Modeling and Simulation Strategies in Electromagnetics: *Teaching via Virtual Tools*

Activity

IEEE AP-S International Symposium & USNC/URSI National Radio Science AMEREM Meeting, July 9-14, 2006, Albuquerque, New Mexico, USA

Abstract

This short course provides a tutorial introduction into modeling and simulation strategies pertaining to complex electromagnetic problems and supply several user-friendly Matlab-based virtual tools [1-8] which are believed to be very effective in teaching lectures such as EM Wave Theory, Transmission Lines, Antennas, Radiowave Propagation, etc. Modeling and simulation concepts, strategies and challenges in electromagnetic engineering will be discussed. Topics to be covered include fundamental concepts such as accuracy, precision, resolution, physical problems and modeling, discrete environment, analytical models, numerical models, deterministic and stochastic modeling, simulation, validation, and verification, etc. Canonical tests and examples will be included to illustrate range of validity, parameter optimization, and time and frequency domain comparisons. The 2D groundwave virtual propagators can handle user-specified terrain irregularities as well as atmospheric refractivity. The antenna array of isotropic radiators virtual tool can be used to visualize radiation patterns as well as beam forming and beam steering capabilities. The virtual TD Reflectometer tool can be used to investigate termination and fault effects along Transmission Lines.

The short course will provide for the participants short course notes and the user-friendly virtual tools.

References

1 L. Sevgi, Ç. Uluışık, "A Matlab-based Visualization Package for Planar Arrays of Isotropic Radiators", I**EEE Antennas and Propagation Magazine**, Vol. 47, No. 1, pp. 156-163, Feb 2005

2 L. B. Felsen, F. Akleman, L. Sevgi, "Wave Propagation Inside a Two-dimensional Perfectly Conducting Parallel Plate Waveguide: Hybrid Ray-Mode Techniques and Their Visualisations", **IEEE Antennas and Propagation Magazine,** Vol. 46, No.6, pp.69-89, Dec 2004

3 L. Sevgi, "A Ray Shooting Visualization Matlab Package for 2D Ground Wave Propagation Simulations", **IEEE Antennas and Propagation Magazine**, Vol. 46, No 4, pp.140-145, Aug 2004

4 L. Sevgi, Ç. Uluışık, F. Akleman, "A Matlab-based Two-dimensional Parabolic Equation Radiowave Propagation Package", **IEEE Antennas and Propagation Magazine**, Vol. 47, No. 4, Aug 2005

5 L. Sevgi, Ç. Uluışık, "A Matlab-based Transmission Line Virtual Tool: Finite-Difference time-Domain Reflectometer", **IEEE Antennas and Propagation Magazine**, (to appear) Vol. 47, No.6, Dec 2005

6 L. Sevgi, "Sturm-Liouville Equation: The Bridge Between Eigenvalue and Green's Function Problems", **ELEKTRIK, Turkish J. of Electrical Engineering and Computer Sciences** (to appear) 2005

7 L. Sevgi, F. Akleman, L. B. Felsen, "Visualizations of Wave Dynamics in a Wedge-waveguide with non-penetrable Boundaries: Normal, Adiabatic, and Intrinsic Mode Representations", **IEEE Antennas and Propagation Magazine**, (in review) Sep 2005

8 L. Sevgi, Ç. Uluışık, "A LabView-based Virtual Instrument for Engineering Education: A Numerical Fourier Transform Tool", **IEEE Signal Processing Magazine**, (in review) 2005

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Tech. level

A half day Short Course

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Modeling and Simulation Strategies in Electromagnetics: *Teaching via Virtual Tools*

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This course targets undergraduate and graduate level electric, electronic, communication and computer engineering students, engineers and researches form industry, as well as university researchers and lecturers. The goal is to present and exercise variety of virtual tools that can be used as both teaching and research aids. Attendees may practice virtual tools during the course if they bring their laptops with Matlab Version 6.5 or higher.

PART I – Introduction *(~20 min)*

1.1 Modeling and Simulation in Antennas and Propagation Engineering
1.2 Fundamental Concepts, Analytical and Numerical Models
1.3 VV&A: Validation, Verification and Accreditation
1.4 Accuracy, Precision, Resolution, Error, Uncertainty
1.5 Model-based Forecasting and Prediction in Engineering

PART II – Plane Waves and Waveguides *(~30 min)*

2.1 Plane Waves and 1D FDTD Matlab Virtual Tool : PLWAVE
2.2 Parallel Plate Waveguide and Ray-Mode Virtual Tool: RAYMODE
2.3 Normal, Adiabatic, and Intrinsic Mode Representations
2.4 Wedge Waveguide Virtual Tool: WEDGE
2.5 Planar Optical Waveguide Virtual Tool: DiSLAB

PART III – Transmission Lines *(~30 min)*

3.1 Wave and Circuit Theories
3.2 Plane Wave – Transmission Line Analogy
3.3 Transmission Line Representations
3.4 Line Termination and Fault Effects
3.5 Fourier and Laplace Analyzes
3.6 FDTD based Time domain Reflectometer Virtual Tool: TDRMeter

PART IV – Antenna theory *(~40 min)*

4.1 Fundamental Antenna and Array Concepts
4.2 Communication and EMC Antennas
4.3 Isotropic Radiators and Arrays, Beam Forming and Beam Steering
4.4 Array Analysis Virtual Tool: ArrANALYSIS
4.5 Array Synthesis Virtual Tool: ArrSYNTH

PART V – Wave Propagation Theory *(~40 min)*

5.1 Groundwave Propagation Modeling: Short Review
5.2 Atmospheric refractivity Virtual Tool: GrSNELL
5.3 Diffraction Effects Virtual Tool: GrKNIFE
5.4 A 2D Radiowave Propagator Virtual Tool: GrSSPE
5.5 Method of Moments based Propagator Virtual Tool: GrMoM

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