Size Reduction of a 15-element Yagi-Uda Array for High Gain Applications

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The Yagi-Uda antenna has withstood the test of time as far as reliable wireless communication systems are concerned. The reliability of the design procedure ensures accurate results that can be easily replicated for numerous applications. The issue that arises with the Yagi-Uda antenna is the expansive size of the elements that make up the antenna. With size-reduction techniques, the size of a high-gain Yagi-Uda antenna can be miniaturized. Previously, size reduction of the three-element Yagi-Uda antenna with close (0.02λ) spacing between the elements is achieved with multiple folding techniques (S. Lim and H. Ling, IEEE Antennas Wireless Propag. Lett., 303-305, 2006). This method, however, provides diminishing returns on narrow impedance bandwidth and limited realized gain. In particular, the realized gain does not increase as much as subsequent elements are added to the antenna.

In this paper, a size-reduced 15-element Yagi-Uda antenna is presented using a T-shaped top-loading method. The T-shaped top-loading allows for a full-sized 1.6 *kr* dipole to be truncated to 0.9 *kr* while maintaining almost the same impedance bandwidth. At first, a full-sized, 15-element Yagi-Uda antenna is constructed using set element lengths and spacing. Next, the full-sized elements that make up the reflector, driver, and directors have been replaced by the T-shaped top-loaded elements. The 15-element, size-reduced Yagi-Uda antenna with T-shaped top-loadings has the -10-dB impedance bandwidth from 1.46 GHz to 1.52 GHz (4%), which is comparable to the full-sized, 15-element Yagi-Uda antenna (4.1%). The surface of the full-sized, 15-element Yagi-Uda antenna measures 4.24λ × 0.475λ, while the size-reduced antenna still has the similar performance, but only measures 4.58λ × 0.27λ. The size-reduced antenna design produces a realized gain of 13.7 dBi compared to the full-size version producing a realized gain of 16.2 dBi. This 2.5 dB loss of realized gain comes from the directivity of the dipole antenna elements. The 0.9 *kr* size-reduced dipole has a slightly lower directivity (1.8 dBi) than the traditional half-wavelength dipole (2.1 dBi).

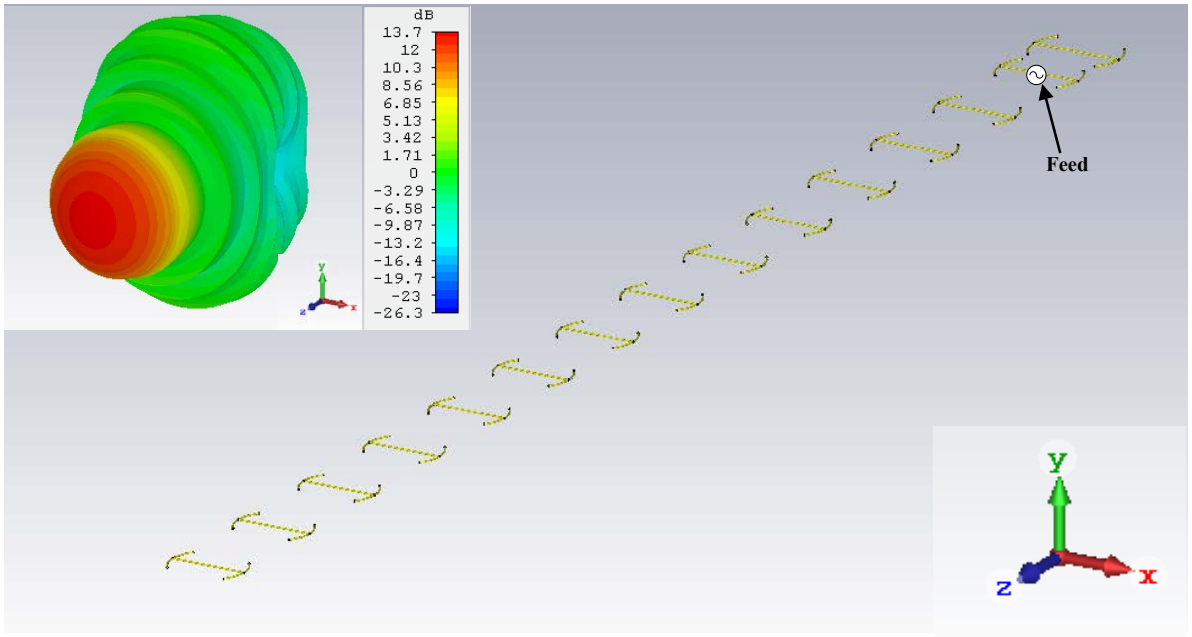

Fig. 1. The proposed 15-element, size-reduced Yagi-Uda antenna with T-top top-loadıngs and sımulated 3D realized gain pattern.