ON MAXIMUM AVAILABLE DIRECTIVITY OF CONFORMAL ARRAYS

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There is presently a lot of interest in conformal antennas, mainly for their good scanning characteristics. For optimum design, it is of interest to know the maximum available gain for a given structure and radiating element, the optimum amplitude and phase distribution, which generates this maximum directivity.

We have previously presented (N. Herscovici, Z. Sipus, P-S. Kildal, S. Raffaelli, 2nd European workshop on conformal antennas, The Hague, Netherlands, April 2001) a numerical approach to determine the maximum directivity of a conformal array. After this presentation there have been comments to us that the maximum gain of conformal antennas already had been considered analytically (A. Hessel, J-C Sureau, IEEE Trans. Antennas Propagat., 1971, pp. 122-124), and that their results were more general than ours. In the present paper we will explain the difference between the two approaches, and we will show by numerical computation that our approach is simpler and actually gives higher directivity than the previous approach.

The **maximum realized gain** (i.e. gain including mismatch losses) of a given array in a specified direction was by Hessel and Sureau found to be equal to the sum of the individual element gain functions in the direction of interest. The disadvantage of using this approach is that we need to determine the element gain function of each of the elements in the array in the presence of the other elements, when each of these are terminated in a load with the same impedance as the transmission line connecting to it. These element gain functions are very laborious and time costly to determine, independent of whether we do it by measurements or computations. Furthermore, the approach is valid for a given antenna, and it will normally be possible to improve the realized gain by matching each of the antenna elements in the active situation, in which case an iterative procedure must be applied. The maximum **available** realized gain will be the realized gain when all elements are ideally matched, and this is clearly larger than that obtained by Hessel and Sureau's approach.

We use numerical optimization of the excitations of the array to obtain the radiation pattern with the **maximum directivity**. As an example, we consider an array of cylindrical microstrip patches, but the analysis approach can be easily applied to other types of antenna elements. The optimization procedure gives as a result the optimum element current distribution along the array. This distribution does not correspond to the optimum source voltage distribution, because the active impedance of each element will be different. We will demonstrate numerical results showing that our optimum current distribution of the array elements give higher **directivity** than the "optimum" source voltage distribution from Hessel and Sureau. In addition, we calculate the optimum source voltage distribution from our optimum element current distribution, and we show that this is significantly different from that of Hessel and Sureau. Thus, our approach is a way of determining the maximum available directivity of a conformal array, i.e., an upper limit of the realized gain, whereas Hessel and Sureau's approach gives the maximum realized gain of a given antenna if we are allowed to change the excitations of each element but not the impedance match. The latter can normally be improved by matching the elements of the array better in the active situation. In order to determine the maximum directivity by our method, the isolated element pattern of the array is needed, i.e. the element pattern when the other elements are removed. This is (normally) the same for all elements. Our approach to determine the maximum directivity is thereby much simpler as we do not need to determine the mutual coupling matrix.

The numerical analysis has been performed by computer programs for antennas on multilayer circular cylinders based on the G1DMULT algorithm.