good agreement with the theoretical improvements of 12.88 dB and 5.44 dB, respectively.

10:40

3aUWb3. The shallow sea experiment with usage of linear hydrophone array. Wojciech Szymczak (Hydroacoustic Inst., Polish Naval Acad., str. Smidowicza 69, Gdynia 81-103, Poland, ws2@o2.pl), Eugeniusz Kozaczka (Gdansk Univ. of Technol., Gdynia, Poland), Grazyna Grelowska, Ignacy Gloza, and Sławomir Kozaczka (Hydroacoustic Inst., Polish Naval Acad., Gdynia, Poland)

Purpose of this article is to present designed and made linear hydrophone array and the results obtained during *in situ* trails on Gulf of Gdańsk. The measuring system allowed to localize hydrophones in the selected points and perform measurements in both the horizontal antenna positioning and vertical. Made in this way recordings allow creating accurate 3D imaging of sound intensity/propagation. During research three floating objects were measured: small ship (18 m long), yacht (12 m long) and 5 m pontoon with engine and paddles used to drive. In the article, accurately will be described the entire measurement system and complementary devices (navigation system, sound speed profiler, online underwater monitoring to control linear antenna position) and procedures used during *in situ* measurement circuit check and calibration using Lubell Underwater Speaker with amplifier and connected generator with set of reference signals. Characteristic arrangement of sensors allows use of hyperbolic navigation algorithms which results will be presented with an emphasis on measurements when the unit performed circulation around the measurement system. Furthermore, some spectrograms, cross correlations and frequency classification dependence of the speed using a prepared script in MATLAB programing environment will be discussed and presented.

11:00

3aUWb4. Laboratory investigation with subbottom parametric echosounder SES-2000 standard with an emphasis on reflected pure signals analysis. Wojciech Szymczak, Grazyna Grelowska (Hydroacoustic Inst., Polish Naval Acad., str. Smidowicza 69, Gdynia 81-103, Poland, ws2@o2.pl), Eugeniusz Kozaczka (Gdansk Univ. of Technol., Gdynia, Poland), and Sławomir Kozaczka (Hydroacoustic Inst., Polish Naval Acad., Gdynia, Poland)

The main goal of the paper is to describe correlations between measurements results of trials taken on Guls of Gdańsk bottom sounded with parametric echosounder SES-2000 Standard and laboratory research where collected during survey sediments were measured. Stationary tests took place at Gdańsk University of Technology where 30 meters long 1.8 meter deep and 3 meters wide water tank is located. Main lobe of antenna was directed parallel to the longest dimension. Hydrophones used during experiment were fixed to the 3D positioning system—ISEL, which gave the opportunity to place sensor with high precision in the middle of main lobe or other specified places. Using prepared to this experiment frames different sea bottom layers configurations corresponding to the natural structure were sounded. Data obtained during laboratory measurements and trials *in situ* were combined to draw conclusions about proper interpretation of echograms and begin the process of sediments classification. Analyses were done with MATLAB programing software were data were imported and used to the simulations and comparisons.

11:20

3aUWb5. Environmental acoustic parameters of the Sea of Japan shelf (Peter the Great Gulf). Alexandr N. Samchenko, Igor O. Yaroshchuk, and Alexandra V. Kosheleva (V.I.Il`ichev Pacific Oceanological Inst., 43, Baltiyskaya Str, Vladivostok, 690041, Russia, samchenko.alexandr@yandex.ru)

The paper describes general geoacoustic model of the Peter the Great Gulf (the largest gulf of the Sea of Japan) and detailed model of its part of 400 square km in size. The general geoacoustic model is formed on the basis of geological, seismic, and bathymetric data. It includes distribution of P-, S-wave, density, and attenuation of friable sediments at the bottom surface and averaged characteristics for different types of rocks in the gulf. Bathymetric data processing was carried out by means of two-dimensional singular spectrum analysis, based on the ratio between the size of relief structures and the energy expended under the development of tectonic processes. Detailed geoacoustic model is based on processing of hydroacoustic and seismic authors' studies (3.5 kHz sonar, 50–100 kHz sonar and air-gun). Three sedimentary layers and the location of upper edge of the granite stratum are marked in the observable shelf area. The model demonstrates significant changes in P-, S-wave in the sediments of the lateral (1500–1750 m/s—P-wave and 120–600 m/s—S-wave) and vertical (1500–5400 m/s—P-wave and 120–3300 m/s—S-wave). Some of the most important oceanographic mechanisms determining both large- and small-scale spatio-temporal variations of sound speed field in the same area are presented. These data were obtained by the authors within last several years. Qualitative analysis of the propagation of low-frequency signals is presented as an example of application of the model.

WEDNESDAY AFTERNOON, 5 JUNE 2013 513ABC, 1:00 P.M. TO 2:00 P.M.

Session 3pAAa

Architectural Acoustics and Musical Acoustics: Virtual Concert Hall Acoustics II

Sungyoung Kim, Cochair
RIT, ENT-2151, 78 Lomb Memorial Dr., Rochester, NY 14623

Wieslaw Woszczyk, Cochair
Music Res., McGill Univ., Schulich School of Music, 527 Sherbrooke St. West, Montreal, QC H3A1E3, Canada

Contributed Papers

1:00

3pAAa1. Is there really a whispering gallery at the Great Ballcourt at Chichen Itza, Mexico? David Lubman (DL Acoust., 14301 Middletown Ln., Westminster, CA 92683-4514, dlubman@dlacoustics.com)

A "whispering gallery" (WG) at the Great Ballcourt (GBC) was first reported during its excavation in the 1920s by American archaeologist Silvanus Morley (1883–1948), Director of the Carnegie Institution's Chichen Itza project. In his 1925 National Geographic article Morley wrote: "Standing in this temple one can speak in a low voice & be heard distinctly at the other end of the court, 500 ft away." Around 2000–2001, queries on AZTLAN, a semi-official Mesoamerican archaeology Internet discussion group, found little or no belief in a WG by mesoamericanists. Some opined that any WG would surely be a design accident or an artifact of ballcourt ageing or reconstruction. They stiffened at the suggestion that the ancient Maya might have possessed the requisite knowledge for intentional design.

Was Morley mistaken? Or are modern mesoamericanists missing something? During a tour of Chichen Itza following the fall 2002 joint acoustical meeting in Cancun, Mexico, the author and two of his colleagues convincingly demonstrated a GBC WG to about 100 acousticians and their companions. This paper describes WG phenomena observed at the Great Ballcourt and suggests physical models to explain them. He also presents evidence for intentional design.

1:20

3pAAa2. Three-dimensional sound spatialization at Auditorio400 in Madrid designed by Jean Nouvel. Emiliano del Cerro and Silvia M[a] Ortiz (TIC, Universidad Alfonso X el Sabio, Avenida Universidad 1, Madrid 28691, Spain, ecerresc@uax.es)

The auditorium 400 was designed by the team of Jean Nouvel, the French architect, Pritzker Prize winner in 2008. It belongs to the organization of the National Museum and Reina Sofia Art Centre in Madrid, and is incorporated in a special room within the cultural life of Madrid (Spain). The center collaborates with the Spanish Ministry of Culture, and organizes a series of concerts of contemporary music and electronic and computer music. To achieve the sound projection equipment, the direction of the audience chose the system Acousmonium, designed by the GRM inside the ORTF in Paris. This paper will explain the involvement of the group LIEM (laboratory for Computer and Electronic Music), from Reina Sofia Museum with space in music: The musical relationships and implications of this choice, as well as the technical, architectural, and signal processing techniques used for the design of algorithms for spacialization of sound. After giving a very general overview of specific algorithms for spacialization, we explain some musicals examples designed specifically for this space, and the impact of its implementation and diffusion in the auditorium400 that have very special technical and artistic features.

1:40

3pAAa3. Effect of acoustic and visual stimuli on preference for different seating positions in a concert hall and an opera theater. Shin-ichi Sato, Adrián Saavedra, Alejandro Bidondo (Ingeniería de Sonido, Universidad Nacional de Tres de Febrero, Varentín Gómez 4752, Caseros, Buenos Aires 1678, Argentina, ssato@untref.edu.ar), Shuo Wang, Yuezhe Zhao, Shuoxian Wu (State Key Lab. of Subtropical Bldg. Sci., South China Univ. of Technol., Guangzhou, China), Nicola Prodi, and Roberto Pompoli (Dipartimento di Ingegneria, Università degli Studi di Ferrara, Ferrara, Italy)

The sound fields and the views of several positions in a concert hall and an opera theater were simulated and the subjective preference for different seating positions was investigated. First, the seat preference with and without visual stimuli under the conditions of (1) the original sound level (the sound pressure level at each position was maintained as the impulse response measurements in the auditoria) and (2) the equalized sound level were compared since the subjective scale of seat preference showed the highest correlation with sound level in the previous study investigating the opera theater [Sato *et al*., Acustica united with Acta Acustica **98**, 749–759 (2012)]. Some positions were judged acoustically preferred but visually less preferred or vice versa. Thus, another preference test was conducted by using the combinations of the acoustic and the visual stimuli of different positions to further investigate the audio-visual interaction.

Demonstration

The organizers of "Virtual Concert Hall Acoustics" have arranged a demonstration and a live music concert using virtual acoustics technology of McGill University. The demo and concert will take place Wednesday evening in the Multimedia Room (MMR) at the Schulich School of Music of McGill University. For information, please contact Sungyoung Kim (sxkiee@rit.edu) or Wieslaw Woszczyk (wieslaw@music.mcgill.ca).

WEDNESDAY AFTERNOON, 5 JUNE 2013 513DEF, 1:00 P.M. TO 3:00 P.M.

Session 3pAAb

Architectural Acoustics: Balancing Risk and Innovation in Acoustical Consulting

Eric L. Reuter, Chair
Reuter Assoc., LLC, 10 Vaughan Mall, Ste. 201A, Portsmouth, NH 03801

Invited Papers

1:00

3pAAb1. Risk and innovation—Following on from the 2012 Knudsen Lecture, recent experience with calculated risk for the purpose of creating remarkable spaces is reviewed. Scott D. Pfeiffer (Threshold Acoust. LLC, 53 West Jackson Blvd., Ste. 815, Chicago, IL 60604, spfeiffer@thresholdacoustics.com)

Owner expectations, architectural vision, and creation of the intended aural environment often come together at a critical point in the design process. Frequently the answer that satisfies all of the requirements stretches the comfort level of all parties. When balanced properly, this element of risk frees the entire project team and reaches unexpected, but welcome, outcomes. The author will illustrate these critical decision points in several project examples, outlining the calculation in the calculated risk, and the opportunity to deepen the confidence in the consulting process through further research.

1:20

3pAAb2. Letters from the edge: Less conventional acoustical solutions. Jack B. Evans (JEAcoustics, Engineered Vib. Acoust. & Noise Solutions, 1705 West Koenig Ln., Austin, TX 78756, Evans@JEAcoustics.com)

The essence of acoustical analysis and problem solving still is source–path–receiver; yet, as standards, criteria and products evolve, solution precedents should be revalidated or invalidated, so that new, innovative approaches may be considered. While weighing the best interests of the client, should one rigidly follow procedures developed long ago for average or anticipated conditions, or might the conventional wisdom not always be correct? This paper presents a series of short case-studies where noise or vibration were treated at the source and/or along the path, but with some "twist" or variation, either from typical solution applications or owner/client response. Relevant standards, ordinances, or criteria are referenced. Where available, on-site acoustical measurements, observations, photos, or receiver experiences illustrate concepts. For the case studies presented: indicate (i) importance of the problem, (ii) method of the development used for problem solving, (iii) original contribution of the work, and (iv) conclusions. Case studies may include any of the following: standby power generators for data center, university cafeteria, and dining hall, coffee grinding and packaging shop within a grocery market, exercise/therapy floor impact above offices, air-cooled refrigeration chillers near residences, high-rise elevator equipment room adjacent to residential units, and/or high-rise domestic water booster/circulation pump room adjacent to residential unit.

1:40

3pAAb3. Design and implementation of a tuned low-frequency absorber in a residential music listening/practice room. Aaron M. Farbo and Christopher A. Storch (Cavanaugh Tocci Assoc., 327F Boston Post Rd., Subury, MA 01776, afarbo@cavtocci.com)

The historic Bradley Mansion in Boston's Back Bay neighborhood was recently completely renovated and subdivided into multiple luxury-level condominium units built to suit to the new homeowners requirements. The historic preservation requirements imposed on the project presented challenges for designing and implementing sufficient acoustic absorption and sound isolation for the design of a new music listening and piano practice room in the lowest level residence. A custom-designed low-frequency absorber was developed to fit within an existing architectural niche at one end of the elliptical music room, and additional absorptive treatment was added to the walls to blend in with the existing finishes. Sound isolation to the neighboring condominium above the music room was improved via floor/ceiling modifications—a task made more challenging by the need to retain the terracotta structure and other historic details. Construction details and measurement results will be discussed in this case study presentation.

2:00

3pAAb4. A statistical analysis of acoustical measurement uncertainties for assemblies within multi-family dwellings in the United States. David W. Dong and John LoVerde (Veneklasen Assoc., 1711 16th St, Santa Monica, CA 90404, wdong@veneklasen.com)

Over the last several years, the authors have demonstrated that the uncertainties in the methods of acoustical testing are much larger than realized by professionals and lay people [LoVerde and Dong, J. Acoust. Soc. Am. **125**, 2629 (2009); J. Acoust. Soc. Am. **126**, 2171 (2009); J. Acoust. Soc. Am. **130**, 2355 (2011)]. Acceptance of the large uncertainty immediately raises many practical questions. How much of the uncertainty is inherent in the test procedure and how much is due to differences between laboratories, installation methods, contractors, materials, etc.? Is the data hopelessly chaotic, or is there "true value" that can be obtained by suitable data processing? How many tests are required to feel confident in the characterization of an assembly? Some rules of thumb have been developed based on our experience [LoVerde and Dong, J. Acoust. Soc. Am. **131**, 3319 (2012)], but these questions have not yet been systematically addressed before. A statistical analysis has been performed using a database of thousands of laboratory and field noise isolation tests. Results are presented that address these questions.

2:20

3pAAb5. Coping with curves in room design. Timothy Foulkes (Cavanaugh Tocci Assoc., 327 Boston Post Rd., Sudbury, MA 01776, tfoulkes@cavtocci.com)

Concave curves are pleasing to the eye, but they cause a number of different acoustic anomalies. Depending on the radius of curvature, finish material, included angle, and position relative to source and receiver, one may hear a strong return echo, a noticeable coloration of the frequency balance, a dramatic shift in the acoustic image, or extended reverberation at low frequencies. The effects of standard curved forms such as the Capital rotunda are well known. These anomalies are of little consequence in a transient space such as a lobby, but are problematic in rooms for speech and music presentation. Covering the entirety of the concave surface with sound absorbing material is not always the best solution. In most cases, the client will want to know the minimum acoustic treatment to avoid complaints. The author will present a series of case studies showing room designs with concave curves and the acoustic solutions.

Contributed Paper

2:40

3pAAb6. Building information modeling and the consultant: Managing roles and risk in an evolving design and construction process. Norman H. Philipp (Geiler & Assoc., 1840 E. 153rd Circle, Olathe, KS 66062, nphilipp@geileracoustics.com)

Paramount changes are occurring within the building and construction industries, fueled by the ever expanding abilities of computer modeling technologies. This revolution not only impacts our approach to and execution of the physical design of a building, but also the construction and the day to day management of the facilities. Current technologies have allowed the Building Information Modeling (BIM) process to replace many of the time tested design methods of the past. With this shift to new technologies also come new risks which require recognition by the acoustical consultant to ensure our evolution to meet the new paradigm of the current design environment. In this paper the importance of understanding the purpose and role of a BIM implementation/execution plan will be covered inclusive of defining the role, responsibilities, and risks associated with the acoustical consultant.

Session 3pAB

Animal Bioacoustics and Psychological and Physiological Acoustics: Perceiving Objects II

Caroline M. DeLong, Cochair
Psychology, Rochester Inst. of Tech., 18 Lomb Memorial Dr, Rochester, NY 14623

Eduardo Mercado, Cochair
Dept. of Psych., Univ. at Buffalo, Buffalo, NY 14260

Chair's Introduction—12:55

Invited Papers

1:00

3pAB1. Categories, concepts, and calls: Auditory perceptual mechanisms and cognitive abilities across different types of birds. Allison H. Hahn, Lauren M. Guillette, Marisa Hoeschele (Psychology, Univ. of Alberta, P217 Biological Sci. Bldg., Edmonton, AB T6G2E9, Canada, ahhahn@ualberta.ca), Robert G. Cook (Psychology, Tufts Univ., Medford, MA), and Christopher B. Sturdy (Psychology, Univ. of Alberta, Edmonton, AB, Canada)

Although involving different animals, preparations, and objectives, our laboratories (Sturdy's and Cook's) are mutually interested in category perception and concept formation. The Sturdy laboratory has a history of studying perceptual categories in songbirds, while Cook laboratory has a history of studying abstract concept formation in pigeons. Recently, we undertook a suite of collaborative projects to combine our investigations to examine abstract concept formation in songbirds, and perception of songbird vocalizations in pigeons. This talk will include our recent findings of songbird category perception, songbird abstract concept formation (same/different task), and early results from pigeons' processing of songbird vocalizations in a same/different task. Our findings indicate that (1) categorization in birds seems to be most heavily influenced by acoustic, rather than genetic or experiential factors (2) songbirds treat their vocalizations as perceptual categories, both at the level of the note and species/whole call, (3) chickadees, like pigeons, can perceive abstract, same-different relations, and (4) pigeons are not as good at discriminating chickadee vocalizations as songbirds (chickadees and finches). Our findings suggest that although there are commonalities in complex auditory processing among birds, there are potentially important comparative differences between songbirds and non-songbirds in their treatment of certain types of auditory objects.

