ORTHOGONAL METHODS FOR ARRAY SYNTHESIS pdf

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Orthogonal Methods for Array Synthesis outlines severalprocedures of orthogonal methods suitable for antenna arraysynthesis. The book presents a simple approach to the design ofantenna arrays to enable the reader to use the classical OrthogonalMethod for synthesis of linear arrays.

INTRODUCTION Optimization and synthesis methods for antenna arrays have been studied by many researchers; the exi stance alone of a long series of papers on these subjects is enough to emphasize the importance of these areas. Specifically Dolph [1] and Riblet [2] have published a series of very interesting papers. These papers, by using Chebyshev polynomials, give a synthesis for uniform linear arrays which offers the minimum beam- width for a prescribed sidelobe level. Unz[], Harrington[7] , King, et al. On the array optimization Uzkov [10] first found by using linear transformations, the maximum directivity of linear arrays. Tai [14] considered the problem of achieving maximum directivity in uniform linear arrays of short dipoles and gave many useful graphs on the subject. Cheng [15] studied the determination of directivity in more complicated arrays. Sungiri and Butler [17] have used the eigenvalue method to find the solution for the maximum directivity with constraints on the resulting sidelobes. Matrix methods were applied by Strait and Kuo [18], Sarkar and Strait [19] and Sahalos [20] for constrained optimization of various performance indices of arrays with straight parallel or nonparallel thin wire antennas. The orthogonal method for arrays consisting of arbitrarily oriented short dipoles was applied by Sahalos []. The orthogonal method one decade ago was used first by Unz [23] and recently by Sahalos [] in many antenna array applications. In the present work an effort is made to give some useful formulas applicable to synthesis and optimization problems when the arrays con- sist of nonparallel wire antennas. By defining a right handed orthogonal coordinate system n,,? Richmond and is true for electrically thin wires. The quantities in Equations 1 and 4 are given by: The far zone field transmitted by an antenna can be expressed as: If the center of the segment has coordinates and direction angles then: By a method analogous to that of orthogonality we can express the field as a situation of N ortho- gonal vectors of the same space. Some of the usual performance indices which are involved follow. Equation 27 is expressed as N , 1 2 y V-. E fficiency Indices The efficiency indices are very important parameters describing the performance of an array. Many indices can be defined by several ways. Gain-Directive Gain and Efficiency Indices Maximization Until now we have seen that all the above indices can be written in the following formula. If the field in the K direction is related with the Eq in the direction of maximum by the form: If we want some of these to be the si delobe levels then we can use an iterative procedure. Thus we find first the feed voltages by the above procedure and the level of the electric field sidelobes. These are compared with the desired levels. The new directions of sidelobes are used to find new feed voltage, etc. The procedure is continued until all the sidelobes take on the desired values. Synthesis In all examples we assume that the wires have radius 0. For the case of synthesis a double integration is applied. In Appendix II we show a method of numerical integration with good accuracy. This method is extended in Reference [30] and uses the Chebyshev polynomials. Let us suppose at first that we have two dipoles normal to each other with their centers a distance about equal to the diameter of the wire. Suppose a directive field of the form: Seven dipole linear array. T 7 [cos 1. Linear array with 8 non-parallel wire antennas. It is interesting to say that in this case there are critical equaldistances in which we have maxima. In this case the directive gain increases as the diameter decreases. Another one example is the design of. CONCLUSION As a result of the foregoing discussion, we have seen that the orthogonal method can be applied to an arbitrary array of wire antennas, and that it can solve synthesis and optimization problems with good accuracy, apart from rendering it easily solvable with the aid of a computer. The method can be applied for any case of parallel or non- parallel wire antennas, while the parallel wire array is a special case of an arbitrary array. For optimization problems the orthogonal method has the advantage of using easily applied formulas without the necessity of inverting matrices. But in the case of optimization under the constraint that one index has a given value, the matrix method must be used. That is because in nonlinear constraints the formulas given by the orthogonal method will be more complex. At least this problem needs to be studied further. In the other cases linear constraints a comparison between the Matrix and the Orthogonal method reveals that the second one is faster and needs less computer time than the first one. So, both methods have advantages and disadvantages which a designer must keep in mind. In Equations 4 - 7 the involving parameters are: The electric field which is desired may or may not be one function with a closed form mathematical expression. In all cases the description of the electric field may be done Dy sample points which we will show as follows. If we have the integration fb rd j f i;. Some examples to show the accuracy i of the method follow. Application of the formula 55 gave the following table: Application of the formula 1 gives n AP-8, March , pp. AP-9, March , pp. AP-8, July , pp. Commerce, Boulder, Colorado, Rep. AP, January , pp. AP, May , pp. AP, March , pp.

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3: Orthogonal Methods for Array Synthesis (1st Ed.) by Sahalos, Sahalos & Sahalos

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