19TH EUROPEAN CONFERENCE ON ANTENNAS & PROPAGATION

STOCKHOLM
MARCH 30 – APRIL 4 2025

TECHNICAL PROGRAMME

2025

16:30 Modeling and Analyses of Transparent Antennas on Vehicles

Ozgur Eris (Middle East Technical University, Turkey); Mehmet Emre Eralp (Middle East Technical University & Accelerate Simulation Technologies, Turkey); Lale Alatan (METU, Turkey); Ozlem Aydin Civi and Ozgur Ergul (Middle East Technical University, Turkey)

This paper presents accurate and efficient analyses of transparent antennas near platforms. Various numerical electromagnetic simulation tools are investigated during analyses of antennas mounted on platforms. The simulation environment developed in this work utilizes the equivalent source (ES) representations, and employs surface integral equation-based solutions accelerated by multilevel fast multipole algorithm to model interactions between antennas and vehicles, focusing on the impact of placements. The tool demonstrates remarkable performance compared to commercial tools and enables realistic simulations of transparent antennas on actual vehicle windshields. This facilitates more effective performance assessments and optimizations of antenna orientations and placements.

16:50 Dynamic Ray-Tracing for RF Propagation and Scattering in Hypersonic Plasmas

Andrea Scarabosio (LINKS Foundation, Italy); Salvatore Esposito, Domenic D Ambrosio and Giuseppe Vecchi (Politecnico di Torino, Italy)

Hypersonic flight regime is conventionally defined for Mach>5; in these conditions, the flying object becomes enveloped in a plasma. We present an update of our hybrid scheme \cite{ScarabosioTAP2022} for radio frequency propagation in complex media as a plasma. As an inhomogeneous media, the typical hypersonic plasma induces strong refraction but also complete reflection at the boundary with negative refractive index regions. The EM field presents caustics and the degree of inhomogeneity often exceed the condition of smooth varying media, a basic assumption in the asymptotic analysis. These physical features decrease the accuracy and applicability of standard ray-tracing methods. We extend our model using paraxial ray theory to improve caustics detection and phase shift correction. We also introduce special boundary layers or interfaces to approximately cope with extreme inhomogeneous regions. We show that the new algorithm provides higher fidelity results by comparing with full-wave calculations in presence of hypersonic plasma backgrounds

17:10 Hybrid Method for Optimizing Radiation of Implantable Antennas in Diverse Scenarios

Jakub Liška and Lukas Jelinek (Czech Technical University in Prague, Czech Republic); Mingxiang Gao (EPFL, Switzerland & IT'IS Foundation, Switzerland); Miloslav Capek (Czech Technical University in Prague, Czech Republic); Anja K. Skrivervik (EPFL, Switzerland)

This paper presents a combination of three computational methods in a hybrid approach designed to model the radiation of antennas within arbitrarily shaped capsules implanted in a host body. A surface method of moments is employed to represent the radiation source, offering the advantage of a low number of unknowns, as well as enabling performance limitation evaluation and topology optimization. The volumetric method of moments is then applied to model the antenna's surroundings, including its encapsulation. To reduce the use of the more computationally demanding volumetric method of moments, a vector spherical vector wave expansion is used to describe the host body, minimizing computational complexity.

Room: Björk (33)

EurAPP Working Groups

WG Active Array Antennas

Room: Bergman (34)

Scientific Workshop

SW11 The 1924 2.2 km electrically small Grimeton VLF antenna

Room: Felsen (35+36)

P10 - Propagation for body network and bio applications

T06 Biomedical and health / / Propagation

Chairs: Hadeel Elayan (Northeastern University, USA), Declan O'Loughlin (Trinity College Dublin, Ireland)

15:50 Optimization of the Monitoring Procedure for Determining the Ablation Zone in Ex-Vivo Bovine Liver

Mohamed Lamhamdi (University of Applied Science RheinMain, Germany); Ali Esmaeili (RheinMain University of Appilied Science, Germany); Georg Rose (OVGU, Germany); Holger Maune (University of Magdeburg, Germany); Andreas Brensing (Hochschule RheinMain, Germany); Bernd Schweizer and Mohamed El Hadidy (RheinMain University of Applied Sciences, Germany); Dana Jabali and David-Jonas Bader (Hochschule RheinMain, Germany)

This work presents optimization studies for a novel microwave ablation zone monitoring concept based on phase-shift measurements. Several ablations are carried out on ex-vivo bovine liver with a power of 50 W and an ablation time of 10 minutes. The previous research status was that the ablation zone with the novel method could be predicted reproducibly, but with a mean deviation of 70.2% and a standard deviation of 4.1%. The results from this work show that the ablation zone can now be predicted with a mean deviation of 16.8% and a standard deviation of 5.6%.

