Reconfigurable Arrays for Broadband Feedback Control of Aircraft Fuselage Vibrations

Thursday, January 27, 2000 4:00 p.m.

Michael Fripp
Massachusetts Institute of Technology
Cambridge, Massachusetts
http://www.mit.edu

Reconfigurable arrays of sensors and actuators can provide robust broadband feedback control with high performance and limited modeling. The weighted summation of the sensor signals identifies the modes that are important to performance and rejects the remaining modes, thus reducing the required complexity of the controller. A simple proof demonstrates that the method developed to calculate the weights is globally convergent. The deleterious effects of spatial aliasing are explored. The use of reconfigurable arrays is motivated by the desire to reduce the noise within aircraft cabins. A fifteen element collocated actuator and sensor array was bonded to a representative fuselage test-bed. Array weights were calculated and successfully applied to isolate important modes. Simple closed-loop feedback control of a broadband structural disturbance was performed using two sets of modal weights, and the panel acceleration was reduced by over 10 dB for each of the targeted modes.

Next Generation Acoustic Transducer Materials: 1-3 Piezocomposite and Beyond

Friday, February 4, 2000 4:00 p.m.

Dr. Leslie Bowen
Materials Systems, Inc.
Littleton, Massachusetts
http://www.matsysinc.com

1-3 piezocomposite is a relatively new entry into the piezoelectric materials portfolio of acoustic transducer designers. Originally conceived in the 1970s at Penn State’s Materials Research Laboratory, the material was of limited academic interest until the early 1990s when MSI developed a commercially-viable manufacturing process for piezocomposite production. Since then 1-3 piezocomposite has become the material of choice for many advanced transducer designs for both commercial and defense applications. 1-3 piezocomposite can be viewed as a replacement for conventional piezoelectric transducer materials or as a transducer itself. It is an excellent transmitter as well as a highly sensitive receiver. The material offers broad bandwidth and low acoustic impedance as well as design versatility for a wide range of active and passive sonar applications. Transducer design is simpler with 1-3 piezocomposite than piezoelectric ceramics because the composite behaves largely as theory predicts. However, there are pitfalls to avoid when selecting the right material and packaging. This seminar will review the development history, properties, design guidelines and applications of piezocomposite materials and transducers. The current state-of-the-art in piezocomposite materials and applications will be reviewed, along with new research into single crystal transducer materials that offer enhanced projector performance for both piezocomposite and conventional transducers.

Acoustic Data Telemetry: Oil Drilling Application

Friday, February 11, 2000 4:00 p.m.

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

Real time data collection in down-hole environments has long been a goal of the drilling and oil industries. Information such as pressure, deviation from vertical, and temperature near the drill bit is used for decision making by the operator. Currently, the rate of transmission (using choked mud pulses) is on the order of 2-4 bits/second. Acoustic telemetry (which uses the drill string as the information carrier) has the potential to significantly increase the rate of data transmission, by perhaps two orders of magnitude. However, because of the periodicity of the drill string structure, several issues must be overcome. These include the highly dispersive and filtering properties of the waveguide, as well as the inherent attenuation mechanisms in the environment. The challenges in the transmission of data through a periodic structure will be presented in detail for a simple one-dimensional model. The effects of dispersion and filtering on a broadband signal are demonstrated via numerical simulation. Finally, the concept of an electronic terminating impedance is discussed. Design of this termination is the subject of ongoing research, the focus of which includes signal cancellation, filtering techniques, and acoustic arrays.

Progress and Challenges in Ultrasonic Gas Flow Measurement

Friday, February 18, 2000 4:00 p.m.

