Acoustic Scattering from Ocean Sediment Surfaces
NONLINEAR DYNAMICS SEMINAR

Monday, 25 January 2016, 1:00 p.m. RLM 11.204

Dr. Marcia Isakson
Applied Research Laboratories
The University of Texas at Austin
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Visible light scatters from molecules in the atmosphere, giving the sky its blue color. Subatomic molecules can scatter from each other in particle accelerators. Here we examine acoustic scattering from the bottom of the ocean, particularly from rough terrain. Different measurement methods and models will be introduced and applied to some canonical surfaces.

Acoustics of Fine-Grained Marine Sediments

Friday, January 29 2016, 4:00 p.m. in ETC 4.150

Dr. Megan S. Ballard and Dr. Kevin M. Lee
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While the acoustics of granular marine sediment has been extensively studied, less attention has been paid to the physics of acoustic propagation in fine-grained muddy sediment. Our research seeks to investigate the acoustics of fine-grained sediment through a combination of laboratory and field measurements. A sampling of this work will be presented.

Laboratory experiments were undertaken to develop an understanding of the relationship between microscopic properties (e.g., flocculent structure) and macroscopic acoustic properties of muddy sediment. Measurements of compressional and shear waves were performed in reconstituted mud formed from kaolinite and water. A suite of additional measurements was also performed to characterize the physical properties of the model sediment. These material parameters were used as inputs to various sediment acoustic propagation models including card-house theory and viscous grain-shearing theory for comparison with the acoustic measurements.

In another experiment, in situ measurements of compressional and shear wave speed and attenuation were collected below the water-sediment interface in Currituck Sound, North Carolina. Two measurement locations characterized by fine-grained sand with different concentrations of mud were investigated. At each site, grab samples were collected and later analyzed in the laboratory to quantify physical properties of the sediment, and acoustic measurements were performed in situ using a custom-built apparatus. Wave properties were extracted from the acoustic measurements and compared to predictions from two models originally intended for describing sandy sediment: the extended Biot model and viscous grain-shearing theory.

Approach for Designing Broadband Transducer Systems and Evaluation of Various Cylindrical Transducer Technologies

Wednesday, February 10 2016, 1:30 p.m. in ARL Conference Room 1

Dr. Corey Bachand
BTech Acoustics LLC
Barrington, Rhode Island
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Underwater transducers for broadband communication rely on effective tuning and matching to a power amplifier for maximum signal bandwidth and efficiency. This analysis follows a systematic approach to design an efficient and effective broadband acoustic transmit system. Power switching (Class D) amplifiers use a variety of modulation schemes to reduce the losses incurred at the high power amplification stage. Filtering, impedance matching, and tuning are essential for efficient, high power delivery to the transducer over a broad frequency range. There are a wide variety of transduction technologies to suit the performance and cost criteria of a given application. Several cylindrical transducer designs having the different transduction elements yet the same form factor are evaluated. Construction of an equivalent electrical circuit of the fluid-loaded transducer permits full system characterization to be performed in the convenience of a laboratory on the benchtop.

Visualizing Noise Sources in an Aero-Acoustic Wind Tunnel with Real-Time Acoustic Beamformers

Friday, February 12 2016, 4:00 p.m. in ETC 4.15

Kurt Veggeberg
Business Development Manager, Test Cell Applications
National Instruments
Austin, Texas
http://www.ni.com

The Hyundai Aero-acoustic Wind Tunnel (HAWT) is a ¾ semi-open jet test section with a closed circuit that was designed to improve aerodynamic and wind noise characteristics of vehicles. The $40 Million facility was recently upgraded for visualizing wind noise. This is a part of a campaign by Hyundai to improve their quality which is paying off in improved J.D. Power rankings. Three 96 channel sound cameras were used for making measurements simultaneous from the side and overhead. An additional array was placed on the turntable to facilitate measurements underneath the vehicle being tested. In addition a portable as well as panoramic sound camera system was developed for use in visualizing noise sources in the car interior. This presentation will include a live demonstration of the SeeSV Sound Camera used for making the interior cabin noise measurements along with samples of a variety of tests of real world applications.

Acoustic Monitoring of Femtosecond Laser Ablation

Friday, February 19 2016, 4:00 p.m. in ETC 4.150

Kenneth Ledford
The Graduate Program in Acoustics
The Pennsylvania State University
http://www.acs.psu.edu

Acoustic measurement methods can often be used as an inexpensive and robust data collection tool. One such case is using acoustic data to better understand some various nonlinear behaviors of high intensity femtosecond laser pulses. Using acoustic measurements of plasma formation from surface ablation, various nonlinear optical effects can be studied, including plasma filament formation and the Kerr focusing effect. Theory, experimental setup and data collected will be discussed.

