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The spatial laser interferometry with combination of fast Fourier transformation technique applied to measuring micro object 3D profile

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Summary

The spatial laser interferometry with combination of fast Fourier transformation (FFT) technique has been applied to analyze and reshape 3D profile of micro objects in this paper. In this technique, two beam of coherent spatial laser would superpose and interfere with each other to produce fringes with constant pitches. Deformed fringe lines would be generated on a tested object surface for its 3D height existence when a micro-movable platform with the tested object on it is placed in the spatial interferential fringe field. On the analysis of the fringe pattern collected by CCD which carries not only the 3D height information of the tested objects but also carrier wave (reference) fringe information, the phase difference between the deformed fringes and the reference fringes (fringes in places without tested object) would be obtained by FFT and inverse FFT. Thus the object's height values related to the phase information could be calculated and its 3D profile could be reproduced.

A validation test on 3D profile measurement of a glass microsphere demonstrated the feasible of the technique in this investigation. Compared with the phase shifting technique, the newly developed technique owns three outstanding advantages: (1) It would simplify the complex optical path as well as the adjustment process compared with other similar projection fringe method such as automated phase-measuring profilometry and fringe projection method. The technique in this investigation would not claim for a quarter-wave plate. And also, the flatness of the rotatable polarizer employed in this technique is more gently required. (2) In this technique, Only one image which contains deformed fringes as well as reference fringes is needed. Through image processing by FFT without phase shifting, the phase information would be obtained and it would reduce the error brought in by phase shifter or rotatable polarizer and quarter-wave plate. (3) The frequency of the reference fringe generated by the spatial laser interferometry could be easily adjusted according to the measurement necessary of tested objects. That means, this technique provide a widely application ranges from submicron scale to macroscale.

The experimental obtained results demonstrate that sensitivity of the technique would be superior to 100nm and it could be perfectly applied to analyze and reshape 3D profile of micro objects. And also, it owns the potential to indicate the roughness information of object surface.