A NOVEL TECHNIQUE FOR ITERATIVE SOLUTION OF MATRIX EQUATION ARISING IN THE METHOD OF MOMENTS FORMULATION

Soon Jae Kwon, Yongsup Kim, Austin Kim
Samsung Electronics Co., Ltd.
soonjae.kwon@samsung.com

ABSTRACT

In this paper, we present an iterative process for solving the matrix equation by using an extrapolated initial guess in conjunction with the Conjugate Gradient (CG) method. The initial guess is computed from the orthonormalized version of the solutions at previous frequencies. The number of iterations needed to make the residual error smaller than a tolerance is reduced via the application of the extrapolated initial guess. The effectiveness of this approach is illustrated in several numerical examples.

I. INTRODUCTION

Iterative techniques are often used for an efficient solution of a large system of linear equations arising from the MoM formulation, often in conjunction with efficient algorithms for matrix-vector multiplication. Although the use of the latter helps reduce the solution time considerably by decreasing the time for each iteration, the number of iterations needed to achieve convergence governs the overall solution time. To accelerate convergence, one often turns to preconditioning, a topic which has been extensively covered in the literature [1-3] but is beyond the scope of this work.

Instead, we focus on an important topic that is seldom ever discussed in the literature, i.e., the choice of the initial guess that plays a significant role in determining the speed of convergence of an iterative procedure. Numerous attempts have been made in the past [4] to derive a good 뵏uess? for the solution via extrapolation (though not in the context of iteration), which is derived from the solutions at previous frequencies. The procedure outlined in [4] can be quite complex because it is necessary to first express the induced current in terms of a set of constituent waves that have their unique frequency behaviors, which must be extrapolated individually. Although such an extrapolation approach has been successfully applied to a number of scattering problems뿢 ostly two-dimensional in nature뻐he method is not as robust as desired for a general problem for which there is no obvious way to split up the induced current into the constituent waves that can be conveniently extrapolated as functions of frequency. Yet another strategy is to extrapolate the solutions derived at previous frequencies by using a polynomial fitting [5]. Although this approach is considerably more general than the one in [4], it also has difficulties in dealing with structures that exhibit a resonance behavior. With this background, we seek an alternate approach that takes advantage of the knowledge of the solutions at previous frequencies for extrapolation, although it does so in a completely different way than those implemented in [4, 5]. In this paper, we present a simple and efficient technique for generating the initial guess for an iterative solution of a large, dense system of linear equations arising in the Method of Moments (MoM) formulation of layered structure problems. The proposed approach involves an estimation of the solution vector based on the solutions at previous frequencies. The computational time involved in generating the estimate is negligible compared to that of the MoM matrix generation and the iterative solution. To demonstrate its versatility, we apply this technique to microstrip patch array antennas. We demonstrate the effectiveness of the proposed technique in accelerating the convergence of the iterative procedure. We also discuss the stopping criterion of the iteration procedure.