AALBORG UNIVERSITY
DENMARK

Audio Analysis Lab
Department of Architecture
Design and Media Technology
Rendsburggade 14
9000 Aalborg
Denmark

Invitation to PhD Defense

Taewoong Lee will defend his PhD dissertation

Tuesday, January 11, 2022, 10:00, presented via Zoom

Title:

"The Creation of Perceptually Optimized Sound Zones Using Variable Span Trade-Off Filters"

Sign Up & Questions:

The defense will be presented via Zoom. To sign up or to pose questions regarding the PhD defense, please contact secretary Kristina Wagner Rojen.
Phone: +45 9940 9926
Email: kwro@create.aau.dk

Assessment Committee:

Professor Stefania Serafin (Chairwoman)
Department of Architecture, Design and Media Technology, Aalborg University, Denmark

Professor Thushara D. Abhayapala
The Australian National University

Professor Filippo Maria Fazi
The University of Southampton

Supervisors:

PhD Supervisor Professor Mads Græsbøll Chistensen
Department of Architecture, Design and Media Technology, Aalborg University, Denmark

Assistant PhD Supervisor Signal Processing Specialist Jesper Kjær Nielsen
Siemens Gamesa Renewable Energy A/S (formerly Associate Professor at Aalborg University)

Program for PhD Defense:

10:00 – 10:05	Moderator Stefania Serafin welcomes the guests
10:05 – 10:50	Presentation by PhD student Taewoong Lee
10:50 – 11:00	Break
11:00 – 13:00	Questions
13:00 – 13:30	Assessment – The supervisors will join if the committee have any questions
13:30 –	Announcement from the committee and we will propose a toast for Taewoong Lee

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Abstract:

Acoustical isolation in a shared space, e.g., a living room, could be naturally achieved if the users are located in different rooms or use headphones at the cost of limited social interaction between the people. A personal sound system aims to create sound zones that provide such acoustical isolation for different audio contents by using a set of loudspeakers.

Generally, two different types of sound zones are considered: a bright zone and a dark zone. The bright (or listening) zone denotes an area in which the desired audio content is reproduced as faithfully as possible, or the acoustic potential energy is maximized. On the other hand, the dark (silent or quiet) zone indicates the area whose acoustic potential energy is minimized as much as possible. Tackling the problem of creating sound zones is usually done by either maximizing an acoustic contrast, i.e., the acoustic potential energy ratio between the bright and dark zones, or minimizing a reproduction error, i.e., the difference between the reproduced and desired sound fields. As traditional sound zone control methods optimize such physical quantities, the human auditory system, i.e., how we perceive sound, is not directly related to them.

This thesis focuses on proposing a framework that generates sound zones in a perceptually optimized manner. A fundamental foundation based on a subspace method, i.e., a generalized eigenvalue decomposition (GEVD), is proposed to provide such a framework, which controls the trade-off between acoustic contrast and reproduction error by tuning user parameters. On top of it, the human auditory system is integrated into the framework first in a nonadaptive manner later in an adaptive manner. The proposed framework is compared with the well-known sound zone control methods and evaluated via performance metrics, including acoustic contrast and reproduction error; furthermore, formal listening tests are also conducted. Apart from this, we have investigated practical aspects to understand the proposed method better, e.g., the computational complexity and the performance analyses for the tuning parameters. The frequency domain approach is investigated to reduce computational complexity while pertaining similar performance to the time domain approach. Besides, another subspace-based method, i.e., the conjugate gradient (CG), is also proposed to reduce the computational complexity and provide fast convergence compared to the GEVD-based approach. Lastly, we investigated a variety of precise control strategies for the proposed frameworks.