Optimization of the Folded Conical Helix Antenna Using a Genetic Algorithm

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A folded conical helix (FLEX) antenna was proposed earlier for achieving a highly efficient antenna with good bandwidth performance in an electrically small size (J. A. Dobbins and R. L. Rogers, *IEEE Trans. Antennas Propagat,* **49**, 1777–1781, 2001). More recently, a folded spherical helix has also demonstrated excellent results with a geometry that efficiently fills a spherical volume (S. R. Best, *IEEE Trans. Antennas Propagat,* **52**, 953–960, 2004). In this paper, we use a generic folded conical helix structure in an effort to assess the effect of geometry on the performance of an electrically small antenna. A genetic algorithm (GA) and the Numerical Electromagnetics Code (NEC) are used to generate optimized designs under either the optimum efficiency or optimum bandwidth criterion.

Fig. 1 (a) Apex-down geometry (b) Apex-up geometry

Both the apex-down geometry (Fig. 1(a)) and the apex-up geometry (Fig. 1(b)) are considered in the GA population within the same kr hemisphere (where k is the wave number and r is the radius of the enclosing sphere). The angle for the apex-up cone is allowed to vary from 10° to 70°, and for the apex-down cone, from 10° to 45°. The number of turns and the number of folding arms are also allowed to vary. The wire radius is fixed at 0.5mm. The optimization is carried out separately for different antenna sizes at kr=0.2, 0.3, 0.4 and 0.5.

The efficiency and the bandwidth are studied separately in the GA optimization, while satisfying the 50Ω matching requirement at 30MHz. Our results show that the apex-down design is preferred over the apex-up design for the efficiency optimization at all the sizes considered. We believe the reason is the apex-down design provides more capacitance between the antenna and ground. This effect makes the total electrical length of the antenna shorter and lessens the loss resistance, which in turn increases the efficiency. Similar findings are also observed in the bandwidth optimization.