DEVELOPMENT OF LINEAR ARRAY

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INTRODUCTION

The problem of the development and analysis of a linear array of antennas is widely discussed in the literature. Related surveys may be found in the classical references. The far-field radiation pattern of a single isolated element is often given in form of an analytic expression. Assuming some excitation distribution for the elements, the array factor is derived and its product with the given element pattern yields the general far-field radiation pattern of the array.

In the present work, the analytic expression for the radiation pattern of an isolated element is replaced by measured data. The coupling characteristics between the elements is incorporated into the model by using the well-known element-by-element technique and the array-element patterns (AEP) of the various elements located within the array are then calculated. These were compared to measured patterns. Then, using a Taylor excitation distribution, both the measured and the calculated AEP's were summed independently to obtain the general far-field radiation pattern and compared. A statistical measurement error was introduced for the experimental results. A fairly good agreement between the two general radiation patterns was obtained for various frequencies and scan angles.

ANALYSIS

The values of the mutual impedances for free flat dipoles were taken from Wang, Richmond and Gilreath [3]. Employing the method of images combined with an interpolation scheme, the appropriate mutual impedance values were derived. Likewise, the self-impedance value of each element was determined.

The inversion of the mutual impedance matrix (Z) was performed with aid of a technique developed by Gera [1]. It requires a reduced computer memory size and it is faster than using general computer subroutines. The method relies on the special structure of the mutual impedance matrix.

A survey of the effects of random errors on the far-field radiation pattern was given by Jasik [2]. For instance, 84% of the sidelobe levels will be less than -29.1 dB for an array comprised of 12 elements and designed to yield a sidelobe level of -40 dB.

A random statistical error of $\Delta\theta = \pm 1.5^{o}$ in the phase of the exciting voltages is assumed. This is a reasonable accuracy tolerance. The mean radiation pattern (M) together with the $M \pm \sigma$ patterns for the analytical model were thus derived.

MEASUREMENTS AND RESULTS

A linear array of 16 flat dipoles above a ground plane was built and tested. The inter-element spacing and height above ground are variable parameters within this design. Its purpose is to provide an aperture for a multibeam array. Together with the aperture distribution, this enables the synthesis of an optimized pattern.

First, the isolated element pattern was measured and the <u>theoretical</u> AEP's and array pattern were derived using the above analysis. Then, the AEP's of the variously located elements were <u>measured</u> within the array of 16 dipoles. Using these measured AEP's, the relevant array patterns were evaluated, including a statistical error distribution. The theoretical and measured patterns were compared as shown in figures 1-4. A satisfactory correlation between the two can be observed.

CONCLUSION

A method of computer analysis of the radiation pattern from a linear array, involving measured element patterns, was developed and tested. Rather a good correlation is found at different frequencies and scan angles. Consequently, this method may be efficiently used for designing multibeam and phased arrays.

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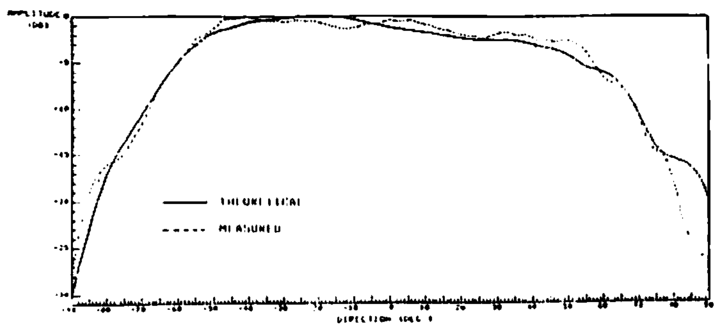

Fig. 1: A.E.P. 1st Element

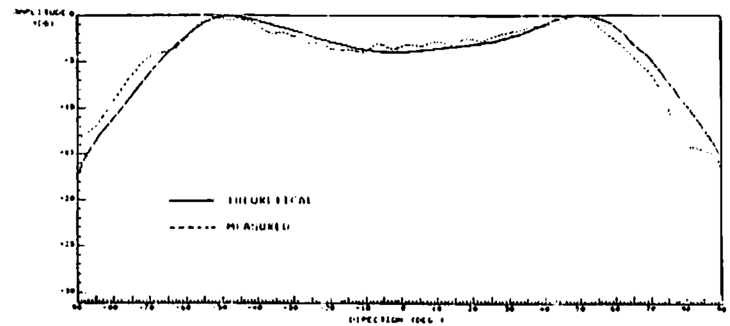

Fig. 2: A.E.P. 8th Element

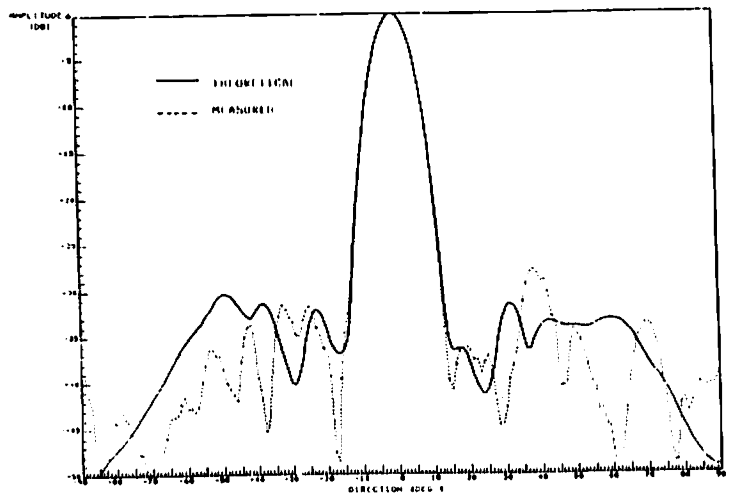

Fig. 3: Array Pattern (Taylor 40dB, n=5 Distribution) at Broadside

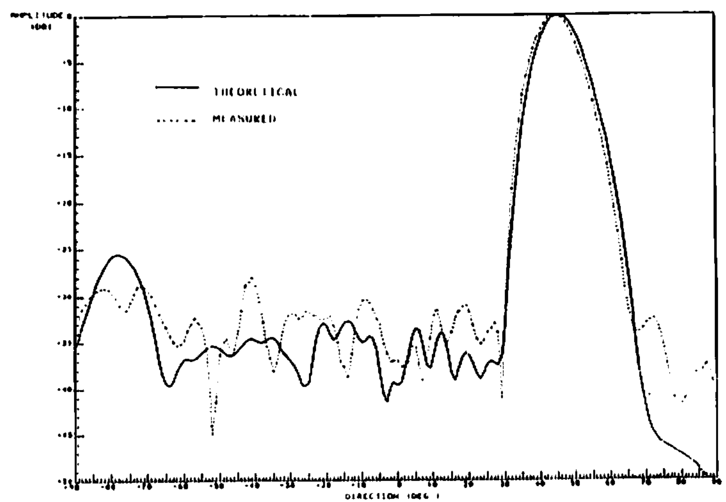

Fig. 4: Same as Fig. 3 at 45° Scan Angle