average in the vicinity of about 5–15 dB SPL. While much has been learned about OAEs since their discovery 40 years ago, it still is not clear whether having strong OAEs helps a person with the various challenges of everyday listening. A large-scale study was conducted to answer that question. Performance was measured on several common psychoacoustical tasks for about 70 subjects. Subjects were tested behaviorally in same-sex crews of 6–8 members, and behavioral testing required from 8–10 weeks for each crew. The tasks included several types of simultaneous and temporal

masking. Also measured were spontaneous OAEs, click-evoked OAEs, and distortion-product OAEs. Of interest were the correlations between psychoacoustical performance and the various OAE measures – i.e., do OAEs covary with behavioral performance? During data analysis, it became clear that some outcomes were affected by race/ethnicity, so analyses for that variable also were conducted. The correlations between OAE measures were moderately high as expected, but unexpectedly, the correlations between psychoacoustical tasks and the different OAE measures generally were low. That is, the individual differences observed in psychoacoustical performance generally were only weakly related to the individual differences in the various OAE measures. For these subjects, at least, psychoacoustical performance seemed unrelated to the mechanisms underlying OAEs.

Teaching Musical Acoustics to Students with Diverse Backgrounds

Friday, September 29, 2017
4:00 p.m. in ETC 2.136

Dr. James M. Gelb
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

In spring 2015 I introduced an undergraduate course in musical acoustics in the Mechanical Engineering Department designed for non-technical students. This course was taught again in spring 2017, and it was cross-listed in the new undergraduate Arts and Entertainment Technologies (AET) major that was created in the College of Fine Arts to meet the increasing demands of electronic arts. Current plans are to continue offering the course every other spring semester. My last Acoustics Seminar, in fall 2014, reviewed my original plans for how to teach such a course. In the present seminar I will begin by covering general concepts in musical acoustics and then provide insights into teaching technical material to students with a wide range of backgrounds, as the course has been populated by a mix of non-technical and technical students. The course focuses on traditional acoustics with the theme of teaching the science of sound, treating instruments as filters, and providing an intuition for the physical and mathematical aspects of harmonics. Throughout the seminar I will comment on methods of teaching technical material to non-technical students while still engaging technical students. The talk explains the physical generation of approximate pure and complex tones produced by actual instruments. Theories of consonance are presented including modern refinements due to critical bands. This in turn is used to explain the non-uniform spacing of notes in the ubiquitous pentatonic and diatonic scales.

Arctic Coke™ Acoustics

Friday, October 6, 2017
4:00 p.m. in ETC 4.150

David A. Nelson, P.E.
Nelson Acoustics
Elgin, Texas
www.nelsonacoustical.com

Yes, you read that correctly. This seminar is about something called "Arctic Coke™". And yes, it has to do with acoustics. The Coca-Cola Company is just bringing to market a method to turn Coke™ into slush right there in the bottle at the point of purchase. It turns out that a super-cooled fluid can be induced to nucleate by applying ultrasound at sufficient amplitudes. This otherwise straightforward exercise in sonochemistry becomes challenging when considering the variety of products and packaging involved. The seminar will cover the basics of bubble dynamics, cavitation, and ultrasound projection as they relate to this unique practical application.

Acoustic Scattering from Partially Exposed Elastic Targets at a Flat Interface

Friday, October 13, 2017
4:00 p.m. in ETC 4.150

Dr. Aaron M. Gunderson
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

The use of conventional sonar systems to study underwater targets of interest is complicated by scattering from the targets' environment. Objects may be resting on or buried within the seafloor, which adds acoustical scattering paths and blocks, obscures, or redirects others. Models such as the partial wave series, ray theory, and the Kirchhoff approximation each have their own strengths and limitations, but together allow the scattering from partially exposed elastic spheres and cylinders to be analyzed over a range of grazing angles and target exposure levels. Results from these models are presented in both the time and frequency domains, and are compared to experimentally determined scattering records from the same elastic targets at an air-water and a sand-water interface. The amplitude, timing, and frequency content of the various scattering paths and their interference patterns can be shown to be strongly, but predictably, dependent on the level of target exposure through the interface. Gradual transitions in the scattering are associated with the covering/uncovering of path coupling points and changes in path lengths as the exposure level is altered.

Mechanical Waves in Microscale Granular Crystals: Nonlinearity and Rotational Dynamics

Friday, October 20, 2017
4:00 p.m. in ETC 4.150

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

Granular crystals, which are ordered arrays of spherical particles in contact, have been shown to exhibit rich nonlinear dynamics stemming from contact forces and hold promise as a class of mechanical wave-tailoring media. In recent years, advances in self-assembly fabrication methods and laser ultrasonic experimental characterization have enabled the study of granular crystals composed of microscale particles. Initial studies have revealed differences between microscale granular crystals and their macroscale counterparts; in particular, short-range adhesive forces between particles, which are negligible at macroscale, are several orders of magnitude stronger than gravity at microscale. In this talk, recent advances in analytical and computational modeling of microscale granular crystals will be presented, in particular concerning the interplay of nonlinearity, shear interactions, and particle rotations. Problems involving locally-resonant metamaterials, nonlinear localized modes, amplitude-dependent energy partition, and other dynamical phenomena will be explored, and recent experimental results will be summarized. This work enhances our understanding of microscale granular media, which may find applicability in ultrasonic wave tailoring, signal processing, shock and vibration mitigation, powder processing, and other fields.

