Echo-aware signal processing for audio scene analysis

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Introduction

Echo-aware signal processing for audio scene analysis

Image animation here

Scenario

Sound recorded by microphones carries

Semantic information about source nature and content

Temporal information

Spatial information about due to *sound propagation*

Audio Scene Analysis

- extraction and organization of all the information in the sound
- typical *problems*

  - *Sound Source Separation*
  - *Speech Enhancement*
  - *Sound Source Localization*
  - *Room Geometry Estimation*
  - *Acoustic Measurements*
  - *Speaker Diarization*
  - *Automatic Speech Recognition*
  - *etc.*

Signal Processing

Microphone recordings x_i and sound sources s_j are (digital) signals

$$x_i(t) = (h_{ij} * s_j)(t)$$

It is the role of mathematics and computer science

General Pipeline

- Models
- Representation
- Estimation
- Adaptive Processing

Acoustic Echoes

- Product of the sound propagation
- Sound repetition
  - “same” content: can be integrated
  - “different” sounds: carry info about the reflection
  - different direction of arrival: spatial information

Compromise

Between the full simplification and the full model

Thesis objective

1. provide new methodologies and data to process and estimate acoustic echoes
2. extend previous classical methods for audio scene analysis

1D Outline

Echo-aware signal processing for audio scene analysis

2D Outline

Projects

Modeling

Physics $\longrightarrow$ Signal Processing

Sound propagates and Green equation

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Acoustic Reflection

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Room Impulse Response

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Signal Processing $\longrightarrow$ Digital Signal Processing

Signal model in time domain

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Signal model in the discrete time domain

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Signal model in the frequency domain

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Approximations

The Echo Model

Time Domain

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Frequency Domain

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Approximations

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Interim Conclusion I

Approximations
Echoes are off-grid by nature Sampling and quantization make them hard

Acoustic Echo Estimation

Taxonomy and Approaches

Image of taxonomy

Toxonomy

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Existing Approaches

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AER as Discrete SIMO BCE

Limitation and Bottleneck

Proposed Approach

Results

Echo-aware Application