NEWSLETTER

Centre for Acoustic Signal Processing Research (CASPR)

December 2018

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 Aalborg University, the Oticon Foundation, Oticon A/S, and Innovation Fund Denmark.

Contents

p. 2-3 Research & Teaching

p. 4 Research Highlights

p. 5 MLSP

p. 6 News

p. 7 Publications

p. 8 PhD Stipends

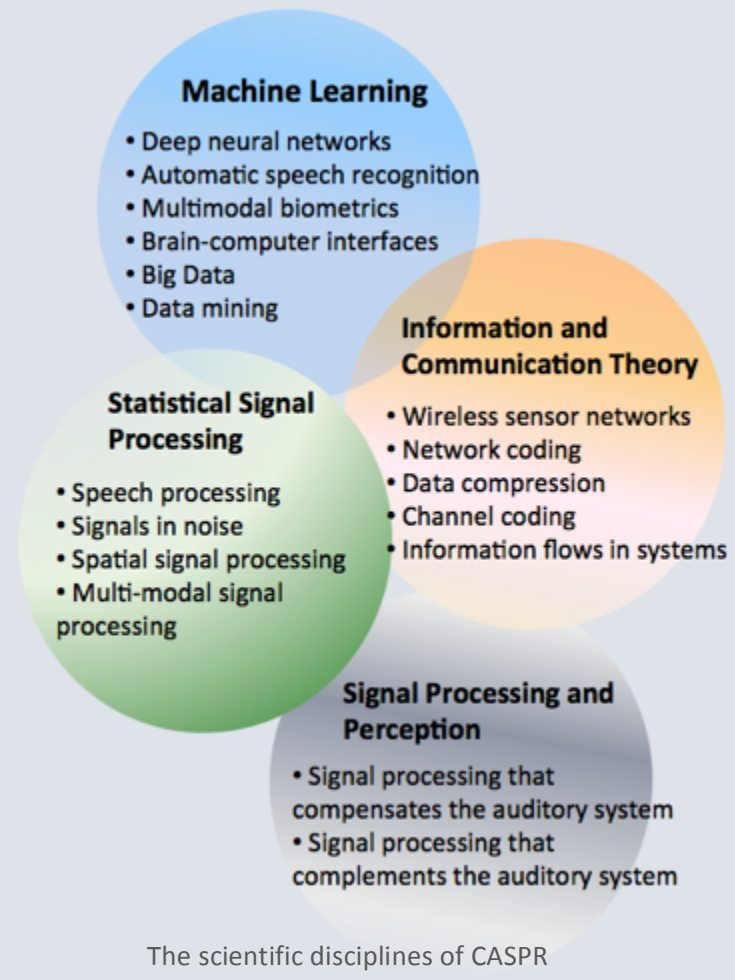
Department of Electronic Systems
Signal and Information Processing Section
Aalborg University

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 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, 2018.
- Deep Learning (PhD course), Spring 2018.
- Information Theory (Master and PhD courses), Fall 2018.
- Array and Sensor Processing (Master course), Fall 2018.
- Optimization Methods (Master course), Fall 2018.

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

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

CASPR is currently involved in six student projects:

Project 3.
Keyword spotting using machine learning.
Signal Processing and Acoustics. 9th Semester project with Oticon A/S.
Jacob Theilgaard Lassen.

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

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

Project 6.
Data Compression in Distributed Optimization.
Signal Processing and Acoustics. 7th Semester.
Jakob Sloth Lauridsen, Jonas Koldkjær Jensen
Mads Bangshaab, Thomas Damgaard.