1:20

3pAB2. Reverberlocation in chickadees? Eduardo Mercado, Matthew W. Wisniewski, Brittany E. McIntosh (Dept. of Psych., Univ. at Buffalo, Buffalo, NY 14260, emiii@buffalo.edu), Lauren M. Guillette, and Christopher B. Sturdy (Dept. of Psych., Univ. of Alberta, Edmonton, AB, Canada)

Chickadee songs provide conspecifics with information about the locations of singers. Song amplitude, frequency, and reverberation all vary with distance, and it is thought that chickadees use such cues to estimate distance. The current study examined transmission of chickadee songs in an open field to assess whether other cues such as relative changes in inter-note timing or relative differences in spectral energy might also provide useful information about a singer's location. Surprisingly, the difference between direct signal energy and reverberant spectral energy provided clear indications of how far a song had traveled. Preliminary analyses suggest that this cue may be robust to variations in source level, note duration, note frequency, and transmission loss. If chickadees use this cue to judge auditory distance, then this may explain why they maintain specific spectral ratios between the notes within their songs. Specifically, the spectral spacing of notes within songs appears to be directly related to chickadee auditory filter bandwidth. We describe ranging of a singing chickadee based on the spectral profile of its songs as reverberlocation (construed as an instance of passive echolocation) because it involves comparisons between a direct signal and echoes of a signal.

Contributed Papers

1:40

3pAB3. Localization of flying insects by echolocation. Ikuo Matsuo (Tohoku Gakuin Univ., Tenjinzawa 2-1-1, Izumi-ku, Sendai 9813193, Japan, matsuo@cs.tohoku-gakuin.ac.jp) and Takuma Takanashi (Forestry and Forest Products Res. Inst., Tsukuba, Japan)

Using the echolocation, bats can capture insects in real 3D space. Bats can accurately localize these objects from echoes by emitting the frequency modulation sound. The object's range could be estimated from delay times between the emitted sound and echoes from objects. In the case of flying insects, the echoes were influenced by Doppler shift, that is, the wing beats and flight speed. In the case of the linear frequency modulated (LFM) sound, this range accuracy was dependent on not only the frequency width of emitted sound but also the Doppler shift. It has been shown that the previous proposed model could accurately estimate each range of static objects by using the frequency modulation sound. However, it was unknown whether this model could estimate locations and movements of the flying insect. In this study, the echoes were measured from the flying insect by emitting intermittently the LFM sounds. At the same time, the movements of the insects were measured by the camera. The time-frequency pattern

were computed by using the convolution of the chirplet filters. It was examined that the the insect's positions were estimated by extracting the onset from the time-frequency pattern. [Research supported by JST, CREST.]

2:00

3pAB4. Analysis of Northern bottlenose whale pulses and associated reflections recorded from the Gully Marine Protected Area. Bruce Martin (Halifax, JASCO Appl. Sci., 32 Troop Ave., Ste. 202', Dartmouth, NS B3B 1Z1, Canada, bruce.martin@jasco.com) and Hilary Moors-Murphy (Bedford Inst. Of Oceanogr., Dept. of Fisheries and Oceans, Dartmouth, NS, Canada)

The Gully Marine Protected Area (MPA) is a large submarine canyon at the edge of the Scotian Shelf, south of Nova Scotia. A resident population of northern bottlenose whales are known to occur in the Gully throughout the year, and the canyon provides important foraging grounds for the population. Bottom-mounted Autonomous Multichannel Acoustic Recorders (AMAR) were deployed in the Gully for ten days in in March 2010 (sampling rate = 375 ksps) and two days in October 2011 (sampling rate = 128 ksps). Bisonar pulses produced northern bottlenose whales (likely used to echolocate prey) were recorded consistently throughout these AMAR deployments. The swept FM characteristics of the northern bottlenose whale pulses recorded were consistent over both years, and both data sets contained clear pulse reflections from bottom clutter or prey targets. In this paper, we provide a description of the northern bottlenose whale pulses recorded in the Gully and make recommendations on short-time Fourier transform parameters for analysis of the pulses. A description of the pulse reflections is also provided, based on analysis of the reflection patterns using short-time Fourier transforms and by matched filtering with the direct arrival from the whales.

2:20

3pAB5. Preliminary results from collaborative referring to impulsive sonar sounds. Charles F. Gaumond (Acoust. Div., Naval Res. Lab., Code 7162, 4555 Overlook Ave. SW, Washington, DC 20375, charles.gaumond@nrl.navy.mil), Derek Brock, and Christina Wasylyshyn (Information Technol. Div., Naval Res. Lab., Washington, DC)

A recent experiment is described wherein pairs of listeners (a "director" and a "matcher") collaboratively refer to eight-element sets of impulsive sonar sounds, which are the same, but ordered differently for each listener. The sounds in a given set are privately displayed on each listener's computer as a line of blank cards that play a corresponding sound when clicked and can be rearranged from left to right. The listeners' task is to move the matcher's sounds into the same order as the director's. Through conversation, the listeners work out how to verbally characterize the sounds and develop a shared vocabulary. This vocabulary is presented for selected participants and is shown to generally consist of names, actions, and properties of familiar, everyday auditory events. In general, these references function as classes and descriptors. Classes correspond to causal categories that are aurally analogous to (i.e., homophonic with) the acoustic origins of the impulsive sonar sounds. Similarly, descriptors, distinguish between the properties of signal processing features that are appropriate to impulsive sounds within a given category. [Research funded by the Office of Naval Research.]

2:40

3pAB6. An auditory perception of changes in the intensity of pulses, presented in complicated sound complex. Liudmila K. Rimskaya-Korsakova (Lab. of Bioacoustics, N.N. Andreev Acoust. Inst., Shvernika. st 4, Moscow 117036, Russian Federation, lkrk@mail.ru)

The auditory system of humans and animals is able to detect and discriminate high frequency pulses in a complicated sound complex. The purpose of the work was to find new examples of a facilitation the discrimination of intensity (or level, defined by a peak amplitude) of a test pulses, presented under composite masking conditions, and to find the possible mechanisms underlying the facilitation. The discrimination tended to deteriorate if the test pulse was presented through 50 ms after a pulse's masker. However, if the test pulse was mixed with stationary noise, the beginning of which coincided with the end of the pulse's masker, discrimination became better. The noise levels, at which facilitation occurred, depended on amplitudes of both the test pulses and the pulse's maskers. When the duration of the noise was less than 50 ms, an auditory adaptation could not influence on the discrimination. The reason of the facilitation could be in the temporal redistribution of the auditory nerve fibers activities, which occurred at coding of the complicated sound complex "pulse's masker - test pulse - stationary noise."

WEDNESDAY AFTERNOON, 5 JUNE 2013 510D, 1:20 P.M. TO 2:40 P.M.

Session 3pAO

Acoustical Oceanography: Ocean Acoustical Tomography

Lora J. Van Uffelen, Chair
Univ. of Hawaii at Manoa, 1000 Pope Rd., MSB 205, Honolulu, HI 96815

Contributed Papers

1:20

3pAO1. Influence on sound spread considering the flow velocity in a horizontal layer media. Yang Song and Zhenqi Zhao (Sci. and Technol. on Underwater Acoust. Lab., Harbin Eng. Univ., Harbin 150001, China, syang@163.com)

The marine currents could often influence sound propagation underwater. The traveling time of sound ray is distinctly effected by the velocity of current in some conditions. So it will be made certain errors in seeking eigen rays and inversing sound speed profile if the velocity of the current is ignored. In order to improve the computation accuracy of sound ray model, a sound ray model of horizontal layer is induced in which the media flow is considered. Eigen rays are searched and their traveling time is calculated by the ray model. It is also discussed that the velocity of flow media influences ray trace and traveling time. An average sound speed profile measured under a shallow water is cited to calculate the eigen rays. The differences of sound ray are given under two kinds of condition which the velocity of current is considered and not considered. The computation results show that the sound ray trace is changed indistinctively under small Mach number condition, but the traveling time of eigen rays is fluctuated obviously. The fluctuation of ray traveling time is bigger according to the larger Mach number and the longer spread distance. The results of study will provide some help in the inversion of ocean acoustic tomography.

1:40

3pAO2. Time-angle ocean acoustic tomography using sensitivity kernels: The forward problem. Florian Aulanier, Barbara Nicolas (Gipsa lab, Institut Polytechnique de Grenoble, 11 rue des Mathématiques, Grenoble Campus BP46 F, SAINT MARTIN D'HERES Cedex 38402, France, Florian.Aulanier@gipsa-lab.grenoble-inp.fr), Philippe Roux (ISTerre, Observatoire des Sci. de l'Univers, Université de Grenoble, Grenoble, France), and Jérôme I. Mars (Gipsa Lab., Institut Polytechnique de Grenoble, Grenoble, France)

Broadband acoustic signals around 1 kHz propagate through shallow water oceanic waveguides of ~100 m in depth and ~2 km in range as multiple ray-like wavefronts. These acoustic arrivals can be characterized by the following observables: travel-time (TT), direction-of-arrival (DOA), and direction-of-departure (DOD). By applying double-beamforming on the point-to-point signals recorded between two source-receiver arrays, the acoustic contribution of each arrival can be separated from the multi-reverberated data and the TT, DOA, and DOD observable variations are accurately measured. This study deals with the use of time-angle sensitivity kernels (TASK) to estimate the observable variations induced by sound speed perturbations in the waveguide. This approach is based on the first order Born approximation and takes into account the finite-frequency effects associated with wave propagation. The robustness the TASK approach is analyzed and compared to numerical parabolic equation simulations involving different sound speed perturbations. For example, parameters such as the perturbation location, the value and shape of the perturbation in the waveguide are modified. The combination of several perturbations and the influence of the source-receiver array apertures on the TT, DOA, and DOD estimates are also studied.

2:00

3pAO3. Time-angle ocean acoustic tomography using sensitivity kernels: Numerical and experimental inversion results. Florian Aulanier, Barbara Nicolas (Gipsa Lab, Institut Polytechnique de Grenoble, 11 rue des Mathématiques, Grenoble Campus BP46 F, SAINT MARTIN D'HERES Cedex 38402, France, Florian.Aulanier@gipsa-lab.grenoble-inp.fr), Philippe Roux (ISTerre, Observatoire des Sci. de l'Univers, Université de Grenoble, Grenoble, France), Romain Brossier (ISTerre, Observatoire des Sci. de l'Univers, Université de Grenoble, Saint Martin D'Heres, France), and Jérôme I. Mars (Gipsa Lab, Institut Polytechnique de Grenoble, Grenoble, France)

In shallow water acoustic tomography, broadband mid-frequency acoustic waves (1 to 5 kHz) follow multiple ray-like paths to travel through the ocean. Travel-time (TT) variations associated to these raypaths are classically used to estimate sound speed perturbations of the water column using the ray theory. In this shallow water environment, source and receiver arrays, combined with adapted array processing, provide the measurement of directions-of-arrival (DOA) and directions-of-departure (DOD) of each acoustic path as new additional observables to perform ocean acoustic tomography. To this aim, the double-beamforming technique is used to extract the TT, DOA, and DOD variations from the array-to-array acoustic records. Besides, based on the first order Born approximation, we introduce the time-angle sensitivity kernels to link sound speed perturbations to the three observable variations. This forward problem is then inversed by the maximum *a posteriori* method using both the extracted-observable variations and the proposed sensitivity kernels. Inversion results obtained on numerical data, simulated with a parabolic equation code, are presented. The inversion algorithm is performed with the three observables separately, namely TT, DOA, and DOD. The three observables are then used jointly in the inversion process. The results are discussed in the context on ocean acoustic tomography.

2:20

3pAO4. Toward subsurface positioning of gliders using fixed acoustic tomography sources. Lora J. Van Uffelen, Eva-Marie Nosal, Bruce M. Howe, Glenn S. Carter (School of Ocean and Earth Sci. and Technol., Univ. of Hawaii at Manoa, 1000 Pope Rd., MSB 205, Honolulu, HI 96815, loravu@hawaii.edu), Peter F. Worcester, Matthew A. Dzieciuch (Scripps Inst. of Oceanogr., Univ. of California, San Diego, La Jolla, CA), Kevin D. Heaney, Richard L. Campbell (OASIS, Inc., Fairfax, VA), and Patrick S. Cross (OASIS, Inc., Honolulu, Hawaii)

Acoustic Seagliders can be positioned precisely using GPS at the surface, but are underwater and unable to utilize GPS for up to 9 h at a time as they dive to depths of up to 1000 m. During this time, a kinematic model estimates the position of the glider. Four acoustic Seagliders were deployed in the Philippine Sea November 2010–April 2011, and received transmissions from five broadband acoustic tomography sources moored in the region. Over 2000 acoustic receptions were recorded at ranges up to 700 km from the moored sources. Measured acoustic arrival peaks were unambiguously associated with ray arrivals predicted using the model-estimated glider position at the time of reception and a mean sound-speed profile. Estimates of source-receiver range uncertainty were calculated from statistics of travel-time offsets between the measured arrivals and the eigenray dispersion patterns. The uncertainty in range between the source and the modeled glider position during a dive is estimated to be 639 m (426 ms) rms disregarding the effects of ocean sound-speed variability, which are anticipated to be on the order of 70 ms rms.

Session 3pBA

Biomedical Acoustics: Biomedical Acoustics Best Student Paper Award Poster Session

Kevin J. Haworth, Chair
Univ. of Cincinnati, 231 Albert Sabin Way, CVC3940, Cincinnati, OH 45209

The ASA Technical Committee on Biomedical Acoustics offers a Best Student Paper Award to eligible students who are presenting at the meeting. Each student must defend a poster of her or his work during the student poster session. This defense will be evaluated by a group of judges from the Technical Committee on Biomedical Acoustics. Additionally, each student will give an oral presentation in a regular/special session. Up to three awards will be presented to the students with USD$500 for first prize, USD$300 for second prize, and USD$200 for third prize. The award winners will be announced at the meeting of the Biomedical Acoustics Technical Committee. Below is a list of students competing, with their abstract numbers and titles listed. Full abstracts can be found in the oral session associated with the abstract numbers.

All entries will be on display and all authors will be at their posters from 1:00 p.m. to 3:00 p.m.

1aBA3. A contrast source inversion method for breast cancer detection. Student author: N. Ozmen-Eryilmaz

1aBA7. Electromagnetic hydrophone for high-intensity focused ultrasound measurement. Student author: Pol Grasland-Mongrain

1pBAa4. Sound speed estimation in single cells using the ultrasound backscatter power spectrum. Student author: Eric M. Strohm

1pBAa6. An analysis of the acoustic properties of the cell cycle and apoptosis in MCF-7 cells. Student author: Maurice M. Pasternak

1pBAb2. Acoustic and optical characterization of targeted ultrasound contrast agents. Student author: Camilo Perez

1pBAb4. Radiation for bubble contrast agents in inhomogeneous media. Student author: Chrisna Nguon

1pBAb5. Temporal evolution of subharmonic emissions from a lipid-encapsulated contrast agent. Student author: Himanshu Shekhar

1pBAb6. Simulations of transcranial passive acoustic mapping with hemispherical sparse arrays using computed tomography-based aberration corrections. Student author: Ryan Jones

1pBAb11. Passive acoustic mapping of magnetic microbubbles in an *in vitro* flow model. Student author: Calum Crake

1pBAb12. A two-component speckle model for detection of microbubble signals in linear contrast-enhanced ultrasonography. Student author: Matthew R. Lowerison

2aBA9. Ultrasonic atomization: A mechanism of tissue fractionation. Student author: Julianna C. Simon

2pBAa7. Investigating the sensitivity of microbubble acoustic response for biosensing applications. Student author: Caroline J. Harfield

2pBAa8. Modeling of microbubbles pushed through clots via acoustic radiation force. Student author: Ascanio Guarini

2pBAa11. Effect of shell thickness on sound propagation through encapsulated bubbles: A resonator approach. Student author: Craig N. Dolder

2pBAb5. Validation of three-dimensional strain tracking by volumetric ultrasound image correlation in a pubovisceral muscle model. Student author: Anna S. Nagle

2pBAb6. Measurement of surface acoustic wave in soft material using swept-source optical coherence tomography. Student author: Yukako Kato

3aBAa5. Small interfering ribonucleic acid delivery with phase-shift nanoemulsions. Student author: Mark T. Burgess

3aBAb4. Improving the acousto-optic detection of high-intensity focused ultrasound lesions. Student author: Matthew T. Adams

3aBAb6. The origins of nonlinear enhancement in *ex vivo* tissue during high intensity focused ultrasound ablation. Student author: Edward Jackson

4aBA5. Investigation on the inertial cavitation threshold of micro-bubbles. Student author: Xiasheng Guo

5aBAa3. Ultrasonic assessment of the *in vitro* biomechanical stability of a dental implant. Student author: Romain Vayron

5aBAa6. Developement and validation of resonant ultrasound spectroscopy for the measurement of cortical bone elasticity on small cylindrical samples. Student author: Simon Bernard

5aBAa8. Computational simulations of time of flight and attenuation of first arriving signal from healing process of diaphyseal femur fractures. Student author: Paulo Tadeu Rosa

5aBAb1. The effect of boundary proximity on the fundamental and subharmonic emissions from individual microbubbles at higher frequencies. Student author: Brandon Helfield

5aBAb2. Bifurcation structure of the ultrasonically excited microbubbles undergoing buckling and rupture. Student author: Amin Jafari Sojahrood

5aBAb5. Temporal and spatial characteristics of nonlinear acoustic field generated by an extracorporeal shockwave therapy device: Modeling and measurements. Student author: Maria Karzova

WEDNESDAY AFTERNOON, 5 JUNE 2013 512AE, 12:55 P.M. TO 3:00 P.M.

