Artificial Neural Networks Approach To Finite Elements Modeling Of Problems In Electromagnetic Engineering

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Abstract

The need to develop new computational techniques with higher effeciency is considered here in order to solve accurately and inexpensively complex and higher dimensional electromagnetic field problems. In this thesis, a new Artificial Neural Network (ANN) model is proposed from the standpoint of the topological relationship analogy between the Finite Element Method (FEM) and ANN, and due to the main property of the Hopfield Neural Network (HNN) to minimize the stored network energy. This type of neural network can easily find applications in FEM analysis.

The neurons can be arranged on all corresponding FEM elements. The synaptic weights of each neuron are predetermined using FEM's formulation procedure. The unknown inputs of the network are updated using Backpropagation (BP) technique and the Conjugate-Gradient (CG) algorithm is used for training the BP network.

The edge-based FEM is employed to analyze deterministic bounded problems. As an example, the cross-talk levels,between the signal tracks of a shielded printed circuit board (PCB), are computed using FEM and ANN techniques and compared with exact solution.

Several examples of two dimensional scattering problems are considered. The radar cross-section of multilayered circular and rectangular cylinder is computed. Near field calculations of circular cylinder coated with lossy materials are presented. The obtained results using ANN show execellent agreement with theoretical solutions and solutions produced by other solvers.