Seminar on

The Physics and the Mathematics for MIMO
by
Prof Tapan K Sarkar
Department of Electrical Engineering and Computer Science
Syracuse University, Syracuse, New York 13244-1240, USA

Date : 03 April 2017 (Monday)
Time : 10:00 am – 11:00 am
Venue : Room 15-202, meeting room of State Key Laboratory of Millimeter Waves, 15/F, Lau Ming Wai Academic Building, City University of Hong Kong

Abstract
The objective of this presentation is to illustrate that the principle of superposition of power is not always valid in electrical engineering and hence not applicable to analysis of multi antenna systems where multi-streams are affected by mutual interference. In electrical engineering, it is the voltage and the current that always can be superposed and that is why another name of it is field theory, as the voltages and the currents are the results of the fields. Examples are presented to illustrate how the Maxwellian physics can be introduced to improve the system performance of multi antenna systems. This group also includes MIMO systems. The first objective of this presentation is to define the appropriate metric for comparison of performance between various multiantenna systems. In addition, when comparing the performance between systems, the input power needs to be the same for all the systems, as it is not clear how one excites an antenna in theory using a priori power, as antennas are excited with voltage sources just like in circuit theory. It becomes clear that the use of the Hartley definition of channel capacity is more appropriate to use for a multiantenna system rather than the Shannon Channel capacity which uses the superposition of power as Shannon did not develop the theory for wireless systems where the presence of self-interference is the limiting factor in the performance of a system rather than background thermal noise. From a physics perspective, it is illustrated that a 1×1 SISO system may perform better than a 2×2 MIMO system under specific circumstances. However, as the concept of channel capacity is developed on purely mathematical grounds based on entropy, it is difficult to relate the physics to the mathematics as the capacity is defined with respect to background thermal noise whereas no receiver can accept a signal weaker than 100 μV/m in the absence of interference, which is far above the background noise. One of the goals is also to illustrate that an N×N MIMO system does not necessarily have better performance than N separate SISO systems, using the same total input power.

Biography
Tapan K. Sarkar is a professor of Electrical engineering at Syracuse University. 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 has authored or coauthored more than 360 journal articles and numerous conference papers and 32 chapters in books and fifteen books, including his most recent ones, Iterative and Self Adaptive Finite-Elements in Electromagnetic Modeling (Boston, MA: Artech House, 1998), Wavelet Applications in Electromagnetics and Signal Processing (Boston, MA: Artech House, 2002), Smart Antennas (IEEE Press and John Wiley & Sons, 2003), History of Wireless (IEEE Press and John Wiley & Sons, 2005), and Physics of Multiantenna Systems and Broadband Adaptive Processing (John Wiley & Sons, 2007), Parallel Solution of Integral Equation-Based EM Problems in the Frequency Domain (IEEE Press and John Wiley & Sons, 2009), Time and Frequency Domain Solutions of EM Problems Using Integral Equations and a Hybrid Methodology (IEEE Press and John Wiley & Sons, 2010), and Higher Order Basis Based Integral equation Solver (HOBBIES) (John Wiley & Sons 2012) .

Dr. Sarkar is a Registered Professional Engineer in the State of New York. He was the 2014 President of the IEEE Antennas and Propagation Society. He received Docteur Honoris Causa from Universite Blaise Pascal, Clermont Ferrand, France in 1998, from Politechnic University of Madrid, Madrid, Spain in 2004, and from Aalto University, Helsinki, Finland in 2012. He received the medal of the friend of the city of Clermont Ferrand, France, in 2000.

***** ALL ARE WELCOME *****

Enquiries:
Dr. Hang Wong, Department of Electronic Engineering
Tel.: (852) 3442 5935 Fax: (852) 3442 0562 Email: hang.wong@cityu.edu.hk