Session 3pEA

Engineering Acoustics: Computational Methods in Transducer Design, Modeling, Simulation, and Optimization III

Daniel M. Warren, Chair
Knowles Electronics, 1151 Maplewood Dr, Itasca, IL 60134

Chair's Introduction—12:55

Contributed Papers

1:00

3pEA1. Coupling elastic-poroelastic material in structure-borne sound modeling. Katherina Rurkowska and Sabine Langer (Institut für Angewandte Mechanik, Technische Universität Braunschweig, Spielmannstraße 11, Braunschweig, Niedersachsen 38106, Germany, infaminfo@tu-braunschweig.de)

Porous materials are widely used in noise reduction applications. To minimize the external noise produced by aircraft propeller drives, porous materials are implemented. As a part of the project *Sonderforschungsbereich 880* "Fundamentals of High Lift for Future Civil Aircraft," porous surfaces are used in the High-lift configuration to mitigate the flow noise and to influence the structure-borne sound. In order to model the performance of the applied poroelastic material, an approach coupling a poroelastic material with an elastic structure using Finite Element Method is presented. The Biot's theory is used to model the poroelastic material. The aim of this work is to simulate the effect of the entry and transmission of the structure-borne sound into the poroelastic medium. An example of the implemented model shows the plausibility of presented approach.

1:20

3pEA2. Numerical investigation of the functionally graded materials by the interaction of the plate guided waves with discontinuities and cracks. Farouk Benmeddour, Emmanuel Moulin, and Jamal Assaad (OAE Dept., IEMN, CNRS UMR 8520, Univ. of Valenciennes and Hainaut Cambrésis, Campus Mont Houy, Valenciennes 59313, France, farouk.benmeddour@univ-valenciennes.fr)

This work intends to give a better comprehension of the guided wave interactions with damage in a functionally graded material (FGM). The propagation and interactions of plate guided waves with discontinuities in a FGM composed of ceramic and metal mixture are investigated. For this purpose, a two dimensional finite element (FE) method is used to analyze the near field surrounding the damage. Then, expansion of the solution into sums of guided modes enables the determination of the reflection and transmission coefficients of each existent mode. The determination of the modal features is ensured by the way of the so called semi-analytical finite element (SAFE) method applied to the one dimensional inlet and outlet cross-sections. The latter has the benefit to study an arbitrary shape-like damage in an infinite structure having the same shape by translation in the propagation direction in a fast and efficient way. Results are obtained by solving the global system of the 2D hybrid FE-SAFE method. Different symmetrical and asymmetrical notches are studied and so for cracks. Results are achieved and discussed for a FGM and compared to those obtained for an isotropic material.

1:40

3pEA3. Generalized Debye series expansion to improve the non-destructive testing and health monitoring of cylindrical structures by guided waves. Slah Yaacoubi (Institut de Soudure, Yutz, France), Marc Deschamps, Eric Ducasse (I2M, Bordeaux, France), Laurent Laguerre (IFSTTAR, Bouguenais, France), Weina Ke Yaacoubi (Institut de Soudure, Yutz, France), Peter McKeon (Georgia Insitute of Technol., GTL, Metz, France, peter.mckeon@gatech.edu), Salah Ramadan (Institut de Soudure, Yutz, France), and Nico F. Declercq (Georgia Insitute of Technol., Metz, France)

Many structures in civil engineering notably bridges and nuclear power plants must be regularly, strictly, and carefully tested to avoid any human or environmental catastrophe. Among the NDT techniques, which can be

applied, ultrasonic guided waves are a good candidate to monitor bars and cables. However, its multimodal and dispersive behaviors can limit its performances. Theoretical modeling is sometimes needed to understand the behavior of the traveling waves to improve the testing/monitoring and made a right *in-situ* decision. The aim of this paper is to derive the space-time velocity field in a cylindrical waveguide perfectly embedded in an infinite solid matrix and generated by an inside bounded beam. This beam is generated by an off-axis source. Vector Hankel transform and Fourier series are combined to decompose the inside field into infinity of elementary cylindrical waves propagating in radial direction and planar waves propagating in axial direction. Global resolution method and Generalized Debye series expansion are used both to calculate the 3D global cylindrical reflection/transmission coefficients. The method is demonstrated through a steel bar embedded in cement matrix. Simulated frequency–wavenumber diagrams show that the embedding material acts like filter for different frequency ranges. Other results will be presented.

2:00

3pEA4. The effect of a middle layer on ultrasonic wave propagating in a three-layer structure. Raymond B. Mabuza and Ngeletshedzo Netshidavhini (NDT and Phys., Vaal Univ. of Technol., Private Bag X021, Vanderbijlpark, Gauteng 1900, South Africa, raymondm@vut.ac.za)

In this paper, the focus of attention is on the effect of an elastic middle layer on the propagation behavior of ultrasonic waves. Systematic parametric studies are conducted to quantify the effects of the middle layer upon the ultrasonic wave propagation, including its thickness and acoustic impedance. We treat this problem analytically and numerically. The three-layer structure is also used to investigate the influence of the imperfect interfaces between two outer layers and a middle layer on the ultrasonic wave propagation. The theoretical analysis considers successive reflections of waves radiated by the transmitting transducer. The output signal is a superposition of successive reflections. Our results demonstrate clearly that there is significant influence of the middle layer in our three-layer problem. Various aspects of our approach are discussed and numerical examples are used to illustrate the suitability of our approach. Some details about the numerical methods employed are also given. The results are presented and discussed.

2:20

3pEA5. Comparison of finite element models simulating the interaction of ultrasonic guided waves with sites of disbonding in composites. Peter McKeon (Mech. Eng., Georgia Insitute of Technol., 2 rue Marconi, Metz 57070, France, peter.mckeon@gatech.edu), Slah Yaacoubi (Institut de Soudure, Yutz, France), Nico F. Declercq (Mech. Eng., Georgia Insitute of Technol., Metz, France), and Salah Ramadan (Institut de Soudure, Yutz, France)

Disbonding in composite structures is a serious defect which can dramatically reduce the structures' life, and can lead to catastrophic failure. To avoid this, non-destructive testing or structural health monitoring techniques are needed. One such technique involves ultrasonic guided waves, which has recently found use in this field thanks to its ability to inspect in non-accessible areas and over long distances. Numerical models are often used because they can help explain experimental results, and offer the ability to simulate different damage scenarios, predicting results with less cost than experiments. In this work, sites of disbonding between an orthotropic composite plate and an isotropic polyamide plate were modeled via the finite element method. Several methods for modeling the damage site are employed, and results are compared with experimental ones. Model types range from the introduction of a geometrical void at the interface boundary to addressing boundary conditions between adjacent layers. The amount of mode conversion after interaction with the damage site is used to evaluate the validity of each model type. Results are discussed in terms of computational effort and accuracy in predicting true physical behavior.

2:40

3pEA6. Energy flux streamlines versus acoustic rays for modeling interaction with rigid boundaries: near field of sound from a circular loudspeaker. Cleon E. Dean (Physics, Georgia Southern Univ., P.O. Box 8031, Math/Phys. Bldg., Statesboro, GA 30461-8031, cdean@georgiasouthern.edu) and James P. Braselton (Mathematical Sci., Georgia Southern Univ., Statesboro, GA)

Sound emitted by a circular loudspeaker can be treated as equivalent to a plane wave diffracted by a circular aperture in a rigid, sound absorbing screen. Axial symmetry leads one to expect constructive interference along the symmetry axis in the near field (the Poisson-Arago spot). An energy flux streamline model was developed to help visualize this and other features of the near sound field. The model is used to draw out similarities and differences between energy flux streamlines and acoustic rays, particularly in the transition to the far field.

WEDNESDAY AFTERNOON, 5 JUNE 2013 510C, 1:20 P.M. TO 2:20 P.M.

Session 3pED

Education in Acoustics: Take 5's

Andrew Morrison, Chair
Natural Sci. Dept. Joliet Junior College, 1215 Houbolt Rd, Joliet, IL 60431

For a Take-Five session no abstract is required. We invite you to bring your favorite acoustics teaching ideas. Choose from the following: short demonstrations, teaching devices, or videos. The intent is to share teaching ideas with your colleagues. If possible, bring a brief, descriptive handout with enough copies for distribution. Spontaneous inspirations are also welcome. You sign up at the door for a five-minute slot before the session starts. If you have more than one demo, sign-up for two consecutive slots.

Session 3pMU

Musical Acoustics and Psychological and Physiological Acoustics: Perception and Orchestration Practice

Stephen McAdams, Cochair
Music Res., McGill Univ., 555 Sherbrooke St. W., Montreal, QC H2W 1S2, Canada

Punita G. Singh, Cochair
Sound Sense, 16 Gauri Apartments, 3 Rajesh Pilot Ln., New Delhi 110011, India

Invited Papers

1:00

3pMU1. Timbre as a structuring force in music. Stephen McAdams (Schulich School of Music, McGill Univ., 555 Sherbrooke St. W., Montreal, QC H2W 1S2, Canada, smc@music.mcgill.ca)

Most of the music we enjoy uses the musical qualities of different instruments to create specific perceptual and emotional effects that composers sculpt over time. Timbre is the auditory attribute that distinguishes different instruments. Research on timbre perception has demonstrated that it is multifaceted and contributes in many ways to the perceptual organization of musical structures. The art of structuring music with timbre is orchestration. A survey of orchestration treatises reveals the dearth of underlying theory, in sharp contrast to other traditional areas such as harmony and counterpoint, which have long theoretical traditions. We seek to develop a theoretical ground for orchestration practice starting with the structuring role that timbre can play in music. Many aspects of musical structuring are achieved by auditory scene analysis, the perceptual processes that result in unified events, integrated streams of events, groups of events segmented into phrases and sections, and larger-scale units extended over time that we call orchestral gestures. The roles that timbre plays in the manifestation of these principles in orchestration practice will be considered as potential elements of a theory of orchestration. How such principles might be incorporated into computer-aided orchestration systems and computer-aided orchestral rendering systems will also be examined.

1:20

3pMU2. Acoustic and musical features of emotional response to orchestral gestures. Meghan Goodchild (CIRMMT and McGill Univ., 4515 rue Drolet, Unit 6, Montreal, QC H2T 2G1, Canada, meghan.goodchild@mail.mcgill.ca)

Recent empirical research indicates the impact of prominent changes in instrumentation on the listening experience: several studies suggest that timbral changes evoke music-induced emotions. However, orchestration remains an underdeveloped area of music theory. A model of orchestral gestures defined by changes in instrumentation in terms of time course (gradual or sudden) and direction (addition or reduction) is presented. An exploratory behavioral study that tested the perceptual relevance of orchestral gestures on listeners' continuous ratings of emotional intensity was conducted. We demonstrate a new type of visualization that illustrates the relative textural density of each instrument family over time combined with other time-varying parameters extracted from the signal (loudness, spectral centroid, tempo, and roughness) and calculated from the score (instrumental texture, melodic range, and attack density). In addition to quantitative and qualitative comparison of similar orchestral gestures across pieces, we use this method to study the interaction of specific instrumentation changes and other musical parameters. Through discussion of the visualizations, we highlight relationships between the perceptual and musical/acoustical dimensions and quantify elements of the temporality of these experiences.

1:40

3pMU3. Perception and orchestration of melody, harmony, and rhythm on instruments with "chikari" strings. Punita G. Singh (Sound Sense, 16 Gauri Apartments, 3 Rajesh Pilot Ln., New Delhi 110011, India, punita@gmail.com)

The use of "chikari" strings on instruments such as the sitar and sarod manifests principles of Auditory Scene Analysis in creating a harmonic reference, melodic contrast, and rhythmic accompaniment. Unlike the principal "baj" strings on which the main melody is played, or resonant "tarb" strings that reinforce volume, the "chikari" strings are sounded at strategic points in performance to provide a drone, add texture, outline chords, mark rhythmic positions, and keep tempo. Listening and transcription experiments conducted with recordings of interleaved notes played on "chikari" and "baj" strings validate how differences in their timbre and tuning help to keep them perceptually apart while forming more coherent patterns based on timbre similarity and pitch proximity. Such grouping and segregation can affect the perception of temporal order, maintain the illusion of melodic continuity and in some cases of virtual polyphony. These observations add to the growing body of evidence supporting the role of timbre as a structural dimension of music and illustrate how a single instrument can bring about orchestral effects via the strategic use of devices such as "chikari" strings.

2:00

3pMU4. Predicting blend between orchestral timbres using generalized spectral-envelope descriptions. Sven-Amin Lembke (Ctr. for Interdisciplinary Res. in Music Media and Technol. (CIRMMT), Schulich School of Music, McGill Univ., 555 Sherbrooke St. West, Montreal, QC H3A 1E3, Canada, sven-amin.lembke@mail.mcgill.ca), Eugene Narmour (Dept. of Music, Univ. of Pennsylvania, Philadelphia, PA), and Stephen McAdams (Ctr. for Interdisciplinary Res. in Music Media and Technol. (CIRMMT), Schulich School of Music, McGill Univ., Montreal, QC, Canada)

Composers rely on implicit knowledge of instrument timbres to achieve certain effects in orchestration. In the context of perceptual blending between orchestral timbres, holistic acoustical descriptions of instrument-specific traits can assist in the selection of suitable instrument combinations. The chosen mode of description utilizes spectral-envelope estimates that are acquired as pitch-invariant descriptions of instruments at different dynamic markings. Prominent local spectral-envelope traits, such as spectral maxima or formants, have been shown to influence timbre blending, involving frequency relationships between local spectral features, their prominence as formants, and constraints imposed by the human auditory system. We present computational approaches to predict timbre blend that are based on these factors and explain around 85% of the variance in behavioral timbre-blend data. Multiple linear regression is employed in modeling a range of behavioral data acquired in different experimental investigations. These include parametric investigations of formant frequency and magnitude relationships as well as arbitrary combinations of recorded instrument audio samples in dyads or triads. The cataloguing of generalized acoustical descriptions of instruments and associated timbre-blend predictions for various instrument combinations could serve as a valuable aid to orchestration practice in the future.

2:20

3pMU5. Timbre saliency vs. timbre dissimilarity – What is the relationship? Song Hui Chon and Stephen McAdams (CIRMMT, McGill Univ., 3484 Rue Durocher #401, Montreal, QC H2X 2E4, Canada, songhui.chon@mail.mcgill.ca)

We have proposed the notion of timbre saliency as the attention-capturing quality of timbre. The definition of saliency requires an object to stand out with respect to its surroundings, implying dissimilarity between the object and its neighbors. What then might be the relationship between timbre saliency and timbre dissimilarity? A classic timbre dissimilarity experiment and a timbre saliency experiment were carried out with 20 participants on the same set of stimuli. Multidimensional scaling revealed a two-dimensional dissimilarity space. Using the features obtained from the Timbre Toolbox [Peeters *et al.*, J. Acoust. Soc. Am. **130**, 2902–2916 (2011)], the first dimension shows a high correlation with spectral centroid [$r(13) = 0.845$, $p < 0.0001$] and spectral spread [$r(13) = 0.855$, $p < 0.0001$], both based on the ERB-FFT model spectrum, and the second with the attack time [$r(13) = -0.692$, $p = 0.004$] and power spectral crest [$r(13) = 0.732$, $p < .005$]. This confirms spectral centroid and attack time as two major acoustic correlates of timbre dissimilarity. The saliency dimension shows a moderate correlation with the second dimension [$r(13) = 0.578$, $p = 0.0241$] but not with the first dimension [$r(13) = 0.182$, $p = 0.517$], suggesting that the saliency might be more related to the temporal characteristics of timbre.

WEDNESDAY AFTERNOON, 5 JUNE 2013 511BE, 1:00 P.M. TO 2:20 P.M.

