Celebrating Best Student Research Winners from Acoustics 23 in Sydney, Australia

Marissa L. Garcia

Students are a life force in the Acoustical Society of America (ASA), and ASA meetings represent one such venue where this is evident. The semiannual cadence of ASA meetings allows students multiple chances to showcase their research with the broader acoustics community over the course of their degree program. For each of the 12 technical committees in the ASA, dozens of students, spanning both undergraduate and graduate degree programs, share their findings via poster sessions and oral presentations. This opportunity allows students to receive rich feedback from field experts that directly feeds back into enhancing their research and cementing promising career outcomes long term.

Best Student Presentation Awards are a most striking example of how the ASA supports students. Often, for at least one ASA meeting each year, each technical committee grants a Best Student Presentation Award to a few students for exceptional research. Several of these awards were granted at the Acoustics 23 meeting in Sydney, Australia.

The Student Council seeks to celebrate these students and feature their work. Here, you can learn more about the cutting-edge research of some of these award winners:

Animal Bioacoustics: Acoustic Catalog of Fish Sounds

Audrey Looby (alooby101@gmail.com) will graduate

in Summer 2024 with a PhD in fisheries and aquatic sciences from the University of Florida, Cedar Key. In her undergraduate research at the University of Southern California, Los Angeles, Audrey conducted biodiversity monitoring in California kelp forests. She earned her master's degree at the University of Florida, where she studied the effects of submerged aquatic vegetation. Her studies evolved into her PhD under Charlie Martin and Laura Reynolds, where she focused on fish sound production and soundscape-habitat interactions in coastal habitats. Now, she is the colead of the FishSounds (see fishsounds.net/index.js) effort to compile global fish sound production information and recordings, which she shared in her award-winning presentation, "FishSounds: A Data-Sharing Website of Global Soniferous Fish Diversity," at the Sydney conference.

> "Fish sounds serve wide-ranging ecological roles and monitoring applications, but despite extensive endeavors to document them, the field of fish bioacoustics has been historically constrained by the lack of a comprehensive inventory of known fish sound production. To create such an inventory, I extracted information from over 900 references from the years 1874–2021, finding over 1,000 fish species that have been shown to produce active (i.e., intentional) sounds. This information is available on the FishSounds website at FishSounds.net alongside representative recordings of fish sounds that can be easily searched through and accessed by users. FishSounds has since launched new initiatives to develop regional acoustic catalogs for fisheries management applications as well as a free education program that has reached over 2,500 participants across the United States and Canada. The data available on FishSounds can be similarly adapted to meet other research or management needs, improve public awareness of underwater soundscapes, and aid in the discovery of novel soniferous behaviors across fishes globally" (adapted from abstract).

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Physical Acoustics: Acoustic Detection of Ice Fractures

John Case (jackcase97@gmail.com) is in his sixth year of his PhD in acoustics in the Graduate Program in Acoustics at the Pennsylvania State University, State College. He received his BS in mechanical engineering from the University of Hartford, West Hartford, Connecticut. Under the guidance of Andrew Barnard and Daniel Brown, he researches ice fracture acoustic detection and classification using machine learning, which he presented in part in his award-winning Sydney presentation, "Marine and Lacustrine Ice Fracture Detection."

"In recent years, the need to detect and classify ice-fracturing events has become increasingly important to fisheries and climate science as well as to local communities. Fractures primarily occur due to stress relief within an ice sheet during temperature shifts and ice movement. These events create mechanical waves within the sheet that couple into the water column, which manifest as pressure and particle velocity fluctuations that we can acoustically detect. In this study, we used machine-learning algorithms to detect and classify ice-cracking events through their acoustic signature. We compared multiple models to assess efficiency and accuracy along with an extensive preprocessing algorithm. We automatically detected acoustic signatures of ice fracturing events in several different locations, including Northern Alaska and the Great Lakes" (adapted from abstract).