Dr. Kevin Warner and Dr. Elan Yogeswaren
Daniel Measurement and Control, Inc.
Houston, Texas
http://www.danielind.com

Use of ultrasound transit time to measure flow was first proposed in the late 1920s, but not until the 1960s did an operational device become available. Work initiated by British Gas in the 1980s and continued by Daniel led eventually to a practical and commercialized ultrasonic gas flow meter. Even though other devices such as orifice plates and turbine meters are very accurate and reliable, there are important advantages to be gained by using ultrasound. These include the non-invasive nature of the method, the larger range of flow that is encompassed, and better flow diagnostics. Use of multi-path transit time appears to be more reliable than other ultrasonic techniques such as Doppler, cross-correlation, vortex shedding, and the recently proposed plane-wave model. Ultrasonic measurement is rapidly becoming the preferred method for custody transfer of natural gas. A review of the principles and applications of the multi-path transit time technique will be presented. This will be followed by a discussion of recent development work in transducer design, methods to overcome noise, an acoustic impedance measurement probe, and the understanding of flow effects on the measurements.

High-Frequency Acoustics of Ocean Sediments: In-Situ Measurements

Friday, February 25, 2000 4:00 p.m.

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

The participation of ARL:UT in the sediment acoustics experiment (SAX99) is directed towards determining the underlying physical processes in the penetration of sound into sandy ocean sediments, particularly at shallow grazing angles, and the scattering of sound from the sediment. Although a number of measurements have been made in the past, including both in-situ and laboratory experiments, and a number of hypotheses have been advanced, the underlying physical processes could not be determined with any confidence. The hypotheses may be roughly divided into two groups, one in which the sediment is modeled as a fluid, and the other in which the sediment is modeled as a poro-elastic solid according to Biot's theory. There are two competing hypotheses for the penetration path at shallow grazing angles: (1) Biot slow wave refraction and (2) scattering by surface and/or volume inhomogeneities. These two hypotheses are not mutually exclusive. The Biot slow wave path is applicable to a uniform sediment with a flat surface, but it may be enhanced by surface roughness and volume inhomogeneities through energy conversion between the slow and fast waves. The scattering path requires either surface roughness and/or volume inhomogeneities, but it is not known if it can be represented adequately by a fluid-bottom approximation, or if it is necessary to resort to a Biot representation. The experiment will be described and some of the data will be discussed.

Measurement of Piezoelectric and Electrostrictive Coefficients of Thin Polymer Films

Wednesday, March 1, 2000 4:00 p.m.

Francois Guillot
Georgia Institute of Technology
Atlanta, Georgia
http://www.gatech.edu

Piezoelectric polymers such as polyvinylidene fluoride (PVDF) and its copolymers are widely used in electromechanical applications such as sonars, actuators and loudspeakers. Their advantages include low manufacturing cost, low density and modulus, and flexible design possibilities. Another type of polymer, a polyurethane, has received attention recently for potential use in sonar applications because it exhibits large electrostrictive strains and excellent impedance matching to water. However, the electrostrictive behavior of this material has not been completely characterized and is still poorly understood. Accurate determination of the electrostrictive coefficients of this polyurethane is challenging because of its high compliance, which makes measurements very sensitive to experimental conditions. A new method is presented for determination of electromechanical coupling coefficients on thin polymer films. The method relies on a combined experimental and analytical approach. The sample is encapsulated in silicone rubber and its electrically induced displacements are measured using a laser

Doppler vibrometer. The displacements are used in a Rayleigh-Ritz minimization procedure that yields the piezoelectric or electrostrictive coefficients of the material. The main advantage of the method is that measured values of the three true electromechanical tensile coefficients of the polymer are obtained.

Ultrasonic Testing Using Phased Arrays

Friday, March 3, 2000 4:00 p.m.

Dr. Paul A. Meyer
Krautkramer Branson
Lewistown, Pennsylvania
http://www.geinspectiontechnologies.com

The use of ultrasonic nondestructive inspection is well known. Critical components in power generating stations, aerospace vehicles, and chemical plants undergo regular inspections to determine suitability for continued service. Originally, inspections were conducted by an operator who manually scanned a probe over the structure and noted regions with indicated flaws. Although effective at locating flaws, the process was time consuming. Eventually, mechanisms were developed to automate the probe manipulation and test times were reduced. Still, the mechanisms had to be reset every time the geometry of the component changed. With the advent of electronically phased array ultrasound systems, the inspection process has taken another step forward. These systems can alter the location, direction, and focal characteristics of the ultrasonic beam very quickly. The scanning mechanisms are eliminated and setup changes required by component geometry changes can be implemented almost instantly. This presentation reviews the theory of operation of ultrasonic phased array systems and then reviews their use in metal tube fabrication facilities and in a railroad wheel manufacturing and rework facility. Cost effectiveness of such systems is discussed.

