THROUGH FOCUS PHASE RETRIEVAL BY INCIDENT WAVE FRONT SHAPING
JOVERIA BAIG, O.E.L.GAWHARY, H.P.URBACH

ABSTRACT

Through-focus phase retrieval methods are used to obtain phase of an optical field by measuring intensity distributions at several planes in the focal region. Alternatively, intensities measured on a single focal plane correspond to varying incidence wave-fronts can also be used to extract this phase information.

In this project, I intend to achieve a theoretical basis for phase retrieval using a single plane by shaping the incident wave-fronts to retrieve phase of an aberrated optical system.

BACKGROUND

Previous work reported for phase retrieval makes use of intensity measurements on several planes to retrieve the transmission function by the use of different algorithms.

The proposed method involves the use of two incident fields with minimum correlation between their intensities in the focal region in order to extract maximum information from the measured intensity for accurate phase retrieval.

The algorithm implemented is shown in the flowchart. Tikhonov regularization is performed in each iteration to control the noise accumulation during reconstruction.

METHODOLOGY

The algorithm was first implemented using two Bessel beams of order 0 and 1 with a vortex which shows minimum spatial correlation in the incidence plane. Actual transmission function to be retrieved was simulated using two greyscale images as shown in figure 7 and placed inside the pupil aperture. However, the correlation was observed to be very high in the intensities measured in the focal plane which is undesirable for phase retrieval and could not yield accurate results. Rodemburg algorithm was also implemented for the two images in the pupil aperture as shown below:

SIMULATIONS RESULTS

The choice of these planes is important in order to retrieve the phase of the transmission function correctly.

In his recent paper, El Gawhary et al. analyzed phase reconstruction from Fourier conjugated planes and proposed which planes are spatially uncorrelated.

SIGNIFICANCE

Existing methods for phase retrieval use translation stages to achieve this phase information for phase retrieval. Phase retrieval by the use of two Bessel beams with minimum correlation in incidence planes was used, however the intensities in focus still shows a high degree of correlation. Hence, a lateral shifting condition needs to be defined for the incident field such that they give minimal correlation in measured intensities. This method of phase retrieval will eliminate need for a translation stage leading to a more robust setup.

CONCLUSION

ALTERNATIVE APPROACH

Another approach was tried for phase retrieval by incident pixel by pixel wavefront shaping. The phase of incidence beam was varied pixel by pixel and the incidence wavefront for which the intensity squared for the aberrated case becomes very close to the airy non-aberrated pattern was recorded. This beam can then be used to retrieve the phase of the transmitted function. This was implemented for the step wise sequential algorithm case where the values of each pixel were updated after one whole iteration. This could also be performed for the continuous sequential and partitioning algorithm.

However, since simulating this involved parsing pixel by pixel and calculating Fourier transform for each configuration, this algorithm was quite slow.