Session 3pNSa

Noise, ASA Committee on Standards, Engineering Acoustics, and Structural Acoustics and Vibration: Wind Turbine Noise II

Nancy Timmerman, Cochair
Nancy S. Timmerman, P.E., 25 Upton St., Boston, MA 02118

Paul Schomer, Cochair
Schomer and Assoc. Inc., 2117 Robert Dr., Champaign, IL 61821

Sheryl Grace, Cochair
Mech. Eng., Boston Univ., 110 Cummington Mall, Boston, MA 02215

Contributed Papers

1:00

3pNSa1. Wind farm—Long term noise and vibration measurements. Martin Meunier (Environment, SNC-Lavalin, 2271, boul. Fernand-Lafontaine, Longueuil, QC J4G2R7, Canada, martin.meunier@snclavalin.com)

Most of the energy produced in Quebec comes from renewable sources. The concept of wind energy emerged in the late 1990's and has since become a complementary source of energy alongside hydroelectricity. Wind farms are generally seen as a good sustainable way to produce energy. However, they are not implemented without some impact on the environment. SNC-Lavalin Environment has performed many surveys in recent years for wind farm projects, including noise measurements both before and after their commissioning. This presentation will give an overview of one such project where long term noise and vibration measurements where conducted. Vibration measurements, as well as outdoor, indoor, and low frequencies noise measurements were completed both with and without the wind turbines in operation. Data will be presented showing different problems encountered in the analysis phase. For example, multiple intermittent and non-steady noise sources were present during measurement (wind turbines, car pass-bys, wind in the trees, human activities). Methods used to overcome these obstacles will be discussed (use of statistical parameters, linear regression), and the effect of the wind turbine operation on the noise level (including low frequencies) and vibration level will be presented.

1:20

3pNSa2. RoBin - A one-man measurement system for standard acoustic emission measurement according to IEC 61400-11. Daniel Vaucher de la Croix (ACOEM, 200 Chemin des Ormeaux, Limonest 69578, France, daniel.vaucherdelacroix@acoemgroup.com) and Timo Klaas (WOLFEL MESS-SYSTEME, Höchberg, Germany)

Wind turbines are built at more and more locations—which makes their noise emission an important subject. The international standard IEC 61400-11 and the German Technische Richtlinie fur Windenergieanlagen, Teil of the FGW were set up in order to unify the evaluation of noise emission. Measurement of noise emission according to these standards is linked to formidable challenges, especially for the installation of testing equipment and evaluation of data. After a short reminder on the ISO 61400 standard, the proposed paper will discuss the details of operational constraints linked with on-site measurements and how modern communication technologies help in an easy system deployment and most efficient operation for the benefits of its users.

1:40

3pNSa3. Building integrated wind turbines—A pilot study. Ben Dymock (The Acoust. Group, Dept. of Urban Eng., London South Bank Univ., 12 Deans Close, Amersham HP6 6LW, United Kingdom, dymockb@lsbu.ac.uk) and Stephen Dance (The Acoust. Group, Dept. of Urban Eng., London South Bank Univ., London, United Kingdom)

The current planning guidance in London requires that all new or refurnished large buildings should include 20% renewables. As part of a study on urban wind a pilot investigation based on the building integrated wind turbines on the skyscraper Strata Tower in London will be monitored for acoustics, vibration, anemometry and electrical generation. Strata Tower is a 150 m building in an urban location with three 19 kWe turbines in a specially designed venturi housing. The effect of the wind turbines on residents, the local community, and the building structure will be assessed and reported.

2:00

3pNSa4. Assessment of annoyance due to wind turbine noise. Malgorzata Pawlaczyk-Luszczynska, Adam Dudarewicz, Kamil Zaborowski, Malgorzata Zamojska, and Malgorzata Waszkowska (Dept. of Physical Hazards, Nofer Inst. of Occupational Medicine, 8, Sw. Teresy str., Lodz 91-348, Poland, mpawlusz@imp.lodz.pl)

The overall aim of this study was to evaluate the perception and annoyance of noise from wind turbines in populated areas of Poland. The study group comprised 378 subjects. All subjects were interviewed using a questionnaire developed to enable evaluation of their living conditions, including prevalence of annoyance due to noise from wind turbines, and the self-assessment of physical health and well-being. In addition, current mental health status of respondents was assessed using Goldberg General Health Questionnaire GHQ-12. For areas where respondents lived, A-weighted sound pressure levels (SPLs) were calculated as the sum of the contributions from the wind power plants in the specific area. It has been shown that the wind turbine noise at the calculated A-weighted SPL of 30−50 dB was perceived as annoying outdoors by about one third of respondents, while indoors by one fifth of them. The proportions of the respondents annoyed by the wind turbine noise increased with increasing A-weighted sound pressure level. Subjects' attitude to wind turbines in general and sensitivity to landscape littering was found to have significant impact on the perceived annoyance. Further studies are needed, including a larger number of respondents, before firm conclusions can be drawn.

WEDNESDAY AFTERNOON, 5 JUNE 2013 511CF, 1:00 P.M. TO 2:40 P.M.

Session 3pNSb

Noise: Noise Barriers

Murray Hodgson, Chair
UBC, 2206 East Mall, Vancouver, BC V6T1Z3, Canada

Contributed Papers

1:00

3pNSb1. Effect of scaling laws for noise reduction optimization of wind fences. JohnPaul R. Abbott, Richard Raspet, and Jeremy Webster (Dept. of Phys. and Astronomy, National Ctr. for Physical Acoust., Univ. of Mississippi, 1 Coliseum Dr., Rm. 1044, Oxford, MS 38677, johnpaul.abbott@gmail.com)

This paper will report on an investigation to increase noise reductions at low wavenumbers for a large windscreen enclosure described in two earlier papers [J. Acoust. Soc. Am. **129**, 2445 (2011); J. Acoust. Soc. Am. **132**, 2048 (2012)] by first doubling its height and then doubling its diameter. According to the scaling laws developed for small windscreens, windscreens of similar shape but differing size will have nearly identical reductions for scaled wavenumbers; therefore the wavenumbers at which noise reduction for a windscreen occurs is dependent on its size and by increasing either its height or diameter, or both, reductions should shift to lower wavenumbers. Such a shift was observed when the screen's height was doubled. Also, when scaled to height, the measured reductions for the single and double height windscreens were found to match closely, with 6 dB of reduction and greater for wave numbers between 5 and 30 1/m and max reductions of 10–13 dB.

1:20

3pNSb2. Designing canopies to improve downwind shielding at various barrier configurations at short and long distance. Timothy Van Renterghem and Dick Botteldooren (Information Technol., Ghent Univ., Sint-Pietersnieuwstraat 41, Gent 9000, Belgium, tvrenter@intec.ugent.be)

The positive effect of a row of trees to improve downwind shielding in the acoustic shadow zone behind a noise wall has been shown before by means of a wind tunnel experiment, a field study and by numerical simulations. This research focused at a rather short distance in downwind direction, where important recovery of the shielding lost by screen-induced wind refraction was observed. However, opposite effects are possible at longer distance. This can be explained by shifts in the zones with strong (positive) gradients in the horizontal component of the wind speed. Leaving a gap between the barrier top and canopy bottom helps reducing these negative effects at longer distance, and results in a generally optimized performance downwind. Trees behind noise walls at either side of the source lead to a full canceling of wind effects at short distance, but to strong negative effects at longer distances downwind. Trees as windbreaks seem to be especially useful near single, vertically erected noise walls. Near steep berms, no net effect of trees is predicted. The design rules presented in this paper are

derived based on numerical calculations with a previously validated CFD-FDTD-PE model.

1:40

3pNSb3. A review of road traffic barriers for low frequency noise. Samaneh M. Fard, Nicole Kessissoglou, Stephen Samuels (School of Mech. and Manufacturing Eng., The Univ. of New South Wales, 11/127A, Barker St., Sydney, NSW 2032, Australia, fardsmb@gmail.com), and Marion Burgess (School of Eng. and Information Technol., The Univ. of New South Wales, Canberra, NSW, Australia)

Australia relies heavily on road transport due to its large area and low population density in many parts of the country. Trucks and heavy vehicles are commonly used for road freight. In addition to their normal vehicle brakes, heavy vehicles are typically fitted with release engine brakes which operate by causing the engine to act as a compressor when braking. Compression braking generates a distinct low frequency rumble that can heard at large distances and is a major source of community annoyance reactions against the heavy vehicle industry. Noise from compression brakes is an ongoing cause of complaint from many Australian residents, particularly in rural areas and at night-time. Noise barriers can be used to reduce the spread of general traffic noise and their effectiveness is determined by many factors. This paper presents a review of barriers optimized for road traffic noise and the frequency ranges at which the various barrier designs are most efficient, with a view to selecting the barriers that may be more effective at reducing the low frequency noise from compression brakes.

2:00

3pNSb4. *In-situ* measurements of sound reflection and sound insulation of noise barriers: Validation by means of signal-to-noise ratio calculations. Massimo Garai and Paolo Guidorzi (DIN, Univ. of Bologna, Viale Risorgimento 2, Bologna 40136, Italy, massimo.garai@unibo.it)

After some years from its first release, the CEN/TS 1793-5 European standard for *in-situ* measurement of sound reflection and airborne sound insulation characteristics of noise barriers has been significantly enhanced and validated in the frame of the EU funded QUIESST project. The procedure, based on impulse response measurements near the noise barrier and in the free field, is robust and easily applicable but much attention must be paid when: (i) applying the signal subtraction technique to get the reflected signal component and (ii) extracting the transmitted component, especially measuring highly insulating noise barriers. In both cases, it is essential to avoid a poor signal-to-noise ratio of the critical part of the impulse response. In the frame of the QUIESST project specific quality criteria, applicable on site, have been introduced in order to check and validate the result. These criteria are rigorously described here for the first time and illustrative examples are presented.

2:20

3pNSb5. Compliance and vegetated-barrier acoustical testing in a purpose-built sound-transmission suite. Murray Hodgson, Shira Daltrop (Acoust. and Noise Res. Group, Univ. of British Columbia, 2206 East Mall, Vancouver, BC V6T1Z3, Canada, murray.hodgson@ubc.ca), Rick Peterson, and Paul Benedict (Retaining Walls Northwest, Inc., Bellevue, WA)

Random-incidence transmission losses and absorption coefficients of a vegetated noise barrier of Criblock™ construction were measured without and with plants in a sound-transmission suite built specifically for the purpose, constructed from concrete noise barriers, with the vegetated barrier separating source and receiver rooms. The suite was tested for compliance with ASTM E90-09, and found to be substantially but not completely in compliance with respect to uniformity of steady-state levels and surface absorption. It was found that the transmission loss of the vegetated barrier ranged from 42 dB at low frequencies to 66 dB at 1000 Hz; above 1000 Hz only a lower limit of the TL could be determined—values of 57–62 dB were found. These values are at least 25 dB higher than recommended by BC Ministry of Transportation guidelines. The absorption coefficients of the unplanted and planted barriers were measured; the plants decreased the absorption slightly, from NRC 0.42 to 0.37.

WEDNESDAY AFTERNOON, 5 JUNE 2013 516, 1:00 P.M. TO 3:00 P.M.

Session 3pNSc

Noise and Architectural Acoustics: Joint Poster Session on Noise and Architectural Acoustics (Poster Session)

Hideki Tachibana, Chair
Chiba Inst. of Technol., Tsudanuma 2-17-1, Narashino, Chiba 275-0016, Japan

Contributed Papers

All posters will be on display from 1:00 p.m. to 3:00 p.m. To allow contributors an opportunity to see other posters, contributors of odd-numbered papers will be at their posters from 1:00 p.m. to 2:00 p.m. and contributors of even-numbered papers will be at their posters from 2:00 p.m. to 3:00 p.m.

3pNSc1. Remote keyless entry honking, convenience horn honking, and audible car alarms: Redundancies and quieter options. Jeanine Botta (Epidemiology and Biostatistics, CUNY School of Public Health at Hunter College, 1594 Metropolitan Ave., Apartment 7D, Bronx, NY 10462, jbotta@hunter.cuny.edu)

Vehicle sound emissions, car alarms, and horn honking are the subject of many noise complaints. Auto manufacturers spent years engineering quieter vehicles, and have created cars whose approach is so subtle that they pose a danger to blind pedestrians. But while engine noise has decreased and car alarms are less reactive, horn honking that is linked with remote keyless entry (RKE) technology increasingly contributes to community noise. RKE horn noise has never been the subject of public health inquiry. In scientific literature, discussion of road noise and health does not distinguish noise among separate sources, and tends to measure aggregate ambient noise levels rather than impulsive noise. RKE horn noise violates state traffic laws and some local noise ordinances regarding horn use, but there have been no legislative attempts to address the technology. This raises questions about whether political leaders and policy setters are not exposed to RKE noise or do not discern RKE sounds from traffic noise, and are therefore unaware of it. Using available auto industry data and case studies, this paper will introduce key facts about RKE horn use in the United States and Canada, reviewing new technologies that render noisy counterparts still in use as redundant.

3pNSc2. Determination of noise emission data of construction sites. Ilya E. Tsukernikov, Igor L. Shubin (Acoust. Lab., Res. Inst. of Bldg. Phys., Odoevskogo proezd, h.7, korp.2, fl. 179, 21 Lokomotovny pr., Moscow 117574, Russian Federation, 3342488@mail.ru), Nikolay I. Ivanov (Dept. of Health and Safety, Baltic State Tech. Univ., Sankt-Petersburg, Russian Federation), Tatiana O. Nevenchannaya (Dept. of Phys., Moscow State Univ. of Printing Arts, Moscow, Russian Federation), and Igor A. Nekrasov (Stock Co. Algoritm-Acoustics, Moscow, Russian Federation)

The reasons for development and substantive provisions of Russian standard GOST R 53695-2009 "Noise. Method for determination of noise emission data of construction sites" are presented. The concept of the noise emission characteristics of a construction site and the method of their determination are entered. Various kinds of civil work, construction site location, environment acoustic conditions, and feature of a landscape are taken into account. Instead of noise of separate sources operating inside a construction site noise of the construction site as a whole sound source is considered. The mean time averaged and maximum values of A-weighted sound pressure levels along the sides of a construction site are taken as its noise emission data. Sound reflection from the barriers located near to a construction site is considered by means of environmental correction for which determination the special method was developed. Procedures of determination of measurement uncertainty, the noise characteristics declared values which are brought in construction site specifications and accuracy degree of the method to be applied are considered.

3pNSc3. Engine sounds of small boats at night transmitted to room in apartment built along canal. Kenji Muto and Toru Akahira (Commun. Eng., Shibaura Inst. of Technol., Toyosu 3-7-5, Koto-ku, Tokyo 1358543, Japan, k-muto@shibaura-it.ac.jp)

In this paper, we show the measurement results of the engine sounds of small boats that cruise in a canal. The canal that is called an Toyosu canal is in the residential area in Tokyo in Japan. It is a canal with the role of the waterway traffic in Tokyo. The engine sounds were measured there from October to November in 2011. There were a lot of tugboats or tugboats pulling a freighter in daytime. There were a lot of fishing boats day and night, and there were a lot of houseboats at night. Many of engine sounds were sound exposure level around Lae = 80 dB. The level of the the greatest was more than sound exposure level Lae = 90 dB. Especially, the most of boats were passed in the morning and evening. They passed in the early morning when the background noise was 50 dB. They passed while obstructing the conversation or waking up. It was a sound with the influence for the inhabitant by the canal. It was shown the result of the engine sound transmitted to the room. The engine noise of the boat was transmitted to the canal side room with high level. These results was described in this paper.

3pNSc4. Aerodynamic noise reduction of a gangway in a high-speed train. Hee-Min Noh and Hyo-In Koh (Korea Railroad Res. Inst., #176, Cheldo bangmulgwan-ro, Uiwang 437-757, South Korea, hmnoh@krri.re.kr)

Excessive interior noise of high-speed trains causes annoyance, fatigue, and stress to passengers. Moreover, the noise occurred in gangway is greater than other noise in the room. Therefore, a research for gangway noise reduction was carried out. At first, cavity noise which causes major noise between car-sections was simulated with FLUENT 6.0 (computer fluid dynamics program). From the simulation result, the flow feedback loop phenomena in the cavity were observed. Then, noise measurements at internal and external positions in between-cars sections were conducted during the driving of a high-speed train. From the measurement results, noise characteristics of gangway and between-cars section were identified. Finally, noise mitigation methods were suggested in this paper.

3pNSc5. Improvement of the acoustic environment inside the high-speed train stations depending on the increase of the speed. Chan Hoon Haan and Chan Jae Park (Architectural Eng., Chungbuk National Univ., 52 NaeSudong-Ro, HeungDeok-gu, Chungbuk National Univ., CheongJu, Chungbuk 361763, South Korea, chhaan@chungbuk.ac.kr)

The speed of trains has been increased due to the development of railway technologies. Recently, operation speed up to 400 km/h is come to effect in Korea. But, it can be easily predicted that noise and vibration could be increased depending on the speed of trains. Especially, train stations are exposed to much noises for 24-h at the nearest place when high-speed trains stop or pass the terminals. In the present study, noise levels of the passing high-speed trains were measured in four different stations and noise levels at the speed up to 400 km/h were calculated. Also, the predicted noises were analyzed and compared with the interior noise criteria (NC-curve). As a result, it was found that the noise levels exceed 10 dB higher than the noise standards in average when train speed was 350 km/h. Based on the results, some design proposals are suggested to satisfy with the noise standards including reinforcement of walls and ceilings, change of finishing materials, which can improve the sound insulation of rooms in the train stations.

