Efficient Design of Large Finite Array Antenna and its Feeding Network

Ahmed A. Kishk

Professor at Concordia University, Montréal, Québec, Canada

Tier 1 Canada Research Chair in Advanced Antenna Systems

An efficient procedure is proposed to predict large finite planar array performance from the measured or computed small planar array of a similar lattice. The analyses are based on ports measurements of the mutual admittance matrix. The mutual admittance depends on the element type, frequency of operation, polarization, and arrangement lattice. From the small array mutual admittance matrix, the larger array mutual admittance matrix is constructed. Such admittance ignores the mutual coupling between the elements beyond the small array domain. Once the admittance matrix has been constructed for the large array, the array elements active (effective) input impedance under different scenarios can be predicted easily. Also, from the effective voltage terminal of the elements, an array factor, including the mutual coupling, can be computed to predict the array gain and radiation patterns. The proposed method's efficiency comes from dealing with matrices of order equal to the array number of elements. With the corresponding admittance matrix, one can study the array's performance under several scenarios. The effective impedance of the elements can be used to design a feeding network based on the elements' effective input impedance that considers the mutual coupling. Also, it is possible to perform feeding network optimization.

Here, to illustrate the procedure, an example of an air microstrip patch antenna excited by a hook-shaped probe is considered as an array element. The results obtained using the present method are verified by the full-wave numerical analysis of the sizeable finite array.

Also, the gap waveguide technology concept is presented through an example of the feeding network design at millimeter-wave frequencies for an array of magneto-electric dipoles. A procedure is presented to reduce the number of optimization parameters for the sizeable parallel feeding network.

Biography of Prof. Ahmed A. Kishk

Ahmed A. Kishk is a Professor at Concordia University, Montréal, Québec, Canada (since 2011), as **Tier 1 Canada Research Chair in Advanced Antenna Systems**. He was an Associate Editor of *Antennas & Propagation Society Newsletters* from 1990 to 1993, a distinguished lecturer for the Antennas and Propagation Society (2013-2015), an Editor of *Antennas & Propagation Magazine* (1993-2014), an editor of the *ACES Journal* during 1997, an Editor-in-Chief of the *ACES Journal* from 1998 to 2001, the chair of the Physics and Engineering Division of the *Mississippi Academy of Science* (2001-2002), a Guest Editor of the special issue on artificial magnetic conductors, soft/hard surfaces, and other complex surfaces, in the *IEEE Transactions on Antennas and Propagation*, January 2005, and a co-guest Editor in IEEE Antennas and Propagation and Wireless Letter on the special cluster on "5G/6G enabling antenna systems and associated testing technologies." Dr. Kishk was a the general chair of the 2020 IEEE AP-S Symposium on Antennas and Propagation and CNC/USNC-URSI joint meeting and a technical program committee member for several international conferences. He was a member of the AP-S AdCom (2013-2015) and the 2017 AP-S president.

Prof. Kishk research interest includes the areas of millimeter-wave antennas for 5G/6G applications, Analog beamforming network, Dielectric resonator antennas, microstrip antennas, small antennas, microwave sensors, RFID antennas for readers and tags, Multi-function antennas, microwave circuits, EBG, artificial magnetic conductors, soft and hard surfaces, phased array antennas, reflect/transmitarray, wearable antennas, and Feeds for Parabolic reflectors. He has published over 385-refereed journal articles and 510 conference papers. He is a co-author of four books and several book chapters and the editor of four books. He offered several short courses in international conferences.

Prof. Kishk and his students received several awards. He won the 1995 and 2006 outstanding paper awards for papers published in the *Applied Computational Electromagnetic Society Journal*. He received the 1997 Outstanding Engineering Educator Award from the IEEE Memphis section. He received the Outstanding Engineering Faculty Member of the Year in 1998 and 2009, Faculty research award for outstanding research performance in 2001 and 2005. He received the Award of Distinguished Technical Communication for IEEE Antennas and Propagation Magazine's entry, 2001. He also received The Valued Contribution Award for outstanding Invited Presentation, "EM Modeling of Surfaces with STOP or GO Characteristics – Artificial Magnetic Conductors and Soft and Hard Surfaces" from the Applied Computational Electromagnetic Society. He received the Microwave Theory and Techniques Society, Microwave **Prize** 2004. He received the *2013 Chen-To Tai Distinguished Educator Award* of the IEEE Antennas and Propagation Society. In recognition, "*For contributions and continuous improvements to teaching and research to prepare students for future careers in antennas and microwave circuits*, Kishk is a ***Fellow*** of *IEEE* since 1998, Fellow of *Electromagnetic Academy*, and a Fellow of the *Applied Computational Electromagnetics Society* (*ACES*). He is a member of the Antennas and Propagation Society, Microwave Theory and Techniques, Sigma Xi Society, Senior member of International Union of Radio Science, Commission B, Phi Kappa Phi, Electromagnetic Compatibility, and Applied Computational Electromagnetics Society.