On Virtual Prototyping of Medical and Sonar Transducers

Friday, March 10, 2000 4:00 p.m.

Dr. Greg L. Wojcik
Weidlinger Associates
Los Altos, California
http://www.weidlinger.com

Until recently, acoustic transducer designers relied almost exclusively on one-dimensional (1D) semi-analytical models and experimental prototypes. Now, many employ virtual prototyping, i.e., comprehensive computer simulations of 2D and 3D transducer devices. Effectiveness of virtual prototyping depends on five factors: 1) a robust numerical modeling capability; 2) skill with numerical experiments; 3) knowledge of transducer design strategies; 4) accuracy and completeness of material measurements; and 5) representation of manufacturing process effects. Otherwise, modeling is often used poorly and results may be misinterpreted or erroneous, leading to wasted resources or market opportunities. This talk illustrates modern virtual prototyping of both medical and sonar transducers using PZFlex finite element models. PZFlex is a time-domain code for electromechanical device simulation that has become fairly standard in the industry over the last few years. Computational issues and PC-based

solutions are described. Transducer models include medical ultrasound arrays and sonar projectors. Fundamental transduction principles are demonstrated with “elemental” harmonic oscillator models. Material characterization (velocity and absorption of longitudinal and shear waves) by pitch-catch critical angle experiments is shown at megahertz frequencies in polymers. Process effects are illustrated in the context of single-crystal piezoelectric materials. Finally, acoustic propagation models are compared to data for large scale, lossy, nonlinear, inhomogeneous problems using a pseudospectral full-wave solver in PZFlex.

Development of Line-Source and Speaker Arrays for Sound Reproduction in Enclosed Areas

Friday, March 24, 2000 4:00 p.m.

Robert Tupper
Custom Designs, Ltd.
Boerne, Texas

Line-source and speaker arrays have intrinsic properties that render them more suitable than conventional point-source radiators. From the standpoints of psychoacoustics and sound quality, these properties include radiation patterns that minimize both the spatial and timbral distortions introduced by point-source devices. Development of line-source and speaker arrays requires thorough understanding and application of the Thiele-Small parameters, magnetic circuits, and their associated materials. The materials available for diaphragms and sound absorption are also important to the design of these new types of sound sources. How we combine the materials of choice and apply the sciences to design a line array of electrodynamic sound sources determines the results we achieve. This design and its measured characteristics will be presented.

Numerical Simulation of Time-Reversed Sound Beams of Finite Amplitude

Friday, March 31, 2000 4:00 p.m.

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

Time reversal of sound waves permits the realization of systems which automatically retarget energy on scattering sites insonified by an incident probe beam. The self-targeting occurs despite the presence of inhomogeneities that may be present in the medium, and thus provides a means of removing aberration in imaging systems. The theoretical foundation for field reconstruction using time reversal is based on linear theory. However, systems now exist in which time reversal is accompanied by large amplification that introduces finite-amplitude propagation effects. The seminar begins with a brief review of time reversal techniques. The main focus is numerical simulation of time-reversed fields in which nonlinearity must be taken into account. Simulations are obtained using a numerical algorithm for solving the nonlinear parabolic wave equation. A parametric study is performed for incident beams radiated by unfocused and focused circular sources. Shock formation and finite dimensions of the time-reversal mirror

are shown to adversely affect spatial reconstruction of the incident field. Nevertheless, even in the presence of shock formation, the ability of time reversal to retarget most of the energy in the incident beam on the source is found to be remarkably robust. The algorithm is used to simulate experiments performed at the General Physics Institute in Moscow, where time reversal is accomplished using magnetostriction in ferrites to produce phase conjugation (time reversal of a monofrequency wave field). The large amplification realized in the experiments introduces significant distortion of the phase-conjugate beam. Satisfactory agreement is obtained with their preliminary measurements.

