Analiza numerica si Reducerea Ordinului Modelelor electromagnetice

Examen de doctorat.- Programa disciplinei – Prof. Dr. Ing. Daniel Ioan

1. **Generarea modelelor numerice ale dispozitiveleor electromagnetice in regimuri statice si stationare. Extragerea parametrilor RLC**

   Modelarea geometrica si discretizara domeniilor spatiale
   Discretizarea ecuatiilor campului prin metoda integralelor finite - FIT
   Discretizarea ecuatiilor campului prin metoda elementului finit – FEM
   Discretizarea ecuatiilor campului prin metoda elementelor de frontiera – BEM
   Controlul erorii si rezolvarea adaptiva – rafinarea succesiva a reteleleor spatiale

2. **Generarea modelelor numerice ale dispozitiveleor electromagnetice in regimuri cuasistationare si general variabile**
   Discretizarea ecuatiilor campurilor variabile prin metoda integralelor finite - FIT
   Discretizarea ecuatiilor campurilor variabile prin metoda elementului finit – FEM
   Discretizarea ecuatiilor campurilor variabile prin metoda BEM
   Simularea in domeniul timpului si a frecventei. Sampling adaptiv.
   Extragerea modelelor parametrice. Analiza senzitivitatilor. Metoda campului adjunct.

3. **Reducerea ordinului sitemelor invariante in timp**
   Definitia reducerii ordinului
   Metode de reducerea ordinului sisemelor liniare prin proiectie:
      - Metode de tip Krylov, bazate pe egalitatea momentelor
      - Metode bazate pe ralizari echilibrate (SVD)
      - Metode bazate pe descompunere ortogonala proprie (POD)
   Reducerea ordinului sisemelor liniare prin metode ne-proiective
      - Reducerea ordinului prin metoda Vector Fitting (VF)
      - Esantionare adaptiva a precventelor (AFS)
      - Prezervara pasivitatii
   Metode de reducerea ordinului sisemelor neliniare
   Reducerea ordinului istemelor parametrice

4. **Aplicatii si solutii software**
   Modele electromagnetice pentru componentle pasive ale circuiteleor integrate:
   Descompunerea in subdomennii
   Modelarea redusa a interonexiunilor
   Modelarea multi-scala a interactiunilor EM prin abordari ierarhice la nivelul cipului si moduleleor
   Extragerea modelelor componentelor passive din CI cu Chamy
   Reducerea ordinului cu ROMWB

Bibliografie

1. Daniel Ioan, Gabriela Ciuprina, TUTORIAL MATERIAL - Chameleon seminar and workshop - Effective Modeling Methods for Electromagnetic Effects in RF blocks, considering variability and coupling with environment, February 11-12, 2008 – PUB

2. A. Antoulas,"A survey of model order reduction methods for large-scale systems"

3. Schilders, Wilhelmus H.; Vorst, Henk A.; Rommes, Joost (Eds.) Model Order Reduction: Theory, Research Aspects and Applications Series: Mathematics in Industry Subseries: The European Consortium for Mathematics in Industry, Vol. 13 2008, XII, 472 p. 133 illus., 53 in color., Hardcover ISBN: 978-3-540-78840-9

4. Stykel T. "Analysis and numerical solution of generalized Lyapunov equations". Ph.D. thesis, Institut fur Mathematik, Technische Universitat Berlin, 2002

5. Mehrmann, V., Stykel, T. "Balanced truncation model reduction for large-scale systems in descriptor form". In Dimension Reduction of Large-Scale Systems, Lecture Notes in Computational Science and Engineering, Vol. 45, pp. 83-115, Springer-Verlag, 2005

6. Jing Rebecca Li, "Model Reduction of Large Linear Systems via Low Rank System Gramians," Ph.D. thesis, Massachusetts Institute of Technology, 2000.

7. Michał Jerzy Rewie´nski A Trajectory Piecewise-Linear Approach to Model Order Reduction of Nonlinear Dynamical Systems, PhD Thesis at MIT, 2003

8. Eric James Grimme, "Krylov Projection Methods for Model Reduction," University of Illinois at Urbana-Champaign, 1997.

9. Yunkai Zhou, "Numerical Methods for Large Scale Matrix Equations with Applications in LTI System Model Reduction," Rice University, 2002

10. H. Sandberg, A.Rantzer, "Balanced truncation of linear time-varying systems", IEEE Transactions on Automatic Control, v. 49, No. 2, pp. 217-229
11. *Progress In Electromagnetics Research, PIER 32*
http://www.jpier.org/PIER/pier.php?volume=32

12. Peter Fleischmann **Mesh Generation for Technology CAD in Three Dimensions,**
http://www.iue.tuwien.ac.at/phd/fleischmann/diss.html

13. Per-Olof Persson, Mesh Generation for Implicit Geometries
http://math.mit.edu/~persson/thesis/persson-thesis.pdf

14. Ari Requicha Geometric Modeling: A First Course
http://www-pal.usc.edu/~requicha/book.html

15. Stanley Humphries Finite-element Methods for Electromagnetics, CRC Press, 1997
http://www.fieldp.com/femethods.html

16. O. C. Zienkiewicz, R. L. Taylor, Robert Leroy Taylor , The *finite element method*: its basis and fundamentals - 2005

