# A Novel Single-Level SVD to Compress RWG EFIE Matrix for Scattering Problems

Seung-Mo Seo*, Jin-Fa Lee

The ElectroScience Laboratory
The Ohio State University
1320 Kinnear Rd, Columbus, OH 43212
e-mail: sms@esl.eng.ohio-state.edu

An electric field integral equation (EFIE) using RWG basis functions is formulated to solve electromagnetic scattering problems by perfect conducting objects. The solution of large-scale electromagnetic scattering problems using the method of moments (MoM) suffers both the storage and computational complexity of a dense impedance matrix. For a general MoM problems using N basis functions, the computational complexity is $O(N^2)$ for storing and solving the impedance matrix via an iterative algorithm. There have been a number of successful algorithms that reduce the numerical complexity such as the fast multipole method (FMM) (R. Coifman, V. Rokhlin, and S. Wandzura, " The Fast Multipole Method for the Wave Wquation: A Pedestrian Prescription", IEEE AP, pp7-12, 1993) and singular value decomposition (SVD) based algorithms (S. Kapur and D. E. Long, "$IES^3$, IEEE/ACM, 448-455, 1997).

This paper descibes a novel single-level dual rank SVD algorithm to reduce the memory usage and computational complexity for solving PEC scattering problems. The algorithm shows that the memory usage and computational complexity are both $O(N^{3/2})$ with the number of groups chosen to be proportional to $N^{1/2}$ where N is the number of unknowns. The system matrix are divided into two categories: self and coupling matrix blocks. The group self matrix blocks is assembled as a dense matrix. As for the group coupling blocks, the SVD compression scheme is applied except the touching groups which will be assembled as a dense matrix. The SVD algorithm can be divided into four parts: grouping, initialization, construction of Q by dual ranking in an iterative scheme and computation of R by LU decomposition. The unique feature of the proposed approach is that the compression is achieved without assembling the entire matrix. The paper also describes "geo-neighboring" preconditioner. The preconditioner when used in conjunction with GMRES is proven to be both efficient and effective for solving the compressed matrix equations. Details of algorithm and some examples will be presented and discussed at the presentation.