Contributions of the Harvard Underwater Sound Lab to the Development of Underwater Acoustics

Friday, March 4 2016, 4:00 p.m. in ETC 4.150

Dr. F. Michael Pestorius
Former Director
Applied Research Laboratories
The University of Texas at Austin
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The Harvard Underwater Sound laboratory, or HUSL as it was known, was founded in June 1941 under the auspices of the year-old National Defense Research Council. It existed throughout World War II and formally closed on January 31, 1946. HUSL was directed throughout its existence by Prof. Frederick V. Hunt. This presentation traces several of the seminal contributions that HUSL made to undersea warfare through exploitation of underwater acoustics. Chief among these contributions was HUSL's work in sonar and ordnance development. Both the sonar and torpedo projects were supported by numerous subprojects on a wide range of applications that sound familiar today such as reverberation suppression, Doppler enhancement and torpedo transducer design. Particular attention in this presentation is given to work on air-dropped and submarine launched acoustic homing torpedoes. HUSL's far-reaching influence continues to be evident in sonar and torpedo systems in use today. This presentation also honors the contributions of living HUSL alumnus, Prof. Wilson Nolle, who came to HUSL from the University of Texas and worked there throughout the war.

Structural Health Monitoring of Civil Infrastructure Systems by Using Guided Ultrasonic Waves

Friday, March 11 2016, 4:00 p.m. in ETC 4.150

Professor Salvatore Salamone
Department of Civil, Architectural, and Environmental Engineering
The University of Texas at Austin
http://caee.utexas.edu

The increase in traffic volume and loads applied to aging and deteriorating infrastructure systems, and the desire to reduce downtime associated with regular maintenance operations have all sparked interest and research into structural health monitoring (SHM) methods. Such research is fueled by the evolution of the maintenance paradigm from “time-based” to “condition-based”, which implies that a sensing and processing system, integrated with the structure, notifies the operator in real-time that degradation is occurring. While a wide variety of SHM methods have been proposed, in this presentation recent developments in state-of-the-art ultrasonic wave-based methods will be presented. The advantages of these methods include: (1) the use of low profile sensors that can be permanently attached to the structure to perform real-time monitoring and routine inspection with the same sensing system, (2) the ability to probe a large area of the structure, locating damage from only a few monitoring points and (3) the capability to detect both active cracks and pre-existing cracks by toggling between the modes of “passive” acoustic emission testing and “active” ultrasonic testing. The presentation will discuss research issues and challenges, along with some examples of research being undertaken in the Smart Structures Research Group at UT.

Airborne Capacitive Micromachined Ultrasonic Transducer Cell Design

Friday, March 25 2016, 4:00 p.m. in ETC 4.150

Dr. Asli Yilmaz
Electrical Engineering Department
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All transducers used in airborne ultrasonic applications, including capacitive micromachined ultrasonic transducers (CMUTs), incorporate loss mechanisms to increase the frequency bandwidth. However, CMUTs can yield high efficiency in airborne applications and unlike other technologies, they offer increased bandwidth due to their low characteristic impedance, even for efficient designs. Despite these advantages, achieving the full potential is challenging due to the lack of a systematic method for design. In this presentation, a method for airborne CMUT design will be explained. A lumped element circuit model and a harmonic balance (HB) approach to optimize CMUTs for maximum transmitted power is proposed. Airborne CMUTs have a narrowband characteristic behavior mechanically, due to low radiation impedance. In this presentation, the analysis is restricted to a single frequency and the transducer is

driven by a sinusoidal voltage with half of the frequency of operation frequency, without any dc bias. A new mode of airborne operation for CMUTs is proposed, where the plate motion spans the entire gap. This maximum swing is achieved at a specific frequency applying the lowest drive voltage and this mode of operation is called Minimum Voltage Drive Mode (MVDM). An equivalent circuit-based design for airborne CMUT cells is presented and verified by the testing of fabricated CMUTs. The performance limits for silicon membranes for airborne applications are derived. Experimental results show that 78.9 dB re 20 μPa @ 1 m source level at 73.7 kHz is obtained, with a CMUT cell of radius 2.05 mm driven by 71 V sinusoidal drive voltage at half the frequency. The measured quality factor is 120.

