Time Domain Finite Element Method using Laguerre Polynomials as Temporal Basis Functions

Young-Seek Chung[§], Tapan Kumar Sarkar*, and Baek Ho Jung**

[§] Department of Communication Engineering, Myongji University, Yongin, Kyunggi 449-728, Korea
*Department of Electrical Engineering and Computer Science, Syracuse University, Syracuse, NY 13244
**Department of Information and Communication Engineering, Hoseo University, Asan, Chungnam 336-795, Korea

E-mail: ychung05@syr.edu, tksarkar@syr.edu, bhjung@office.hoseo.ac.kr

In recent times, the finite element method in time domain (FETD) has been introduced to analyze transient electromagnetic problems. By introducing triangular or tetrahedral elements in two or three-dimensional problem, it is easy to apply the FETD method to highly complex shaped models. And by using the Newmark-Beta method, one can obtain an unconditionally stable FETD formulation. By introducing the Newmark-Beta method, although one can eliminate the limitation of time step, the larger value of the time step causes larger numerical error.

In this paper, we propose a new unconditionally stable solution procedure for the FETD method using weighted Laguerre polynomials as temporal basis and testing functions. By introducing the temporal testing procedure, instead of the marching-on in time technique, we introduce the marching-on in order of the temporal functions. Therefore, we can obtain the unknown coefficients for the basis functions from the 0^{th} order to the N_L^{th} order by solving recursively the proposed new FETD. And also, the proposed method produces the same banded sparse system matrix as the conventional FETD method, which is independent of the order of temporal basis functions. So, assembling this sparse system matrix only once as like the conventional FETD method with the Newmark-Beta method, we can obtain the transient electromagnetic fields. Considering the bandwidth and the time interval, we can calculate the minimum number of the temporal basis functions. Numerical results are presented to illustrate the validity of this algorithm.