Analysis & Optimisation of Holographic Antennas Using an Integral Equation Formulation

Pradiv Sooriyadevan* & Derek M[c]Namara
University of Ottawa, 161 Louis Pasteur Street, Ottawa, Ontario, K1N6N5, Canada.
Aldo Petosa & Apisak Ittipiboon
Communications Research Centre Canada, Ottawa, Ontario K2H 8S2, Canada.

Antennas based on holographic principles have been proposed for (amongst other applications) multipoint wireless communications because of their flat profile and potentially high gain. Most published design work on holographic antennas (eg. K.Lévis, A.Ittipiboon, A.Petosa, L.Roy & P.Berini, *IEE Proc.-Microwav. Antennas Propagat.,* **148**, 129-132, 2001) has been based on approximate expressions and experimental experience. No attempt appears to have made to use some computational electromagnetics approach to model these antennas. Thus no numerical optimization has been possible.

One aspect that makes the modeling/optimization process difficult is that such holographic antennas are electrically large. For instance, the combined length of the finite-width conducting strips on the antennas in the above-mentioned reference can be more than $100\lambda_0$. In this paper we apply a two-dimensional analysis that allows one to determine the H-plane radiation characteristics of the holographic antenna. This analysis consists of a well-known integral equation formulation for a line source illuminating a structure consisting of conducting strips and dielectric material, and its solution using the method of moments (eg. X.Yuan, R.F.Harrington, & S.S.Lee, *JEWA*, **2**, 21-44, 1987). A similar approach has previously been used to model the principal plane patterns of horn antennas with complex flare geometries (eg. D.J.Heedy & W.D.Burnside, *IEEE Trans.*, **AP-33**, 1223-1226, 1985). We will show how it can be applied in the modeling of the holographic antennas in question. It is possible to model the holographic antenna's feedhorn, the holographic antenna proper, and its interaction with the feedhorn. In addition, we have integrated the electromagnetic analysis with numerical optimization algorithms, and will show what antenna geometries (such as the distribution of conducting strip widths) are obtruded by such algorithms as being optimum in some sense.

In order to apply numerical optimisation it is of course necessary to translate a set of practical requirements into mathematical expressions that define the objective functions to be minimized. We will illustrate how the optimal solutions for the holographic antenna design change with alterations to the possible objective functions.