Underwater Acoustics: Passive Acoustics in Aid of Autonomous Underwater Vehicle Navigation

Junsu Jang (jujang@ucsd.edu) is a fourth-year PhD candidate in oceanography at the Scripps Institution for Oceanography, La Jolla, California. Hailing from South Korea, he received a BS in electrical and computer engineering from Carnegie Mellon University, Pittsburgh, Pennsylvania. He then pursued an MS in media arts and sciences at the MIT Media Lab at the Massachusetts Institute of Technology, Cambridge. At MIT, he grew his interest in oceanography through researching an underwater stereo-imaging system to track marine snow in the twilight zone. In his PhD research, he develops and applies statistical signal-processing methods to process various oceanographic data. Some of this research was featured in his talk, "Waveguide Invariant Navigation of an Autonomous Underwater Vehicle."

"Passive acoustics is a nonintrusive yet powerful approach to a wide variety of oceanographic applications, ranging from ecosystem monitoring to situational awareness. In my research, I have been investigating the use of passive acoustics to supplement the navigation of an autonomous underwater vehicle (AUV) equipped with a hydrophone and relatively low-budget navigation sensors. I am interested in leveraging the acoustical recordings of a source of opportunity, such as a passing container ship, in shallow water.

"The interference pattern of the propagating acoustic fields (modes) in a waveguide form striations of intensity bands as a function of frequency and range, which can be summarized by a scalar parameter called the waveguide invariant. Using this parameter, the range information between the source and the receiver can thus be extracted from the spectrogram. I have been investigating the estimation and incorporation of this range information into the AUV navigation.

"At the ASA meeting in Sydney, I proposed a new statistical model of the received signals that allows us to perform range estimation and implemented a sequential Bayesian filter to fuse the range information with the onboard navigation sensor measurements. This capability was demonstrated using both simulations and real data."

Speech Communication: English Speakers Adapting to Tonal Language Learning

Yanping Li (yanping.li@westernsydney.edu.au) is in the final year of her PhD at Western Sydney University, Penrith, Australia, where she is completing her research on accent variability in Mandarin lexical tones and its effects on tone perception by English learnings. Uniquely, as a PhD candidate in the Covid-19 generation, Yanping used virtual resources such as E-Prime Go and Zoom to collect her data. Her past academic training includes a BA in Chinese linguistics and literature from Xinyang Normal University, Xinyang, China, and an MA in linguistics and applied linguistics from Beijing Language and Culture University, Beijing, China. Her thesis research was shared in part through her talk, "Categorization and Discrimination of Mandarin Lexical Tones by Naive English Listeners."

"Unlike tone languages such as Mandarin, English lacks tones at the sublexical level. Accordingly, English listeners have difficulty perceptually assimilating tones as categorized or uncategorized native segments (perceptual assimilation model [PAM). While English listeners can categorize the four lexical tones of Mandarin, i.e., level contour, rising, dipping, and falling, when given *question, statement, exclamation*, and *uncertainty* intonations as category choices. This does not address tone assimilation at the segmental level. We reasoned that they might assimilate tones as nonassimilable nonspeech patterns if given visual icons as tone category choices (flat, rising, dipping, and falling lines, respectively) with no reference being made to English intonation categories. Accordingly, 76 monolingual English listeners (Mage = 24.85 years, 50 females) were set two tasks: to use visual icons to categorize Mandarin tones in naturally produced tone words (/ga, ti, tu, gu/ × 4 tones) and to discriminate all six pairwise tone contrasts. All tone pairs showed ceiling-level discrimination, and listeners split their categorizations of falling and level stimuli between the falling and flat icons, suggesting that when given visual icons, tone-naïve English listeners perceive Mandarin tones as nonspeech acoustic patterns, which is consistent with PAM's nonassimilation predictions" (from abstract).

