Some Properties of Antenna Arrays of Closely Packed Elements

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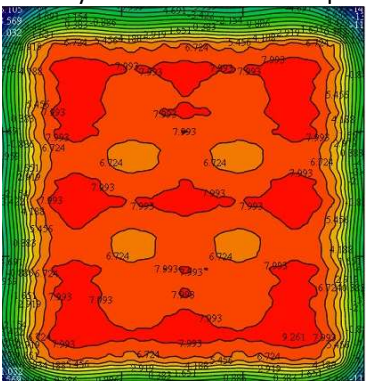
Two common ways to achieve directive radiation is through reflector antennas and arrays. Until recent times, the reflector offered the cheaper, wider band, and more flexible alternative. However, it occupies a significant volume for a given aperture dimensions. With reducing costs due to integrated manufacture and the desire for compact, conformal alternatives, the array is once again being considered in which now mutual coupling is fully utilized rather than avoided [1]. Elements are closely coupled arrangement of antennas (CCA), which can offer wideband performance as well. In this compact arrangement, the equivalent aperture current can be modelled as a current sheet much the same way as a reflector as suggested by Wheeler [2]. In many senses the two concepts have converged.



In conventional arrays where elements are typically around 0.5 λ apart, while in CCAs elements are often 0.2 λ or less apart. As an example, the figure on the left shows the aperture field of a 15 x 15 CCA consisting of fat dipoles of 0.15 λ in length with 0.2 λ spacing. The outer ring of elements are terminated in passive impedances to achieve a good overall match to the central 13 x 13 array, which is uniformly excited. It is seen the current is slightly tapered which will lower sidelobes in the radiation pattern. The purpose of this paper is to compare the aperture fields of the reflector and the CCA, and to outline some of the flexibility possible with the array.

References:

[1] T.S. Bird, 'Mutual coupling between antennas', Wiley, Chichester UK, 2021
[2] H.A. Wheeler, 'Simple relations derived from a phased-array antenna made of an infinite current sheet', IEEE Trans. Antenna Propagat., Vol. AP-13, no. 4, July 1965, pp. 506-514.