Underwater Electroacoustic Transducers: Design Styles and Challenges to Meet Application Goals

Friday, April 14, 2000 4:00 p.m.

Ender Kuntsal
International Transducer Corporation
Santa Barbara, California
http://www.itc-transducers.com

Designing an underwater electroacoustic transducer involves a unique combination of engineering disciplines including acoustical, electrical, mechanical and materials science. Transducer performance specifications, although different for almost every application, typically include stringent specifications such as transmit/receive response, efficiency, beam pattern, impedance, corrosion resistance, depth and weight. This unusual combination of requirements, coupled with an added concern for cost, often makes challenging specification trade-offs necessary to achieve a final design goal. In this talk major transducer design parameters, their relationships and common transducer styles will be presented. Specific transducer examples and their applications will be included in the presentation. Currently available transducer design tools will also be introduced.

Cavitation and Nonlinear Effects in Focused Acoustic Fields Used in Therapy

Monday, April 17, 2000 4:00 p.m.

Dr. Oleg A. Sapozhnikov
Moscow State University
Moscow, Russia
http://www.phys.msu.su

Intense ultrasound is a promising therapeutic tool. Focused shock pulses are a way to obtain very high (up to 100 MPa) acoustic pressures locally inside the human body and are now clinically used to comminute kidney stones (extracorporeal shock wave lithotripsy—ESWL). Using cw focused ultrasonic beams, intensities of several thousands W/cm^2 can be achieved at a focus, i.e., a large amount of energy can be delivered to the pathologic tissues in a few seconds, causing tissue death and thus offering the potential of non-invasive tumor treatment (focused ultrasound surgery—FUS). Another promising application of high intensity focused ultrasound (HIFU) is cauterization of internal bleeding (acoustic hemostasis). Effects caused by the ultrasound waves in biological tissue include heating, cavitation, acoustic streaming, and shear stresses. Many features of these phenomena are not well studied yet. In

the presented work, the cavitation phenomena accompanying ESWL and FUS are studied. In addition, the possibility of using acoustic nonlinearity to enhance heat deposition by HIFU is investigated. The cavitation was studied experimentally using passive cavitation detectors (PCD) that identify cavitation events by sensing acoustic emissions generated by the collapse of bubbles. A dual passive cavitation detector (dual PCD), consisting of a pair of orthogonal confocal receivers, is described for use in shock wave lithotripsy. The radiated acoustic pressure 10 mm from the collapsing cavitation bubble in the focus of the lithotripter was measured to be more than to 10 MPa, which indicates that bubbles serve as local intensifiers of the acoustic pressure and therefore play an important role both in stone comminution and tissue damage. In HIFU application, PCD is also used to detect subharmonic generation from the focus of transducer in liver in vitro, which a good indication of cavitation activity. To test enhanced heating by finite amplitude waves, temperature measurements in gelatin tissue phantom were performed for different duty cycles by equal acoustic powers of HIFU source. It is shown that nonlinearity can increase heating by a factor of ten if shocks are formed close to focus.

Statistical Prediction of Crack Growth in a Tensioned Steel Band

Thursday, April 27, 2000 4:00 p.m.

