Master's Dissertation at the Div. of Engineering Acoustics

SENSOR ARRAY OPTIMIZATION FOR MULTIPLE HARMONIC SOUND SOURCE SEPARATION AND DOA

Elisabet Suárez López

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Supervisors
Delphine Bard, *Assoc. Prof.*
Div. of Engineering Acoustics, Lund

Examiner
Kristian Stålne, *PhD*
Div. of Structural Mechanics, Lund

The work is performed at
Div. of Engineering Acoustics,
Faculty of Engineering,
Lund University

Background
In the last years a lot of researches about source separation have been realized, applications like vocal recognition, motor engine or environmental noise. Most of techniques for sound source estimation use the signal-subspace approach, where the number of emitting sources is determined by the multiplicity of the lowest eigenvalue of the correlation matrix. The problems arise when the number of microphones is smaller or equal to the number of sources radiating, hence the noise subspace could not exist.

Objective
The purpose of this work is to investigate how to realize a Goniometer Antenna to record communications, as well as the implementation of an algorithm to optimize the location of the sensors in order to separate the different sound sources in the at-worst case (number of sources equal number of sensors) and with one extra sound source.

Method
An acoustic goniometer is a system that measures the angle between a source and a receptor using the phase delay, thereby obtaining the source direction. The implementation of each algorithm is based on three parts:

- Time delay estimation used in source localization by computing the azimuth.
- Adaptation of a typical MPE block for sources frequency extraction:
  > *Predominant Pitch Detection: recognizes the frequencies corresponding to each source (detects the picks of the FFT).*
  > *Remove the estimated frequencies from the spectrum.*
- Iterate as many times as number of sources are on.

Then, it is explored the relation between sensor array geometry and eigenvalues to obtain the optimal sound sources separation and detection. Distance between microphones is minimized to accomplish the condition of sources separation. The optimization procedure is done using different SQP Methods: Active Set and Interior Point.

Finally, an optimization approach is presented for a system composed by two sensors and three sound sources. Taking advantage of the procedure followed for the previous case and combined with the circumcenter calculation, the optimal distance for the microphones is found.

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