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Direction estimation of wideband acoustic sources using joint sparse representation model

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Abstract

Direction of arrival estimation of acoustic wave has been an active research area in signal processing field. Conventional methods in this area usually use the beamforming concept to provide a spatial filter and to estimate the propagation direction of wave. Low resolution, low discriminability of closely spaced sources and high sensitivity to spatial aliasing effect are the main disadvantages of this approach. In order to prevent these drawbacks, this study utilized the joint sparse representation models to estimate the direction of wideband acoustic sources. To this end, an Augmented Lagrangian-based method is proposed in the estimation of sparse coefficient matrix stage. The performance of the joint sparse model is compared with three well-known methods (Bartlett, MUSIC and Capon) in the context of direction of arrival estimation. Simulation results show that the method with sparsity constraint outperforms the three previously mentioned methods in terms of angular resolution, discriminability of closely spaced sources, robustness to spatial aliasing and detection of simultaneous acoustic sources. Furthermore, the robustness of the joint sparse method in terms of noise level was almost similar to that of MUSIC and Capon (optimum beamformer). Comparison of the proposed method and one of the most significant sparse approaches in estimation of sound direction show that, complexity (execution time) is reduced by the presented method in this paper while the good performance in terms of angular resolution, discrimination power and detection rate are also preserved.

Keywords: Direction estimation, Joint sparse representation, Steering vector, Sparse coefficient vector, Overcomplete dictionary.

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