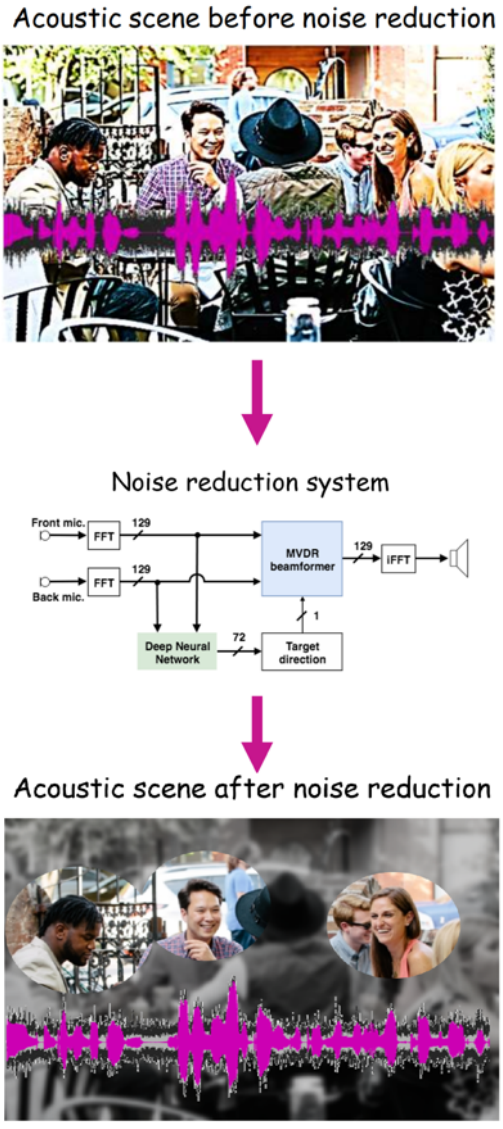
CASPR Research Project in Focus

PhD Project: User-Symbiotic Speech Enhancement for Hearing Aids by Poul Hoang
Start date: August 15, 2018.

The human hearing is one of our most important senses and is crucial for us to communicate through spoken language. It is often the case for hearing impaired, that the ability to understand speech degrades depending on the severity of the hearing impairment and the amount of noise in the environment. To help increase speech intelligibility and listening comfort, modern hearing aids typically apply advanced signal processing algorithms to the noisy microphone signals in order to enhance the desired speech signal by reducing the noise from the environment. Although noise reduction is not a new concept in hearing aid technology, existing algorithms still lack robustness in very noisy environments, where many competing speakers are present.

One of the problems faced when applying noise reduction algorithms, such as beamforming, is that the algorithms require that the direction of the desired speaker to be known. Traditionally, beamforming and noise reduction algorithms have been relying on mathematical models that only to some extent describe the signals we observe at the microphones. The advantage of this approach is that the resulting algorithms tend to be computationally simple, which is important for battery-driven, low-complexity computational devices such as, e.g., hearing aids. On the other hand, these simple mathematical models don't capture all details of the observed microphone signals, leading to algorithms, which do not fully exploit all available information available in the microphone signals.

As an alternative, this PhD project explores the use of deep learning methods, which do not rely on simple parametric models of the microphone signals. In particular, we develop artificial neural networks to estimate the speaker position, and, subsequently, the target sound signal, based on the noisy microphone signals. We will explore algorithm variants that work in closer symbiosis with the hearing aid user. More specifically, we believe that we can improve the noise reduction algorithms by providing them with additional information about the user collected from sensors besides microphone signals.



MLSP2018

The IEEE 28th International Workshop on Machine Learning for Signal Processing (MLSP2018), was held in Aalborg, Denmark, September 17-20, 2018, with **Zheng-Hua Tan** of CASPR as the general chair.

Over 140 participants from all over the world participated in this annual event organized by the IEEE Signal Processing Society MLSP Technical Committee. The workshop featured 4 keynote talks, 2 tutorials, and 9 oral/poster sessions, presenting the most recent and exciting advances in machine learning for signal processing.

