A Novel Meshless Method for Solving Electromagnetic Problems

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Level: Intermediate
Time: Feb 9, 2025 4:00 PM to 6:00 PM Pacific Time (US and Canada)

Abstract

Volume integral equations (VIEs) are indispensable for solving inhomogeneous or anisotropic electromagnetic (EM) problems by integral equation approach. The solution of VIEs strongly relies on the appropriate discretization of volume integral domains, and tetrahedral discretization is usually preferred for arbitrarily-shaped geometries. Unlike discretizing a surface domain, the discretization of a volume domain could be very difficult in practice and special commercial software is needed in general even for a simple and regular geometry. To reduce the cost of descretizing volume domains, especially remove the constraint of mesh conformity required by the traditional method of moments (MoM), we propose a novel meshless method for solving the VIEs recently. The method is based on the transformation of volume integrals into boundary or surface integrals through the Green–Gauss theorem when integral kernels are regularized by excluding a small cylinder or cube enclosing an observation node. The original integral domain represented by the object is also expanded to a cylindrical or cubic domain circumscribing the object to facilitate the evaluation of boundary integrals. The singular integrals over the small cylinder or cube are specially handled with singularity subtraction techniques. Several numerical examples for solving typical EM problems are presented to illustrate the method and good results can be observed.

Bio

Meisong Tong received the B.S. and M.S. Degrees from Huazhong University of Science and Technology, Wuhan, China, respectively, and Ph.D. degree from Arizona State University, Tempe, Arizona, USA, all in electrical engineering. He is currently a Humboldt professor in the Chair of High-Frequency Engineering, Technical University of Munich, Munich, Germany, and is on leave from the Distinguished/Permanent Professor and Head of Department of Electronic Science and Technology, and Vice Dean of College of Microelectronics, Tongji University, Shanghai, China. He has also held an adjunct professorship at the University of Illinois at Urbana-Champaign, Urbana, Illinois, USA, and an honorary professorship at the University of Hong Kong, China. He has published more than 700 papers in refereed journals and conference proceedings and co-authored eight books or book chapters. His research interests include electromagnetic field theory, antenna theory and technique, modeling and simulation of RF/microwave circuits and devices, interconnect and packaging analysis, inverse electromagnetic scattering for imaging, and computational electromagnetics.

Prof. Tong is a Fellow of the Electromagnetics Academy, Fellow of the Japan Society for the Promotion of Science (JSPS), and Member (Commission B) of the USNC/URSI. He has been the chair of Shanghai Chapter since 2014 and the chair of SIGHT committee in 2018, respectively, in IEEE Antennas and Propagation Society. He has served as an associate editor or guest editor for several well-known international journals, including IEEE Antennas and Propagation Magazine, IEEE Transactions on Antennas and Propagation, IEEE Transactions on Components, Packaging and Manufacturing Technology, International Journal of Numerical Modeling: Electronic Networks, Devices and Fields, Progress in Electromagnetics Research, and Journal of Electromagnetic Waves and Applications, etc. He also frequently served as a session organizer/chair, technical program committee member/chair, and general chair for some prestigious international conferences. He was the recipient of a Visiting Professorship Award from Kyoto University, Japan, in 2012, and from University of Hong Kong, China, 2013. He advised and

coauthored 15 papers that received the Best Student Paper Award from different international conferences. He was the recipient of the Travel Fellowship Award of USNC/URSI for the 31th General Assembly and Scientific Symposium (GASS) in 2014, Advance Award of Science and Technology of Shanghai Municipal Government in 2015, Fellowship Award of JSPS in 2016, Innovation Award of Universities' Achievements of Ministry of Education of China in 2017, Innovation Achievement Award of Industry-Academia-Research Collaboration of China in 2019, "Jinqiao" Award of Technology Market Association of China in 2020, Baosteel Education Award of China in 2021, Carl Friedrich von Siemens Research Award of the Alexander von Humboldt Foundation of Germany in 2023, and Technical Achievement Award of Applied Computational Electromagnetic Society (ACES) of USA in 2024. In 2018, he was selected as the Distinguished Lecturer (DL) of IEEE Antennas and Propagation Society for 2019-2022.