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Colocated MIMO radar waveform-design based on two-step optimizations in spatial and spectral domains

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Key words: MIMO radar; Waveform design; Spectral factorization; Fractional quadratically constrained quadratic programming

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Motivation

- MIMO radar waveform determines the performance of a radar system.
- Optimized correlated waveform in the spatial domain can focus the transmit energy on the interested region and strengthen the reflected target signal and improve the SINR of the received signal.
- The spectral environment is crowded nowadays. Designing waveform in the spectral domain can avoid the spectral interference bandwidth.
- The second optimization in the spectral domain has no influence on the shape of the transmit beam pattern formed by the correlated waveform via spatial optimization.

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Main idea

- In the spatial domain, the minimum ISL strategy is adopted to form the optimization model, which can suppress the side-lobe level and flexibly form a spatial nulling.
- For spectral interference, a phase-changing diagonal matrix is introduced and optimized to avoid the interference bandwidth with no influence on the shape of the formed transmit beam pattern in the spatial domain.

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Method

1. Charnes-Copper transformation is introduced to reformulate the resulting non-convex fractional programming problem into a general quadratically constrained quadratic programming problem. The hidden convexity of the resulting optimization problem is recovered via a semidefinite relaxation followed by a spectral factorization theorem.
2. Spectral optimization can be achieved via iterative optimization by means of power method-like iterations.

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Major results

Our method can form a good transmit beam pattern in the spatial domain with flat main-lobe and low side-lobe.

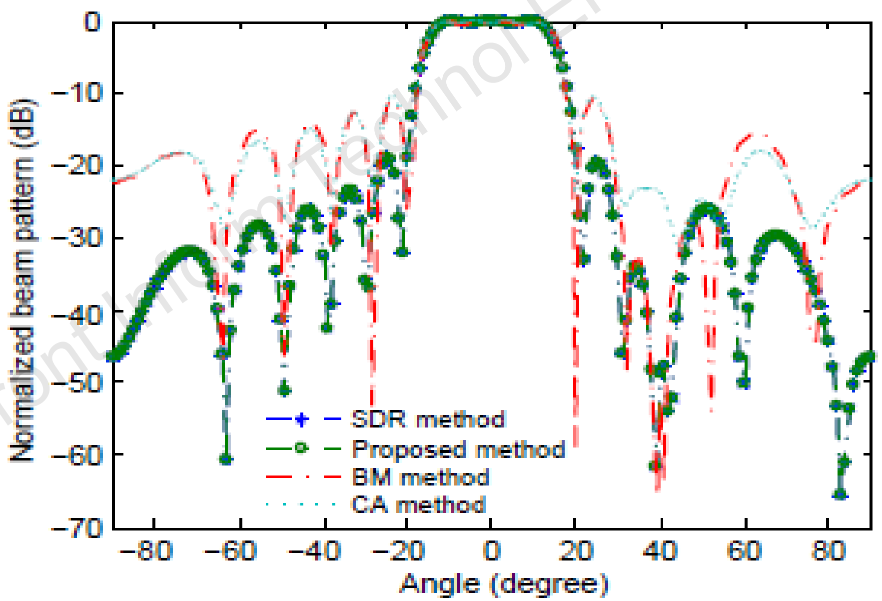

Fig. 5 Beam pattern comparisons between the proposed method and the BM and CA methods

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Major results

The optimized waveform can flexibly avoid different spectral interferences via the proposed method.

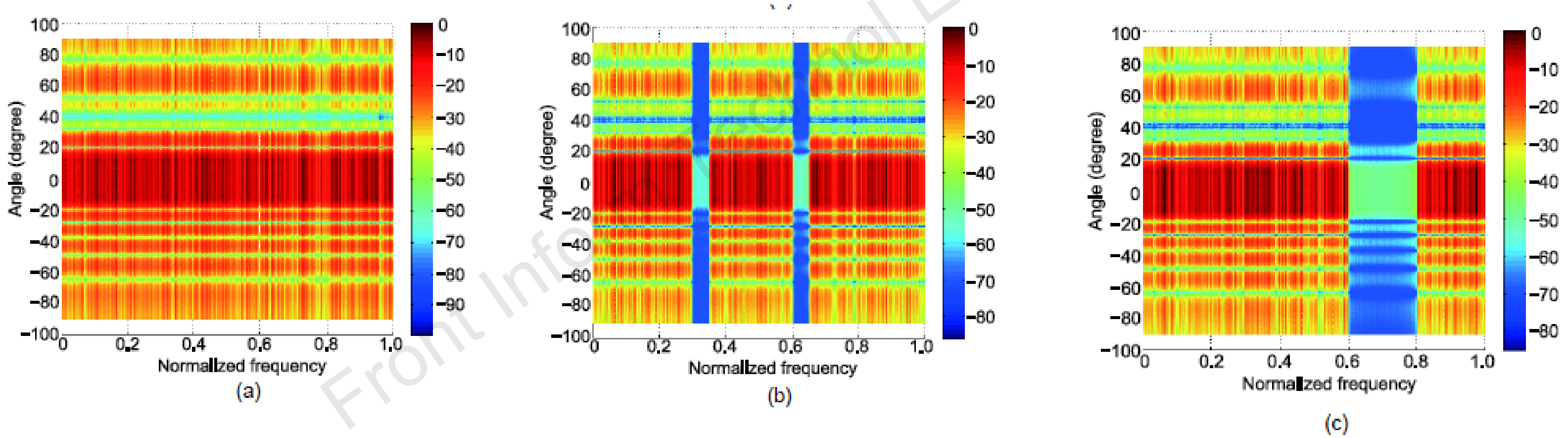

Fig. 2 Two-dimensional transmit beam pattern formed by optimized waveforms via only spatial optimization (a), two-step optimization with the overlaid bands [0.3, 0.35] and [0.6, 0.65] (b), and two-step optimization with the overlaid band [0.6, 0.8] (c)

Conclusions

- An efficient waveform design method has been considered for colocated MIMO radar. The transmit waveforms are optimized in the spatial domain and spectral domain via two steps.
- The resulting non-convex optimization problem in the spatial domain has been addressed via hidden convexity.
- Further spectral optimization is performed by means of power method-like iterations to mitigate the spectral interferences and improve the spectral compatibility with other overlaid licensed radiators.

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