Invited talks:

- End to End Speech Recognition Systems Explored.
  Distinguished Scientist and Vice General Manager, Dong Yu, Tencent AI Lab, Seattle, USA
- Temporal Models with Low-rank Spectrogram.
  Senior Researcher Cédric Févotte, CNRS, Toulouse, France
- The Bayesian Bonus: Benefits of Being Bayesian in the Deep Learning Era.
  Prof. Max Welling, Professor at the University of Amsterdam, the Netherlands and VP Technologies at Qualcomm, USA
- A Reality Check on Data Driven Business – What are the Real Life Potential and Barriers?
  Data Science Evangelist Kaare Brandt Petersen, Implement Consulting Group, Copenhagen, Denmark
- Opening the Black Box – How to Interpret Machine Learning Functions and Their Decisions.
  Prof. Lars Kai Hansen and Laura Rieger, Technical University of Denmark, Denmark
- Bayesian Filtering and Smoothing Methods for Machine Learning.
  Prof. Simo Särkkä, Aalto University, Helsinki, Finland

For details, refer to http://mlsp2018.conwiz.dk

MLSP2019 will be held in Pittsburgh, Pennsylvania, USA, 13-16 October 2019.

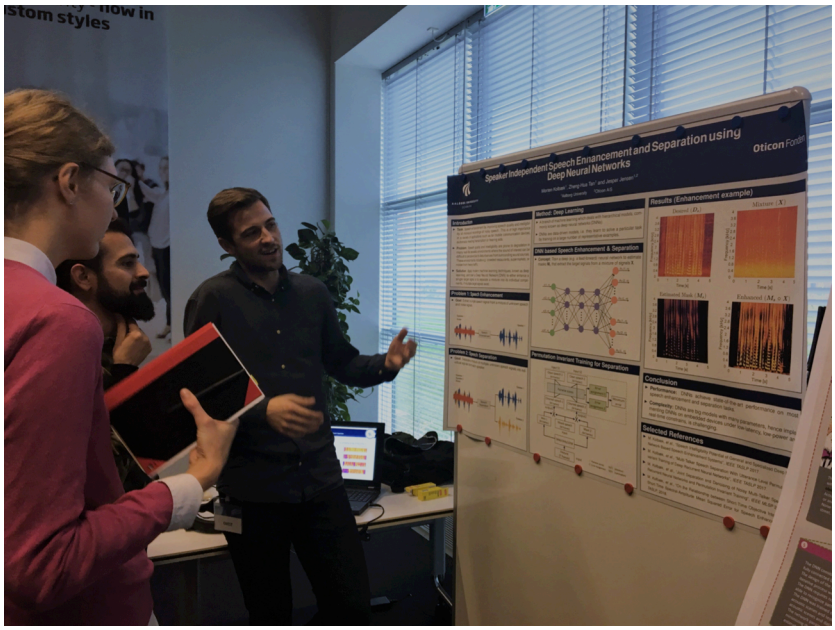
NEWS

Iván López-Espejo will be employed from January 1, 2019 as a postdoc in low-resource keyword spotting for hearing assistive devices.

Manual operation of hearing assistive devices is cumbersome in various situations. With advances in machine learning and speech technology, voice interfaces are being deployed for hearing assistive devices. Hearing assistive devices are characterized by strict memory and computational complexity constraints and by the fact that they are expected to operate flawlessly, even in acoustically challenging situations.
This postdoc project aims to develop personalized, noise-robust and super low-resource voice control systems for hearing assistive devices, using microphone signals and other modalities.

Adel Zahedi's industrial postdoc application entitled "Brain-Inspired Jointly Optimal Hearing Loss Compensation and Noise Reduction for Hearing Assistive Devices" has been granted by Innovation Fund Denmark. The project is in cooperation between CASPR and Oticon.

Prof. Wai-Yip Geoffrey Chan from Queens University, Kingston, Canada is visiting CASPR for four months in the period September to December 2018. Prof. Chan will be working on new ideas in Deep Learning for speech intelligibility enhancement.



CASPR projects were presented at the Oticon Demo Day. The Oticon Demo Day is an annual conference-like event, where developers and researchers present ideas and progress.

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

- Effects of Lombard Reflex on Deep-Learning-Based Audio-Visual Speech Enhancement Systems
- Single-Microphone Speech Enhancement and Separation Using Deep Learning

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

Please visit the CASPR website http://caspr.es.aau.dk for more news.

Recent CASPR Related Research Publications

Journal Papers

1. 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., Issue 3., pp.472-481, 2019.

2. 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. Accepted for publication in Signal Processing, Elsevier Journal, 2019.

