Technical University of Denmark

NEWSLETTER

HEARING SYSTEMS IN PROFILE

August 2018

HEARING SYSTEMS

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News

In the middle of the week, a social event was planned including a guided tour to Kronborg Castle, Elsinore, a boat trip to Humlebæk Harbour at the east coast ending with a visit and dinner at Louisiana Museum of Modern Art. Photo: Eva Helena Andersen.

International Symposium on Hearing 2018

On June 10-15, researchers from all over the world travelled to Snekkersten, Denmark, in order to participate in the 18th International Symposium on Hearing (ISH). This year's theme was "Hearing: Psychophysics, Physiology, and Models". ISH has been held approximately every three years in Europe since 1969. The hallmark of this truly interdisciplinary meeting is to bring together well-known researchers, as well as young talents, specializing in psychophysics, physiology and models of hearing. The program consisted of a podium of 51 presentations, each of about 20 min. in length. Each presenter also prepared a paper, which will be published in a special open access issue of Acta Acustica united with Acustica in the autumn of 2018.

The total number of participants, including the podium speakers, was 90 people. There was great support for the meeting from industry, both in the form of financial support and in the form of attendance at the meeting. Read more about ISH and see the program at www.ish2018.dk and at our webpage ww.hea.elektro.dtu.dk

The next ISH Conference Symposium will be held in 2021 in Lyon, France.

Projects 2018

Cognitive Control of a Hearing Aid (COCOHA)

The news of a thought-controlled hearing aid reached Danish media and was covered extensively in the last few months. The Hearing Systems group participates in the international Cognitive Control of a Hearing Aid project (COCOHA). COCOHA researchers have created a feedback system that uses real-time EEG brain signals to control the sound levels of simultaneous talkers in a simulated multi-talker 'cocktail party' scenario. The aim is going forward to create a hearing instrument technology that aids speaker separation by using attention-related brain signals. The Hearing Systems group participates in this project with partners from École Normale Supérieure in Paris, University College London, ETH in Zürich, and Eriksholm Research Centre.

Uncovering Hidden Hearing Loss (UHEAL)

The Novo Nordisk Foundation has awarded DKK 15 million for the collaborative synergy project UHeal with the goal to understand, describe, and diagnose hidden hearing loss. The term 'hidden hearing loss' refers to noise-induced damage to synapses in the auditory nerve that can exist without shifts in audiometric thresholds. Although standard audiometric tests may not reveal a hearing loss, such neuropathic damage is suspected to cause problems with listening in noisy environments. Yet, the nature and the extent of hidden hearing loss in human patients are unknown. In the UHeal project, three international partners combine expertise in auditory physiology, clinical audiology and MR imaging, with the aim to reveal biomarkers in human patients. The partners are the Hearing Systems group at DTU, The Massachusetts Eye and Ear at Harvard Medical School, and the Danish Research Centre for Magnetic Resonance at Copenhagen University Hospital Hvidovre.

Tinnitus Assessment, Causes and Treatments (TIN-ACT)

Two new PhD projects are starting in the autumn, which focus on tinnitus diagnostics and management. Both projects will combine extensive auditory profiling, subjective measures of tinnitus, and objective electrophysiological indicators of tinnitus-related changes in the nervous system. The aim is to provide new diagnostic tools for tinnitus and to use these tools for designing individualized tinnitus management approaches. The projects will be run in collaboration with Interacoustics Research Unit (IRU) and Widex A/S, and are part of the EU Marie Skłodowska-Curie Innovative Training Network TIN-ACT (Tinnitus Assessment, Causes and Treatments, http://tinact.eu).

Spherical microphone for 3D sound capture

As part of the recent PhD project started by Naim Mansour in the Hearing Systems group, an Eigenmike spherical microphone array was purchased by DTU with sponsorship from Widex A/S. This state-of-the-art technology enables the capture of realistic sound scenarios which can be used to better evaluate hearing aid algorithms.

