**ECE 7650 (Advance Matrix Algorithm)**

**PROJECT REPORT**

*On*

**“Adaptive Cross Approximation Algorithm”**

*By*

**Jamiu Babatunde Mojolagbe**

(Student ID: #7804719)

The Department of Electrical and Computer Engineering

University of Manitoba

*Submitted to*

**Ian Jeffrey, PhD**

(Course Instructor)

1. **Introduction**

The sole purpose of this project is to explore the generation of low-rank approximation, in form of an outer product approximants, of rank deficient matrices by an algorithm known as “Adaptive Cross Approximation (ACA)”. Perusal into merits, demerits as well as complexity of the algorithm in contrast with existing traditional method (Singular Value Decomposition) is also presented.

While as contained in the original paper proposed by Bebendorf et al in [3], the purpose of the algorithm is to obtain low-rank approximants for matrices obtained from solving integral equations – which are in fact, full rank, but contains rank deficient sub-blocks. However, for the sake of this presentation, the performance of this algorithm was based on randomly generated rank deficient matrices.

**1.1 Merit of ACA**

The advantage of ACA is that the performance of already existing computer codes can be improved easily without changing the routines for the calculation of the matrix entries. Also the algorithm presented adapts the rank of the approximant to the respective needs, whereas in the existing methods the rank has to be fixed a priori from theoretical error estimates.

One more beautiful thing about this algorithm is its rank revealing nature and as such can be dubbed rank-revealing LU decomposition [1] - without undergoing computationally demanding Modified Gram Schmidt process.

**References**

[1] M. Bebendorf, “Approximation of boundary element matrices,” *Numer. Math.*, vol. 86, no. 4, pp. 565-589, Jun. 2000.

[2] S. Kurz, O. Rain, and S. Rjasanow, “The adaptive cross-approximation technique for the 3-D boundary element method,” *IEEE Trans. Magn.*, vol. 38, no. 2, pp. 421–424, Mar. 2002.

[3] M. Bebendorf and S. Rjasanow, “Adaptive low-rank approximation of collocation matrices,” *Computing*, vol. 70, no. 1, pp. 1–24, Mar. 2003.

[4] K. Zhao, M. N. Vouvakis and J. Lee, “The adaptive cross approximation algorithm for accelerated method of moments computations of EMC problems,” *IEEE Trans. Magn.*, vol. 47, no. 4, pp. 763–773, Nov. 2005.

[5] Z. Liu et al, “Using adaptive cross approximation for efficient calculation of monostatic scattering with multiple incident angles,” *ACES Journal*, vol. 26, no. 4, pp. 325–333, Apr. 2011.