

ONE-SHOT THREE-DIMENSIONAL SURFACE PROFILOMETRY USING DMD-BASED TWO-FREQUENCY MOIRÉ AND FOURIER TRANSFORM TECHNIQUE

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Abstract- This article presents an optical measurement method for acquiring rapidly accurate geometric 3-D surface morphology of objects. To achieve high-speed profilometry and avoid disturbance due to in-field vibration, one-shot Fourier transform profilometry (FTP) using two wavelength digital moiré pattern was developed to detect the morphology of the measured object at a speed of up to 60 frames or more per second. Single-fringe interferogram sufficient for FTP can be rapidly captured within a theoretical CCD acquisition time of down to 1 μ s. The interferogram thus captured can be applied for further phase retrieving using the developed frequency transform and band-pass filtering strategies. The band-pass filter is designed to obtain phase information for optimizing the 3-D surface reconstruction with both dimensional and structural measurement accuracy. Furthermore, a standard step-height target was measured to analyze accuracy and repeatability of the developed methodology. Experimental results verified that the measurable step height can be effectively increased using the equivalent wavelength established by analyzing two-frequency moiré pattern, thus increasing practical applicability of the developed system while achieving a micro-scale measuring depth resolution. The maximum measured error can be kept within 3.5% of the overall measuring range.

Index terms: Optical metrology, Automatic optical inspection (AOI), Fourier transform, Surface profilometry, Fourier transform profilometry (FTP), Dynamic measurement.