Session P1 : Numerical Methods

Tuesday 12 April 2011: 11:30am

P1-01: A finite difference polar-cartesian grid approach for mode computation in rounded-end waveguides

Alessandro Fanti, Giuseppe Mazzarella
University of Cagliari Department. of Electrical and Electronic Engineering, Cagliari, Italy

A finite-difference technique to compute Eigenvalues and mode distribution of non standard waveguide (and aperture) is presented. It is based on a mixed mesh (cartesian-polar) to avoid discretization of curved edges, and is able to give an accuracy comparable to FEM techniques with a reduced computational burden.

P1-02: Parallel FDTD modeling of the spherical optical black hole

Christos Argyropoulos, Yang Hao
Queen Mary, University of London, London, United Kingdom

A spherical optical black hole is studied using a parallel radially dependent finite-difference time-domain simulation technique. The device requires non-dispersive metamaterial structures and is capable of broadband operation, based on transformation optics. Excellent absorption is demonstrated for normal wave incidence.

P1-03: Numerical analysis of posture variation effect on the ultra wideband on-body radiopropagation channels using advanced modelling techniques

Qammer H. Abbasi, Andrea Sani, Akram Alomainy, Yang Hao
Queen Mary University of London, London, United Kingdom

The paper presents radio propagation study in wireless body area networks using a simulation tool based on the parallel finite-difference time-domain technique. This technique is well suited to model the radio propagation around complex, inhomogeneous objects such as the human body. The impact of different postures in on-body radio channel was studied. Simulations were performed at the frequency of 3-10 GHz considering a typical hospital environment and were validated by on-site measurements with reasonably good agreement.

P1-04: Improvement of accuracy of extraction of radiation patterns from FDTD modelling of axisymmetrical antennas

W Gwarek, M Olszewska
Warsaw University of Technology, Warsaw, Poland

This paper presents a discussion on the accuracy of extraction of radiation patterns of BOR antennas from FDTD simulations. The effect of the "main beam shadow" causing errors in extracted back radiation was explained. The methods of its elimination were proposed.

P1-05: Comparative analysis of A-V and A-T-T_0 calculations of induced currents in multiply connected regions

Rafal M. Wojciechowski[1], Andrzej Demenko[1], Jan K. Sykulski[2]
[1]Poznan University of Technology, Poznan, Poland, [2]University of Southampton, Southampton, United Kingdom

The paper offers a comparative analysis of two methods, both using potentials, for electromagnetic field computation in multiply connected regions, including a conventional A-V approach and a fairly new and much less popular A-T-T_0 formulation. The relevant finite element equations are provided. To facilitate comparisons the TEAM Workshop Problem No. 7 has been solved and the results of both methods verified by measurements. Computational times have been considered and the A-T-T_0 approach found to be much more efficient.

P1-06: Calculation of field distribution in electromagnetic problem with random domains

Hung Mac[1,2], Stephane Clenet[1], Jean-Claude Mipo[1]
[1]L2EP/Arts et Métiers ParisTech, Lille, France, [2]VALEO Systemes Electriques, Créteil, France

While solving a problem with random domains, discontinuities on the magnetic field distribution in the stochastic dimension appear. Numerical methods are already available to account for random domains. Some of them require the use of additional approximation functions to tackle the problem of discontinuity. In this paper, we focus on a method based the use of a random mapping and we show that in that case the discontinuities are naturally approximated and that no additional approximation function needs to be added.

P1-07: Application of the finite element method for the analysis of the grounding grid implying the finite line elements

Anton Habjanic, Marko Jesenik, Mladen Trlep
University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor, Slovenia

In this paper, the new numerical model is presented to analyze the electromagnetic field around the grounding grid. In contrast to recently existent procedure based on the "classical" finite element method (FEM), in this new methodology the soil and the air domain of the problem are discretized by the 3-D finite elements and the conductors of the grounding grid are discretized by 1-D finite line elements. The results of calculations have been verified by comparison with the results of measurements found in the literature.

P1-08: Boundary recovery for conforming Delaunay triangulation of curved complexes

Andre Cerqueira, Adriano Lisboa, Renato Mesquita
Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil

This paper presents a method to recover boundaries of Delaunay meshes conformed to curved geometries. The method uses a topological property to identify simplices and to insert Steiner points into the original mesh before its refinement. A pruning algorithm is introduced to avoid unnecessary predicate tests. Its implementation is both effective and efficient.

P1-09: 3-D time-harmonic eddy current problems solved by the geometric multigrid preconditioned conjugate gradient method

Chao Chen, Oszkar Biro
IGTE, TU Graz, Graz, Austria

The focus of this paper is on the efficient solution of 3-D time-harmonic eddy current problems discretized by the finite element method with bad quality meshes. The systems of equations arising from the finite element formulations are solved by a geometric multigrid preconditioned conjugate gradient method. The efficiency of the proposed method will be analyzed by numerical examples.

P1-10: **A two-level solver for nonlinear magnetic field problems using the p-version of the FEM**

Andreas Hauck[1], Manfred Kaltenbacher[2]
[1]Department of Sensor Technology, University of Erlangen-Nuremberg, Erlangen, Germany, [2]Applied Mechatronics, University of Klagenfurt, Klagenfurt, Austria

In this work we present an approach for solving nonlinear magnetostatic fields by utilizing the p-version of the FEM. The hierarchical H(curl)-conforming elements enable a natural splitting in lower order Nédélec-type shape functions and higher order ones. We develop a two-level solver analogous to the multigrid method, where the initial solution of the nonlinear problem on the lower order space is inserted into the higher order one, thus reducing the computational effort. Due to the explicit representation of gradients in the shape functions, the higher order space can be solved robustly using a simple Schwarz type preconditioned Krylov method. The efficiency of the proposed method is demonstrated by TEAM benchmark problems.

P1-11: Boundary element computation of line parameters of on-chip interconnects on lossy silicon substrate

Dongwei Li, Luca Di Rienzo
Politecnico di Milano, Milano, Italy

A BEM formulation is applied to the extraction of series parameters of interconnects on lossy silicon substrate. The numerical formulation can take into account both a semi-infinite homogeneous conductive substrate and a homogeneous conductive substrate of finite thickness with backside metallization.

P1-12: Electromagnetic source reconstruction by reversed-TLM method

Alina Ungureanu, Fabien Ndagijimana, Tan-Phu Vuong
IMEP-LAHC, Grenoble, France

Classical methods for source synthesis are iterative, time consuming and not always adapted to the desired problem. In this paper we present a new method of electromagnetic source synthesis based on the time reversal technique. This approach employs the Reversed TLM method and permits the reconstruction of an unknown source distribution, from its electromagnetic far field radiation. Point like source reconstruction results show that by using this method, the "classical" half wavelength resolution limit is overcome.

P1-13: An internal fractional boundary placement model for the transmission-line modelling method

Mark Panitz, Christos Christopoulos
The University of Nottingham, Nottingham, United Kingdom

This paper describes a fractional boundary placement model for the transmission line modelling method enabling the positioning of internal boundaries at non-integer cell locations. The model does not introduce any restriction on the maximum timestep of simulations. The model is developed in two dimensions and is validated using a band-pass waveguide filter model.

P1-14: A mode matching analysis of rectangular dielectric discontinuities in metal waveguides applicable to characterisation of liquids

Olumide Ogunlade
University of Greenwich, UK, United Kingdom

In this paper we present a generalised scattering matrix approach using mode matching to analyse a generic case of a rectangular dielectric sample and sample holder partially filling a metal waveguide; as encountered in liquid measurements. The results for both samples having real and complex permittivity values, for varying sample thickness are presented and compared to that obtained by a commercial finite element method software.