3pNSc6. Position optimization of Helmholtz resonator in ducts using a genetic algorithm. Maria A. Nunes and Gabriela Silva (Faculdade UnB Gama - Automotive Eng., Universidade de Brasília, Área Especial de Indústria Projeção A – UnB Setor Leste, Gama, DF 72.444-240, Brazil, maanunes@unb.br)

The Helmholtz resonators (HR) are classic reactive mufflers used to attenuate noise at low frequencies mainly pure tones propagating in ducts from venting systems. In industrial environments the equipments layout, the maintenance and operation purposes limit the installation of this kind of device in terms of space and location. As part of the muffler design it is necessary to considerate these restrictions and an optimization process may necessary in order to increase its acoustic performance. Keep in mind that in real application the downstream radiating end of the duct must be modeled as an open end radiating into free space, the insertion loss (IL) parameter is more proper for evaluating the HR's performance than the transmission loss. Using the IL to estimate the effectiveness of the acoustic filter, the main purpose of this paper is to numerically analyze and maximize this parameter in the maximum attenuation frequency considering position restrictions (bounds constraints) in a duct. An evolutionary search algorithm (GA) has been applied in order to solve the best position for a fixed shape HR in a duct. The finite element method was used to model the acoustic system HR/duct. The pressure data and the optimization step were processed in MATLAB®. For optimal positions the results reveal an increase of 19 dB in the IL parameter at the desired frequency. To verify the sensibility of the methodology simulations were performed varying some GA parameters.

3pNSc7. Possibility of sound environmental design by introducing wave sound into the indoor space. Takane Terashima (Architecture, Mie Univ., 1577 Kurimamachiya-cho, Tsu 5148507, Japan, tera@arch.mie-u.ac.jp) and Kazuhiro Shimahashi (School of Design & Architecture, Nagoya City Univ., Nagoya, Japan)

The purpose of this study is to develop the means of designing sound environment of waterfront area. As one of the means of improving sound environment in the campus space of our university, introducing wave sound from the adjoining seashore into campus area has been proposed and its feasibility have been studied. But wave sound reaches 300 m inland at most and cannot be listened in the most of campus area outdoor. So we plan to introduce wave sound by picking up through microphone and steaming over the campus LAN. In this report, if wave sound is streamed and broadcasted to indoor spaces, the influence of wave sound as background/masking noise on the mental state of users in the space is studied. The samples of various wave sound recorded at seashore near the campus are broadcasted in indoor spaces, such as cafeteria, learning spaces, etc. And subjects are asked to answer the questionnaire about preference and subjective impression for indoor environment. The results show that wave sound is almost accepted by users, but to be recognized by uses, output level must be high and could be harmful. The optimum level of wave sound in the space is discussed.

3pNSc8. A design of control signal in reducing discomfort of the dental treatment sound based on auditory masking. Yuko Suhara, Daisuke Ikefuji, Masato Nakayama, and Takanobu Nishiura (Grad. School of Information Sci. and Eng., Ritsumeikan Univ., 1-1-1 Nojihigashi, Kusatsu 525-8577, Japan, is023083@ed.ritsumei.ac.jp)

In dental treatment, patients feel a strong discomfort feeling by the treatment sounds which arise by a tooth grinding. In order to add comfort to quality of life, we aim to reduce the discomfort feeling with dental treatment sounds. We previously proposed the unpleasantness reduction method based

on auditory masking to reduce discomfort feeling of noise. The previously proposed method can reduce discomfort feeling by emitting a control signal to a listener, but we had focused on unpleasantness reduction to noise which has a peak frequency. Meanwhile, dental treatment sounds tend to consist of multiple spectral peaks. Therefore, in the present paper, we propose the design method of control signals for reducing discomfort feeling of dental treatment sounds which have multiple spectral peaks. More specifically, we detect the main spectral peaks, which bring a discomfort feeling, and design the control signal, which can mask these spectral peaks. Also, we employ the sound of running water as a source for the control signal. We carried out subjective evaluation experiments to confirm the effectiveness of the proposed method. As a result of evaluation experiments, we confirmed the effectiveness of the proposed method.

3pNSc9. Noise in hospitals as a strain for the medical staff. Silvester Siegmann and Gert Notbohm (Inst. for Occupational and Social Medicine, Heinrich Heine Univ. Duesseldorf, Universitätsstr. 1, Duesseldorf, NRW D-40225, Germany, siegmann@uni-duesseldorf.de)

Noise research in hospitals focuses mainly on the harmful effects on patients. But at least in intensive care units and operation theaters, also the staff is exposed to high levels of noise during considerable portions of working time. Evidence from literature is summarized here. During operation sessions lasting from 30 min to several hours, reported average Leq values range from 58 to 72 dB(A) with maximum levels above 105 dB(A). Similar noise levels are reported from emergency departments. As concentration, precise communication, and fast decisions are necessary in these situations, the acoustical environment has to be considered an enormous strain for the staff and a potential risk with regard to faults at work. But also during normal day and night shifts in intensive care units, noise is mentioned as an important disturbance by the medical staff. Most disturbing are noises from telephones and other communication tools and the signals and sounds from medical devices. Questionnaire surveys result in 80 to 91% of the staff reporting negative effects of noise in their daily work. A variety of measures for noise reduction and prevention in hospitals is suggested in literature emphasizing that the staff plays a decisive role in such projects.

3pNSc10. A consideration on sound masking system for achieving speech privacy using parametric acoustic array speaker. Takahiro Tamesue and Tetsuro Saeki (Yamaguchi Univ., 2-16-1, Tokiwadai, Ube 755-8611, Japan, tamesue@yamaguchi-u.ac.jp)

Speech privacy in open spaces is becoming increasingly important in various situations. Although measures such as the use of sound partitions are already used in many cases, measures that mask speech by emitting sounds have also been considered. A method of masking meaningful speech with meaningless noise would be valuable. Because of this, previous studies have investigated the ability of meaningless steady noise to mask speech and consequently achieve speech privacy. However, the research to date has focused on evaluating speech privacy when the masking noise is emitted from the normal loud speaker system all over the room. The masking noise emitted to the area where high level of speech privacy is not required, may cause an increased psychological impression of annoyance, leading to a decline in performance. In this study, we used a highly directional sound from modulated ultrasound as a masking noise for achieving speech privacy in the narrow area. Psychological experiments were conducted in which the masking sound was transmitted to participants from frontal or above directions with a parametric acoustic array speaker. Using the experimental data, the relationships between the degree of speech privacy and frequency characteristics and directivity of parametric acoustic array speaker were investigated. The results suggested that it is possible to maintain speech privacy in the narrow area by presenting highly directional masking sound.

3pNSc11. Categorization of street types in urban thermoacoustic analysis. Elcione L. Moraes, Irving M. Franco, Marcelle V. Silva, Isabela A. Rocha, Dorival F. Pinheiro, and Mindiyarauakti P. Freitas (Architecture and Planning, Federal Univ. of Pará, av. Augusto Corres, 01, Belém, Pará 66075900, Brazil, elcione@ufpa.br)

Urban areas suffer several environmental perturbations as a result of human activities and technological developments that contribute to the formation of heat islands and increasing noise contamination. Environmental effects are incorporated by population in urban areas and, especially, in areas near roads with heavy traffic. This paper presents a theoretical-experimental analysis on the relationship between climatological conditions and the propagation of noise in traffic corridors with high, medium, and low intensity. Some variables, such as the width of the streets, the height of the buildings, the distance between buildings, the volume flow of vehicles offer the possibility to make traditional techniques for mitigating the air temperature increase and reduce noise levels in urban zones. The results obtained in this work by measuring temperature, humidity, and noise levels, made during certain periods of time in different parts of the city of Belem/Brazil, were linked to a database georeferenced (GIS) that allowed interpolation of data in a single platform, enabling integration between data allowing to correlate them in order to assess which typological conditions are most favorable to the thermoacoustic comfort.

3pNSc12. Effects of age on feasible sound level of possible warning sounds for quiet vehicles. Katsuya Yamauchi (Faculty of Eng., Nagasaki Univ., Bunkyo 1-14, Nagasaki 852-8521, Japan, yamauchi@cis.nagasaki-u.ac.jp), Takayuki Shiizu, Fumio Tamura, and Yuichiro Takeda (Pioneer Corp., Kawagoe, Japan)

It has been noted that reduced noise can also lead to potentially dangerous situations for pedestrians because electric and hybrid vehicles are quieter than conventional internal combustion engine vehicles. Hence, the use of warning sounds which are radiated by the vehicle to alert pedestrians is being considered by various governments. To design the sound itself or to develop the regulation concerning the sound, it is much important to know the feasible sound level of the warning sounds compared to the background sounds. Pilot studies on this topic were performed by Yamauchi *et al.* in 2011 with young subjects. This present study was aimed to reveal the effect of age on feasible sound level of warning sounds. In the experiment, level of five possible warning sounds was adjusted in three different urban environmental sounds in a laboratory. Thirty subjects aged from 19 to 74 years old participated in the experiment. The subjects were asked to adjust the level of warning sounds so that they are clearly audible or just audible depends on the instruction. Results of the adjustments are presented and compared to current recommendations for sound levels of warning signals in quiet vehicles.

3pNSc13. Green cork-based innovative resilient and insulating materials: Acoustic, thermal, and mechanical characterization. Marco Caniato, Sbaizero Orfeo (Architecture and Eng., Univ. of Trieste, via valerio 6/a, Trieste 34100, Italy, mcaniato@units.it), Jan Kaspar, and Roberta Di Monte (Dept. of Chemistry Sci., Univ. of Trieste, Trieste, Italy)

Nowadays, efficient thermal insulation is a principal requirement for buildings and, accordingly, huge amounts of insulators are applied in the constructions, particularly for external walls, radiant floor, etc. Acoustic insulation is another of the most stringent parameters to be taken into account both in the construction of new buildings or their rejuvenation in order to obtain good internal comfort. On the other hand, the use of bio-derived construction materials is gaining stronger and stronger interest. Cork has a low density (120–240 kg m^3) and can be regarded as a hydrophobic and viscoelastic material, with good thermal and acoustic insulation properties. With respect to wood, it presents good resistance to microbial activity and water. Last but not least is the negative carbon fingerprint of cork-based materials. Here we will describe a new class of polymer—inorganic oxides—cork composites that feature enhanced thermal and acoustic properties with respect to traditional commercial composites and maintain, at the same time, all the favorable properties of conventional cork-base composites.

3pNSc14. Impulse response measurement in public space using musical signal including swept-sine signals. Fumiaki Satoh, Junichi Mori, Tomoya Nishii, and Hideki Tachibana (Chiba Inst. of Technol., Tsudanuma 2-17-1, Narashino 275-0016, Japan, fumiaki.satoh@it-chiba.ac.jp)

In design of public spaces, e.g., railway stations, airport terminal buildings, and underground shopping centers, careful attention should be paid from an acoustical viewpoint. It is not only for acoustical comfort but also for safety ensured by a public address system with high intelligibility. As a study for this aim, we have been investigating acoustical characteristics of various public spaces. In these studies, it is strongly desired to measure impulse responses in the spaces under live condition with occupants but the

usual measurement method using Swept-Sine signals are not applicable because the signals sound very peculiar to the occupants. To mitigate such a problem, we are trying a method using test music signals in which Swept-Sine signals are inserted. In this paper, the availability of this measurement technique is outlined and some measurement results are introduced.

3pNSc15. Modeling room impulse response via composites of spatial-temporal Gaussian processes. Tatsuya Komatsu (Grad. School of Information Sci., Nagoya Univ., Furo-cho, chikusa-ku, Nagoya, Aichi 464-8601, Japan, komatsu.tatsuya@g.sp.m.is.nagoya-u.ac.jp), Gareth W. Peters (Dept. of Statistical Sci., UCL, London, United Kingdom), Tomoko Matsui (Dept. of Statistical Modeling, Inst. of Statistical Mathematics, Tokyo, Japan), Ido Nevat (Wireless & Networking Lab., CSIRO, Sydney, NSW, Australia), and Kazuya Takeda (Grad. School of Information Sci., Nagoya Univ., Nagoya, Japan)

We develop a novel algorithm to estimate a spatial-temporal transfer function of a time-domain room impulse response for reverberation in closed environments. This novel approach involves developing two non-parametric models, one for the early phase and the other for the late phase for reverberation. These models are based on a composite of two Gaussian Process (GP) structures. We also investigate the impact of the choice of spatial and temporal kernels on the estimation and prediction performance. The proposed algorithm incorporates as a special case the widely utilized exponentially decaying model and also extends this model structure within the GP setting to more advanced spatial-temporal structures suitable to perform estimation of the reverberant transfer function. The performance of the proposed algorithm is evaluated in a real environment using nine spatially distributed microphones. The microphones collect reverberant response from a directional speaker allowing observation of noisy realizations of the impulse response to reverberate during early and late stages. We compare the performance of our algorithm with a 3D spatial-temporal cubic interpolation algorithm and show that the proposed algorithm provides equal or better performance than the cubic interpolation.

3pNSc16. Large-scale sound field rendering with graphics processing unit cluster for three-dimensional audio with loudspeaker array. Takao Tsuchiya (Dept. of Information Systems Design, Doshisha Univ., 1-3 Tatara-Miyakodani, Kytanabe City, Kyoto 610-0321, Japan, ttsuchiy@mail.doshisha.ac.jp), Yukio Iwaya (Dept. of Elec. Eng. and Information Technol., Tohoku Gakuin Univ., Tagajo, Miyagi, Japan), and Makoto Otani (Dept. of Comput. Sci. and Eng., Shinshu Univ., Nagano, Nagano, Japan)

The sound field rendering is a technique to simulate the sound field from the three-dimensional numerical models constructed in the computer, and it is the same concept as the graphics rendering in the computer graphics. In this paper, a graphics processing unit (GPU) cluster system is applied to the sound field rendering for a large room simulation. The compact explicit finite difference time domain (CE-FDTD) method is implemented on the GPU cluster system. The CE-FDTD method is a kind of the finite difference method in which the wave equation is directly discretized based on the central differences. The developed GPU cluster system consists of eight PC nodes in which four GPUs are mounted respectively. The rendering results are reproduced by a speaker array system in which 157 speakers surround a small room. The sound field renderings are performed for a large room with a volume capacity of about 5000 cubic meters, in which the impulse responses of one-second length with a sampling rate of 40 kHz are calculated at 157 points corresponding to the loudspeaker positions. The impulse responses are then convoluted with dry music sources. The sound field rendering with the 157ch loudspeaker array system provides the realistic sound field reproduction with natural reverberation.

3pNSc17. Acoustic characterization of three archeological sites in the state of Guanajuato, Mexico. Alejandro Ramos-Amezquita (Comput. Sci. Dept., Tecnológico de Monterrey, Calle del Puente 222, Colonia Ejidos de Huipulco Tlalpan, Mexico City, Mexico DF 14380, Mexico, alejandro.ramos.amezquita@itesm.mx) and David I. Ibarra-Zarate (CAEND, Universidad Politécnica de Madrid, Madrid, Spain)

The present work shows the results obtained in collaboration with the government of the state of Guanajuato in Mexico in a project that looked to include the acoustical analysis of Archaeological sites as a tool for gathering information regarding the historical social use of the areas in question. To that end, the acoustical characterization of 3 archaeological sites recently opened to the public in the state was in order: Cañada de la Virgen, Peralta and Plazuelas. Results include the 3D modeling of the areas of interest and the simulation of the acoustic response of them using the software EASE. Specific acoustic parameters were extracted from the simulations and then analyzed in comparison to archeological hypothesis of the use of such spaces as areas of public appearances, performance, ethno-musicological reports on the type and use of musical instruments, and other archaeological findings in the area in order to support or disprove such hypothesis.

3pNSc18. Basic study on discrimination between sound fields of architectural spaces. Maya Katoh and Takane Terashima (Architecture, Mie Univ., 1577 Kurimamatiya-cho, Tsu, Mie 514-8507, Japan, 412m409@m.mie-u.ac.jp)

Many objective criteria by attenuation property of room acoustic energy have been suggested, and relationships with subjective attributes have been elucidated. The difference of synthetic subjective impression between sound fields could be discriminated by acoustical parameters, i.e., objective criteria above, but details of mechanism in discrimination among different sound fields, weightings or grounds of judgment, etc. have not been clarified. The purpose of this study is to clarify the discrimination factor over difference between sound fields. In this report, subjective experiments are carried out by using impulse response data of existing ten concert halls and music data, made from convolution of impulse responses and dry sources, as stimuli. In these experiments, subjects are asked to evaluate the impression of each stimulus, and to judge the difference among stimuli in pared comparison. The results of these experiments are analyzed and it seems that the factor related to the difference of Reverberance is dominant in discrimination by factor analysis, but there are some cases in which Loudness or Clarity is dominant. The weightings of factors, the boundary to switch judgment between factors, etc. will be discussed.

3pNSc19. Effect of visual information on subjective impression for sound field in architectural space. Yuko Wani, Takane Terashima (Architecture, Mie Univ., 1577 Kurimamachiya-cho, Tsu, Mie 514-8507, Japan, 412m421@m.mie-u.ac.jp), and Yasunobu Tokunaga (Civil Eng., Maizuru National College of Technol., Maizuru, Japan)

In architectural and urban space, we are always exposed to multimodal stimuli of visual information and sound fields in various scenes of everyday life. The purpose of this study is to clarify relationship of subjective impression of vision and auditory, and acquire knowledge which contributes to architectural design or acoustic design. In this report, two following experiments are carried out in which subjects are presented with sound fields by real time convolution as auditory stimuli and panoramic VR images of 360 interactive views of interior as visual stimuli. (1) Comparison between subjective responses for single or multi modal presentations of visual and auditory stimuli from various architectural spaces. (2) Comparison between subjective responses for various combinations of multi modal presentations of visual and auditory stimuli from various architectural spaces. Analysis for results of these experiments clarify the influence of visual information upon the subjective impression for sound field and mutual relationship between subjective impression of vision and auditory of interior of buildings. It is already found that visual information significantly effects subjective impression for sound field by experiment 1, and the details of relationship between elements of visual information and parameters of sound field will be clarified by experiment 2.

