Peano Antennas

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Space filling curves are of interests in many antenna applications since they provide a planar resonant structure that could have a very small footprint as one increases the step-order in iterative filling of a 2-D region. The most widely used of these curves is the one proposed by David Hilbert in 1891, and indeed several research groups in the last few years have studied the radiation properties of the antennas whose geometry are formed by using the Hilbert-curve algorithm [see e.g., Vinoy, *et al.*, *MOTL*, Vol 29, No. 4, pp. 215-219, May 2001; Anguera, *et al. Digest of the 2002 IEEE AP-S Internat. Symposium*, San Antonio, TX, pp. 546-549, vol. 4]. Like other electrically small antennas, Hilbert antenna has a small radiation resistance and a small input resistance, in the order of a few ohms, when it is center-fed at its point of symmetry. We have previously shown, however, that a properly chosen off-center feed point can always provide, regardless of how high n is, a 50 ohm match at the structure's *lowest* resonant frequency [Zhu, *et al.*, USNC/URSI National Radio Science Meeting digest, p. 373, San Antonio, TX, June 2002].

In this work we have investigated the application of another family of space-filling curves, namely Peano curve, in design of small planar resonant antennas. It is noteworthy that Peano curve, proposed by G. Peano in 1890, was in fact the first demonstration of any space-filling curve [Hans Sagan, *Space-Filling Curves*, Springer- Verlag, 1994]. The first few step-order iterations of the Peano curve are shown in the figure below. By applying a moment-method-based simulation code we have performed a detailed parametric study of Peano antenna as the step-order increases from n = 1 to n = 4. We have found that, as in the case of Hilbert antenna, it is possible to locate an off-center feed point that results in an approximate input resistance of between 50 and 100 ohms and negligible input reactance for all the step orders investigated .The corresponding feed points for the step orders n = 1 and n = 2, for a 50-ohm match, and n = 3, for a 75-ohm match, are shown in the figure below. A matched Peano antenna has far-field patterns that resemble those of a dipole antenna, as Hilbert antennas do, and has cross-polarization levels that decrease significantly as the step order, n, is increased. For a given footprint and a fixed step order n, the Peano antenna resonates at a lower fundamental resonant frequency and, therefore, results in an electrically more compact radiator than a comparable Hilbert antenna, albeit at the expense of a smaller input-impedance bandwidth. This is expected because of the relatively higher compression rate of the Peano-curve algorithm in filling of a 2-D region. A detailed parametric study of the radiation characteristics of the Peano antenna will be given in the presentation and compared with those of the Hilbert antenna.