

Immersive Audio Rendering: Acoustic Noise Reduction

Hesu Huang and Chris Kyriakakis

Research Goal

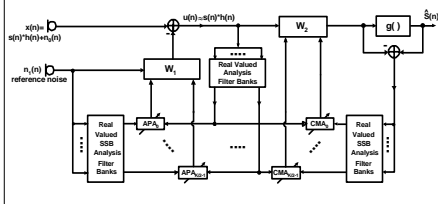
- Single microphone noise reduction for both ambient noise and convolutive noise
 - Additive noise and convolutive noise in the form of reverberation degrade audio signal's quality
- Binaural noise reduction for ambient binaural colored noise
 - Most real-world additive noise is colored

Role in IMSC

- Critical element for high fidelity communication in 2020Classroom and ImmersiNet projects
- Traditional noise reduction methods are not well-suited to multichannel audio

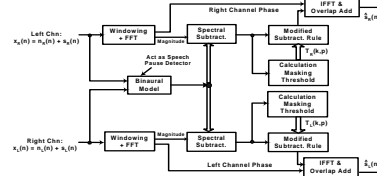
Research Approach

- Affine Projection Algorithm (APA) based causal RDSAF to reduce the additive ambient noise
- Constant Modulus Algorithm (CMA) based non-causal RDSAF to dereverberate the signal



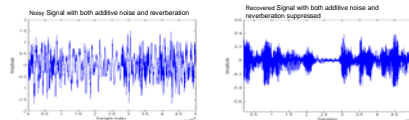
Research Approach

- Binaural colored noise reduction
 - Simplified binaural model to replace the conventional Voice Action Detector (VAD)
 - Perceptually weighted spectral subtraction technique on each channel with band-specific over-subtraction factors and spectral floors



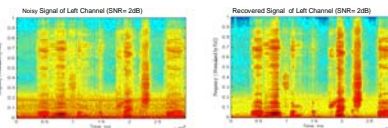
Accomplishments

- Single microphone noise reduction
 - Suppress most ambient noise, achieve dereverberation performance comparable to fullband CMA approaches
- Publications
 - "Subband Adaptive Filtering for Acoustic Noise Reduction", 115th AES Convention, New York, Oct. 2003
 - "Blind Speech Dereverberation Based on Non-Causal Delayless Subband CMA", 117th AES Convention, San Francisco, Nov. 2004 (Submitted)



Accomplishments

- Binaural colored noise reduction
 - Suppress most binaural noise even under low SNR conditions with less musical noise
 - Simple to implement and more efficient
- Publications
 - "Binaural Noise Reduction Combining Binaural Analysis and Psycho-acoustically Motivated Spectral Subtraction", 38th Asilomar Conference on Signals, Systems and Computers, California, Nov. 2004 (Submitted)



Uniqueness & Related Work

- Causal/Non-causal RDSAF structures for single microphone noise reduction
- Simplified binaural model acting as Voice Action Detector to reduce binaural noise
- Band-specific over-subtraction factors and spectral floors for colored noise reduction
 - Widrow, B., Glover, etc., "Adaptive noise cancelling: principles and applications", *Proceedings of IEEE*, vol. 63, 1975
 - Bodden, M., "Modeling Human Sound Source Localization and the Cocktail-Party-Effect." *Acta Acustica 1(1)*, pp.43-55, 1993.
 - Tsoukalas, D., etc., "Speech Enhancement Using Psychoacoustic Criteria", *Proc. IEEE ICASSP*, 1993

5-Year Plan

- The application of blind deconvolution algorithms in audio signal dereverberation for multichannel music (ImmersiNet)
- The integration of speech features such as harmonics in single microphone noise reduction (2020Classroom)
- The utilization of Blind Source Separation techniques in binaural noise reduction