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STUDY OF THE BANDWIDTH OF RESONANT RECTANGULAR MICROSTRIP ANTENNAS

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ABSTRACT

A new method based on the backpropagation multilayered preceptor network for calculating the bandwidth of resonant rectangular microstrip patch antenna and permittivities and is useful for the computer aided desing (CAD) of microstrip antennas. The method may find wide application in high-frequency printed antennas, especially at the millimeter – wave frequency range.

Keywords: - Backpropagation, multilayered, perceptron, network, computer aided design. Bandwidth

INTRODUCATION

Convention microstrip antennas, consisting of a single conduction patch on a ground dielectric substrate have received much attention in recent year due to their many advantages, including low profile, light weigt and easy integration with printed circuits. However, due to their resonant behavior behaviour, they radiate efficiently only over a narrow band of frequencies, with bnandwidths typically only a few percent.

Consider a rectangular patch of width W and L over a ground plane with a substrate of thickness h and a relative dielectric constant Er. I However, the very thought of utilizing the microwave frequency region for obtaining directional patterns remained obscure for decades. This was mainly due to lack of adequate experimental facilities for high frequencies. Ultimately the World War II caused a breakthrough in the direction because of the widespread requirement of radar and other communication systems and thus a new era of development of microwave aerials began. The development of high power generators of centimetre and shorter wavelength was an important landmark in the direction as with it a series of microwave aerials completely unknown to the long wave region followed. The present day position is that many types of microwave aerials are in use, of which the important ones are: (i) Aperture aerial consisting of horns, slot and open-ended waveguides, (ii) Dielectric and surface wave aerials comprising of the dielectric road, tube and horn aerial and (iii) Secondary aerial which can be subdivided into two classes (a) Reflectors and (b) Lenses.

The main difference between these aerials and those employed at lower frequencies lies in the fact that in these microwave aerials are required shaping of the beam of radiation is achieved not by individually feeding discrete radiating element but by techniques akin to those used in optics. As the dimensions of the aerials are generally large compared with the wavelength optical design principles are both preferable and practicable.

Incidentally, it may be mention here that among all these aerials mentioned above the dielectric group of aerial is the newest and as a consequence least developed. This group consisting of the dielectric road, the dielectric hollow tube and the dielectric horn aerial are primarily aerials and the dielectric lens as the secondary found some use in the Second World War. A few array of 4-dielectric rod aerials were used as search serials by Germans, whereas Bell Telephone Laboratories developed an array of 42-dielectric rods for use in U.S Naval ships. Inspite of all these, even today there use is restricted to limited applications for no exact or even approximate design procedure exists. The lack design data is reflected in the difference of opinion about the way in which a uniform dielectric rod radiates. The theoretical concept of radiation from a hollow dielectric tube is further complicated because of additional complex boundary conditions. The dielectric horn which resembles the metal horn but for the use of dielectric material in construction o side walls as against the metal conventionally employed, indicated better directivity than the corresponding metal horn of the same dimensions. This, however, remained only as academic achievement for non- availability of literature to substantiate the fact theoretically and thus to justify the experimented results. Consequently detailed theoretical studies on dielectric rod and hor have been included in the present thesis. Furthermore, some of the aerials widely employed at the lower frequencies, find widespread use at microwave region as well. An example of array of half wave dipoles. A half wave dipole when used along produces a beam which is too wide too be of any significant use of any frequency, but fairly the performance of the directive patterns have been obtained when a large number of such dipoles radiates receive simultaneously in the form of an array. It is well known that larger the number of the elements in such an array, higher is the gain and directivity can be further enhanced by utilizing continuous sheet of displacement current in place of a closely packed array of discrete dipoles.

