Patch Antenna above Hilbert High-Impedance Surface

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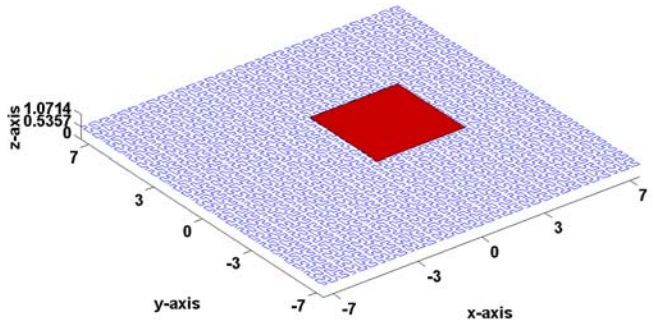
As known in the mathematics literature, Hilbert curve is an example of family of curves known as space-filling curves [Hans Sagan, *Space-Filling Curve*, Springer-Verlag, NY, 1994], and it is a continuous mapping from a normalized [0,1] interval to a two-dimensional regions, $[0, 1]^2$ that passes through every point in the region. As iteration order of Hilbert curve is increased, longer line can be compacted into a small 'surface" area, and therefore as an electromagnetic scatterer, conducting wires shaped as Hilbert curves may have resonant wavelength much longer than its footprint. In our previous work, we have shown that a metamaterial surface made of 2-D periodic arrangement of "Hilbert-curve" inclusions, closely placed above a highly conducting ground plane, can attain high surface impedance at certain frequencies, causing it to effectively behave as a magnetic wall with reflection coefficient $R \simeq +1$ [J. McVay, N. Engheta and A. Hoorfar, "High Impedance Metamaterial Surface Using Hilbert Inclusions", *2002 USNC/URSI National Radio Science Meeting*, San Antonio, TX, p. 226, June 2002]. We also explore the radiation characteristics of a resonant wire antenna above such a high-impedance surface [McVay, *et al*., submitted for presentation at the *2003 IEEE MTT-S International Microwave Symposium* (IMS'2003), Philadelphia, PA, June 8-13, 2003].

In the present study, we examine numerically the performance of another class of antennas, i.e., a probe-fed patch antenna, located above such a Hilbert high-impedance ground plane (See Figure). The operating frequency of this patch antenna is chosen to be near the frequency of operation of Hilbert surface. We explore the effects of Hilbert iteration order, separation from the ground plane, and probe location for patch antenna on the input impedance, impedance bandwidth, directivity, and efficiency of such patch antennas. We also explore the role of small foot print of Hilbert inclusion as "compact resonator" on the performance of the patch antennas.



In this talk, we will present some of our numerical results and will discuss physical insights and intuitive remarks on mathematical findings.