Phase microscopy of technical and biological samples through random phase modulation with a difuser

A technique for phase microscopy using a phase diffuser and a reconstruction algorithm is proposed. A magnified specimen wavefront is projected on the diffuser plane that modulates the wavefront into a speckle field. The speckle patterns at axially displaced planes are sampled and used in an iterative phase retrieval algorithm based on a wave-propagation equation. The technique offers a whole-field and high-resolution wavefront reconstruction of unstained microstructures. Phase maps of photoresist targets and human cheek cells are obtained to demonstrate the effectiveness of our method. (C) 2010 Optical Society of America

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Angular displacement and deformation analyses using speckle-based wavefront sensor

Wavefronts incident on a random phase plate are reconstructed via phase retrieval utilizing axially displaced speckle intensity measurements and the wave propagation equation. Retrieved phases and phase subtraction facilitate the investigations of wavefronts from test objects before and after undergoing a small rotation or deformation without sign ambiguity. Angular displacement (Delta theta) between incident planar wavefronts is determined from the light source vacuum wavelength (lambda) divided by the fringe spacing (Lambda). Fourier analysis of the wavefront phase difference yields a peak frequency that is inversely proportional to Lambda, and the sign gives the direction of rotation. Numerical simulations confirm the experimental results. In the experiments, the smallest Delta theta measured is 0.031 degrees. The technique also permits deformation analysis of a reflecting test object under thermal loading. The technique offers simple, high resolution, noncontact, and whole field evaluation of three-dimensional objects before and after undergoing rotation or deformation. (C) 2009 Optical Society of America

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Computerized laser wavefront alignment with aberration correction using a speckle-based phase retrieval method

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Contributors: Almoro, P., Hanson, S. G.
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Fast-convergent algorithm for speckle-based phase retrieval and a design for dynamic wavefront sensing

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Numerical correction of aberrations via phase retrieval with speckle illumination
What we believe to be a novel technique for wavefront aberration measurement using speckle patterns is presented. The aberration correction is done numerically. A tilted lens is illuminated with a partially developed speckle field, and the transmitted light intensity is sampled at axially displaced planes. The speckle intensity patterns are then sent to a phase-retrieval algorithm to reconstruct the complete wavefront. The nature of the wavefront aberration is determined through Zernike polynomials. Numerical correction of the perturbed wavefront is performed based on rms error and the Strehl ratio. Restoration of the wavefront from a phase object with high spatial frequency content shows the effectiveness of our method. (C) 2009 Optical Society of America

Object wave reconstruction by speckle illumination and phase retrieval
An innovative setup for the speckle-based phase retrieval method is proposed. In the conventional setup, a plane wave illuminates the test object and the transmitted wavefront is incident on a diffuser aperture generating a speckle field. The sampled speckle intensities at axially displaced planes are input into a phase retrieval algorithm based on a wave propagation equation. In the new setup, the arrangement of the diffuser and the object is reversed. A plane wave incident on the diffuser generates a speckle field which, in turn, is used to illuminate the object. The transmitted wavefront is then directed to the camera sensor. The advantage of the proposed setup is the increased resolution since the limiting aperture is the full area of the sensor.

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Shape and deformation measurements of 3D objects using volume speckle field and phase retrieval

Shape and deformation measurement of diffusely reflecting 3D objects are very important in many application areas, including quality control, nondestructive testing, and design. When rough objects are exposed to coherent beams, the scattered light produces speckle fields. A method to measure the shape and deformation of 3D objects from the sequential intensity measurements of volume speckle field and phase retrieval based on angular-spectrum propagation technique is described here. The shape of a convex spherical surface was measured directly from the calculated phase map, and micrometer-sized deformation induced on a metal sheet was obtained upon subtraction of the phase, corresponding to unloaded and loaded states. Results from computer simulations confirm the experiments. (C) 2009 Optical Society of America.

Complete deformation analysis of transparent samples using digital shearography and holography

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Interferometric evaluation of angular displacement using phase retrieval

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Measuring angular displacements using phase retrieval

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Phase error correction in wavefront curvature sensing via phase retrieval

Wavefront curvature sensing with phase error correction system is carried out using phase retrieval based on a partially-developed volume speckle field. Various wavefronts are reconstructed: planar, spherical, cylindrical, and a wavefront passing through the side of a bare optical fiber. Spurious fringe pattern in the reconstructions due to a small tilt in the plane illumination wave is detected and numerically corrected for. Difference in the curvatures of two spherical wavefronts is also evaluated. Possible applications include angular displacement and range measurements.
Phase retrieval based on the constraints taken from parallel capture of intensity patterns of a volume speckle field

Power loss due to beam splitter cascade in the simultaneous sampling of a volume speckle field for phase retrieval