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ANALYSIS OF INFINITE PHASED DIPOLE ARRAYS HAVING DIELECTRIC SHEATH AND GROUND PLANE

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<u>Introduction</u> Among many works on infinite phased arrays, the exact analysis by Amity and Galindo on dielectric loaded and covered circular waveguide phased arrays[1] confirmed the existence of the surface wave resonances. The leaky wave resonances[2], however, have not been thoroughly studied. The author found an approximate formula of the array-element pattern in terms of active impedance [3],and he anticipated that the null in radiation pattern would necessarily appear at the angle where the active impedance is anomalously large. This angle is determined by the phase constant of the leaky wave existing over the array whose feed-points are not loaded with resistors but are open-circuited.

This paper deals with infinite phased dipole arrays having dielectric sheath and ground plane, which is shown in Fig.1, with emphasis on the anomalous change in active impedance.

<u>Green's function</u> The dipole antennas are assumed to be made of infinitely thin tapes carrying the unidirectional currents with uniform amplitudes across the tapes. From the periodicity of the structure, the electric field and the current of each element are related in the common equation:

$$E_\xi(\mathbf{r})=\iint_A G_{\xi\xi}(\mathbf{r},\mathbf{r}')J_\xi(\mathbf{r}')d\xi d\eta \quad (1)$$

where A denotes the area of one element. Equation (1) is equivalent in the form of itself to that of the isolated antenna, but it is to be noted that the Green's function $G_{\xi\xi}$ is asymmetric with respect to $\mathbf{r}$ and $\mathbf{r}'$, and is the function of the scan angle. Hence the currents are in general asymmetric with respect to the feedpoint although the feedpoints are at the center of each element. The procedure of obtaining $G_{\xi\xi}$ are as follows.

(1) To introduce the reciprocal lattice vectors $(\mathbf{h}_1,\mathbf{h}_2)$

(2) To express the fields in each region, and the current in the sum of modes with the wave number $(n\mathbf{h}_1,m\mathbf{h}_2)$.

(3) To impose the conditions of continuity and discontinuity on the fields, and to get the field

on the tapes.

Three-term solution by Improved Circuit Theory[4,5] We adopt the following three current functions :

$$J^1(\xi)=\sin k(h-|\xi|),\quad a^1=\sin kh \qquad (2)$$

$$J^2(\xi)=1-\cos k(h-|\xi|),\quad a^2=1-\cos kh \qquad (3)$$

$$J^3(\xi)=\sin\pi\xi/h,\quad a^3=0 \qquad (4)$$

The active impedance Z, and the current distribution J_ξ are computed in the following steps.

$$z^{lm}=-\iint_A\iint_A \frac{J^l(\xi)}{\delta}G_{\xi\xi}\frac{J^m(\xi')}{\delta}d\xi d\eta\, d\xi' d\eta'$$
$$(l=1,2,3;\ m=1,2,3) \qquad (5)$$

$$\left(y^{lm}\right)=\left(z^{lm}\right)^{-1} \qquad (6)$$

$$Z=1/\left(\sum_l\sum_m a^l y^{lm} a^m\right) \qquad (7)$$

$$J_\xi(\xi)=V\sum_l\sum_m y^{lm}a^m J^l(\xi) \qquad (8)$$

Computed results and discussions

The computations have been made on square and hexagonal lattice arrays, and the effect of the dielectric on the performance of the array will be discussed.

Refferences

(1) N. Amitay and V. Galindo, "Characteristics of dielectric loaded and covered circular wave-guide phased arrays,"IEEE Trans., Antennas and Propagation, vol. AP-17,pp.722-729, November,1969.

(2) R.C.Hansen(editor),Microwave Scanning Antennas, vol.2.

(3) N.Inagaki and T.Sekiguchi," Array-element pattern and active impedance of phased array antennas,"Trans.IECE,Japan, vol.53-B,12,pp.752-759, December,1969.

(4) N. Inagaki,"An improved circuit theory of an multi-element antenna,"IEEE Trans.,vol. AP-17, pp.120-124, March,1969.

(5) N.Inagaki and T.Sekiguchi," Analysis of dipole antenna array with arbitrary lengths by the Improved Circuit Theory,"Natl. Conv. Record of I.E.C.E.,Japan, 357,1969.

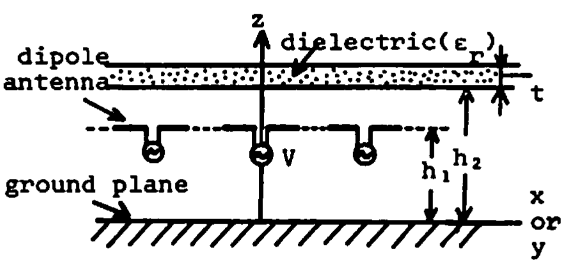

Fig.1. Geometry of the problem.