P1-15: New coupling between PEEC method and an integro-differential approach for modelling solid conductors in the presence of magnetic-conductive thin plate

Le Duc Tung, Chadebec Olivier, Guichon Jean-Michel, Meunier Gerard
G2elab, Grenoble, France

In order to introduce magnetic conductive thin plate in quasi-static PEEC method, a coupling with the integro-differential method is proposed. This coupling enables to take the advantage of each method. The complex conductor geometry is achieved thanks to PEEC method. The modeling of thin plates is taken into account thanks to an integro-differential one.

P1-16: The Voronoi-Delaunay dual diagram : mesh generation and cosmetics

Zhongqiang Xie, Oubay Hassan, Kenneth Morgan
Swansea University, Swansea, United Kingdom

The weighted Voronoi diagram has been developed to improve the overall quality of the resulting Voronoi-Delaunay dual diagram. Several optimization techniques have also been studied and compared in this work, which includes the direction search, particle swarm optimization and the new metaheuristic optimization algorithm - Cuckoo Search. Numerical results show that these optimization techniques can play an important role in reducing the number of bad elements with CVT reinsert loop.

P1-17: Estimation of an equivalent short solenoid model using different numerical methods

Olivia Miron[1], Daniele Desideri[2], Dan Micu[1], Alvise Maschio[2], Andrei Ceclan[1], Levente Czumbil[1]
[1]*Technical University of Cluj-Napoca, Cluj-Napoca, Romania,* [2]*University of Padova, Padova, Italy*

The paper deals with an inverse magnetostatic problem related to the reconstruction of a permanent magnet encapsulated inside the cathode of a magnetron sputtering device. Different numerical methods were compared for achieving the best match to a set of magnetic flux density measurements.

P1-18: Inner-outer preconditioning strategy for 3D inductance extraction coupling with fast multipole method

Trung-Son Nguyen, Jean-Michel Guichon, Olivier Chadebec, Gerard Meunier, Le Duc Tung
Grenoble Electrical Engineering Laboratory, Grenoble, France

This paper presents an efficent preconditioning technique in order to couple Partial Element Equivalent Circuit (PEEC) method with Fast Multipole algorithm (FMM).

P1-19: Application of wedge functions to 2D magnetostatic problems

Ernst Huijer, Sami H. Karaki
American University of Beirut, Beirut, Lebanon

In this paper the application of so called wedge functions is presented to solve two-dimensional simple geometries magnetostatic and electrostatic problems, e.g. rectangles of varying aspect ratio and with different values of the magnetic permeability μ. Such wedge solutions contain surface pole distributions of a certain power. The same pole distribution functions have been used in the analysis of conducting and infinite permeability structures. Here we apply such functions in a boundary integral analysis method of finite permeability.

Session P2 : Electromechanical Systems

Tuesday 12 April 2011: 15:30pm

P2-01: Verification of boundary conditions for thermal analysis of the power module with various methods

Jelena Popovic, Drago Dolinar, Miro Milanovic
University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor, Slovenia

The paper reflects an analysis of thermal behaviour of a half-bridge IGBT power module. The main objective of this research is achieved by proposing analytical, numerical and experimental methods for boundary conditions determination and temperature calculation. The analytical approach is carried out from basic heat equation and corresponding boundary conditions. The modelling of boundary conditions offers an entirely new definition for temperature calculation for this particular case. The finite element method (FEM) investigates the influence of different boundary conditions on the transient thermal analysis. The experiment confirms the obtained results.

P2-02: Study of the high frequency electromagnetic behavior of planar inductor design for resonant circuits in switching power converters

Arash Nejadpak, Mohammadreza Barzegaran, Osama Mohammed
Florida International University, Miami/FL, United States

In this paper a planar inductor based resonant circuit is designed for zero-current switching (ZCS) buck converter. The electromagnetic behavior of the design is analyzed by finite element (FE) methods for EMI interactions. A high frequency model for conducted EMI in the resonant circuit is obtained. To suppress the conducted EMI in the circuit, a method based on the resonant circuit impedance control is proposed. All the results are compared to conventional circuits and improvement in responses were observed and verified through simulation and laboratory experimentation.

P2-03: Non-linear FE physics based modeling of induction machines for real time integrated drive simulations

Ali Sarikhani, Osama Mohammed
Florida International University, Miami/FL, United States

The linear and non-linear FE-based model of a three phase wound rotor induction machine is presented. The effect of stator and rotor currents on the self and mutual inductance is considered. The mathematical representation of the machine in presence of saturation is developed. The calculated model is compared with a simple d-q model, full FE- model, and a linear FE-based phase variable model. The calculated result shows a good match in accuracy with full-finite element model and in run-time with the d-q model.

P2-04: On the dynamics of an hydropower generator subjected to unbalanced magnetic pull

Yogeshwarsing Calleecharan, Jan-Olov Aidanpää
Luleå Tekniska Universitet, Luleå, Sweden

Eccentricity leading to unbalanced magnetic pull (UMP) in electrical machines is a significant concern in industry. The UMP is known to be composed of two components: A radial component and a tangential one. Models that are used in industry currently tend to include the radial component alone. In this paper, a Jeffcott rotor model together with a new UMP model that incorporates both radial and tangential UMP constituents is studied for an industrial hydropower generator. Characterising the UMP as springs permits the model to inherit UMP stiffness contribution. Interesting dynamics are observed with the new model for a wide range of external forcing frequencies. It is shown firstly that the new UMP model is sensitive to forcing frequency in the rotor movements. Moreover, complex dynamics in the displacements of the rotor are observed for some forcing frequencies and it is noted that the rotor does not need to be forced by frequencies above its critical speed for this less desirable motion to occur. Eigenvalue-based stability analysis is performed and shows that damping of the rotor and of the bearings are important when non-synchronous whirling of the rotor is considered. Accounting for both components of UMP is an important cornerstone in the generation of better rotor design parameters which can help to curb rotor-stator malfunction and can contribute in the design of long lasting rotors to the betterment of hydropower technology.

P2-05: Characterization of two-axis equivalent circuit model of PM-BLDC motor by FEA

Mariusz Jagiela[1], Ernest A. Mendrela[2], Pavani Gottipati[2]
[1]Opole University of Technology, Opole, Poland, [2]Louisiana State University, Baton Rouge, Louisiana, United States

It was shown recently that the state-variables averaging method is applicable to permanent magnet brushless DC (PM-BLDC) motors and yields an equivalent circuit model analogous to that of the PM-BLAC motor. Calculation of the averaged reference frame voltages is difficult, but is crucial for the modeling accuracy. The identification of the averaged (dq) voltages must be carried out using detailed analysis. Here it is done using a dynamic finite element model of an inverter-driven motor. It is shown that these voltages can be modeled by quadratic functions of rotor speed. This lays down the basis for experiment to perform in order to identify these variations. The results obtained from the circuit model compare well with those obtained from the dynamic finite element analysis. Some results from physical model are given.

