A finite element code for solving the regularized Maxwell equations in engineering applications

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This work presents a nodal-based finite element code in frequency domain called ERMES. The novelty of this computational tool rest on the formulation behind it. ERMES (*E*lectric *R*egularized *M*axwell *E*quations with *S*ingularities) is the C++ implementation of a simplified version of the weighted regularized Maxwell equation method [1, 2]. This finite element formulation has the advantage of producing well-conditioned matrices [3, 4] and the capacity of solving problems in the low (quasi-static) and high frequency regimens. As a consequence of this versatility, ERMES has been applied successfully to microwave engineering [2], specific absorption rate computations [4, 5], electromagnetic compatibility [6] and electromagnetic metal forming [7]. In this work we will describe the main features of ERMES and its formulation (peculiarities, comparative performance with edge-based formulations,etc...). Also, we will show how to use this numerical tool for computing electromagnetic fields in a wide variety of engineering applications. The version of ERMES described in this work (executable files, documentations and source code) is freely available under request to the author.

References

[1] M. Costabel, M. Dauge, Weighted regularization of Maxwell equations in polyhedral domains, Numerische Mathematik 93 (2) (2002) 239-277.

[2] R. Otin, Regularized Maxwell equations and nodal finite elements for electromagnetic field computations, Electromagnetics 30 (1-2) (2010) 190-204.

[3] R. Otin, L. E. Garcia-Castillo, I. Martinez-Fernandez, D. Garcia- Donoro, Computational performance of a weighted regularized Maxwell equation finite element formulation, Progress In Electromagnetics Research 136 (2013) 61-77.

[4] R. Otin and H. Gromat, Specific absorption rate computations with a nodal-based finite element formulation, Progress In Electromagnetics Research 128 (2012) 399-418.

[5] R. Otin, Numerical study of the thermal effects induced by a RFID antenna in vials of blood plasma Progress In Electromagnetics Research Letters 22 (2011) 129-138.

[6] R. Otin, J. Verpoorte and H. Schippers, A finite element model for the computation of the transfer impedance of cable shields, IEEE Transactions on Electromagnetic Compatibility 53 (4) (2011) 950-958.

[7] R. Otin, A numerical model for the search of the optimum frequency in electromagnetic metal forming, International Journal of Solids and Structures 50 (10) (2013) 1605-1612.