3pNSc20. Study of the acoustic of Jean Nouvel's Auditorium 400, at the Museum Reina Sofia in Madrid. Emiliano del Cerro and Silvia M[a] Ortiz (TIC, Universidad Alfonso X el Sabio, Avenida Universidad 1, Madrid 28691, Spain, ecerresc@uax.es)

The Auditorio 400 is one of the buildings that make up the National Art Museum Reina Sofia in Madrid. It is the work of renowned French architect Jean Nouvel. This space was designed to accommodate primarily chamber music concerts but now can be considered as a multi-purpose venue. This hall hosts events with different content: acts with the voice as main sound

source as conferences, seminars etc. and concerts with music from diverse styles, classical, contemporary, avant-garde, and electro acoustic music. This versatility assumes that the acoustic conditions required for the different uses of Auditorio 400 must be diverse and special depending on the sound source, in order to achieve the adequate sound quality for the various events that are held there. This paper presents the study of the acoustics of the Auditorium 400, analyzing various parameters for evaluating the sound quality of the room, highlighting the worst areas of listening, the reasons for the existence of such areas and the description of improvements to be made to ensure that the enclosure meets the expectations in a hall of its relevance.

3pNSc21. Influence of visual information on sound evaluation in auditorium. Yasunobu Tokunaga, Daichi Okuie (Maizuru National College of Technol., 234 Shiroya, Maizuru-shi 625-8511, Japan, tokunaga@maizuru-ct.ac.jp), and Takane Terashima (Grad. School of Eng., Mie Univ., Tsu-shi, Japan)

When hearing music in an auditorium, audience is provided with aural information and visual information at the same time. Visual and auditory sense sometimes interact with each other so that the auditory sense is considered to have some influence on sound evaluation made by audience. The purpose of this study is to reveal an influence of visual information obtained in audience seats in a hall on subjective evaluation. We investigated the relationship between sound evaluation and whether a musical performance video as visual stimulus is provided or not, and between the sound evaluation and evaluation concerning the space at certain position in the audience seats. As a result, it was revealed that visual information gave statistically significant influence on sound evaluation.

3pNSc22. Design and positional accuracy of straight-path traversing room acoustic measurement system based upon low-cost servo motor and light-weight multi-field microphone. Roger M. Ellingson (RM Ellingson Design & Development, LLC, 8515 SW Barnes Rd., Portland, OR 97225, Rogere@Rmegen.net) and Guillaume J. Bock (Bruel & Kjaer, North America Inc., Snohomish, WA)

The construction and operation of a straight-path traversing, acoustical microphone-based, measurement system is described. The system was designed to support test room qualification procedures such as prescribed in standards ANSI S12.35-1990 and Annex A of ISO 3745-2003. Major system components include a taut line suspending a sliding microphone carriage drawn by a string attached to a rotating drum. Central to the overall light-weight, low-power, mechanical design is the physically small Bruel & Kjaer 4961 microphone, holder, preamp, and signal cable whose multi-field response characteristic should well support accurate room qualification measurements. The battery-powered drum drive mechanism is built using the servo motor, wheels, and gears from a Lego Mindstorms NXT kit. Precision motor rotation is remotely programmable over the NXT controller's wireless Bluetooth interface. Commonly available sport fishing tackle composes the majority of the suspension assembly. A software interface library is also described which enables PC-based applications to automate microphone positioning in synchrony with source emission, signal acquisition, and analysis. The system has been used to document the free-field characteristic of a perimeter loudspeaker array with centrally located listener in a fully anechoic chamber environment. Together with construction and operational detail, results indicating overall microphone positioning accuracy and reliability are presented here.

WEDNESDAY AFTERNOON, 5 JUNE 2013 519B, 1:00 P.M. TO 2:40 P.M.

Session 3pPAa

Physical Acoustics: Borehole Acoustics Logging for Hydrocarbon Reservoir Characterization II

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Contributed Papers

1:00

3pPAa1. Simulation of sonic logging for deviated wells in anisotropic formations. Evgeniya Deger (SKK, Schlumberger, 2-2-1 Fuchinobe, Chuo-Ku, Sagamihara, Kanagawa 252-0206, Japan, emyalo@slb.com), Marwan Charara (SMR, Schlumberger, Moscow, Russian Federation), Henri-Pierre Valero (SKK, Schlumberger, Sagamihara, Japan), Denis Sabitov, and Grigory Pekar (SMR, Schlumberger, Moscow, Russian Federation)

Interpretation of sonic logging data acquired in environments with complex anisotropy is a difficult problem attracting attention of researchers and oil industry. In order to better understand physics of wave propagation in highly anisotropic medium and be able explaining observations from field data there is a need for fast and accurate numerical modeling capability. To address such challenge, we developed an efficient and accurate numerical algorithm for the simulation of sonic logging experiments in highly anisotropic formation. The basis of the approach is a heterogeneous spectral element method implemented on multi-GPU applied to acoustic-elastic wave equation. The approach was designed to simulate wave propagation in 3D arbitrary anisotropic elastic media with attenuation for a constant quality factor via standard linear solid using the tau-method. Due to the use of an unstructured grid, the spectral element algorithm enables handling tools in a fluid-filled borehole with surrounding geological models of high complexity. Several examples of log simulations for deviated wells in VTI formations for monopole, dipole, and quadrupole source symmetries and their comparison with real field data will be presented in this paper. Discussion regarding complex wave propagation will be developed in view of these simulations and real data.

1:20

3pPAa2. Numerical simulations of dipole sonic responses in a liquid-filled trough with arc-shaped section. Xiao He, Hao Chen, and Xiuming Wang (State Key Lab. of Acoust., Inst. of Acoust., Chinese Acad. of Sci., 21, Northern 4th Ring Rd. West, Haidian District, Beijing 100190, China, hex@mail.ioa.ac.cn)

To test the running performance of a sonic logging tool, it is an effective way to place the tool in a water-filled trough and record the sonic responses for an integrated check of the transducers in laboratory. Hence it is necessary to investigate the wave propagation in such a non-symmetric structure. In this study, we present the numerical modeling results of dipole sonic responses in a trough with arc-shaped section. A 3D cylindrical finite

difference code as well as the irregular free-surface conditions is implemented. It is revealed that the flexural mode in a trough is evidently slower than that in a cylindrical pipe with same sizes. The flexural velocity decreases with the increasing gap angle of the trough. Moreover, the trough structure shows strong elastic anisotropy. The in-line responses (XX and YY) of the logging tool are difference in phases and amplitudes. The amplitudes of both cross-line responses (XY and YX), which reflect the level of anisotropy, become greater as the gap angle increases. The waveforms with varying dipole orientations are also illustrated. The XY and YX responses excited by an inclined transmitter are much stronger than those generated by a horizontal or a vertical dipole source.

1:40

3pPAa3. Research on a kind of low-frequency broadband cross-dipole projector. Dai Yuyu, Xin Penglai, Wang Xiuming, and He Hongbin (The Ultrasonic Phys. and Exploration Lab., Inst. of Acoust., Chinese Acad. of Sci., No.21, Bei-Si-huan-Xi Rd., Beijing 100190, China, daiyuyu001@126.com)

The finite element method (FEM) is used to simulate a low-frequency broadband cross-dipole projector based on trilaminar bender bar in this paper. In the simulated model, four long trilaminar bender bars and four short trilaminar bender bars are attached on a skeleton two form two square arrays, and very array excite two different response frequencies. The four response frequencies distribute on the range from 400 Hz to 5 kHz to reach broadband exciting. Finally, a sample is fabricated, and test in an anechoic tank, it is shown that the test result meet the simulated result very well.

2:00

3pPAa4. Phase-based dispersion analysis of borehole acoustic logs. Said Assous (Geoscience, Weatherford, East Leake, Loughborough LE126JX, United Kingdom, said.assous@eu.weatherford.com), Laurie Linnett (Geoscience, Weatherford, Edinbourgh, United Kingdom), and Peter Elkington (Geoscience, Weatherford, East Leake, United Kingdom)

The dispersive behavior of acoustic waves in boreholes is of interest in the evaluation of reservoir rocks, particularly from the point of view of near wellbore stress distribution. It is also used as a quality control on dipole sonic calculations that estimate formation shear slowness from the low frequency asymptote of the flexural wave slowness. Multiple methods are available for dispersion analysis; the paper reviews the most commonly used, including the Prony and the spectral semblance methods, and proposes a new phase-based analysis technique that has the benefit of improved slowness resolution. The methods are applied to synthetic and real data sets, and results compared. The new method is show to have lower slowness uncertainty for any given frequency, and the upper and lower frequency limits for which dispersion can be calculated is also extended.

2:20

3pPAa5. Unrelaxed drained bulk modulus for fluid-saturated rocks on full frequency range. Yong J. Song, Hengshan Hu (Dept. of Astronautics and Mech., Harbin Inst. of Technol., P.O. Box 344 92 West Dazhi St., Harbin, Heilongjiang (+0086)150001, China, songyongjia061220110@126.com), and Changwen Li (Technol. Ctr. of China Petroleum Logging CO., LTD., Xian, China)

Local flowing between cracks and pores is called squirt-flow that usually induce elastic moduli dispersion and waves attenuation. Expression of unrelaxed drained bulk modulus on full frequency range is derivated in this paper when liquid pressure in soft crack is unrelaxed. Unrelaxed drained bulk modulus's real part increases with frequency, and unrelaxed drained bulk modulus's imaginary part is nonzero. This studies also show that liquid pressure in cracks equals to zero at he low frequency limitation, that is to say liquid pressure in cracks have sufficient time to relax and in this case the drained bulk modulus correspondents to Biot's static drained bulk modulus.At the high frequency limitation, the unrelaxed drained bulk modulus approximate to Mavko-Jizba's expression. The expression of drained modulus in this paper also degenerates to Biot theory's drained bulk modulus when crack density equals zero, but the latter is just a modulus on a hypothetical state and is not the true static experiment data when rocks contain soft cracks. Unrelaxed drained bulk modulus is used to calculate fast P-wave and slow P-wave velocities and attenuation instead of static drained or dry bulk modulus in Biot's theory. Squirt-flow generates much more velocity dispersion and attenuation in fast P-wave than Biot flow. The magnitude of attenuation depends on crack density and the relaxation frequency depends on aspect ratio.

WEDNESDAY AFTERNOON, 5 JUNE 2013 519A, 1:00 P.M. TO 2:40 P.M.

Session 3pPAb

Physical Acoustics: General Physical Acoustics II

Raymond Panneton, Chair
Mech. Eng., Univ. de Sherbrooke, 2500 Universite Blvd., QC J1K 2R1, Canada

Contributed Papers

1:00

3pPAb1. Modeling sound fields from radially symmetric impulsive planar sources using Rayleigh's Integral. Stephen I. Warshaw (LLNL (Ret.), Univ. of CA, 40 West 15 St Loft 1C, New York, New York 10011, siw1939@yahoo.com)

The evaluation of Rayleigh's integral in cases where the integrand contains delta functions with time-dependent arguments provides a highly useful and easily implemented vehicle for modeling and understanding the radiation of impulsive sound waves from planar sources. We present elementary examples of such calculations and show their application in various realistic scenarios, including the radiation of impulsive aeroacoustic sound from buried explosions and potential extensions to lithotripsy. In this paper, we represent the surface motions of a planar radiating source as delta functions of radially expanding or contracting arguments with easily specified geometrical parameters, and present model near-field to far-field calculations of the launched sound waves using analytic and numerical integration. We show that significant features in these traveling impulses can easily be related to the details of the kinematic history of the planar source. We restrict our purview to the time domain and to radial symmetry; frequency analyses and azimuthally asymmetric motions will not be considered.

1:20

3pPAb2. Application of the spectral method for computation of the spectrum of anisotropic waveguides. Timur Zharnikov, Denis Syresin (Schlumberger Moscow Res., Pudovkina St., 13, Moscow 119285, Russian Federation, tzharnikov@slb.com), and Chaur-Jian Hsu (Schlumberger-Doll Res., Cambridge, MA)

Spectral method is formulated in cylindrical coordinates for the general case of waveguide with arbitrary anisotropy with the spatial dependence. According to the idea of this approach, matrix representation of operator in

the right-hand side of governing equations is considered. As a result, the latter are cast into exact infinite set of integro-differential equations. Explicit expressions for their kernels expose coupling between axial and azimuthal harmonics. Coupling of axial harmonics vanishes in important case of waveguide with translational invariance in axial direction. It results in the set of differential equations, which is used to introduce practical approximation procedure. The latter yields generalized eigenvalue problem, which can be solved numerically for the spectrum of the operator. The spectrum is sorted according to eigenmodes' properties. Thus dispersion curves of eigenmodes are constructed. Presented consideration can be adapted for waveguides of different physical nature (elastic, electromagnetic, etc.) and different geometry (rectangular, elliptical, etc.). Developed technique is verified by comparison with results of controlled laboratory measurements on anisotropic sample. Monopole, dipole and quadrupole normal modes for scaled borehole in anisotropic rock sample with TTI symmetry are considered. The comparison of spectral method results with the dispersion analysis of synthetic data is provided as well.

1:40

3pPAb3. Influence of reflecting walls on edge diffraction simulation in geometrical acoustics. Alexander Pohl (HafenCity Universität Hamburg, Hebebrandstrasse 1, Hamburg 22297, Germany, alexander.pohl@hcu-hamburg.de), Dirk Schröder (EPFL Lausanne, Lausanne, Switzerland), Uwe M. Stephenson (HafenCity Universität Hamburg, Hamburg, Germany), and U. Peter Svensson (NTNU Trondheim, Trondheim, Norway)

Edge diffraction can be introduced into geometrical acoustics mainly by three models: detour-based, energetic and wave-based diffraction models. In the past, we thoroughly compared Maekawa's detour law, the uncertainty relation based diffraction method and the secondary source model by the example of edge diffraction of a single wedge. However, the influence of the wedge shape has not yet been analyzed. Therefore, we consequently study in this contribution the influence of the wedge's faces. This is analyzed by varying both the faces' reflection properties and their opening angle. This is extended to the crucial case of approximately parallel faces (inner angle, e.g., 179°), where diffraction is physically neglectable, but computationally problematic for the uncertainty based diffraction method. Additionally, wedges are placed on an infinitely long surface. Therewith, we can analyze the floor reflections' impact on the sound field behind the wedge by varying both their absorption and scattering coefficients. Furthermore, we discuss artifacts which can arise in the uncertainty based diffraction model due to arbitrary positioning of diffraction planes, so called "transparent walls." Finally, we discuss the advantages and disadvantages of the presented methods.

2:00

3pPAb4. Acoustic response of a buried landmine with a low grazing-angle source array, focused on the ground. Benjamin J. Copenhaver, Justin D. Gorhum, Charles M. Slack, Martin Barlett, Thomas G. Muir, and Mark F. Hamilton (Appl. Res. Labs., The Univ. of Texas at Austin, P.O. Box 8029, Austin, TX 78713-8029, bcopenhaver@utexas.edu)

An array of 16 loudspeakers, deployed along a segment of the base of a right circular cone, was used to focus intense tone bursts at low audio frequencies on a soil, with and without a buried target, having a compliant lid. The response of the target site was examined as a function of source frequency, intensity level, and excitation signal type, including multi-tone radiations. Nonlinear interaction to produce sum and difference frequencies at the target site was examined and compared with observations of Korman and Sabatier [J. Acoust. Soc. Am. **116**, 3354 (2004)]. [Work supported by the ARL:UT McKinney Fellowship in Acoustics.]

2:20

3pPAb5. The farfield impulse response for a rectangular piston in viscous media. Pedro C. Nariyoshi and Robert J. McGough (Michigan State Univ., 2120 Eng. Bldg., East Lansing, MI 48864, mcgough@egr.msu.edu)

Calculations of the transient radiation pattern in the farfield of rectangular transducers often employ the impulse response of the velocity potential. Analytical expressions for the impulse response are known for lossless media, and similar expressions are needed for propagation in viscous media. Solutions are obtained with two different Green's functions for viscous media. One solution, which is causal, is based on an approximate Green's function for the Stokes wave equation, and the other solution, which is noncausal, is based on an approximate Green's function for the Blackstock wave equation. The impulse response is calculated with these Green's functions using the Rayleigh-Sommerfeld integral, and the results of these calculations are compared to analytical expressions for the impulse response derived for viscous media. Numerical results are obtained for a 1 mm by 1 mm square transducer evaluated in the farfield region, where the Rayleigh-Sommerfeld integral provides the reference calculated with 400 abscissas in each direction. The results show that the causal and noncausal solutions are nearly identical in the farfield region, and the analytical impulse response expressions derived from the causal and noncausal Green's functions are consistently within 1% of the Rayleigh-Sommerfeld reference in the farfield. [Work supported in part by NIH Grant R01 EB012079.]

