Iterative Extrapolation for Image Reconstruction by Phase Retrieval from Truncated Far Field Intensity Measurements

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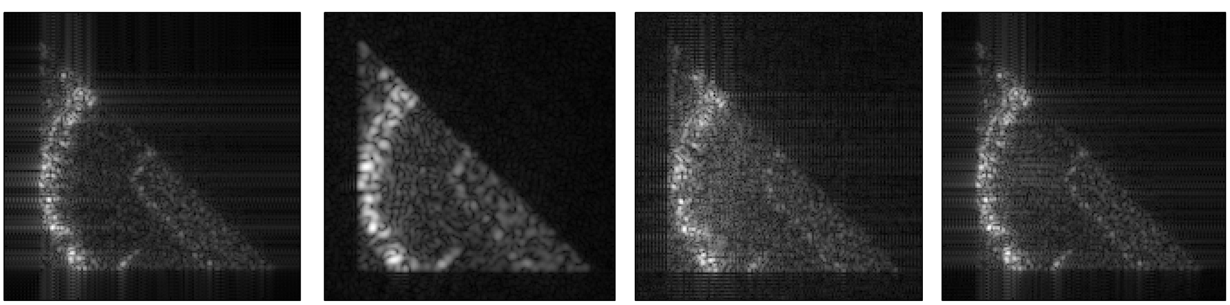
Phase retrieval algorithms have been shown to be able to reconstruct an image from a measurement of the far field radiation intensity pattern, if the object is illuminated with coherent source, by using *a priori* knowledge of the object support [1-3], *i.e.*, a set of points outside of which the object is known to be zero. When a diffuse, reflective object is coherently illuminated, it naturally back-scatters energy that falls out of the intensity detector array and any image formed from this truncated measurement will present side lobes that extend beyond the object support even if the object is spatially finite. In this situation image reconstruction algorithms are presented with an ill-posed problem since a spatially finite function is not consistent with a truncated, or finite, far field intensity pattern. As the hard-edged object constraint is continually reinforced, iterative algorithms tend to wraparound the phases at the computational window edge and are found to stagnate on a solution that has significant artifacts, as shown in Fig. 1(c).

Satisfactory reconstructions have been previously obtained by applying low-pass windows on the measured data. This reduces the image side lobes below the noise level and allows the algorithm to reach a faithful solution at the expense of resolution in the final image [Fig. 1(b)]. We propose a modified iterative transform algorithm that allows an analytic continuation of the far field measurement by applying weighted projections in Fourier space, thus allowing the far field data to be consistent with a finite support and achieving fully resolved reconstructions [Fig. 1(d)]. This approach is robust in the presence of noise and allows for a loose support constraint.



(a) (b) (c) (d)

Figure 1. (a) Speckled image. Image reconstructions (b) with and (c) without side lobe reduction filter. (d) Reconstruction with iterative extrapolation.

Iterative extrapolation methods for image super-resolution have been proposed previously [4]; in contrast our approach is not to achieve super-resolution but to use the slightly extrapolated data to improve image reconstruction algorithm convergence.

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