IEEE MTT-S Young Professionals Workshop on Electromagnetic Modeling and Optimization

EMO 2022

NANJING, CHINA · OCT. 22, 2022

Program Book

MTT-S
IEEE MICROWAVE THEORY & TECHNOLOGY SOCIETY

EMO 2022

IEEE MTT-S Young Professional Workshop on Electromagnetic Modeling and Optimization

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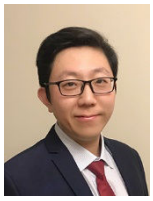

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Workshop Agenda (in China Standard Time, UTC+8)

Saturday, October 22, 2022 Zoom Conference (ID: 892 2893 9285, https://us06web.zoom.us/j/89228939285)	
Young professionals talks (Morning session) Chair: Weicong Na, *Beijing University of Technology* Shuxia Yan, *Tiangong University*	
08:30～08:35	**Welcome from Advisory Committee Chair** Q. J. Zhang, Carleton University, Canada
08:35～08:40	**Welcome from the General Chair** Jianan Zhang, Southeast University, China
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09:20～10:00	**Invited Talk 2:** **Knowledge-Guided Active Base Element Modeling in Antenna Array Design** Qi Wu, Southeast University, China

10:00～10:40	**Invited Talk 3:** **Unsupervised Microwave Filter Design based on Surrogate-assisted Optimization** Yang Yu, National Space Science Center, Chinese Academy of Sciences, China
10:40～11:20	**Invited Talk 4:** **Optimization Design of Antenna and Wireless Power Transfer** Hongcai Chen, Southeast University, China
11:20～12:00	**Invited Talk 5:** **Neuro-Space Mapping Modeling for Microwave Devices** Shuxia Yan, Tiangong University, China
Young professionals talks (Afternoon session) Chair: Wenyuan Liu, Shaanxi University of Science and Technology Wei Zhang, *Beijing University of Posts and Telecommunications*	
14:00～14:40	**Invited Talk 6:** **AI for Coding Metasurface Design and Diffractive Neural Network** Che Liu, Southeast University, China
14:40～15:20	**Invited Talk 7:** **High-Order Deep Recurrent Neural Network With Hybrid Layers for Modeling Nonlinear High-Frequency Circuits** Sayed Alireza Sadrossadat, Yazd University, Yazd, Iran

15:20～16:00	**Invited Talk 8:** **Compact, Order Extensible, and Wide-Stopband Bandpass Filter Based on SIW Cavity with Rectangular Ring Slot** Rusan Kumar Barik, Reykjavik University, Iceland
16:00～16:40	**Invited Talk 9:** **A Microwave Filter Yield Optimization Method Based on Off-Line Surrogate Model-Assisted Evolutionary Algorithm** Zhen Zhang, Guangzhou University, China
16:40～17:20	**Invited Talk 10:** **Advanced Neural Network Modeling and Electromagnetic Optimization Approaches for Microwave Passive Components** Jing Jin, Central China Normal University, China
Interaction with senior professionals (Evening session) Chair: Jianan Zhang, *Southeast University* Feng Feng, *Tianjin University*	
21:00～21:15	**Suggestions for young professionals** John W. Bandler, McMaster University, Canada
21:15～21:30	**Short presentations and comments from senior professionals** **21:35 – 21:40 Presentation 1:** Mutian Li **21:40 – 21:45 Presentation 2:** Ke Liu **21:45 – 21:50 Presentation 3:** Jiahua Lyu
21:30～21:50	**Panel session** John W. Bandler, McMaster University, Canada Zhizhang (David) Chen, Dalhousie University/Fuzhou University, Canada/China Q. J. Zhang, Carleton University, Canada Qingsha Cheng, Southern University of Science and Technology, China
21:50～21:55	**Close the workshop and thanks**

Detailed Zoom Conference Information:

Topic: 2022 IEEE MTT-S Professional Workshop on Electromagnetic Modeling and Optimization (EMO 2022)

Time: Oct 22, 2022, 08:00 AM Beijing, Shanghai

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Invited Senior Professionals