Photo Eva Helena Andersen

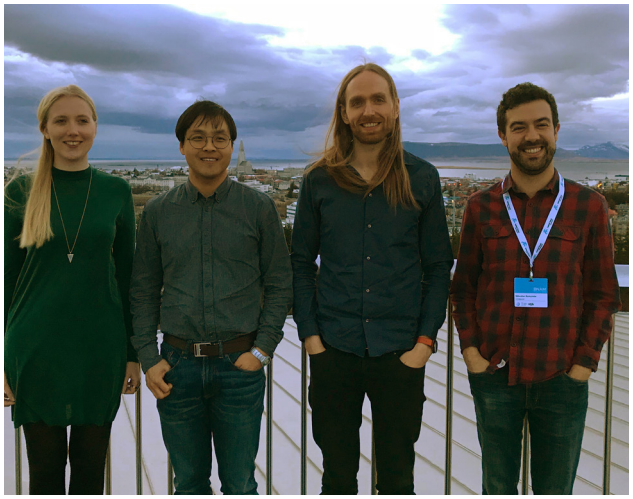
Visiting Professor from Aalto University

Ville Pulkki, Associate Professor from the Department of Signal Processing and Acoustics at Aalto University, Helsinki, was Visiting Professor at Hearing Systems from January until the end of June. Ville Pulkki's main focus is on spatial sound generation and perception by amplitude panning techniques. This is particularly interesting and relevant also for the Hearing Systems group, where alternative techniques have been used to recreate sound scenes in the laboratory. The idea of Ville Pulkki's visit has been to discuss and develop novel methods of sound field reproduction in order to study sound processing and perception in controlled complex acoustic environments.

"Hearing Systems is one of the biggest groups that are active in this research area, and I have also discussions with the Acoustic Technology group. We did acoustical measurements with laser-induced pressure pulses three years ago," Ville Pulkki explained. "In Denmark there is so much acoustics going on. The Hearing Systems Group has a lot of expertise in auditory perception, technical audiology and applied hearing research. But there is a mutual interest in collaboration between our research groups because some of the studies in the Hearing Systems Group are within the area of spatial audio," he said.

Those interested in finding out how spatial recordings can actually sound depending on the recordings, had the opportunities to listen to samples from Ville Pulkki's work in the audio visual immersion lab (AVIL).

Torsten Dau, Head of Hearing systems was very pleased to have Ville Pulkki as a guest in the group: "Ville Pulkki is known worldwide for his achievements within spatial audio reproduction techniques and his research on the perception of spatial sound in complex audiovisual environments. Furthermore, he has also worked on functional modelling of auditory brain mechanisms. So we have various areas where we can interact and learn from each other."



Leftmost: Ida Ørduk Hoffmann, Cheol-Ho Jeong, Finnur Pind Jörgensson, Sébastien Santurette

Baltic-Nordic Acoustic Meeting in Reykjavik

About 150 acousticians from the Nordic and Baltic countries met in April in Reykjavík, Iceland for the biennial Baltic-Nordic Acoustics Meeting (BNAM). Our Hearing Systems and Acoustic Technology groups contributed to the event with several scientific presentations. Cheol-Ho Jeong, Finnur Pind, and Sébastien Santurette co-chaired sessions on "Hospital acoustics", "Computational acoustics", and "Musical acoustics, hearing, and acoustic communication", respectively. DTU was also represented at a round table on "Dealing with the increasing demand for acoustics graduates in industry and academia" organized by the Young Acousticians Network.

From Hearing Systems, the results of Bertrand Smits' MSc project on the effects of concert noise on supra-threshold hearing, which built upon the work of PhD student Pernille Holtegaard, were presented. Sébastien Santurette also presented a review of the group's recent findings on the effects of musical experience and hearing loss on pitch perception.

From Acoustic Technology, Cheol-Ho Jeong and Ida Ørduk presented the noise and room acoustic conditions in a Korean tertiary hospital and several Danish hospitals. PhD student Finnur Pind also presented his work on acoustic virtual reality. The next BNAM meeting will take place in Norway in two years' time, and it will be Denmark's turn to be the host country in 2022.

At the Hearing Aid Study Group, time is spent on presentations and discussions. Photo: Eva Helena Andersen

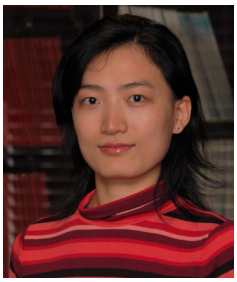
Hearing Aid Study group

The Hearing Aid Study Group is a new initiative at DTU Hearing Systems from our PhD students to stimulate research collaboration, expand knowledge and skills, and to establish best practices. All of this aims to make our hearing-aid research more solid and grounded in the "real world". The meetings usually take place every second week. The time is spent on presentations and discussions. Everyone is welcome to participate and to present, including people from other research groups, universities and companies. For more information contact Borys Kowalewski: bokowal@elektro.dtu.dk

Staff news

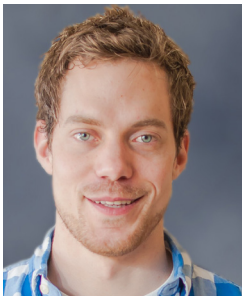
From September 1, Sébastian Santurette starts a position as Senior Researcher at Oticon.

