New Results in FDTD-Backed Optimization of Complex Microwave Scenarios

Brian G. Cordes[1], Ethan K. Murphy[2] and Vadim V. Yakovlev[1]

[1] Worcester Polytechnic Institute, Worcester, MA, USA
[2] Colorado State University, Fort Collins, CO, USA

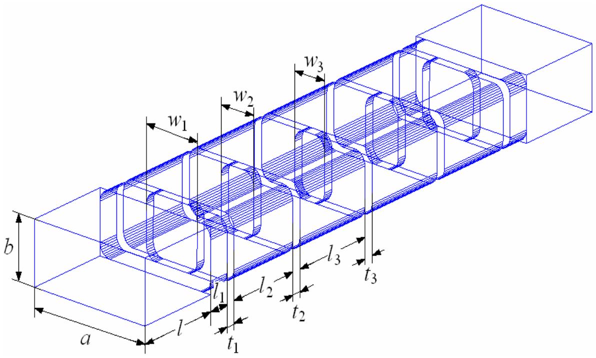
In our recently developed algorithm of microwave optimization [1] complex systems are optimized by a decomposed RBF network backed by dynamically generated 3D FDTD data and re-trained after getting a new portion of data. This approach allows for optimizing frequency responses of *S*-parameters of the devices which cannot be characterized by simplified/empirical models but rather require a full-wave 3D numerical solution. With special formulations of the goal functions, the algorithm is capable of optimizing the return loss and radiation patterns of single- and multi-band antennas. Another new approach [2] proposes an efficient technique for solving a fundamental problem of the intrinsic non-uniformity of microwave heating with the use of (*i*) comprehensive FDTD modeling and (*ii*) subsequent synthesis of the optimal process guaranteeing uniformity of temperature fields.

In this contribution, we discuss the capabilities of these tools by reviewing several examples of their application, namely, in finding a geometry of a pass-band filter with a widened frequency band (Fig. 1), in determining a configuration of a quasi-fractal antenna with a required double-band characteristic (Fig. 2) and in optimizing a process of microwave heating (i.e., minimizing time to uniformity) of a block of beef in a rectangular single-mode cavity (Fig. 3).

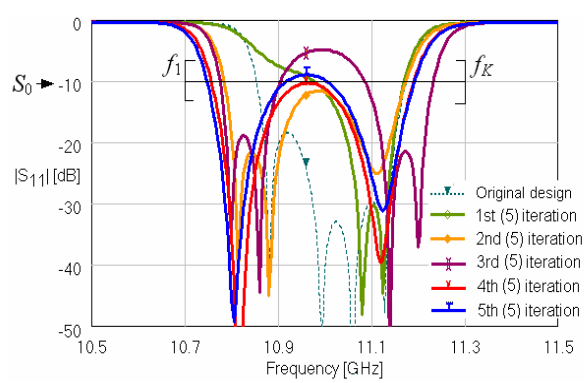
References

[1] E.K. Murphy and V.V. Yakovlev, RBF network optimization of complex microwave systems represented by small FDTD modeling data sets, *IEEE Trans. Microwave Theory Tech.*, vol. 54, No 7, pp. 3069-3083, 2006.

[2] B.G. Cordes, E.E. Eves and V.V. Yakovlev, CAD of microwave heating applicators with uniform temperature fields, to be presented at the *11th AMPERE Conf. Microwave and HF Heating, Oradea, Romania, Sept. 2007*.

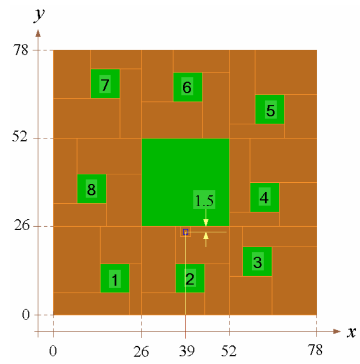


(a)