Noise: Noise Limit Explorations for Civil Supersonic Aircraft

Joshua Kapcsos (jlk642@psu.edu) is a fifth-year PhD candidate in the Graduate Program in Acoustics at the Pennsylvania State University, State College. He is a Joseph and Irene Tobis Graduate Fellow in Acoustics in the College of Engineering, advised by Victor Sparrow. Born and raised in Bethlehem, Pennsylvania, he received his BS in physics right in his hometown at Lehigh University. His thesis research was in part featured in his invited paper, "Progress Update on Inclusion of Atmospheric Profiling for Sonic Boom Propagation Through Turbulence."

"With the recent unveiling of experimental supersonic aircraft such as NASA's X-59 Quesst (see nasa.gov/mission/quesst), which seeks to demonstrate that sonic "booms" can be mitigated to "thumps," international efforts continue to push for development of civil supersonic aircraft. To revise the governmental restrictions on civil supersonic flight by exchanging the existing Mach 1 speed limit for a noise limit, simulations must closely match real-world data produced by the demonstrators. While the KZKFourier tool developed at Penn State simulates sonic boom propagation through turbulent atmospheric boundary layers, the original only supports homogeneous atmospheres. I modified the code to take in humidity profiles by looping through matrices of each value's solutions, providing a more realistic simulation.

"Thus far, uniform layers of humidity values were used in the newly modified propagator, and the results presented in Sydney are consistent with the known results that higher humidity leads to higher peak pressure. Additionally, compared to homogeneous atmospheres of 10% and 80% relative humidity, profiling the atmosphere between these values yields results that intuitively fit in between. I continue to implement more realistic profiles, thicker boundary layers, and the shaped boom waveforms of demonstrators, which will help develop technical standards to aid in certifying civil supersonic aircraft.

"This research was funded by the US Federal Aviation Administration (FAA) Office of Environment and Energy through ASCENT, the FAA Center of Excellence for Alternative Jet Fuels and the Environment, and project 57 through FAA Award Number 13-C-AJFE-PSU under the supervision of Sandy Liu. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA."

Signal Processing in Acoustics: Active Noise Control in Vehicles

Jun Young Oh (eric6518@snu.ac.kr) is in the fourth year of his PhD in mechanical engineering at Seoul National University, Seoul, South Korea. He pursued his undergraduate studies at the Korea Advanced Institute of Science & Technology (KAIST), Daejeon, South Korea. His PhD research focuses on active noise control and vehicle noise, vibration, and hardness (NVH), which he investigated in his commended talk, "Updating the Secondary Path Using Deep Learning Models to Enhance the Performance of Active Road Noise Control."

"The accuracy of the secondary path estimate significantly influences the performance of active noise control (ANC) in vehicles, especially in dynamic environments that alter the secondary path. We proposed deep learning-based methods to update the secondary path estimate in real time, addressing fluctuations caused by head movements. These methods showed high estimation accuracy and low data storage requirements, with the principal component analysis (PCA)-based approach using only 1.5% compared to storing all cases. Updating the secondary path estimate in real time led to reductions of 10.2 and 17.2 dB in road noise and 500- 1,000-Hz random noise, respectively. The improvement was notable for both types of noises, indicating that the suggested method can expand the frequency range of ANC.

"For future research, we are adapting our application to real driving cases. In these cases, where installing microphones at ear positions isn't feasible, virtual-sensing technology is used to estimate acoustic pressure at these locations using surrounding microphones. This approach necessitates updating much more transfer functions in real time, which is expected to benefit significantly from the update method proposed in this study."

Summary

Ranging from fish ecology to ice fractures, from autonomous underwater vehicle navigation to tone languages, from noise control for both civil supersonic aircraft and vehicles alike, students in the ASA are paving their paths in their respective fields. We at the Student Council look forward to seeing how these students continue to advance knowledge as they wrap up this stage in their educational journey and progress further into their careers. You can learn more about the Student Council, its activities, and many other outstanding students at the Council's website (see asastudents.org) and at the AT Connections website (see bit.ly/3TYFaU7).

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