In a paraboloidal reflector, with a point source of radiation situated at its focus, a similar situation exists and hence a very high gain and directivity ensure with the result that a verynarrow beam of radiations is produced. However, for many important practical applications such as beam scanning, it is necessary to keep the primary source off axis. The defocusing introduce a phase error which is turn tend to deteriorate the performance of the paraboloidal reflector feed combination. These phase error have been computed in terms of the focal length to aperture diameter ratio and the off-axis angle. Following the computation method to minimise them, by eliminating the second order phase error, have been suggested in the thesis. During recent years increasing demand is found for point to point communication for the facility of supervisory control, telemetering, load control, protective relaying and allied functions. However the crowding of the lower frequency spectrum and the susceptibility of the wire line to outage in select storm and other bad weather conditions make it desirable to perform many of these function by utilizing the microwave frequencies. The roal of microwave in a communication is further increased by the widespread use of television as a medium of mass communication and “Radar” for defence purposes. Lately the development of interplanetary communication has further changed its importance. Though all portions of the equipment employed for the purpose are equally important, microwave aerial system require special attention for their role in the radiating it in accordance with present requirements.

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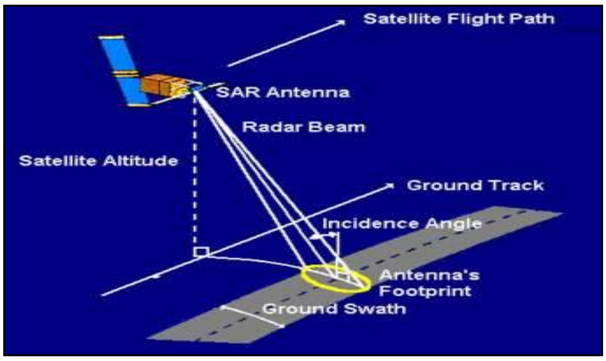

Fig: - (1)

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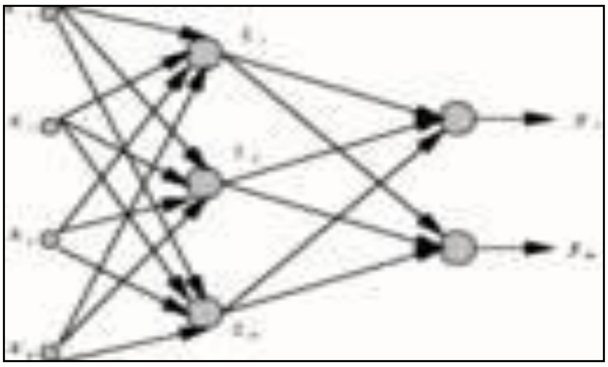

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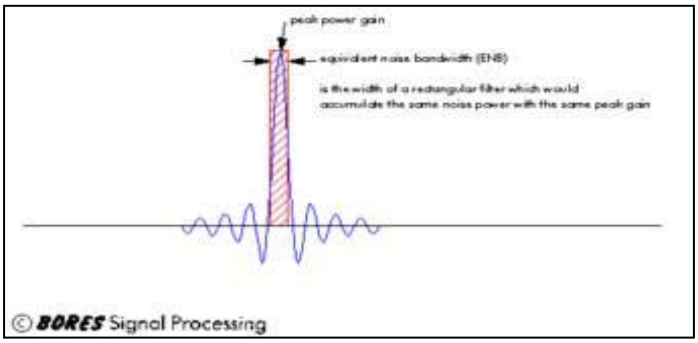

Fig :-(3)

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$$S(r) = So + 6 \qquad (1)$$

Where s has the constant value s_o on a given initial wavefront and where 6 denotes the distance from o along a ray measured positively in the direction of wave propagation. If (61,62) is a system of orthogonal curvilinear co-ordinates on o, a ray may be labelled by two parameters (61,62). Thus (61,62, 6) from a system of ray co-ordinated (fig.3).

