NEWSLETTER

Centre for Acoustic Signal Processing Research (CASPR)

January 2020

The Centre for Acoustic Signal Processing Research (CASPR) is a research centre at the Section for Signal and Information Processing, Department of Electronic Systems, Aalborg University, Denmark. CASPR is supported by the Demant Foundation, Oticon A/S, and Aalborg University.

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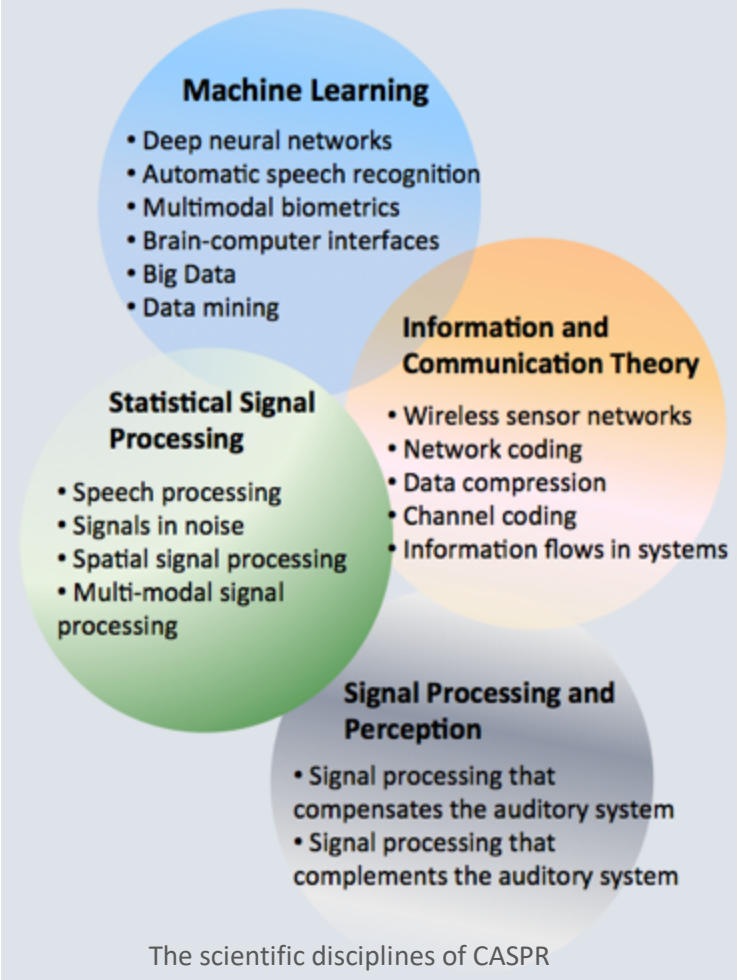
Department of Electronic Systems
Signal and Information Processing Section
Aalborg University

Research in CASPR

CASPR is conducting research related to advanced statistical signal processing solutions for assistive listening. The research finds direct use in communication devices such as hearing aids, helmets, headphones, cochlear implants, ear monitor, ear pieces, diagnostic equipment, etc. However, the envisioned research also finds use in related areas such as robust speech/speaker recognition, brain computer interfaces, acoustic event detection, etc.
The scientific scope of CASPR encompasses

- statistical signal processing.
- machine learning.
- information and communication theory with applications to wireless exchange of information between listening devices and other external devices.
- pattern recognition.
- data mining in body worn sensor data.
- perception-based statistical signal processing.



The scientific disciplines of CASPR

CASPR will navigate in a rapidly changing technological landscape: we envision a near future, where the technological landscape allows very different, and better, hearing assistive devices than are known today. Specifically, we envision that near-future hearing assistive devices will:

- increase the wireless exchange of information with each other, with other body-worn devices and with devices outside the body.
- make use of additional microphones on or outside the body, and will employ other types of body-worn or outside-the-body sensors.
- work in a much closer symbiosis with the user.

Teaching in CASPR

Current courses related to CASPR

CASPR is heavily involved in teaching and education at B.Sc., M.Sc., PhD., and Postdoc level in disciplines that are relevant to the scientific scope of CASPR:

- Machine Learning (Master course), Fall, 2019.
- Information Theory (Master course), Fall 2019.
- Optimization (Master course), Fall 2019.
- Reinforcement Learning and Dynamic Programming (PhD course), Fall 2019.
- Research in Vision, Graphics and Interactive Systems (Master Course), Fall 2019.
- Platforms and Methods for Multi-Modal System Architectures (Master course), Fall 2019.