Portable Infrasound Source

Friday, October 27, 2017
4:00 p.m. in ETC 4.150

Dr. Martin L. Barlett
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

Applied Research Laboratories has developed a unique trailer-mounted infrasound source based on a pneumatic siren principle. The source produces a tone-like burst that is comprised of a fundamental tone and a series of harmonics and has been demonstrated to produce tones of less than 0.25 Hz (a wavelength of almost a mile) at useful levels. In this talk, the development and acoustic characterization of the source will be reviewed, and an application of the source to assess the calibrations and health of an operational infrasound sensor system described. The interplay between the source signal characteristics and the signal processing methods applied for this application will be described to highlight both the limitations and some of the unique capabilities of the ARL infrasound source.

Understanding Auditory Cortical Computation

Monday, October 30, 2017
12:00 p.m. in SEAY 4.244

Professor Josh H. McDermott
Department of Brain and Cognitive Sciences
Massachusetts Institute of Technology
http://mcdermottlab.mit.edu

Just by listening, humans can determine who is talking to them, whether a window in their house is open or shut, or what their child dropped on the floor in the next room. This ability to derive information from sound is enabled by a cascade of neuronal processing stages that transform the sound waveform entering the ear into cortical representations that are presumed to make behaviorally important sound properties explicit. Although much is known about the peripheral processing of sound, the auditory cortex is less understood, particularly in humans, with little consensus even about its coarse-scale organization. This talk will describe our recent efforts to develop and test models of auditory cortical computation, to delineate function within auditory cortex, and to understand the role of the cortex in robust sound recognition.

Projects and Perspectives of an Acoustics Entrepreneur

Friday, November 3, 2017
4:00 p.m. in ETC 4.150

Jeff G. Schmitt, P.E.
ViAcoustics
Austin, Texas
http://www.viacoustics.com

Since graduating with an engineering degree in acoustics from UT Austin in 1983, the speaker has been a practicing acoustics entrepreneur for almost 35 years, operating small businesses that provide products and services to a wide variety of customers and applications in acoustics. His current business, ViAcoustics, develops software and systems for measurement of acoustic emissions of products and equipment, and acoustic properties of materials and devices. This presentation will provide an overview of some of his most recent and interesting projects. The overviews will include projects related to noise emissions near threshold of hearing from LED light bulbs, peak sound levels from weapons with sound suppression devices, measurement of effectiveness of hearing protection systems, analysis of alarm signals from medical devices, and determination of hearing thresholds in the US population as part of the National Health and Nutrition Examination Survey. The challenges and lessons learned while operating small businesses that focus on acoustics will be discussed.

Shock Formation in Plane Acoustic Waves

Friday, November 10, 2017
4:00 p.m. in ETC 4.150

John M. Cormack
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

Propagation of a plane nonlinear sound wave in a lossless fluid baffled early investigators because solutions to the exact equations of motion inevitably predict locations in the field where the waveform overturns, becoming multivalued. The incorporation in the model equations of mechanisms for energy loss such as viscosity balances nonlinear effects and prevents waveform overturning, instead leading to the formation of thin “shocks” in the waveform. However, not all models for energy loss (e.g., relaxation or power-law attenuation) share viscosity's ability to always prevent waveform overturning from occurring. This seminar opens with a historical review of early modeling of shock formation and propagation, highlighting dilemmas faced by early investigators. Waveform overturning in complex media is then investigated by considering nonlinear propagation in a relaxing fluid and in a fluid that exhibits power-law attenuation. Numerical simulation of multivalued waveforms is made possible by transforming the model equations into an intrinsic coordinate system. Conditions for which waveform overturning occurs are determined for an initially sinusoidal waveform.

Tunable, Nonlinear Acoustic Metamaterials with Structural Instabilities

Wednesday, November 15, 2017
3:00 p.m. in ETC 3.108

Stephanie G. Konarski
Department of Mechanical Engineering
The University of Texas at Austin

This dissertation studies the fundamental behavior associated with a class of nonlinear acoustic metamaterials that derive their material properties from a random distribution of non-interacting hyperelastic inclusions with designed mechanical instabilities embedded in a nearly incompressible viscoelastic matrix material. A metamaterial is an effective element whose behavior originates due to the subwavelength structure and not the inherent mechanical properties of the constituents. Metamaterials can attain behavior, such as negative stiffness, that is unattainable with conventional materials. Often metamaterials utilize resonance phenomena and periodicity of unit cells to achieve the desired response; however, the present work focuses on negative stiffness induced via nonlinear structural elements with engineered instabilities. These instabilities induce a local stiffness that varies as a function of an applied pre-strain. Since acoustic phenomena of interest, such as harmonic generation or energy dissipation, are often on the macroscale, homogenization methods to define the macroscopic heterogeneous medium are necessary.