John W. Bandler, OC

McMaster University professor emeritus John Bandler, OC, is an engineer, entrepreneur, innovator, researcher, artist, speaker, and author of fiction, including stage plays. See YouTube for examples of his workshops, and his theatrical work such as *Christmas Eve at the Julibee Motel*. He wrote, produced, and directed the short 2021 film *The Caffeine Rabbit Hole*. See also his 2014 TEDx McMasterU presentation. He has published more than 500 technical papers and contributions to books, and pioneered the space mapping technology in 1993. In 1997, Hewlett-Packard acquired his company Optimization Systems Associates Inc. He won several professional awards, including the IEEE Canada McNaughton Gold Medal, and the IEEE MTT-S Microwave Application and Microwave Career awards. He is a Life Fellow of the IEEE, a Fellow of the Royal Society of Canada, and a Fellow of the Canadian Academy of Engineering. He has been honoured by a Queen Elizabeth II Diamond Jubilee Medal; appointed to Officer of the Order of Canada; and won the 2018 Gold Medal from Professional Engineers Ontario. In 2023 he receives the IEEE Electromagnetics Award for "For contributions to electromagnetic optimization and the modeling of high-frequency structures, circuits, and devices." He coaches and mentors individuals for presentations, and initiated the first ever 3MT® competition at the IEEE International Microwave Symposium in 2017, continuing annually, held virtually in 2020 and 2021. He spearheaded McMaster's first ever Department of Electrical and Computer Engineering 3MT® competition in 2018.

John W. Bandler, McMaster University, bandler@mcmaster.ca

Invited Senior Professionals

Zhizhang (David) Chen

Zhizhang Chen received the Master degree in Radio Engineering from Southeast University, P. R. China, the Ph.D. degree in Electrical Engineering from the University of Ottawa, Canada. He was an NSERC postdoctoral fellow with McGill University, Montreal, Canada. He is a professor in Electrical and Computer Engineering. He has been a guest editor, track editor, and associate editor for IEEE journals, including the IEEE Transactions on Microwave Theory and Techniques, IEEE Journal of Microwaves, and the IEEE Journal on Multiscale and Multiphysics Computational Techniques. His current research interests include time-domain electromagnetic modelling techniques, ultra-wideband wireless communication systems, and wireless power transfer. He is the Fellow of the IEEE, the Canadian Academy of Engineering and the Engineering Institute of Canada. He is the Chair of the Technical Committee on Field Theory and Computational Electromagnetics of the IEEE Microwave Theory and Technology (MTT) Society and an Ad-Com member of the IEEE Antennas and Propagation Society.

Zhizhang Chen, Dalhousie University/Fuzhou University, zz.chen@ieee.org .

Invited Senior Professionals

Qijun Zhang

Qijun Zhang received the B.Eng. degree from the Nanjing University of Science and Technology, Nanjing, China in 1982, and the Ph.D. Degree in Electrical Engineering from McMaster University, Hamilton, Canada, in 1987.

He was a research engineer with Optimization Systems Associates Inc., Dundas, Ontario, Canada during 1988-1990 developing advanced optimization software for microwave modeling and design. He joined the Department of Electronics, Carleton University, Ottawa, Canada in 1990 where he is presently a Chancellor's Professor. His research interests are modeling, optimization, and neural networks for high-speed/high-frequency electronic design. He is an author of the book Neural Networks for RF and Microwave Design (Boston: Artech House, 2000), a coeditor of Modeling and Simulation of High-Speed VLSI Interconnects (Boston: Kluwer, 1994), and a coeditor of Simulation-Driven Design Optimization and Modeling for Microwave Engineering (London, UK: Imperial College Press, 2013).

Dr. Zhang is a Fellow of the IEEE, and a Fellow of the Canadian Academy of Engineering. He is an Associate Editor for the IEEE Transactions on Microwave Theory and Techniques, and a Topic Editor for the IEEE Journal of Microwaves. He was the Chair of the Technical Committee on Design Automation (MTT-2) of the IEEE Microwave Theory and Technology (MTT) Society. He is the guest-editor of the Special Issue on AI and Machine Learning Technologies for Microwaves for the IEEE Transactions on MTT scheduled for publication in 2022.