Katrine Louise Bang Thermansen, Project Administrator, has left the Hearing Systems group from August 1.



Lanchen Fan is a fifth-year PhD student in Biomedical Engineering at the University of Rochester, working with Dr. Laurel Carney. During July and August, she has been a visiting student in the group working on the area of computational models.

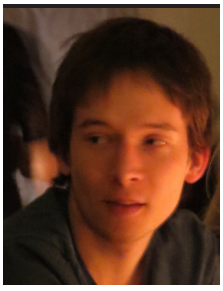
PhD Defences



On January 18, Christoph Scheidiger succefully defended his PhD thesis "Assessing speech intelligibility in hearing-impaired listeners". Christop Scheidiger now holds a position as Advanced Analytics Manager at Amazon, Seattle.

On Febuary 5, PhD student Thomas Bentsen successfully defended his thesis "Computational speech segregation inspired principles of auditory processing". Thomas Bentsen now works as Development Engineer at Oticon.

On February 20, Alan Wiinberg successfully defended his Phd thesis "Perceptual effects of non-linear hearing aid amplification strategies". Alan Wiinberg now works as Technical Audiology Specialist at Widex A/S.



On June 26, Francois Guérit successfully defended his PhD thesis "Spectral and temporal processing in electric hearing". Francois Guérit now works at the University of Cambrige as a Postdoc.

New PhD projects

Auditory-training strategies to improve speech intelligibility in hearing-impaired listeners

Nicolai Pedersen

This project explores the use of multi-modal deep neural networks (DNNs) to extract and investigate audio-visual speech features. The DNNs are to exploit correlations between higher-level visual and auditory features in speech to obtain and enhance the sounds of individual speakers in cocktail-party scenarios. In the first part of the project, DNN algorithms are used to associate real-time audio streams with facial features in multi-talker audio-visual scenarios. The second part of the project focuses on using a video input and eye-tracking to assist audio source separation with DNNs.

The influence of vision on spatial hearing of hearing-impaired and aided hearing-impaired listeners

Thirsa Huisman

As a side effect of improving speech intelligibility, many hearing-aid processing algorithms degrade the acoustic spatial cues, thereby reducing the ability of aided hearing-impaired people to localize sound sources. Ironically, this ability to locate sound sources allows normal-hearing listeners to separate a target of interest within a complex acoustic environment, thus aiding speech intelligibility. However, localizing sound sources does not rely solely on acoustic spatial cues; it relies on both acoustic and visual cues. Thus, hearing-impaired listeners may rely more on visual cues to compensate for their degraded acoustic spatial cues. This PhD project aims to investigate the influence of vision on sound localization, especially for hearing-impaired and aided hearing-impaired listeners, potentially allowing manufacturers and clinicians to better balance the trade-offs of different algorithms.

Characterizing consequences of hearing impairment and hearing-aid processing on speech perception in competing-talker scenarios

Paolo Mesiano

Speech comprehension is a crucial component of all social interactions. Normal-hearing (NH) listeners exhibit exceptional abilities in understanding a target talker when additional competing talkers are speaking simultaneously. In contrast, hearing-impaired (HI) listeners experience great difficulties in such situations. Currently, the perceptual mechanisms that facilitate these abilities in NH listeners and limit the performance in HI listeners are not entirely understood.

This project aims to extend the current knowledge about the processing mechanisms responsible for successful speech reception in competing-talker scenarios, which will be of value in the development of hearing-aid solutions that aim to improve the users' listening experience.

