Speckle interferometry: three-dimensional deformation field measurement with a single interferogram

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An electronic speckle interferometer, arranged for out-of-plane sensitivity and with an off-axis reference beam to produce spatial phase bias, is used for three-dimensional deformation field measurements. The complex amplitude of the object wave is calculated by application of a Fourier-transform method to a single interferogram. The change in phase after object deformation yields the out-of-plane component of the displacement field. The two in-plane components are obtained by cross correlation of subimages of the reconstructed object wave's intensity, a method that is also referred to as digital speckle photography. The Fourier-transform algorithm is extended and modified, leading to random measurement errors that are below widely accepted theoretical limits and also to an extended measuring range. These properties and the mutually combined information improve the accuracy of both methods compared with their usual single implementation. The performance is evaluated in experiments with pure out-of-plane, pure in-plane, and combined deformations and compared with theoretical values. An example of a practical application is given. © 2001 Optical Society of America
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1. Introduction

Electronic speckle pattern interferometry (ESPI) is

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sensor; other issues include the imperfect spatial frequency response of phase-shifting formulas when one

tion information can be gained by use of a more-complex stereoscopic setup.[11] Speckle photography,

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