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Wavefront sensor based on modified Talbot effect
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Introduction

Wavefront measurements are important in many fields of applied optics such as wavefront control of laser beams, optical diagnostics of the surface, human-eye aberration measurements, etc. The sensor, based on the Talbot effect, can be a good alternative to the Shack–Hartmann sensor: A modified method of shearing grating interferometry is presented. This novel method allows measuring of freeform wavefronts with high accuracy. The experimental results are obtained using a binary amplitude grating and a spatial filter for the zero order. The filtering of the zero diffraction order results in an improved contrast and measurement performance. By means of robust and fast software, we are able to precisely reconstruct the wavefront. A comparison of this method with Shack Hartmann Sensor (SHS) is presented.

1. Standard wavefront measurement method

Shack Hartmann principle

2. Talbot wavefront sensor

According to Takeda, the sub-spectra of the Talbot plane interfere and make the filtering of the right sub-spectra difficult. Since the reconstruction of the wavefront based on the gradient integration always includes errors, we will compare in this calculation only the signal gradient maps and their reconstruction. The integration error is then eliminated.

3. Modified Talbot sensor

The idea is to image the Talbot-Plane into the Camera Plane with a 4 f System. The +1 and -1 orders in x and y direction in the Fourier plane of the first lens are filtered. With such filtering, we are able to select the intensity of the sub-spectrum on the camera plane without losing any information.

4. Experiment

Freeform optic wavefront

Grating

Period = 50µm

Filter

CMOS Eye Camera

Pixel size: 5,3µm

4 f System. The +1 and -1 orders in x and y direction in the Fourier plane of the first Lens are filtered. With such filtering, we are able to select the intensity of the sub-spectrum on the camera plane without losing any information.

Conclusion

We have presented a method of wavefront measurement by modified digital Talbot interferometry. The experimental results were found to be in good agreement with the result obtained by ray trace calculation in Zemax. The technique enables a fast measurement of the wavefront with improved accuracy and sensitivity compared to conventional Talbot interferometry. A comparison of this method with Shack Hartmann sensor is presented.

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References


Literature


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