Qijun Zhang, Carleton University
qjz@doe.carleton.ca

Invited Senior Professionals

Qingsha S. Cheng

Qingsha S. Cheng (S'00–M'05–SM'09) is currently a tenured associate professor with the Department of Electrical and Electronic Engineering, Southern University of Science and Technology (SUSTech), Shenzhen, China. He is also with Shenzhen Key Laboratory of EM Information. He received the B.Eng. and M. Eng. from Chongqing University, China. He received his Ph.D. at McMaster University, Canada in 2004. He has been with the Department of Computer Science and Technology, Peking University, China. He took various positions with the Department of Electrical and Computer Engineering, McMaster University as a post-doctoral fellow, research associate academic, research engineer and lecturer. In 2014, he joined SUSTech as an assistant professor. His research interests include smart modelling and optimization of microwave components and antennas, surrogate modelling and optimization, multi-objective optimization, and artificial intelligence. He has authored or co-authored more than 200 publications in book chapters, international technical journals, and refereed conference proceedings. His works have been cited more than 3500 times according to Google Scholar. His research is funded by the National Natural Science Foundation of China (NSFC) and the Ministry of Science and Technology (MOST) of China.

Qingsha S. Cheng, Southern University of Science and Technology,
chengqs@sustc.edu.cn

Invited Talk 1

Recent Advances in Space Mapping for EM Design Optimization

Feng Feng

School of Microelectronics,
Tianjin University

Abstract

Space mapping (SM) is a recognized engineering optimization methodology in the microwave area. The space mapping concept combines the computational efficiency of coarse models with the accuracy of fine models. The coarse models are typically empirical functions or equivalent circuit models, which are computationally efficient. However, such models are often valid only in a limited region of input space, beyond which the model predictions become inaccurate. On the other hand, detailed or "fine" models can be provided by an electromagnetic (EM) simulator, or even by direct measurements. The detailed models are accurate, but can be expensive (e.g., CPU-intensive simulations). The space mapping technique establishes a mathematical link between the coarse and the fine models and directs the bulk of the CPU-intensive computations to the coarse model, while preserving the accuracy offered by the fine model. To further speed up the optimization process, it is necessary to explore more efficient SM methods. One of the advanced methods is to introduce parallel computational techniques into SM. In practical cases, equivalent circuit coarse models are not always available. To address this situation, coarse and fine mesh SM optimization technique is presented. Further development on coarse and fine mesh SM is to incorporate mesh deformation techniques to address the continuity issue for the coarse mesh optimization, resulting in faster optimization and better convergence.

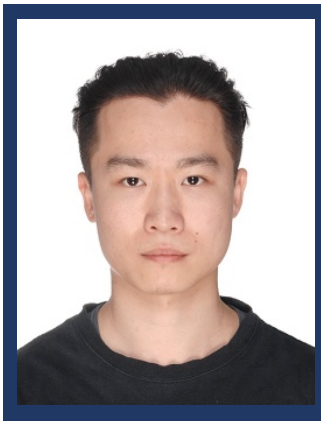
Biography

Feng Feng received the B.Eng. degree in Tianjin University, Tianjin, China, in 2012, and the Ph.D. degree in the School of Microelectronics at Tianjin University, Tianjin, China, and the Department of Electronics at Carleton University, Ottawa, ON, Canada, in 2017. From 2017 to 2020, he was a Postdoctoral Fellow in the Department of Electronics at Carleton University, Ottawa, ON, Canada. In 2020, he joined the School of Microelectronics at Tianjin University, Tianjin, China, where he is currently an Associate Professor. His research focuses on electromagnetic (EM)/multiphysics parametric modeling and design optimization algorithms, and has authored/co-authored over 100 journal and conference papers.

Dr. Feng is a member of the Technical Committee on Design Automation (MTT-2) of the IEEE Microwave Theory and Technology Society

(MTT-S). He serves as reviewer for many IEEE scientific publications, including IEEE Transactions on Microwave Theory and Techniques, IEEE Microwave and Wireless Components Letters, IEEE Access, etc. He served as the Publication Chair of IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization (NEMO) in 2015, a Session Chair and a member of Technical Program Committees of IEEE MTT-S NEMO in 2020, a Session Chair of IEEE MTT-S UK-Europe-China Workshop on Millimetre-Waves and Terahertz Technologies (UCMMT) in 2020, and the General Chair, 2021 IEEE MTT-S Young Professionals Workshop on Electromagnetic Modeling and Optimization (EMO 2021).

