NEWSLETTER

Centre for Acoustic Signal Processing Research (CASPR)

August 2019

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 Oticon Foundation, Oticon A/S, and Aalborg University.

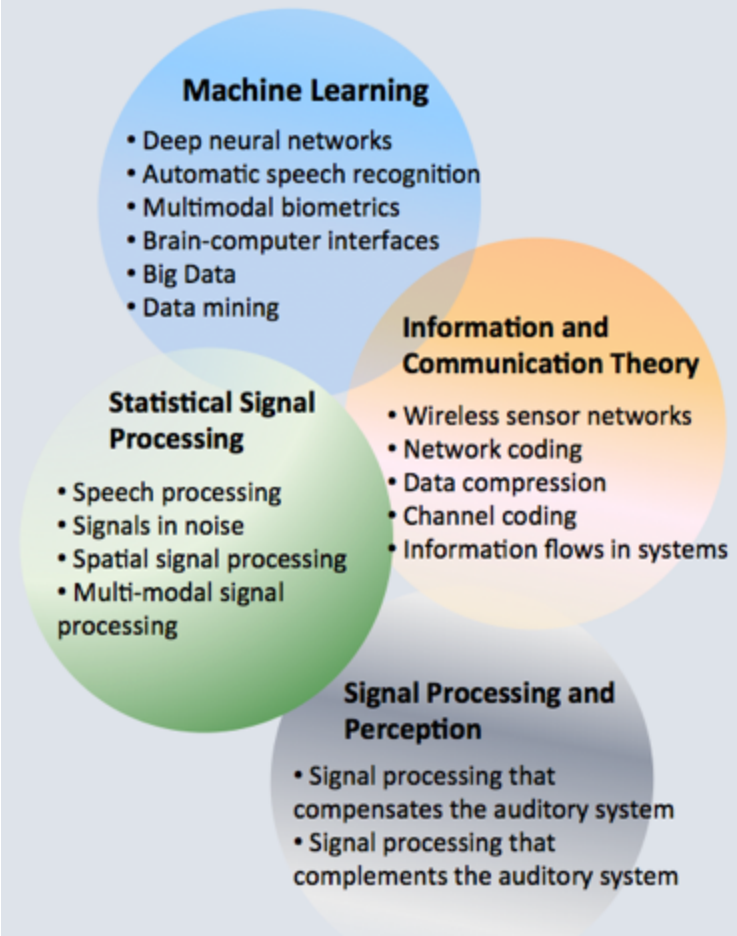
Contents

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 and PhD courses), Fall+Spring, 2019.
- Deep Learning (PhD course), Spring 2019.
- Information Theory (Master course), Fall 2019.
- Optimization (Master course), Fall 2019.
- Array and Sensor Processing (Master course), Fall 2019.

CASPR is currently involved in six student projects:

Project 1.
Deep learning in speech coding.
Mathematical Engineering, long M.Sc. thesis project with RTX A/S.
Barbara Martinovic.

Project 2.
User voice retrieval using microphones and an additional sensor.
Mathematical Engineering, long M.Sc. thesis project with Oticon A/S.
Julius Garde.

Project 3:
Music Signal Prediction using DNN.
Mathematical Engineering, B.Sc. thesis project with B&O.
Christina Dorf Falberg Pedersen.

Project 4.
Sound field estimation using Deep Neural Networks.
Mathematical Engineering, long M.Sc. thesis project with B&O.
Sanne D. Nielsen and Morten Ø. Nielsen.

Project 5.
Zero-delay multiple description audio coding.
Mathematical Engineering, long M.Sc. thesis project.
Andreas J. Fuglsig.

Project 6:
Deep Learning based Adversarial Example detection
Signal Processing and Acoustics, M.Sc. thesis project.
Jacob Theilgaard Lassen, Amalie Vistoft Petersen, and Sebastian Biegel Schiøler.

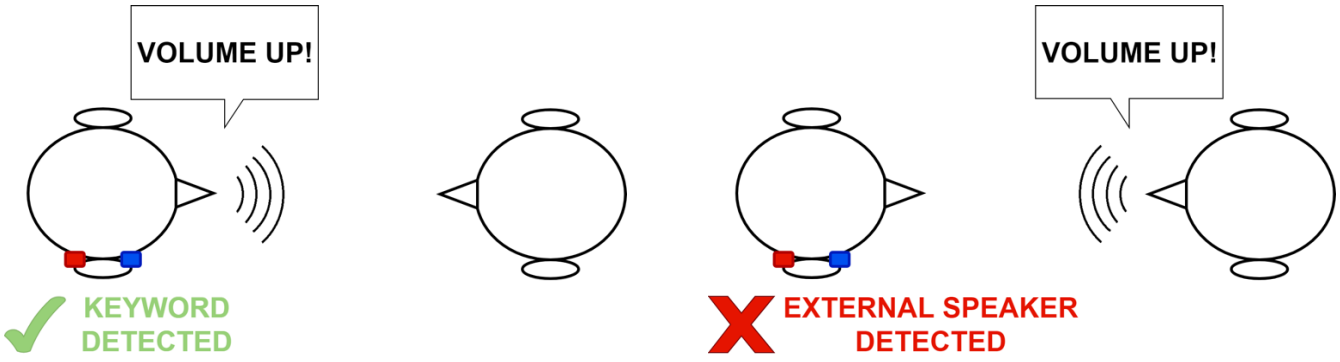
CASPR Research Project in Focus

Postdoc Project: Low-resource Keyword Spotting for Hearing Assistive Devices
Start date: January 1st, 2019.

