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SYNTHESIS OF POLARIZATION FOR PLANAR ARRAYS : AN EXAMPLE.

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Abstract :

This paper deals with antenna synthesis in the case of an array of N elements. The use of a variationnal method described in [1] allows us to synthetize the complex weights to be applied to the elements in order to obtain a linear polarization for the total electric field and to meet a desired power pattern.
An example of this synthesis technique will be given in the case of an uniform linear array of N dipoles, the orientation of each being fixed randomly. A linear polarization along $\vec{u_\theta}$ is desired in the plane $\varphi = 0^o$ of the spherical coordinates. The power pattern will be directionnal.

Radiation intensity of one element :

The electric field emitted by a dipole (with length 2.l), fed with a current $\vec{I} = I_m.sin(\frac{2.\pi}{\lambda}.(l - \mid x \mid) . \vec{u_x}$ can be found using the expression :

$$\vec{d}(\theta,\varphi) = A_E(\theta,\varphi).cos(\varphi).\vec{u_\theta} - A_H(\theta,\varphi).sin(\varphi).\vec{u_\varphi}. \quad (1)$$

$$\begin{cases} A_E = \frac{1}{(cos(\theta).cos(\varphi)^2-1)} . (cos(\frac{2.\pi}{\lambda}.l) - cos(\frac{2.\pi}{\lambda}.sin(\theta).cos(\varphi))) \\ A_H = A_E.cos(\theta) \end{cases}$$

If the orientation of the element is repeared by an angle α_1, this expression becomes :

$$\vec{d^1}(\theta,\varphi) = d^1_\theta(\theta,\varphi-\alpha_1).\vec{u_\theta} + d^1_\varphi(\theta,\varphi-\alpha_1).\vec{u_\varphi} \quad (2)$$

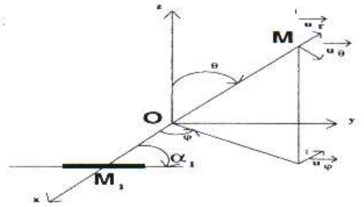

FIG. 1 –

The dipole is described by its position M_1 and its angle α_1 (see figure 1)

Array of N elements :

For an array of N elements, described by their positions (with respect to a fixed point O : $\vec{OM_p}$) and by their orientation (with respect to the Ox axis : α_p), the radiation intensity can be written as :

$$D(\theta,\varphi) = \mid \sum_{p=1}^{N} d^p_\theta(\theta,\varphi).I_p.exp(\frac{2.i.\pi}{\lambda}.\vec{OM_p}.\vec{u_r}) \mid^2 + \mid \sum_{p=1}^{N} d^p_\varphi(\theta,\varphi).I_p.exp(\frac{2.i.\pi}{\lambda}.\vec{OM_p}.\vec{u_r}) \mid^2 \quad (3)$$

where d^p_θ and d^p_φ are given by equations (1) and (2).

Synthesis technique :

With a variationnal technique described in [1], one can minimize :

- the difference between the desired pattern and $D(\theta,\varphi)$ for a set of spherical angles.
- the cross-polarization in a desired plane.

so that the polarization is along a desired vector.
An example of N=32 half-wavelenght dipoles will be presented and several other examples will be given during the presentation.
For the array of 32 dipoles, the total electric field is forced to follow the vector $\vec{u_\theta}$ in the plane φ=0^o.
In the main lobe, the cross polarization is 20dB below the modulus of the coefficient of $\vec{u_\theta}$.
In the side lobes, the modulus of the total electric field is less than -30dB for all the angles θ. The angles α_p are randomized numbers between -π/4 and +π/4.

[1] J.M FLEURIAULT, P.GONNET, J.J FUCHS, C.TERRET "Antenna pattern synthesis for conformal arrays. Comparison of two different methods.", *PIERS 1995 conference*, SEATTLE, July 1995.