Speech processing in hearing impaired Chinese

Florine Bachmann

All over the world, older adults suffer from speech comprehension difficulties. Yet, most speech intelligibility research is being conducted in non-tonal language contexts. In tonal languages, pitch modulations not only determine prosody, but also convey lexical meaning. These pitch modulations covary with changes in the temporal envelope, and neural entrainment to the temporal envelope facilitates speech understanding. Hence, tonality likely impacts the importance of selected auditory cues on speech understanding. This project aims to identify crucial cues for speech intelligibility in Mandarin speakers. Based on the results, hearing solutions might offer improved speech intelligibility in tonal languages.

Improving cochlear implant performances with new pulse shapes: a multidisciplinary approach

Charlotte Amalie Navntoft

A cochlear implant (CI) can provide a sense of hearing to deaf people. A major factor limiting the performance in CI users is, however, the spread of electric current when an electrode is stimulated. In this project, the current spread with new electrical pulse shapes will be investigated. It is hypothesise that novel non-rectangular pulse shapes produce a more efficient and focused stimulation in a CI animal model and a better speech perception in CI users compared to the rectangular pulse shapes used in current CI devices. If successful, this project may be a significant step towards improving sound perception in many people with severe hearing impairment.

New Post Doc project

Validation of new strategies (Better Hearing Rehabilitation Project, BEAR)

Oscar Cañete

One of the BEAR project's goals is the development of a new diagnostic test battery that can form a solid base for a clinician to make decisions regarding the choice of the device and the initial fitting as the development of new outcome measures to effectively measure the benefit for the individual hearing-aid user. The validation of the new strategy vs the existing strategy by objective assessment of aided performance in clinical populations plays a key role within BEAR. In this project, Oscar Cañete will contribute with the clinical implementation of the BEAR test batteries and with the design of the clinical hearing-aid fitting trials in collaboration with the BEAR project in Aalborg and Odense.

Publications (since January 2018)

Journal papers

May T, Kowalewski B, Dau T (2018) Signal-to-noise-ratio-aware dynamic range compression in hearing aids. Trends in Hearing 22

May T (2018) Robust speech dereverberation with a neural network-based post-filter that exploits multi-conditional training of binaural cues. IEEE/ACM Transactions on Audio, Speech, and Language Processing (2) P 406-414

Paredes Gallardo A, Madsen S, Dau T (2018) The role of place cues in voluntary stream segregation for cochlear implant users. Trends in Hearing 22

Paredes Gallardo A, Madsen, S, Dau T, Marozeau J (2018) The role of temporal cues on voluntary stream segregation in cochlear implant users. Trends in Hearing 22

Madsen S, Dau T, Moore B (2018) Effect of harmonic rank on sequential sound segregation. Hearing Research

Bentsen T, Kressner A, Dau T, (2018) The impact of exploiting spectro-temporal context in computational speech segregation. Journal of the Acoustical Society of America 143 (1) P 248-259

Hjortkjær J, Märcher-Rørsted J, Fuglsang S Dau , T (2018) Cortical oscillations and entrainment in speech processing during working memory load. European Journal of Neuroscience

de Cheveigné A, Wong D, Di Liberto, Giovanni M, Hjortkjær J, Slaney M, Lalor E (2018) Decoding the auditory brain with canonical component analysis. Neuroimage 172 P 206-216

Chang J, Marschall M (2018) Periphony-lattice mixed-order ambisonic scheme for spherical microphone arrays IEEE/ACM Transactions on Audio, Speech, and Language Processing 26 P 924-936

Wiinberg A, Jepsen ML, Epp B, Dau T (2018) Effects of hearing loss and fast-acting compression on amplitude modulation perception and speech intelligibility. Ear and Hearing

Bentsen T, May T, Kressner A, Dau T (2018) The benefit of combining a deep neural network architecture with ideal ratio mask estimation in computational speech segregation to improve speech intelligibility. P L o S One 13 (5)

Wiinberg A, Zaar J, Dau T (2018) Effects of expanding envelope fluctuations on consonant perception in hearing-impaired listeners. Trends in Hearing 22

Wendt D, Koelewijn T, Książek P, Kramer S, Lunner T (2018) Toward a more comprehensive understanding of the impact of masker type and signal-to-noise ratio on the pupillary response while performing a speech-in-noise test. Hearing Research

Ohlenforst B, Wendt D, Kramer S Naylor G, Zekveld A, Lunner T (2018) Impact of SNR, masker type and noise reduction processing on sentence recognition performance and listening effort as indicated by the pupil dilation response. Hearing Research

