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Design of Nonlinear Mutual Coupling Operator for Antenna Arrays Using a Novel ACGF-Deep-Learning Technology

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1 Extended Abstract

Electromagnetic mutual coupling is a fundamental problem in antenna array systems that cannot be ignored in many important situations, especially when the inter-element spacing becomes less than half wavelength. There has been numerous approaches to the topic of mutual coupling compensation in literature, with many and diverse theoretical analyses to justify the specific used approach. It was recently proposed that the use of the Antenna Current Green's Function (ACGF) formalism [1] can provide a very general apparatus for mutual coupling without recourse to extensive full-wave analysis. Recently, a direct mutual coupling compensation (MCC) method was devised by the authors to integrate a general strategy capable of decoupling Rx antennas by harnessing the ACGF method to provide for EM data deployed in searching for a best MCC matrix [2]. In the current paper we introduce a nonlinear MCC operator at the receiving mode and use machine learning to find a best such operator. A basic Direction-of-Arrival (DoA) system based on wire antennas is considered to verify the basic method. We develop a deep learning technology powered by multilayer nonlinear neural networks to approximate the nonlinear MCC operator. Using the ACGF of the antennas to supply the machine learning algorithm with the proper data set, the nonlinear MCC operators are found to be consistently superior to the linear MCC obtained using the same machine learning procedure. We conclude after several examples that nonlinear MCC is in principle superior to traditional linear MCC methods.

References

[1] Said M. Mikki and Yahia M. M. Antar, *New Foundations for Applied Electromagnetics*, Artech House, 2016.

[2] Abdelelah M. Alzahed, Said M. Mikki and Yahia M. Antar, "An Innovative Method of Mutual Coupling Compensation For DOA Estimation," *in IEEE Conference on Antenna Technology and Applied Electromagnetics (ANTEM)*, Montreal, 2016.

[3] *WIPL-D 3D* Electromagnetic solver Version 10.