Manual operation of hearing assistive devices is cumbersome in a number of situations. To assist in addressing this issue, voice interfaces are envisioned as a means for handling and operating hearing assistive devices in a practical manner. Furthermore, it is key that such voice interfaces take into account that hearing assistive devices are characterized by strict memory and computational complexity constraints.

In spite all the progress made in both machine learning and speech technology in recent years, there is still a long way to go in the development of voice interfaces that operate flawlessly in acoustically challenging (i.e., noisy) situations. Therefore, the goal of this project is the research and development of personalized, noise-robust and low-resource keyword spotting systems for hearing assistive devices. To meet all these requirements, we explore the combined use of multi-microphone signals from hearing assistive devices along with signal processing and the latest deep learning techniques. We expect to improve the robustness and performance over existing keyword spotting systems by exploring systems that take into account user-specific aspects, e.g., voice characteristics or head-related acoustics of the specific user. In addition, we will investigate whether other signal modalities may aid to further improve the performance of the developed voice interfaces. As a result, we expect to contribute to enhance the life quality of hearing-impaired people.

In this respect, it is worth to mention that we have recently proposed a keyword spotting system for hearing assistive devices that is robust against external speakers, published at Interspeech 2019, with the concept illustrated in the figure. Thanks to exploiting state-of-the-art deep learning methods along with multi-microphone signals from hearing assistive devices, we have been able to achieve significant keyword spotting accuracy improvements with respect to systems that do not deal with external speakers. This is an important result since no person but the user of a hearing assistive device should be allowed to control it, also by means of her/his voice.



NEWS

New demos have been released which demonstrate the latest research that CASPR members have been involved in:

- Deep-learning-based audio-visual speech enhancement in presence of Lombard effect.

The demos are available on the CASPR website:
http://caspr.es.aau.dk/demos

Payam Shahsavari Baboukani is employed in CASPR from February 2019 as a Ph.D. student. The title of the project is "Estimating acoustic signal quality using miniature EEG devices."

- CASPR members participated the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP 2019) in Brighton, UK. Zheng-Hua Tan chaired two sessions, and Daniel Michelsanti presented two articles:
    - On Training Targets and Objective Functions for Deep-Learning-Based Audio-Visual Speech Enhancement. D. Michelsanti, Z.-H. Tan, S. Sigurdsson and J. Jensen. 10.1109/ICASSP.2019.8682790
    - Effects of Lombard Reflex on the Performance of Deep-Learning-Based Audio-Visual Speech Enhancement Systems. D. Michelsanti, Z.-H. Tan, S. Sigurdsson and J. Jensen. 10.1109/ICASSP.2019.8682713

Nine students at AAU supervised by CASPR staff successfully defended their theses in June 2019:

- Andreas J. Fuglsig, M.Sc. degree
- Sanne D. Nielsen, M.Sc. degree
- Morten Ø. Nielsen, M.Sc. degree
- Barbara Martinovic, M.Sc. degree
- Julius Garde, M.Sc. degree
- Jacob Theilgaard Lassen, M.Sc. degree
- Amalie Vistoft Petersen, M.Sc. degree
- Sebastian Biegel Schiøler, M.Sc. degree
- Christina D. F. Pedersen, B.Sc. degree