Session 3pPP

Psychological and Physiological Acoustics: Multimodal Influences on Auditory Spatial Perception

William L. Martens, Cochair
Univ. of Sydney, 148 City Rd., Wilkinson Bldg. G04, NSW 2006, Australia

Shuichi Sakamoto, Cochair
Res. Inst. of Elec. Commun., Tohoku Univ., 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan

Invited Papers

1:00

3pPP1. Spatial sound and its effect on visual quality perception and task performance within a virtual environment. Brent Cowan (Business and Information Technol., Univ. of Ontario Inst. of Technol., Oshawa, ON, Canada), David Rojas (SickKids Learning Inst., The Hospital for Sick Children, Oshawa, ON, Canada), Bill Kapralos (Business and Information Technol., Univ. of Ontario Inst. of Technol., 2000 Simcoe St. North, Oshawa, ON L1H 7K4, Canada, bill.kapralos@uoit.ca), Karen Collins (The Games Inst., Univ. ofWaterloo, Waterloo, ON, Canada), and Adam Dubrowski (SickKids Learning Inst., The Hospital for Sick Children, Toronto, ON, Canada)

Immersive 3D virtual environments such as simulations and serious games for education and training are typically multimodal, incorporating at the very least both visual and auditory cues, each of which may require considerable computational resources, particularly if high fidelity environments are sought. It is widely accepted that sound can influence the other modalities. Our own previous work has shown that sound cues (both contextual and non-contextual with respect to the visual scene) can either increase or decrease (depending on the sound) visual fidelity (quality) perception in addition to the time required to complete a simple task (task completion time) within a virtual environment. However, despite the importance and benefits of spatial sound (sound that goes far beyond traditional stereo and surround sound techniques, allowing users to perceive the position of a sound source at an arbitrary position in three-dimensional space), our previous work did not consider spatial sound cues. Here we will build upon our previous work by describing the results of an experiment that will be conducted to examine visual fidelity (quality) perception and task performance in the presence of various spatial sound cues including acoustical reverberation and occlusion/diffraction effects, while completing a simple task within a virtual environment.

1:20

3pPP2. Touch the sound: The role of audio-tactile and audio-proprioceptive interaction on the spatial orientation in virtual scenes. M. Ercan Altinsoy and Maik Stamm (Chair of Commun. Acoust., Dresden Univ. of Technol., Helmholtzstr. 18, Dresden 01062, Germany, ercan.altinsoy@tu-dresden.de)

Being able to localize objects in the space close to the body is an important prerequisite for precise object interaction. It is also very important for the spatial orientation in virtual scenes. Since sound is usually produced by the vibrations of a body, sound emitting objects, such as shaver or hair dryer, provide both auditory and haptic information. This study focuses on auditory-haptic localization in the spatial domain. We carried out two experiments to investigate the interaction effects. In the first experiment, the influence of tactile signals on auditory localization task was investigated. Similar to the ventriloquist effect from auditory-visual interaction, the results of the first experiment show that the perceived location of auditory stimuli is influenced by tactile stimulation. The results also indicate some hints that there may be an audiotactile precedence effect. In the second experiment, the influence of auditory signals on proprioception was investigated. The results show that the auditory and proprioceptive information can be combined in such a way that the localization errors in a virtual scene are minimized.

1:40

3pPP3. Compression of perceived auditory space during forward self-motion. Shuichi Sakamoto (Res. Inst. of Elec. Commun., Tohoku Univ., 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi 980-8577, Japan, saka@ais.riec.tohoku.ac.jp), Wataru Teramoto (Grad. School of Arts and Letters, Tohoku Univ., Sendai, Japan), Fumimasa Furune (Grad. School of Information Sci., Tohoku Univ., Sendai, Japan), Yôiti Suzuki (Res. Inst. of Elec. Commun., Tohoku Univ., Sendai, Japan), and Jiro Gyoba (Grad. School of Arts and Letters, Tohoku Univ., Sendai, Japan)

Humans can perceive a stable auditory environment and appropriately react to a sound source, even when they are moving. This suggests that the inputs are reinterpreted in the brain, while being integrated with information on the movements. Although several studies have shown the influence of the vestibular semicircular canal signals on auditory localization, it is not clear how auditory space representation is modulated by linear accelerations which are obtained from the macular receptors of the otolith system (utricle and saccule). We investigated the effect of the linear acceleration on auditory space representation. During the forward/backward self-motion, a short noise burst was presented from one of the loudspeakers which were aligned parallel to the motion direction when the listener's coronal plane reached the location of one of the speakers (null point). The results showed that the sound position aligned with the subjective coronal plane was displaced ahead of the null point only during forward self-motion. Moreover, all the sounds that were actually located in the traveling direction were perceived as being biased towards the null point. These results suggest a distortion of perceived auditory space in the direction of movement during forward self-motion.

2:00

3pPP4. Dominance of head-motion-coupled directional cues over other cues during walking depends upon source spectrum. William L. Martens (Faculty of Architecture, Design and Planning, Univ. of Sydney, 148 City Rd., Wilkinson Bldg. G04, Univ. of Sydney, NSW 2006, Australia, william.martens@sydney.edu.au), Shuichi Sakamoto (Res. Inst. of Elec. Commun. and Grad. School of Information Sci., Tohoku Univ., Sendai, Japan), Luis Miranda, and Densil Cabrera (Faculty of Architecture, Design and Planning, Univ. of Sydney, Sydney, NSW, Australia)

Listeners who walk past a continuously presented speech sound source emanating from a fixed spatial position will typically experience veridical perception of source location. If, however, walking listeners are fitted with binaural hearing instruments that allows for the signals reaching their ears to be interchanged, left for right and right for left, the sound source is typically reported to be located in a spatial region that is reversed with respect to all three spatial axes: left for right, front for back, and above for below. This result has been taken as evidence for the relative dominance of dynamic interaural directional cues over the spectral directional cues associated with each listener's own pinnae which should support veridical perception. In order to investigate the relative importance of the spectral energy distribution of the source on the illusory reversals of source location, bursts of broadband noise were presented rather than continuous speech. Under these circumstances, with greater energy in higher frequency bands, the reversals did not readily occur. Therefore, it has been concluded that head-motion-coupled directional cues are likely to dominate spectral cues associated with the filtering effects of the listener's pinnae only for sources containing greater energy at lower frequencies.

2:20

3pPP5. Impact of dynamic binaural signal associated with listener's voluntary movement in auditory spatial perception. Tatsuya Hirahara, Daisuke Yoshisaki, and Daisuke Morikawa (Faculty of Eng., Toyama Prefectural Univ., 5180 Kurokawa, Imizu 939-0398, Japan, hirahara@pu-toyama.ac.jp)

The effect of listener's voluntary movement on the horizontal sound localization was investigated using a binaural recording/reproduction system with TeleHead, a steerable dummy head. Stimuli were static binaural signals recorded with a still dummy-head in head-still condition, dynamic binaural signals recorded with a dummy-head that followed precise or modified listener's head rotation, dynamic binaural signals produced by steering-wheel rotation with listener's hands in head-still condition, and dynamic binaural signals produced by an experimenter in head-still condition. For the static binaural signals, some were localized within the head and the front-back errors often occurred. For the dynamic binaural signals, none of them was localized within the head, and the front-back confusions seldom occurred. Sound images of the dynamic binaural stimuli produced by head rotation were localized out-of head, while those produced by the steering-wheel rotation or by an experimenter were moving around the listener's head. Listeners could judge the orientation of each stimulus more correctly with dynamic binaural signals produced by listener's head or steering-wheel rotation than with static binaural signals and with dynamic binaural signals produced by an experimenter. Results suggest that the dynamic binaural signal associated with listener's voluntary movement play crucial role in sound localization.

2:40

3pPP6. Cue weighting and vestibular mediation of temporal dynamics in sound localization via head rotation. Ewan A. Macpherson (National Ctr. for Audiol., Western Univ., Elborn College, 2262, 1201 Western Rd., London, ON N6G 1H1, Canada, ewan.macpherson@nca.uwo.ca)

Our studies have quantified the salience and weighting of dynamic acoustic cues in sound localization via head rotation. Results support three key findings: (1) low-frequency interaural time-difference (ITD) is the dominant dynamic binaural difference cue; (2) when available, high-frequency spectral cues dominate front/rear localization; and (3) the temporal dynamics of dynamic cue processing are particular to auditory-vestibular integration. ITD dominance is shown indirectly in findings that head movements are highly effective for localizing low-frequency targets but not narrow-band high-frequency targets and that only normal low-frequency hearing is required to localize via dynamic cues. Direct evidence comes from manipulation of dynamic binaural cues in spherical-head simulations lacking spectral cues. If the stimulus provides access to dominant high-frequency spectral cues, location illusions involving head-coupled source motion fail. For low-frequency targets, localization performance improves with increasing head-turn angle, but decreases with increasing velocity such that performance depends primarily on stimulus duration; ~100 ms being required for accurate front/back localization. That duration threshold only applies in dynamic localization tasks, and not in auditory-only tasks involving the same stimuli. Correct spatial interpretation of dynamic acoustic cues appears to require vestibular information about head motion, thus the 100-ms temporal threshold is likely a property of vestibular-auditory integration.

Session 3pSAa

Structural Acoustics and Vibration, Noise, Engineering Acoustics, and Physical Acoustics: Acoustic Metamaterials II

Yun Jing, Cochair
Mech. Eng., North Carolina State Univ., 911 Oval Dr., EB III, Campus Box 7910, Raleigh, NC 27695

Dean Capone, Cochair
Penn State, P.O. Box 30, State College, PA PA

Contributed Papers

1:00

3pSAa1. Broadband transparent periodic acoustic structures. Gregory J. Orris (Acoust. Div., U.S. Naval Res. Lab., 4555 Overlook Ave. SW, Washington, DC 20375, gregory.orris@nrl.navy.mil), Christopher N. Layman, Christina J. Naify (National Res. Council, Washington, DC), Theodore P. Martin, and David C. Calvo (Acoust. Div., U.S. Naval Res. Lab., Washington, DC)

The creation of acoustically transparent materials is of interest for enhanced energy focusing in metamaterial lenses, vibration isolation and structure concealment in underwater environments. It has previously been shown that metal pentamode metamaterials may provide water like behavior yet retain enough shear to provide structural stability. This is achieved through a periodic lattice with sub-wavelength cells. The current talk presents a study on the simulated and experimental behavior of other structural materials that operate similar to pentamode composites, which exhibit transparency in underwater conditions. Specifically, we examine a two-dimensional design composed of a honeycomb arrangement of fluid inclusions in a solid polymer background. Materials, designs and simulations are supported through both band structure calculations and transmission modeling of finite slabs of the device. Experiments are performed in a water-filled test tank and broad frequency behavior is examined. [Work supported by ONR.]

1:20

3pSAa2. Evaluation of an acoustic metamaterial leaky-wave antenna. Christina J. Naify, Christopher N. Layman (National Res. Council, 4555 Overlook Ave. SW, Washington, DC 20375, christina.naify.ctr@nrl.navy.mil), Theodore P. Martin, David Calvo, and Gregory J. Orris (Acoustics, Naval Res. Lab., Washington, DC)

An acoustic projector array, which can be steered between ± 90 degrees backfire to endfire directions based solely on input frequency, is presented using a combination of transmission line (TL) analysis and negative index metamaterial ideas. An acoustic version of a leaky wave antenna, this TL structure is composed of acoustically loaded membranes (acoustic masses) and open channels (acoustic shunts). This type of TL structure had been shown previously to have broadband negative index behavior below a cutoff frequency, and positive index behavior above the cutoff frequency. By carefully designing the geometry of the acoustic elements, continuous scanning with no acoustic bandgap was achieved. The fast-wave radiation band of the antenna was determined using a lumped acoustic parameter method. Angle of radiation of the acoustic waves out of the acoustic shunts was continually scanned backfire-to-endfire, including broadside. Applications of this antenna structure include both source and sensing technologies. Finite element analyses and acoustic circuit analysis were used to predict the angle of radiation of the antenna which agreed with experimentally obtained results. [Work supported by the Office of Naval Research.]

1:40

3pSAa3. Underwater sound transmission through thin soft elastomers containing arrays of pancake voids: Measurements and modeling. David C. Calvo, Abel L. Thangawng (Acoust. Div., Naval Res. Lab., 4555 Overlook Ave., SW, Washington, DC 20375, david.calvo@nrl.navy.mil), and Christopher N. Layman (NRC Postdoctoral Fellow, Naval Res. Lab., Washington, DC)

Measurement of underwater sound transmission through thin (~750 microns) layers of the soft elastomer polydimethylsiloxane (PDMS) containing microfabricated arrays of pancake-shaped cavities is presented. Cavities are 120 microns in diameter and 2.5 microns in height with a nominal lattice spacing of 300 microns. A sound transmission minimum is found at 282 kHz which agrees with predictions of a finite-element model of the array and the value for monopole resonance frequency of an air-filled single pancake cavity in unbounded PDMS. This resonance is a factor of 0.62 lower than the null that would occur for spherical cavities of equivalent volume. The width of the minimum is also significantly broader than that which would be obtained with spherical voids. Modeling results incorporate careful measurements of attenuation for both shear and compression waves in PDMS done in a separate effort. Acoustic transmission variation as a function of lattice spacing and the number of layers is discussed. We also present measurements of transmission through PDMS layers featuring randomly positioned (but not overlapping) pancake cavities to evaluate how the lattice constant (or lack thereof) affects sound transmission near the pancake resonance frequency or in higher acoustic bandwidths. [Work sponsored by the Office of Naval Research.]

2:00

3pSAa4. Broadband acoustic metamaterials with electro-magnetically controlled properties. Dimitri Donskoy (Civil, Environ., and Ocean Eng. Dept., Stevens Inst. of Technol., 711 Hudson St., Hoboken, NJ 07030, ddonskoy@stevens.edu) and Vladimir Malinovsky (Dept. of Phys. and Eng. Phys., Stevens Inst. of Technol., Hoboken, NJ)

The proposed class of acoustic metamaterials utilizes clouds of electrically charged nano or micro particles exposed to an external magnetic field. The particles are also elastically supported or embedded into elastically compliant medium in a way that the designed structure exhibits two resonances: mechanical spring-mass resonance and electro-magnetic cyclotron resonance. It is shown that if the cyclotron frequency is greater than the mechanical resonance frequency, the designed structure could be highly attenuative (40–60 dB) for vibration and sound waves in a very broad frequency range covering low and very low frequencies. The approach opens up wide range of opportunities for design of adaptive acoustic metamaterials by controlling magnetic field and/or electrical charges.

2:20

3pSAa5. Broadband directional ultrasound propagation using sonic crystal and nonlinear medium. Dipen N. Sinha and Cristian Pantea (Mater. Phys. & Applications, Los Alamos National Lab., MPA-11 D429, P.O. Box 1663, Los Alamos, NM 87545, sinha@lanl.gov)

The development of a passive, sonic crystal-based device with unusual properties will be reported. This device combines a 1D sonic crystal, a nonlinear medium, and an acoustic low pass filter to allow broadband ultrasound propagation as a collimated beam for specialized underwater communication. The signal to be transmitted is first amplitude modulated with a high-frequency ultrasonic carrier wave and applied to one side of the device. The device then demodulates this signal and the original low frequency signal appears as a collimated beam on the other side. The sonic crystal provides a band pass acoustic filter through which the high-frequency ultrasonic signal can pass through and the nonlinear medium then demodulates the signal and also generates the low frequency sound beam through the parametric array concept. The low pass filter removes any remaining high frequency components. The device also functions in a unidirectional manner. Design details of the device and experimental data will be presented.

2:40

3pSAa6. Equations for energy characteristics of oscillatory systems with internal (hidden) degrees of freedom and application to acoustic metamaterials. Yuri Bobrovnitskii (Theor. and Appl. Acoust., Blagonravov Mech. Eng. Res. Inst., 4, Griboedov Str., Moscow 101990, Russian Federation, yuri@imash.ac.ru)

General equations are derived for calculating the kinetic and potential energies and other energy characteristics of linear oscillatory NDOF-systems a portion of DOFs of which are internal or inaccessible for measurement and excluded from consideration. The energy characteristics are expressed through parameters pertaining only to the input or accessible DOFs. The equations are based on the certain novel properties of the so-called Shur matrix complement. The theory is applied to calculating the energy characteristics of acoustic metamaterials for which this is still an unsolved problem, especially for those with negative effective density and stiffness. A metamaterial is thought as a medium or periodic structure in which the role of effective inertia and elastic elements is played by sufficiently complex oscillatory systems with internal DOFs. Applying the derived equations to a cell of periodicity of a metamaterial one can obtain the exact values of the needed energy characteristics. The theory is verified in computer simulation and laboratory experiment.

WEDNESDAY AFTERNOON, 5 JUNE 2013 512BF, 1:00 P.M. TO 3:00 P.M.