The transport equation (1) is an iterative system of equations for finding em-1. They reduce the ordinary linear differential equations along a given ray. The solution of the latter are found to be

$$em6=em\ (6)\ [J6oJ6]^{1/2} - 1266[J(6'6')]^{1/2}\ \ 2em\text{-}1(6')d\ 6' \qquad (2)$$

M=0, 1, 2,...
Where J(6) is the Jacobian of the transformation from ray co-ordinates r = (X1', X2', X3'):

$$J(6) = J(61'\ \ 62'\ \ 6)= X1', X2', X3(61'\ \ 62'\ \ 6) \qquad (2.1)$$

The Jacobian J(6) along a given ray is related to the cross-section of a narrow pencil of ray d (6) by the well-known formula:

$$d\ (6) = |J(6)|d6_1d6_2 \qquad (3)$$

Thus apart from the phase factor, the Jacobian ratio in (3) is equal to the square root of the cross-section of a pencil at the two points on a ray. From elementary geometry we find:

$$d(6)d(6o)=|(R1+6o\ \ (R2+6o)R1+6\ (R2+6)| \qquad (4)$$

Where (o, o, 6 = $-R_1$) and (o, o, 6 = $-R_2$) are the co-ordinates of the centres of the curvature of the initial wavefront o and R_1 and R_2 the associated radii of curvature which are taken positive if the rays omanating from the corresponding focus are divergent and negative if the rays are convergent. It can be shown (3) that the Jacobian J(6)6 o is exactly equal to the right hand side of (4) where the absolute value has been removed. Thus

$$[J(6o)1/2J(6)] = (R1+60)12\ \ \ (R2+6o)1/2(R1+ 6)12\ \ (R2+6)1/2] \qquad (5)$$

Note that when $6_o+R_2 < 0$ the focus line F_2 lies between the wavefront defined by 6 and 6_o. In other words when we progress along the ray pencil from 6_o to 6 in the direction of wave propagation we cross a focal line. Then a change of π/2 is introduced in the amplitude. This condition is verified if the following convention for the square root in (5) is adopted: $(R_1, 2^{+6})^{1/2}$ takes positive real, positive imaginary or zero values.

Let us now come back to (6). this formula enables one to continue e_m along a given ray.

eo (6) = eo(6_o) [J(6oJ(6)]1/2 (6)

Thus, for the zeroth-order amplitude eo, it is only necessary to know one initial value of e_o at a reference point 6_o in order to carry out this continuation. We see also that the directioneo, which defines the polarization of zeroth-order field, remains constant along a ray. In addition, it is found from (1) and (2) that:

s.eo = 0, ho = 1 x eo (7)

Which means that (eo, ho, s) from a right handed system of vectors. Thus the landing term of the asymptotic expansion (3) describes a local plane wave field. At the caustic point where 6 = -R_1.eo (6) becomes infinite, hence (4) fails.

For a higher order amplitude em (m>0) more information is needed in order to continue em along a given ray. In addition to the initial value em (6_o). 2e_{m-1} ($6^{'}$) must be taken for all $6^{'}$ in the range $6_o < 6^{'} < 6$. For m=1 for instance one needs 2eo ($6^{'}$). According to (5) and (6) this implies the knowledge of the first and second derivatives.

For the Zeroth order field we saw that this law describes the polarization of the wave which remains constant along a ray. This property holds for m > 0. It has been proved (3) that, whenever em(6) satisfies (4) at one point on the ray, then it does so along the whole ray. This does not mean that the polarization direction of em with m > 0 is orthogonal to the ray, like EO. In general the polarization directions of higher order terms are nor orthogonal to the ray. The corresponding pointing vector is therefore not account for energy flow transverse to the ray. According to the hypothesis underlying the perturbation method, this energy flow and hence the corresponding angle are supposed small. Having determined a general asymptotic solution to Maxwell equations for K large. We now go over the second step of the resolution process consisting to apply to this solution the boundary conditions on the surface of the scattering object.

CONCLUSION

A new method based on artificial neural networks t6rained with the back propagation algorihm for calculating the band width of both electrically thin and thick rectagularr microstrip antennas with the data from the Green function methods. This excellent agreement supports the validity of neural models.

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