17. Jianming Jin, The Finite Element Method in Electromagnetics, 2nd Edition, 2002, Wiley-IEEE Press
18. C.A. Brebbia, J. Dominguez Boundary Elements. An Introductory Course
http://www.boundaryelements.com/

19. Whye-Teong Ang A Beginner's Course in Boundary Element Methods
http://www3.ntu.edu.sg/home/mwtang/bemsite.htm

20. Alfio Borzi, Introduction to multigrid methods
http://www.ing.unisannio.it/borzi/mgintro.pdf

21. Schilders, Wilhelmus H.; Vorst, Henk A. van der; Rommes, Joost (Eds.) Model Order Reduction: Theory, Research Aspects and Applications, Springer 2008

PAGINI WEB SI SOLUTII SOFTWARE:

Retele de discretizare http://en.wikipedia.org/wiki/Mesh_generation

http://view.eecs.berkeley.edu/wiki/Structured_Grids

http://www.cs.berkeley.edu/~jrs/mesh/

http://math.mit.edu/~persson/mesh/

http://www-users.informatik.rwth-aachen.de/~roberts/meshgeneration.html

FEM http://en.wikipedia.org/wiki/Finite_element_method

http://www.comsol.com/

BEM http://en.wikipedia.org/wiki/Boundary_element_method

http://www.integratedsoft.com/papers/research/hybrid/

http://www.cvel.clemson.edu/modeling/

Multigrid http://en.wikipedia.org/wiki/Multigrid_method

http://www.math.ust.hk/~mawang/teaching/math532/mgtut.pdf

MOR http://web.mit.edu/mor/ http://modelreduction.com/
http://www.ee.kth.se/~hsan/modred.htm

Vector Fitting http://www.energy.sintef.no/produkt/VECTFIT/index.asp

SLICOT - Thematic Networks Programme NICONET, under contract number BRRT-CT97-5040, **http://www.icm.tu-bs.de/NICONET/index.html**

Matlab code for the Proper Orthogonal Decomposition (POD) and extensions developed by Tan Bui and Karen Willcox Two MATLAB standard toolboxes: control systems toolbox and robust control toolbox. http://www.mathworks.com/products/control/

ARTICOLE:

1. A. Odabasioglu, M. Celik, L. T. Pileggi, "PRIMA: passive reduced-order interconnect macromodeling algorithm,"
   IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, Vol. 17, no. 8, pp. 645-654, Aug. 1998.
2. J. R. Phillips, "Automated extraction of nonlinear circuit macromodels," in proceedings of the Custom Integrated Circuit Conference, pp. 451-454, 2000.
3. P. Feldmann, R. W. Freund, "Efficient linear circuit analysis by Pade approximation via the Lanczos process,"
   IEEE Trans. Computer-Aided Design, vol. 14, pp. 639-649, 1995.
4. Y. Chen and J. White, "A Quadratic Method for Nonlinear Model Order Reduction," International Conference on Modeling and Simulation of Microsystems, Semiconductors, Sensors and Actuators, San Diego, March 2000.
5. Z. Bai, "Krylov subspace techniques for reduced-order modeling of large-scale dynamical systems,"
   Applied Numerical Mathematics, Vol. 43, pp. 9-44, May 2002.
6. Michal Rewienski, Jacob White, "A Trajectory Piecewise-Linear Approach to Model Order Reduction and Fast Simulation of Nonlinear Circuits and Micromachined Devices," IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, v.22, no 2, pp. 155-70, 2003
7. Evgenii B. Rudnyi and Jan G. Korvink MODEL ORDER REDUCTION FOR LARGE SCALE FINITE **ELEMENT ENGINEERING MODELS** European Conference on Computational Fluid Dynamics, ECCOMAS CDF 2006, P. Wesseling, E. Oñate, J. Périaux (Eds), TU Delft, Delft The Netherland, 2006
8. R. Remis AN EFFICIENT MODEL-ORDER REDUCTION APPPROACH TO LOW-FREQUENCY TRANSMISSION LINE MODELING *Progress In Electromagnetics Research, PIER 101, 139{155, 2010*
9. Joel R. Phillips, Efficient full-wave electromagnetic analysis via model-order reduction of fast integral transforms
10. **M. Clemens and T. Weiland,** DISCRETE ELECTROMAGNETISM WITH THE FINITE INTEGRATION TECHNIQUE, *Progress In Electromagnetics Research, PIER 32, 65–87, 2001*
11. Ioan, D.; Ciuprina, G.; Reduced Order Electromagnetic Models based on dual Finite Integration Technique, 2006 IEEE Conference Electromagnetic Field Computation – CEFC, extended in Scientific Computing in Electrical Engineering Mathematics in Industry, 2007, Volume 11, Part III, 287-294
    http://160.97.10.132/comson/research/publications/2007/Ioan-SCEE06.pdf
12. Ioan-Alexandru LAZĂR, Gabriela CIUPRINA and Daniel IOAN, EFFECTIVE EXTRACTION OF Accurate REDUCED ORDER MODELS FOR HF-IC USING MULTI-CPU ARHITECTURES, OIPE Sofia 2010