Computing Sound Location in the Brain

Friday, April 8 2016, 4:00 p.m. in ETC 4.150

Professor Nace Golding
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One of the most challenging computations in the brain is that of computing sound location. Horizontal sound location is computed by detecting small time differences (so-called “ITDs”) in the time of arrival of acoustic waveforms to the two ears. Remarkably, the spatial resolution of sounds along the horizontal plane corresponds to 10 μs, approximately an order of magnitude narrower than the width of the action potentials that signal sensory information. I will discuss the brain circuits that mediate sound localization as well as the biophysical adaptations that neurons have developed to process synaptic information with microsecond precision.

Vibroacoustic Loads that Form from Clustered Rockets Undergoing Stagger Startup

Friday, April 22 2016, 4:00 p.m. in ETC 4.150

Dr. Charles E. Tinney
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The effect of stagger startup on the vibroacoustic loads that form during the end-effects regime of clustered rockets is studied using both full-scale (hot gas) and laboratory scale (cold gas) data with vehicle geometry. Both configurations comprise three nozzles with thrust optimized parabolic contours that undergo free shock separated flow and restricted shock separated flow as well as an end-effects regime prior to flowing full. Acoustic pressure waveforms recorded at the base of the nozzle cluster are analyzed using various statistical metrics as well as time-frequency analysis. The findings reveal a significant reduction in end-effects regime loads when engine ignition is staggered. However, regardless of stagger, both the skewness and kurtosis of the acoustic pressure time derivative elevate to the same

levels during the end-effects regime thereby demonstrating the intermittence and impulsiveness of the acoustic waveforms that form during engine startup.

Acoustical Engineering at Dell

Friday, April 29 2016, 4:00 p.m. in ETC 4.150

Chris E. Peterson and Paul Waters
Concept Systems Engineering and Acoustical Engineering Teams
Dell, Inc.
Round Rock, Texas
www.dell.com/en-us

Acoustical engineering at Dell, Inc., covers several areas of server design. Traditional server acoustical metrics include A-weighted sound power level and A-weighted sound pressure level, the measurements and reporting of which are governed by ISO standards. Dell has set thresholds for these metrics but has also determined sound quality and thus its regulation and design to be important to server customers. Sound quality includes metrics such as prominence ratio, modulation, and tonality, and describes acoustical characteristics that trigger human assessment, such as perception of performance or degree of annoyance, of a product. A final area to be discussed in the presentation is throughput degradation of rotational media. Vibration transmitted through a server from fans interrupts the ability of hard drive to read and write to its platters, and sound pressure levels attained in a server are also sufficient to interfere with hard drive performance.

Brief Historical Highlights of Underwater Acoustics and the Defense Research Laboratory and Applied Research Laboratories of the University of Texas at Austin

Thursday, September 1 2016, 4:00 p.m. in ETC 5.132

Dr. Thomas G. Muir
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Man’s involvement with sound in the ocean has been motivated by intellectual curiosity as well as by necessity, in response to threats. These have included navigational hazards, catastrophes, and world events including shipwrecks and many problem areas associated with naval warfare. In this short talk, the general historical timeline as well as a few illustrative examples will addressed, through the end of WWII. The subsequent founding and early days of the Defense Research Laboratory, now Applied Research Laboratories, will then be summarized through 1980. Examples will be given of early underwater acoustics research and development at this organization, which is closely allied with the academic program in acoustics at UT Austin.

Optimizing Acoustical Parameter-Extraction Methods

Friday, September 9 2016, 4:00 p.m. in ETC 4.150

Dr. Daniel R. Tengelsen
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The impedance tube has long been used as an acoustical parameter-extraction device due to the fact that, under certain assumptions, it can be modelled using a one-dimensional wave equation. Since the 1980's, several techniques have been proposed in the literature to use this device to obtain values for the acoustic properties of various materials. However, most of the methods proposed in the literature fail to pose the problem in a statistically-robust manner. Thus, extracted parameters may vary highly from sample to sample, depending on the material under test. In this talk, we reframe one of the more common extraction methods as an optimization problem and show that more stable parameters are obtained.

"Great Place to Stay. Beware the Train!"

Friday, September 16 2016, 4:00 p.m. in ETC 4.150

David A. Nelson, INCE Bd. Cert., PE
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www.nelsonacoustical.com

It's a nice hotel, convenient to everything, comfortable, nice staff, etc. But one-third of the online reviews mention its only drawback: the train. A freight train passes behind the hotel roughly once per hour. Guests are being awakened, sometimes several times per night. The economics of the situation are equally unpleasant: regular refunds given and clientele potentially lost through unhappy internet reviews significantly affect the bottom line. Audible sound and vibration entering through windows, air conditioners, and even the ground, combine to produce a 2-in-5 chance of being awakened. Evaluation of the relative contribution of the various sound paths was challenging because of the (acoustically) tight quarters. The benefit of noise control options were compared in terms of their potential to reduce awakenings, which is far more meaningful to the client than decibel values.