The intent of this work is thus twofold. First, modeling techniques for the quasi-static and dynamic response of the micro- and macroscale are required. The dynamic behavior captured by a generalized Rayleigh-Plesset equation is developed to study the dispersive and frequency-dependent properties of

the heterogeneous medium, such as phase speed, attenuation, and parameters of acoustic nonlinearity. In the low-frequency limit, the resulting constitutive relationship allows the subresonant dynamics to be explored via a coupled multiscale model to predict energy dissipation due to the inclusion oscillations and nonlinearity via harmonic generation. To properly model the quasi-static behavior, an augmented Hashin-Shtrikman method that accounts for material and geometric nonlinearity up to cubic order is also developed to obtain effective material properties of the macroscopic heterogeneous medium. Agreement between the two quasi-static effective medium constitutive relationships would suggest the resulting behavior properly captures the systems of interest. The models of interest are explored for one example inclusion design for the class of acoustic metamaterials of interest. The resulting material response on both the micro- and macroscales are obtained as a function of deformation, which offers the ability to tune and tailor the macroscopic response to achieve a desired result.

Transformation Acoustics, Phononic Structures and Applications

Thursday, November 16, 2017
11:00 a.m. to 12:30 p.m. in NOA 1.102

Professor Andrew N. Norris
Department of Mechanical and Aerospace Engineering
Rutgers University
http://mae.rutgers.edu/andrew-norris

Transformation acoustics (TA) offers the acoustical designer the potential to alter sound propagation in an exact manner that satisfies the wave equation regardless of frequency, high or low. This is the reason why TA is the foundation for exotic effects such as acoustic cloaking, which requires material properties that are anisotropic and difficult to realize in practice. This talk will concentrate on the special case of isotropic TA and its applications. The motivation for focusing on isotropic TA is that materials with the required properties can be realized by a wide variety of homogenized structures. We concentrate on underwater acoustic devices and show that quasi-phononic structures with unit cells comprising circular, square and other shaped cylinders in water provide the range of required properties. Implications are explored, including the ability of conformal mappings to yield highly accurate focusing lenses. A class of focusing devices is described that are optimally matched in both impedance and focusing. Numerical examples and data from experimental measurements will demonstrate these ideas.

The Life and Work of Lord Rayleigh

Friday, November 17, 2017
4:00 p.m. in ETC 4.150

Dr. Kyle S. Spratt
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

John William Strutt (1842-1919), better known by the title Lord Rayleigh, made significant contributions to practically every branch of physics in the latter half of the nineteenth century. Throughout his illustrious career he served as president of the Royal Society, received the Nobel Prize for Physics in 1904, and

eventually became chancellor of the University of Cambridge, among many other notable achievements. His 1877 book The Theory of Sound, which he began writing in Egypt while traveling down the River Nile on a houseboat, is widely regarded as the greatest book on physical acoustics ever written. This talk will give an overview of Rayleigh's life, while highlighting a few of his many contributions to the field of acoustics.

Doctoral Dissertation Defense

An Evaluation of Competing Geoacoustic Models and Their Applicability to Sandy Ocean Sediments

Tuesday, November 28, 2017
2:00 p.m. in ETC 9.130

Anthony L. Bonomo
Department of Mechanical Engineering
The University of Texas at Austin

This dissertation studies five models that make up a cross section of the geoacoustic models that have been used to study sandy sediments: a simple fluid model, the effective density fluid model (EDFM) of Williams, the viscous grain-shearing [VGS(λ)] model of Buckingham, the Biot-Stoll model, and the corrected and reparameterized extended Biot (CREB) model of Chotiros. The first objective is to use numerical experiments and model/data comparisons to determine the usefulness and assess the physical validity of these five models. The second objective is ascertain the current state of knowledge of sandy sediments and describe what physical truths can be learned from model/data comparisons. To complete these objectives, the models' predictions of geoacoustic quantities such as wave speeds, attenuations, and bottom loss are compared with published measurements and to each other through Bayesian inference and computational studies. It is determined that while each model has its uses, no one model can fully capture the wave physics of sandy sediments.

Photoacoustic Computed Tomography in Heterogeneous Acoustic Media: Status and Open Challenges

Thursday, December 7, 2017, 1:00 p.m. in POB 6.134

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Photoacoustic computed tomography (PACT) is an emerging soft-tissue imaging modality that has great potential for a wide range of preclinical and clinical imaging applications. It can be viewed as a hybrid imaging modality in the sense that it utilizes an optical contrast mechanism combined with ultrasonic detection principles, thereby combining the advantages of optical and ultrasonic imaging while circumventing their primary limitations. In this talk, we review our recent advancements in image reconstruction approaches for PACT in acoustically heterogeneous media. Such advancements include physics-based models of the measurement process for both fluid and elastic media and associated optimization-based inversion methods. Applications of PACT to transcranial brain imaging will be presented. Open challenges related to the joint reconstruction of optical and acoustic parameters in PACT will also be presented.