

The 4th Meeting of the
MidSouth Chapter of the
Acoustical Society of America

The University of Central
Arkansas
Conway, AR 72034

March 6-7, 2009

Meeting Proceedings

Meeting Schedule:

Friday, March 6

- 1:00-2:00PM : Registration
- 2:00-3:30PM : Opening Sessions
- 3:30-3:45PM : Break
- 3:45-4:45PM : Afternoon Sessions
- 6:00-7:30PM : Dinner at Mike's Place

Saturday, March 7

- 7:30-8:30AM : Coffee & Donuts
- 8:30-9:30AM : Poster Sessions
- 9:30-11:00AM : Morning Sessions
- 11:00-11:15AM : Break
- 11:15-12:00AM : Closing Session
- 12:00-1:30PM : Business Meeting

Meeting Location: The meeting will be held in Lewis Science Center located on Bruce Street on the University of Central Arkansas campus. Parking is available in the lots on the east side of the building. Sessions will be held in the north end of the building in room 101 with posters displayed in the atrium. Check the Chapter website for building and campus maps.

Announcements: The next meeting of the MidSouth Chapter of the Acoustical Society of America will be in the month of September in Oxford, MS.

Check the chapter website:

<http://www.acosoc.org/RegChapters/MidSouth/>

for more details about the upcoming meeting in the months ahead.

Oral Abstracts

Friday, March 6

2:00-2:45PM

Technical Aspects of Acoustical Engineering for International Space Station. Chris S. Allen (NASA JSC, Mail Code SF22, 2101 NASA Road 1, Houston, TX 77058, christopher.s.allen@nasa.gov)

It is important to control acoustic levels on manned space flight vehicles and habitats to protect crew-hearing, allow for voice communications, and to ensure a healthy and habitable environment in which to work and live. For the International Space Station (ISS) this is critical because of the long duration crew-stays of approximately 6-months. NASA and the JSC Acoustics Office set acoustic requirements that must be met for hardware to be certified for flight. Modules must meet the NC-50 requirement and other component hardware are given smaller allocations to meet. In order to meet these requirements many aspects of noise generation and control must be considered. This presentation has been developed to give an insight into the various technical activities performed at JSC to ensure that a suitable acoustic environment is provided for the ISS crew. Examples discussed include fan noise, acoustic flight material development, on-orbit acoustic monitoring, and a specific hardware development and acoustical design case, the ISS Crew Quarters.

2:45-3:00PM

Effect of cortical layer on ultrasonic backscatter measurements of cancellous bone. Brent Hoffmeister (Rhodes College, Department of Physics, 2000 North Parkway, Memphis TN, hoffmeister@rhodes.edu)

Ultrasonic techniques offer a promising means to detect density changes that occur to bone as a result of degenerative diseases such as osteoporosis. Most techniques transmit ultrasonic pulses through bone to measure speed of sound and/or attenuation. However, there is increasing interest in developing ultrasonic backscatter techniques for bone assessment. Several studies have shown that ultrasonic backscatter measurements can correlate well with bone density, depending on several factors. Most studies however, have been performed on excised specimens of cancellous (i.e., spongy) bone with the outer ivory-like cortical layer removed. The goal of this study was to perform backscatter measurements on specimens of human cancellous bone with the outer cortical layer preserved. Measurements were performed in a water bath using a 5 MHz broad band transducer. Ultrasonic pulses were propagated into the specimens and the backscattered signals were analyzed to measure the frequency averaged backscattered power. A total of 52 specimens were measured. A linear regression analysis was performed to determine the correlation between our backscatter measurements and specimen density as determined by x-ray CT. Measurements performed through the cortical layer demonstrated a slightly weaker correlation than measurements performed in the same region of interest without the intervening cortical layer ($R = 0.45$ vs. $R = 0.56$). We conclude that the cortical layer has a detrimental effect on backscatter measurements, likely due to distortion of the ultrasonic wavefront by the curved intervening cortical layer of bone.

3:00-3:15PM

Acoustic Measurement of Fines. Brian Carpenter* (Research & Development Engineer I, National Center for Physical Acoustics, University of Mississippi, 1 Coliseum Drive, University, MS 38677, wocarp@olemiss.edu), Daniel Wren (USDA-ARS-NSL, P.O. Box 1157, Oxford, MS 38655), Roger Kuhnle (USDA-ARS-NSL, P.O.