Dr. David C. Swanson
Pennsylvania State University
State College, Pennsylvania
http://www.psu.edu

Bending waves on a mid-way notched steel band under constant tension are monitored during many hours of transverse vibration excitation until the band breaks due to crack growth across the notched area. The crack growth is experimentally observable through downward shifts in the resonance frequencies of the structure. Extensive modeling of the notched band using transfer mobilities shows that the crack growth can be effectively modeled as an increasing rotational compliance in the notch area. Further analysis of the transfer mobility model provides simple expressions for the expected resonance frequency shift as a ratio of band-to-crack stiffness. For mid-span cracks, all resonances will shift downward by the same percentage. For a crack closer to one end of the band, the resonances of modes for which the crack is near an antinode will decrease more than the resonances of modes for which the crack is near a node, thus allowing crack location to be determined. Application of Skudrzyk's mean value method allows one to estimate (from the measured transfer function) the damping, minimum detectable crack compliance, and ultimately crack depth. The mode frequencies and parameters from the physical transfer mobility model are used in a Kalman filter to generate statistical estimates of the crack depth, growth rate, and acceleration. The Kalman state vector and covariances are then used to estimate the probability of survival, current hazard rate for breakage, and the time until expected band failure. Typical experimental results show the remaining band life estimate to be accurate to within about 5 minutes about 1 hour prior to actual band breakage.

Two Topics in Sediment Acoustics

Friday, May 5, 2000 4:00 p.m.

Dr. Masao Kimura
Tokai University
Shizuoka, Japan
http://www.u-tokai.ac.jp

(1) Shear wave velocity measurements using radiation impedance. Shear wave velocity is important in characterizing surficial marine sediments. It was demonstrated that the shear wave velocities in viscoelastic media can be determined from the frequency at which the radiation reactance becomes zero, which permits the shear wave velocity of sands to be measured. The shear wave velocities in a layered sediment model are measured. The effect of the thickness of the upper medium on the measured values of shear wave velocities are considered.

(2) Investigations of the Biot Parameters. The Biot-Stoll model for acoustic wave propagation in fluid saturated, porous media such as marine sediment has been used extensively. This model requires 13 physical parameters which are divided into three categories: the grain, the pore fluid, and the frame. Of these parameters, the values of the grain bulk modulus, and of the frame bulk and shear moduli, are currently subjects of debate in the community. In this study, the value of the grain bulk modulus, and the relationship between the values of the frame bulk and shear moduli in air and water saturated glass beads, are investigated.

Nonlinear Effects in an Acoustical Resonator

Friday, September 22, 2000 4:00 p.m.

Dr. E. A. Zabolotskaya & Dr. Y. Ilinskii
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

Recent advances in the development of thermoacoustic engines and acoustical compressors require an understanding of extremely intense sound fields (acoustic Mach numbers of order one) in resonators that are not cylindrical. Nonlinear effects such as harmonic generation, waveform distortion, and nonlinear frequency shift are investigated with a one-dimensional model. The 1D model retains all nonlinear terms in the gasdynamics equations and describes potential and isentropic gas motion inside a resonator for which the cross-sectional area varies. The model permits all properties of the flow field throughout the resonator to be calculated numerically. To estimate energy losses in the resonator, we consider the gas flow in the boundary layer along the walls of the resonator in the linear approximation and match it to the nonlinear solution in the volume. Energy loss due to turbulence is evaluated by introducing a model for eddy viscosity. Results obtained with this 1D model are in good agreement with experiments performed by MacroSonix Corp.

Parametric Array in Air: Improvements in Method and Apparatus

Friday, September 29, 2000 4:00 p.m.

Joe Norris
American Technology Corp.
San Diego, California
http://www.atcsd.com

This presentation will cover the inherent difficulties associated with the Parametric Array in Air implementation, and explore recent developments in transducer design and signal processing techniques designed to maximize the available performance of a practical system. A demonstration unit will also be shown. The abundant Parametric Array literature makes clear the compromises an engineer is confronted with, especially in signal processing techniques, when designing a practical system. An analysis of Berktay's farfield solution suggests that the design parameters chosen may result in high-distortion levels, or low efficiency and low output, or an unreasonable bandwidth requirement. A unique signal processing method for minimizing the problems in all three areas simultaneously will be presented. The design of a new type of transducer optimized for this application will be discussed and shown.

Harmonic Generation in Nonlinear Elastic Waveguides

Friday, October 6, 2000 4:00 p.m.

