Compromise between Peak Sidelobe Level and Element Number and Density for Electrically Scanned Rotational Aperiodic Subarrays

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To reduce the cost of phased array antennas, a wide variety of sparsification techniques have been used. Although arrays with large element spacing benefit from reduced mutual coupling and low number of electronic components across the array aperture, grating lobes become a major issue to the scanned periodic arrays when the element spacing is larger than one half-wavelength. Aperiodic elements placement techniques offer one possible solution for mitigation grating lobes and reducting of side lobes. Compared to a periodic structure, aperiodicity makes such arrays difficult to design and fabricate. Recently, arrays with periodically rotated random subarrays have been developed. The identical subarray units and fewer degrees of freedoms help to reduce the design and fabrication complexity for aperiodic arrays [1]. In this paper, we improve the design of rotational aperiodic subarrays with optimized discrete rotation angles. The relationship between peak sidelobe level and element number and density for scanned planar arrays is studied.

The peak side lobe level behavior for scanned planar arrays is studied using an array model with approximate identical isolated radiation pattern for each elements to represent different embedded patterns. A genetic algorithm is used to minimize the sidelobe level for steered beams by optimizating element positions in the subarray and subarray rotation angles. The peak sidelobe level behavior is studied for different element densities and aperture sizes. The results show that the peak side lobe level of arrays with rotated aperiodic subarrays is comparable to a fully optimized aperiodic array. The minimized peak sidelobe level linearly decreases with the array element density for a given array aperture size and with the square root of the element number when the elements density is fixed. This study shows a simple relationship between the sidelobe level and element number and density, which can be considered as a guideline for the design of sparse aperiodic planar arrays.

References

[1] K. C. Kerby and J. T. Bernhard, "Sidelobe level and wideband behavior of arrays of random subarrays," *IEEE transactions on antennas and propagation*, vol. 54, no. 8, pp. 2253–2262, 2006.