Box 1157, Oxford, MS 38655), and Jim Chambers (National Center for Physical Acoustics, University of Mississippi, 1 Coliseum Drive, University, MS 38677)

This research investigates the use of acoustics as a surrogate measurement technique to investigate the concentration of fines (particles smaller than 100 microns in diameter) in a water column. Both the backscattered sound from one transducer emitting sound into the water as well as the attenuation of sound passed between two transducers will be investigated as potential measurement techniques. The frequency response as a function of the concentration of fines will be made in a laboratory tank. Allied work on larger particles (100-1000 micron in size) suggests a required frequency range of between 5-50 MHz to investigate the fines. Using 20 MHz immersion transducers, data will be acquired using a computer equipped with an oscilloscope PCI card and a 1 GS/s A/D card. Data will be analyzed and presented for known concentrations of bentonite and kaolinite.

3:15-3:30PM

Cavitation Threshold Dependence on High Static Pressures. Kenneth Bader (University of Mississippi National Center for Physical Acoustics, 1 Coliseum Dr., University, MS 38677, kbader@olemiss.edu)

When a fluid is subject to a sound wave, it undergoes compression and tension with the positive and negative pressures of the acoustic field. If the tension is large enough, the liquid can fracture and a cavity will form, a process known as acoustic cavitation. The dependence of the cavitation threshold on hydrostatic pressure has been reported up to 100 bar, but in the attempt to push cavitation phenomena into higher energy regimes, higher hydrostatic pressures are being explored. This work will report measured cavitation threshold as a function of static pressure in water. The water is degassed and filtered to remove particulate nuclei. The cavitation vessel is a stainless steel spherical resonator (24.1 cm outer diameter, 1.9 cm thick) with a $Q > 10,000$ when fluid loaded. These measurements will be compared with data reported in the literature over the common parameter space, and will also be used to extrapolate the cavitation threshold to static pressures as high as 1 kbar.

3:30-3:45PM

Break

3:45-4:30PM

Listening for Ivory-billed Woodpeckers. David Luneau (Department of Engineering Technology, University of Arkansas at Little Rock, Little Rock, Arkansas 72204, mdluneau@ualr.edu)

Ornithologists and amateur birders more often than not identify bird species by hearing their call notes or songs. Consequently, the search for the endangered Ivory-billed Woodpecker involved listening for, recording, and synthesizing sounds. The presentation includes a brief history of the bird, a discussion of search techniques, and a demonstration of acoustic and video evidence. Ongoing search efforts for the bird will also be discussed.

4:30-4:45PM

Computer modeling for bridge aerodynamics. R. Panneer Selvam* and Shanique Murray (University of Arkansas, BELL 4190, rps@uark.edu)

Long span bridges need to be designed against bridge flutter failure. Measuring the critical flutter velocity from wind tunnel

costs about \$100k. The time taken to perform wind tunnel tests is around three months. Computer modeling of flow around bridges and the interaction of flow and structure can reduce the time from 3 months to one month. The model can be run in a personal computer. The predicted critical flutter velocity from the computer model will be compared with experimental measurements. The challenges in the computer modeling and the predicted fluid structure interaction will be discussed in detail. Animations are made to explain the flutter phenomena and the flow structure around the bridge. The flow around the bridge is computed at each time using finite element method. The challenges in making proper grid resolution around bridges will be discussed. To improve the efficiency adaptive FEMs are tried. The Navier-Stokes equations are solved at each time to calculate the pressure around the bridge and the computed pressure is used to calculate the forces on the bridge and the structural dynamics equation is solved to get the position of the bridge from the applied force. To perform this operation a moving grid is used. Proper precaution were taken to satisfy the geometric conservation law and this allows to take larger time step than others approach. At this time the computer model can compute the critical flutter velocity in around one month. The cost of the computer costs less than \$1000. Over all the cost is for the engineer to run and interpret the model.

Saturday, March 7

9:30-10:15AM

Delineation of buried geological structure in eastern Arkansas. Haydar Al-Shukri*, Okba Al Kadi, and Hanan Mahdi (University of Arkansas at Little Rock, 2801 South University Ave, hjalshukri@ualr.edu) and Martitia Tuttle (United States Geographical Survey, Memphis, TN)

