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Three-dimensional localization of near-field and strictly noncircular sources using steering vector decomposition

Key words: Localization; Centro-symmetric cross array; Noncircular sources; Near-field; Steering vector decomposition

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Motivation

1. For array signal processing, near-field (NF) source localization plays an important role and has been widely applied in many fields such as wireless communication, sonar, and radar.

2. In wireless communication, noncircular (NC) signals have been widely applied due to their noncircularity property. The noncircularity property of NC sources is helpful in improving the estimation accuracy by offering more degrees of freedom in direction-finding.

3. Studies of the three-dimensional (3D) localization problem for NF and NC sources with a centro-symmetric cross array (CSCA) have been reported very rarely.

Main idea

1. We consider the 3D localization problem for the NC sources in NF with CSCA and aim to further improve the estimation performance of our previous algorithm.

2. We decompose the multiple parameters of the steering vector in a specific order so that the steering vector can be converted into the products of several matrices, and each of the matrices includes only one parameter.

3. On the basis in 2, each parameter to be resolved can be estimated by performing 1D spatial spectral search; i.e., the proposed algorithm can also avoid the multi-dimensional spatial spectral search.

Major results

1. The root mean square error (RMSE) performance:

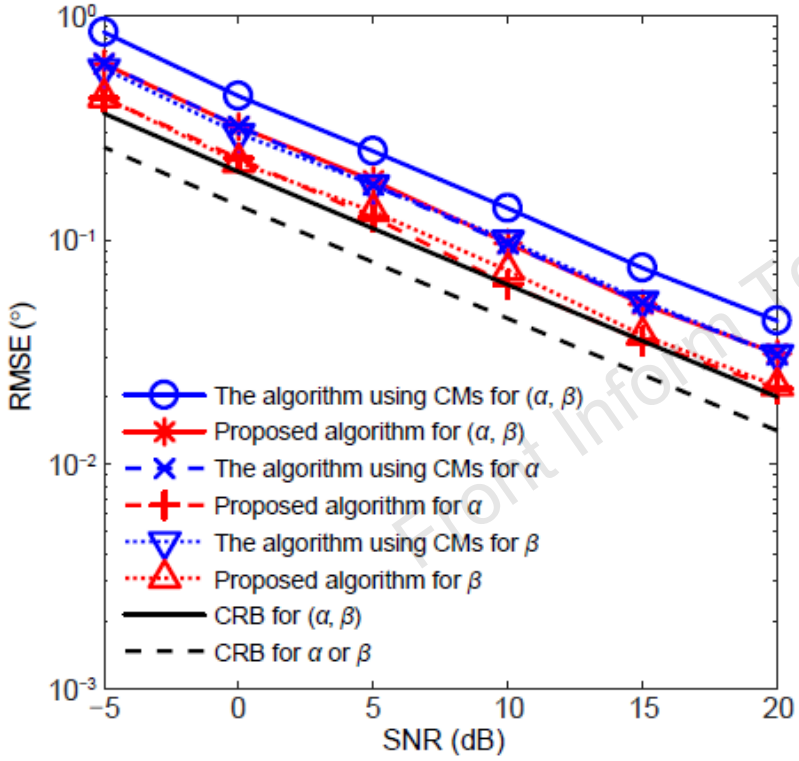

Fig. 7 The RMSE results regarding DOA estimation versus SNR

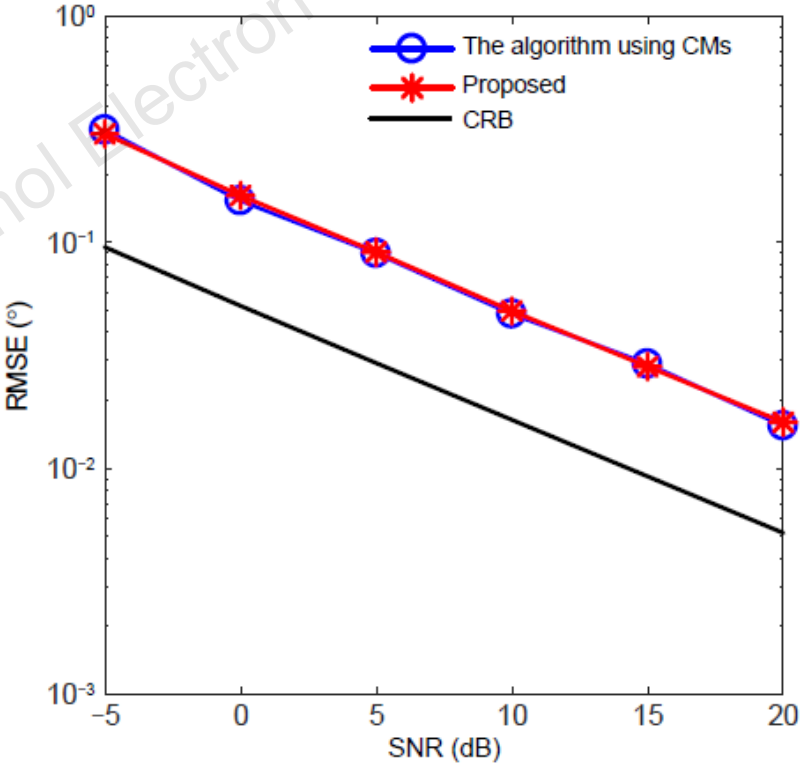

Fig. 8 The RMSE results regarding range estimation versus SNR

Major results

2. The angle resolution:

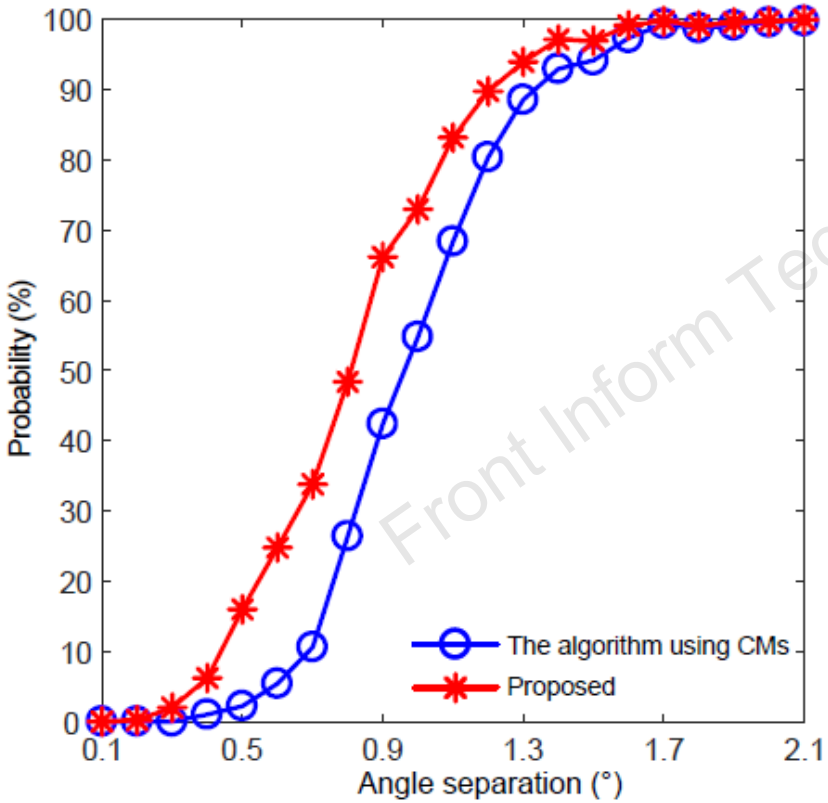

Fig. 11 The DOA resolution versus angle separation

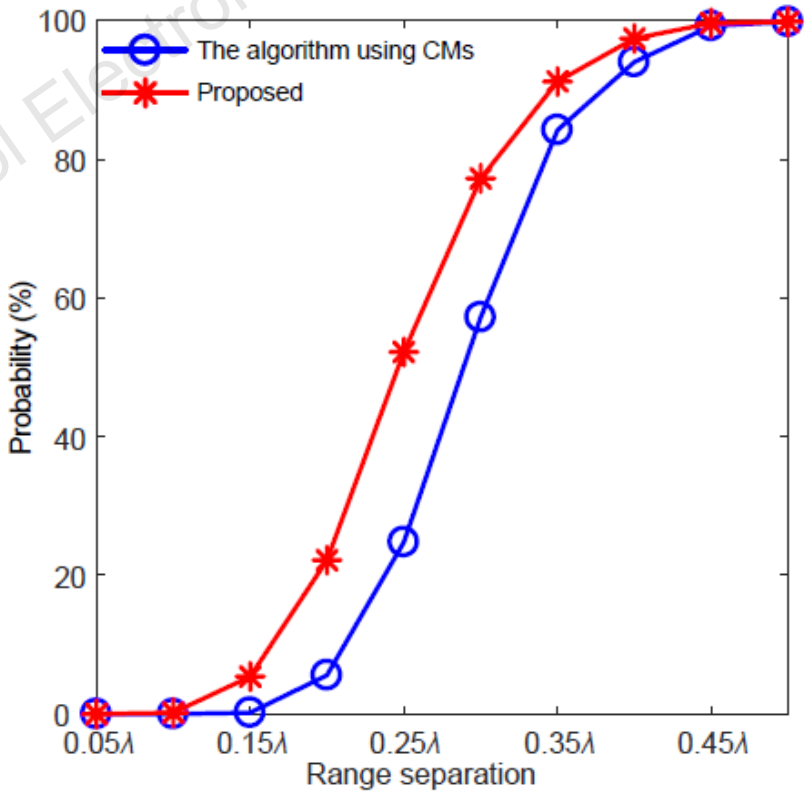

Fig. 12 The DOA resolution versus range separation

Conclusions

1. The proposed algorithm outperforms the algorithm using connection-matrices (CMs) in terms of the angle estimation error, while the range estimation performance of the proposed algorithm can be maintained.

2. The proposed algorithm can also obtain better angle resolution than the algorithm using CMs.

3. The proposed algorithm does not need additional angle-pairing.

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