Washington De Lima
Department of Mechanical Engineering
The University of Texas at Austin
http://www.me.utexas.edu

This seminar describes a theoretical approach to modeling harmonic generation associated with the propagation of finite-amplitude elastic waves in homogeneous, isotropic plates and rods. Solutions of the nonlinear equations of motion for harmonic generation in elastic waveguides are obtained by perturbation. A novel feature of the formalism is the application of a reciprocity relation developed originally for the linear response of forced elastic waveguides. This approach permits the derivation of first-order differential equations for the nonlinear modal amplitudes, the solutions of which individually satisfy all source and boundary conditions at second order. Solutions are thus obtained for the second harmonic, sum, and difference frequency components generated by bifrequency excitation of the waveguide. There are no restrictions on the modes or frequencies of the primary waves. Conditions for phase matching and power transfer that ensure resonant generation of the harmonic components are quantified. The analysis is applied to infinite plates, cylindrical rods, and cylindrical shells. Predictions of resonant harmonic generation in typical experimental configurations are presented.

Acoustic Agglomeration: Experiments, Modeling, and Applications

Friday, October 13, 2000 4:00 p.m.

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

No abstract available.

Applying Gradient Sensing Techniques To Directional Receiving Apertures for Acoustic Positioning

Friday, October 20, 2000 4:00 p.m.

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

At the 108th AES convention in February 2000, Angelo Farina of the University of Parma presented a paper entitled "Simultaneous measurement of impulse response and distortion with a swept-sine technique". The paper shows how to use a logarithmically-swept sine FM chirp to measure the frequency response and the distortion characteristics of a system simultaneously. The technique uses an inverse filter to extract the impulse response and separate the harmonic responses. It is especially suited to acoustical measurements, because it is robust to harmonic distortion, unlike the popular maximal length sequence (MLS) technique. The talk will cover swept sine measurement methods, such as time-delay spectrometry (TDS), which are special cases of this technique. The spectrogram, which is closely related to the new technique, will be explained in detail. MATLAB simulations will be presented, and computation issues will be examined.

Impulse Response And Distortion Measurement With Swept Sine Chirps

Friday, October 27, 2000 4:00 p.m.

Dr. Tom D. Kite
Audio Precision
Beaverton, Oregon
http://audioprecision.com

At the 108th AES convention in February 2000, Angelo Farina of the University of Parma presented a paper entitled “Simultaneous measurement of impulse response and distortion with a swept-sine technique”. The paper shows how to use a logarithmically-swept sine FM chirp to measure the frequency response and the distortion characteristics of a system simultaneously. The technique uses an inverse filter to extract the impulse response and separate the harmonic responses. It is especially suited to acoustical measurements, because it is robust to harmonic distortion, unlike the popular maximal length sequence (MLS) technique. The talk will cover swept sine measurement methods, such as time-delay spectrometry (TDS), which are special cases of this technique. The spectrogram, which is closely related to the new technique, will be explained in detail. MATLAB simulations will be presented, and computation issues will be examined.

Nonlinear Sound Propagation in Fibrous Sound-Absorbing Materials

Friday, November 3, 2000 4:00 p.m.

Professor C. L. Morfey
Institute of Sound & Vibration Research
University of Southampton
Southampton, UK
http://www.soton.ac.uk

