

Adaptive Processing using a Utilizing a Single Snapshot of Data

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Tutorial Description:

The objective of the course is to present an accurate and efficient technique for the evaluation of the adaptive weights in phased array antennas. This approach is unlike the conventional statistical techniques by eliminating the requirement of an interference covariance matrix and represents a rethinking of the entire conventional approach to adaptive processing. Thus, it provides greater flexibility in solving a wider class of highly transient problems at the expense of a slightly reduced number of degrees of freedom. It will be shown how to apply this method for the estimation of the signal in the presence of jammers, clutter and thermal noise utilizing a nonuniform nonplanar array of antennas. The goal is also to couple the electromagnetics and the signal processing aspects of the problem so that mutual coupling between the sensors and near-field scattering can be taken into consideration.

Radars were originally designed as detectors of targets. The goal was to transmit a signal with the maximum available power and then observe whether the received signal contained a portion of the transmitted signal. A matched filter was then designed using the transmitted waveform to detect the received signal and based on some statistical hypothesis testing a decision was made on whether a target is present or absent. However, when multiple targets are to be examined or one wants to search for a low observable near a large target, the conventional detection based radar processing is not adequate. A need for finding small targets in the presence of clutter and jammer evolved into an estimation theory problem rather than detection. It is illustrated that use of a phased array in a SIMO mode can perform quite well as one does not have to worry about the inhomogeneity of the clutter associated with multiple transmissions in a MIMO system as the processing becomes quite complicated. Also, the compensation of mutual coupling becomes difficult in a practical deployment on a moving platform. It is important to note that one can still exploit the advantages of super-resolution processing using estimation theory keeping the advantages of a single high power transmitting antenna in a phased array deployment. This presentation will illustrate such a methodology and compare it with the recent

MIMO developments. Examples will be presented related to a single snapshot based least squares methodology that can cancel interferer in the main beam using a phased array radar but performing a deterministic processing using the same number of degrees of freedom as a multisnapshot case for coherent processing.

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Tapan K. Sarkar received the B.Tech. degree from the Indian Institute of Technology, Kharagpur, in 1969, the M.Sc.E. degree from the University of New Brunswick, Fredericton, NB, Canada, in 1971, and the M.S. and Ph.D. degrees from Syracuse University, Syracuse, NY, in 1975.

From 1975 to 1976, he was with the TACO Division of the General Instruments Corporation. He was with the Rochester Institute of Technology, Rochester, NY, from 1976 to 1985. He was a Research Fellow at the Gordon McKay Laboratory, Harvard University, Cambridge, MA, from 1977 to 1978. He is now a Professor in the Department of Electrical and Computer Engineering, Syracuse University. His current research interests deal with numerical solutions of operator equations arising in electromagnetics and signal processing with application to system design. He obtained one of the "best solution" awards in May 1977 at the Rome Air Development Center (RADC) Spectral Estimation Workshop. He received the Best Paper Award of the IEEE Transactions on Electromagnetic Compatibility in 1979 and in the 1997 National Radar Conference.

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Dr. Sarkar is a Registered Professional Engineer in the State of New York. He received the College of Engineering Research Award in 1996 and the Chancellor's Citation for Excellence in Research in 1998 at Syracuse University. He was an Associate Editor for feature articles of the IEEE Antennas and Propagation Society Newsletter (1986-1988), Associate Editor for the IEEE Transactions on Electromagnetic Compatibility (1986-1989), Chairman of the Inter-commission Working Group of International URSI on Time Domain Metrology (1990-1996), distinguished lecturer for the Antennas and Propagation Society from (2000-2003), Member of Antennas and Propagation Society ADCOM (2004-2007), on the board of directors of ACES (2000-2006), vice president of the Applied Computational Electromagnetics Society (ACES), and a member of the IEEE Electromagnetics Award board (2004-2007). He is currently an associate editor for the IEEE Transactions on Antennas and Propagation. He is also on the editorial board of Digital Signal Processing – A Review Journal, Journal of Electromagnetic Waves and Applications and Microwave and Optical Technology Letters. He is the chair of the International Conference Technical Committee of IEEE Microwave Theory and Techniques Society # 1 on Field Theory and Guided Waves. He is a member of Sigma Xi and International Union of Radio Science Commissions A and B.

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