13. Irina Munteanu1, Franz Hirtenfelder1Convergence of the Finite Integration Technique on Various Mesh Types, GeMiC 2005, http://duepublico.uni-duisburg-essen.de/servlets/DerivateServlet/Derivate-14581/Paper/7b_3.pdf
14. NK Nikolova, JW Bandler, MH Bakr -**Adjoint techniques** for **sensitivity** analysis in high-frequency structure CAD Microwave Theory and **Techniques**, 2004 – Citeseer
15. Gabriela Ciuprina, Daniel Ioan, Dragos Niculae, Jorge Fernández Villena and Luis Miguel Silveira, Parametric Models Based on Sensitivity Analysis for Passive Components, in Studies in Computational Intelligence, 2010
16. D. Ioan, and G. Ciuprina "Reduced order models of on-chip passive components and interconnects, Workbench and Test Structures.", in, W.H.A. Schilders, H.A. van der Vorst, J. Rommes, Eds. *Model Order Reduction: Theory, Research Aspects and Applications*, Springer series on Mathematics in Industry, Springer-Verlag, Heidelberg, 2008, pp.447-467.
17. B.Gustavsen, A.Semlyen,"Rational approximation of frequency responses by vector fitting", *IEEE Trans. Power Delivery*, vol. 14, pp.1052-1061, 1999.
18. B. Gustavsen, "Improving the pole relocating properties of vector fitting", IEEE Trans. Power Delivery, vol. 21, no. 3, pp. 1587-1592, 2006.
19. D. Deschrijver, T.Dhaene, "Passivity-based sample selection and adaptive vector fitting algorithm for pole-residue modeling of sparse frequency-domain data", Proc. Of the 2004 IEEE Int. Behavioral Modeling and Simulation Conference, pp. 68-73, 2004.
20. G.Antonini, D.Deschrijver, T.Dhaene, "Broadband rational macromodeling based on the adaptive frequency sampling algorithm and the partial element equivalent circuit method", IEEE Trans. Electromagnetic Compatibility, vol. 50, no. 1, pp. 128-137, 2008.
21. M. Clemens, T. Weiland, "Discrete electromagnetism with the finite integration technique", Progress in Electromagnetics Research (PIER), vol. 32. pp. 65-87, 2001.
22. D. Ioan, G. Ciuprina, M. Radulescu and E. Seebacher, "Compact modeling and fast simulation of on-chip interconnect lines", IEEE Trans. Magnetics, vol. 42, no. 4, pp. 547-550, 2006.
23. D. Ioan, G. Ciuprina, W. Schilders, "Parametric models based on the adjoint field technique for RF passive integrated components". IEEE Trans. Magnetics, vol. 44, no. 6, pp. 1658–1661, 2008.
24. D. Ioan, W. Schilders, G. Ciuprina, N. van der Meijs, W. Schoenmaker, "Models for integrated components coupled with theirEnvironment", COMPEL- The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, vol. 27, no.4, pp.820-829, 2008.
25. G. Ciuprina, D. Ioan, D. Mihalache, and E. Seebacher, "Domain partitioning based parametric models for passive on-chip components", Scientific Computing in Electrical Engineering SCEE 2008, in the series Mathematics in Industry (J. Roos, L. Costa Eds), Vol. 14, pp. 37-44, Springer, 2010.
26. Eric James Grimme, "Krylov Projection Methods for Model Reduction," University of Illinois at Urbana-Champaign, 1997.
27. Yunkai Zhou, "Numerical Methods for Large Scale Matrix Equations with Applications in LTI System Model Reduction," Rice University, 2002
28. A. Odabasioglu, M. Celik, L. T. Pileggi, "PRIMA: passive reduced-order interconnect macromodeling algorithm," IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, Vol. 17, no. 8, pp. 645-654, Aug. 1998.

29. J. R. Phillips, "Automated extraction of nonlinear circuit macromodels," in proceedings of the Custom Integrated Circuit Conference, pp. 451-454, 2000.
30. P. Feldmann, R. W. Freund, "Efficient linear circuit analysis by Pade approximation via the Lanczos process," IEEE Trans. Computer-Aided Design, vol. 14, pp. 639-649, 1995.
31. Y. Chen and J. White, "A Quadratic Method for Nonlinear Model Order Reduction," International Conference on Modeling and Simulation of Microsystems, Semiconductors, Sensors and Actuators, San Diego, March 2000.
32. Z. Bai, "Krylov subspace techniques for reduced-order modeling of large-scale dynamical systems," Applied Numerical Mathematics, Vol. 43, pp. 9-44, May 2002.
33. B. Gustavsen and A. Semlyen, "Rational approximation of frequency domain responses by vector fitting", *IEEE Trans. Power Delivery*, vol. 14, no. 3, pp. 1052-1061, July 1999.