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Abdallah Mohamed Hamed

Modulated Apertures and Resolution in Microscopy

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Preface

Since the invention of the laser in 1960, there has been a renaissance in optics and optical electronics. With optics and optical electronics, new applications have been found in all branches of science and engineering. The famous book *Introduction to Fourier Optics and Holography* by Goodman JW (1968) and *Confocal Microscopic Imaging* by Sheppard CJR (1978), followed by my recent publications about aperture modulation, led to the presentation of the book *Modulated Apertures and Resolution in Microscopy*. The book's content extracted from my recent publications adds information on resolution improvement in microscopy due to the modification in the aperture distribution. We intended this book for senior undergraduate and graduate students in optical sciences.

The object of drafting a book on modulated apertures with different distributions is outlined below. When we replaced the circular aperture of uniform transmittance with the modulated gaps, the point spread function (PSF) changed, and the cutoff spatial frequency decreased, leading to a resolution improvement in the conventional optical microscope. In addition, the PSF related to resolution in an optical microscope further improves the resolution in a confocal laser scanning microscope. We study the modified distribution inside the circular aperture using different shapes. These are linear, quadratic, graded index, and black-and-white gaps. That described cracks we used in the computation of the point spread function from the Fourier transform operation. The cutoff spatial frequency obtained from the PSF corresponding to each aperture provides information about the resolution, remembering that the resolution limit cutoff is dependent on the numerical aperture NA and the wavelength of the illumination according to the Rayleigh criterion formula.

The book is composed of two parts. Part I is around the fabrication of modulated apertures and computation of the impulse response or the PSF. We presented an introductory chapter (1) on axial and lateral resolution in microscopy. In the following chapters (2–6), the resolution was computed for the modulated apertures and compared with uniform circular and annular gaps.

Part II is concerned with applying the modulated Cauchy aperture in the confocal imaging chapter (7) and speckle imaging chapter (8).

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