Characteristic Modes Special Interest Group

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Scholar Spotlight:

Hui Li (S'08-M'13-SM'19) received the B.E. degree in Optical Engineering from Tianjin University (TJU), China, in 2007 and Ph.D degree in Electrical Engineering from the Royal Institute of Technology (KTH), Sweden, in 2012. From 2012 to 2015, she was a postdoc researcher at the Department of Electrical and Information Technology, Lund University, Sweden.

She is currently a professor with Dalian University of Technology, and a visiting professor at Tohoku University. Her current research interests include compact antennas in MIMO systems, theory of characteristic mode, RFID antennas, mobile terminal antenna, antenna-user interactions, wearable antennas and reconfigurable antennas in wireless communications.

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Featured Article

"Reducing Hand Effect on Mobile Handset Antennas by Shaping Radiation Patterns", *by Hui Li et al.*

User interaction can significantly degrade handset antenna performances through frequency detuning and absorption. In this work, the relationships between the hand effects and the radiation patterns of the antennas are investigated using characteristic mode theory. Firstly, the characteristic far fields of a typical monopole-loaded handset antenna with metal frames have been investigated at two frequency bands, as presented by modes 1-6 in Fig. 1 for the low band. Afterwards, the radiation patterns of the handset antenna are simulated and obtained in two different scenarios, i.e., in free space and with hand, using full wave simulations. The total antenna patterns in two scenarios are obtained, as given in Fig. 1. Those patterns are mapped to the characteristic mode patterns by calculating the weighting coefficients α_n, which stand for the field contributions of the modes.

Less variation in the weighting coefficient indicates that the mode is robust to hand loading. Take the modes at 1.7 GHz as an example in Fig. 2. Mode 3, with a bi-conical pattern, suffers little from the hand loading and contributes the most to the total radiation in different user scenarios. As a result, the handset antenna is less influenced by the hand, with efficiency degradations of 4.75 dB and 3 dB, respectively, with left hand and right hand loadings. The efficiency drops more for the antenna loaded with the left hand due to larger coefficient variations.

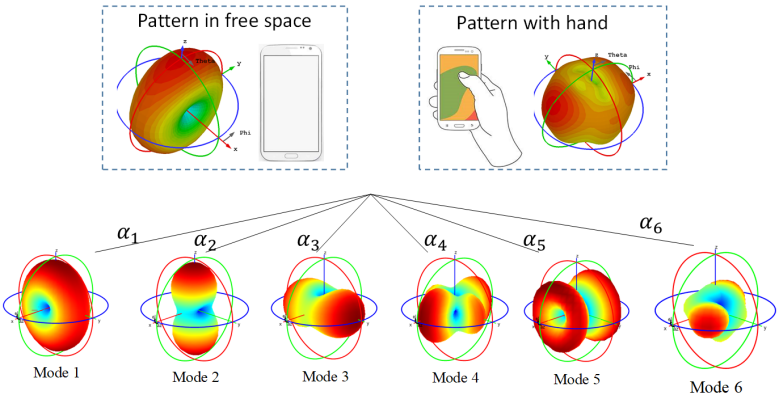

Figure 1: Mapping of total radiation patterns at different scenarios to the characteristic patterns in free space.

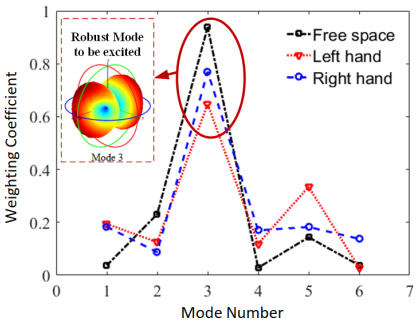

Figure 2: Absolute values of the weighting coefficients for the characteristic patterns in free space, with left and right hands at 1.7 GHz.

The robust modes are found to share the same feature that the mode radiate little power towards the boresight and the backward direction. Accordingly, robust antenna is designed with pattern synthesis, which radiates little power towards the boresight direction. Compared with the reference antenna with the same feeding location, the efficiencies of the synthesized antenna have been improved by 4.1 dB and 6.3 dB, respectively, for the left hand and right hand scenarios. Experiments have been carried out for the hand effects, with the measured results agreeing reasonably with the simulated ones. Apart from the user effect, the proposed method of characteristic mode mapping can also be applied to design antennas in other unstable environments, such as RFID antennas on different background materials.

