10th Mini-Conference on Acoustics (MCA)
30 November 2017

University of Maryland
School of Medicine (Baltimore Campus),
Baltimore, MD

Washington DC Chapter of the
Acoustical Society of America

Program

6:00-6:30	Upload Presentations / Ice breaker
6:30-6:35	Welcome and introduction to the Washington DC Chapter of the Acoustical Society of America and the 10th Mini-Conference of Acoustics Jennifer Cooper (Treasurer, Washington DC Chapter of the ASA)
6:35-7:00	Keynote Speech: Focused ultrasound-mediated immuno-modulation for the treatment of brain tumors Pavlos Anastasiadis
7:00-7:15	NAVAIR noise measurements of military jet aircraft Michael Smith
7:15-7:30	Quantification of nanoparticle distributions in focused ultrasound-mediated delivery models *in vivo** Ali Mohammadabadi, Pavlos Anastasiadis, David Hersh, Graeme Woodworth, Anthony Kim, and Victor Frenkel
7:30-7:45	Damage assessment from civil Infrastructures using airborne ultrasonics Hajin Choi and Hoda Azari
7:45-8:00	Is there a clinical application for tablet-based automated audiometry in children?* Lauren Pasko, Jenna Supinski, Olivia Pereira, Mackenzie Hammond, Alexa Bullard, Thierry Morlet, and Kyoko Nagao
8:00-8:15	Neurophysiological speech processes in children with auditory processing disorder* Olivia Pereira, T. G. Morlet, A. Hestvik, and K. Nagao

8:15-8:30	Frequency-agile, low-intensity, broadband ultrasonic array as a brain computer interface technology for improving neurological health Shane Lani, Allan Rosenberg, Steven Magruder, Nikhil Pateel, and Grace M. Hwang
8:30-8:45	Ultrasound-enhanced therapy delivery Raghu Raghavan
8:45-9:00	Announcing Results for Best Students Paper Competition
9:00	Adjourn

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* Papers qualified for the Best Student Papers Competition

Abstracts

Keynote Speech: Focused ultrasound-mediated immuno-modulation for the treatment of brain tumors

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Cancer immunotherapy has emerged as a promising therapeutic modality due to its targeted nature and inherent reduced cytotoxicity. Even though immunotherapies have overall led to novel approaches in the treatment of various cancers, no noticeable improvements have been reported for glioblastoma multiforme (GBM). GBM is a detrimental malignant tumor characterized by an aggressive invasion into adjacent brain tissues. It is the most frequent primary brain cancer accompanied by a very poor prognosis. Currently, the standard of care treatments involves biopsy with subsequent tumor resection, followed by adjuvant chemotherapeutic and radiation therapy.

Transcranial pulsed focused ultrasound (TCpFUS) has attracted increased attention as a novel and exciting technology. Its ability to provide safe and effective blood-brain barrier disruption (BBBD) has been demonstrated in numerous pre-clinical studies. TCpFUS acts by enabling controlled thermal and mechanical perturbation of brain regions at astonishingly high precision levels. This has led to the FDA-approval of focused ultrasound for the treatment of essential tremor, prostate cancer, bone metastases and uterine fibroids. Our pilot study revealed that TCpFUS-mediated immunomodulation triggered immune responses in a GMB mouse model with the up- or downregulation of key factors such as regulatory T cells, CD4+ and CD8+ T cells, and dendritic cells.

NAVAIR noise measurements of military jet aircraft

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The Veterans Affairs office spends $4.2 Billion annually on veteran's hearing loss. Military aircraft with supersonic exhaust jets produce significant noise to the nearby flight deck crew on an aircraft carrier, as well as noise to the nearby community. Some of the flight deck crew stand or kneel in the region of peak noise of the jet to perform their function, such as the final checkers.

The Navy has been pursuing multiple noise reduction techniques on various aircraft. One goal is to apply chevrons technology on the F/A-18 Super Hornet Platform. This presentation will focus on the ANSI-12.75 standard that is used to measure noise of a full scale installed engine with a supersonic exhaust jet and the development of techniques and test plan standards to improve ANSI-12.75's measurement uncertainty. The Navy has completed two separate noise test campaigns of the F/A-18E with chevrons (December 2012 and October 2014). Through testing modifications, the uncertainty in the measurement improved from 5.8dB to ~0.22dB. This allowed the Navy to more accurately determine the effectiveness of chevrons. These testing modifications will be discussed.

Quantification of nanoparticle distributions in focused ultrasound-mediated delivery models in vivo*

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One of the main research directions in our lab is the use of focused ultrasound (FUS) for enhancing the delivery of therapeutics. Among the challenges in this endeavor is evaluating the efficacy of these procedures using accurate and consistent quantification of the delivery of the agents and their surrogates. Recently, we developed a custom image-processing procedure to quantify the distribution of polyethylene (PEG)-coated NPs, specifically formulated to limit interactions with biological molecules and hence, improve penetration through tissues. The PEG-NPs were injected directly in to brains of rodents following pulsed focused ultrasound (FUS) treatment with an MRI guided FUS system. The custom MATLAB script employs an established image processing technique called the Otsu method, to correct, segment and quantify the images. This technique analyzes the images separately, creating gray-scale histograms. The script determines the thresholds automatically and segments each image to the agents and tissue regions. The volume of distribution of the agents is then calculated with a custom algorithm that compiles the entire stack of tissue sections being analyzed. In this presentation, we will demonstrate this procedure for our brain study and show how we plan to use this technique in a solid tumor model of head and neck squamous cell carcinoma.

