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Recent Advances in the Shooting and Bouncing Rays (SBR) Method for Practical Applications

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The shooting and bouncing rays (SBR) method extends back to the 1980s as an asymptotic technique for solving RCS and installed antenna problems on electrically large structures. In this presentation, SBR is understood to be a technique where geometrical optics (GO) rays are launched from a radiation source to a scattering object, and these rays are used to "paint" physical optics (PO) currents on the target. The scattered field is determined by radiating the currents. SBR can be summarized as an efficient technique for extending PO to multiple bounces using GO ray tracing.
An important limitation of traditional SBR is its exclusive reliance on GO as the mechanism for capturing interaction effects between different parts of the scatterer. However, a more general understanding SBR, which we distinguish as SBR+, allows the full array of well-established UTD techniques, such as edge diffraction and creeping wave rays, to be deployed to model interactions within the scatterer. That is, any legitimate UTD ray path can be used to paint PO-like equivalent currents, not just the GO rays at the foundation of a UTD solution. This is particularly important where regions of the scattering geometry in the shadow of GO rays have surface currents that create significant field contributions to a region observation points or angles. This presentation focuses on the implementation of SBR at Delcross Technologies, including these enhancements that help allow SBR to reach its full potential. Numeric examples are presented based on Delcross' Savant commercial package for installed antenna performance prediction. Current SBR research challenges are also identified.

BIOGRAPHY

Dr. Kipp received a B.S. in Electric Engineering and a B.S. in Mathematics from Rose-Hulman Institute of Technology in 1987. He earned a M.S (1990) and Ph.D. (1993) in Electrical Engineering at University of Washington. His Ph.D. dissertation was on mixed-potential integral equation solutions for layered media structures, high-frequency interconnects, and frequency selective surfaces.

From 1993 to 2006, Dr. Kipp served as a senior research scientist with SAIC (Champaign, IL). He was principal investigator on multiple projects for development of electromagnetic modeling and visualization tools for radar, antenna, electronic warfare, and radio wave propagation applications, focusing on the implementation of SBR and UTD ray tracing for these problems.

Since co-founding Delcross Technologies with Matthew Miller in 2006, Dr. Kipp has served as its Chief Scientist, working in the Chicago office. His research and development work has centered on implementation and enhancement of SBR for installed antenna and RCS applications, including hybridization with full-wave solvers. He is the product lead and original developer of Savant, a widely respected commercial tool based on SBR for predicting the stand-alone performance and co-site interference of multiple antennas installed on realistic platforms and vehicles.

Dr. Kipp has authored 11 peer-reviewed journal papers and 25 conference papers in the area of computational electromagnetics.