DIFFRACTION IMAGING BY OPTICAL SYSTEMS AFFLICTED WITH OFF-AXIS ABERRATIONS AND IMAGE MOTION

by

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ABSTRACT

The influence of primary coma, astigmatism and image motion has been investigated on the diffraction imagery of various objects like disk, annulus, bar, edge and truncated periodic. These considerations are important in OTF measurements, image simulation programs for lens design and image evaluation in aerial photography and microscopy.

The intensity distribution in the diffraction images of incoherent extended circular, annulus and truncated periodic sine and square wave targets has been calculated using optical transfer approach. The results are presented graphically along various azimuths to show the marked asymmetry and distortion in the images for different amounts of aberration. Results for encircled energy distribution were also obtained.

The study dealing with the effect of coma is then extended to obtain the intensity distribution, encircled energy and angular resolution in the far field diffraction patterns under the partially coherent light due to atmospheric turbulence. The diffraction images of partially coherent truncated bar patterns were also evaluated. in presence of coma. That it is impossible to reduce the aberrations of an optical system precisely to zero is well known, therefore, the influence of optimum balanced coma is studied on the diffraction

images of disk, annulus, edge and bar objects. Strehl intensity criterion is used to obtain the optimum balance among various coma terms. The validity of the Strehl criterion was examined on the imaging of these types of extended objects.

The effect of primary astigmatism has been investigated on the intensity distributions, encircled energy and Strehl ratio in the far-field diffraction patterns under partial coherent illumination. Further the effect of a quadratic phase factor in the mutual coherence function has also been taken into account to evaluate intensity distributions. Intensity distribution in diffraction images of incoherent annulus object has also been studied for different object sizes and contrast between the object and their surround in the presence of astigmatism.

Next, investigations have been made on the diffraction images of single bar, truncated periodic and annulus objects in the presence of parabolic image motion occuring in transverse scanning panoramic and tilted frame cameras. The deleterious effects of motion in various cases have been described in detail.

In the end we have reviewed briefly some of the recent work related to Schell's theorem.

The work reported in the present thesis has resulted in the following publications:-

1. Diffraction images of extended circular targets in presence of coma, Can.J.Phys., 55, 1025 (1977).

2. Diffraction theory of image formation in the presence of linear coma; Annulus object, Optica Applicata, 7, 47 (1977).

3. Diffraction images of truncated incoherent periodic objects in presence of primary coma (submitted for publication).

4. The joint influence of atmospheric turbulence and primary coma on the far-field diffraction of a circular aperture (Submitted for publication).

5. Influence of primary coma on partially coherent imagery; truncated periodic bar patterns (submitted for publication).

6. Influence of optimum balanced coma on disk spread functions, Can. J.Phys. 56, 12 (1978).

7. Diffraction theory of image formation in the presence of optimum balanced coma; Annulus object, Jemna Mechanika A Optika, 2, 41 (1978).

8. Influence of optimum balanced coma on diffraction images of bar and edge objects, Microscopica Acta, 80, 313 (1978).

9. Partially coherent far-field diffraction in the presence of primary astigmatism, Can.J.Phys., 56 (1978) in Press.

10. Effect of a quadratic phase factor on the partially coherent far-field diffraction in the presence of primary astigmatism (Submitted for publication).

11. Diffraction images of incoherent annulus object in presence of primary astigmatism. Microscopica Acta, 80, 359 (1978).

12. Motion degraded bar images in panoramic cameras, Ind. J.Pure Appl.Phys., 13, 767 (1975).

13. Bar spread functions for parabolic image motion, Photogramm. Engn. Remote Sensing, 43, 529 (1976).

14. Diffraction images of truncated periodic targets in the presence of parabolic image motion, Current Science, 45, 41 (1976).

15. Diffraction images of incoherent annulus object in the presence of parabolic image motion, Atti.Fond G. Ronchi, 31, 609 (1976).

16. Intensity point spread function of slit in presence of linear image motion, J.Optics (India) 4, 68 (1975).

CONTENTS

Section-II