URSI AP-RASC, Sydney, Australia, 17-22 August 2025

Near-field Source Localization Under Intermittent Interference

Jannatul Ferdous and Fauzia Ahmad*
Temple University, Philadelphia, PA 19122, USA; e-mail: fauzia.ahmad@temple.edu

Source localization using sensor arrays is an important problem in a wide range of applications, including radar, sonar, and wireless communications. Such problems can be categorized as far-field and near-field localizations. The former conforms to the assumption that the sources are sufficiently far from the array, thereby implying plane wavefront approximation. In this case, source localization is posed as a direction-of-arrival (DOA) estimation problem. The latter category considers sources to be close to the array, in which case the curvature of spherical wavefronts cannot be ignored. As a result, both DOA and range are required to localize the near-field sources. Traditionally, the 2D MUSIC algorithm can be employed to jointly estimate source ranges and DOAs by performing a 2D grid search [1]. As the received signals are a coupled function of source ranges and DOAs, other methods (e.g. [2]) aim to decouple these parameters to reduce computational complexity but at the expense of additional constraints.

In this work, we consider near-field source localization in the presence of intermittent interference. The 2D MUSIC technique is known to be sensitive to outliers and provides degraded performance when applied to the corrupted snapshots. Owing to the resilience of L1-norm principal component analysis against outliers, we extend the L1-MUSIC algorithm [3] to 2D for near-field source localization. We also propose a 2D L1-MUSIC based method for multi-frequency near-field operation. Extensive simulations demonstrate that 2D L1-MUSIC outperforms 2D MUSIC and sparse recovery methods for both single-frequency and multi-frequency operations under intermittent interference. We note that the proposed algorithm is applicable to uniformly-spaced arrays and both fully and partially augmentable sparse arrays. It also does not impose any symmetry and minimum interelement spacing constraints on the array.

For illustration, we compare the localization performance of the 2D L1-MUSIC, 2D MUSIC, and a two-step sparse recovery technique that exploits the cross-correlations between symmetric sensors under the Fresnel approximation to decouple range and angle estimations [2]. We assume two uncorrelated near-field sources at $(10\lambda, 30°)$ and $(12\lambda, 50°)$, both with a signal-to-noise ratio of 10 dB, and a single interference at $(8\lambda, 5°)$ with an interference-to-noise ratio of 18 dB, all incident on a 9-element sparse array with sensor positions $[-9, -7, -4, -1, 0, 1, 4, 7, 9]\ \lambda/4$. The Fresnel zone for this array corresponds to ranges in $[5.9\lambda, 40\lambda]$. Figure 1 plots the root-mean-square error (RMSE) of the DOA and range estimates for single-frequency operation, averaged over 500 independent trials, as a function of the jammer activity probability. The superiority of the proposed method is clearly visible.

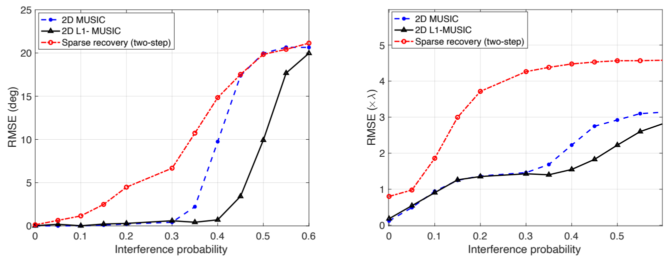

Figure 1. RMSE of DOA (left) and range (right) estimates for two sources and a single interference scenario.

1. Y-D. Huang and M. Barkat, "Near-field multiple source localization by passive sensor array," *IEEE Trans. Antennas Propag.*, **39**, 7, July 1991, pp. 968–974, doi:10.1109/8.86917.

2. K. Hu, S.P. Chepuri and G. Leus, "Near-field source localization using sparse recovery techniques," *Int. Conf. Signal Process. Communications*, 2014, pp. 1-5, doi: 10.1109/SPCOM.2014.6983929.

3. P. Markopoulos et al., "Realified L1-PCA for direction-of-arrival estimation: Theory and algorithms," *EURASIP J. Advances in Signal Process.*, **2019**, Article ID 30, 2019, doi:10.1186/s13634-019-0625-5.