A FAST BROADBAND BEAMSPACE TRANSFORMATION

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Abstract: We present a new fast algorithm for a classic computational imaging problem from array processing: transformation into beamspace. The algorithm takes an ensemble of signals from a sensor array and transforms them into an ensemble of signals indexed by angle; each output signal is a "beam" focused in a different direction. In the narrowband regime, where the bandwidth of the incoming signals is small compared to the aperture of the array, this transform is simply a spatial FFT taken sample-by-sample. In the broadband regime, spatio-temporal processing is necessary; state-of-the-art algorithms have a computational complexity O(MB)/sample, where M is the number of sensors and B is the number of beams. We show how combining two techniques from numerical analysis, pseudo-polar FFTs and superfast Toeplitz inversion, yields an algorithm of computational complexity O(M log M + B log M)/sample. To close, we will discuss how machine learning might play a role in this and other imaging problems in array processing.