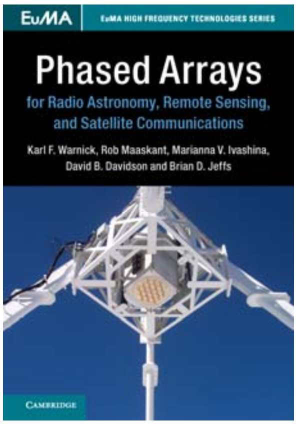
The 15th European Conference on Antennas and Propagation (EuCAP)
22 – 26 March 2021 | Virtual Conference

SC04: Array Signal Processing and Network Theory for Multi-antenna Receiver System Design

Abstract:

The short course will develop a modern approach for antenna array modelling at the system level that combines numerical simulation methods for the antenna array, network analysis for amplifiers and electronics, and array signal processing theory for array calibration and beamforming. Concepts from array signal processing theory, including array gain or SNR gain, the array signal covariance matrix, and the maximum-SNR beamforming algorithm will be covered. Theoretical connections between the array covariance matrix, the isotropic noise response of the array, and the mutual impedance matrix will be explained. Attendees will receive working sample modelling codes that implement the techniques covered. Attendees may optionally bring a laptop with MATLAB installed in order to execute examples during the course, to allow for hands-on learning, discussion, and practical implementation of key tools for modern array simulation and design optimization.



Recommended prerequisites for attendees:

The course builds on basic knowledge of antennas and assumes familiarity with circuit theory and matrix analysis.

Learning objectives:

Understand the role of the correlation matrix in array antenna modelling and signal processing.
Develop a model for the signal and noise response of a simple array antenna.
Apply the lossless, resonant, minimum scattering approximation (LRMSA) for fast array analysis.
Use the signal and noise response to understand the sensitivity and efficiency behaviour of the array as a function of beam steering angle.

Course outline:

The course consists of about 130 slides which will be used as a basis for a group discussion. Questions and comments are welcome during the course. Sample array receiver modelling codes will be provided. Participants may bring a personal laptop to run sample codes that will be provided by the instructor as part of the course.

Instructor

Karl F. Warnick received the B.S. degree in Electrical Engineering and Mathematics and the Ph.D. degree in Electrical Engineering from Brigham Young University (BYU), Provo, UT, in 1994 and 1997, respectively. From 1998 to 2000, he was a Postdoctoral Research Associate and Visiting Assistant Professor in the Center for Computational Electromagnetics at the University of Illinois at Urbana-Champaign. Since 2000, he has been a faculty member in the Department of Electrical and Computer Engineering at BYU, where he is currently a Professor. He is a Fellow of the IEEE and a recipient of a National Science Foundation Graduate Research Fellowship, Outstanding Faculty Member Award for Electrical and Computer Engineering, the BYU Young Scholar Award, the Ira A. Fulton College of Engineering and Technology Excellence in Scholarship Award, and the BYU Karl G. Maeser Research and Creative Arts Award. Dr. Warnick has published many books, scientific articles and conference papers on electromagnetic theory, numerical methods, antenna applications, and high sensitivity phased arrays for satellite communications and radio astronomy.

Key bibliography

1. K. F. Warnick, R. Maaskant, M. V. Ivashina, D. B. Davidson, and B. D. Jeffs, Phased Arrays for Radio Astronomy, Remote Sensing, and Satellite Communications, Cambridge, UK: Cambridge University Press, 454 pages, 2018.