Recent CASPR Related Research Publications

Journal Papers

1. rVAD: An Unsupervised Segment-Based Robust Voice Activity Detection Method. Z.-H. Tan, A. Sarkar, and N. Dehak, accepted by Computer Speech and Language. Source code: http://kom.aau.dk/~zt/online/rVAD/.
2. 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.
3. Robust Joint Estimation of Multi-Microphone Signal Model Parameters, A. I. Koutrouvelis, R. C. Hendriks, R. Heusdens, J. Jensen, IEEE Trans. Audio, Speech, Language Process. Vol. 27, No. 7, pp. 1136-1150, July, 2019.
4. Sound Quality Improvement for Hearing Aids in Presence of Multiple Inputs. A. Kar, A. Anand, J. Østergaard, S.H. Jensen, and M.N.S. Swarmy. Circuits, Systems, and Signal Processing, Springer, 38(8), 3591-3615, April 2019.
5. Personalized Signal-Independent Beamforming for Binaural Hearing Aids, A. H. Moore, J. M. de Haan, M. S. Pedersen, P. A. Naylor, M. Brookes, and J. Jensen, J. Acoust. Soc. Am., Vol. 145, No. 5, pp. 2971-2981, April 2019.
6. Mean Square Performance Evaluation in Frequency Domain for an Improved Adaptive Feedback Cancellation in Hearing Aids. A. Kar, A. Anand, J. Østergaard, S.H. Jensen, and M.N.S. Swarmy. Signal Processing, 157, pp. 45-61. ISSN 01651684.
7. Information Loss in the Human Auditory System, M. Z. Jahromi, A. Zahedi, J. Jensen, and J. Østergaard, IEEE Trans. Audio, Speech, Language Process., Vol. 27, No. 3, pp. 472-481, March 2019.
8. A Convex Approximation of the Relaxed Binaural Beamforming Optimization Problem, A. I. Koutrouvelis, R. C. Hendriks, R. Heusdens, and J. Jensen, IEEE Trans. Audio, Speech, Language Process., Vol. 27, No. 2, pp. 321-331, Feb. 2019.
9. On the Relationship between Short-Time Objective Intelligibility and Short-Time Spectral-Amplitude Mean-Square Error for Speech Enhancement, M. Kolbæk, Z.-H. Tan and J. Jensen, IEEE Trans. Audio, Speech, Language Process., Vol. 27, No. 2, pp. 283-295, Feb. 2019.
10. Asymmetric Coding for Rate-Constrained Noise Reduction in Binaural Hearing Aids, J. Amini, R. C. Hendriks, R. Heusdens, M. Guo, and J. Jensen, IEEE Trans. Audio, Speech, Language Process., Vol. 27, No. 1, pp. 154-167, Jan. 2019.

Conference Papers

1. Keyword Spotting for Hearing Assistive Devices Robust to Interfering Speakers . I. Lopez-Espejo, Z.-H. Tan and J. Jensen, *Proc. Interspeech.* 2019. Accepted.
2. 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. Accepted.
3. Estimation of Sensor Array Signal Model Parameters Using Factor Analysis . A. Koutrouvelis, R. Hendriks, R. Heusdens, J. Jensen, *Eusipco.* 2019. Accepted.
4. A Novel Binaural Beamforming Scheme with Low Complexity Minimizing Binaural-Cue Distortions . A. Koutrouvelis, R. Hendriks, R. Heusdens, J. Jensen, M. Guo, *Proc. Int. Conf. Acoust., Speech, Signal Processing,* 2019.
5. Effects of Lombard Reflex on the Performance of Deep-Learning-Based Audio-Visual Speech Enhancement Systems . D. Michelsanti, Z.-H. Tan, S. Sigurdsson, and J. Jensen, *Proc. Int. Conf. Acoust., Speech, Signal Processing,* 2019.
6. On Training Targets and Objective Functions for Deep-Learning-Based Audio-Visual Speech Enhancement . D. Michelsanti, Z.-H. Tan, S. Sigurdsson, and J. Jensen, *Proc. Int. Conf. Acoust., Speech, Signal Processing,* 2019.
7. Subjective Annotations for Vision-Based Attention Level Estimation. A. Coifman, P. Rohoska, M.S. Kristoffersen, S.E. Shepstone, and Z.-H. Tan, The 14th International Conference on Computer Vision Theory and Applications (VISAPP 2019), Prague, Czech Republic, 25-27 February 2019.

PhD Stipends available in CASPR

The Centre for Acoustic Signal Processing Research (CASPR) will have a new fully funded PhD stipends available in 2019.

We are looking for highly motivated, independent, and outstanding students that desire to do a successful 3-year PhD programme at Aalborg University. The ideal candidates must have strong expertise in one or more of the following disciplines: statistical signal processing, auditory perception, machine learning, information theory, or estimation theory. Good English verbal and written skills are a must. Excellent undergraduate and master degree grades are desired.

PhD positions in Denmark are fully funded, i.e. no tuition fees, and come with a salary. The salary is subject to a pay grade system based on prior working experience since completing your undergraduate degree. The yearly gross salary is in the range 41.500 – 50.100 Euros.

You may obtain further information about the PhD stipends from Professor Jan Østergaard (jo@es.aau.dk), Professor Zheng-Hua Tan (zt@es.aau.dk), or Professor Jesper Jensen (jje@es.aau.dk), CASPR, Aalborg University, concerning the scientific aspects of the stipends.

Aalborg University (http://www.en.aau.dk) is one of the leading Danish universities with campuses in Aalborg, Esbjerg and Copenhagen. The student population of AAU comprises of around 21.000 regular (both undergraduate and postgraduate) students and 947 PhD students. AAU is famous for its innovative problem and project based learning approach (PBL) where students work on team-based projects solving 'real-life' problems in collaboration with organisations or companies. Aalborg University is acknowledged for collaboration with industry and according to Shanghai/ARWU World Rank, Aalborg University is no.7 in the world within the research field of Electronic and Electrical Engineering. Aalborg University is ranked the best university in Europa and the eighth best university worldwide for engineering according to the Best Global Universities list published by U.S. News and World Report, 2017.