Acoustics Seminar Abstracts 2005
University of Texas at Austin

Cochlear Implants

Friday, February 4, 2005 4:00 p.m.

Patrick W. Slater, M.D., Neurotologist, and Amy L. Gensler, M.A., Cochlear Implant Audiologist
Austin Ear Clinic
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Cochlear implants are life-changing prosthetic devices that can dramatically improve hearing for people with severe-to-profound sensorineural hearing loss. This discussion will focus on all aspects of cochlear implants. Dr. Patrick Slater is a highly trained ear specialist who treats and performs surgery on patients with a variety of auditory and vestibular problems. He will discuss the anatomy of the auditory system, when an implant should be used, and all aspects of the cochlear implant surgery. Amy Gensler is an audiologist who performs electrophysiological tests of the auditory system, as well as programs and adjusts all cochlear implant equipment after surgery. She will focus on all aspects of programming and manipulating the cochlear implant speech processor and internal electrode array. These include variations in internal electrode arrays and speech processors, creation of speech processing programs for an implant user, and parameters that can be manipulated via computer for different types of auditory stimulation.

Measurement and Evaluation of the Acoustic Quality of Violins

Friday, February 11, 2005 4:00 p.m.

Alex Mayer
Institute for Musical Acoustics
The University for Music and Performing Arts, Vienna

and

Todd Hay
Department of Electrical and Computer Engineering
The University of Texas at Austin
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For nearly 25 years the Institute for Musical Acoustics (IMA) in Vienna has been developing simulation, measurement and optimization methods for the study and characterization of musical instruments. One of the tools developed at the IMA is VIAS (Violin Instrument Analysis System) which is used to measure the acoustic characteristics of stringed instruments without the use of an anechoic chamber. VIAS consists of a computer-controlled transducer, optical sensor, and data analysis software which are continuously under development. The software allows the user to obtain a `fingerprint' of the instrument but further interpretation of the data requires the experience of an expert. Recently, artificial intelligence techniques were developed to enable automatic interpretation of the measured data. This seminar will briefly introduce the IMA, the various components of the VIAS system and directions for further research.

Accelerated Tissue Heating from Inertial Cavitation Produced by High-Intensity Focused Ultrasound

Friday, February 25, 2005 4:00 p.m.

Professor Ronald A. Roy
Department of Aerospace and Mechanical Engineering
Boston University
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Rapid tissue heating resulting in necrosis is a useful therapeutic modality for clinical application of high-intensity focused ultrasound (HIFU). At therapeutic intensities, acoustic hyperthermia is often accompanied by bubble activity. In vitro and in vivo experiments alike have shown that under certain conditions bubble activity can give rise to a doubling of the heating rate. With a view towards harnessing the energy-concentrating effects of bubbles to do useful clinical work, we report the results of experiments and modeling for the dynamic and thermal behavior of bubbles subjected to 1 MHz ultrasound at megapascal pressures. The dominant heating mechanism depends on bubble size, medium shear viscosity number and frequency-dependent acoustic attenuation. The bubble size distribution, in turn, depends on insonation control parameters (acoustic pressure, pulse duration), medium properties (notably dissolved gas concentration) and bubble-destroying shape instabilities. The evidence obtained so far points to a range of control parameters for which bubble-enhanced heating can be assured.

Ultrasound-Assisted Thrombolysis for Stroke Therapy

Wednesday, March 23, 2005 3:00 p.m. in ETC 2.132

Professor Christy K. Holland
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Stroke is the third leading cause of death and the leading cause of disability in the United States. Thrombolytics, or clot-busters, such as recombinant tissue plasminogen activator (rt-PA) have advanced the treatment of ischemic stroke. Unfortunately, thrombolytics also can cause bleeding in the brain. Adjuvant therapies that lower the dose of rt-PA or increase its efficacy would represent a significant breakthrough in stroke treatment. Our long term objective is to develop an ultrasound-assisted thrombolysis system that minimizes the risk of bleeding, promotes rapid restoration of cerebral blood flow in the early stages of ischemia, and thus increases the number of stroke survivors and improves long-term prognosis. To aid in the development of a transcranial ultrasound thrombolysis system, the synergistic thrombolytic effect of rt-PA and ultrasound was assessed in vitro in a porcine clot model. The degree of the ultrasound enhancement of rt-PA was explored at 120 KHz and 1 MHz. With ultrasound exposure, clot mass loss increased by as much as 150% over sham (rt-PA alone). A weak dependence of clot mass loss on ultrasound duty cycle was noted. The in vitro thrombolysis results to date as well as the three-dimensional characterization of the intracranial sound field will be described. Possible mechanisms for the ultrasound-drug interaction will also be discussed. Two confocally aligned passive cavitation detection systems were employed to detect subharmonic emissions from stable cavitation and broadband superharmonic emissions from inertial cavitation, respectively. Stable cavitation was detected in clots exposed to ultrasound alone and a combination of rt-PA and ultrasound. Curiously, inertial cavitation was detected only in samples containing rt-PA. The presence of both stable and inertial cavitation correlated with increased clot mass loss and a distinct pattern of fibrin degradation on histologic evaluation.

