1. Introduction

Most recordings are 2-channel stereo recordings.

Surround sound systems provide an atmosphere beyond the content of the stereo recording.

Extracting spatial information enhances upmixing.

One way is by separating the primary-ambient sources:
- **Primary Sources:** Sources perceived as coming from a certain direction
- **Ambient Sources:** Sources perceived as a surrounding sound coming from all around

Channel upmixing:

A common application is upmixing from $n$ to $m$ channels, where $m > n$.

The primary sources are directed to the front channels to preserve the intended direction of the sound in the recording.

The ambient sources are directed to the all the channels to give a surrounding atmosphere.

2. Applications

**Channel upmixing:**

A common application is upmixing from $n$ to $m$ channels, where $m > n$.

The primary sources are directed to the front channels to preserve the intended direction of the sound in the recording.

The ambient sources are directed to the all the channels to give a surrounding atmosphere.

3. Proposed Solution

**Idea:** Use classification approach for primary-ambient separation.

Classifier decides for each time-frequency point how much the signal is primary/ambient.

**Input:** Feature vector describing the time-frequency point.

**Output:** Probability that this time-frequency point is primary/ambient.

4. Computational System

Network is trained independently on ambient and primary signals.

A dataset of 100 primary sources and 100 ambient sources were collected for the training step.

**Proposed System**

5. Evaluation

Our subjective evaluation is based on a listening test where different methods were played anonymously and users were asked to rate them.

**Participants:** 11

**Task:** order from 1 to 5 (1 is best)

**Playback Systems Evaluation**

<table>
<thead>
<tr>
<th>Mono</th>
<th>Stereo</th>
<th>4CH</th>
<th>Ambient Back</th>
<th>Ambient All</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>3.7</td>
<td>2.6</td>
<td>2.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Separation Systems Evaluation**

<table>
<thead>
<tr>
<th>Neural Network</th>
<th>PCA by Goodwin</th>
<th>Avendano</th>
<th>Panning Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>2.5</td>
<td>2.9</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Our objective evaluation is based on the BSS_Eval toolbox.

The evaluation is performed by mixing one ambient source with one primary source and then applying the five different PAE methods and evaluate the results using BSS_Eval.