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

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.

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.

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.

Major results

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

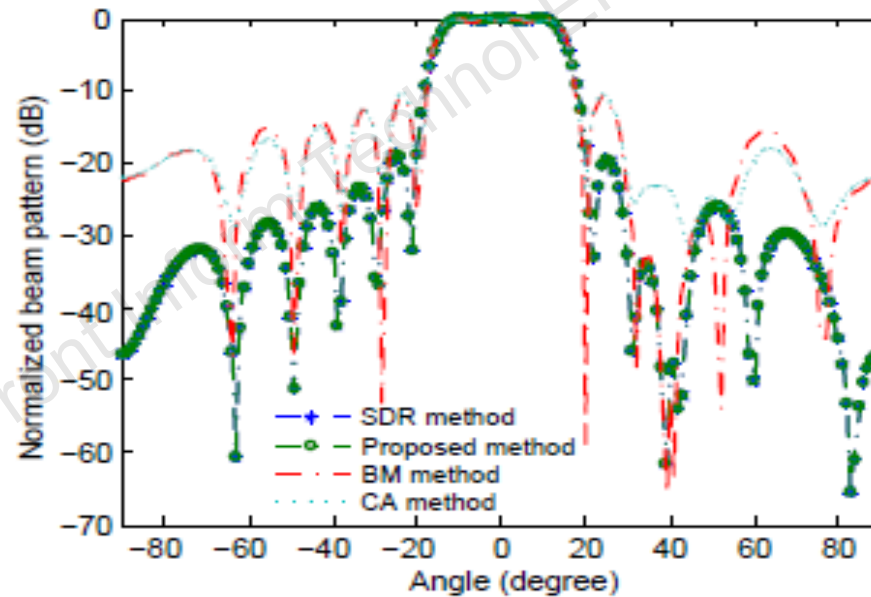


Fig. 5 Beam pattern comparisons between the proposed method and the BM and CA methods

Major results

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

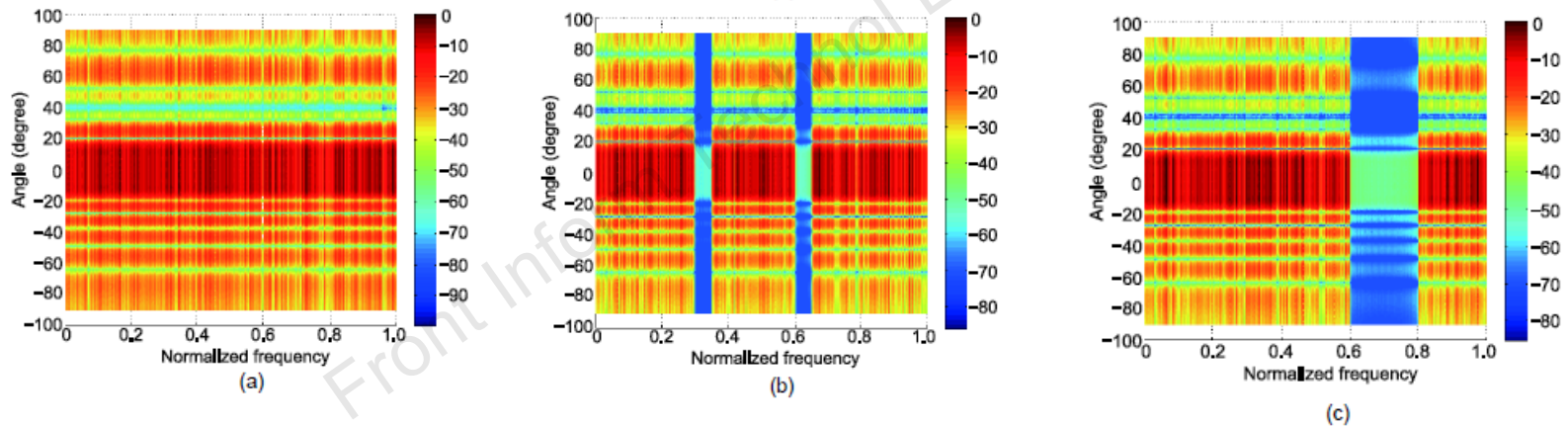


Fig. 2 Two-dimensional transmit beam pattern formed by optimized waveforms via only spatial optimization (a), two-step optimization with the overlaid bands [0.3, 0.35] and [0.6, 0.65] (b), and two-step optimization with the overlaid band [0.6, 0.8] (c)

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.