High-resolution geophysical and geological surveys allowed the mapping of a zone of sand blows and sand dikes for a distance of 10 km near Marianna, Arkansas. Thin and linear zone is possibly the surface expression of a buried fault. The Marianna area was found to be characterized by very large sand blows, sand dikes, and related ground failures indicative of earthquakes. This was a surprising finding given that few modern or historic earthquakes have occurred in the study area or the surrounding region. During this study, we collected GPR data using a 400 MHz mono-static antenna and a high-speed data acquisition system. We collected data for more than two hundred profiles and three high-resolution 3-dimensional datasets at 27 sites along a prominent light-colored lineament identified on aerial photographs and satellite imagery. A common feature in the profiles is a sharp discontinuity between the sand blow and the underlying silt loam (old surface) that is correlated between profiles. Sand dikes in the silt loam are well defined in the GPR data and present in almost all the profiles. The largest sand dikes strike northwest and are correlated between profiles. A total of seven trenches have been excavated in the study area to verify that features imaged with GPR are sand blows and sand dikes and to collect samples for dating purposes. Trench logs show a perfect match between the actual subsurface structure and the GPR profiles. In the future, other geophysical techniques will be used to characterize the proposed fault at greater depths.

10:15-10:30AM

Ring Laser Measurements of Seismic/Acoustic Waves. Robert Dunn (Hendrix College, Department of Physics, 1600 Washington, Conway, Arkansas 72032, dunn@hendrix.edu)

During the last decade, large ring lasers have become a valuable tool for making geophysical measurements. A large ring large deployed north of Conway, Arkansas has measured seismic induced

ground rotation, responses from hurricanes in the Gulf of Mexico, and responses that are apparently from volcanic eruptions in the Aleutian Islands. The most distinct frequencies detected from hurricanes and volcanoes fall between 1 and 8 mHz; whether the detected waves are seismic, infrasound, or some combination of the two is not totally clear. Examples of these measurements will be presented.

10:30-10:45AM

Efforts in Distributed Arrays for Infrasound Measurements. Kevin Dillion (Miltec, National Center for Physical Acoustics, The University of Mississippi, Room 1069, University, MS 38677, kdillion@mil-tec.com)

Infrasound signals contain very low frequency components and travel very long distances, yet wind noise magnitudes often cover up the infrasound signal magnitudes. This presentation presents the collection and analysis of infrasound signals measured with distributed arrays. Techniques for reducing wind noise to uncover signals of interest and identifying signals based on their spectral components are also presented.

10:45-11:00AM

A generalized Earth-flattening transformation for sound. Santosh Parakkal* and Ken Gilbert (National Center for Physical Acoustics, University of Mississippi, University, MS 38677, sparakka@gmail.com)

A practical conformal mapping method is derived that is applicable to sound propagation over realistic irregular terrain. Coupled with a parabolic equation model, the mapping method predicts transmission loss that is in good agreement with data from the Joint Acoustic Propagation Experiment (JAPE). A useful aspect of the mapping method is that, in the mapped coordinates, the terrain is flat, but the effective sound speed is c/\sqrt{J} , where c is the sound speed derived from meteorology, and J is the Jacobian of the conformal mapping. Thus, the effect of irregular terrain can be represented within the same framework as for sound-speed gradients due to temperature and wind. In general, terrain-generated sound speed gradients are 50-200 times greater than those due to temperature and wind and hence are critical for accurately predicting sound propagation over realistic irregular terrain.

11:00-11:15AM

Break

11:15AM-12:00PM

The Science and Art of Marimba Bar Tuning. David Peterson (University of Central Arkansas, Conway, AR 72034, DavidP@UCA.edu)

Wind chimes, xylophones, and several other instruments use "untuned" bars or rods, i.e. the modal frequencies of vibrations do not form a harmonic series $f_n/f_1 \neq \text{integer}$. For instance, with bars $f_2 = 2.76f_1$. Since humans seem to prefer harmonic sounding instruments, marimba makers contour the bars so that $f_2 = 4f_1$ and $f_3 = 10f_1$. But marimba bars do not scale - the bar for middle C is not just a longer version of the bar that is an octave higher. Marimba makers have general patterns (there are mathematical formulas) for each bar and then individually tune them depending on the nature of each particular piece of wood. I will illustrate how this is done and will also demonstrate how the strike position changes the sound of the bar.

