ABSTRACT

The requirements for very high performance antennas are in great demand, necessitating such parameters to be incorporated on Spacecraft, Aircraft,Terrestrial and Maritime applications to meet the challenging mission objectives.These antennas are required to provide high gain,low sidelobe, large bandwidth combined with multiple beam capability. Recent research trend indicates that a phased array antenna can meet these diverse specifications.

A major problem encountered in the development and measurement of these sophisticated array antennas is to characterize its performance. Near-field measurement techniques can solve these problems in an efficient and cost-effective manner. A distinct advantage of the above testing scheme is the unique ability of providing antenna diagnostics besides facilitating the setting up of an indoor laboratory co-located to the production lines.

The possibility of diagnosis of faults on a synoptic basis by transformation of the radiated field onto the aperture, as opposed to the interrogation of the array on an element by element basis is the method adopted in this dissertation.Restricting, to the study of planar near-field scanning with major emphasis on antenna diagnostics it was discerned, that majority of the investigators did not consider the invisible region fields for reconstructing the faulted aperture distributions.It is also observed that a very precise technique to tackle the problem of convolution of faults in the midst of an array environment was not available.The research investigations undertaken in this dissertation are the detailed studies attempted to address the above problems. A systematic approach to fault diagnosis on array antennas has been attempted utilizing i) Spectral domain analysis featuring plane wave spectrum approach ii) Signal processing technique involving the Cepstrum method.

The spectral technique basically reconstructs the aperture distribution via the backward transform starting from the near-field. Great care and restraint has been exercised to include adequate spectral domain fields in the invisible region to characterize sharp faults simulated on the aperture plane. In the signal processing method the cepstrum technique exploits the convoluted faulted signal caused by element failure or bank of elements and deconvolves the fault via the cepstral domain.

The spectral domain analysis has been attempted utilizing the fourier optics approach featuring two distinct methods which are: i) Vector potential and ii) Spectral method.

Detailed analysis has been undertaken utilizing the above methods and various simulated faults reconstructed and verified. A distinct limitation of the above methods is to diagnose convoluted faults resulting in a blurring effect on reconstructed aperture distribution patterns.

Utilizing the cepstrum technique the above mentioned problem has been overcome and the convoluted faults have been isolated and quantitative information provided. The same cepstral technique utilizing the Blind Deconvolution method is founded by which the probe compensation is implemented. With a quest to improve the accuracy and the speed of computation, besides fitting a basis function to the discrete array architecture an analysis featuring Walsh functions is investigated for characterizing sharp and stepped faults.

KEY WORDS : Array faults, Near-field testing, Cepstrum Analysis, Homomorphic Deconvolution, Spectral Domain, Blind Deconvolution, Walsh Transform, Probe Compensation, Aperture Field Reconstruction.