SOUND SOURCE LOCALIZATION IN A REVERBERANT ROOM USING HARMONIC BASED MUSIC

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Summary

- **Goal:** Localize multiple sound source positions in a reverberant real-world environment.
- **Problem:** Acoustic reflections add confusion to source position.
- **Method:** Account for reflections by incorporating a harmonic coupling model of the room transfer function.
- **Results:** Improved robustness and position estimation.
- **Conclusions:** Reflections can be helpful when used carefully.

**MUSIC Subspace Localization Method**

- **Reverberant Room**
  - To a sound receiver, each acoustic reflection looks like a duplicated sound source.
  - It is difficult to know which source is the original when we do not account for reflections.

**Figure 1** Acoustic reflections and their secondary sound sources

- **Noise Subspace**
  - Noise subspace is found from covariance of measured sound.
  - We propose a localization method that models the direct sound and reflected sound components with spherical harmonics.
  - Reflections are modeled and incorporated with harmonic room transfer function coupling coefficients [3].

**Harmonic MUSIC**

- Source position is estimated with a MUSIC algorithm [1, 2].
  - Source appears as peaks in the MUSIC spectra plot.

**Figure 3** Acoustic regions

**Simulation**

- 4 x 6 x 3 m reverberant shoebox room by image source method.
- Source positions:
  1) (0.4m, 60°, 50°)
  2) (0.6m, 120°, 30°)
  3) (0.8m, 120°, 20°)
  4) (1.0m, 60°, 50°)

**Source Localization Without Modeling Reflections**

- Identifies two sound sources.
- Unable to uniquely distinguish nearby sources 2 & 3.
- Cannot radically separate same angular sources 1 & 4.

**Robustness Against Reflection**

- Radial focusing improves with the reflection level.
- Sources are localized in highly reflective environments, H = 0.9

**Proposed Localization Method**

- We propose a localization method that models the direct sound and reflected sound components with spherical harmonics.

**Figure 4** MUSIC spectra of proposed method

- Radial focusing confirms no sources at 0.6 m.
- Can radially separate and identify same angular sources 1 & 4.