Abstract

- Beamformer’s (BF) spatial filtering performance depends on microphone array (MA) geometry
- Uniform circular array (UCA) introduces + directivity pattern stability around array plane – high sensitivity to reflections from ceiling and floor
- Reduce this kind of sensitivity by using genetic algorithm (GA) for planar array synthesis without loosing directivity pattern stability and without suffering from significant performance degradations
- Alternative method presented

1. Problem Statement & Distant Speech Recognition
Given distant speech recognition system with fixed source localization/tracking, source separation, and automatic speech recognition system, its performance depends on
- microphone array geometry
- beamformer: delay&sum, convex-optimization based

UCA with or without center microphone (CM)
+ directivity pattern stability around array plane
– high sensitivity to reflections from ceiling and floor
Optimize MA to reduce sensitivity to reflections from ceiling and floor without suffering from significant performance degradations and without loosing directivity pattern stability around array plane

2. Multi-Objective Genetic Algorithm
Given GA based on binary coding and
- non-dominated sorting
- crowded tournament selection
- random multi-point crossover and mutation
optimizing set of M randomly initialized MAs considering
- beamformer
- multiple objective measures as fitness measures
  – main-to-side-lobe ratio (MSR)
  – 3dB-beamwidth (3dB-BW)
  – directivity index (DI)
- symmetry constraint: optimize microphone positions within single disc sector and add rotated copies to remaining disc

3. The Evolved Microphone Array
Given delay&sum BF and 25 microphones
- First-ranked 25 microphone individual of last generation
- Improvement in directivity (not optimized / optimized)

4. Optimization Using Convex Optimization-based BF
Given 2-dimensional convex optimization-based BF and UCA.
3-dimensional optimization allows directivity control outside plane of interest, which yields similar optimized directivity as shown above.

5. Conclusion
Improving beamforming by using GA for planar array synthesis or by using BF optimized to 3 dimensions to decrease high sensitivity to reflections from ceiling and floor by at least 3.194 dB without suffering from significant performance degradations.

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