2nd Meeting
MidSouth ASA Chapter

The Center for Earthquake Research and Information (CERI) University of Memphis

April 18, 2008

Meeting Proceedings

Meeting Schedule:

- Meeting Registration: 8:00AM (name tags, etc)
- Presentations: 9:00-10:30AM
- Posters: 10:30-12:00PM
- Lunch: 12:00-1:30PM
- Tour of CERI: 1:30-2:30PM
- Chapter Business Meeting: 3:00-4:00PM

Announcements:

- The next meeting of the MidSouth Acoustical Society of America Chapter 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.

- Special thanks to Charles Langston at CERI for helping to organize this meeting.

Oral Abstracts

8:00

Array observations of thunder infrasound and its induced ground motions. T. Lin* and C. Langston (CERI, University of Memphis, 3876 Central Ave., Suite 1, Memphis, TN 38152, tllin@memphis.edu)

A small array consisting of five three-component short-period surface seismometers, a three-component borehole seismometer, and five infrasound microphones was built to investigate thunder-induced ground motions. Nineteen thunder events were chosen to investigate the seismo-acoustic coupling. The incident slowness differences between acoustic pressure and ground motions suggest that ground motions were first initiated somewhat away from the array by a curved pressure wave front. Possible non-linear interaction for acoustic propagation into the soil at the surface was observed. The acoustic-to-seismic ground motions show a consistent reverberation series at frequencies near 5 Hz and have the characteristics of air-coupled Rayleigh wave where reverberations of P waves and P-to-S conversions are trapped in the layer. These impulsive acoustic waves excited P and S reverberations in the near surface that depend on both the incident wave horizontal slowness and the velocity structure in the upper 30 meters at the site.

8:20

Atmospheric Earthquakes: The Seismic Signature of the 7 November 2007 Re-entry of Space Shuttle Discovery Recorded by the New Madrid Cooperative Seismic Network. C. Langston (CERI, University of Memphis, 3876 Central Ave., Suite 1, Memphis, TN 38152, clangstn@memphis.edu)

The sonic boom generated by Shuttle Discovery in its re-entry from the STS-120 mission generated a spectacular set of seismic signals on broadband and short period sensors of the New Madrid Cooperative Seismic Network. Comparison of acoustically induced ground motions from the shuttle and a meteor (3 November 2003) show that the relatively low Mach number and high mass of the shuttle combined to allow significant acoustic coupling of low frequency ($\sim$0.5 Hz) Rayleigh waves into the thick, unconsolidated sediments of the Mississippi embayment. Many stations also show precursory head wave phases that arrive before the direct acoustic wave. Ground motions induced by the meteor were higher frequency ($\sim$5 Hz) and were controlled by the high acoustic wave horizontal phase velocity across the network; coupling was confined to structure in the upper tens of meters. The acoustically induced Rayleigh waves from the shuttle sonic boom are sensitive the entire thickness and velocity structure of the unconsolidated sediments and represent an unusual data opportunity for understanding low frequency shaking hazards in the New Madrid Seismic Zone.

8:40

Capabilities Study of Airborne Acoustic Sensor Arrays. W. Prather (Miltec Research & Technology, 9 Industrial Park Dr., Oxford, MS 38677, wprather@mil-tec.com)

Miltec Research & Technology along with the National Center for Physical Acoustics, Raspet Flight Research Laboratory, and Mississippi State University Aerospace Department have performed a detailed study of the benefits and issues associated with the implementation of an array of acoustic sensors on airborne platforms both moving and stationary. In order to facilitate this a platform has been developed for the testing of airborne acoustic arrays used in detection, tracking, and identification of objects of interest. The

test bed has been selected such that it is optimized for this effort within reasonable limitations on complexity and costs. This approach allows for the determination of best case performance parameters for acoustic arrays on aerial platforms. Issues related to the design of the platform as well as measured results will be presented.

9:00

Porous Materials Research at the National Center for Physical Acoustics. J. Sabatier (Univ. of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, sabatier@olemiss.edu)

The ground surface, to a depth of a few meters, is a granular fluid-filled porous material. Acoustic methodologies describe soils through parameters such as velocity, attenuation, impedance, bulk modulus, and flow resistivity. The Porous Materials Group investigates physical phenomena relating to the interactions of acoustic waves with these porous media. The need to accurately measure minute vibrations of the ground when acoustically excited has led to the development, in conjunction with industry partners, of advanced Doppler vibrometry technologies for rapid area measurements. Applications of this research include characterization of soil properties, landmine detection, tunnel detection, human detection, and obscured vehicle detection.