Acoustical Engineering for Sound Quality in the Computer Industry

Friday, April 1, 2005 4:00 p.m.

Chris E. Peterson
Dell Enterprise Acoustical Engineering
Round Rock, Texas

Computer products generate noises that vary in the degree of annoyance to target customers. The goals of acoustical engineering in the computer industry are the following:
– Characterize signatures of acoustical noise
– Predict impact of various types of noises on target customers
– Develop specifications that limit of acoustical noise characteristics
– Identify sources of noise
– Identify potential solutions
– Negotiate implementation of solutions that are mutually acceptable across product development teams
– Track impact of solutions

In this seminar, members of Dell's acoustical engineering team will present computer noise characteristics, demonstrate means of analysis, and discuss means to predict acoustical impact based on feedback from customers.

Linear and Nonlinear Laser Opto-Acoustics in Solids from Macro- to Nano-Scale

Friday, April 29, 2005 4:00 p.m.

Dr. Alexandre A. Kolomenskii
Department of Physics
Texas A&M University
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Recent developments in laser technology enable studies of elastic properties of materials at different scales ranging from centimeters to nanometers. In this talk some examples will be presented that include studies with focused and straight-crested surface acoustic waves (SAWs) and femtosecond measurements of acoustic oscillations in nanoparticles. We investigated the changes of the pulse shape in SAWs propagating through a surface region with inhomogeneities, such as roughness produced by laser ablation, coating by a thin liquid film, or a thermal field. Converging SAW pulses, in particular the variation of phase during the passage through the focal region (Gouy phase shift) were also studied. With nanosecond laser pulses we excited very high-amplitude surface acoustic wave pulses (Mach numbers about 0.01). Their propagation in polycrystalline metals and dielectrics was accompanied by nonlinear compression/extension, generation of higher harmonics, formation of shock fronts, and an increase of stresses in the material. These observations were confirmed by analytical and numerical calculations. Recently, nanoparticles of different sizes (from a few to tens of nanometers) and shapes in solutions and solid matrixes were fabricated. The optical, mechanical and thermodynamic properties of nanoparticles are size-dependent, and the possibility to investigate them with a femtosecond pump-probe technique by exciting confined acoustic oscillations was demonstrated.

Improving Speech Intelligibility with a Constant-Beamwidth, Wide-Bandwidth Acoustic Array

Friday, May 6, 2005 4:00 p.m.

Douglas F. Winker
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The University of Texas at Austin
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Speech intelligibility in rooms, particularly ones that are highly reverberant, is often difficult to achieve. Typical loudspeaker applications require multiple installation locations, and compromises in audience coverage must often be made. The acoustic environment of a typical, multi-use hall was measured and simulated using CATT-Acoustic (TM) a commercial software package for room acoustics prediction and auralization. The simulation results agreed with the measurements and provided a method for analyzing various beam patterns and array applications. A multi-element array with constant beamwidth from 500 Hz to 4 kHz was designed to match the room. The proposed array is in the form of a cross, with the horizontal arm containing 9 loudspeakers, and the vertical arm containing 11 loudspeakers. Constant beamwidth is achieved by using different combinations of loudspeakers for different frequency bands. Simulations of the radiated acoustic field in the room will be presented that indicate uniform improvements in coverage and speech intelligibility can be obtained with the array. Plans for construction and implementation of the array will also be discussed.

Hypervelocity Impact

Friday, September 16, 2005 4:00 p.m.

