Research Topic for the ParisTech/CSC PhD Program

Subfield: Information and Communication Sciences and Technologies

ParisTech School: Telecom ParisTech

Title: Quantification of antenna uncertainties in uncontrolled environments and impact on (5G and beyond) wireless networks

Advisor(s): Joe Wiart (joe.wiart@telecom-paristech.fr) and Christophe Roblin (christophe.roblin@telecom-paristech.fr).
https://www.telecom-paristech.fr/eng; http://chairec2m.mines-telecom.fr

Short description of possible research topics for a PhD:

The future 5G and beyond networks will use dense architectures and single/multiple antennas for MIMO and massive MIMO systems. Wireless devices will be operating in uncontrolled conditions because of the variability and the lack of knowledge of the characteristics of their close electromagnetic environment. This brings new issues for the management of the uncertainties of the antenna properties and their impact on network performance. Traditionally indeed, antennas are considered as deterministic objects, operating in fixed environments and with sufficiently known characteristics. The high degree of variability of the radio channel is usually only involved in the propagation channel. Such a conventional approach does not allow quantifying and mastering the impact of antenna uncertainties on the network key performance indicators (KPIs).
The objective of this thesis is thus to develop innovative statistical models of environed antennas, able to much better describe the true performance of single or multiple antennas. Spherical Modes Expansion and surrogate modeling (e.g. Chaos Polynomials Expansion or Low Rank Tensor Approximation) will in particular be used to build parsimonious and compact surrogate models. These environed antenna models will then be used in network deterministic design tools as well as in statistical radio channel models, to quantify the impact of such a variability on the KPIs.
The work will take advantage of existing scientific collaborations between the C2M research Chair at Telecom ParisTech and two major High Tech companies: Micro Wave Vision (MVG) on near field measurement and SIRADEL on propagation and network planning tools.

Required background of the student: The student must have a good background in Electromagnetism, radio propagation, antennas, and adequate knowledge in telecommunications and statistical methods

List of 5 representative publications of the group:
- Y. Y. Huang & J. Wiart, *Simplified Assessment Method for Population RF Exposure Induced by a 4G Network*, IEEE JREM, Sept 2017.
- Jinxin Du and C. Roblin, *Stochastic Surrogate Models of Deformable Antennas based on Vector Spherical Harmonics and Polynomial Chaos Expansions: Application to Textile Antennas*, IEEE Transactions on Antennas and Propagation, vol. 66, n° 7, July 2018, pp. 3610-3622.
- P. Kersaudy, B Sudret, N. Varsier, O Picon, J Wiart, *A new surrogate modeling technique combining Kriging and polynomial chaos expansions. Application to uncertainty analysis in computational dosimetry*, Journal of Computational Physics, 2015.
- RK Arya, P Kersaudy, J Wiart, R Mittra, *Statistical Analysis of Periodic Structures and Frequency Selective Surfaces using the Polynomial Chaos Expansions*, e-fermat. 2015.
- A. Sibille, C. Roblin, S. Bories and A.-C. Lepage, *A Channel-Based Statistical Approach to Antenna Performance in UWB Communications*, IEEE Transactions on Antennas and Propagation, vol. 54, n° 11, pp. 3207-3215, Nov. 2006.