Invited Talk 2



Knowledge-Guided Active Base Element Modeling in Antenna Array Design

Qi Wu

State Key Laboratory of Millimeter Waves
School of Information Science and Engineering
Southeast University, China

Abstract

Machine learning (ML)-assisted antenna array design methods suffer from heavy computational burden. In this talk, a knowledge-guided active base element modeling (KG-ABEM) method is proposed for practical antenna designs to largely alleviate this burden. With the introduction of prior physical knowledge and trustworthy assumptions, the ML is only introduced to scenes where analytical methods are not able to build accurate models, which achieves great efficiency and accuracy improvement simultaneously when compared with conventional ML-assisted modeling methods. By integrating the proposed KG-ABEM into a ML-assisted optimization algorithm, fast and reliable array design is achieved. A set of design examples, including both linear and planar array design problems, are provided to validate the effectiveness and advantages of the proposed modeling and optimization method.

Biography

Qi Wu (Member, IEEE) received the B.S. degree in communication engineering from the Communication University of China, China, in 2012, and M.S. and Ph.D. degrees in electrical engineering from Southeast University, China, in 2015 and 2019, respectively. He joined the State Key Laboratory of Millimeter Waves, Southeast University, in March 2019. Now he is a Lecturer. From October 2016 to September 2017, he was a Junior Visiting Fellow at Ando and Hirokawa Laboratory, Tokyo Institute of Technology, Tokyo, Japan. He has authored and co-authored over 40 technical publications in peer reviewed international journals and conference proceedings, and over 20 patents. He was the recipient of the Honorable Mention at the student contest of IEEE APS-URSI Conference 2018, selected as the Finalist in the IEEE EuCAP 2016, the student paper contest of iWAT 2018 and the best poster contest of iWAT 2019. He has served as a reviewer for the IEEE TAP, the IEEE AWPL and the IEEE MWCL. His current research interest is AI-powered antenna and radiofrequency technologies (iART).

Invited Talk 3

Unsupervised Microwave Filter Design based on Surrogate-assisted Optimization

Yang Yu

Key Laboratory of Microwave Remote Sensing,
National Space Science Center, Chinese Academy of Sciences,
Beijing.

Abstract

Microwave filters are indispensable passive devices for modern wireless communication systems. Nowadays, electromagnetic (EM) simulation-based design process is a norm for filter designs. Many EM-based design methodologies for microwave filter design have emerged in recent years to achieve efficiency, automation, and customizability. The majority of EM-based design methods exploit low-cost models (i.e., surrogates) in various forms and artificial intelligence techniques assist the surrogate modelling and optimization processes. Focusing on surrogate assisted microwave filters designs, this talk first analysed the characteristics of the filter design based on different design objective functions and briefly reviews the-state-of-the-art microwave filter design techniques. Then, a new concept called unsupervised filter design optimization method is discussed focusing on the specific characteristics of the microwave filters. Finally, some design applications of filters and multiplexers are discussed.

Biography

Yang Yu (Member, IEEE) was born in Tianjin, P.R. China, in 1991. He received the B.Eng. degree in communication engineering and the M.Eng. degree in information and communication engineering at Tianjin Polytechnic University, Tianjin, P.R.China, in 2013 and 2016, respectively, and Ph.D. degree in electronic and electrical engineering from University of Birmingham, Birmingham, Edgbaston, U.K., in 2022. He was also a joint Ph.D. student with Southern University of Science and Technology (SUSTech), Shenzhen, P.R.China. He is currently a Special Research Assistant with Key Laboratory of Microwave Remote Sensing, National Space Science Center, Chinese Academy of Sciences, Beijing. He is also an Honorary Research Fellow with the Emerging Device Technology Group, University of Birmingham. His current research interests include synthesis and design of RF/microwave components, 3D printed and micromachined MMW/THz devices and computational intelligence techniques for engineering.

