FREQUENCY-BASED CUSTOMIZATION OF MULTIZONE SOUND SYSTEM DESIGN

Nasim Radmanesh, Bhaskar D. Rao

California Institute for Telecommunication and Information Technology, UC San Diego

Email: nradmanesh@ucsd.edu, brao@ucsd.edu

INTRODUCTION

- Control of both the speakers' locations and their weights using Lasso-LS optimization allows multizone sound reproduction with a limited number of speakers [1].
- A time dependent dictionary was suggested in [2] to reduce the complexity of subset selection by applying the optimization only over previously unselected vectors.
- Employment of a novel frequency dependent dictionary in Lasso-LS optimization reduces the computational complexity of loudspeakers' location search [3].
- The frequency contents should be adjusted for customization of multizone sound system design.

MULTIZONE SOUNDFIELD REPRODUCTION

- Generate S isolated sound fields in N zones
- Use a Linear array of L speakers
- Use a pressure matching approach to calculate speaker weights

\[ D_{s,q} = H_q W_{s,q} \]

where \( H_q \) is the Green's function matrix, \( W_{s,q} \) is the vector of speaker weights and \( D_{s,q} \) is the vector of desired matrix, sound pressures at the matching points.

Single Stage LS Weight Estimation

The speaker weights can be determined by:

\[ W_{s,q} = \arg\min_{W_{s,q}} \left[ \frac{1}{2} \| H_q W_{s,q} - D_{s,q} \|^2 + \delta \| W_{s,q} \|_2^2 \right] \]

where \( \| \cdot \|_2 \) is the \( L_2 \)-norm and \( \delta \) is the LS penalty parameter.

Single Stage Lasso Weight Estimation

The speaker weights can be calculated from:

\[ W_{s,q} = \arg\min_{W_{s,q}} \left[ \frac{1}{2} \| H_q W_{s,q} - D_{s,q} \|^2 + \lambda \| W_{s,q} \|_1 \right] \]

where \( \| \cdot \|_1 \) is the \( L_1 \)-norm and \( \lambda \) is the Lasso penalty parameter.

EHN DICTIONARY FOR LASSO SUBSET SELECTION

- An efficient harmonic nested Lasso-LS algorithm was employed for multizone wideband sound field generation.
- The ability of this approach in adjusting the performance of sound system across frequency was investigated.
- Up to 24dB improvement in the MSE was achieved over a single-stage LS optimization for multizone sound reproduction using e.g. 17 speakers.

CONCLUSIONS

SELECTED REFERENCES