Optimization of Corrugated Horn Antenna Design based on Integration of HFSS Commercial Code and Genetic Algorithm

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The demand for customized antenna designs has been drastically increased by the growing popularity of wireless communication, which requires the antenna designs to meet different customers' specifications such as frequency bands of operation, antenna gain/beamwidth, and etc.. A conventional design procedure usually begins with a rough estimation on the antenna structure, which is then followed by successively adjusting the structure parameters in a trial-and-error manner until the antenna performance meets the requirements. This process will cost substantial manpower especially for less experienced engineers even with today's well-developed numerical electromagnetic analysis codes.

Considering currently available tools, commercial codes such as HFSS and IE3D are very reliable and relatively accurate in antenna performance evaluation. It remains to effectively find a satisfying antenna design in a cost effective way by using those codes. Previously the authors had successfully integrated the IE3D codes with the genetic algorithm for antenna design automation(W.-J. Liao, Y.-C. Hou, H.-T. Chou, 2005 APS/URSI, S030P03U). In the example shown in the previous work, the geometric parameters of the initial microstrip antenna design were altered by the genetic operation to yield different descendents and their performance was accessed by the IE3D simulation results in an iterative manner. After a few iterations, the design was optimized to meet the prescribed bandwidth requirements, which was obtained by automation without any manual intervention.

The IE3D package was developed based on method of moment and is suitable for planar antenna designs. It is not capable of handling 3D structures. In this paper the efforts to combine the genetic algorithm for design optimization and the HFSS simulation package for performance evaluation will be presented. Since the HFSS was built on finite element method and able to analyze more general geometric structures, a design optimization of a circular corrugated horn for parabolic antenna feed was chosen to demonstrate the validity of the proposed design automation approach. Furthermore, through our coding efforts, general antenna performance parameters such as the antenna gain and pattern are extracted from HFSS simulation results to evaluate the performance of the design.

The design subject comprises a circular waveguide section and a circular horn with four circular corrugated ridges. The ridge profile, which includes the ridge length, width and spacing, are the tuning parameters to be optimized by the genetic algorithm. The fitness of the design is examined via the maximum gain at the desired frequency, which is in the Ku band in this case. Experiment results show the design automation code successfully improves the performance of the initial horn design and demonstrates that this software can be a useful tool for design automation.