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Adaptive Beamforming with Steering Error and Mutual Coupling between Antenna Sensors

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Abstract : Owing to close antenna spacing between antenna sensors within a compact space, a part of data in one antenna sensor would outflow to other antenna sensors when the antenna sensors in an antenna array operate simultaneously. This phenomenon is called mutual coupling effect (MCE). It has been shown that the performance of antenna array systems can be degraded when the antenna sensors are in close proximity. Especially, in a systems equipped with massive antenna sensors, the degradation of beamforming performance due to the MCE is significantly inevitable. Moreover, it has been shown that even a small angle error between the true direction angle of the desired signal and the steering angle deteriorates the effectiveness of an array beamforming system. However, the true direction vector of the desired signal may not be exactly known in some applications, e.g., the application in land mobile-cellular wireless systems. Therefore, it is worth developing robust techniques to deal with the problem due to the MCE and steering angle error for array beamforming systems. In this paper, we present an efficient technique for performing adaptive beamforming with robust capabilities against the MCE and the steering angle error. Only the data vector received by an antenna array is required by the proposed technique. By using the received array data vector, a correlation matrix is constructed to replace the original correlation matrix associated with the received array data vector. Then, the mutual coupling matrix due to the MCE on the antenna array is estimated through a recursive algorithm. An appropriate estimate of the direction angle of the desired signal can also be obtained during the recursive process. Based on the estimated mutual coupling matrix, the estimated direction angle, and the reconstructed correlation matrix, the proposed technique can effectively cure the performance degradation due to steering angle error and MCE. The novelty of the proposed technique is that the implementation procedure is very simple and the resulting adaptive beamforming performance is satisfactory. Simulation results show that the proposed technique provides much better beamforming performance without requiring complicated complexity as compared with the existing robust techniques.

Keywords : adaptive beamforming, mutual coupling effect, recursive algorithm, steering angle error
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