Topic 5: Measurement of Imaging Properties

Aim

This lecture looks at the practical aspects of measuring PSF, OTF and Wavefront Aberrations in optical systems.

References

- Guenther, Appendix 5-A, & 5-B, Part of chapter 4.

- Steel, *Interferometry*. (Details of interferometers)

- Malacara, *Optical Shop Testing*, Wiley 1978, (Reference text).

5 Optical Measurements

A short set of "practical" problems associated with the measurement of the properties of real optical systems. The computer simulation program is of particular interest and should be played with, again there is no actual programming required, you just run the program.

5.1 Line Scan Measurement

You wish to measure the OTF of a 80 mm, $F_{No} = 2.8$ camera lens by scanning the image of a slit with a 50:1 object to image distance. Sketch a suitable optical system and calculate suitable slit widths to use in the object and image plane.

5.2 Twyman-Green Interferometer

A high quality 300 mm focal length lens of diameter 50 mm is placed in a Twyman-Green interferometer with a spherical mirror and the system adjusted to give a single fringe. The spherical mirror is translated 0.05 mm along the optical axis. Calculate the wavefront aberration induced by this translation and sketch the expected fringe pattern.

5.3 Test Scheme

You a asked to devise a testing scheme for quailty control in manufacture of a low cost camera lens. The camera lenses have a focal length of 35mm and a $F_{No} = 3.5$. These leses are specified to have a OTF of better than 0.1 at 80 line/mm in the centre and 45 line/mm at the edge when used with a 35 mm film. The scheme should be able to test a lens in less than 1 minutes, and not use wet photographic process.

Hint: There is a large range of possible "correct answers"!.

5.4   Fringe Program

Try the program `fringe` avaliable on the CP laboratory machines that calculate and display digitally simulated fringe patterns. The programme is located at:

$$wjh/mo/examples/fringe$$

Run program, and you will be prompted for aberrations, the fringe pattern is displayed by `xv` which allows you to save the fringe pattern.

Tasks to try with this programme:

1. Try various amounts of defocus and check that you get the fringe pattern you expect. You may have to use tilts to make the shape visible.

2. Examine the shape of the wave front at the Strehl limit for Spherical Aberration with cancelling defocus.

3. Look at the shape of other aberrations.