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Vibration and dynamic deformation measurement by digital holographic interferometry

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Summary

An experimental measurement system of digital holographic interferometry is established. The sequence of holograms during the dynamic deformation of a specimen can be captured by the CCD camera continuously. These holograms are reconstructed by a 2D Fourier transform and subsequently the phase difference values between any instant and initial instant can be calculated. The original phase sequence is full of noise in both spatial and temporal domains. A windowed Fourier filtering can be employed to remove the noise and retrieve the clear phase distribution. A further windowed Fourier ridges processing makes it possible to evaluate the first-order derivative and second-order derivative of the phase. Moreover, a premagnify lens can be added to the light path to increase the transverse resolution of the specimen with a very small size.

In our work, the vibration of a micro cantilever beam is measured by the digital holographic microscopic system. The precise vibration parameters are extracted by the windowed Fourier analysis. The displacement, velocity and acceleration on each point of the micro cantilever beam at each time instant are obtained. Also, a chloroprene rubber latex membrane is excited by the random variation of air pressure and its stochastic vibration is measured by digital holographic interferometry. The vibration parameters of the membrane, such as displacement, velocity and acceleration, in both the spatial and temporal domains are given by the three-dimensional windowed Fourier processing. In another experiment, the crystallization process of sodium chloride solution is measured by transmission digital holographic microscope. The concentration variation on each point of the solution during the course of crystal growth can be obtained by retrieving the phase and filtered by the windowed Fourier filtering.