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DIRECTIVE LOOP ARRAY ANTENNA

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The directive loop array antenna consisting of a feeding element, a reflector and one or several directors is investigated experimentally. In this endfire array antenna, the feeding element and the directors are circular wire loops with circumferences about one wavelength long. Adachi and Mushiake were the first to investigate the directive loop antenna with one director[1,2]. This antenna has been found to have advantageous characteristics such as high gain, wide bandwidth and mechanical compactness. Therefore, it might be expected that a highly directive antenna could be constructed by using several loops as directors.

The purpose of this paper is to investigate the variation in actual gain with the number of directing loops when their spacings and diameters are optimized. In particular, different optimizations are carried out in order to find the maximum obtainable actual gain when the length of the array is limited to 6 wavelengths at the test frequency 650 MHz. The reflector is a quadratic metallic plate with an area of 50 × 50 cm^2.

The actual gain is defined as the ratio of the power delivered into a 75 ohms standard load by the test antenna to the available power at the terminals of an isotropic antenna. This means that one optimizes the sum of directivity and impedance mismatch loss. From the results obtained in this manner, it is expected to be able to indicate whether it is possible to construct a directive loop array antenna with a high directivity.

Three approaches to the optimization of the directive loop antenna are made:

1) Directive loops are added one by one to the antenna consisting of the feeding loop and reflector. After the addition of every director, all spacings and diameters are varied. Perturbations are repeated until no significant increase in gain is obtained. Fig. 1 shows the results obtained. The antenna was 6 wavelengths long after the addition of director no. 15 and a working gain of 17.1 dB was obtained.

2) In the second approach, all elements are located with equidistant spacing. The circumferences are equal to the average of the circumferences of the loops of the antenna just mentioned. The working gain variation as a function of the equispacing and the number of directors is investigated. This approach gives a maximum gain of 17.0 dB for an antenna with 21 directors.

3) Based on the previous results, the following optimization was carried out. For different equispacings between the directors and for different distances between the first director and the reflector, the position of the feeding element was optimized. This resulted in an antenna with 21 directors and a gain of 17.7 dB. Finally, the positions and diameters of the loops of this antenna are perturbed several times until no significant increase in gain is obtained. The resultant antenna has a gain of 18.2 dB.

For the different optimized antennas mentioned above, impedance measurements showed that the mismatch loss is about 0.1 dB and the bandwidth is about 3 to 4%. This means that the directivities of the optimized antennas are nearly equal to their actual gain. It is expected that the directivities obtained can be increased 1 to 2 dB, if one maximizes the directivity instead of the actual gain. Planned experiments will reveal this and give further details about the characteristics of the directive loop antenna. The results will be presented in the full paper.

References:

[1] Adachi, S. and Y. Mushiake, "Directive Loop Antennas", Research Institute of Tohoku University, Sci. Rep. Ser. B., Res. Inst. Elect. Com., Vol. 9, No. 2, pp. 105-112, Sept. 1957.

[2] Adachi, S., Y. Mushiake and G. Saito, "Characteristics of Directive Loop Antennas and Broadening of Their Frequency Bandwidths", Electronics and Communications in Japan, The Journal of the Institute of Electrical Communication Engineers of Japan, English Edition, Vol. 48, No. 4, pp. 214-217, April 1965.

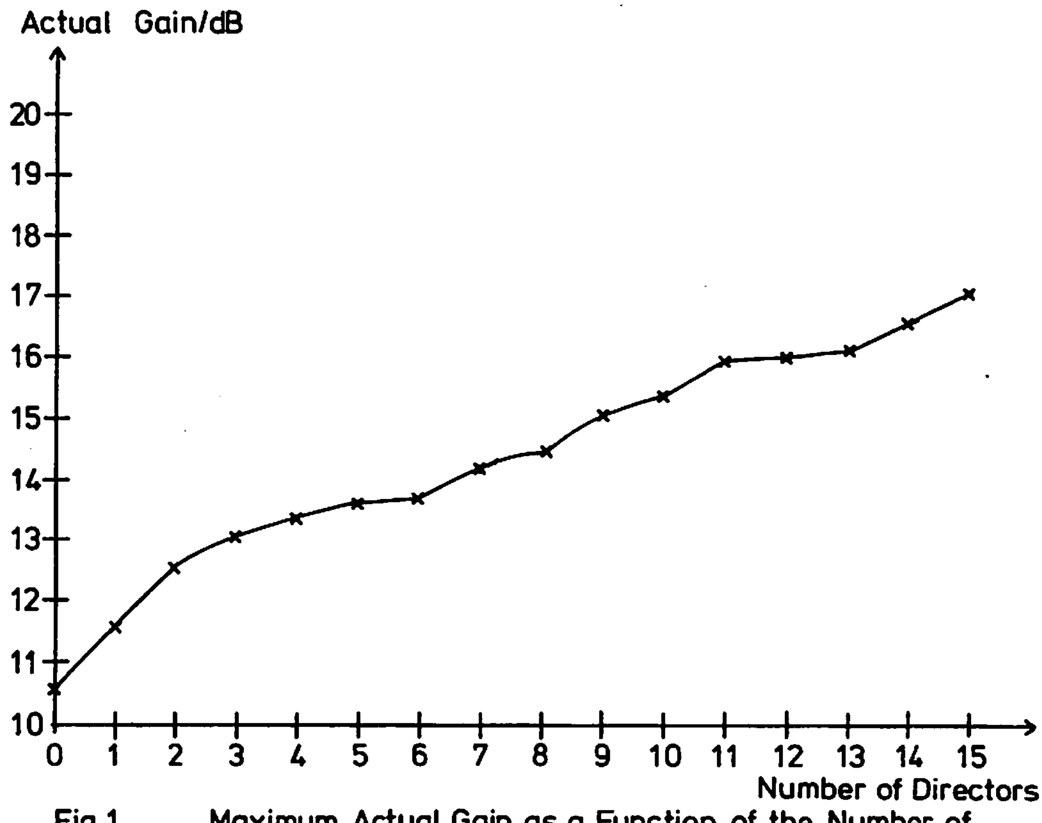

Fig. 1 Maximum Actual Gain as a Function of the Number of Directors of the Directive Loop Array Antenna.