Dr. Stephan J. Bless
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Impact regimes are characterized by the ratio of inertial stresses to strength. “Hypervelocity” refers to impacts where the role of target strength is relatively small. Well known examples are planetary craters. Others are space craft protection from meteorites, planetary accretion, and high pressure physics. Another application under investigation at UT concerns projectiles fired from electric guns, which can strike targets in the hypervelocity regime. The mechanics of hypervelocity impact are dominated by shock effects, which cause failure both in compression and tension. Two subjects of particular interest to UT investigators will be developed in more detail: impact failure of brittle materials, and design of hypervelocity penetrators.

Structure and Ground Borne Vibration Control for a 25 MW Steam-Turbine Generator Installation near Academic Teaching and Research Laboratories

Friday, September 30, 2005 4:00 p.m.

Jack B. Evans
JEAcoustics
Austin, Texas
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The University of Texas at Austin has an on-campus electrical power generation plant with steam turbine generators. The plant is surrounded by academic teaching and laboratory buildings, in which more sensitive laboratory spaces have experienced vibration disturbances in the past. A planned 25 MW turbine-generator installation would increase generation capacity and permit retirement of an older unit, but could also increase vibration disturbance. The engineering and architectural design team for the project was charged with controlling groundborne vibration from the plant to mitigate or reduce vibration disturbance to surrounding science and engineering laboratory spaces. This presentation and tour will discuss the vibration environment around the plant and in nearby buildings based on pre-construction groundborne and floor vibration measurements. Design criteria and vibration control strategies based on recommended vibration isolation schemes will be presented with discussion of recommended and rejected solutions. Post-construction vibration measurement results will be discussed for the generator base, both groundborne and floor vibration, both in and near the power plant. Overall results and degree of compliance with criteria are presented with short discussion of possible design improvements.

The Application of Cochlear Analysis Techniques to Percussion in Electro-acoustic Music

Friday, October 7, 2005 4:00 p.m.

Anderson Mills
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This Presentation is focused upon the audio analysis involved in the creation of a “pseudo-score” for electro-acoustic music. This research was undertaken because the lack of an objective visual representation prevents music theorists from being able to easily discuss electro-acoustic music in written form. The “holy grail” of automatic computer music analysis has most often been the translation of a continuous pressure variation into traditional Western musical notation. Since electro-acoustic music is rarely able to be transcribed into this type of notation, the automatic analysis of electro-acoustic music confounds many previous algorithms. A top-down approach is suggested in order to extract acoustic and musical information from recordings of electro-acoustic music. Because humans are the best known system for translating a continuous pressure variation into useful acoustic information, a cochlear model, Patterson’s Auditory Image Model (AIM), is used as a front end. The audio property of self-similarity of percussion has been chosen for initial study. This self-similarity property requires first that the audio property of percussion is quantified. The nuances of using AIM to determine percussion will be discussed. Models of self- similarity of percussion for varying time- scales will then be discussed.

Broadband Nearfield Beamformer with Compact Size using the Nash Genetic Algorithm

Friday, October 14, 2005 4:00 p.m.

Soonkwon Paik and Dr. Elmer L. Hixson
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The goal of this project was to design and implement a microphone array suitable for hands-free cell phone use in a car. The acoustical environment of a car interior was investigated. It was decided that a narrow beam broadband microphone was needed to reject noise and improve speech quality. Space limitations required a nearfield array with extra consideration given to low frequencies. The Nash Genetic Algorithm was used to fit an optimum sized array with a 20 cm beam width and -20 dB side lobe levels into the space available. Filtered nested arrays provided constant beam width from 500Hz to 4kHz. The 9 element array was implemented with inexpensive electric microphones. Tests in the anechoic room verified that the design goals were achieved.

The Songs of Bats

Friday, October 28, 2005 4:00 p.m.

Professor George D. Pollak
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Bats are best known for their echolocation abilities but they also are among the most colonial of mammals, living in caves with populations that can number in the millions. To establish and maintain their communities in total darkness, they employ acoustic signals for social interactions. My students and I have been studying the vocal repertoire of a colony of Mexican free tailed bats maintained in Austin by my colleague, Barbara French. What I will show, and what is so surprising, is that their vocal communication is composed of a rich repertoire of complex signals. The most elaborate signals are used for courtship and territorial defense, and are actually “songs” that have defined structures and perhaps even a grammar and syntax. I will show the features common to both calls, as well as the features that distinguish them. I will then briefly discuss how acoustic signals are processed by the central auditory system, and show that inhibition allows the system to respond differentially to even subtle acoustic features. I will explain how inhibition shapes the differential responsiveness, and how such response differences could provide the neural substrate for both distinguishing among the social communication calls and individual recognition.