Poster Abstracts

Simple Models of Photoacoustic Spectroscopy. Logan Marcus*, R. Raspet, S. Aranchuk (National Center for Physical Acoustics, University of Mississippi, University, Mississippi 38677, LSmarcus@olemiss.edu)

Photoacoustic Spectroscopy (PAS) has been shown to be a useful tool in detection of trace chemicals. This poster will detail work that has been done in developing a one dimensional model of a PAS system using a Laser Doppler Vibrometer (LDV) as the measurement device. There are two main mechanisms that affect the optical path length of a probe laser beam that must be considered in a simple model. The first is the vibration of the sample surface due to the periodic heating of the sample, and the second is the variation of the index of refraction of the air caused by temperature and pressure changes. From the literature we can say that the surface motion of the sample is independent of the periodic pressure variation produced in the air above the solid; this leads to a simple model of the surface velocity for a sample to be calculated. A second simple model has been developed for the changes in the index of refraction of the air. The index of refraction of the air is dependent on the fluctuating pressure and temperature caused by the periodic heating of the sample. The new model includes the effect on the probe beam from both the surface motion and the fluctuations of the index of refraction of the air. Future modeling work will also be discussed.

A novel ultrasonic device for measuring the viscoelastic properties of fluids. Jenna K. Smith, Stephanie M. Milazzo*, Brent K. Hoffmeister (Rhodes College, Department of Physics, 2000 North Parkway, Memphis, TN 38112, milsm1@rhodes.edu)

The goal of this project is to develop an ultrasonic measurement system that can measure the viscosity and shear stiffness of fluids. The system uses a 5 MHz AT cut (shear mode) quartz resonator that is swept over a range of frequencies to measure the center frequency and half width of the fundamental mode resonance. When the resonator is immersed in a fluid, the center frequency decreases and the half width increases. These changes can be analyzed to determine the complex reflection coefficient at the fluid-resonator interfaces from which the viscoelastic properties of the fluid may be determined if the density of the fluid is known. Measurements were made on fluids whose viscosity ranged from approximately 1-600 centipoises and compared to measurements performed with a standard viscometer. We observe a good linear correlation between measurements made with our ultrasonic system and a standard viscometer. Viscosities determined with the ultrasonic technique, however, are generally less than viscosities measured using a standard viscometer.

Motion Analysis of an Oscillating Target Using Laser Speckles. Chris Peters, (University of Mississippi, 1 Coliseum Dr., University, MS 38677, clpeter2@olemiss.edu)

Recent research on human detection has shown that a walking person could be detected by the periodicity in the motion of his limbs and body. Different techniques have been used to detect human motion, such as seismic sensors, microphones, and ultrasonic motion sensors. While processing the signals from these sensors allows reliable detection of a walking person, the sensors themselves have a detection range limited to about 20 meters in a typical urban environment. For this reason, we proposed the concept of an optical motion sensor based on the phenomenon of dynamic laser speckles, which can work at longer distances. The principle consists of illuminating a target with a laser beam and analyzing the variations of speckles formed in the image and focal planes of

the lens, which collects the scattered light. Periodic motion of the target causes periodic fluctuations of the speckles. Detection of intensity fluctuations of speckles with a single photodetector and correlation analysis of the photodetector signal allow the extraction of the information about the periodicity of the target motion. The experiments to measure the periodicity of an oscillating diffuse target have been performed. The autocorrelation function of the intensity of speckles in the focal plane of the lens has been calculated and revealed the expected period of oscillation of the target. The description of the experimental setup and the experimental results are discussed in the current work.

Analysis of frequency modulation in vocalizations of infant and juvenile African elephants. Tatiana Riddle (Arkansas School for Mathematics, Sciences, and Arts, 205 Pumpkin Center Circle, Quitman, AR 72131, tatiana.riddle@gmail.com)

Infrasound communication between elephants is applied in a variety of complex situations, both in the wild and in captivity. The more significant aspect of infrasound is that it can be phonated and transmitted over long distances, allowing elephants separated from their herd to find and communicate with one another. Elephants have also been recorded communicating through concrete walls in a captive setting, therefore supporting the idea that male and female elephants in the wild can live independent lives, but still reproduce as a result of their ability to communicate and find a mate through infrasonic vocalizations. Research has also shown that elephants in a savannah environment can communicate with infrasound as far as four kilometers away from each other. It was supported that the males vocalizations would be lower in frequency than the female calfs calls, but that vocalizations of both elephants would correlate to their behavior. The African elephants analyzed in this experiment are currently residing at Riddles Elephant and Wildlife Sanctuary. The vocalizations of an infant female African elephant (*Loxodonta africana*) calf and a juvenile male African elephant differ in structure, as the infant females calls are higher in frequency and shorter in duration than the juvenile males calls. Vocalizations from both a 10-month old and 5 year old African elephant, Miss Bets and Maximus, respectively, were recorded and analyzed in order to identify the context and characteristics of the calls.