CASPR is currently involved in six student projects:

Project 1
Noise Covariance Estimation for Acoustic MVDR Beamforming Using Gender-Specific DNNs.
Mathematical Engineering, 7th semester project with Oticon A/S.
Jonas Witting Rabjerg, Kristian Juul Tilsted, Rasmus Vestergaard Lykke. Thor Pilgaard Knudsen.

Project 2
Deep learning based approach to classification of EEG signals.
Signal Processing and Acoustics 9th semester project
Mads Bangshaab, Thomas Damsgaard, Mads Hulegaard Jensen.

Project 3
Reliable estimation of directional entropy.
Mathematical Engineering, long M.Sc. thesis project.
Martin Kamp Dalgaard.

Project 4
Bayesian dictionary learning for EEG source identification.
Mathematical Engineering, long M.Sc. thesis project.
Trine Nyholm Kragh, Laura Nyrup Mogensen.

Project 5
Low latency packet loss concealment using neural networks.
Signal Processing and Acoustics, 9th semester project with RTX A/S.
Jonas Koldkjær Jensen, Filip Mathias Lillelund Jørgensen.

Project 6
The benefit and user experience of hearing aids controlled by user behavior during face-to-face communication.
Product and Design Psychology, 10th semester thesis project with Oticon A/S.
Lucca Julie Nelleman.

Open Lab Event in CASPR and SIP

CASPR and the Section on Signal and Information Processing, where CASPR is anchored, had an Open Lab event on Thursday November 7th from 9.00 – 12.00.

Participants from 19 different companies enjoyed the latest research in *AI and sound for hearing assistive devices* via exciting presentations, demonstrations, posters, and lab tours.

Prof. Jesper Jensen gave a presentation on “statistical signal processing and deep learning for sound processing”, and demonstrated the latest research on speaker separation using DNNs.

Prof. Zheng-Hua Tan gave a presentation on “AI and audio-visual speech enhancement”, and demonstrated the latest research on adversarial attacks on DNN based speech recognition.

Poster presentations

- Brain-inspired joint noise reduction and hearing loss compensation for hearing aids, presented by Industrial postdoc Adel Zahedi
- Speech intelligibility prediction using deep learning, presented by PhD researcher Mathias B. Pedersen
- Deep neural networks for speech enhancement and separation, Presented by Prof. Zheng-Hua Tan
- Low-resource keyword spotting for hearing assistive devices, presented by Ivan Lopez-Espejo
- Overview of research projects in CASPR, presented by Prof. MSO Jan Østergaard

NEWS

Morten Ø. Nielsen started on a PhD Project in CASPR entitled "Training methods for DNNs under computational ressource constraints".
Morten has an M.Sc. degree from Aalborg University.

CASPR members participated in the Danish Sound Day 2019.

- Poul Hoang participated in the Research Pitch Battle with his work on User-symbiotic speech enhancement for hearing aids.

- Adel Zahedi presented a poster on his work on Brain inspired jointly optimal hearing loss compensation and noise reduction for hearing assistive devices.
- Ivan Lopez-Espejo presented a poster on his work on low-resource keyword spotting for hearing assistive devices.

Prof. Zheng-Hua Tan is elected as Vice Chair of the Machine Learning for Signal Processing Technical Committee (MLSP TC) of the IEEE Signal Processing Society for 2020 and shall become Chair of the TC for the term of 2021-2022

Prof. Zheng-Hua Tan is appointed as an Associate Editor for IEEE/ACM Transactions on Audio, Speech and Language Processing for a three-year term.

PhD researcher Daniel Michelsanti attended the Deep Learning Barcelona Symposium (DLBCN 2019) presenting the following article:

- Deep-Learning-Based Audio-Visual Speech Enhancement in Presence of Lombard Effect. D. Michelsanti, Z.-H. Tan, S. Sigurdsson and J. Jensen. https://www.doi.org/10.1016/j.specom.2019.10.006

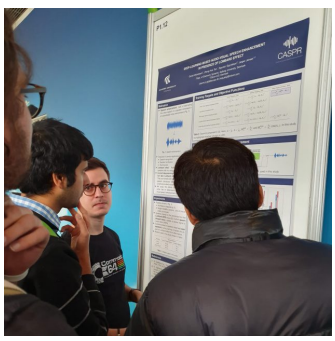
PhD student Juan M. M. Donas from University of Granada, Spain, was visiting CASPR for three months in the period September to November 2019. Juan was working on new ideas in multi-channel speech enhancement.