16:10 Near-Field Intra-Body Optical Communication: Leveraging the Power of Bessel Beam

Hadeel Elayan (Northeastern University, USA); Josep M Jornet (Northeastern University & Institute for the Wireless Internet of Things, USA)

This work explores the use of Bessel beams as a solution for near-field optical intra-body communication. Bessel beams possess unique non-diffracting and self-healing properties, making them superior to traditional Gaussian beams in maintaining intensity through complex biological environments. In this paper, we introduce the concept of near-field intra-body optical communication and the conditions under which it occurs. We propose a system that employs optical nanoantenna arrays to generate Bessel beams at a wavelength of 1550 nm, which falls within the biological transparency window. The system model, along with the corresponding mathematical formulation, is presented in detail. Our results offer a comparison of the propagation characteristics of Bessel and Gaussian beams in intra-body contexts, emphasizing the impact of near-field effects in enhancing spatial resolution at the sub-cellular level.

16:30 Assessment of the Representativeness of Numerical Subjects for the WBAN Indoor Channel Modeling

Badre Youssef (Thales & Télécom ParisTech-Institut Mines-Télécom LTCI, France); Christophe Roblin (Telecom Paris - Institut Polytechnique de Paris & LTCI - Institut Mines-Télécom, France)

WBAN peculiarities can be summed up in two points: firstly, the high number of sources of variability, i.e. the subject, the antennas, the frequency; secondly the strong electromagnetic disturbance of the human body. Concerning the subject, there are two aspects that can be considered: the morphology and the dynamic. When this source of variability is considered in the channel modeling, the problem is the difficulty of obtaining a representative statistical sample. One solution would be to use numerical subject models. The purpose of this article is to assess the representativeness of this approach in the context of WBAN channel modeling, by comparing key channel parameters (the mean Path Loss of the on-body cluster (PL)^On and the surrounded antenna pattern) obtained from simulations results for different numerical subjects and experimentations performed with a whole body phantom. The results obtained are satisfactory, and validate the use of this approach.

16:50 Heat Focusing in Head and Neck Hyperthermia Considering Vessels Blood Flow

Maryam Firuzalizadeh (Politecnico di Torino, Italy); Rossella Gaffoglio (Fondazione LINKS, Italy); Giorgio Giordanengo and Marco Righero (LINKS Foundation, Italy); Marcello Zucchi (Politecnico di Torino, Italy); Giuseppe Musacchio Adorisio (Fondazione LINKS, Italy); Aurora Bellone, Alberto Vallan, Guido Perrone and Giuseppe Vecchi (Politecnico di Torino, Italy)

This paper investigates how blood flow in major vessels affects temperature distribution during hyperthermia treatments in the head and neck (H&N) region. To do this, we used an in-silico model and a physical phantom of the neck region where a silicon tube with flowing water was introduced to simulate the presence of the two jugular veins and two carotid arteries. The results show that temperature variations of more than 5°C can affect temperature simulations when the effect of blood flow is not considered. The achieved results were confirmed by temperature measurements performed using the physical phantom and a full-operating mock-up reproducing an hyperthermia treatment in the neck region.

17:10 A Preliminary Study on the Impact of Model Complexity in Classification in Breast Microwave Imaging

Ana Catarina Pelicano (Instituto de Biofísica e Engenharia Biomédica, Fac. Ciências Un. Lisboa & FCiencias ID, Portugal); Nuno Araújo (Centro de Física Teórica e Computacional, Fac. Ciências Un. Lisboa, Portugal); Daniela M. Godinho (Instituto de Biofísica e Engenharia Biomédica - Faculdade de Ciências - Universidade de Lisboa, Portugal); Raquel C. Conceição (Instituto de Biofísica e Engenharia Biomédica, Faculdade de Ciências, Universidade de Lisboa, Portugal)

This study investigates the capability of microwave signals to classify benign and malignant breast tumours. The novelty of this study lies in the anatomically and dielectrically accurate breast tissue models - including tumours - used in the simulations, in multiple scenarios with different tissue types (fat, fibroglandular, skin, and muscle) and varying heterogeneity. Principal Components Analysis (PCA) was applied as a Feature Extraction Method (FEM), and Support Vector Machines (SVM) for the classification. Key metrics including accuracy, sensitivity, specificity, F1 score, and Matthews Correlation Coefficient (MCC), assessed each antenna's diagnostic capability and the combined performance across all antennas. Results suggested that combining classifications from all antennas via majority voting improved accuracy, while tumour classification was unaffected by tissue heterogeneity. Increasing model complexity did not impact SVM performance except when muscle tissue was added, slightly reducing the diagnostic performance.

THURSDAY