3. 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. Accepted for publication in IEEE Trans. Audio, Speech, Language Processing, 2019.

4. Asymmetric Coding for Rate-Constrained Noise Reduction in Binaural Hearing Aids. J. Amini, R. C. Hendriks, R. Heusdens, M. Guo, and J. Jensen. Accepted for publication in IEEE Trans. Audio, Speech, Language Processing, 2019.

5. A Convex Approximation of the Relaxed Binaural Beamforming Optimization Problem. A. I. Koutrouvelis, R. C. Hendriks, R. Heusdens, and J. Jensen. Accepted for publication in IEEE Trans. Audio, Speech, Language Process, 2019.

6. Spoofing Detection in Automatic Speaker Verification Systems Using DNN Classifiers and Dynamic Acoustic Features. H. Yu, Z.-H. Tan, Z. Ma, R. Martin, and J. Guo, IEEE Transactions on Neural Networks and Learning Systems, vol. 29, no. 10, pp. 4633-4644, October 2018.

7. Refinement and Validation of the Binaural Short Time Objective Intelligibility Measure for Spatially Diverse Conditions. A.H. Andersen, J.M. de Haan, Z.-H. Tan and J. Jensen. Elsevier Speech Communication, Vol. 102, pp. 1-13, Sept. 2018.

8. Non-Intrusive Speech Intelligibility Prediction using Convolutional Neural Networks. A.H. Andersen, J.M. de Haan, Z.-H. Tan and J. Jensen. IEEE Trans. Audio, Speech, Language Process., Vol. 26, No. 10, pp. 1925-1939, Oct. 2018.

9. Zero-Delay Rate Distortion via Filtering for Vector-Valued Gaussian Sources. P. A. Stavrou, J. Østergaard, and C. Charalambous. IEEE Journal of Selected Topics in Signal Processing, Vol.12, Issue 5, pp. 841 – 856, October 2018.

10. A Spatial Self-Similarity Based Feature Learning Method for Face Recognition under Varying Poses. X. Duan and Z.-H. Tan, Pattern Recognition Letters, vol. 111, pp. 109-116, August 2018.

11. Bias-compensated Informed Sound Source Localization Using Relative Transfer Functions. M. Farmani, M.S. Pedersen, Z-H. Tan, and J. Jensen, IEEE/ACM Transactions on Audio, Speech, and Language Processing, vol. 26, no 7., pp. 1275 – 1289, July 2018.

Conference Papers

1. Public Perception of Android Robots: Indications from an Analysis of YouTube Comments. E. Vlachos and Z.-H. Tan, the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018), Madrid, Spain, 1-5 October 2018.

2. Multi-Task Adversarial Network Bottleneck Features for Noise-Robust Speaker Verification. H. Yu, T. Hu, Z. Ma, Z.-H. Tan and J. Guo, IEEE International Conference on Network Infrastructure and Digital Content (IC-NIDC 2018), Guiyang, China, August 22 – 24, 2018.

3. The Sound or Silence: investigating the influence of robot noise on proxemics. G. Trovato, R. Paredes, J. Balvin, F. Cuellar, N.B. Thomsen, S. Bech, and Z.-H. Tan, the 27th IEEE International Conference on Robot and Human Interactive Communication, RO-MAN 2018, Nanjing and Tai'an, China, 27-31 August 2018.

4. Evaluation of Binaural Noise Reduction Methods in Terms of Intelligibility and Perceived Localization. A. Koutrouvelis, R.C. Hendriks, R. Heusdens, S. van de Par, J. Jensen, and M. Guo. Proc. European Signal Processing Conference, 2018.

5. Operational Rate-Constrained Beamforming in Binaural Hearing Aids. J. Amini, R. C. Hendriks, R. Heusdens, M. Guo, and J. Jensen. Proc. European Signal Processing Conference, 2018.

PhD Stipends available in CASPR

CASPR will have one or more 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 (MSO) 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 23.000 regular (both undergraduate and postgraduate) students and 900 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 U.S. News & World Report, Aalborg University is the best Engineering University in Europe and the fourth best worldwide.