Modeling and Design of Diffraction Gratings for Optically-Read Vibration Sensors

Friday, September 23 2016, 4:00 p.m. in ETC 4.150

Randall P. Williams, PE
Department of Mechanical Engineering, and
Microelectronics Research Center
The University of Texas at Austin
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Displacement detection using optical interferometric techniques allows for high sensitivity and low sensor self-noise which are unmatched by other displacement measurement methods. However, diffraction gratings commonly used in such applications can generate zeroth-order reflected beams which result in reduced sensor performance and packaging limitations. A new grating concept has been designed, fabricated, and tested at the UT Microelectronics Research Center which has a reduced zeroth-order reflected beam, opening the doors for new sensor integration approaches. The design criteria for zeroth-order beam elimination is illustrated using a simple model based on phasor arithmetic, and Fourier propagation techniques are used to model the optical field for realistic grating geometries and incident beam profiles. Important insight into the behavior of the sensor is gained for a range of different operating conditions, which commonly used grating models often fail to capture. Finally, comparisons between the models and experimental measurements on prototypes gratings will be presented and discussed.

Willis Coupling in Acoustic Metamaterials

Friday, October 7 2016, 4:00 p.m. in ETC 4.150

Michael B. Muhlestein
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Acoustic metamaterials (AMM) are deeply subwavelength acoustic structures which have been engineered to exhibit specific, often exotic, material properties. Material properties are related to field variables through constitutive equations, such as Hooke's law, where the pressure and strain are related through a material property, the bulk modulus. Another common constitutive equation is the definition of momentum density in terms of the particle velocity and the material property of mass density. While the behavior of most AMM structures may be fully described by homogenizing the effect of subwavelength heterogeneities using effective bulk modulus and mass density, this is not always the case. Specifically, Willis (Wave Motion, 1981) showed that in a general heterogeneous elastic medium there is an additional material property which couples the constitutive relations for the momentum density and stress fields. This talk first discusses the physical origin of Willis coupling in one-dimensional materials based on asymmetric microstructure. An examination of the physical behavior leads to a method for predicting Willis material properties for a known one-dimensional microstructure. A method for determining Willis material properties from an experiment based on a plane-wave impedance tube is also presented, and results from in-air tests are compared with theoretical predictions and shown to be in strong agreement.

This experiment represents the first known experimental evidence of Willis coupling. Finally, with an eye toward future applications, a homogenization method accounting for coupled inclusions in an elastic matrix is presented.

The X-15 Research Rocket Airplane: A Step into Space at Six Times the Speed of Sound

Friday, October 14 2016, 4:00 p.m. in ETC 4.150

Professor Ronald L. Panton
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The University of Texas at Austin
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The X-15 Airplane was carried aloft under the wing of a B-52 bomber. After being released it started a rocket motor for a flight and then returned to an unpowered landing on the dry lake at Edwards Air Force Base. The program operated in the 1960s and investigated aerodynamic heating and flight at hypersonic speeds. Altitudes above 99.9% of the atmosphere were achieved. This required vehicle control in space, and allowed experiments about the physical properties of space. This presentation will review the program, emphasizing that technical progress involves making mistakes, meeting unexpected problems, and dealing with unanticipated events.

Bubble Acoustics and the Sound of Water Drops

Friday, October 21 2016, 4:00 p.m. in ETC 4.150

Dr. Kyle S. Spratt
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The acoustic properties of gas bubbles in liquids has become a prevalent field of study in the last century due to the large number of practical applications in both underwater acoustics and biomedical acoustics. Given the myriad practical applications, it is interesting to note that some of the earliest papers written on the subject of bubble acoustics were motivated by a number of physicists' sheer curiosity about the sound that is generated by a water drop as it splashes into a pool of water. In this talk we will review the work done in the early twentieth century on the physics of water drop splashes that led directly to M. Minnaert's 1933 paper deriving the resonance frequency of a gas bubble oscillating in an incompressible liquid, as well as some subsequent splash-related bubble research. Along the way we will discuss the basic physics of bubble oscillations by considering the sound scattered by a large air bubble in water.