Invited Talk 4

Optimization Design of Antenna and Wireless Power Transfer

Hong Cai Chen

Southeast University, China

Abstract

As full-wave electromagnetic (EM) simulations are always time consuming, EM device optimization is time costly. Various attempts have been made to reduce the computational cost of EM device optimization, such as surrogate-assisted optimization, multifidelity optimization, and multifidelity surrogate-assisted optimization methods. It establishes a surrogate model to replace full-wave EM simulations in the design space. Then optimization algorithms such as heuristic algorithms are adopted on the surrogate rather than EM simulations. There are many surrogate-assisted optimization methods for optimization.

However, most of these methods are not efficient for EM device design because the optimal design of an EM device is usually not located at the extreme edge portion or margin of the design space. Suitable optimization methods are required for specific EM designs. This work presents our recent works on the optimization of antenna and wireless power transfer. New optimization strategies are developed based on the devices' characteristics. Optimal designs are found according to the algorithms.

Biography

Hong Cai Chen (S'17–M'18) received the B.S. degree in electronic science from Hefei University of Technology, Hefei, China, in 2012, and the Ph.D degree in electrical engineering from Hong Kong Polytechnic University, Hong Kong, in 2018. From February 2017 to August 2017, he was a visiting scholar at Duke University, Durham, NC, USA. From July 2018 to September 2021, he was a Research Assistant Professor with Academy for Advanced Interdisciplinary Studies, Southern University of Science and Technology, Shenzhen, China.

He is currently an Associate Professor with the School of Automation at Southeast University, Nanjing, China. His research interests are electromagnetic compatibility, electromagnetic optimization design, intelligent fault detection and wireless power transfer.

Invited Talk 5

Neuro-Space Mapping Modeling for Microwave Devices

Shuxia Yan
Tiangong University

Abstract

In the RF/microwave design area, the learning and generalization features of artificial neural networks have provided a unique capability to address challenges in modeling and design. The Neuro-space mapping (Neuro-SM) technique uses a novel formulation of space mapping with a neural network to automatically modify the behavior of the existing device model to accurately match new device behavior. The Neuro-SM model retains the speed of the existing device model while improving the model accuracy. This talk will discuss the Neuro-SM modeling method. Several model structures and training methods will be outlined and discussed. Moreover, the application of Neuro-SM to electromagnetic and nonlinear device modeling will be reported, showing the accuracy and efficiency of the method.

Biography

Shuxia Yan received the B. Eng. degree in communication engineering from Tianjin Polytechnic University, Tianjin, China, in 2010, and the M.E. and Ph.D. degree in electromagnetic field and microwave technology from Tianjin University, Tianjin, China, in 2012 and 2015, respectively. Since 2015, she has been with the School of Electronics and Information Engineering, Tiangong University. Her main research interests are neural-net-work-based methods for microwave device modeling and circuit design and the development of a neuralnetwork-based circuit simulator.

Invited Talk 6

AI for Coding Metasurface Design and Diffractive Neural Network

Che Liu

State Key Laboratory of Millimeter Waves
School of Information Science and Engineering
Southeast University, China

Abstract

Metamaterials and metasurfaces have inspired worldwide interest in the recent two decades due to their extraordinary performance in controlling material parameters and electromagnetic properties. The concepts of digital coding and programmable metasurfaces proposed in 2014 further opened a new perspective to characterize and design metasurfaces in a digital way. In this talk, the artificial intelligence methods for automatic coding metasuface design will be introduced. Meanwhile, an unsupervised deep learning method for real-time intelligent coding metasurface holograms will be demonstrated. Lastly, a fully programmable AI machine (PAIM) using multiple layers of information metasurfaces will be displayed, which can directly receive EM waves in free space, and achieve direct calculations in wave space by adjusting the transmission gains of meta-atoms with a wide dynamic control range. The experimental demonstrations with a prototype of PAIM will also be introduced for various functions including programmable image recognition, automatic beam focusing, and wireless communications.

Biography

Che Liu (Member, IEEE) was born in Suzhou, Jiangsu, China, in 1993. He received the B.Eng. and Ph.D. degrees in information science and technology from Southeast University, Nanjing, China in 2015 and 2022, respectively. He joined the State Key Laboratory of Millimeter Waves, Southeast University, in June 2022. Now he is a Post doctor. He was awarded the fellowship of China National Postdoctoral Program for Innovation Talents in 2022. His research fields mainly include computational electromagnetic, metamaterial, deep learning, etc. He is committed to use artificial intelligence technology solving electromagnetic issues, including RCS simulation, ISAR imaging, holographic imaging, inverse scattering imaging, automatic antenna design, diffraction neural network, etc.

