SAGE: A Simulated Annealing Genetic Algorithm for Predicting the RCS of Electrically Large Targets

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A more thermodynamically consistent modification to the conventional Simulated Annealing algorithm was hybridized with elements of Genetic Algorithms to develop a novel Simulated Annealing Genetic Algorithm (SAGE) which reduces the computational complexity of solving the linear MoM equation from order N^2 to order 2N per iteration. SAGE was implemented and used to predict the Radar Cross Sections of several infinite conducting cylinders of very large electric size. The algorithm is scaled for generality, and appears to be simple and robust. It produces results having peak error well within the typical 5dB peak systematic error inherent in any experimental RCS test range facility, even for very large test cases. It consistently produces results with an RMS error of approximately 1 dB for all test cases. It is likely that application of a Fourier or wavelet transform to smooth the predicted RCS data would further increase the accuracy.

The electromagnetic scattering from an infinite conducting cylinder of radius equal to sixty wavelengths was obtained on an Intel office PC using SAGE, and on an SGI Mainframe using the single level Fast Multipole Method. Although the FMM data shows remarkable accuracy, the results were obtained at enormous computational expense using logarithmic acceleration. The SAGE algorithm obtained the same scattering to within less than 5dB peak error and less than 1dB RMS error on an office PC in 11% of the computation time required using the FMM on an SGI mainframe computer. It is, perhaps, most important to point out that although this presentation details one particular application of this technique to two dimensional problems, because two dimensional and three dimensional problems have the same mathematical form, successful reduction of the two dimensional problem from order N^2 to order 2N per iteration implies reduction of three dimensional problems to order 2N as well.