Acoustics in the Oilfield

Wednesday, November 2, 2005 3:00 p.m.

Dr. Fernando García-Osuna
Sugar Land Technology Center, Schlumberger Corporation
http://www.schlumberger.com

Acoustic measurements for geophysical well logging were introduced in the oil industry in the mid-1920s as a companion to seismic exploration to measure compressional velocity. In the 1950s researchers at universities, oil, and service companies extended the theory of wave propagation in continuous elastic matter to porous elastic media saturated with a viscous fluid, marking the beginning of an increase in the role of acoustic measurements in boreholes. More recently, novel multipole acoustic logging tools with symmetric and asymmetric sound sources and receiver arrays with individual azimuthal sensors have been developed to enhance our understanding of the mechanical properties of petroleum reservoir rocks. In addition, with the advance of electronic components, sensors miniaturization and high performance materials, the formation's compressional, fast and slow shear and Stoneley velocities can be obtained in real-time over a wide measurement range. This talk will describe Schlumberger's wireline and logging while drilling (LWD) acoustic well logging tools, services, and the role that worldwide multidisciplinary teams, among them acousticians, play in the development of this technology. Special attention is placed on tool physics, sonic sources and receivers to excite and measure non-dispersive and dispersive acoustic waves in open- and cased-hole environments.

Towards a Model of Vocal Production and its Evolutionary Analysis

Friday, November 11, 2005 4:00 p.m.

Professor Michael J. Ryan
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Most of the 5000 frog species produce mating calls that females use to identify appropriate mates. The call of the tungara frog has two components, the whine is necessary and sufficient for females to recognize the species, while the addition of the chuck further enhances the call's attractiveness to females, as well as to frog-eating bats and blood- sucking flies. An unusual structure emanating from the vocal folds, the fibrous mass (FM), is implicated in chuck production. Both among species and among populations within a species, the presence of a large FM correlates with production of chucks. Surgical removal of the posterior portion of the chuck also results in calls without chucks. We would like to develop an analytical model of the tungara frog vocal system, similar to what others have done with birds (e.g. Fletcher 1988, J. Theor Bio) in order to: (i) specify the vocal system variables crucial for chuck production; (ii) identify the roles of nonlinearities (e.g. Hopf bifurcations) in the system; (iii) validate the model by determining the degree to which it predicts weak- chucks and proto- chucks in closely related species; (iv) simulate the evolution of the vocal system by using phylogenetic algorithms to estimate ancestral states of model parameters and (v) use female frogs and artificial neural networks to determine the ability of the model to predict evolution-past.

The Effects of Poro-Elasticity, Grain Dynamics and Rough Interface Scattering on the Broadband Acoustic Behavior in Water Saturated Unconsolidated Sediment

Friday, November 18, 2005 4:00 p.m.

Dr. Marcia Isakson
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Unconsolidated sediments comprise much of the world's littoral ocean bottoms. Therefore it is important to understand the acoustics of these materials in order to model long range coastal propagation and shallow water sediment characterization. However, the acoustics of unconsolidated sediments is complicated by the effects of the motion of the interstitial fluid, the motion of the individual grains and the geometry of the interface. Poro-elastic theory can describe the relative motion between the sand grains and the interstitial fluid, however, there is evidence that effects such as squirt flow and grain contact dynamics must be accounted for within the theory. Additionally, data suggest that the dynamics of the individual sand grains may be important as acoustic energy may be partitioned into rotational degrees of freedom of each grain. Lastly, the micro-topography and ripple structure of the water/sediment interface can influence the reflection and transmission coefficients. This roughness can add a large variance in the data or allow sub-critical penetration. The current state of understanding of these effects will be discussed and new avenues for understanding the nature of acoustic behavior in unconsolidated sediments will be presented.

Tour of Acoustic Systems

Friday, December 2, 2005 4:00 p.m.

Bill McKenna
Acoustic Systems
Austin, Texas
http://www.acousticsystems.com/index.htm

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