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Dynamic 3-D shape measurement using Fourier method

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Summary

Fourier transform method has been widely sued on fringe analysis in optical metrology, including the structured illumination metrology and the interference metrology. The Fourier transform profilometry is one of the popular non-contact 3-D shape measurement methods, where a Ronchi grating or sinusoidal grating is projected onto a 3-D diffuse surface, and the resulting deformed grating image is detected by a CCD camera and processed by a computer. This method requires only one frame of the deformed fringe pattern to retrieve the surface of measured object, so it has obvious advantage for real-time data acquisition and 3-D measurement of dynamic process. In this paper, we review some dynamic 3-D shape measurement methods mainly proposed in our Lab based on Fourier fringe analysis, discuss some important problems, including sampling and frequency spectra overlapping, phase calculation, phase unwrapping, and 3-D reconstruction of dynamic process. When the measured dynamic object is spatially isolated or breaking into several isolated parts (e. g. an impact process), it will bring some difficulties for phase unwrapping. We embedded a special mark into the projected sinusoidal gratings to identify the fringe order, and at the same time the mark will not affect the Fourier spectra of the deformed fringe. In this paper we discuss some applications in the different fields. The applications include 3-D shape and deformation measurement of rotating object, the measurement for the vibrated shape, dynamic measurement of vortex shape, the 3-D shape measurement for breaking object surface and so on. With the development of computer hardware and software and availability of high frame rate CCD camera, the dynamic 3-D shape measurement using Fourier method will be a promising one for acquiring 3-D data of dynamic object.