P2-06: Simulation of an induction motor including eddy-current effects in core laminations

Hai Van Jorks, Erion Gjonaj, Thomas Weiland
Technische Universität Darmstadt, Darmstadt, Germany

The purpose of this paper is to investigate the common mode ground current induced in an induction machine controlled by Pulse Width Modulation(PWM)at high frequencies. Using the transmission line approach the parameters are extracted from both two-dimensional (2D) and three-dimensional (3D) field simulations. 2D finite element (FE) analysis is an efficient tool for simulating the entire motor cross section. However, eddy currents in the lamination cannot be modeled explicitly and have to be approximated by a semi-analytical formulation. The paper investigates the accuracy of this model for a wide frequency range (100 Hz...100 kHz). The results show the necessity of fully 3D simulations taking into account the detailed distribution of eddy currents in the laminations. A specialized 3D simulation tool for induction motors with laminated cores is being developed and will be presented in the full paper.

P2-07: Frequency response of the transformer model with simulated windings deformations and electric faults

Szymon Banaszak, Konstanty Gawrylczyk
West Pomeranian University of Technology, Szczecin, Poland

The diagnostics of power transformers is very important in order to plan repairs and replacements of aged population of transformers operated in Poland and Europe. As the Frequency Response Analysis (FRA) is based on comparison of measured curves, which are not always available from previous measurements, the computer modeling was applied to create models of windings' response.

P2-08: Turbine-generator end-region analysis using the quasi-3D method

Tanmay Joshi, Alison Baker
Alstom Grid Research & Technology, Stafford, United Kingdom

A quasi-3D numerical technique for the quick computation of the temperature rise in turbine-generator end-regions is described. This method takes advantage of the sinusoidal variation of quantities in the peripheral direction of the generator and the nature of the stacking of the stator core plates.

P2-09: Comparing different approaches for the numerical identification of R, L parameters of HF multi-winding transformers

Zacharie De Grève[1,2], Olivier Deblecker[1], Jacques Lobry[1]
[1]*University of Mons, Fac. of Engineering, Dept. of Power Electrical Engineering, Mons, Belgium,* [2]*Belgian Fund for Research F.R.S/FNRS, Brussels, Belgium*

In this paper, mathematically rigorous R, L circuits of high frequency multi-winding transformers are numerically extracted. Two procedures based on the Finite Element Method (FEM) are investigated. In the first one, a Cholesky decomposition is applied to the resistance and inductance matrices of the device, which are obtained using a FE model. The second approach employs the FEM as a virtual laboratory in order to perform numerically open and short-circuit tests on the transformer. The two methods are compared regarding the overall computational burden and the obtained lumped parameters, for 2D and 3D models.

P2-10: Design of linear motor with two degrees of freedom

Marcin Karbowiak, Bartosz Jankowski, Dariusz Kapelski, Marek Przybylski, Barbara Slusarek
Tele and Radio Research Institute, Warsaw, Poland

This paper presents a construction of the flat stepper motor with a complex move of soft magnetic plate with one multipolar permanent magnet. Stator has 16 cylindrical electromagnets which are combined in 4 phases. This solution is advantageous because it simplifies the way of controlling motor. In this case there are only 8 wires and the external driver controls currents in only 4 phases. Unlike in the solutions where many glued permanent magnets are used, it was considered a possibility to produce one permanent magnet which will be multipolarly magnetized. A special magnetization fixture allows hard magnetic material to be magnetized in the required distribution of poles. Flat stepper motor with multipole permanent magnet can lead to further considerations on the construction of linear rotary motor.

P2-11: 3D finite element analysis of the turbogenerator rotor electromagnetic field

Michael G. Pantelyat[1,2], Alexander N. Saphonov[2], Nikolaj G. Shulzhenko[2]
[1]*Institute for Fundamentals and Theory in Electrical Engineering, Graz University of Technology, Graz, Austria,* [2]*Institute of Problems in Machinery, National Academy of Sciences of Ukraine, Kharkov, Ukraine*

A finite element technique and computer code for the finite element analysis of 3D transient electromagnetic fields due to negative sequence currents in large synchronous turbogenerator rotors are developed. It is impossible to carry out accurate numerical simulation of 3D transient electromagnetic processes within whole structure of the rotor because of huge computational expenses. Therefore, this paper is devoted to finite element analysis of electromagnetic processes in important structural parts of the rotor - joints of nonmagnetic slot wedges by the rotor length. Results will be used for computer simulation of thermal and vibration behaviour of the rotor.

P2-12: Analysis of contact resistance effect between magnet segments on eddy current losses

Mehran Mirzaei, Bogdan Funieru, Andreas Binder
Electrical Energy Conversion, Darmstadt University of Technology, Darmstadt, Hessen, Germany

This paper presents analytical formulations and 3D finite element calculations for the analysis of effects of the contact resistance between two poorly insulated magnet segments regarding eddy current losses. The calculations deal with low speed large direct drive permanent magnet wind turbine generators. The analytical and finite element results are compared for different contact conductivities. The analysis considers the low frequency harmonics of the concentrated stator winding neglecting the eddy current self field.

P2-13: Determination of performance parameters of a small-size high-speed induction motor using the field-circuit method

Krzysztof Komeza, Maria Dems
Technical University of Lodz, Lodz, Poland

Core losses generated in small size high-speed induction motors constitute a significant part of total losses in the motor, in particular at higher frequencies. Precise determination of these losses is vital to assure the proper functioning of the motor. Core losses in electrical machines depend on the power loss density of the electrical sheets used, which in turn depends strongly on frequency, magnitude and form of the applied magnetic field. The specific losses are usually only given for the 50 Hz alternating flux. Consequently, various estimations are applied for higher frequencies. To avoid errors associated with such an approach a direct use of specific losses measured on ring samples has been proposed. The no-load and load losses in the core have been calculated using a field-circuit and a circuit method. The machine parameters and load characteristics have also been determined at supply frequencies from 50 to 200 Hz. The computational results have been verified against measurements.

P2-14: Prospective method for partial discharge detection in large AC machines using magnetic sensors in low electric field zones

S Ait-Amar[1,2], D Roger[1,2]
[1]Université Lille Nord de France, Lille, France, [2]UArtois, Béthune,, France

The aim of the paper is to present a new prospective method for on-line monitoring of partial discharge (PD) in large AC motors. The principle of this system consists to measure the weak magnetic high frequency field, due to PD, in the space between the magnetic core and the machine external frame of large generators. Special sensors, trimmed to the machine winding resonances, may perform such field measurements. With several sensors, it will be possible to localise PD activity corresponding to insulation weaknesses.

P2-15: New concept of permanent magnet excited synchronous machines with improved high-speed features

H May[1], R Palka[2], P Paplicki[2], S Szkolny[2], W-R Canders[1]
[1]TU Braunschweig, Braunschweig,, Germany, [2]West Pomeranian University of Technology Szczecin, Szczecin, Poland

Permanent magnet (PM) excited synchronous machines used in modern drives for electro-mobiles suffer in high speed regions from the limited battery-voltage. The field weakening requires machine designs with reduced power conversion properties or oversize of the power converter. A new concept of such machine features PM excitation, single teeth winding and an additional circumferential excitation coil fixed on the stator in the axial center of the machine. By the appropriate feeding of this coil, the amplitude of the voltage effective excitation field can be varied from zero to values above those of the conventional PM-machines.

P2-16: Magnetic stresses analysis of a two speed, large power synchronous motor in abnormal working conditions

J Bialik, J Zawilak
Wroclaw University of Technology, Wroclaw, -

This paper deals with the electromagnetic calculations of the stator magnetic stresses in the two-speed, large power, silent pole, synchronous motor. Prediction of such stresses is very important in understanding vibration phenomena of these special electrical machines. Because of non-symmetrical armature (stator) and field (rotor) winding the only one way of investigation is Finite Element Modelling. The simulations results for nominal load, for two different rotational rotor speeds: n=500 rpm (p=6) and n=600 rpm (p=5) are presented.