Invited Talk 7

High-Order Deep Recurrent Neural Network With Hybrid Layers for Modeling Nonlinear High-Frequency Circuits

Sayed Alireza Sadrossadat

Department of Computer Engineering,
Yazd University

Abstract

A new technique for macromodeling of high-frequency circuits called high-order deep recurrent neural network (HODRNN) is presented. This technique explores an alternative approach to learn RNN for time dependencies in more efficient way resulting in more accurate model. HODRNN uses more memory units to track previous hidden states, all of which are returned to the hidden layers as feedback through various weight paths. Moreover, new improved structure called Hybrid-HODRNN is proposed for further increasing the modeling accuracy of HODRNN. The proposed Hybrid-HODRNN uses hybrid layers with both single and high orders for taking advantage of HODRNN and also reducing the overfitting problem which finally leads to more accurate model. Additionally, the proposed method requires less training signals compared to the conventional shallow and deep RNNs in order to create a model with similar accuracy. Also, the obtained models from the proposed method are considerably faster than the transistor-level models while having similar accuracy. By presenting the modeling results of three high-frequency circuits, we conclude that the HODRNN and its Hybrid structure offer the ability to create a better macromodel than the conventional RNN which verifies the superiority of the new macromodeling techniques.

Biography

Sayed Alireza Sadrossadat received the B.S. degree from University of Tehran, Iran, in 2007, the master's degree from University of Waterloo, Canada, in 2010, and Ph.D. degree from Carleton University, Canada, in 2015. He is currently the Chair of the Artificial Intelligence Group, Department of Computer Engineering, Yazd University, Yazd, Iran. His current research interests include neural network-based modeling and optimization of linear/nonlinear components, computer-aided design, deep learning, VLSI design and yield maximization.

Dr. Sadrossadat has been a Technical Reviewer for several IEEE/IET journals, such as IEEE TRANSACTIONS ON NEURAL NETWORK AND LEARNING SYSTEMS, IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUE, IEEE TRANSACTIONS ON VERY LARGE-SCALE INTEGRATION SYSTEMS, IET Microwave and Propagation, IET Electronic Letters, and IEEE CANADIAN JOURNAL OF ELECTRICAL AND COMPUTER ENGINEERING.

Invited Talk 8

Compact, Order Extensible, and Wide-Stopband Bandpass Filter Based on SIW Cavity with Rectangular Ring Slot

Rusan Kumar Barik

Engineering Optimization & Modeling Center (EOMC)
Department of Electrical Engineering
Reykjavik University

Abstract

This talk introduces novel architectures of bandpass filters (BPFs) using a substrate integrated waveguide (SIW) cavity with a rectangular ring slot (RRS) for compact size, extensible order, and broad stopband responses. Two bandpass filters, which demonstrate a second- and a fourth-order Chebyshev response, respectively, are realized by employing identical cavities with RRS, without increasing the physical size of the circuit. The working principles of the filters are illustrated by applying the eigenmode analysis, field distribution, and the coupling matrix. Finally, a second-order BPF centered at 0.87 GHz, and a fourth-order BPF centered at 0.92 GHz are synthesized, fabricated, and experimentally validated. As compared to the earlier works, the proposed fourth-order BPF offers competitive performance with a low insertion loss of 0.7 dB, compact size of $0.036\lambda^2$, and a wide passband of 22.1%. Additionally, the second-and the fourth-order BPFs achieve wide upper stopband responses of $3.86f_0$ at a level greater than 20dB and $3.98f_0$ at a level greater than 30dB, respectively.

Biography

Rusan Kumar Barik (Member, IEEE) received his BTech degree in Electronics and Communication Engineering from the Biju Patnaik University of Technology, Rourkela, India in 2012, an MTech degree in Communication Systems Design, and a Ph.D. degree in Electronics Engineering from the Indian Institute of Information Technology, India in 2015 and 2018, respectively. He joined the Department of Electronics and Communication Engineering, Christ University Bangalore, India, as an assistant professor in 2018. In 2019, he joined a post-doctoral researcher in the Department of Electrical and Electronic Engineering, Southern University of Science and Technology, Shenzhen, China. Currently, he is working as a post-doctoral researcher with the Engineering Optimization & Modeling Center (EOMC), Department of Electrical Engineering, Reykjavik University, Iceland. His research interests include multiband microwave devices, SIW components, surrogate-based modeling, and optimization.

