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Original article

A new approach to the solution of electromagnetic problems with the impedance method

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Abstract

We propose a new approach based on the use of interpolation which provides a significant increase in the accuracy of electric potential calculation using the impedance method. In a rectangular three-dimensional grid, we use a first order interpolation function to describe the distribution of electric potential within each voxel of the mesh. The electric field obtained analytically from this function is used as a solution of the continuity equation applied to each node of the mesh. The system of node equations is then solved to obtain the potential distribution. The obtained results show that this technique provides better accuracy than the conventional impedance method. This approach is exemplified in this article in problems involving high dielectric constant and low conductivity media similar to biological materials.

Keywords: Impedance method; Interpolation; Continuity equation; Electrical potential calculation

1. Introduction

The impedance method and similar methods use lumped parameters of electric circuit to model the electric properties of the related materials [4,7]. Such methods have been applied in several important situations of electromagnetic modeling in linear materials [3,5,6], especially those involving excitation with sinusoidal sources, where the technique of phasor analysis can be applied. These methods are simple to implement, because they basically involve a three-dimensional mesh of rectangular voxels. Naturally, like the method of finite differences, their biggest limitation is the representation of curvilinear surfaces.

The impedance method provides accurate results when the size of the media is small compared with the wavelength of the electric field in the frequency of the source. This method is based on quasi-static approximations of Maxwell's equations, so the potential distribution can be obtained from the equations of the electric circuit theory. Thus, the conductivity and permittivity of the media are modeled by lumped circuit elements as conductance and capacitance that connect the voxels of the discretization mesh. The impedance and admittance of connection between two neighboring

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