Optimization of Rotated Tiled Aperiodic Array Antennas

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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 element placement techniques offer one possible solution for mitigation grating lobes and reducing side lobes for array applications that do not require a full horizon to horizon scan range. Compared to a periodic structure, aperiodicity makes such arrays difficult to design and fabricate. Recently, arrays with periodically rotated random tiles have been developed. The identical tile units and fewer degrees of freedoms help to reduce the design and fabrication complexity for aperiodic arrays. In this paper, we improve the design of rotated aperiodic tiles with optimized discrete rotation angles. The relationship between peak side lobe level, element number and density and the element radiation pattern is studied.

The peak side lobe level behaviors for an aperiodic array and an array with discrete rotated aperiodic tiles are compared using an array model. A genetic algorithm is used to minimize the sidelobe level for steered beams by optimizating element positions in the tile and tile rotated angles. An approximate formula indicates that the peak side lobe level for the aperiodic and tiled arrays can be reduced by enhancing the element directivity at the steered beam direction, increasing the element number and reducing the array size. Peak side lobe level, bandwidth, directivity and design and fabrication complexity for uniform arrays, aperiodic arrays and tiled arrays are compared in Table 1. This study shows a compromise between system performance and array cost and complexity, which can be used to guide the design of an electronically phased array antennas.

Table 1: Comparison for array performance

	Uniform	Aperiodic	Rotated Tiles
PSLL	High	Low	Moderately Low
PSLL Bandwidth	Narrow	Wide	Moderately Wide
Directivity (Dense Array)	High	Low	Moderate
Complexity	Easy	Difficult	Moderately Easy