

A Method of Moments Formulation for Numerically Efficient Analysis of Problems Involving 3D Uniaxial Media

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An efficient Method of Moments (MoM) technique which utilizes modified RWG basis has been used in the past for numerically efficient analysis of problems that involved isotropic and uniform media (K. Sharma, “Techniques for Numerically Efficient Analysis of Multi-scale Problems in Computational Electromagnetics,” PhD Dissertation, The Pennsylvania State University, Dec. 2017). Using the aforementioned technique, scattered fields were obtained in closed-forms, thus facilitating efficient matrix computation. In this paper, we introduce a Method of Moments formulation which utilizes modified RWG basis and closed-form dyadic Green’s functions (G. Mumcu, K. Sertel, and J. L. Volakis, “Surface Integral Equation Solutions for Modeling 3-D Uniaxial Media Using Closed-Form Dyadic Green’s Functions,” IEEE Transactions on Antennas and Propagation, vol. 56, no. 8, Aug. 2008) to handle problems involving 3D uniaxial media. The numerical analysis herein involves a uniaxial medium characterized by the constitutive relations as shown in Eq. (1) below.

$$\bar{\epsilon} = \epsilon_{\perp} \bar{I} + (\epsilon_{\parallel} - \epsilon_{\perp}) \hat{c} \hat{c} \quad \text{and} \quad \bar{\mu} = \mu_{\perp} \bar{I} + (\mu_{\parallel} - \mu_{\perp}) \hat{c} \hat{c} \quad (1)$$

In the above equation, $\epsilon_{\parallel}$ is the relative permittivity along the distinguished axis ($\hat{c}$ or $\parallel$ axis) and $\epsilon_{\perp}$ is along the other directions ($\hat{a}$ or $\perp$ axis) perpendicular to the $\parallel$ axis. Similarly, $\mu_{\parallel}$ and $\mu_{\perp}$ are the relative permeability along the $\parallel$ and $\perp$ axis, respectively. $\bar{I}$ denotes the identity dyad.

The current distribution along a current path on the modified RWG basis function and the associated testing procedure for matrix evaluation is shown below in Fig. 1.

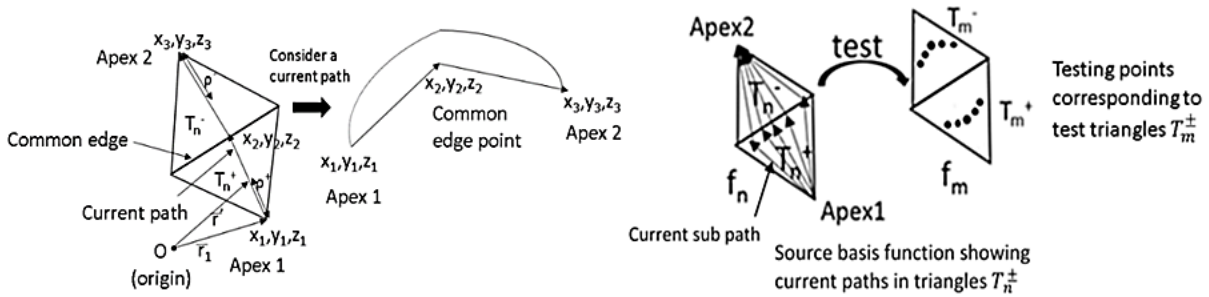


Figure 1. Current distribution along a current path on the modified RWG basis function (left) and testing procedure associated with the modified RWG basis function (right).

Scattered field expressions obtained using the proposed formulation are in closed-forms and matrix calculation is highly efficient. Additionally, the proposed formulation is stable in implementation. Comparison of numerical results obtained for different problems solved using the proposed formulation and a commercial MoM code will be discussed during the presentation.