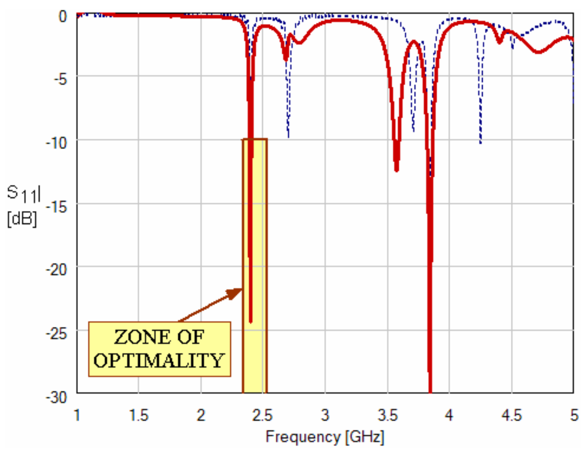
(b)

Fig. 1. Inductively coupled waveguide filter with rounded corners (a) and in its characteristics (b); the band of the original design: 320 MHz; the best solution from the iterative RBF network optimization (4th iteration): 433 MHz; 5-parameter optimization; CPU time: 48.7 h (Dual 3.2. GHz Xeon PC).

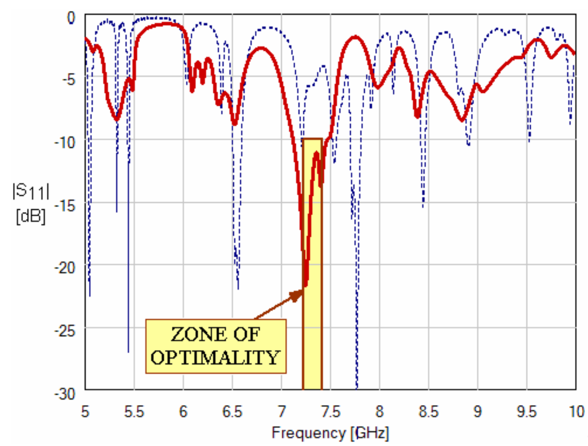


(a)

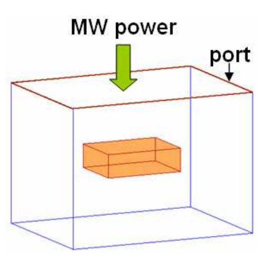
Fig. 2. Configuration of the pseudo-randomly modified Sierpinski carpet (SC) fractal antenna (a) optimized for two frequency bands: (2.35, 2.53) GHz (b) and (7.2, 7.4) GHz (c); dotted curve: the characteristic of a non-modified SC antenna.



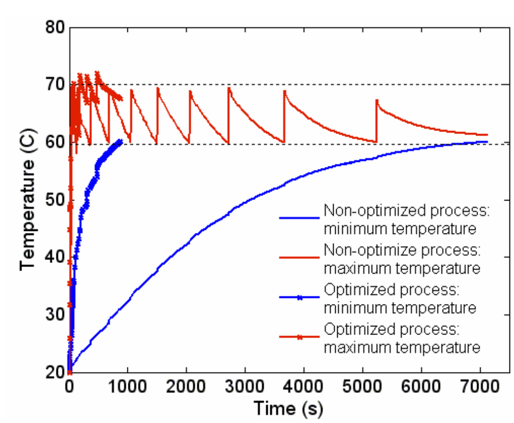
(b)



(c)

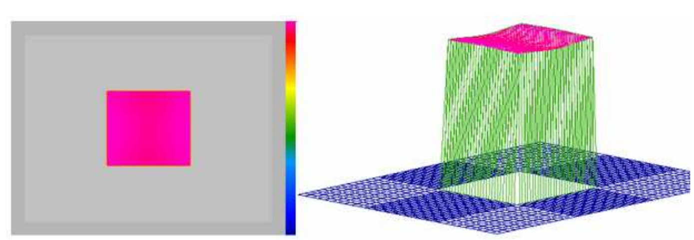


(a)



(b)

Fig. 3. Configuration of a cavity with a heated load (a), heating rates of the minimum and maximum temperatures in a non-optimized and optimized processes (b), and the resulting temperature field of the optimized process in the horizontal central plane through the load (c); frequency: 915 MHz; cavity: 248 x 186 x 180 mm; load: 100 x 76 x 30 mm, raw beef, temperature-dependent thermal and electric material parameters.



(c)