Damage assessment from civil Infrastructures using airborne ultrasonics

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Airborne ultrasonic test configuration including electrostatic transducer and micro-electromechanical system (MEMS) array is applied to concrete slab for internal damage assessment. The measurement procedure is fully non-contact and controlled by robotic system. While the transducer emits ultrasound with a center frequency of 50kHz, the MEMS array receives leaky surface waves and direct acoustics. Using two-dimensional Fourier transform, the measured data is analyzed in frequency-wave number (f-k) domain. In the f-k domain, apparent energy of different wave modes is presented by the product of Fourier transform. The developed hardware and algorithm are evaluated under full-scale concrete slab where has artificial defects such as delamination and honeycomb. The experimental results demonstrate that the internal defects cause unique apparent energy patterns in f-k domain such as the separation of guided wave modes and back-scattering. The airborne ultrasonics has a great benefit of the application in civil infrastructure.

Is there a clinical application for tablet-based automated audiometry in children?*

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Recent research (e.g., Rourke et al., 2016) supports the clinical use of automated audiometry for pediatric hearing screenings. However, very few studies have tested whether tablet-based automated audiometry can offer a reliable alternative to traditional manual audiometry for estimation of hearing thresholds in children. This study examined the validity and efficiency of automated audiometry in school-age children.

Hearing thresholds for 0.5, 1, 2, 4, 6, and 8 kHz were collected in 32 children ages 6-12 using standard audiometry and tablet-based automated audiometry in a soundproof booth. Test duration, test preference and medical history were collected, as well.

Results exhibited that the majority (67%) of threshold differences between automated and standard were within clinically acceptable range (10 dB). The threshold difference between the two tests showed that automated audiometry thresholds were lower by 9dB in 6 year olds, 7dB in 7-9 year olds, and 3dB in 10-12 year olds. In addition, results showed no significant difference between the two test durations.

These results support the use of automated audiometry in children from ages 7-12. However, the results suggest that the clinical use of automated audiometry may not be feasible in children 6 years of age.

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Neurophysiological speech processes in children with auditory processing disorder*

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Auditory processing disorder (APD) is a neurological hearing disorder. Children with APD have difficulties understanding speech in a noisy environment. Currently, the underlying neurophysiologic processes in APD are not fully understood. The aim of this study is to determine whether speech perception difficulties in children with APD stem from problems with phonetic processing or an inability to access phonemic representations. We tested if children with APD have atypical access to abstract phoneme categories (/d/ and /t/) using the varying standards oddball paradigm to elicit the mismatch negativity (MMN) event related potential. In the varying standards paradigm, a set of stimuli with varying voice onset time but within the same phoneme (/d/) are used as standards, while the deviant stimulus is a contrasting phoneme (/t/). To measure the auditory impairment at two separate levels, we also obtained behavioral categorical speech perception data. We have collected data from five typically developing children and four children with APD. Results suggested that both MMN latency and amplitude reflect behavioral speech

identification abilities. Furthermore, MMN results showed abnormal hemispheric differences in children with APD. Our results imply that the varying standards oddball paradigm could be a useful tool for examining auditory processing abilities in children.

Frequency-agile, low-intensity, broadband ultrasonic array as a brain computer interface technology for improving neurological health

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Background: The skull is a complex medium that causes phase aberrations in transcranial ultrasound which can limit the focusing resolution of low-intensity ultrasound. **Objective:** Determine whether time-reversal broadband ultrasonic transducer arrays can focus ultrasound through high fidelity skull diploe layer adaptively with frequency selectivity between 0.5 and 10 MHz. **Methods:** Analytic methods were used to validate simulation results from k-Wave pseudo spectral time domain (PSTD) solver. A three-layer skull was modeled at three different diploe widths including 1.8, 4.6, and 2 mm. Time-reversal focusing was implemented for simulated arrays of varying apertures and bandwidth. **Results:** We achieved spatial resolution of 0.6 mm x 0.6 mm at greater than 8.4 mm depth, showing demonstrated improvement using an array with a larger bandwidth compared with state-of-the-art focusing. **Conclusions:** Simulation results suggest that a broadband ultrasonic array has the potential to perform real-time, steerable stimulation at an unprecedented small focal volume thru skull. This opens up applications on the use of low intensity, frequency-agile, ultrasound for non-invasive treatment of neurological disorders (e.g., insomnia, anxiety, depression, post-traumatic stress disorder, and attention deficit hyperactivity disorder) and the potential for neurofeedback to accelerate learning of cognitive and motor skills.

Ultrasound-enhanced therapy delivery

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In addition to its directly therapeutic uses, exemplified by High Intensity Focused Ultrasound (HIFU) used for tissue ablation, ultrasound is increasingly being explored for enhancing the delivery of therapies. This area is well represented in a recently held (by the time of this mini-conference on acoustics) meeting on drug delivery : including both blood-brain barrier disruption and ultrasound-enhanced convective delivery (UeCD) using both focused and unfocused acoustic sources. This talk will (i) rapidly review for a broader community in acoustics the results contained in the talks presented at the meeting; and (ii) discuss recent experiments we have conducted in delivery into the liver where we monitored the concentration of the agents delivered to get a more refined look at the distribution and the modulation effects of ultrasound excitation. Further, while we presented theoretical results in acoustic streaming in porous media and comparisons with published experiments in delivery of agents to the brain last year, we present (iii) refinement of those calculations and other mechanisms afforded by acoustics in this field. We argue that a major benefit of UeCD will be to enhance the uniformity of the distribution enabling the drug to reach more of its target cells within its vicinity.