News and Events

1. EuCAP 2022 Madrid – as usual, CM-SIG is active at EuCAPs. In Madrid, we will have a CM Convened Session and our annual members meeting. We hope that many of you can make it there despite the pandemic. The annual meeting will be held on Wed, 30 March 2022, 14.00-15.00, in "Buenos Aires".
2. IEEE Antennas and Propagation Magazine's CM Special Issue has been finalized for publication in the April issue. Many in our CM-SIG have worked hard to make this happen, and we hope it can contribute to more awareness of this topic and newcomers who can bring in fresh ideas.
3. A special session on recent developments in the theory of characteristic modes and its applications to modern antenna systems will be held at the 2022 IEEE APS/URSI conference in Denver CO, July 10-15 2022. The conveners are Binbin Yang (NC A&T State University) and Nader Behdad (University of Wisconsin-Madison).

New Member Introduction

Bio: Arturo Mediano is a member of the Group of Power Electronics and Microelectronics (GEPM) at the Engineering Research Institute of Aragon (I3A). He received his M.Sc. (1990) and his Ph.D. (1997) in Electrical Engineering from University of Zaragoza (Spain), where he has held a teaching professorship in EMI/EMC/RF/SI from 1992. He is the founder of The HF-Magic Lab®, a specialized laboratory for design, diagnostic, troubleshooting, and training in the EMI/EMC/SI and RF fields at I3A (University of Zaragoza). Click here for full profile.

View on CMA: *"With a lot of experience in EMI/EMC and RF design and troubleshooting CMA appears to be a very interesting field for research in the next years. New in this topic (we have started a few years ago for some industrial and telecommunication projects) and we have discovered a powerful tool to understand how systems can radiate intentionally (ANTENNAS) or unintentionally (EMI/EMC)."*

Summary of CMA Research: *Same as Miguel Labodía section.*

Bio: Miguel Labodia received his M.Sc. (1990) in Electronics Eng. from the University of Zaragoza (Spain), a member of IEEE. He is currently working as a researcher in the Group of Power Electronics and Microelectronics (GEPM) at the Eng. Research Institute of Aragon (I3A). The research group's projects are related to electronic and RF radio frequency systems, EMI/EMC, IoT antenna design, and human exposure to EM fields. He is currently developing his doctoral thesis related to these fields.

View on CMA: *"Specialized in the numerical simulation of electromagnetic fields (ANSYS) for a few years, we have known the method of Characteristic Modes. We have found that CMA greatly facilitates the physical understanding of the behavior of EM fields and systematizes the process of adapting the geometry of a new antenna to the system in which it must be installed."*

Summary of CMA Research: *"We have applied CMA regularly in all the projects our working group tackles, both in the design of antennas and in the behavior of EMI/EMC interference. We have experience using it in consumer and industrial applications that incorporate radiant systems. We have applied for two patents, pending granting, in which CMA is used for the treatment of electromagnetic fields in consumer appliances."*

Resources

Open Source Tools for CMA:

- FEKO-student edition
- CM MATLAB Software
- Antenna Toolbox for MATLAB (AToM)

Webinars:

- Our webinars on YouTube
- Our webinars on Bilibili
- Webinars from FEKO

Benchmarking Activity:

- Benchmarking in 2018

Available Courses:

- Courses offered by ESoA

Past Special Issues on CMA:

- Special issue on TCM in the July 2016 issue of IEEE Transactions on Antennas and Propagation.

Past Issues of CM-SIG Newsletter:

- CM-SIG Newsletter

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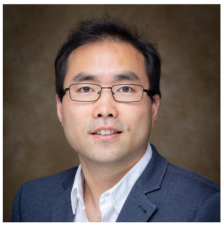

About CM-SIG: Characteristic Modes-Special Interest Group was initiated at the Special Session on CMs during the 2014, IEEE International Symposium on Antennas and Propagation in Memphis, TN, on 10 July 2014. CM-SIG was formed as a platform to promote technical activities in the field of CMs. For more information, please visit our website: http://www.characteristicmodes.org/.