Design of a Size-Reduced, 15-Element, Circularly-Polarized, Yagi-Uda Antenna

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The Yagi-Uda antenna was invented in 1926, and it is still used today due to its reliability as a means of wireless communications. The expansive nature of the lengths of each element on the full-size Yagi-Uda antenna causes design concerns. Size reduction techniques can be used to correct the issue, while also maintaining high gain. Previously a linearly polarized (LP), size reduced, 15-element Yagi-Uda with top loadings was created, and 13.7 dBi was achieved (J. Howell and S. Lim, USNC-URSI National Radio Science Meeting, 2018). A circular polarization (CP) is the intent as it allows the signal to be efficiently sent despite changes in plane orientation.

In this paper, a 15-element, CP, Yagi-Uda antenna is introduced on the basis of a size-reduced cross dipole design with arcs at each end where the vertical arc lengths are greater than the horizontal arc lengths (Figure 1). The size of each antenna element of the Yagi-Uda antenna is reduced to a *kr* of 0.9 and the Yagi-Uda antenna is tuned at 1.5 GHz. Only the spacing between the reflector and the driver is set at 0.25λ, while the spacing between the directors and the driver are optimized using the genetic algorithm for maximum realized gain and also attaining CP. The antenna has -10-dB fractional impedance bandwidth of 0.86%. The maximum realized gain of the size reduced Yagi-Uda antenna reaches to 12.7 dBic, and 3 dimensional (3D) realized gain pattern at 1.5 GHz is shown as the inset of Figure 1. Overall, the realized gain is within 1 dB less than that of the size-reduced, 15-element, LP, Yagi-Uda antenna. The axial ratio (AR) at 1.5 GHz is 2.3 dB. The 3-dB fractional AR bandwidth is 0.084%. The overall efficiency of 95% is obtained at 1.5 GHz. For a full-sized CP Yagi-Uda antenna the sizes of each element is determined to be 0.475λ for the reflector, down to 0.390λ for the 15th element, (Peter P. Viezbicke, Yagi Antenna Design, NBS Technical Note 688, 1976). With the size-reduced Yagi-Uda, these values are scaled down to 0.9 *kr*. Hence an overall 67.2% reduction in surface area using 0.9 *kr* antenna elements is achieved compared to the full-sized, CP Yagi-Uda antenna.

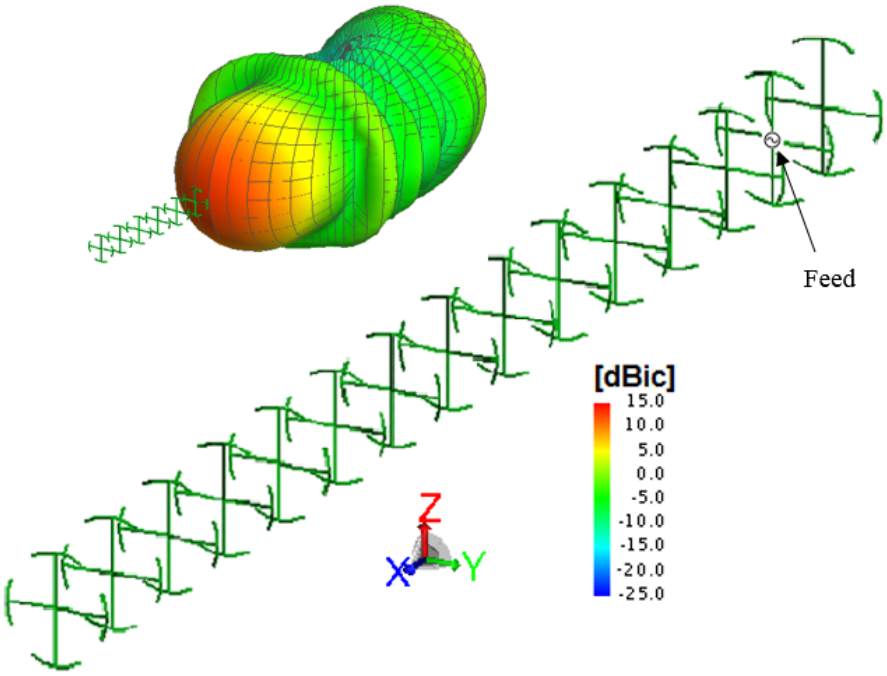

Figure 1. Size-reduced, 15-element, CP Yagi-Uda antenna with 3D realized gain pattern.