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IMPROVING BEAMFORMING BY OPTIMIZATION OF ACOUSTIC ARRAY MICROPHONE POSITIONS

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Abstract

Assigning proper positions to microphones within arrays is essential in order to reduce or eliminate side- and grating lobes in 2D beamform images. In this paper an objective function is derived providing a measure for the presence of artificial sources. Using the global optimization method Differential Evolution an optimized microphone configuration is obtained by minimization of this objective function. Results show that optimizing the microphone locations can significantly enhance the array performance. In a large part of the scan region surrounding the true source location, no side- or grating lobes are present, meaning that the source can be unambiguously located. From the optimization it is also found that the optimized array configuration shows the microphones distributed at almost constant distance. A linear relation is found which shows that the distance decreases with increasing frequency. This knowledge is important information for the design of an optimal microphone configuration.

1. INTRODUCTION

When applying beamforming for imaging acoustic sources, the resulting image identifies the source locations as areas with high sound levels. However, often high levels are also found at locations with no sound source present. We can divide these spurious sources in two groups: side lobes and grating lobes. Grating lobes have levels equal to that of the actual source position. They result from complete constructive interference. For line arrays, for example, they are the result of having inter-microphone distances larger than half the wavelength of the signal of interest. Side lobes are considered as all other areas in the image with high levels, resulting from partial constructive interference.

objective function

$$J(\vec{x}_1,\cdots,\vec{x}_N) = \frac{\pi k}{N^2}\Big(Nk\left[\sin^2(\phi_{max}) - \sin^2(\phi_{min})\right] \\ +4\sum_{m=1}^{N-1}\sum_{n=m+1}^{N}\frac{\sin(\phi_{max})J_1[k\sin(\phi_{max})d_{mn}] - \sin(\phi_{min})J_1[k\sin(\phi_{min})d_{mn}]}{d_{mn}}\Big), \quad (53)$$

where we notice the summation boundary changed reducing the amount of calculations for J by half.