McWalter R, McDermott J (2018) Adaptive and selective time averaging of auditory scenes. Current Biology 28 (9) P 1405-1418

Wong D, Fuglsang S, Hjortkjæ J, Ceolini E, Slaney M, De Cheveigne A (2018) A Comparison of regularization methods in forward and backward models for auditory attention decoding. Frontiers in Neuroscience 12, 531

Mehraei G, Shinn-Cunningham B, Dau T (2018) Influence of talker discontinuity on cortical dynamics of auditory spatial attention. NeuroImage 179 P 548-556

Wang Y, Zekveld A, Wendt D, Lunner T, Naylor, G., & Kramer, S. E. (2018). Pupil light reflex evoked by light-emitting diode and computer screen: Methodology and association with need for recovery in daily life. PloS one 13(6)

Wang Y, Naylor G, Kramer, S, Zekveld, A, Wendt D, Ohlenforst B, Lunner T (2018) Relations between self-reported daily-life fatigue, hearing status, and pupil dilation during a speech perception in noise task. Ear and hearing, 39 (3) P 573-582

Paredes-Gallardo A, Innes-Brown H, Madsen S, Dau, T, Marozeau J (2018) Auditory stream segregation and selective attention for cochlear implant listeners: Evidence from behavioral measures and event-related potentials. Frontiers in Neuroscience

Conference Papers

Santurette S, Bianchi F, Dau T (2018) Effects of musical training and hearing loss on pitch discrimination. Presented at: Baltic-Nordic Acoustics Meeting 2018, Reykjavík

Smits B, Holtegaard P, Jeong C, Santurette S (2018) Evaluation of supra-threshold hearing following an event of recreational acoustic exposure Presented at: Baltic-Nordic Acoustics Meeting 2018, Reykjavík

Sanchez Lopez R, Fereczkowski M, Bianchi F, Piechowiak T, Hau O, Pedersen M, Behrens T, Neher T, Dau T, Santurette S (2018) Technical evaluation of hearing-aid fitting parameters for different auditory profiles. Presented at: Euronoise 2018, Hersonissos, Crete

Zaar J, Kowalewski B, Dau T (2018) Effects of non-stationary noise on consonant identification Presented at: International Symposium on Auditory and Audiological Research, 2017, Nyborg

Datasets

Sørensen AJ Fereczkowski M MacDonald E (2018) Task dialog by native-Danish talkers in Danish and English in both quiet and noise

Fuglsang S, Wong D, Hjortkjær J (2018) EEG and audio dataset for auditory attention decoding. Zenodo

Hjortkjær J, Märcher-Rørsted J, Fuglsang S, Dau Torsten (2018) EEG Data for: "Cortical oscillations and entrainment in speech processing during working memory load" Zenodo

Book production

Santurette S, Christensen-Dalsgaard J, Tranebjærg L, Andersen T, Poulsen T, Dau T (2018) Adaptive Processes in Hearing. Trends in Hearing (22) ISAAR Special Issue: Editorial, 2018. Presented at: International Symposium on Auditory and Audiological Research, 2017, Nyborg

Software

Wong Daniel, Hjortkjær J, Ceolini E, Cheveigné A (2018) COCOHA Matlab Toolbox. Zenodo

PhD theses

Christoph Scheidiger (2018) "Assessing speech intelligibility in hearing-impaired listeners"

Thomas Bentsen (2018) "Computational speech segregation inspired principles of auditory processing"

Alan Wiinberg (2018) "Perceptual effects of non-linear hearing aid amplification strategies"

Francois Guérit (2018) "Spectral and temporal processing in electric hearing"

Master projects

Tobias Toft Christensen. Mikkel Heber Hahn Petersen. Artificial bandwidth extension of bone conducted speech using deep neural networks. Supervisor: Tobias May (DTU)

Andreas Eckey. Conversational Dynamics: Manipulation of acoustic cues and the effect on turn-end prediction performance.
Supervisor: Ewen MacDonald (DTU)

Rasmus Bendsen. Spatial perception in reverberant environments with cochlear implant recipients
Supervisors: Abigail Anne Kressner, Torsten Dau (DTU)

Evan Ho Wei Li. Modeling of speech quality in telecommunication devices.
Supervisors: Marton Marschall, Torsten Dau (DTU) Wookeun Song (B&K)

Cocktail party anno 2018. Photo : Joachim Rode