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Area: Microwave & Radio Frequency

Host: Assoc Prof Chen Xudong

TOPIC	**:**	**Nature of Antenna Radiation Revealed by Full-wave Micro-Modeling Circuit**
SPEAKER	**:**	**Prof. Ke-Li Wu** **Dept of Electronic Engineering,** **The Chinese University of Hong Kong**
DATE	**:**	**16 December 2019, Monday**
TIME	**:**	**10am to 11.30am**
VENUE	**:**	**E3-06-01, Engineering Block E3, Faculty of Engineering, NUS**

ABSTRACT

Since Guglielmo Marconi employed antennas and sent the first ever wireless communication over the Bristol Channel with the message “Are you ready” on 13 May 1897, the antenna has become an indispensable tool in the daily lives of human beings for transmitting and receiving signals through radio waves. Since then, efforts to elucidate the fundamental principles of antennas have never been ceased. Among these works, finding a physically sensible circuit model of an antenna that could represent the essence of the antenna has long constituted a challenge, as a circuit model is the most familiar tool to engineers. A physical circuit model of an antenna will not only facilitate antenna design specifically but also provide a novel way to understand the fundamental mechanisms of antennas in general.

This talk will be started by reviewing the theory of full-wave generalized partial element equivalent circuit (G-PEEC). The G-PEEC model is the only passive full-wave circuit model for general EM problem. Its real valued self- and mutual-capacitance and inductance are associated to the charge and current meshes, respectively. Having introduced the static capacitances, the complex inductance incorporates all the radiation effect. Derived from the G-PEEC) model based on a physically inspired equivalent circuit transformation, a physical meaningful concise micro-modeling circuit can be obtained. The basic theory, algorithm, and its passivity enforcement of the micro-modeling circuit will be discussed in detail in the talk.

To investigate the nature of antenna radiation, the full-wave micro-modeling circuit (MMC) developed recently for interconnection problems can be employed. The MMC provides a new perspective to describe an antenna problem from a sensible and holistic circuit point of view. In addition to traditional antenna characteristics, such as input impedance and resonance modes, most significantly, the circuit model comprises a holographic radiation diagram that explains how positive and negative radiated power are associated with antenna geometry. It is found that, for a given antenna configuration, each self-radiation resistance of one antenna segment contribute to positive radiated energy, some mutual radiation resistances associated with interactions among antenna segments contribute to positive radiated energy, and the others contribute to negative radiated energy (absorbed energy). In contrast with classic antenna theories, which only predict the limitation of radiation efficiency in a broad sense, it will be shown in this talk that MMC is able to explain how the positive and negative radiated power contributed by mutual resistance determine the radiation efficiency. The revealed nature of antenna radiation should enable new ways to create efficient antennas for various wireless applications.

BIOGRAPHY

Ke-Li Wu received the B.S. and M.Eng. degrees from the Nanjing University of Science and Technology, Nanjing, China, in 1982 and 1985, respectively, and the Ph.D. degree from Laval University, Quebec, QC, Canada, in 1989. From 1989 to 1993, he was with the Communications Research Laboratory, McMaster University, as a Research Engineer and a Group Manager. In March 1993, he joined the Corporate R&D Division, COM DEV (now Honeywell Aerospace), Cambridge, ON Canada, where he was a Principal Member of Technical Staff. Since October 1999, he has been with The Chinese University of Hong Kong, Hong Kong, where he is a Professor and the Director of the Radiofrequency Radiation Research Laboratory (R3L).

He has authored or coauthored numerous publications in the areas of EM modeling and microwave passive components, microwave filter and antenna engineering. His current research interests include electromagnetic modeling of high speed circuits, RF and microwave passive circuits and systems, robot automatic tuning of microwave filters, MIMO array antennas for wireless communications, and IoT technologies and applications.

Prof. Wu is a Fellow of IEEE, a member of IEEE MTT-8 subcommittee (Filters and Passive Components) and also serves as a TPC member for many prestigious international conferences including International Microwave Symposium. He was an Associate Editor of IEEE Transactions on MTT from 2006 to 2009. He was the recipient of the 1998 COM DEV Achievement Award and Asia Pacific Microwave Conference Prize in 2008 and 2012.