Abbe-SVD: Compact Abbe's Kernel Generation for Microlithography Aerial Image Simulation Using Singular-Value Decomposition Method

Jerry Chiang and Charlie Chung-ping Chen
EE Department
National Taiwan University

Lawrence S. Melvin III
Synopsys Inc.

Abstract:

The Hopkin's method and Abbe's method are the most popular microlithography aerial image simulation methods. The Hopkin's method is generally more popular for the high speed aerial image simulation domain used in model based Optical Proximity Correction (OPC). This is due to a general perception that the Hopkin's method can generate a more compact set of kernels than the Abbe method due to the application of a SVD (Singular Value Decomposition) process to the large Hopkin's Transmission Cross Coefficient(TCC) matrix. However, the Abbe method easily decomposes the source field into independent point sources using 2D partitions, but this makes the Abbe method kernels larger on average than the Hopkin's kernels.

In this paper, it will be demonstrated that it is possible to generate compact and accurate Abbe kernels efficiently. By applying SVD to the original Abbe kernels that simulate the aerial image, we can extract the essential kernels according to their singular values. Note the matrix size of full Abbe kernels is generally much smaller than the Hopkin's TCC matrix size. This occurs because the Abbe method only discretizes the sources into a relatively small numbers of square point sources while the Hopkin's TCC matrix is constructed from a scan of the full ambit region x and y-dimensions. Furthermore, by taking advantage of the symmetry and conjugate properties of the point light sources, the Abbe kernels can be further reduced by at least 4X.

Using this novel algorithm, the SVD Abbe's method, simulations can take advantage of the fast kernel generations of Abbe's method and the compact size of kernels from the property of SVD. The experimental results show over 100X of both runtime and memory saving over traditional Hopkin's methods for kernel generation.