Morten Kolbæk's research on intelligent hearing aids have been documented in a podcast and an article on reflektionstid.dk https://refleksionstid.dk

Postdoctoral researcher Iván López Espejo attended the 20th Annual Conference of the International Speech Communication Association (INTERSPEECH 2019) presenting the following article:

- Keyword Spotting for Hearing Assistive Devices Robust to External Speakers. I. López-Espejo, Z.-H. Tan and J. Jensen. 10.21437/Interspeech.2019

Prof. (MSO) Jan Østergaard is appointed Head of the Section on Signal and Information Processing, Department of Electronic Systems, Aalborg University.



Recent CASPR Related Research

Journal papers

1. On Loss Functions for Supervised Monaural Time-Domain Speech Enhancement. M. Kolbæk, Z.-H. Tan, S. H. Jensen and J. Jensen. Accepted by IEEE/ACM Transactions on Audio, Speech and Language Processing.

2. The Importance of Context When Recommending TV Content: Dataset and Algorithms. M. S. Kristoffersen, S. E. Shepstone, and Z.-H. Tan. Accepted by IEEE Transactions on Multimedia.

3. SketchSegNet+: An End-to-end Learning of RNN for Multi-Class Sketch Semantic Segmentation. Y. Qi and Z.-H. Tan. Accepted by IEEE Access.

4. rVAD: An Unsupervised Segment-Based Robust Voice Activity Detection Method. Z.-H. Tan, A. Sarkar, and N. Dehak, accepted by Computer Speech and Language, vol. 59, pp. 1-21, January 2020. Source code: http://kom.aau.dk/~zt/online/rVAD/.

5. A Moving Horizon Framework for Sound Zones. M. Møller and J. Østergaard. IEEE Transactions on Audio, Speech and Language Processing. Accepted for publication, 2020.

6. Rate-Constrained Noise Reduction in Wireless Acoustic Sensor Networks," J. Amini, R. C. Hendriks, R. Heudsens, M. Guo, J. Jensen, IEEE Transactions Audio, Speech and Language Processing," Vol. 28, No.1, pp. 1-12, Jan. 2020.

7. Zero-delay multiple descriptions of stationary scalar Gauss-Markov sources. A. Fuglsig, J. Østergaard. Entropy, MDPI, 21(12), 1185, December 2019.

8. Deep-learning-based audio-visual speech enhancement in presence of Lombard effect. D. Michelsanti, Z.-Hua Tan, J. Jensen, Speech Communication, Vol. 115, pp. 38-50, Dec. 2019.

9. Time-Contrastive Learning Based Deep Bottleneck Features for Text-Dependent Speaker Verification. A. Sarkar, Z.-H. Tan, H. Tang, S. Shon, and J. Glass, IEEE Transactions on Audio, Speech and Language Processing, vol. 27, no. 8, pp.1267-1279, August 2019.

