A Novel Technique to Tilt Radiation Beams in Bowtie Antennas

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Bowtie antennas have desirable characteristics for base station operation. They have a wide bandwidth, they are easy to manufacture, and have a similar radiation pattern to that of a dipole antenna. This ease of use has led many researchers to design bowtie antennas to increase bandwidth and gain, such as quasi-Yagi designs with complex directors to increase gain (A. Dadgarpour, B. Zarghooni, B. S. Virdee, T. A Denidni, IET Microwaves, Antennas & Propag., 9, 1254-1259, 2015) as well as a printed ground plane to realize unidirectional radiation patterns with enhanced gain (G. Zheng, A. A. Kishk, A. W. Glisson, A. B. Yakovlev, Microwave and Optical Technology Lett., 47, 534-536, 2005). Some have used multiple periodic bowtie antenna elements to achieve a greater bandwidth (S. Qu, J. Li, Q. Xue, C. Chan, IEEE Antennas Wireless Propag. Lett., 7, 314-317, 2008). In all aforementioned bowtie designs, the antenna radiation pattern was broadside. However, antennas with tilted radiation patterns are much preferred for base stations in order to maximize the received signals by mobile devices. This adds unnecessary cost to the construction and design of such base stations. For example, an electronically scanned phased array may be used, which requires a complex feeding network to control amplitude and phase of each array element.

This paper focuses on a technique to tilt the main beam direction of a bow-tie antenna without adding much complexity to its design. This is realized by cutting the bowtie arms in half through its axis of symmetry. This will result in shifting the equi-phase line of the antenna structure away from its original axis of symmetry. As such, the wave fronts will constructively add up off the boresight direction of $\theta = 0^\circ$, thus generating a tilted beam pattern. The technique would come at the cost of reduced gain, but would allow for simpler base station design by reducing the number of parts needed to tilt the antenna main beam.

This technique has already given some promising results using full-wave EM solver analyzing bowtie opening angles as well as half-ellipse shapes. The angle of E-plane tilt can be directly controlled by the opening angle of the bowtie antenna's triangles as well as fine tuning the matching characteristics of the antenna. The return losses are well below -15dB for the half-triangular bowtie antennas with an average bandwidth of 1.2 GHz throughout the X band. The maximum angle of tilt achieved for the half-triangular antenna is 41.5°. The printed version of these antennas with unidirectional radiation needs extra care in the design of the supporting ground plane in order to effectively direct the radiation beam in a desired direction. The corresponding results will be presented and discussed in the conference.