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A STUDY OF PERFORMANCE LIMITATIONS IN PHASED
ARRAYS AND SOME METHODS TO OVERCOME THEM

BY

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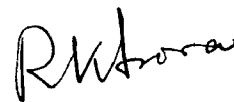
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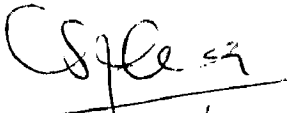
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ABSTRACT

In the course of phased array development over the last two decades, the power and versatility of phased array systems has been recognized. Every system, however, has certain limitations. The limitations arising due to mutual coupling effects, phase quantization, aperture illumination error, feed dispersion effects, etc., have been studied in the past. The objective of this thesis is to present investigations carried out on certain performance limitations in phased array systems and some methods to overcome these limitations. In particular, the limits of high speed scanning in frequency scanned arrays and the signal distortions in wideband pulse compression systems are studied. A method is described to reduce the angle dependence of signal distortions in wideband pulse compression systems. Also included in the thesis is a design of an electronic scanning signal processing antenna system, which achieves beam compression using linear processing of frequency coded signal to improve angular resolution.

The dynamic radiation pattern for frequency scanned antenna arrays is derived using retarded potentials and taking the feed effect into account. The high speed radiation patterns thus obtained for linear and circular arrays are seen to differ from the respective slow scanning patterns. A criterion is obtained for the scanning speeds that can be

realized for a prescribed degree of pattern distortion.

Limitations arising due to modulo 2π phase scanning in wideband pulse compression systems are studied next. The effect is studied with specific reference to a linear FM pulse in linear and circular array geometries. The array is shown to affect the signal envelope in the case of linear array with parallel and series-end feeds and also circular array with corporate feed. In a linear array with center-fed series-feed the pulse shape as well as the phase of the carrier are affected. The overall response of the system depends on the array configuration, aperture size, signal bandwidth and the array look direction.

Compensation of the array dispersion effects using phase corrections in each element of the array has been attempted. The objective is to obtain a system output which is largely independent of scan angle. A non-linear optimization technique is used to realize the goal. Simulation studies using the above method show a substantial reduction in the angle dependence of the system response.

An electronic scanning signal processing antenna system incorporating beam compression is described next. The system uses the well-known modulation scanning technique in conjunction with a pulse compression type of signal processor. The transmitter pulse is stepped linear FM coded. The array system output shows an improvement in angular

resolution by a factor equal to the number of steps in stepped linear FM pulse. This is accomplished without any deterioration in system range resolution or signal-to-noise ratio. The effect of transmission bandwidth on system performance is also studied.

As far as possible, throughout the thesis the results are presented in a generalized manner so as to be applicable to an arbitrary array. A few suggestions for further work are also included at the end.

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