Invited Talk 9

A Microwave Filter Yield Optimization Method Based on Off-Line Surrogate Model-Assisted Evolutionary Algorithm

Zhen Zhang

Guangzhou University

Abstract

Most existing microwave filter yield optimization methods target a small number of sensitive design variables (e.g., around 5). However, for many real-world cases, more than ten sensitive design variables need to be considered. Due to the complexity, yield optimization quality and efficiency become challenges. Hence, a new method, called yield optimization for filters based on the surrogate model-assisted evolutionary algorithm (YSMA), is proposed. The fundamental idea of YSMA is to construct a single high-accuracy surrogate model offline, which fully replaces electromagnetic (EM) simulations in the entire yield optimization process. Global optimization is then enabled to find designs with substantial yield improvement efficiently using the surrogate model. To reduce the number of necessary samples (i.e., EM simulations) while obtaining the required prediction accuracy, a customized machine learning technique is proposed. The performance of YSMA is demonstrated by two real-world examples with 11 and 14 design variables, respectively. Experimental results show the advantages of YSMA compared to the current dominant sequential online surrogate model-based local optimization methods.

Biography

Zhen Zhang (Member, IEEE) received the Ph.D degree from the Harbin Institute of Technology, Harbin, China, in 2022. From 2020 to 2022, she was a Visiting Ph.D. Student with the University of Glasgow, Glasgow U.K. She is currently a lecturer with School of Electronics and Communication Engineering, Guangzhou University, Guangzhou, China. Her research interests include antenna design optimization, rapid design optimization method of microwave components, uncertainty analysis, and yield optimization, reconfigurable intelligent surfaces modeling, and optimization.

Invited Talk 10

Advanced Neural Network Modeling and Electromagnetic Optimization Approaches for Microwave Passive Components

Jing Jin

Central China Normal University

Abstract

Microwave modeling and optimization techniques play important roles in electromagnetic (EM)-based microwave component design. We propose a new deep neural network technique employing both the sigmoid function and the smooth ReLUs as activation functions to solve high-dimensional microwave modeling problems which are more challenging than those solved by previous shallow neural networks. We further investigate the efficient surrogate-based EM optimization method and propose an advanced cognition-driven EM optimization method for EM geometry optimization of microwave filters. We propose to extract transfer function-based feature parameters for optimization to address the challenge that the features cannot be clearly and explicitly identified from the filter response. Multiple transfer function-based feature parameters are extracted and used to develop the feature surrogate model for the proposed cognition-driven optimization. The proposed method can achieve faster convergence than existing feature-assisted EM optimization methods. Moreover, we propose an efficient EM topology optimization technique for microwave component design. A new method to integrate Matrix Pade via Lanczos (MPVL) and Householder formula is proposed to reduce the effort of solving the large finite element method (FEM) matrix equation at many frequencies to the effort of solving only a small matrix problem at a single frequency point, thereby speeding up the topology optimization process. We further propose a new method exploiting the inheritance pattern of genetic algorithm (GA) to further reduce the computational expense. The proposed technique incorporating advanced FEM-MPVL and the inheritance pattern of GA can greatly accelerate the topology optimization process.

Biography

Jing Jin received the B. Eng degree from Wuhan University, Wuhan, China, in 2014. She received the Ph.D. degree in the School of Microelectronics, Tianjin University, Tianjin, China, and the Department of Electronics at Carleton University, Ottawa, ON, Canada, in 2021. She joined the College of Physical Science and Technology, Central China Normal University, Wuhan, China in 2021, where she is currently an associate researcher. Her research interests include microwave circuit modeling and design, deep neural network technique for microwave modeling, surrogate-based EM optimization, and EM topology optimization. She has authored/co-authored more than 30 journal and conference papers. Her publications have been cited more than 400 times according to Google Scholar.

Technical Sponsor

IEEE MTT-S Technical Committee on Design Automation (TC-2)