Conference Papers

1. S. Samizade, Z.-H. Tan, C. Shen, X. Guan, "Adversarial Example Detection by Classification for Deep Speech Recognition," Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP). Accepted.
2. A Neural Network for Monuaral Intrusive Speech Intelligibility Prediction. M. B. Pedersen, A. H. Andersen, S. H. Jensen, J. Jensen. Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP). Accepted.
3. Maximum Likelihood Estimation of the Interference-plus-noise Cross Power Spectral Density Matrix for Own Voice Retrieval. P. Hoang, Z.-H. Tan, T. Lunner, J. M. de Haan, J. Jensen. Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP). Accepted.
4. A Constrained Maximum Likelihood Estimator of Speech and Noise Spectra with Application to Multi-Microphone Noise Reduction. A. Zahedi, M. S. Pedersen, J. Østergaard, L. Bramsløw, T. U. Christiansen, J. Jensen. Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP). Accepted.
5. Robust Joint Estimation of Multimicrophone Signal Model Parameters. A. Koutrouvelis, R. Hendriks, R. Heusdens, J. Jensen. Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP). Accepted.
6. Rate-Constrained Noise Reduction in Wireless Acoustic Sensor Networks. J. Amini, R. C. Hendriks, R. Heusdens, M. Guo, J. Jensen. Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP). Accepted.
7. The Exponential Distribution in Rate Distortion Theory: The Case of Compression with Independent Encodings. U. Erez, J. Østergaard, and R. Zamir. Proc. *IEEE Data Compression Conference*, 2020. Accepted.
8. Robust Bayesian and Maximum a Posteriori Beamforming for Hearing Assistive Devices. P. Hoang, Z.-H. Tan, J. M. de Haan, T. Lunner and J. Jensen. The 7th IEEE Global Conference on Signal and Information Processing (GlobalSIP 2019), Nov. 11-14, 2019, Shaw Centre, Ottawa, Canada.
9. Soft Dropout and Its Variational Bayes Approximation. J. Xie, Z. Ma, G. Zhang, J.-H. Xue, Z.-H. Tan and J. Guo. 2019 IEEE International Workshop on Machine Learning for Signal Processing (MLSP 2019), Oct. 13–16, 2019, Pittsburgh, PA, USA.
10. Deep Joint Embeddings of Context and Content for Recommendation. M. S. Kristoffersen, J. L. Wieland, S. E. Shepstone, Z.-H. Tan and V. Vinayagamoorthy. CARS 2.0 – Workshop on Context-Aware Recommender Systems, in conjunction with RecSys' 2019, 20 September 2019, Copenhagen, Denmark.
11. Keyword Spotting for Hearing Assistive Devices Robust to Interfering Speakers . I. Lopez-Espejo, Z.-H. Tan and J. Jensen, *Proc. Interspeech.* 2019.
12. Improvement and Assessment of Spectro-Temporal Modulation Analysis for Speech Intelligibility Estimation . A. Edraki, W.-Y. Chan, J. Jensen and D. Fogerty, *Proc. Interspeech.* 2019.
13. Estimation of Sensor Array Signal Model Parameters Using Factor Analysis . A. Koutrouvelis, R. Hendriks, R. Heusdens, J. Jensen, *Proc. Eusipco.* 2019.

Winter School -
Signal Processing for Hearing Assistive Devices

Building on the success of our previous CASPR Winter School in 2017, we are happy to announce that there will be a new CASPR Winter School in November 2020. The Winter School is also open for Industry.

Hearing assistive devices (HADs) are ubiquitous. They include, for example, devices such as headsets for speech communication in noisy environments (air plane crews, emergency/rescue teams, combat soldiers, police forces, etc.), headsets for office use, gaming, etc., and hearing care systems, e.g. hearing aids and cochlear implants.

The Winter school consists of lectures and hands-on exercises, which allow the participants to understand in-depth the technical problems related to HADs and their potential solutions. The school has three main parts. The first part is an introductory part, which lays the foundation for the rest of the course, covering fundamental topics such as auditory perception (normal and impaired hearing) and a discussion of the basic principles of HADs. The second part provides an overview of fundamental signal processing problems encountered in HADs, and an in-depth treatment of state-of-the-art solutions. These include methods for beamforming and noise reduction, direction-of-arrival estimation, feedback and echo control, hearing loss compensation, etc. Furthermore, an overview is given of methodologies for evaluating HADs with a particular focus on methods for intelligibility assessment and estimation. The third part of the Winter school presents emerging technologies for hearing assistive devices, including machine learning techniques for processing of speech in noise, audio-visual signal processing, user-aware/symbiotic signal processing, methods for own-voice processing, etc. While the course focuses on the HAD application, many of the discussed techniques are very general and find use in the much broader field of general sound processing. The course is multi-disciplinary, including topics such as basic auditory perception, statistical signal processing, deep learning, practical do's and don'ts.

The course also bridges the gap between theoretical background and practical/robust application in practice. The course is a one-week concentrated course to be held in the Fall, 2020.

Date of Winter School: 2nd – 6th November, 2020.
Place: Aalborg University, Fredrik Bajers Vej 7b, 9220 Aalborg, Denmark.

For more information about the Winter School, feel free to contact the organizers:
Prof. Jesper Jensen (jje@es.aau.dk), Prof. Zheng-Hua Tan (zt@es.aau.dk), and Prof. MSO Jan Østergaard (jo@es.aau.dk).

Registration is not yet open. When the registration opens, it will be announced on the CASPR website: http://caspr.es.aau.dk