P2-17: Limitation of higher harmonics in line start permanent magnet synchronous motor by star-delta mixed stator winding

T Zawilak, M Gwozdziewicz
Wroclaw University of Technology, Wroclaw, Poland

On the basis of FEM simulations star-delta mixed winding application in Line Start Permanent Magnet Synchronous Motors was investigated. The main goal of star-delta mixed winding in LSPMSM is current higher harmonics limitation. LSPMSM (based on the 90L-4 IM type) FEM model was built. Two stator winding types were utilized: conventional star winding (the same like in the 90L-4 IM type) and star-delta mixed winding. EMF during idle-running and influence of load torque on current higher harmonics were examined.

P2-18: The field and power losses computation in structural components of HV power transformer

S Wiak, P Drzymala, H Welfle
Technical University of Lodz, Lodz, Poland

The paper presents the discrete model of the structural components HV transformer. Transformer model is created as 3D geometry. The paper presents the methodology of the model generation for the full geometry of the transformer flat bars and flat bars connectors. The electromagnetic field analysis leads to the identification of the points with high dense losses of the structural components of 3D transformer geometry. The field and power losses distribution computation is essential for further investigations leading to the design of structural components. Proper designing procedure of the elements it is so important and show the strong influence on the total transformer power losses terms.

P2-19: Effects of external yoke and end-bells on AC motor external field

J P Lecointe[1,2], F Morganti[1,2], F Zidat[1,2], R Romary[1,2], T Jacq[3], F Streiff[4]
[1]Univ Lille Nord de France, Lille, France, [2]UArtois, Béthune, France, [3]EDF-R&D-Département THEMIS Groupe, Clamart, France, [4]ADEME-SEET, Angers, France

This paper focuses on the external flux in the vicinity of AC electrical rotating machines. The influence of the external housing, the external yoke and the end-bells, is studied with a Finite Element modelling, an analytical model and an induction machine equipped of flux sensors.

P2-20: Towards accurate evaluation of iron losses in electric machines

S C Taylor, A M Michaelides
Cobham Technical Services, Kidlington, United Kingdom

The paper describes the application of an advanced Finite Element Analysis (FEA) solver for the treatment of material magnetization: hysteretic behaviour prediction in soft ferromagnetic materials is outlined, demonstrating how remanent forces and hysteresis loss can now be accurately quantified. Results from analysis on a wound-field synchronous machine demonstrate the usefulness of the new algorithm in the design of such highly specialized devices.

Session P3 : High Frequency

Wednesday 13 April 2011: 11:000am

P3-01: Layered medium discrete dipole approximation

Ergun Simsek, Baris Sonmez
Bahcesehir University, Istanbul, Besiktas, Turkey

In this work, we improved discrete dipole approximation (DDA) to layered medium by formulating the problem with layered medium Green's functions (LMGFs). In order to calculate thousands of LMGF samples, we subtract the singularities of LMGFs and add their contributions analytically. This new layer medium DDA can solve electromagnetic scattering from arbitrarily shaped objects embedded in a layered medium accurately. Numerical results clearly demonstrate the efficiency of the method with respect to regular DDA and frequency domain full wave solvers.

P3-02: Wave propagation in microstrip lines with gyrotropic magnetic substrate

Alireza Farahani, Doug Lavers
University of Toronto, Toronto, ON, Canada

The time domain numerical modelling at microwave frequencies of a microstrip line that incorporates a saturable magnetic substrate is considered. The strip line is subjected to a DC magnetic field bias such that the quiescent operating point is near or above the saturation knee point. An algorithm that ensures numerical stability in the time domain is described. The predicted scattering parameters are shown to be in good agreement with measured data.

P3-03: A combined Bowtie-Peano antenna for wideband performance

Ioannis Papadopoulos-Kelidis, Antonios Lalas, Nikolaos Kantartzis, Theodoros Tsiboukis
Department of Electrical and Computer Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

The concept of folded bowtie antennas is presented in this paper. To pursue this objective, a Peano space-filling curve approach is utilised. Thus, the combined Bowtie-Peano antenna (BPA) is introduced, exhibiting the broadband performance of the bowtie antennas combined with the compactness of the Peano designs. Numerical results obtained via a Finite-Difference Time- Domain (FDTD) scheme clearly illustrate the behaviour of the novel structure. The feasibility of bandwidth enhancement is signified at specific resonances.

P3-04: A new topology for ultra-wideband directional couplers

P Miazga
Warsaw University of Technology, Warsaw, Poland

A new topology for microstrip ultra wide band directional couplers is proposed in this paper. The coupler consists of cascade connection of low-coupled lines or phase shifters (Schiffman lines) and high-coupled sections. The new geometry of Schiffman lines with compensated 180° bend is proposed and verified by electromagnetic simulator.

P3-05: Effects of electromagnetic near-field stress on DC and RF performances of AlGaN/GaN HEMT

Samh Khemiri, Moncef Kadi, Anne Louis, Belhaceune Mazari
IRSEEM\ESIGELEC, Saint Etienne du Rouvray, France

AlGaN/GaN HEMTs have positioned themselves as strong candidates for future radar applications requiring high power at microwave frequencies. In the context of studying the reliability of RF High Power Amplifiers (HPA) in their real environment, a study of the effect of electromagnetic stress on AlGaN/GaN HEMTs performances is presented in this paper. A near field setup is used to disturb with electromagnetic field a device under test (DUT). A comparative study between the injection of CW (Continuous Wave) and pulsed RF power are presented. Degradations in DC and power characteristics are observed. Thermal and trapping processes induce them. Pulsed RF power allows reducing the effect of self-heating.

P3-06: On an inverse electromagnetic procedure for frequency and spatial reconstruction of the lightning return stroke current

Andrei Ceclan, Vasile Topa, Dan Micu, Levente Czumbil
Technical University of Cluj-Napoca, Cluj-Napoca, Cluj, Romania

An inverse problem is proposed for the identification of the lightning return stroke current, from the electromagnetic fields that occur. The approach deals with Fredholm integral equations of the first kind and with an improved regularization procedure based on a spatial and time dependent harmonic reconstruction of the lightning current. All the preliminary evaluations appear to be in good agreement with the actual characterization current models for the lightning; moreover the precision as regarded to the effect is considerably improved.

P3-07: User friendly EMI software for induced A.C. potential evaluation

Levente Czumbil[1], Dan Micu[1], Georgios Christoforidis[2], Andrei Ceclan[1], Olivia Miron[1]
[1]Technical University of Cluj-Napoca, Cluj-Napoca, Romania, [2]Technological Educational Institute of West Macedonia, Kozani, Greece

Electromagnetic interference problems between high voltage power lines and underground metallic pipelines, which runs in the same right of way, are studied. To evaluate the induced A.C. potentials, in underground pipelines, a hybrid method is used. This method combines finite element (FEM) calculation with Faraday's law applied on an equivalent electric circuit which models the EMI problem.

An electromagnetic interference (EMI) software (InterfStud) was developed to construct and analyse the equivalent electrical circuit model which solves the studied electromagnetic interference problem.

