Topology optimization of metallic antennas design for radiation energy maximization

***Shutian Liu[1], Qi Wang[1], and Renjing Gao[1]**

[1]State Key Laboratory of Structural Analysis for Industrial Equipment, Dalian University of Technology, Dalian, China

*Corresponding author: stliu@dlut.edu.cn

The antenna design problem can be treated as a problem to find the optimal distribution of conductive material in a certain domain. Although this problem is well suited for topology optimization method, the volumetric distribution of good conductors based on 3D finite element method has been known to cause numerical bottlenecks such as skin depth problem. We present a topology optimization based method for configuration design of antennas with optimized radiation energy in which the numerical issues are remedied. The candidate structure of the metallic antenna is approximately considered as a resistive sheet with position-dependant impendence. In this way, the electromagnetic property of the antenna can be analyzed easily by use of the method of moments (MOM) to solve a radiation of the resistance sheet in the finite domain, thus the skin-depth problem is remedied. The topology of the antenna is depicted with the distribution of impendence related to the design parameters or relative densities. The conductive material (or metal) has zero or very low impendence. The non-conductive material is simulated as a material with a finite but large enough impendence value, and this finite impendence value is determined through a series of numerical simulations. The impendence interpolation function between conductive material and non-conductive material is a power function at the standard log-scale. The designs of planar bow-tie antennas are optimized for radiation energy improvement at different frequencies and based on different mesh resolutions. The validity of the proposed method is confirmed by several numerical examples.

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