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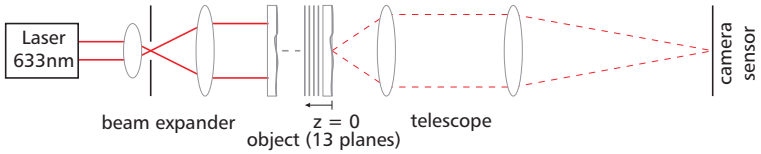
Introduction

Phase Retrieval (PR) techniques represent an alternative to holography for estimating the complex amplitude of an optical wavefield. Typically, these techniques rely on iterative algorithms [1-4]. Factors that effect the performance include
- propagation algorithm,
- initial guess at phase,
- prefiltering intensity images and
- filtering during propagation.

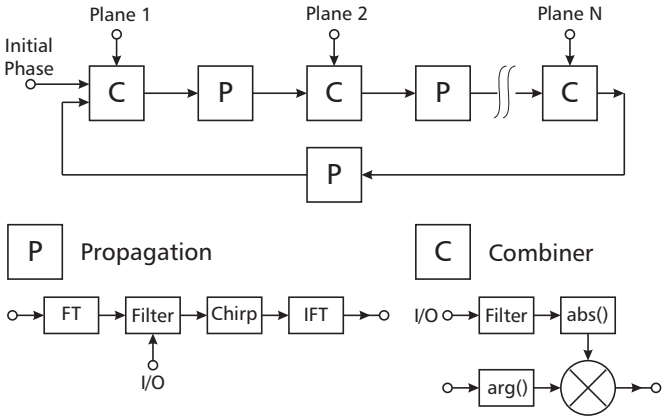
Here a preliminary investigation into the performance of a multi-plane PR scheme for real experimental results is performed. Best results were obtained by filtering in the spatial frequency domain as the SM was implemented.

Optical Setup



This experimental setup was used to capture 13 different intensity images of a volume containing scattering particles. Between captures the volume was displaced longitudinally in steps of 50 μm. Images 1, 3, 5 etc. are used in the PR algorithm, while Images 2, 4, 6 … are used to compare against the predictions of the phase retrieval algorithm.

Flow Chart of Algorithm



Results

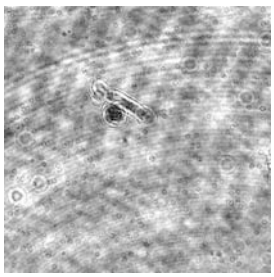


Fig. 2: Actual experimental result for z = 50 microns (Image 2)

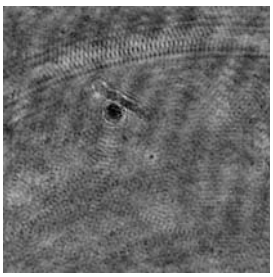


Fig. 3: Estimated intensity distribution at the same plane using PR technique on Images 1,3,5 …

Results

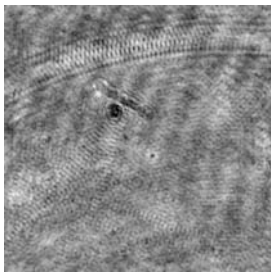


Fig. 4: Same as Fig. 3 except the input intensities have been filtered before using PR algorithm.

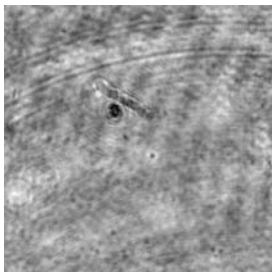
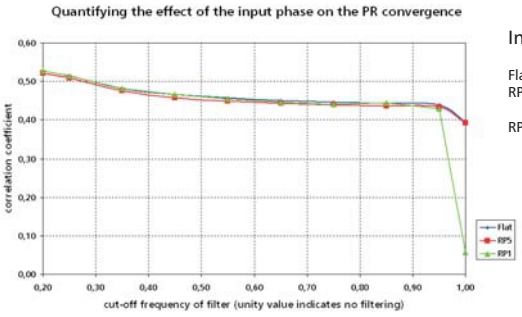


Fig. 5: Same as Fig. 3 except filtering is performed during propagation. Filtering removes detail from the image.

Summary



Initial phase:

Flat - uniform phase
RP5 - autocorrelation width ~5.1 pixels
RP1 - delta autocorrelated random phase (one pixel wide)

Preliminary experimental results indicate:
keep high resolution intensity images,
filter during propagation
provides robustness to initial phase choice.

[1] J. R. Fienup: Phase retrieval algorithms: a comparison. Appl. Optics, 2758-2769, 1982;
[2] G. Pedrini, W. Osten, Y. Zhang: Wavefront reconstruction from a sequence of interferograms recorded at different planes. Opt. Lett. 30, 833-835, 2005;
[3] P. F. Almoro, S. G. Hanson: Random phase plate for wavefront sensing via phase retrieval and volume speckle field. Appl. Optics, 2979-2987, 2008;
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