



Antenna Design Optimization using GAN-based Surrogate Model

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Deep neural network (DNN) based surrogate models have been used to rapidly create antenna characteristics as a function of design geometry parameters in place of computationally expensive electromagnetic (EM) solvers. The limitation of single neural network frameworks is that a large and diverse volume of training data, generated over many hours of measurements or simulations, is required to produce realistic antenna characteristics across various designs. In the proposed work, we present a deep learning framework called generative adversarial network (GAN) with two competing neural networks for realizing surrogate models. These models use a modest volume of training samples of antenna designs analyzing corresponding antenna characteristics. The effectiveness of GAN is demonstrated for optimizing the unit cell design in the partially reflecting surface of a Fabry-Pérot cavity (FPC) antenna. The generative model is used for the evaluation of multiple antenna design candidates and for the selection of the optimal design with the highest gain, lowest axial ratio, and high bandwidth. The GAN-based design is then validated using full-wave simulations and measurements with a fabricated antenna structure.

Solutions to classical electromagnetic (EM) problems often require the use of full-wave electromagnetic solvers, for example, the method of moments (MOMs), finite difference time domain (FDTD) techniques, multilevel fast multipole method (MLFMM), finite element methods (FEM) - where the computational time and memory scale with the increase in electrical dimension, shape, or size. In this note, we propose the use of generative solutions emanating from modern deep learning neural network algorithms to complement classical electromagnetic techniques to accelerate the time required for problem-solving without a corresponding increase in computational memory requirements.