P3-08: Reduction of sensitivity to measurement errors in the derivation of equivalent models of emission in numerical computation

Xin Tong, Dave Thomas, Angela Nothofer, Philip Sewell, Christos Christopoulos
The University of Nottingham, Nottingham, United Kingdom

In this paper, the accuracy of an equivalent dipole model for representing electromagnetic emissions from printed circuit boards (PCB) is studied. The optimization of near-field measurement parameters and required PCB parameters for building a numerical model are discussed and their impact on the accuracy of emission predictions is examined.

P3-09: A non-homogeneous Dirichlet boundary condition on the electric potential for the finite element analysis of grounding systems

Lucas Blattner Martinho[1], Sérgio Luís Lopes Verardi[2], Mário Leite Pereira Filho[3], Marcelo Facio Palin[2], Viviane Cristine Silva[1], José Roberto Cardoso[1]
[1]Escola Politécnica da Universidade de São Paulo, São Paulo, Brazil, [2]InSciTI Consultoria e Desenvolvimento de Software, São José do Rio Preto, Brazil, [3]Instituto de Pesquisas Tecnológicas, São Paulo, Brazil

A procedure to take into account the unbounded nature of the three dimensional domain employed in the finite element analysis of grounding systems is presented. It consists in applying non-homogeneous Dirichlet boundary conditions on the electric potential calculated according to a point current source approximation. The numerical scheme was tested in an example, and showed very good agreement with the solution given to the same problem by an integral method.

P3-10: Numerical investigation of Fano resonances in metamaterials with electric asymmetry

Mihai Rotaru, Jan K. Sykulski
University of Southampton, Southampton, United Kingdom

The excitation of high quality factor asymmetric Fanotype resonances on a double layer metafilm structure is investigated through numerical simulation. The paper demonstrates that it is possible to design simple structures capable to sustain a very high quality factor resonance by reducing their radiation losses. An equivalent circuit formed by two linearly coupled resonant RLC circuits is extracted in an attempt to explain the observed Fano resonance through classical circuit theory.

P3-11: Combination of neural-mass models with anisotropic head models to simulate EEG signals

Ulf Zimmermann, Sabine Petersen, Lars Schwabe, Ursula van Rienen
University of Rostock, Rostock, Mecklenburg-Vorpommern, Germany

With the help of neural-mass models it is possible to simulate different kinds of electroencephalographic signals in the human brain. By implementing several populations of a neural-mass model in a finite element model of the human head the influence of each population to the potentials measured at the scalp can be simulated. To achieve more realistic values, our model of the human head considers the anisotropic conductivity of the brain and the skull. This paper describes how the neural-mass model as proposed by Friston et al. and an anisotropic head model can be combined to simulate realistic time-dependent electroencephalographic signals on the scalp. As proof of principle we simulate five neural populations in the cerebral cortex.

P3-12: Study on the step voltage caused by lightning current with postured voxel-based human body models

Jing Gao[1,2], Irina Munteanu[1,4], Wolfgang F.O. Mueller[2], Sebastian Suchanek[3], Thomas Weiland[1,2], Volker Hinrichsen[3]
[1]Graduate School of Computational Engineering, TU Darmstadt, Darmstadt, Germany, [2]Computational Electromagnetics Laboratory, TU Darmstadt, Darmstadt, Germany, [3]High Voltage Laboratories, TU Darmstadt, Darmstadt, Germany, [4]CST – Computer Simulation Technology AG, Darmstadt, Germany

This paper studies the effect of the step voltage due to a lightning strike on the human body. Two voxel-based human body models with standing and walking posture were developed and integrated into simulation models to compute the current density distribution in the human body shocked by the step voltage. In order to speed up the transient simulation, the reduced c technique was used, leading to a speedup factor of around 20.
In the paper, the trade-off between speedup and error when using the reduced c technique is discussed, and simulation results are presented in detail.

P3-13: Modeling of the cell membrane response to ultra short electric pulses

J A Ramirez[1], David Lowther[2]
[1]Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, [2]McGill University, Montreal, Canada

This paper discusses the dynamics aspects of pore formation in the cell membrane submitted to ultra short electric pulses. The transient transmembrane potential (TMP) is calculated using an analytical approximation, which is subsequently coupled to the Smoluchowski equation to assess the dynamics of pore generation. Alternatively, the finite element method is also considered for the TMP calculation. The formulation is employed to calculate the pore formation, growth and size evolution in double shell cells of different shapes.

P3-14: Implications of Galilean electromagnetism in numerical modeling

Francesca Rapetti[1], Germain Rousseaux[2]
[1]Universite de Nice, Nice, France, France, [2]CNRS, Nice, France, France

The purpose of this article is to present a wider frame to treat the quasi-static limit of Maxwell's equations. We discuss the fact that there exists not one but indeed two dual Galilean limits, the electric and the magnetic one. We start by a re-examination of the gauge conditions and their compatibility with Lorentz and Galilean covariance. By means of a dimensional analysis on fields and potentials we first emphasize the correct scaling yielding the equations in the two limits. With this particular point of view, the gauge conditions of classical electromagnetism are continuity equations whose range of validity depend on the relativistic or Galilean nature of the underlying phenomenon and have little to do with mathematical closure assumptions taken without physical motivations.

P3-15: A mobile virtual electromagnetics laboratory for iPhone

Daniel Browne, Simon Pomeroy, James Flint
Loughborough University, Loughborough, United Kingdom

Modern mobile devices have now advanced to a point where they can execute computationally-intensive mathematical problems. The Transmission Line Matrix Modelling method (TLM) is a time-domain method allowing the computation of two and three dimensional electromagnetic fields and structures. TLM is able to model complex scenarios whilst utilising a computationally simple method to model structures in discrete spatial units. This paper presents an iPhone Application (App) containing a TLM solver. The simulation output is presented on the screen as the simulation progresses. The performance of the iPhone is sufficient to visualise full-field simulations and to provide an interactive interface for the user.

Session P4 : Optimisation, Coupled Problems, Sensors & Actuators

Wednesday 13 April 2011: 15:30pm

P4-01: Monolithic model of continuous induction hardening of a steel mandrel

Pavel Karban[1], Ivo Doležel[2], Bohus Ulrych[1], Jerzy Barglik[3]
[1]University of West Bohemia, Pilsen, Czech Republic, [2]Institute of Thermomechanics, Prague, Czech Republic, [3]Silesian University of Technology, Katowice, Poland

Continuous induction hardening of axi-symmetric steel bodies is analysed. The mathematical model of the process (consisting of two coupled partial differential equations describing the distributions of magnetic and temperature fields) is solved numerically by a fully adaptive higher-order finite element method in the monolithic formulation. All important nonlinearities of the system (magnetic permeability and other material parameters) are respected. The methodology is illustrated by a typical example whose results are discussed.

P4-02: Actuator with permanent magnet controlled by very short current pulses

Ivo Doležel[1], David Panek[2], Bohus Ulrych[2]
[1]Czech Technical University, Praha, Czech Republic, [2]University of West Bohemia, Plzen, Czech Republic

A new type of electromagnetic actuator with high holding force and extremely low consumption of electric energy is proposed and modelled. The movement of its plunger formed by a permanent magnet is controlled by short pulses of direct current together with a return spring. The paper presents the arrangement of the device and analyses its principal operation characteristics.

