GENERATION OF SUM AND SLS TYPE DIFFERENCE PATTERN FROM ONE APERTURE

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IFF antenna system requires generation of sum and sidelobe suppressed difference pattern. In the conventional antenna system reported in the literature [1] the sum pattern is generated by an antenna array. The sidelobe suppressed difference pattern is generated by simultaneously exciting the array and an omnidirectional antenna in anti phase and with appropriate amplitude ratio [2]. The present work aims at the generation of both the beams from a single aperture using phase only control and on a time shared basis.

With cophasal excitation of the entire aperture a sum pattern is generated using Taylor's formulation [1]. A desired beamwidth and sidelobe level is achieved for a particular amplitude distribution in the aperture plane. Without modifying this amplitude distribution phase distribution required for the generation of sidelobe suppressed difference pattern is determined as follows.

The authors have already worked out the method of transforming a narrow beam into a sector beam using phase only control [3]. The same method is used here for the generation of sector beam symmetric about the line $u \ (= \sin\theta) = 0$.

For a sector beam of width u_o, the derivative of the desired phase function is found to be of the form [2]

$$\Psi'(x) = \pi . \frac{2L}{\lambda} . \frac{u_o}{2} - \pi . \frac{2L}{\lambda} u_o . \frac{\int_{-1}^{x} a^2(x)\,dx}{\int_{-1}^{1} a^2(x)\,dx} \qquad \ldots (1)$$

where 2L is the aperture length, λ is the wavelength and $a(x)$ is the aperture amplitude distribution.

This sidelobe suppressed difference pattern is generated by exciting one half of the aperture uniformly with an additional phase of 180^o. This additional antiphase excitation generates a null in the direction of maximum of the sum pattern.

For an aperture of $2L/\lambda = 150$ the amplitude distribution required for the generation of a pencil beam with a sidelobe level of 28 dB is evaluated using Taylor's formula with $\bar{n} = 2$. The corresponding amplitude distribution is of the form

$$a(x) = 1 + .284 \, \text{Cos}\,\pi x \qquad \ldots (2)$$

Substituting this in equation (1) and solving the differential equation, the nonlinear phase distribution is evaluated numerically for $u_o = .25$ and .4. Adding an additional phase of 180^o to one half of the aperture and using the phase and amplitude distribution so obtained in the radiation integral, the radiation patterns have been evaluated for both the specified values of u_o. The radiation pattern evaluated by collapsing the phase distribution gives the pencil beam or sum pattern.

The curve A represents the pencil beam. The curves C and D represent the sidelobe suppressed difference pattern (also termed control pattern). For the sake of comparison conventional difference pattern obtained for antiphase excitation of the two equal halves of an otherwise cophasal aperture is presented by curve B in Fig.1. It is found from the results presented that the sidelobe suppression achieved by the present method is much better as compared to the suppression obtained by the conventional difference pattern.

References

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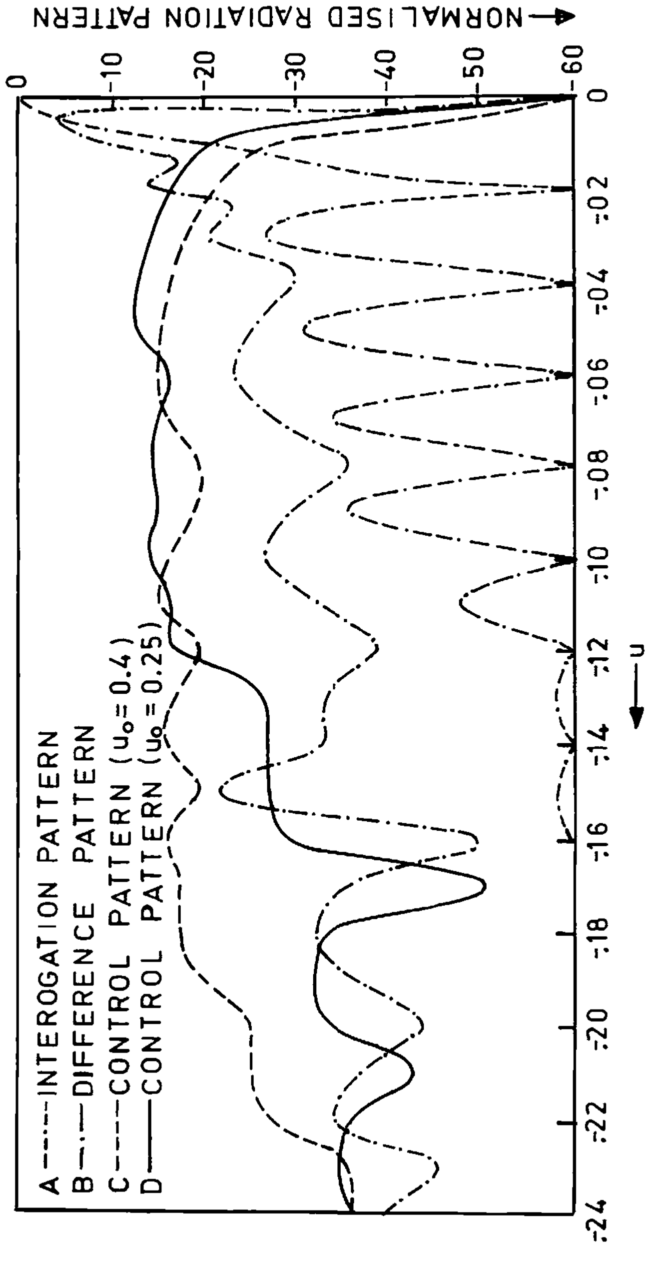
2. M.I. Skolnik, 'Beacons' in 'Radar Handbook', McGraw-Hill, 1970, Ch.38.

3. A. Chakraborty, B.N. Das and G.S. Sanyal, "Determination of phase functions for a desired one dimensional pattern", IEEE Trans. on Antennas and Propagat., 502-506, May, 1981.


A ----- INTEROGATION PATTERN
B —·— DIFFERENCE PATTERN
C - - - CONTROL PATTERN (u_o = 0.4)
D —— CONTROL PATTERN (u_o = 0.25)
NORMALISED RADIATION PATTERN
0
-10
-20
-30
-40
-50
-60
u
0
.02
.04
.06
.08
.10
.12
.14
.16
.18
.20
.22
.24