9:20

Ultrasonic methods for human detection. A. Ekimov* and J. Sabatier (Univ. of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, aekimov@olemiss.edu)

Walking people create periodic broadband frequency envelopes of vibrations in the ground/floor and sound in the air from a few Hertz up to ultrasonic frequencies due to footstep dynamic forces. The authors investigated the physical mechanisms involved in the generation of high frequency signals and their application for human footstep detection. High-frequency sound is produced by friction forces between a foot and the ground/floor and by clothing. These ultrasonic signals allow passive footstep detection in high-noise urban areas and in buildings. Human motion when walking is a cyclic, temporal process. The individual human body parts (torso, legs, arms, etc.) have different cross-sections and velocities that form unique human Doppler signatures. These signatures can be used to distinguish humans from other moving and stationary objects. The active ultrasonic method for human detection utilizes continuous-wave Doppler sonar. Simultaneously collecting Doppler motion and footstep ultrasonic signals reveals correlated timing features between the footstep friction and the Doppler shift from the human motion. [Work supported by Department of the Army, Army Research Office contract W911NF-04-1-0190].

9:40

The study of the environmental influence on soil properties using acoustic techniques. Z. Lu* and J. Sabatier (Univ. of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, zhiqulu@olemiss.edu)

Understanding the environmental influences on soil properties is important for US Army and agricultural applications. In nature, the properties of soils undergo ceaseless variations due to the processes such as temperature fluctuation, rainfall precipitation, infiltration, drainage, water redistribution, evaporation, creep, and compaction. No any laboratory test, no matter how well designed, can simulate such complicated real world conditions. It is valuable to monitor the evolution of soil properties in natural conditions. To do so, an acoustic technique is invoked for a long-term field soil survey by sound speed measurement. In this study, an acoustic probe with five acoustic transducers is inserted into the ground. At different depths, sound speed, temperature, moisture, soil suction or water potential, and rain precipitation have been recorded continuously for two years. It is found that rain-fall causes dramatic disturbance of soil properties due to infiltration and drainage processes which can be reflected by the measurement of sound speed. The study reveals that temperature has a negligible effect on the sound speed, moisture plays a minor role, and soil suction or water potential is the predominant factor governing the sound speed of the shallow field soil. Terzaghis principle of effective stress is brought to explain the observations.

10:00

Rapid acoustic detection of buried landmines using multiple beam laser Doppler vibrometry. V. Aranchuk* and J. Sabatier (Univ. of Mississippi, NCPA, 1 Coliseum Drive, University, MS 38677, aranchuk@olemiss.edu) and R. Burgett (Planning Systems, Inc., University, MS, 38677)

An acoustic method of buried landmine detection consisting of excitation of the ground using airborne sound or seismic waves in the frequency range from about 50Hz to 1000Hz, and obtaining a velocity image of the ground surface with a laser Doppler vibrometer (LDV) has been developed and successfully tested in the laboratory and field experiments. The presence of a buried landmine can be detected by an abnormality in the velocity image. Initially, the scanning single-beam LDV created a velocity image of the ground through point-by-point measurements, which resulted in a long measurement time. To reduce this measurement time, a multiple beam LDV having 16 beams configured in a linear array was developed and successfully used in field experiments. To further reduce the time of measurement, a full-field LDV capable of making 256 vibration measurements in parallel on the target, configured as 16x16 square array of points equally separated in x- and y-directions has been recently developed. The system is capable of creating a 2-dimensional vibrational velocity image of the ground surface in the time defined by the required frequency resolution. The parallel measurement makes the system a unique tool to measure transient vibrations.

Poster Abstracts

Effects of competing messages on human and synthetic speakers. E. Goshorn* and B. Kemker (The Univ. of Southern Mississippi, Hattiesburg, MS 39406, edward.goshorn@usm.edu)

The use of synthetic speech in commercial and audiological diagnostic applications is rapidly growing. For audiological purposes, synthetic speech permits finer control of many linguistic variables. The effects of competing messages on human speech has been investigated but still remains uncertain while little is known about the effects of competing messages on synthetic speech. This study investigated the intelligibility of human and synthetic produced speech under four competing conditions: none; human; synthetic; and white noise. Test signals consisted of a human and a synthetic talker (Microsoft Mike) speaking two word-order variations of the Diagnostic Rhyme Test (DRT). The same human and synthetic talkers produced a ten minute competing message consisting of the “The Walter Mitty Story”. All signals and competing messages were digitally recorded, mixed, and produced to assure uniformity. The talker/competing listening conditions were: Human/None; Human/Human; Human/Synthetic; Human/White Noise; Synthetic/None; Synthetic/Human; Synthetic/Synthetic; Synthetic/White Noise. The subjects were 5 adults with normal hearing. Each subject listened to each combination of talker and

competing message and recorded their responses on a prepared form. Three replicates were obtained for each condition. Results showed that human speech was consistently more intelligible than synthetic speech and human speech was less susceptible to distortion by human or synthetic competing speech than was the synthetic talker. White noise masked each talker equally while synthetic competing speech was more disruptive to the synthetic talker than to the human talker.

