Linear arrays with variable interelement spacings

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Abstract

The synthesis of uniformly excited equally and unequally spaced array employing physical optics technique to achieve sidelobe reduction and narrow beamwidth by varying the elements number (N) and positions, with equal current magnitude of antenna. The elements of this array are considered to be short backfire antennas (SBFAs) fed by coaxial waveguide and excited by TE_{11}-mode. It is observed that by employing the unequally spaced array synthesis technique, the first sidelobe level (FSLL) is reduced by 8.85 dB over that of an equally spaced array patterns for N=15.

In this paper an empirical relation for the unequally spaced antenna arrays was found. This relation expresses the distribution and the height of sidelobes depending on the space broadening factor.

Key Words: Linear array, Antennas arrays, Short backfire antenna.

I-Introduction

It is well-known that the use of antenna arrays rather than single antenna element provides more opportunities of high gain, narrow beamwidth, low side lobe ratio, etc. as required by the designer. It has been accepted since the early 1960s that the positions of radiating elements of an array can be used as an additional set of parameters for advanced array design [1].

Most array antennas employ equal spacings between adjacent elements. The theory is well understood, and convenient analytical procedures are available for antenna design and radiation pattern synthesis. It is possible, however, to operate array antennas with nonuniform, or unequal, spacings between adjacent elements. The element spacings provide another parameter, in addition to the amplitude and phase of the element current, with which to control the radiation pattern. Unequally spaced linear arrays may be used to obtain radiation patterns with low peak side lobes without the need for an amplitude taper. This might be of importance in applications where it is not convenient to individually adjust the amplitude of the current at the elements. The beam width of the unequally spaced array may be as narrow as that of the equally spaced array. The unequally spaced array permits the antenna to operate over a wide frequency range without the appearance of grating lobes. It can also be scanned over a wide angle without the formation of the grating lobes that could appear with the equally spaced array [2].

In this paper, we propose the synthesis problem formulation for the SBFA array with a uniform supply distribution in amplitude and phase. The only parameter which can modify the radiation pattern, in this case, is the distribution of the space sources. The radiated field from the array at a given point in space is the vector sum of the radiated fields from the individual elements. In other words, the far field of the array is determined by superposition [3].

Short backfire antennas are highly efficient radiators of simple and compact construction, and highly directional radiator. The SBFA consists of a leaky cavity resonator formed from two plane reflectors of different diameter, spaced a half-wavelength apart, with a feed placed between them. Here, we shall illustrate the calculation of the array factor and the element factor to determine the radiation field generated by linear array of antennas with uniform current distribution and unequally distance between elements.