Transverse oscillations of a cylinder in a viscous fluid generate a force on the fluid that becomes nonlinear at large oscillation amplitudes. When the cylinder motion is sinusoidal, nonlinearity produces odd-order harmonic distortion in the force. Direct numerical simulation (DNS) based on the incompressible Navier-Stokes equations is used to explore (i) departures of the drag force from linear theory and (ii) the approach to quasi-steady drag behaviour, for oscillations covering a wide frequency range at peak Reynolds numbers between 0.01 and 10. Nonlinearity becomes apparent once the displacement amplitude is comparable with the viscous penetration depth at the oscillation frequency. The DNS drag results provide insight into the attenuation of sound in air-filled fibrous materials, where nonlinear behaviour has been observed at sound pressure levels around 150 dB and upwards [H.L. Kuntz and D.T. Blackstock 1987 J. Acoust. Soc. Am. 81, 1723-1731]. For this purpose a simplified 2-phase acoustic model, appropriate to widely-spaced fibres, has been combined with the drag predictions. This yields the attenuation and phase speed of acoustic plane waves in lightweight fibre blankets, without requiring any empirical data (other than an estimate of the skeleton in vacuo longitudinal wave speed). At low sound pressure levels there is encouraging agreement with measurements for porosities close to 1, although further work is needed to deal with fibre proximity effects. At high sound pressure levels, the isolated-fibre drag predictions imply a level-dependent increase in the attenuation rate of sinusoidal waves that is roughly consistent with the high-porosity measurements of Kuntz and Blackstock [1987].

Sound Propagation in the Near-Ground Atmosphere

Monday, November 13, 2000 4:00 p.m.

Dr. D. Keith Wilson
U.S. Army Research Laboratory
Adelphi, Maryland
http://www.arl.army.mil/main/Main

The surface layer of the atmosphere (roughly the lowermost 50 to 100 m) is characterized by vigorous turbulence and sharp vertical gradients in the wind speed and temperature. These phenomena affect sound propagation near the ground in complex and often dramatic fashion. As explained in this seminar, recent progress in the parameterization and simulation of atmospheric turbulence provides insight into sound propagation. Among topics to be discussed are the following: derivation of “universal” refraction curves from the Monin-Obukhov turbulence similarity theory; modeling the spectrum of the acoustic index of refraction and the relative contributions from wind and temperature; the important, and only recently recognized, role of very large eddies (scale 1 km); and why the traditional treatment of wave propagation in random media may be unsuitable for the near-ground atmosphere.

Using Digital Signal Processing Techniques to Aid the Deaf

Wednesday, November 15, 2000 4:00 p.m.

Assistant Professor Philip Loizou
Department of Electrical Engineering
The University of Texas at Dallas
Dallas, Texas
http://www.utdallas.edu/dept/ee

Cochlear implants are now established as a new option for individuals with profound (sensorineural) hearing impairment. Many of the cochlear implant patients are able to understand speech without lip-reading, and some can communicate over the phone. The success of cochlear implants can be attributed to the combined efforts of scientists from various disciplines including bioengineering, physiology, and signal processing. Signal processing, in particular, played an important role in the development of various techniques for deriving electrical stimuli from the speech signal. The amount of spectral information that can be derived from the speech signal and delivered to the electrodes is limited, since the implant users have a small number (6-22) of electrodes. The designers of cochlear implants are therefore faced with the challenge of developing signal processing strategies that can extract a small, yet sufficient, amount of spectral information from the speech signal without compromising speech intelligibility and/or quality. Depending on the type of spectral information that was extracted from the acoustic signal, different speech processing strategies were developed over the years. This talk will provide an overview of various signal-processing techniques that have been used for cochlear prosthesis over the past 25 years.

Particle Image Velocimetry and Temperature Measurements in Thermoacoustic Stacks

Tuesday, November 28, 2000 4:00 p.m.

Dr. Philippe Blanc-Benon
Ecole Centrale de Lyon
Lyon, France

The knowledge of temperature and flow fields in the microchannels and at the edges of the stack plates becomes an increasingly important issue in the design of heat exchangers for thermoacoustic engines. On these topics we have conducted experiments in a resonant standing wave thermoacoustic refrigerator model. First, we present experimental data obtained using Particle Image Velocimetry: velocity profiles across the microchannels, 2D velocity maps including a zoom for the edges of the stack, and vorticity fields calculated with a criterion based on a normalized angular momentum. Second, using a linear array made of miniature thermocouples, we measured the build-up of the temperature gradient along the stack for different oscillating flow conditions. In particular the effect of the plate spacing is illustrated. Finally, comparisons are made with theoretical models and numerical simulations recently published in the literature.