Robust Free-Spurious Formulation of High Order 2.5 Dimensional Electromagnetic Problems by Using Finite Elements

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The 3D Finite Elements Method (FEM) is an extensively accepted tool for the analysis and design of microwaves/millimetre circuits and antennas based on the use of complex materials and geometries. Despite the huge memory capacity and computation speed of the current informatics systems, the method still suffers from an expensive computational cost when the domain is 3D. In many practical structures, the knowledge of the behaviour of one field component introduces a symmetry in the formulations that allows to project the physical problem onto a bi-dimensional mesh. The result of the former is a dramatic increase of the speed and ease of handling of such kind of problems, achieving efficient tools for the computer assisted design of many complex structures used in the electrical engineering nowadays. Because nothing is free, this simplification in the computation of the numerical problems is reached after a modification into the formulation and discretization of the model in the sense to introduce the symmetry of the field component into the basis functions. Because we need the three field components, we must divide the basis functions in two sets; one keeps the vector character and is applied to approximate the transversal or meridian component of the electromagnetic field and the other set is used for the longitudinal or azimuthal component. Then, we have to work with two elements, one is vector and the other is scalar. Frequently they are called hybrid elements, or 2.5D elements.

This type of problems has been intensively studied by many researchers along the last two decades [1], [2], [3], [4], [5], [6]. However, only lower order basis has been used and, since our knowledge, it has not been developed a theory linking the development of the function spaces for the cited two elements, vector and scalar which make up the hybrid elements. This is especially true when the order of the elements increases, producing the apparition of the frightened spurious modes. Besides of the lack of a robust method to obtain these higher order hybrid elements for the 2.5D problems, we consider that it is worth reviewing these procedures, trying to increase its reliability and robustness. It should be a priority to incorporate the use of higher-order elements to the discretization of 2.5D problems, as the last developments relative to pre and post processors, new and more powerful meshers and solvers. In this way we can develop new numerical tools facing the more complex geometries containing field singularities, diverse materials and multiscale details with curved boundaries that conform the structures that electrical engineers handle nowadays. This work is an extension with some new results of previous presented at [5], [7].

A complete study of the design of conical dielectric core horn antennas, ended by both, convex-plane and double-convex dielectric lens, is carried on, taking advantage of the robust performance of the developed methods.

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