Near-field Compensation Techniques for Coherent Processing using Distributed Receivers

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The desire for high spatial resolution achieved through passive microwave systems is a driving force behind an increased interest in using distributed receivers for aperture synthesis in interferometric or array processing due to the ability to increase the element spacing without adding too much to the size, weight, and power of the system. As the physical spacing between receivers becomes very large, the electrical size of the array grows and the far-field distance for that array increases proportional to the square of its electrical size. Emitters of interest are therefore more likely to be in the near-field of the array. Conventional synthetic aperture interferometric processing relies on the planar wave-front approximation for applying a 2D Fourier transform on the measured spatial covariance to create an image of the intensity distribution of the scene. Similarly, array processing techniques, such as MuSiC, exploit a spatial covariance matrix, utilizing the knowledge of the received differential phases if the wave-front from the signal-of-interest were approximately planar to estimate the Angle-of-Arrival. If an emitter is in the near-field of the array the wave-front will be spherical and these conventional methods will be prone to error.

This work investigates near-field compensation techniques and the limitations of those techniques. A near-field MuSiC algorithm has been applied to data received by four distributed receivers within an anechoic chamber. Results demonstrate the ability to locate a source within the near-field of an array. Compensation techniques for near-field imaging for synthetic aperture interferometry are discussed and demonstrated through MATLAB simulations. The impact of errors in position knowledge of the receivers on the performance of the compenstation technique used is studied through Monte Carlo simulations.