P4-03: Finite element scheme based on magnetic vector potential and mechanical displacement for modeling magnetostriction

Adrian Volk[1], Manfred Kaltenbacher[2], Andreas Hauck[1], Michael Ertl[3], Reinhard Lerch[1]
[1]Department of Sensor Technology, University of Erlangen-Nuremberg, Erlangen, Germany, [2]Applied Mechatronics, University of Klagenfurt, Klagenfurt, Austria, [3]Siemens AG, Power Transmission and Distribution, Nuremberg, Germany

In this work we present a thermodynamically consistent physical model and its finite element formulation for the computation of magnetostrictive materials. Therewith, we decompose the mechanical strain and the magnetic induction into a reversible and an irreversible part. The reversible part is described by the linear magnetostrictive constitutive equations, whereas the irreversible parts are modeled by Preisach hysteresis operators. Since we focus on the magneto-dynamic case, the finite element formulation is done using the magnetic vector potential as well as the mechanical displacement.

P4-04: Coupling between FDTD electromagnetic and FEM CFD software packages for simulation of microwave heating

M Soltysiak[1], M Celuch[2], U Erle[3]
[1]QWED sp. z o.o, Warsaw, Poland, [2]Warsaw University of Technology, Warsaw, Poland, [3]R&D Solon Product Technology, Solon, OH, United States

The coupling of the FDTD electromagnetic software with built-in commercial (HFM) and open source (ELMER) thermal codes is used to simulate the process of heating in household microwave ovens. The commercial code is based on the finite difference time domain method (FDTD), while the open source code utilises the finite element method (FEM). For the two combinations of the solvers, a comparison of temperature patterns over the surface of the cuboidal beef object placed inside the oven after 60 seconds of heating is made.

P4-05: 3-D optimal design of laminated yoke of billet heater for rolling wire rod using ON/OFF

Norio Takahashi, Shunsuke Nakazaki, Daisuke Miyag, Naoki Uchida, Keiji Kawanaka, Hideyuki Namba
Okayama University, Okayama, Japan

The optimization method using the ON/OFF sensitivity analysis has an advantage that an epoch-making construction of magnetic circuit may be obtained. Therefore, it is attractive for designers of magnetic devices. We have already developed the ON/OFF method for the optimization of a static magnetic field problem, and the effectiveness is verified by applying it to the optimization of magnetic recording heads. In this paper, the ON/OFF sensitivity method is extended to the optimization of the eddy current problem using the adjoint variable. The newly developed ON/OFF method is applied to the determination of the optimal topology of the yoke of the billet heater for rolling wire rod. As a result, the optimal shape of yoke, which we could not imagine beforehand can be obtained. It is shown that the local heating of the yoke was reduced without decreasing the heating efficiency.

P4-06: Optimization of the layer thickness distribution in electrochemical processes using the Level Set Method

Ioan Marius Purcar, Vasile Topa, Calin Munteanu, Robert Chereches, Alexandru Avram, Laura Grindei
Technical University of Cluj, Cluj, Romania

This paper proposes a general applicable numerical algorithm for the optimization of the layer thickness distribution using the insulating shields during the electroplating process in an electrochemical reactor. The aim of this method is to develop a systematic modification of the insulating shield position in order to get a more uniform distribution of the current density and layer thickness at the cathode. The strong feature is that it does not need the re-meshing of the computational domain when the insulating shield changes the position. The interface of the insulating shield is implicitly calculated solving a convection equation over a number of predefined time steps proportional with and in the direction of a well chosen rate provided by a genetic algorithm. Finally an example related to the optimization layer thickness distribution in the vicinity of a singularity (incident angle between the electrode and insulator = 180°), using an insulating shield will be presented.

P4-07: Application of a PSO algorithm for identification of Jiles-Athetron hysteresis model

Lukasz Knypinski, Lech Nowak, Piotr Sujka, Kazimierz Radziuk
Poznan University of Technology, Poznan, Poland

In the paper an algorithm and computer code for the identification of the hysteresis parameters of the Jiles-Atherton model has been presented. For the identification the Particle Swarm Optimization method (PSO) has been applied. The computer code has been elaborated using Delphi environment. The results of optimization have been compared to experimental ones. Selected results of the calculation are presented and discussed.

P4-08: Two-level approach for solving the inverse problem of defect identification in eddy current testing-type NDT

Piotr Putek, Guillaume Crevecoeur, Marian Slodicka, Konstanty Gawrylczyk, Roger Van Keer, Luc Dupre
University of Gent, Gent, Flanders, Belgium

An inverse problem of 3D crack identification inside a conductive material from the eddy current measurements is investigated. In order to accelerate the time-consuming direct optimization, the reconstruction is provided by the minimization of a last-square functional of the data-model misfit using space mapping (SM) methodology. This technique enables to shift the optimization load from a time consuming and accurate model to the less precise but faster coarse surrogate. In this work, the finite element method (FEM) is used as a fine model, while the model based on the volume integral method (VIM) serves as a coarse model. The application of this method to the shape reconstruction allows to shorten the evaluation time that is required to provide the proper parameter estimation of surface defects.

P4-09: Reliability analysis of the SMES system in the TEAM workshop benchmark problem 22 utilizing reliability index approach

Dong-Wook Kim[1], Young Hwa Sung[2], Dong-Hun Kim[1]
[1]Kyungpook National University, Daegu, Korea, Republic of, [2]Korea Institute of Science and Technology Information, Daejeon, Korea, Republic of

This paper presents an effective methodology for reliability analysis of electromagnetic devices taking uncertainties of design parameters into account. To achieve the goal, the reliability index approach based on the first-order reliability method is adopted to deal with probabilistic constraints. The validity and efficiency of the proposed method is tested with the TEAM Workshop Problem 22 compared to Monte Carlo simulation.

P4-10: A novel adaptation approach for electromagnetic device optimization

Jun Ouyang, David Lowther
ECE Dept., McGill University, Montreal, Quebec, Canada

In order to carry out a successful case adaptation in our case-based reasoning system for EM device design, we make use of semantic networks to organize related domain knowledge, and then construct a rule system as an inference engine which is based on the network. Based on the rule system, a novel adaptation algorithm is proposed to derive a new device case from an induction motor case-base with high dimensionality.

P4-11: Bootstrapping neural network regression model for motor drive vibration optimization through genetic algorithm

FabioHenrique Pereira[1,3], Daniel Correa[2], Silvio Nabeta[3], Wanderlei Marinho Silva[2]
[1]Nove de Julho University, São Paulo, SP, Brazil, [2]Navy Technology Center in Sao Paulo, São Paulo, SP, Brazil, [3]São Paulo University, São Paulo, SP, Brazil

This work proposes an optimization procedure based on a bootstrapped neural network interpolation approach and the Genetic Algorithm method. The bootstrapped neural network is used to generate designed data sets in order to estimate a mapping from input to output space in an intrinsic experiment in a motor drive vibration study. The optimization procedure is aimed to minimize the motor vibration by adjusting some drive control parameters.

P4-12: Finite element analysis of transient electromagnetic-thermal phenomena in a squirrel cage motor working at cryogenic temperature

Mariusz Baranski, Wojciech Szelag
Poznan University of Technology, Poznań, Poland

The paper presents an algorithm for transient FE analysis of coupled electromagnetic-thermal phenomena in a squirrel cage submerged motor working at cryogenic temperature. The non-linearity of the magnetic circuit, the movement of the rotor, skewed slots, and the influence of temperature on electric and thermal properties of the materials has been taken into account. The results of the simulations and measurements are presented.