Finite Element Modeling for Ocean Acoustics Applications
JOINT ICES SEMINAR AND ACOUSTICS SEMINAR

Thursday, October 27 2016, 3:30 pm in POB 6.304

Dr. Marcia J. Isakson
Applied Research Laboratories
The University of Texas at Austin
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Since electromagnetic propagation in seawater is very limited, acoustics provide the primary means of remote sensing and communication under the ocean. However, the ocean is a complex environment with large variations both temporally and spatially. Historically, acoustic propagation and scattering for underwater acoustics have been modeled using approximations to the Helmholtz equation. However, with the increase of computing power, finite element models are now accessible for the large-scale problems in ocean acoustics. These models are particularly powerful in these applications because they can capture the complexity of the environment. This talk will provide an overview of the application of finite element modeling for ocean acoustics applications in the underwater environment as well as a glimpse into the future of the discipline.

History and Applications of Acoustic Radiation Force

Friday, October 28 2016, 4:00 p.m. in ETC 4.150

Benjamin C. Treweek
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From its theoretical beginnings to its modern applications in both optics and acoustics, radiation force has received considerable attention. The phenomenon arises due to momentum transfer from an incident wave field—either electromagnetic or acoustic—to a reflecting or absorbing body. In acoustics, much of the recent research on radiation force is focused on its biomedical applications, both therapeutic (e.g., movement of kidney stones) and diagnostic (e.g., soft tissue characterization). In this talk, we will first discuss a brief history of radiation force, touching on a few of its many applications in both optics and acoustics, and we will then examine its governing physical principles, with a particular emphasis on the radiation force on a scatterer embedded in liquid or soft tissue. We will conclude by addressing some recent and future work as it relates to measurement of the shear modulus in soft tissue.

Modeling of Strong Shock Waves from Explosions: Not with a Whimper but a Bang

Friday, November 4 2016, 4:00 p.m. in ETC 4.150

Professor Won-Suk Ohm
School of Mechanical Engineering
Yonsei University
Seoul, South Korea
http://web.yonsei.ac.kr/acoustics

Blast waves produced by such events as nuclear explosions are considered as “strong” shock waves, the description of which requires a theoretical framework more accurate than the second-order models such as the weak-shock theory and the Burgers equation. In order to study strong shock waves, computational fluid dynamics (CFD), based on the Euler equation, is frequently used. However, CFD is highly time-consuming especially for blast waves traveling over long propagation distances. In this talk, a fast computational method for solving the Euler equation is presented, which was recently devised by the author and his students at Yonsei University. The method is based on the Riemann solver of Godunov, in which a waveform is discretized into a series of discontinuities. Our departure from Godunov is that these discontinuities are regarded as particle-like entities (dubbed “Hugonions” by the author), which travel, interact with each other, and most importantly, annihilate. Comparison of the method with traditional Riemann solvers and the Burgers equation is given to showcase its relative accuracy and savings in computation time.

From Basic Research to Startup: The Development and Commercialization of University-Based Acoustics Research

Friday, November 11 2016, 4:00 p.m. in ETC 4.150

Dr. Mark S. Wochner
AdBm Corp
Austin, Texas
www.adbmtech.com

An underwater noise abatement system based on research performed at The University of Texas at Austin’s Applied Research Laboratories has been commercialized and is now being prepared for its final demonstration before it enters the offshore wind market. The system uses arrays of acoustic resonators which are tuned to optimally reduce radiated noise from various sources, and has been shown to be very effective in field trials. This presentation will cover the research efforts behind this approach, including the basic research, small-scale testing, and offshore testing at various locations. It will also cover the commercialization efforts behind turning this university-based technology into a salable product, including technology licensing, company formation, patent applications, contracting, and marketing.

Design and Fabrication of Ultra-wideband Tunable Graphene-based NEMS Resonators

Friday, November 18 2016, 4:00 p.m. in ETC 4.150

Professor Michael A. Cullinan
Department of Mechanical Engineering
The University of Texas at Austin
www.me.utexas.edu

Graphene-based nanoelectromechanical (NEMS) resonators have the potential to overcome many of the limitations of traditional microelectromechanical (MEMS) resonators, because of the outstanding electrical and mechanical properties that graphene offers such as its extremely high stiffness-to-weight ratio and its large failure strain ($\varepsilon > 20\%$). However, the incorporation of graphene resonators into real-world products has proven difficult because of the large measured variances in the performance of the graphene resonators that have been produced. This talk will present a method to design and fabricate graphene-based NEMS resonators where a MEMS device is used to tune the resonance frequency of the graphene from the MHz range to the GHz range in order to make wide-band tunable filters and reduce manufacturing variability.