X-Ray diffraction microscopy: reconstruction with partial magnitude and spatial *a priori* information

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X-ray diffraction microscopy is rapidly gaining attention as a potential high resolution microscopy tool. This paper explores the use of x-ray diffraction microscopy for the detection of functional deviations from specification in fabricated devices. It is assumed that full *a priori* design specification information is known and that a small number of diffraction measurements are available. An iterative reconstruction algorithm is presented where the *a priori* information is exploited to partially recover the missing phase information and to estimate missing data. Simulation results are shown which indicate that detection of the presence of deviations can be achieved with as few as a single diffraction measurement in each dimension. Additional measurements localize the position of the deviations.

X-ray diffraction measurements lack explicit phase information. However, with knowledge of the original specification and assuming that the Fourier magnitude has been oversampled, the magnitude of the phase can be recovered. This is achieved by constructing upper and lower bounds for the magnitude of the difference between the measured sample and the original specification. A minimum energy frequency limited solution for the difference magnitude is then constructed. This solution determines the relative signed magnitude of the measurements, i.e. a single bit of phase information. For coefficients where measurements have not been taken the specification is used to provide the signed magnitude information. In both cases the sign is relative to the corresponding phase in the specification.

The spatial structure is recovered by applying the signed magnitude reconstruction algorithm [1]. The algorithm iterates between the Fourier and spatial domains. In the Fourier domain the magnitude and sign of the phase are enforced while in the spatial domain a

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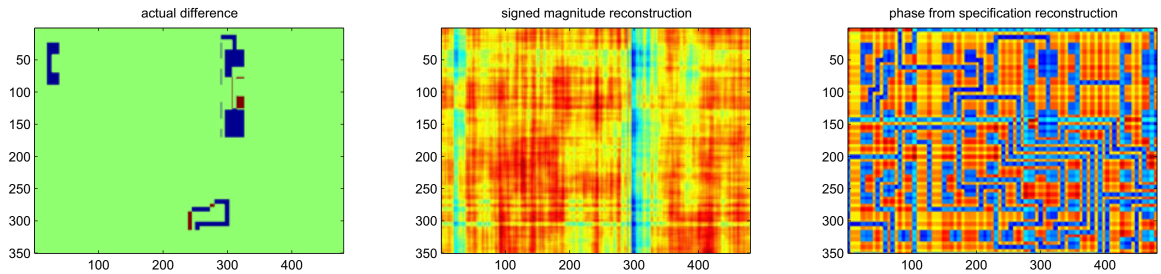
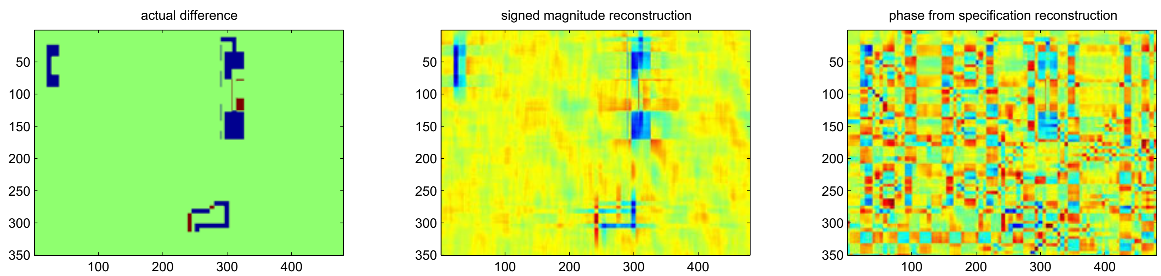


(a)Reconstruction with one measurement along each dimension.



(b)Reconstruction with eight measurements along each dimension.

FIG. 1: Comparision between the signed magnitude reconstruction algorithm and reconstruction by using the phase from the specification. The difference between the modified structure and the specification is shown.

finite support is enforced. The algorithm converges in 20 - 30 iterations. Typical results are shown in figure 1(a) for a single measurement in each dimension and 1(b) where eight measurements are taken in each dimension. The results compare well to the naive approach of taking all phase from the specification.

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[1] Patrick L. Van Hove and Monson H. Hayes and Jae S. Lim and Alan V. Oppenheim, *Signal Reconstruction from Signed Fourier Transform Magnitude*, 1983.