P4-13: Simulations to the influence of the Side-Metal-Effect for inductive proximity sensors using 3D eddy-current field solver

Frank Lebahn, Hendrik Krüger, Hartmut Ewald
University of Rostock, Rostock, Mecklenburg-Vorpommern, Germany

This paper deals with the optimization of a customary inductive proximity sensor. The focus in this paper lays on the significance of the side metal effect in magnetic sensors, which has remarkable influence on the accuracy of these sensors. It will be explained what the sensors field of application is and the difficulties to handle with. Furthermore, solutions for reducing the side metal effect are explained and evaluated.

P4-14: Analysis and simulation of novel hexagonal electrode electrical capacitance tomography sensor

Kostadin Brandisky[1], Dominik Sankowski[2], Robert Banasiak[2]
[1]Technical University of Sofia, Sofia, Bulgaria, [2]Technical University of Lodz, Lodz, Poland

The present paper proposes a new design of 4-layer 32-electrode cylindrical Electrical Capacitance Tomography (ECT) sensor. The novelty is the proposed hexagonal shape of the electrodes, which ensures more uniform sensitivity in the imaging area. The new sensor is analysed using the Finite Element Method and its sensitivity maps are calculated. It is shown that the new sensor will provide more uniform sensitivity in the axial direction than the commonly used rectangular shape electrode sensors.

P4-15: Numeric design engineering of a magneto-inductive foil sensor

Christoph Weissinger, Alexander Oswald, Hans-Georg Herzog
TU Munich, Institute of Energy Conversion Technology, Munich, Germany

In this paper the numeric design engineering of a magneto inductive foil sensor will be discussed. This sensor system is a position sensor which enables to measure distances with high resolution. First the approach of this project is explained and the objectives are presented. Then the build-up sequence and functional active principle of the sensor is described. Therefore appropriate models shall be used to reflect the physical effects of the device accordingly. After that we perform the numerical design engineering of the device using Finite Element Analysis (FEA). For this purpose the geometry and the complexity of the mesh will be presented. Due to the different geometric dimensions of the sensor element and the sender, represented as a permanent magnet, meshing of the whole system is very challenging. After that the comparison between simulation results and measurements are shown. We achieve quite good compliance, only about 3-5% of deviation. The conclusion and outlook, which reviews and discusses further steps, complete the paper.

P4-16: A new physical interpretation of equivalent circuit for 3-phase wye connected winding without neutral wire

Wojciech Burlikowski, Krzysztof Kluszczyński
The Silesian University of Technology, Gliwice, Poland

A paper presents a new physical interpretation of equivalent circuit for three phase wye connected winding without neutral wire. In order to formulate this interpretation a set of elementary circuit simplifications is applied. As an example a reluctance motor stator winding is used. The importance of presented idea results from the fact that wye connected stator winding without neutral wire is by far the most popular winding scheme used in industry.

P4-17: On modelling electrets and piezo-electric actuators

Alain Bossavit, Thu Trang Nguyen, Frédéric Bouillault, Xavier Mininger, Laurent Daniel
LGEP, Gif-sur-Yvette, France

Electrets and piezolectric components of various actuating devices require not to neglect displacement currents, hence a less familiar modelling than in the eddy-currents case. We review basic formulations and how to discretize them.

P4-18: Design and simulation of magnetostrictive actuator with the Terfenol-D core

Bartosz Jankowski[1], Dariusz Kapelski[1], Marcin Karbowiak[1], Marek Przybylski[1], Barbara Slusarek[1], Dorota Stachowiak[2]
[1]Tele and Radio Research Institute, Warsaw, Poland, [2]Poznan University of Technology, Poznan, Poland

This paper describes a structure of a typical actuator with magnetostrictive core. Based on equations of modified Jiles-Atherton model, algorithm and computer application for calculation of magnetomechanical hysteresis, distinctive for magnetostrictive transducers were developed. Furthermore, influence of compressive stress on maximum strain were presented.

Session P5 : Software, Algorithms & Testing

Thursday 14 April 2011: 10:30am

P5-01: Towards a case-based computational model for the creative design of electromagnetic devices

Jun Ouyang, David Lowther
ECE Dept., McGill University, Montreal, Quebec, Canada

In order to explore creativity in design, a computational model based on CBR (an approach to employing old experiences to solve new problems) and other soft computing techniques from machine learning, is proposed in this paper. The new model is able to address four challenging issues: generation of a design prototype from incomplete requirements; judgment and improvement of system performance given a sparse initial case base library; extraction of critical features from a given feature space; adaptation of retrieved previous solutions to similar problems for deriving a new solution to a given design task. The core principle employed by this model is that different knowledge from various level cases can be explicitly explored and integrated into a practical design process.

P5-02: Global and distributed torque calculations using the CDSA approach

Min Li, David Lowther
ECE Dept., McGill University, Montreal, Quebec, Canada

Accurate force and torque calculations are fundamental to being able to predict the operation of an electromechanical device or system. In addition, local distributions of torque are needed to couple to structural and vibration analyses. The conventional Maxwell stress approach cannot provide this easily. An approach based on sensitivity analysis has the potential to deliver local stress and torque values. The paper addresses this possibility.

P5-03: Amelet-HDF converters for computational electromagnetics in aeronautic projects

Janusz Rudnicki[1], Maciej Sypniewski[2]
[1]QWED sp. z o.o., Warsaw, Poland, [2]Institute of Radioelectronics, Warsaw University of Technology, Warsaw, Poland

HIRF (High Intensity Radiated Field) environment and EMC (ElectroMagnetic Compatibility) performance represent an increasingly significant system engineering issue for modern air vehicles, impacting on their functionality, safety, security, and reliability. The pervasive proliferation of all kinds of wired and wireless electronic equipment devices in every aspect of human life requires careful design and engineering methodologies to assure proper and safe functioning of products and systems in their operational environment. HIRF Synthetic Environment research project has the goal to provide to the aeronautic industry with a numerical modeling computer framework, which can be used during the development phase (including upgrade), in order to ensure adequate EM performance, but also in addition and in a considerable reduction to certification/qualification testing phase on air vehicle.

P5-04: GPU accelerated multiplatform FDTD simulator

Piotr Konczak[1], Maciej Sypniewski[2]
[1]QWED Sp. z o.o, Warsaw, 02-010, Poland, [2]Warsaw University of Technology, Warsaw, 00-665, Poland

In this paper, a few practical pieces of advice for implementing a 3D FDTD algorithm in the OpenCL library are presented. The efficiency of the methods shown is tested by comparing performance of OpenCL 3D FDTD implementation with standard C/C++ implementation.

P5-05: Comparison of automatic planar mesh generation schemes facilitating edge meshing

Tomasz Linkowski, Piotr Slobodzian
Wroclaw University of Technology, Wroclaw, Poland

In this paper, a comparison of two automatic surface mesh generation schemes is presented. One is available in a commercial application (Zeland IE3D™), and the other is a scheme proposed and implemented by one of the authors (CGSM). Each scheme uses rectangular and triangular cells and facilitates edge meshing. The comparison consists in using each scheme with the same meshing parameters to discretize several structures. Subsequently, the quality of resulting meshes is compared in terms of: their shape, the number of cells, the number of internal edges, sizes and shapes of the cells as well as the computation times.

P5-06: Efficient calculation of the resonant frequencies of a SIW resonator with FDTD-based macromodel algorithm

J Podwalski, M Mrozowski
Gdansk Uni of Technology, Gdansk, Poland

The paper presents an efficient method to analyse the Substrate Integrated Waveguide resonators. In order to compute the resonant frequencies very fast, the FDFD eigenvalue algorithm with macromodels is used.