Session 3pSAb

Structural Acoustics and Vibration: Applications in Structural Acoustics and Vibration I

Robert M. Koch, Cochair
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Eric E. Ungar, Cochair
Acentech, Inc., 33 Moulton St., Cambridge, MA 02138-1118

3p WED. PM

Contributed Papers

1:00

3pSAb1. Squeal noise generated by railway disc brakes: Experiments and stability computations on large industrial models. Olivier Chiello (LTE, IFSTTAR, 25 avenue François Mitterrand, Case 24, Bron Cedex F-69675, France, olivier.chiello@ifsttar.fr), Jean-Jacques Sinou (Laboratoire de Tribologie et de Dynamique des Systèmes, Ecole Centrale de Lyon, Ecully, France), Nicolas Vincent (Vibratec, Ecully, France), Guillaume Vermot des Roches (SDTools, Paris, France), Franck Cocheteux, Selim Bellaj (Agence d'Essai Ferroviaire, SNCF, Vitry-sur-Seine, France), and Xavier Lorang (Innovative and Res. Dept., Phys. of Railway System and Passenger Comfort, SNCF, Paris, France)

The squeal noise generated by railway disk brakes is an everyday source of discomfort for the passengers both inside and outside the trains in stations. The development of silent brake components is needed and requires a better characterization and understanding of the phenomenon. This is the aim of the experimental and numerical investigations performed in the framework of the French AcouFren project and presented in this paper. The first part is concerned with the analysis of experimental data coming from bench tests in a lot of braking configurations including different brake pads. In the second part, the measurements are compared with the results of a large FE model of the brake taking into account the mechanical complexity of each component, especially the brake pads. Components models have been previously updated using experimental modal analysis but the whole model is a direct assembling of it, without updating. The assumption of unilateral contact and Coulomb friction at the pad/disc interface is sufficient to destabilize the sliding equilibrium of the brake and lead to self-sustained vibrations. Complex vibrating modes are computed in order to describe and understand the dynamic instabilities.

1:20

3pSAb2. The modeling of wheel squeal in the time domain and its validation. Xiaogang Liu and Paul A. Meehan (School of Mech. and Mining Eng., Univ. of Queensland, St Lucia, Brisbane, QLD QLD 4072, Australia, xiaogang.liu@uq.edu.au)

Wheel squeal is a tonal noise generated when a train negotiates a curve, whose sound pressure level is normally 30 dB above rolling noise. The sound pressure level of wheel squeal has been shown to increase with the angle of attack and rolling speed in both field and laboratory tests, but the causes behind the manner of increase are still unknown. To investigate this, a model in the time domain was developed by integrating the contact mechanics with the vibration of the wheel to demonstrate how the nonlinear friction creep behavior interacts with the wheel vibration. This model simulated the vibration velocity of the testrig wheel at different rolling speed and angle of attack. The results correlate well with the recorded sound pressure level of wheel squeal. The lateral creepage and lateral force in various situations were also simulated. It was found that due to the interaction of wheel vibration with lateral force and lateral creepage the vibration velocity amplitude of the wheel at a high angle of attack and rolling speed is larger. This explains why the sound pressure level of wheel squeal also increases in the same manner. The phenomenon is explained theoretically using the mechanics based model.

1:40

3pSAb3. The role of pad-modes and nonlinearity in instantaneous mode squeal. Sebastian M. Oberst and Joseph C.S. Lai (Acoust. & Vib. Unit, School of Eng. and Information Technol., UNSW Canberra, UNSW Canberra, Northcott Dr. bld 15/117, Canberra, ACT 2600, Australia, s.oberst@adfa.edu.au)

Disc brake squeal is a major source of customer dissatisfaction and related warranty costs for automobile manufacturers. Although mode coupling is recognized as a mechanism often found in squealing brakes, recent research results show that friction induced pad-mode instabilities could be the cause of instantaneous mode squeal reported in the literature. In this paper, the nonlinear characteristics of instantaneous mode squeal initiated by pad-mode instabilities are studied by analyzing phase space plots of vibrations and sound pressure for a numerical model of a pad-on-plate system as the friction coefficient increases. Results show that as the friction coefficient increases from 0.05 to 0.65, attractors of vibration in the phase space transits from limit cycle to quasi-periodic, showing signs of approaching chaotic behavior. It is shown here that the correlation of the sound pressure behavior in the phase-space with structural vibration is crucial to understanding the role of pad modes and nonlinearity in instantaneous mode squeal.

2:00

3pSAb4. Squeak and rattle noise prediction for trimmed door of a car using hybrid statistical energy—Finite element method analysis. Sajjad Beigmoradi (Automotive Eng. Dept., Iran Univ. of Sci. & Technol., No13, Emmami alley, Golzarand Alley, Safdari St. Navab Safavi St, Tehran, Iran, s.beigmorady@gmail.com), Kambiz Jahani (Mech. Eng. Dept., Sharif Univ. of Technol., Tehran, Iran), and Hassan Hajabdollahi (Mech. Eng. Dept., Iran Univ. of Sci. & Technol., Tehran, Iran)

Squeak and rattle (S&R) noise are important in-cabin sources of annoyance for occupants. Originally, S&R is generated as a result of colliding and slamming of car's trim and body structure, which in turn occurs because of the dynamic displacements of components excited by road and powertrain. Squeak noise is interpreted as periodic stick and slip phenomena in the contact boundary of two neighbor surfaces. While rattle noise is the emitted noise when adjacent surfaces collide and impact. Both squeak and rattle phenomena happen in high-frequency range, even though the excitation sources (road and powertrain line) works in low frequency range. In practice, squeak and rattle noise can be minimized via controlling the gaps through a tolerance analysis, as well as the appropriate choice of materials. In this research, potential S&R sources are investigated for the trimmed door of a car using clearance analysis. Impact statistics and overall force level at potential rattle places are calculated through random vibration excitation analyses and afterwards, acoustic sensitivity, overall acoustic response, and loudness are calculated by the aim of hybrid SEA-FE method. The results of this prediction will be used in noise and vibration control plan of the whole car in design phase.

2:20

3pSAb5. Intrinsic characterization of structure-borne sound sources and isolators from *in-situ* measurements. Andy Moorhouse, Andy Elliott (Acoust. Res. Ctr., Univ. of Salford, Newton Bldg., Salford M20 1JJ, United Kingdom, a.t.moorhouse@salford.ac.uk), and Yong Hwa Heo (Ctr. for Noise and Vib. Control, KAIST, Daejeon, South Korea)

The paper addresses the problem of how to characterize vibration sources and isolators with measurements made *in-situ*, either on a working installation or on a test bench. For example, automotive components are often characterized by test bench measurements, but there is a need to know how they will behave when coupled to components with potentially different properties in a vehicle. Ideally all components should be characterized by intrinsic properties, which can then be transferred to other installations. In the paper, some novel *in-situ* measurement methods for obtaining these properties are presented. First, the active properties of a source are characterized by the blocked force measured *in situ*. Structural dynamic properties are represented by frequency response functions (mobilities) and it is shown how, if necessary, these may be obtained by indirect measurements, for example when access to measurement points is difficult. New results for dynamic stiffness of isolators are then presented obtained using a novel *in-situ* measurement approach. The method allows rotational (moment) as well as translational (force) dynamic stiffness to be obtained over a wider frequency range than many test rigs. Results are validated by measurement on an ideal laboratory structure.

2:40

3pSAb6. A320 flight deck shape effect on turbulent boundary layer auto-spectrum. Olivier Collery, Manuel Etchessahar, and Miloud Alaoui (Acoust. and Environment Dept., AIRBUS OPERATIONS SAS, 316 route de Bayonne, Toulouse 31060, France, olivier.collery@airbus.com)

The turbulent boundary layer excitation is one of the main sources of aircraft interior noise over a large frequency range and in particular in the flight deck where its geometry drives the physics of the turbulences. The present study investigates measured turbulent boundary layer auto-spectrum properties. For that purpose an A320 has been instrumented with 15 flush-mounted microphones on the upper right quarter of the flight deck. The flight test campaign has been performed in cruise conditions between 27,000 and 39,000 ft with Mach numbers from 0.7 up to 0.82. Analysis of measured data shows strong shape effect on the aerodynamic excitation near windows area. This study points out that advanced numerical tools are required to model these complex aerodynamic phenomena.

Session 3pUW

Underwater Acoustics and Signal Processing in Acoustics: Underwater Acoustic Communications

Mohsen Badiey, Chair
School of Marine Sci. and Policy, Univ. of Delaware, 114 Robinson Hall, Newark, DE 19716

Contributed Papers

1:00

3pUW1. Multiband transmissions for underwater acoustic communication. Aijun Song and Mohsen Badiey (School of Marine Sci. and Policy, Univ. of Delaware, 114 Robinson Hall, Newark, DE 19716, ajsong@udel.edu)

Underwater acoustic communication is important to a variety of scientific and commercial missions in the ocean, for example ocean exploration and monitoring. Due to hardware limitations, often limited bandwidth, for example, 6–7 kHz, has been used in underwater communication systems. In addition to high spectral efficiency, large bandwidth can also lead to increased data rates. When utilizing a large frequency band, frequency-division multiplexing, which refers to dividing an available frequency band into smaller sub-bands, is the common practice. We propose to use multiband transmissions for the underwater acoustic channel, where the wide frequency band is divided into multiple separated sub-bands. The sub-band is much wider than the sub-carrier in the orthogonal frequency-division multiplexing (OFDM). The former is several kilohertz in width while the latter is often only tens of hertz. During our experiment in Hawaii in 2011, high data rates were achieved through the use of multiband transmissions, combined with time reversal demodulation. In the meeting, we will present the receiver algorithms for single- and multi-source acoustic communication systems in the multiband transmission framework. Comparison between the multiband transmissions and OFDM schemes will be also discussed. [Work supported by ONR Code 322OA.]

1:20

3pUW2. Application of differential amplitude and phase-shift keying in underwater acoustic communication based on orthogonal frequency division multiplexing. Pan Zhengrong, Wang Chi, Han Xiao (Sci. and Technol. on Underwater Acoust. Lab., Harbin, Heilongjiang, China), and Yin Jingwei (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China, yinjingwei@hrbeu.edu.cn)

With the increase of of marine resource and underwater users, developing a high-bit-rate underwater acoustic communication has become a hot topic. Amplitude and phase-shift keying (APSK) is a modulation technique having high efficiency in spectrum utilization, it attracts more and more attention in high-bit-rate underwater acoustic communication. Differential APSK (DAPSK) is modulated using differential amplitude and phase code in time domain, and it has higher bandwidth efficiency and be easier to realize the system than APSK. A transmission system based on DAPSK modulation and OFDM is presented to solve the problems of effectiveness and reliability in high-bit-rate underwater acoustic communication. Simulation results show that the system using DAPSK modulation has a better performance than those using APSK and QAM modulation.

1:40

3pUW3. Study on Doppler effects estimate in underwater acoustic communication. Zhang Xiao, Han Xiao (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China), Yin Jingwei (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China, yinjingwei@hrbeu.edu.cn), and Sheng Xueli (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China)

Two estimate methods of the Doppler effects in mobile underwater acoustic communication have been proposed. For the first method the Doppler coefficients are obtained by estimating frequency change of CW impulse signal with notch filter. For the other method the Doppler coefficients are obtained by estimating chirp rate change of LFM signal with fractional Fourier transform (FRFT). And the performance of the Doppler effects estimation method based on notch filter or the FRFT are compared by the computer simulation. The advantages, shortcoming and the application occasion of the two methods are elaborated. The effectiveness and robustness of the two methods have been proved. Key Word: Notch Filter, Fractional Fourier transform, Doppler Effects, Underwater Acoustic Communication

2:00

3pUW4. Influence of multipaths on coherent acoustic communication in shallow water channel. Su-Uk Son and Jee Woong Choi (Dept. of Marine Sci. and Convergence Technol., Hanyang Univ., 55 Hanyangdaehak-ro, Sangnok-gu, Ansan, Gyeonggi-do 426-791, South Korea, suuk2@hanyang.ac.kr)

In shallow water communication channel, acoustic interactions with sea surface and bottom interfaces cause the inter-symbol interference that hinders the efficient and reliable communication. In this case, signal-to-multipath ratio (SMR) rather than signal-to-noise ratio can be used as an indicator to describe the quality of the communication channel. However, it is difficult to estimate precisely the SMR from the measured communication data. In this talk, we propose the energy fraction of the channel impulse response existing within one symbol duration as an alternative to SMR. Communication experiment was conducted on the southern coast of Korea in waters 45 m deep in source-receiver ranges of 100 m to 1 km. The bit-error-rate performance is compared to the energy fraction in one symbol duration. In addition, the correlation between the energy fraction in a symbol and SMR is investigated through a Monte Carlo simulation. [Work supported by ADD (Agency for Defense Development, Korea).]

2:20

3pUW5. Study on time reverse mirror in underwater acoustic communication. Yin Jingwei (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China, yinjingwei@hrbeu.edu.cn), Du Pengyu (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China), Shen Jianwen (Kunming Shipbuilding Electron. Equipment Co. Ltd, Kunming, China), and Guo Longxiang (Sci. and Technol. on Underwater Acoust. Lab., Harbin, China)

Time reversal mirror (TRM) can adaptively match the sound channel without any prior knowledge. In this paper, active TRM, passive TRM and virtual TRM which are all based on a single array element and the application of TRM in the underwater acoustic communication including single-user communication and multi-user communication are studied. Single sensor TRM which has time compression performance lacks array processing space gain, however, it can meet the requirements for underwater acoustic communication nodes being in the pursuit of simple structure and low power consumption. It is verified that TRM could focus multipath signal and achieve real-time adaptive channel equalization through computer simulation and test results, which could suppress the inter-symbol interference(ISI) and improve the signal-to-noise ratio(SNR).

2:40

3pUW6. Study of underwater speech coding technique based on contact conduction transmitter. Xuelli Sheng, Ye Bai, Jia Lu, Jin Han, and Weijia Dong (Harbin Eng. Univ., Shuisheng Bldg., 803#, Harbin, China, shengxueli@yahoo.com.cn)

Low bit rate speech coding of 2.4 kbps is actualized by mixed excitation linear prediction algorithm, which meets the requirement of high data rate of underwater speech communication system and the limit of high communication rate of underwater acoustic communication technique. In the process of speech coding, a great deal of speech data is compressed to high speed underwater acoustic communication, and the main characteristics of speaker are remained perfectly. Meanwhile, the capability of avoiding interference is improved obviously by the speech based on contact conduction transmitter as input signal. This underwater speech coding technique and differential OFDM technique are combined and experimented under 434, 1310, and 2000 m in the lake. The real-time transmission of speech signal is presented in the condition of complicated multi-path in the extremely shallow sea. The results show the synthesized speech has well quality of intelligibility and clarity, which satisfies the demand of underwater speech coding.

Plenary Session and Awards Ceremony

David L. Bradley
President, Acoustical Society of America

Christian Giguère
President, Canadian Acoustical Association

Michael Vorländer
President, International Commission for Acoustics

Acoustical Society of America

Presentation of ASA Fellowship Certificates

Peter F. Assmann – For contributions to vowel perception and the influence of talker variability on speech patterns
Li Cheng – For contributions to vibroacoustic modeling of complex structures
M. Patrick Feeney – For contributions to clinical middle-ear function through wideband reflectance
Eric W. Healy – For contributions of spectral-temporal analysis in speech perception
Philip X. Joris – For contributions to neural encoding in binaural hearing
Michael V. Scanlon – For contributions to the development of systems to detect and localize transient sounds in air
Michael Verslusis – For contributions to high speed imaging of fine scale acoustic phenomena

Presentation of Acoustical Society of America Awards

William and Christine Hartmann Prize in Auditory Neuroscience to Tom C. T. Yin
Medwin Prize in Acoustical Oceanography to Philippe Roux
R. Bruce Lindsay Award to Eleanor P. J. Stride
von Bèkésy Medal to M. Charles Liberman
Helmholtz-Rayleigh Interdisciplinary Silver Medal to Timothy J. Leighton
Gold Medal to Lawrence A. Crum

Canadian Acoustical Association

Announcement of Canadian Acoustical Association Award Recipients

International Commission for Acoustics

Presentation of the ICA Early Career Award to Tapio Lokki

Session 3eED

Education in Acoustics: Women in Acoustics—Listen Up and Get Involved

Tracianne B. Neilsen, Cochair
Brigham Young Univ., N311 ESC, Provo, UT 84602

Marcia J. Isakson, Cochair
Appl. Res. Labs., The Univ. of Texas at Austin, 10000 Burnet Rd., Austin, TX 78713

This workshop for Montreal area Pathfinder Girl Guides (ages 12–18) consists of a hands-on tutorial, interactive demonstrations, and a panel discussion about careers in acoustics. The primary goals of this workshop are to expose the girls to opportunities in science and engineering and to interact with professionals in many areas of acoustics. A large number of volunteers are needed to make this a success. Please email Traci Neilsen (tbn@byu.ed) if you hav time to help with either guiding the girls through the tutorial led by Wendy Adams (5:00 p.m.–6:15 p.m.) or exploring principles and applications of acoustics with small groups of girls (5:45 p.m.–7:30 p.m.). We will provide many demonstrations, but feel free to contact us if you would like to bring your own.

OPEN MEETINGS OF TECHNICAL COMMITTEES

The Technical Committees on the Acoustical Society of America will hold open meetings on Tuesday, Wednesday, and Thursday evenings.

These are working, collegial meetings. Much of the work of the Society is accomplished by actions that originate and are taken in these meetings including proposals for special sessions, workshops, and technical initiatives. All meeting participants are cordially invited to attend these meetings and to participate actively in the discussion.

Committees meeting on Wednesday are as follows:

7:30 p.m. Biomedical Acoustics	519a
7:00 p.m. Signal Processing in Acoustics	510a