Temporal Basis of Weighted Laguerre Polynomials in Finite Element Method

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The finite element method in time-domain (FETD) provides a direct way of solving transient electromagnetic problems. Also, FETD allows analysis of complex structures better than other numerical methods. The time-domain analysis has been usually done with a marching-on time scheme that requires much computation time if the electromagnetic problem is large and many time steps are required.

In this work, a scheme based on temporal basis functions is presented. By using a temporal basis, the transient behavior of the unknown function of the electromagnetic problem is described by a set of coefficients. In this paper the chosen basis functions are weighted Laguerre polynomials with increasing orders. The advantage of this election is that the coefficients of the derivative of a function can be handled analytically from the coefficients of the original function. This fact allows the replacement of the marching on time schemes of classical FETD methods by a recursive relation between the coefficients of different orders. The result of this procedure is a matrix linear system with different right hand vectors for each coefficient of the unknown function but with the same matrix of the linear system. Therefore the computation of all coefficients can be done very efficiently.

Two-dimensional and three-dimensional scattering problems are presented in order to show the efficiency and the accuracy of this numerical technique. Among the two-dimensional problems the incidence of a planar wave over a metallic and dielectric cylinder of infinite length is studied. The scattered electromagnetic field produced by the incidence of a planar wave over a metallic and dielectric cube is studied in order to test the numerical procedure in three-dimensional problems. In all cases a gaussian pulse is used to model the temporal variation of the incident electromagnetic wave.

The results are compared with other electromagnetic analysis tools and the agreement is excellent.