**Toward an editable sound-space system using high resolution sound properties**

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### Abstract

Using signal processing and recording with numerous microphones, a sound field can be decomposed into attributes such as original sound source signals, sound source positions, directivity of sound sources, early reflections, and late reverberation. Sound field editing would be highly versatile after such decomposition. Moreover, the original sound field and a modified sound field can be synthesized by modifying and exchanging these attributes. We are developing signal processing techniques based on a surrounding array of 157 microphones. After introducing this system, this report describes estimation of source positions, original sound source signals, and directivity of sound sources.

### 1 Introduction

**Editable sound-space system**

- **1. Recording sound field**
  - Signal Processing

- **2. Extracting sound field properties**
  - sound positions
  - original sound source
  - directivities of sound sources
  - early reflection
  - reverberation

- **3. Rendering extracted sound properties**
  - not only original sound field [1]
  - but also modified sound field


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### 2 Surrounding microphone array

![Surrounding microphone array diagram](image)

- 157 channel synchronous recording
- reverberation time: 0.15 s

### 3 Estimation of sound source properties

#### 3.1 Directivity model of a sound source

![Directivity model diagram](image)

- Estimating sound source properties from output signals \( x_i(n) \)
- source position \((x, y, z)\)
- source signal \( s(n) \)
- directivity \( h_{Di}(n) \)

- all 157 channel synchronous recording

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### 3.2-3 Estimation of sound source positions and sound source signal

We have developed a estimating source positions method as RAP-MUSIC [2,3] and a dereverberation method as White-LIME [4,5]

1. Estimating impulse responses using sound source
2. Clipping estimates impulse responses at a section of \( t = d/2c \)

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### 3.4 Estimation of directivity of a sound source

![Directivity estimation diagram](image)

- Propagation interval difference between a direct sound wave and the first reflected wave

**Measurements and estimation results of directivity of a sound source**

<table>
<thead>
<tr>
<th>Frequency [kHz]</th>
<th>Measured in anechoic room</th>
<th>Measured in actual room</th>
<th>Proposed method</th>
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