Design and Analysis of Star Spiral with Application to Wideband Arrays with Variable Element Sizes

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(ABSTRACT)

This dissertation details the development of the star spiral antenna and demonstrates the advantages of the star spiral when used in a wideband array with variable element sizes. The wideband array with variable element sizes (WAVES) is a multi-octave array that uses different sized circular Archimedean spirals for each octave of frequency coverage. A two-octave WAVES array has been presented in the literature, but a gap in the two-octave frequency coverage exists along the principal axes. The star spiral antenna was developed to eliminate the performance gap in the WAVES array. The star spiral is a type of slow-wave spiral that also offers array-packing advantages, particularly for the WAVES array. The size reduction that can be achieved with the star spiral is comparable to that of the square spiral, but the star spiral is much more efficient in terms of its expected size reduction compared to its circumference. The far-field patterns, gain, and scan performance of the star spiral are similar to that of the circular Archimedean spiral. The use of the star spiral to eliminate the performance gap in a WAVES array of circular Archimedean spirals is detailed. Furthermore, a three-octave WAVES array of star spirals is built and measured, and the scan performance of the array is investigated via simulation.

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