Neuro FDTD Technique: A New Approach to make FDTD Faster Predictor

Dhruba C. Panda[(1)], Shyam S. Pattnaik*[(1)], Rabindra K. Mishra[(2)], and O. P. Bajpai[(1)]
NITTTR, Chandigarh, India
Sambalpur University, Sambalpur, India
shyampattnaik@yahoo.com

After the land mark FDTD Concept conceived by Yee in 1996, it under gone so much of evolution. In Late 80's during its nascent stage FDTD applied for numerical modeling of electromagnetic scattering and penetration problems with the help of super computer. The objects includes complex aerospace to biological systems. In the last decade, with development of high-speed processors, the computational cost came down. Attempts have been made to reduce the computation intensive iteration of FDTD. Various techniques like code optimization, hybrid FDTD technique, parallel computations, etc have been proposed in the past to decrease the computational time of FDTD(K. L. Shlager and J. B. Schneider, IEEE Ant. & Prop Mag, 37(4), 39-57, 1995, A. Taflove & K. R. Umashankar, IEEE Proceedings, 77(5), 682-699, 1989). The focus is always to make the FDTD applications easy to implement with low computational cost. Though FDTD and its variants have finer discretization capability of complex structures and great degree of freedom compared to MoM, FEM and their variants they fail to predict modern day challenging problems in computational electromagnetics with reasonable resource and time(R. Mitra, URSI EMTS 278-280,2004).

Neural Network based FDTD technique seems to be a promising technique to cut short the iterations. In FDTD based calculations, it's not always necessary to keep record of all the field components or they are necessary at al. Field components only at some selected locations necessary for further analysis and predictions. The time series prediction capability of FIR/IIR based neural network is accurate. They are robust and stable. In the present technique fields of required location is stored. The FIR/IIR based neural network is trained with the fields. After successful training the fields at the required location can be accurately predicted for further time steps. The present techniques reduces iterations of FDTD as well as data storage problem to a great extent. However this technique will be much beneficial where the iteration take much time.

For instance, in the impedance calculation of a square patch antenna or a stacked patch antenna only 500 samples of I(t) and V(t) at feed location from FDTD can be used to train a FIR neural network. I(t) and V(t) for further step can be predicted at subsequent time steps till the evaporation of transient. FFT can be applied on these current and voltage to calculate impedance in time domain. Approximately 3500 time steps of FDTD engine can be saved assuming the 4000 iterations is enough with a 50 ohm source resistance with applied pulse.