Multiband Fractal Yagi Antennas: Design and Simulation

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Introduction Fractal antennas have been shown to increase the versatility of antenna designs. This work includes the design of a Yagi antenna array that can operate on multiple frequency bands. A multiband element based on the Sierpinski gasket is utilized in these arrays. The design involves the analysis of an element that operates at the various frequency bands of interest. This element is then incorporated into an array as parasitic elements that are fed via mutual coupling. The spacing and the size of each of the parasitic elements needs to be optimized to achieve the proper excitation phase to achieve maximum directivity.

Sierpinski Fractal Antenna The multiband response of a fractal Yagi array is based on the Sierpinski gasket fractal antenna. This antenna exhibits multiband behavior stemming from the multiple scales that is present inside the geometry. The antenna and its feed is very similar to a bowtie dipole. The simulated input impedance from a Method of Moments (MoM) analysis program developed at UCLA is shown in Fig. 1and exemplifies the multiple resonances.

Bowtie Yagi Array The bowtie element is the zero order of the Sierpinski gasket and provides a good starting point for a multiband design. A three-element design incorporating bowtie dipoles in a Yagi configuration has been designed and simulated yielding front to back ratios of 8 dB.

Fractal Yagi Array The first piece of the design of a fractal Yagi array is an antenna element that operates at the desired bands of interest. The spacing and the size of each of the reflectors and directors should be optimized to achieve the highest directivity possible. The layout of a three-element design is shown in Fig. 2. Because each of the elements is fed via mutual coupling from the adjacent elements, the magnitude and phase of the excitation of each element cannot be designed independently as would typically be done with a phased array. A design has been initiated which includes two elements operating over two bands to show the feasibility of the concept. The Sierpinski gasket elements, where the director is 1.5 times larger than the driven element, are spaced 0.125λ and 0.45λ apart for the first and second bands, respectively. The simulated front-to-back ratio shows a better performance for the lower band than for the upper band. Further steps in the design include optimizing the spacing and the size to achieve good performance and similar patterns over all of the bands of interest.

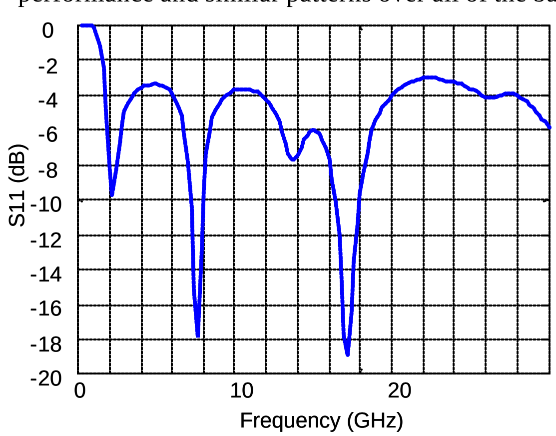

Figure 1: Simulated input impedance for a multiband Sierpinski gasket element

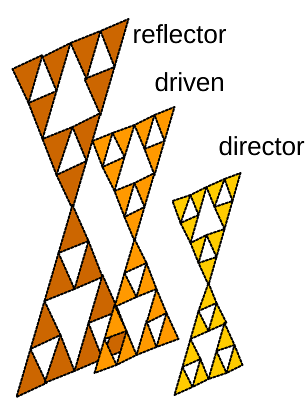

Figure 2: Multiband Yagi array of Sierpinski gasket elements.