Piezoelectric efficiency of plate acoustic waves in ZX-cut lithium niobate. V. Klymko* and I. Ostrovskii (Dept. of Physics and Astron. The Univ. of Mississippi, University, MS 38677, vick@olemiss.edu)

The effective electromechanical coupling coefficient characterizing an efficiency of plate acoustic wave (PAW) excitation is calculated for 8 lowest PAW modes propagating in the Z-cut lithium niobate plate along the X axis. The coupling coefficient is calculated with two different approaches. The known method employs the difference in phase velocities of PAW (Vo-Vm), where Vo is for the plate with both surfaces free and Vm is for the plate with one metallized surface. An alternative approach is to use the difference in dimensionless frequency Y for the mode propagating in a plate with free surfaces (Yo) and with one metallized surface (Ym). The difference (Yo-Ym) is computed for the same wavelength of PAW. The two methods agree well for the low dispersion modes SHo, So. For the highly dispersive mode A1, the coupling coefficient calculated by the Ydifference method is consistent with the experimental data. In the experiment, the transmission loss of crystal plate is measured with a spectrum analyzer Advantest R3131. For A1 mode, the coupling coefficient calculated from the resonance and anti-resonance frequencies is 18%, while the value calculated by the difference in Y is 20.5%. The A1 mode is more efficient than the zero order modes Ao and SHo with the maximum values for coupling coefficient 2% and 14%, respectively.

History and Demonstration of the Photoacoustic Effect. L. Marcus and J. Sabatier (The Univ. of Mississippi NCPA, Oxford, MS 38677, lsmarcus@olemiss.edu)

The poster will relate the history of the photoacoustic effect from its experimental foundation laid by Alexander Graham Bell in the end of the 19th century, through the theoretical work of Rosencwaig and Gersho almost 100 years later. This work has become the basis for a very powerful spectroscopy technique that is used in industry today. Examples of the current use of the photoacoustic effect for chemical analysis are discussed. The photoacoustic effect is a good example of many different basic principles of physics. A demonstration, constructed from easily attainable materials is presented for use in high school, or higher level, demonstrations.

HIFU for Remote Acoustic Hemostasis: Current Status and Challenges. J. Raymond (The Univ. of Mississippi NCPA, Oxford, MS 38677, jraymond@olemiss.edu)

This poster presents an overview of biomedical acoustics research at NCPA. Our ultimate goal is to develop devices to stop bleeding in both remote and hospital settings. One embodiment of this technology would be a transcutaneous application to stop internal bleeding, without the need for surgical exposure. This novel method stems from the unique capabilities of ultrasound to penetrate into soft tissue and focus to a millimeter-size area to achieve the high intensities that lead to tissue cauterization. An image-guided intraoperative acoustic hemostasis device (IGIOAH) was recently tested by trauma surgeons at Tripler Army Medical Center. The purpose of this poster is to describe the development of IGIOAH device designed to stop severe intraparenchymal hepatic bleeding. We understand the engineering challenges that need to be overcome to improve visualization, provide new methods of targeting the injury site and to assess the immediate effects of HIFU therapy.

Configuration of the Moscow, Tennessee, Seismo-acoustic array. T. Lin*, G. Steiner, C. Langston (CERI, University of Memphis, 3876 Central Ave., Suite 1, Memphis, TN 38152, tllin@memphis.edu)

The seismo-acoustic array is located at a private rural residence near the small town of Moscow, TN, at the top of a low hill. The optimal array size was chosen by a series of frequency-wavenumber spectrum computations and logistical considerations. The array was designed to resolve the horizontal slowness of 5 Hz acoustic waves. The array consists of a 5-element, 30-port infrasound array with co-located surface seismic sensors and a 10 meter deep three component borehole seismometer located at the center. Each infrasound microphone includes a 6-port manifold connected to 8-meter long porous garden hoses. The microphone cut-off frequencies defined at the -3 dB amplitude reduction of the passband are at 3 Hz and 28 Hz. The seismic sensors used in the array are Mark Products L-28 geophones. Each geophone (two horizontal, one vertical) was buried at a depth of about 0.2 meter. An additional geophone was installed at the bottom of a 10 meter borehole at the center node. All seismic sensors were calibrated using a shake table. The velocity responses are flat from 4 Hz to 27 Hz. Both microphone and geophone data streams are sampled at a sampling rate of 200 Hz and digitized with a 16-bit resolution digitizer. The seismo-acoustic array used in this study is a practical instrument configuration to resolve infrasound from natural thunder and thunder-induced ground motion. We have shown that thunder can be recorded acoustically and seismically with a good signal-to-noise ratio.

Monitoring of Ash Ejection from Ecuadorean Volcanoes Using Infrasound. C. Hetzer (National Center for Physical Acoustics, 1 Coliseum Drive, University, MS 38677, claus@olemiss.edu)

The Acoustic Surveillance for Hazardous Eruptions (ASHE) project aims to develop and evaluate the capability to use low frequency sound to provide robust, low-latency (5-20 minute) notifications of volcanic eruptions at regional distances. Infrasound monitoring complements both seismic observation and satellite remote sensing to improve continuous monitoring of wide regions of potential eruption hazard at modest cost.