P5-07: Evaluation of circular aperture transmission coefficients in the presence of obscurations

John Davis, Peter Shakespeare, Neil Kiley
BAE Systems, Warton, Preston, United Kingdom

This paper describes a novel parametric approach to the simulation of circular aperture transfer functions in the presence of obscurations at microwave frequencies. A novel virtual 'absorbing box' power loss integration technique is applied to successfully demonstrate its validity for conditions where the aperture diameter approaches one tenth of the plate largest dimension.

P5-08: Axisymmetric electromagnetic resonant cavities solution by a meshless local Petrov-Galerkin method

Ramon Soares, Renato Mesquita, Fernando Moreira
Federal University of Minas Gerais, Belo Horizonte/Minas Gerais, Brazil

This work describes a meshless approach to obtain the resonant frequencies of axisymmetric electromagnetic cavities. The Meshless Local Petrov-Galerkin is used with shape functions generated by Moving Least Squares. Boundary conditions are imposed by a collocation method that does not require integrations. The proposed analysis has a simple implementation and reduces computational effort. Results for TE and TM modes of a spherical cavity are in agreement with analytical solutions.

P5-09: A deflated preconditioned conjugate gradient solver for electro-quasistatic finite element simulations

Markus Clemens, Daniel Schmidthäusler
Bergische Universität Wuppertal, Wuppertal, Germany

The occurrence of materials with large differences in permittivity and conductivity has negative impact to the convergence to the preconditioned conjugate gradient solver used as a linear system solver in an implicit time integrator to solve Electro-Quasistatic Problems. Combining the preconditioned Conjugate Gradient method with a deflation technique can converging faster compared to an Incomplete Cholesky Conjugate Gradient method.

P5-10: Numerical simulation of electrical machines by means of a hybrid parallelisation using MPI and OpenMP for FEM

Stefan Boehmer, Tim Cramer, Martin Hafner, Enno Lange, Kay Hameyer
RWTH Aachen Uni, Aachen, Germany

In this paper, an hybrid parallelisation approach for the simulation of nonlinear electromagnetic problems by means of the Message Passing Interface (MPI) and the OpenMP Application Program Interface for the Finite Element Method (FEM) is investigated. After an introduction, the metrics applied to evaluate the speedup and the efficiency are outlined. By parallelising the institute's in-house FEM-package "iMOOSE" either by MPI or by OpenMP, an evaluation basis for the hybrid approach is being founded. The hybrid parallelisation approach is being evaluated on the high performance computing cluster of university's centre for computing and communication.

P5-11: Shielded cable model development for time domain CEM techniques

Chris Smartt, Steve Greedy, Dave Thomas, Christos Christopoulos, Philip Sewell
University of Nottingham, Nottingham, United Kingdom

A procedure is described which allows the wideband characterisation of shielded cables in a form suitable for direct implementation within time domain CEM modelling techniques such as TLM or FDTD. The process is based on the solution of an inverse problem.

P5-12: Coupling field analysis and non-deterministic optimization by means of multiprocessor parallel computation for characterizing magnetic anisotropy

Paolo Di Barba[1], Krzysztof Komeza[2], Ewa Napieralska Juszczak[3], J P Lecointe[3], Nabil Hihat[3]
[1]University, Pavia, Italy, [2]Technical University, Lodz, Poland, [3]Univ Lille Nord de France, Lille, France

The paper proposes an automated procedure for linking an identification algorithm implemented in a general-purpose environment (MatLab™) with a commercial Finite-Element code for magnetic field analysis (VF-Opera™). This procedure is applied to identify automatically the B-H curve of anisotropic magnetic laminations in the direction normal to the sheet surface. A multiprocessor computer made it possible to perform parallel computations. An identification procedure based on a non-deterministic algorithm allows finding the whole B-H curve for sheet samples.

P5-13: Percolation effects in electrical conductivity of carbon fibre composites

Richard Chippendale, Igor Golosnoy
University of Southampton, Southampton, United Kingdom

The effects due to percolation on the bulk electrical conductivity of Carbon Fibre Composites are studied in detail. To simulate the CFCs manufacturing process the fibres are placed randomly in the polymer matrix using Monte Carlo based simulation techniques. The electric conductivity of the CFCs was then analysed using finite element modelling.

P5-14: Modelling minor hysteresis loops by using modified Preisach technique

Turhan Karaguler
Beykent university, Istanbul, Turkey

An efficient algorithm modelling minor loops of hysteresis phenomena is presented. The new method simply modifies the well-known Preisach model with curve fitting technique using experimental data of the major hysteresis loops. The model is validated by experimentally obtained results.

P5-15: Time-dependent numerical model for localised zinc corrosion

Andrei Demeter[1,2], Vasile Topa[1], Johan Deconinck[2]
[1]Technical University of Cluj Napoca, Cluj-Napoca, Romania, [2]Vrije Universiteit Brussel, Brussel, Belgium

We developed a time-dependent numerical model for localized Zinc corrosion. The model includes mass transport of ionic species inside the liquid film on the metal surface, oxygen reduction and metal oxidation reactions and the formation of corrosion products at the metal-liquid interface. The resulting set of differential equations is discretised using the FEM and solved by the Newton method. Potential and concentrations maps are calculated in time. The simulations can resolve features that are much smaller than the available measuring techniques are able to.

P5-16: Finding a crack in a material and determining of depth

Marko Jesenik, Viktor Goričan, Anton Hamler, Mladen Trlep
University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor, Slovenia

The purpose of this paper is to find geometry of a crack (length and depth) in a conductive plate, on the basis of non-destructive testing with eddy currents. The position of a crack can be determined by taking into consideration the change in the magnetic density between the measured points. The depth is determined with the use of FEM model. The calculated test case points to an accurate determination.

P5-17: Development of a novel approach for the simulation of nanodevices using FDTD

Erping Li, Iftikhar Ahmed, Qinghuo Liu
A-STAR Institute of High Performance Computing, Singapore, Singapore

A new way for the simulation of nano-devices is presented, which consists of Schrodinger's equation, time dependent scalar and vector potential equations derived from Maxwell's equations using Lorenz gauge. For analysis the finite difference time domain (FDTD) method is applied to these equations. To validate the method a two-dimensional semiconductor nanocavity is considered and numerical results are compared with those of the analytical results.

P5-18: Lorentz force eddy current testing: modelling of permanent magnets in dynamic simulation using logical expressions

Mladen Zec, Robert Uhlig, Marek Ziolkowski, Hartmut Brauer
TU-Ilmenau, Ilmenau, Germany

The paper describes an approach for modelling of permanent magnets in dynamic electromagnetic simulations with moving structures. The method is based on an introduction of logical expressions into modelling of the moving permanent magnet domain. The present study investigates numerically and experimentally features of the presented technique through the application to Lorentz force eddy current testing (LET).

P5-19: Lorentz force eddy current testing: force dependency in respect to the lift-off distance--computation & validation

Robert Uhlig, Mladen Zec, Hartmut Brauer
Department of Advanced Electromagnetics, Ilmenau University of Technology, Ilmenau, Thuringia, Germany

Lorentz force eddy current testing is a new nondestructive testing technique that enables its user to detect and localize defects deeply inside a conductive nonmagnetic solid state body. Since the magnet flux density **B** of a permanent magnet is decaying fast in space it is necessary to validate the known model of a point-like dipole by using finite sized magnets. The paper is comparing the dipole model above an infinite plane with the numerical model of finite shaped magnets and validation experiments. Using the obtained results design criteria for measurement setups can be derived.