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EFFECTS OF MUTUAL COUPLING IN ADAPTIVE ARRAYS

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Abstract - mutual coupling effects in microstrip antenna arrays were studied. Mutual coupling between antenna elements can distort array pattern and increase reflected power to antenna feed system.

PATTERN CORRECTION

Pattern distortion due to mutual coupling can be corrected by changing element feed voltages [1]. A linear correction method was established experimentally [2]. Correction was implemented using matrix pseudoinvariance, which is a least square error (LSE) method. Example of correction is seen in Fig.1.

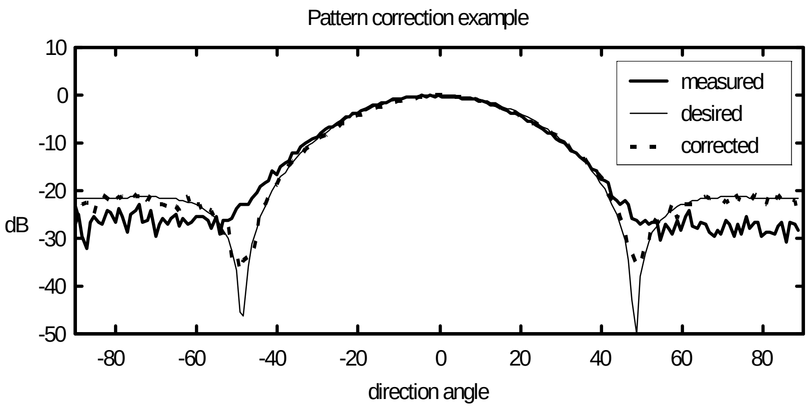

Figure 1 Six element microstrip array corrected using isotropic elements. Element spacing is 0.3λ

Also substrate edge effect takes place when microstip antennas are used. This effect can be corrected within those caused by mutual coupling. The validity of fixed correction over frequency band is also qualified.

REFLECTED POWER

Backscattering can be analyzed using scattering matrix eigenvectors and eigenvalues. Extremal values for reflected power rates are related to extremal eigenvalues. We can find the normalized reflected power for *i*th feeding eigenvector by its eigenvalue

$$P_{back,i} = |\lambda_i|^2 \qquad (1)$$

It was demonstrated, that scan blindness effect [3] can take place in microstrip linear array with six elements [2]. In adaptive antennas backscattering caused by mutual coupling is a statistical phenomenon. Simple models for antenna feeding statistics are needed. We can assume independent antenna element inputs and that phase angles have uniform distribution. For amplitudes we can use Gaussian, uniform or constant value distribution. Backscattered power from array with equal input amplitudes is shown in Fig 2. In this case the distribution for reflected power from one element is very like to exponential when the total reflected power behaves as Poisson distributed.

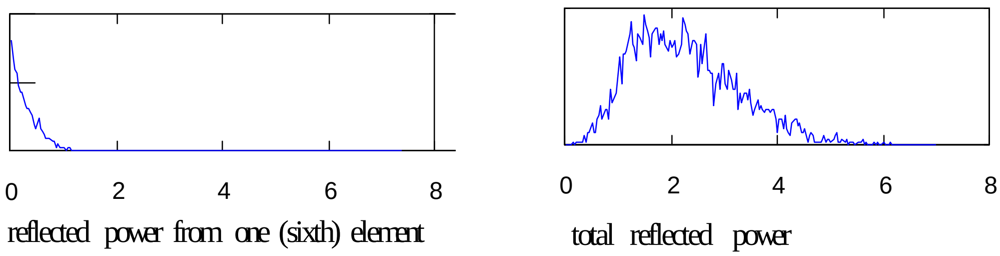

Figure 2 Reflected power statistics in six element microstrip array with element spacing 0.3 λ when each element input power is unity.

The mean backward coupled power for a microstrip array with different element spacing is calculated in Table I assuming the propabilities of each feeding eigenvectors to be equal.

Table I Mean reflected power rate root value calculated from scattering matrix.

Antenna array name (6 elements)	element spacing in wavelengths	$<\|S_{ij}\|> *\sqrt{6}$ (rms)	$<\|\lambda_i\|>$ (rms)
RH1	0,5	0,28	0,27
RH2	0,5	0,39	0,37
RH3	0,3	0,61	0,59
RH4	0,93	0,39	0,38

Results show, that also with typical element spacing mutual coupling effect should be taken into account in accurate systems. It causes array antenna total bandwidth broadening when the bandwidth is calculated statistically, as should be done for adaptive arrays. Bandwidth broadening can be useful in mobile systems, but with increasing mutual coupling the problem of reflected power increases.

References

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[3] Gupta, I., Ksienski, A., "Effect of mutual coupling on the performance of adaptive arrays", *IEEE Transactions on Antennas and Propagation*, Vol. AP-31, Sep. 1983, 785-791.